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Preface

Saint Petersburg Electrotechnical University “LETI” (ETU “LETI”) is pleased to present the Proceedings of 2019 XVIII Russian Scientific and Practical Conference on Planning and Teaching Engineering Staff for the Industrial and Economic Complex of the Region (PTES).

This scientific and practical event annually unites professionals from universities, industrial enterprises and state governing bodies. Its participants discuss the topic of the utmost importance – teaching specialists of high qualification for the priority sectors of the national economy.

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Strategic Partnership of Universities and Industrial Enterprises within the Framework of Smart City Construction

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***Abstract*— Nowadays the issue of strategic management and planning of new urban areas and spaces is acute. This article analyses the cooperation of higher education and urban development companies in the framework of construction of the smart city. An example of closed coexisting system "the developer-city-university" is given below.**

Keywords— engineering education; competencies; educational process; breakthrough technologies, smart city, smart environment, Internet of things, urban space

I. INTRODUCTION

At the moment there is a massive inevitable urbanization of both countries and particular regions. This process is a natural evolutionary path for the development of human society. However with increasing of technology and the emergence of new construction standards, new requirements for the creation of the city as an integrated system, which is capable to satisfy the needs of residents, are appearing. A technically well-designed city project has many advantages compared to a standard city project: from simplifying economic management to the possibility of unimpeded scaling of the city space and the city's ability to change quickly and adapt to the residents needs at the moment.

II. CHALLENGE OF URBAN PLANNING COMPANIES STAFFING

The construction of a smart city involves the implementation of a number of infrastructural transformations connected with the concept of sustainable development. Town-planning companies are tasked with designing cities with a high level of economic competitiveness and a low level of negative impact on residents and the environment. Thus it is necessary for a smart city to meet the following requirements: increasing the general welfare of residents and ensuring economic growth, reducing the environmental load on the occupied area, optimizing management systems, and developing modern approaches to ensuring security. Summing these factors up we can conclude that the maintenance of such staff of diverse specialists within one company is economically costly [1].

One of the options for building a smart city is the construction of this facility from the ground up, with this approach it is possible to avoid many of the problems faced by cities and urban areas that need to be modernized. One such problem is the level of administrative barriers. In the already legally and economically settled urban area the developer has a number of strictly regulated methods for coordinating the project, and the speed of coordination of design and construction activities is one of the important factors. There is an isolation of opinions with creating the infrastructure of the smart district while modernizing the existing municipalities. This factor is due to the fact that representatives of all socio-economic niches, such as representatives of the administration, business, trade unions, ordinary citizens, are present on the already formed soil in the region. Their relationship should be extremely open and clear, and conflicts of interest should be minimized. During the construction of the district from the ground up it is possible to almost completely minimize conflict situations and speed up decision-making as quickly as possible since the developer bears the bulk of the responsibility.

Another limiting factor in the construction of the "smart district" based on the current municipality may be the underdevelopment or obsolescence of the housing and utility services and the transport system. It is very important to understand that for a modern city that meets all the needs of residents, both transport accessibility and timely solution of housing and utility problems are important. In areas of the city, even within the same district, houses belonging to different management, companies can be located, which creates an additional link in the chain of interaction between social groups within the city and an additional factor of conflicts of interest.

Combining all the factors that should be taken into account when constructing both new and modernizing existing municipalities to the state of a smart city, it can be noted that now the main problem is the lack of labor resources of the relevant qualifications for an individual town-planning company.

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The implementation of the smart city concept involves the use of highly motivated and qualified employees and specialists in relevant fields, ongoing training, inviting the best international and local experts in the field of urban planning, the IT sector, and economic development. They would be ready to solve the problems of transforming the urban environment and respond promptly to changing requests population and environmental changes in the area. High requirements to personnel are also caused by creation of automatic control systems smart area of infrastructure and need of their service [2].

III. Cooperation of High Schools and Urban Development Companies in Order to Ensure High Educational Level

One of the solutions to the problem of personnel shortage described above is direct and indirect cooperation between urban planning companies and universities. The relationship of these two structures must be built in such a way that the development of the city's infrastructure and educational space is an economically and socially beneficial interaction between the developer and the university.

In Fig. 1, you can consider an example of interaction between the developer, the city and the university.

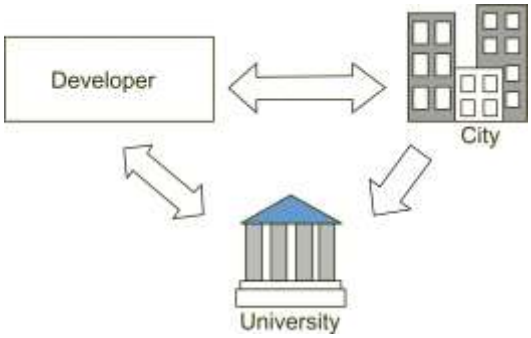

Fig. 1. Scheme of interaction between the developer, the city and the university

The diagram in Fig. 1 illustrates the interaction of the developer, which forms the urban environment and responds to its changes with quality solutions to the tasks. In turn, the city forms the human resource necessary for the existence of higher education institutions. Universities generate highly qualified personnel, which are important for the normal functioning of the urban environment and urban development company, and also help in the development and improvement of smart city systems.

The interaction of the city and the university in a broader sense can be implemented step by step. For example, through the joint efforts of all three stakeholders: the builder, the city and the university, a joint project is being developed to promote schools aimed at early career guidance and the acquisition of certain skills and knowledge by students. Thus, not only the quality of education of a particular educational institution of a secondary school increases, but the overall quality of education in the region as well, the degree of motivation of applicants for admission to a specific higher educational institution increases.

This interaction option can be illustrated by the extended scheme (Fig. 2). The diagram depicted in Fig. 2 illustrates the importance of two-way interaction in the system of directed education between higher education institutions and schools. The creation of cooperation at this level provides the most favorable ground for cooperation: holding joint events, competitions, open days, attending individual lectures and practices, implementing evening school programs for students in school or on vacation. A similar situation is in the bilateral interaction of enterprises with schools and universities. Organization of excursions to enterprises, acquaintance with the profession – these and many other events are aimed primarily at motivating students and additional career guidance, which in the future is beneficial to all participants in the partnership. The industrial enterprise in this scheme is another motivator for schoolchildren and applicants when choosing a profession, for university it is source of additional funding and a science-stimulating factor, for the city it is an executor of creation of infrastructure support.

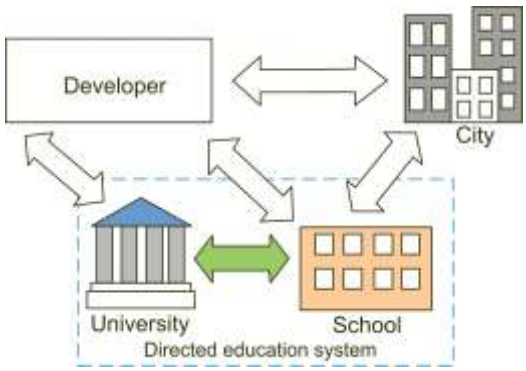

Fig. 2. Scheme of the implementation of the project directed education

IV. Necessary Security of the Draft Strategic Partnership

For the successful implementation of the Smart City project, it is necessary to ensure maximum interaction between the project participants, as well as fulfill the following strategic tasks.

For universities:

- Form and timely update curricula in accordance with the trends of scientific trends;
- Improve the overall quality of education by increasing the state-university-enterprise [2, 3] feedback contacts;
- Ensure maximum transparency during the training of specialists and provide access to employees of enterprises in order to test students' knowledge.

For enterprises:

- Competently carry out financing and cash infusion for the development of educational institutions;
- Participate in a training program for staff;

- Have an idea and formulate requirements for personnel in their preparation [4, 5].

For schools:

- Actively collaborate with universities in order to exchange experience in education;
- Provide additional support to students who are particularly successful in the learning process;
- Provide access to higher education teachers and enterprise workers for the purpose of career guidance and the development of personal qualities of students.

The main management link in this chain should be considered the Ministry of Science and High Education, which quickly responds to the convergence of enterprises and universities and provides more opportunities for the implementation of new educational standards (for example, FSES 3 ++).

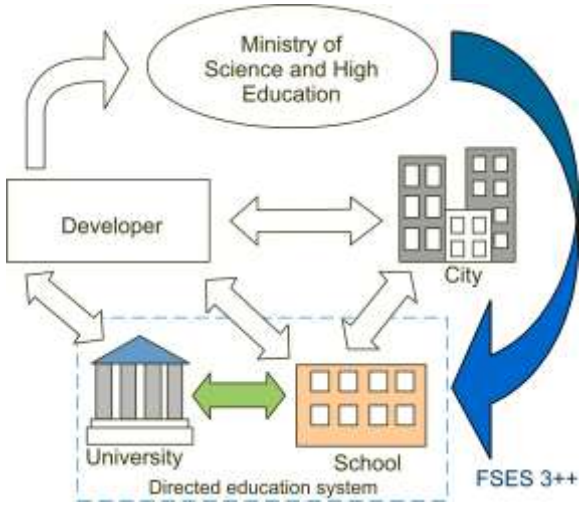

Fig. 3. Scheme of interaction of enterprises with higher educational institutions through federal education standards

Fig. 3 demonstrates the interaction of enterprises (consumers of highly qualified staff) with high schools through a directed education system regulated by the Ministry of Education. The interaction of enterprises and the ministry consists in the timely creation of requests for improving the quality of education and the number of graduates of highly qualified specialists. The Ministry, in turn, forms and implements new educational programs that are aimed at meeting the staff needs of enterprises through the development of directed education systems.

V. Example of Interaction

One example of successful initiatives is a school project with an educational laboratory based on an educational institution. The laboratory can be equipped and built by attracting funds of the construction company itself, and the direct supervision of the project and the preparation of equipment filling plans will be carried out by the university. Further training of school students in this laboratory and preparation of children for admission to universities is carried out by employees of the university curator and school staff. They can also undergo advanced training on the territory of the university curator.

With a longer interaction, such laboratories become clusters, concentrating within their walls not only students of the same school, but uniting many schools in the district and even the region. An example of the successful implementation of such a project is the Kudrovo Education Center. Extracurricular activities of the laboratory are aimed at developing students' independence in obtaining knowledge, attracting them to environmental activities, and developing environmental skills. Students involved in sections of scientific communities receive knowledge about the nature of the most important physical phenomena of the world; change their attitude to the subject component of many school courses through a change in worldview and the development of high scientific and cultural values. As a result, due to the large motivation, and, as a result, better preparation, students get advantages when entering higher educational institutions. The training program in this laboratory is designed for one academic year and is divided into four main blocks, during the development of which students personally are acquainted with scientific equipment and interact with it. Each training block is dedicated to a separate group of environmental problems that people in their life face constantly.

VI. Prospects for the Development of Cooperation

Further development of the strategic partnership, carried out by integrating the latest scientific developments of universities at urban enterprises, is possible through the organization of high-tech and environmental infrastructure.

- Organization of separate garbage collection. It is possible to elaborate a system of public facilities and places aimed at creating a convenient and beneficial system for waste sorting and disposal for residents.
- Introduction of alternative energy sources. In gathering places for residents of districts (playgrounds, parks, etc.), it is possible to install various electrical appliances (chargers for mobile devices, lights, heated benches, etc.) that are “powered” from alternative energy sources.
- Organization of monitoring and control systems for the environmental situation in the area.

With appropriate funding, it is possible to develop and implement more ambitious projects, such as:

- Creating an unmanned delivery of goods and mail within the area.
- Organization of video monitoring systems for the presence of parking spaces or video security systems with the ability to predict the deviant behavior of subjects.

VII. Conclusions

The creation of educational laboratories on basis of the school under the leadership of high schools leads to increased

training not only in the subject activities of the laboratory, but also in general subjects required for admission to the university – physics, mathematics, computer science, etc.

Due to additional training, school students can take part in additional career guidance events held by universities and enterprises, take part in the development of small educational projects and the implementation of the Step into Science program. Such cooperation will lead to the accrual of additional points for admission to higher educational institutions.

For universities, the creation of such laboratories will make it possible to accept the most motivated applicants and provide closer contact when working with enterprises.

For enterprises, the implementation of a strategic partnership is to solve social problems and create a positive image of the enterprise.

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Quantitative Assessment for Training of Senior Scientific Staff

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***Abstract*—The human society since ancient times has questions "Whom to teach?", "What to teach?", "How long to teach?". The answers to these questions are changing along with the structure of human society, the structure of the economy. Currently, the economy requires qualified staff with a good education, and progress requires new technological ideas, the generators of which are representatives of the scientific community. Staff training for the scientific community is a separate complex and spending task. An insufficient number of graduated scientific staff entails inhibition in innovative development, and an oversupply of such graduates is a waste of state money and causes problems for the career path of the graduates themselves.**

Key words—senior scientific staff training; scientific degree; training staff planning; forecasting; labor flow

I. INTRODUCTION

The task of predicting the optimal number of scientific staff becomes relevant. The international scientific community concerns about the significant growth in the number of PhD graduate students [1]. In 2017, the European Science Foundation conducted a study of career paths of people who graduated with a PhD degree [2], in which took part about 23% of those who graduated with a degree in the last 6 years preceding the study. The survey showed that only a little more than a half of respondents work in the academic sector. Less than half of polled people work in non-academic sector and hold a position corresponding to their academic degree or at least a master's degree. The result of the study indicates a certain redundancy of trained specialists with academic degrees.

In Russia, from 2011 to 2018, 121 thousand of doctoral research scholars defended their thesis. Their average age is 32 years. At the same time, the number of researchers under the age of 40 reaches 23 thousand [3], and university workers – 24 thousand [4]. It turns out that less than a quarter of PhD graduates work in science and education, where their academic degree is in demand first of all.

Thus, the process of forecasting the demand for senior scientific staff is necessary for planning the number of enrollment to graduate school and graduation from it with the defense of a thesis.

Forecasting the needs for candidates and doctors of sciences [5] is based on the calculation of the annual additional needs, for the assessment of which it is necessary to know the amount of natural retirement of staff.

Depending on the forecasting models used, two approaches are used to assess the natural staff retirement.

II. NATURAL-AGE RETIREMENT DURING THE LABOR FLOW

For dynamic models describing the labor flow, natural retirement includes two components: death during the performance of labor functions and retirement by age. To calculate the first component, one can use ageing factor obtained from official statistics on the annual age structure of the Russian population over the past 10 years (Table 1).

TABLE I. AGEING FACTOR

Age	Ageing factor
before 25	1
25-29	1
30-34	0,999963
35-39	0,997889
40-44	0,988042
45-49	0,964374
50-54	0,925329
55-59	0,869745
60-64	0,795848
65-69	0,709277
70-75	0,579284

Thus, among researchers up to 70 years old with a scientific degree of a candidate of science, up to 5 thousand people can leave up annually at working age, among researchers who have a scientific degree of a doctor of science – up to 2.7 thousand.

Candidates of science who have reached the age of 70 years and over reach a number of 10.8 thousand people, doctors of science – 9.4 thousand [3], of them at the age of 70 years – about 3.2 thousand candidates of science and 0.9 thousand doctors of science.

If we assume that reaching the age of 70 years is the reason for the retirement of the researcher worker, then annually the natural-age retirement of candidates of sciences will be about 8.5 thousand people, and doctors of sciences – about 3.6 thousand people.

We will carry out similar calculations for the higher education sector. The annual retirement, subjected to termination of employment at the age of 65, is equal to 11.8 thousand for candidates of science, 3.7 thousand for doctors of science.

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III. THE ROTATION COEFFICIENT

The second approach is associated with the calculation of the rotation coefficient, which shows the share of annually retired personnel of the senior scientific staff (candidates of science and doctors of science) in relation to their total number in the current year and is equal to the inverse ratio of the average duration of work of these staff. For its calculation it is necessary to know the age of the beginning of labor activity, which coincides with the age of the thesis defense, and the age of retirement. If we assume that the age of the retirement for a candidate of science is 65 years, and for a doctor of science - 70 years, then the rotation coefficients on average will be 0.031 and 0.043.

It is important to know that for different branches of science and different sectors of the economy, these values differ significantly. Table 2 shows the average age of defense of a candidate thesis in the context of groups of scientific specialties and places of work of doctoral research scholars.

TABLE II. THE AVERAGE AGE OF DEFENSE OF A CANDIDATE THESIS

Specialties	Universities	Academy of Sciences	Other Research Institutes, Industrial Enterprises	Other organizations
01.01.00 Mathematics	30	28	28	29
01.02.00 Mechanics	30	30	31	31
01.03.00 Astronomy	33	30	39	39
01.04.00 Physics	30	31	32	31
02.00.00 Chemistry	29	28	30	30
03.01.00 Physicochemical Biology	30	29	31	32
03.02.00 General biology	31	32	33	34
03.03.00 Physiology	31	30	33	33
05.01.00 Engineering geometry and computer graphics	31		34	31
05.02.00 Mechanical engineering	31	40	31	33
05.04.00 Power, metallurgy and chemical engineering	31	29	39	33
05.05.00 Transport, mining and construction engineering	31	29	30	34
05.07.00 Aircraft, rocket and space technology	30		33	35
05.08.00 Shipbuilding	34	31	31	33
05.09.00 Electrical Engineering	31	28	31	32
05.11.00 Instrument-making, metrology and information-measuring devices and systems	29	33	34	32
05.12.00 Radio engineering and communication	30	31	32	32
05.13.00 Computer Science, Computer Engineering and Control	30	30	30	31
05.14.00 Energetics	30	32	33	32
05.16.00 Metallurgy and materials science	30	32	32	35
05.17.00 Chemical Technology	29	32	34	32
05.18.00 Food Technology	31	29	34	34
05.19.00 Technology of materials and products of textile and light industry	31		29	35
05.20.00 Processes and machines for agroengineering systems	32	36	30	33
05.21.00 Technology, machinery and equipment for logging, forestry, wood processing and chemical processing of wood biomass	32	34	32	33
05.22.00 Transport	31	32	39	35
05.23.00 Sivil engineering and architecture	31	31	33	32
05.25.00 Documentary Information	35	36	34	38
05.26.00 Human Safety	32	30	36	35
05.27.00 Electronics	29	31	34	32
06.01.00 Agronomy	32	33	33	33
06.02.00 Veterinary and Zootechnics	31	32	33	35
06.03.00 Forestry	30	32	32	35
06.04.00 Fisheries	38	31	40	44
07.00.00 History and Archeology	34	33	39	33
08.00.00 Economy	32	31	33	32
09.00.00 Philosophy	35	34	43	35
10.01.00 Literature	33	37	36	32
10.02.00 Linguistics	33	34	33	31
12.00.00 Law	32	29	34	32
13.00.00 Pedagogy	38	40	44	39
14.01.00 Clinical medicine	33	32	33	35
14.02.00 Preventative medicine	35	30	37	40
14.03.00 Biomedical Sciences	33	32	34	37
14.04.00 Pharmacy	30	27	31	33
17.00.00 Art history	37	43	33	38
19.00.00 Psychology	34	32	36	35
22.00.00 Sociology	32	32	34	33
23.00.00 Political science	32	31	36	32
24.00.00 Cultural studies	36	39	34	36
25.00.00 Earth sciences	31	31	34	34

The youngest candidates of science are employees of research institutes engaged in research in the field of the group "01.01.00 Mathematics". Researches from the group "13.00.00 Pedagogy" have the greatest age of thesis defense. Researches from the groups "09.00.00 Philosophy", "06.04.00 Fisheries", and "17.00.00 Art History" also have high age values.

Fig. 1 and 2 show the values of rotation coefficients for candidates and doctors of sciences in the context of groups of scientific specialties and sectors of the economy: universities, institutes of the Academy of Sciences, other research institutes, design bureaus, and other organizations.

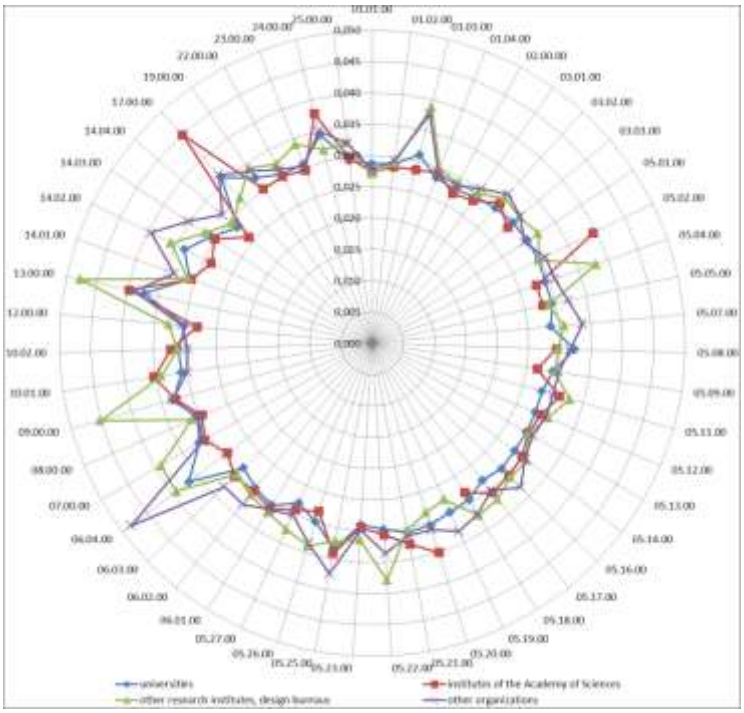

Fig. 1. Values of the rotation coefficient for candidates of science

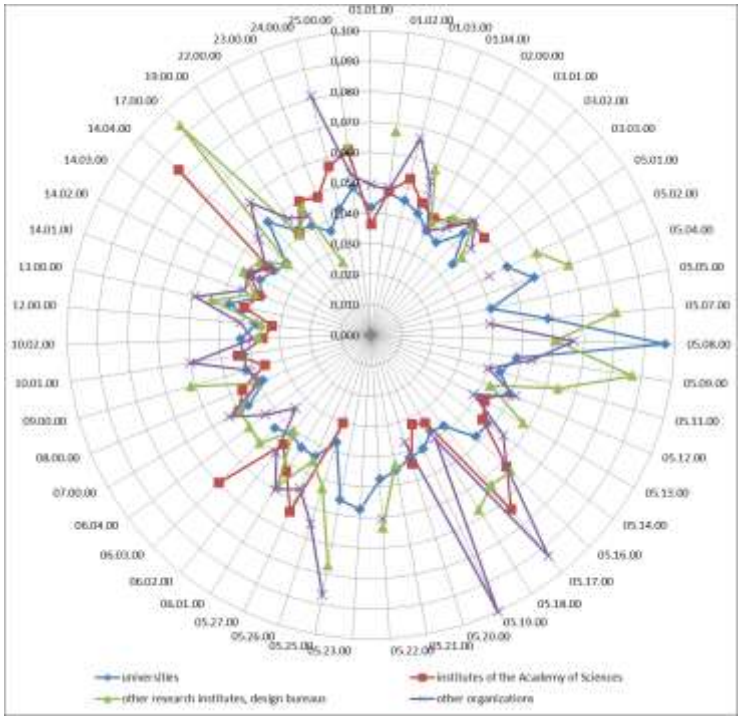

Fig. 2. The values of the rotation coefficient for doctors of science

With an equal age of graduation, the rotation coefficient is higher for those scientific specialties where the age of defense is higher. For doctors of sciences employed in universities, a high value of rotation coefficient is observed for scientific specialties from the group 05.08.00 Shipbuilding, for the Academy of Sciences – 05.17.00 Chemical Technology.

For applicants for a medical degree working in medical institutions, the defense of candidate thesis takes place at a more mature age (Table 3).

TABLE III. AVERAGE AGE OF DEFENSE OF A THESIS IN MEDICAL SPECIALTIES

Specialties	Medical institution	University	Academy of Sciences
14.01.00 Clinical medicine	35	32	32
14.02.00 Preventative medicine	41	35	30
14.03.00 Biomedical Sciences	37	33	32

As a result, the rotation coefficient for these senior scientific staff will be higher and will be equal to: 0.034, 0.042 and 0.036, respectively.

IV. CONCLUSION

To predict the needs of the economy for senior scientific staff, it is necessary to conduct quantitative assessments of the annual natural-age retirement of candidates and doctors of sciences, taking into account the specifics of scientific research and their place of work. The article presents quantitative calculations of these indicators for two types of models in the context of groups of scientific specialties and sectors of the economy.

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Electronic Information and Education Environment as a Training Tool for Resource-Efficient Management of Polymer Waste Processing

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***Abstract*—Industrial engineering of modern enterprises in order to modernize them, improve the quality of products and introduce new production management systems leads to the need to form highly qualified personnel support, which is especially important for processes of polymer waste processing in order to reduce environmental pollution and return valuable raw materials to production. For resource-saving control of polymer waste processing processes functional structure of electronic information and educational environment is proposed, which allows to form individual paths and to carry out practical-oriented training of specialists involved at each stage of life cycle of production of technical polymer products from secondary raw materials. The electronic information and educational environment proposed in the work was successfully tested on the basis of the training center "Polymer-ecology" of Saint-Petersburg State Institute of Technology with cooperation with LLC "Plastic processing plant named after "Komsomolskaya Pravda". The use of the environment as a tool to ensure the quality of training of highly qualified personnel of polymer industry enterprises allows to increase the professional level of specialists in the field of development of composite polymer mixtures based on secondary polymer materials and technologies of their processing into technical products with improved environmental and consumer characteristics.**

Keywords— engineering team; polymer recycling; polymer waste; secondary raw materials; e-learning

I. INTRODUCTION

In "Industrial Development Strategies for Processing, Recycling and Disposal of Production and Consumption Wastes up to 2030", Approved by Order of the Government of the Russian Federation No. 84-r of 25 January 2018, as one of the main areas of action for the task of establishing and expanding a national industrial industry and processing infrastructure, disposal and decontamination of wastes, their use as secondary raw materials for production of new products is indicated the necessity to create a highly qualified personnel reserve, as well as training, retraining and advanced training of industry personnel in waste treatment and disposal [1, 2].

Polymer wastes, partially recovered in the process of solid municipal waste treatment, as well as formed in the process of production and use of plastic products, are promising to be used as secondary resources for production of technical products (polymer film, carving products, polymer pipes, packaging materials, containers, fasteners, heat-sound insulating material, etc.). At the same time, the main difficulty lies in separation and isolation of pure fractions from mixed wastes, as local and common heterogeneities of composition of composite mixtures can be present, which accidentally vary, and which are difficult to describe quantifiably [3, 4].

One of the tools of resource saving, waste treatment and recycling is development of personnel support system of polymer industry enterprises [5], which provides on the basis of development and introduction of innovative technologies complex life cycle management of technical polymer products from secondary raw materials with improved ecological and consumer properties.

Thus, the development of an electronic information and educational environment for comprehensive training of specialists in the field of resource-saving management of polymer waste processing is a pressing, socially significant and economically viable task.

II. FORMATION OF TRAINING PATH FOR SPECIALISTS IN THE FIELD OF POLYMER WASTE PROCESSING

The difficulty of controlling the process of polymer technical products production is due to the presence of a changing (unpredictable) composition of raw materials, multi-factor interactions and connections arising in the course of the process, diversity of physical and chemical processes of secondary raw materials and materials processing, variety of technological equipment, a large number of controlled parameters, sensitivity to the occurrence of scrap in the selection of control effects, as well as strict requirements to environmental indicators of production [3, 6]. Therefore, in order to train specialists in the field of resource-saving control of polymer materials processing processes, it is necessary to apply a complex approach, which takes into account all stages

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of the life cycle of the technical product. Taking into account the requirements of professional standards, the personnel target groups include the following specialists involved in each stage of the technical product life cycle: specialists to ensure the production cycle of secondary polymer materials, technical and economic assessment of the life cycle, monitoring and ensuring the safety of the production environment, as well as automated production management using digital technologies [5, 7]. The training path methodology is based on a frame description and includes the steps shown in Fig. 1:

1) Define a target personnel group (*TPG*) for training $Fr^{(1)}$ ::= <*TPG*, $Q^{(1)}$, $A^{(1)}$>, where $Fr^{(1)}$ – frame prototype *"TPG"*, components of which are attributes $Q^{(1)}$ and its characteristics $A^{(1)}$. Target personnel groups are given in Fig. 2.

2) Creating a set of professional competences (*PCs*) for training *TPG* $Fr^{(2)}$ :: = <*PCs*, $Q^{(2)}$, $A^{(2)}$> based on an analysis of Generic Labour Functions (*GLF*) of the respective professional standards for each *TPG*. The list of *PCs* is given in Fig. 2.

3) Development of practical-oriented training modules for learning results (*PCs*) (*TM*) $Fr^{(3)}$ :: = <*TM*, $Q^{(3)}$, $A^{(3)}$>, given in Fig. 2.

4) Development of e-learning course (*ELC*) $Fr^{(4)}$ :: = <*ELC*, $Q^{(4)}$, $A^{(4)}$>. Training complexes are used to learn the competency results of training, allowing taking into account the characteristics of the object of study, to accumulate expert knowledge in the field of process control, as well as to form competency-oriented training results.

5) Development of control and measuring material (*CMM*) $Fr^{(5)}$ ::= <*CMM*, $Q^{(5)}$, $A^{(5)}$>. *CMM* as test jobs are used to quantify *PCs* ($q_1^{(5)}$). For qualitative assessment of educational results (*ER*) the instructor is given the opportunity to set additional situations at the object of study; monitor the actions of the trainee ($q_2^{(5)}$) and modes of operation of the subject of study ($q_3^{(5)}$); analyze and evaluate the trainee 's actions based on the results of training protocols ($q_4^{(5)}$).

6) Final evaluation of *ER* development of *PCs* $Fr^{(6)}$ :: = <*ER*, $Q^{(6)}$, $A^{(6)}$>. To evaluate the final *ER*, criteria grid is used, which compares the training criteria and the results achieved, and allow the instructor to formalize the evaluation process based on the results of the practical task. The result of the training of specialists in the field of polymer waste processing is the formation of a certificate of polymer technical product production taking into account the requirements of the product market, environmental safety requirements and economic efficiency of each stage of the life cycle and production as a whole. The certificate of manufacture of the polymer product from the secondary raw material includes description of the raw material preparation process, equipment data, tooling and tools, ranges of technological modes of the injection casting process, requirements to the product quality indicators, environmental safety requirements, as well as technical and ecological production indicators. The product certificate is formed based on the results of combining reports for each stage of the life cycle of the polymer product with unique properties. At the same time results of work of each stage (stage) are transferred to the subsequent, and data of the report of the previous stage are input data for studying and performance of the subsequent practical tasks.

III. Functional Structure of The Electronic Educational and Information Environment

In order to implement the proposed path of training of specialists in the field of polymer waste processing in the form of electronic training, an electronic information and educational environment has been developed, including electronic information and educational resources in the field of polymer processing and production, a set of information and telecommunication technologies, appropriate technological means and ensuring the full development of educational results [8-10]. The enlarged functional structure of the environment, presented in Fig. 3, includes: information support (database of technological regulations and maps, which contains information on finished products, raw materials and materials, technological modes of production, equipment, database of professional standards, trainees, educational and methodological materials); algorithm support (module for formation of individual training paths of specialists, module for formation of technical polymer product production certificate), user interface (trainees), instructor interface, administrator interface, expert interface.

The core of the electronic information and educational environment is training complexes, which allow on the basis of mathematical models of key processes (drying, extrusion, injection casting) to carry out research of cause-and-effect relations of the object of study, to determine technological modes of equipment for obtaining polymer products with specified quality requirements, as well as to simulate the occurrence of abnormal situations in order to train specialists in the skills of accident-free operation of technological processes.

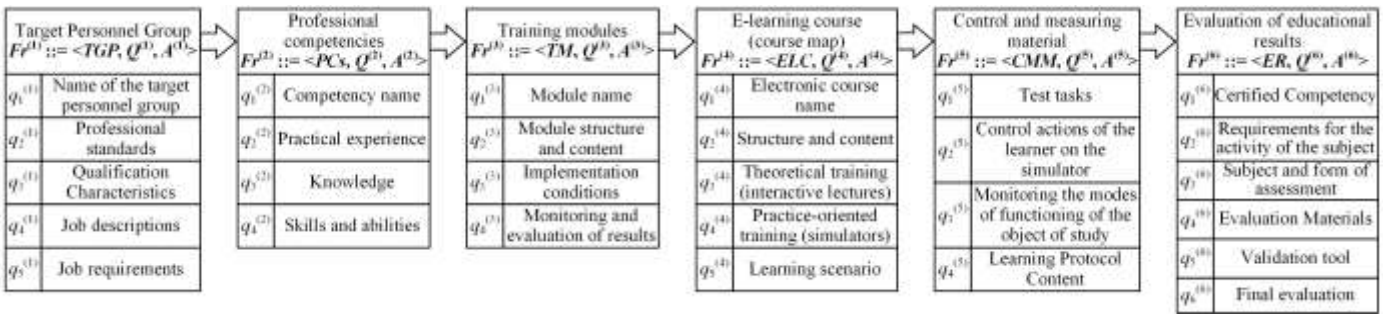

Fig. 1. Process of formation of training path of specialists in the field of polymer waste processing

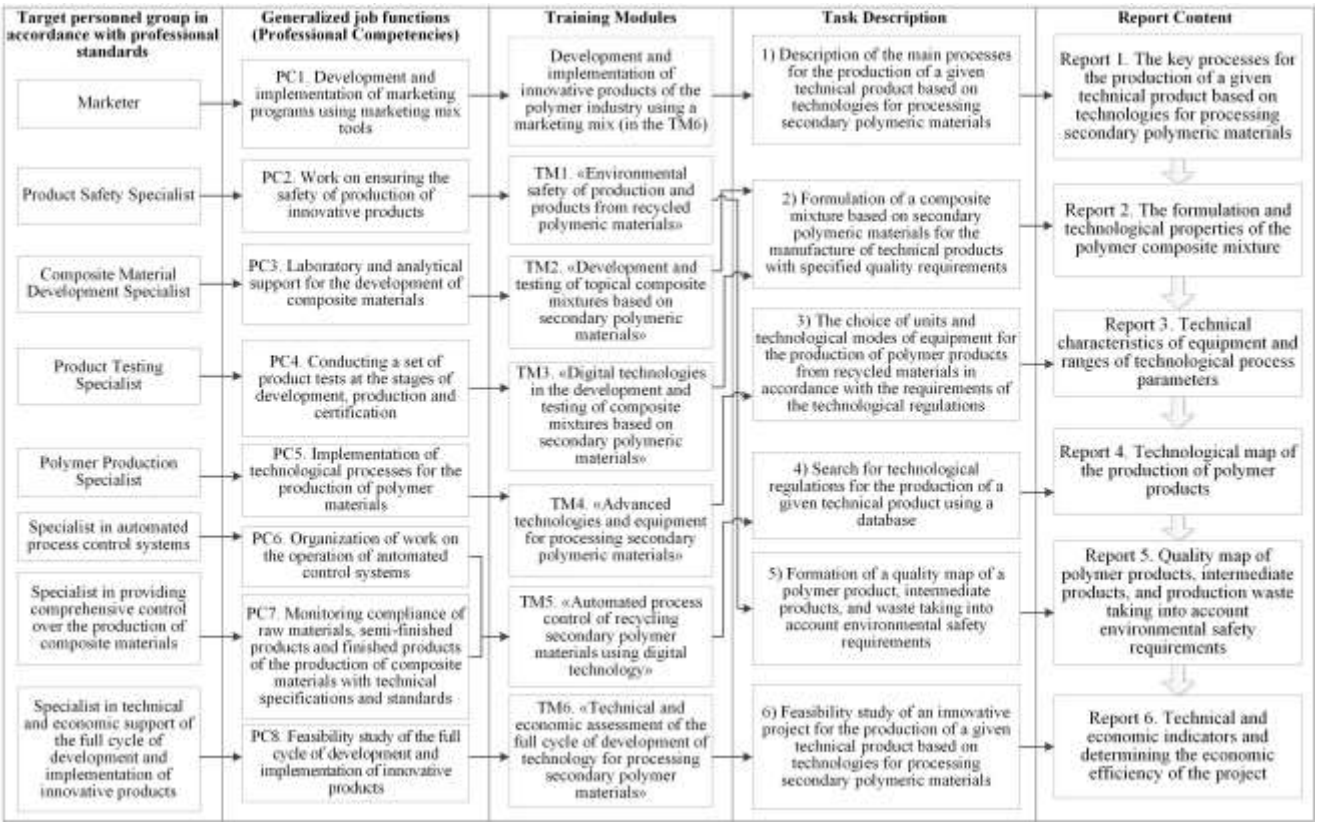

Fig. 2. Structure of personnel support model for resource-saving control of polymer waste processing processes

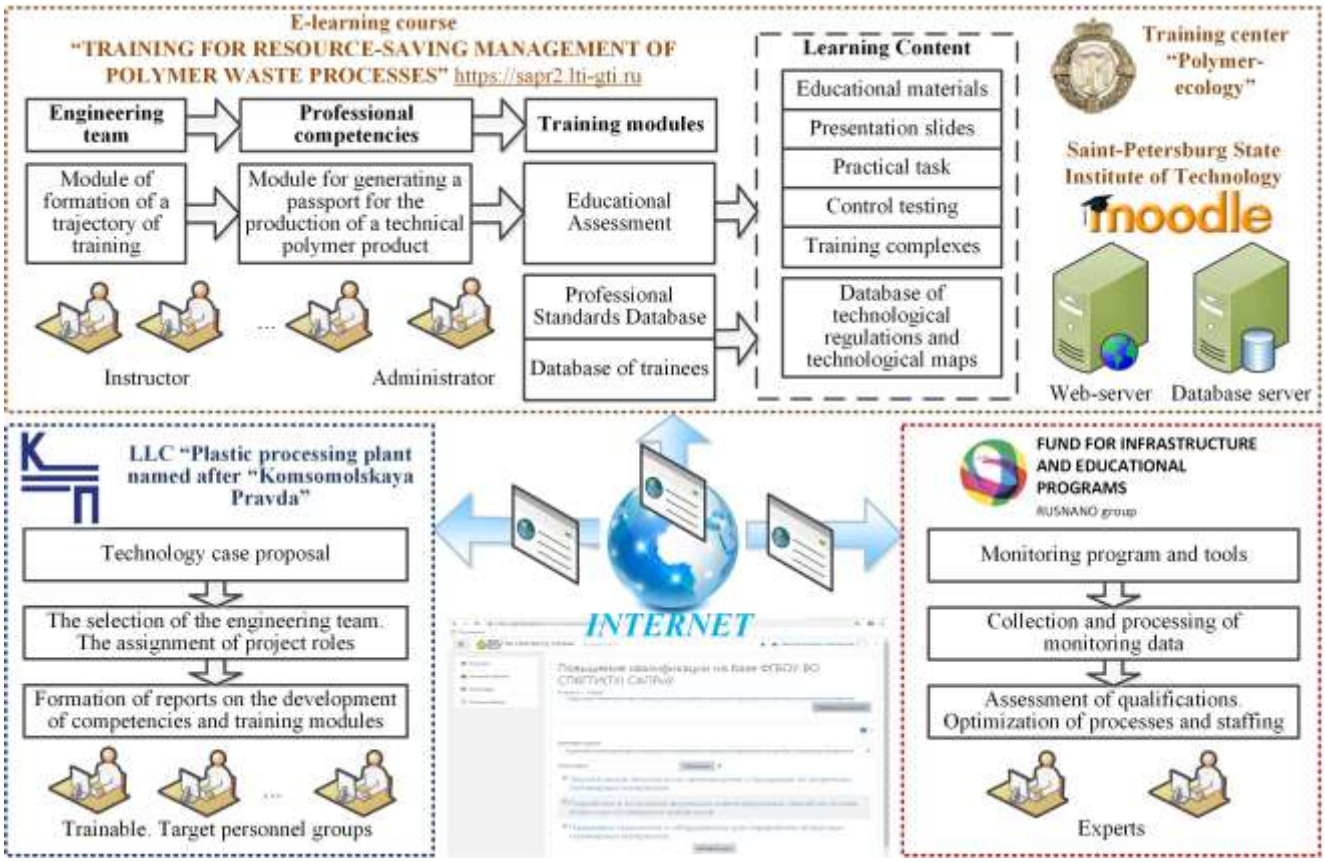

Fig. 3. Structure of the electronic information and education environment

The information support of the medium is adjusted to different modes of operation of the control object (processes of polymer waste processing) by changing the ranges of the corresponding parameters. This enables the adaptation of the electronic information and education environment to various modifications of the subject of study, which allows using the environment for training in resource-efficient management of various technological processes and production with recycling.

The electronic information and education environment is based on the Moodle learning management system using the SQLite database management system and MS Visual Studio software development environment. The developed environment software has a flexible architecture that supports enhanced functionality by developing and connecting additional software modules.

IV. Conclusion

Testing of the electronic information and educational environment, carried out on the basis of the training center "Polymer-ecology" of Saint-Petersburg State Institute of Technology with cooperation with LLC "Plastic processing plant named after "Komsomolskaya Pravda", confirmed its operability and the possibility of using it to train specialists in solving the problem of reconfiguration of production to a new type of product, problems of determining a formulation of a composite mixture based on secondary polymer materials; as well as tasks of selection of technological modes of polymer product production with specified requirements for quality and consumer properties of final product.

The use of modern technologies of practical-oriented training allows to increase efficiency of production due to introduction of innovative production technologies, to increase quality of produced products, to intensify recycling processes, to improve ecological characteristics, and, above all, to increase professional level of personnel support of industrial enterprises in conditions of digitalization of economy and modernization of system of professional standards and qualifications.

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Continuous Information Support of the Curriculum Life Cycle within the Digital University

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***Abstract*—The paper presents the concept of continuous information support of the life cycle of the curriculums within the digital University. This concept assumes complex automation of development and adjustment of working curricula, training programs, funds of estimated means, electronic educational resources, planning and distribution of educational loading, and support of educational process staff. The paper shows that introduction of continuous information support of the life cycle of curriculums will ensure the transition of the process of targeted training of highly qualified personnel to a qualitatively new level, will increase the degree of individualization of the educational process, will minimize routine work on the preparation of supporting documentation, create conditions for replication of the best educational practices.**

Keywords—digital university; information support of the curriculums life cycle; complex automation of university management; complex model of electronic educational resource; qualimetric model of educational resources; adaptive educational resources; qualimetric model of the student; indicators of achievement of competences set; e-learning; automation of management of individual trajectories of training

I. INTRODUCTION

In modern conditions, the training of highly qualified specialists is impossible without the introduction of the latest educational and information technologies. Modern realities require a radical revision of the existing system of management of higher education and the organization of the educational process. It is necessary to abandon outdated forms of document management, including the requirement to submit reports of student papers in paper form. In addition, there is a need for a radical reduction in the routine work of teachers to fill out multiple reports, often reduced to presenting the same information in different forms. As a result, one of the basic principles of modern information technology is violated- "Don't repeat yourself, DRY" ("do not repeat yourself") [1]. In addition to wasting time, violation of the DRY pattern leads to errors, leading to inconsistency of documents (antipattern "False tile") [2].

The solution of the problems inherent in modern education (not only higher education) is possible within the framework of the introduction of the concept of "Digital University", which provides for a comprehensive Informatization of all processes of higher education within a single educational cyber environment. It should be noted that the digitalization of the educational process is not an end itself. Modern technologies should be subordinated to the main goal facing higher education, namely, formation of a creative personality of a specialist capable of self-development, self-education, and innovation [3]. Only such specialists can be classified as highly qualified personnel.

II. DIGITAL UNIVERSITY, INFORMATION SOCIETY AND INDUSTRY 4.0

The digital University should be based on a single cyber environment, created on the basis of three basic principles: 1) Agency, 2) information self-service and 3) managed information openness [4]. On the basis of these principles can also be created and a single cyber information society [5], formed in the merger of ciberred individual organizations. The academic cyber environment is which an Association of all educational environments, a part of a single cyber environment of the information society. Within the framework of the educational cyber environment of the digital University, continuous comprehensive information support of the life cycle of the main educational programs is carried out.

Given the trend of deep integration of computing resources into physical entities of any kind, cyber environments are often referred to as cyberphysical systems or cyberphysical environments. However, the term cyber environment does not contradict the possibility of integrating computing resources into physical entities, so these terms can be considered equivalent. In this article, we will use the term cyberphysical environment, if it is necessary to emphasize the phenomenon of "mixed" reality, assuming the above integration.

The concept of a digital University corresponds to the concept of" industry 4.0", which involves the mass introduction of cyber-physical systems into production [6–8]. Table 1 compares the basic concepts of "Industry 4.0" and "Digital University".

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TABLE I. COMPARATIVE ANALYSIS OF THE CONCEPTS "INDUSTRY 4.0" AND "DIGITAL UNIVERSITY"

Industry 4.0	Digital University
Cyberphysical system – information technology system, which implements a deep integration of computing resources into physical entities of any kind	Cyberphysical educational environment is an educational environment that provides deep integration of computing resources into the educational process
Deep customization of the product	Individual educational trajectory
PLM – product lifecycle management	Automated life cycle management of curriculums
Smart Factory-seamless connection of individual stages (operations) of the production process, from the stage of marketing research and product design, to the organization of production and process control, to distribution, operation and disposal	Continuous information support of the life cycle of the main educational programs
Interoperability (functional independence) – the ability of a product or system whose interfaces are fully open to interact and function with other products or systems without any restrictions on access and implementation	Interoperability of software and algorithmic support and processes of various digital universities, colleges, schools and other organizations, allowing to combine the environment of individual organizations into a single academic cyber environment
IIoT is an industrial Internet of things. Provides interaction of physical production operations and related processes	AIoT is an academic Internet of things. Provides interaction of the objects which are a part of material and technical support of educational process

III. AUTOMATED LIFE CYCLE MANAGEMENT OF CURRICULUMS

Life cycle management of the main educational programs in the framework of the digital University involves a comprehensive end-to-end automation of the following processes (Fig. 1):

- development of working curriculum and working curricula of disciplines, practices and state final certification;
- student population management;
- personnel management of the educational process;
- management of material and technical support of the educational process;
- operational management and monitoring of the educational process.

Consistency of all processes and artifacts obtained at all stages of the life cycle of the main educational program requires a single model:

$$CM = <P, S, R>, \quad (1)$$

where:

CM – multidimensional model of the curriculum;

P – the working curriculum and work programs, including the fund of assessment tools;

S – stuff, material-technical and educational-methodical support of the curriculum;

R – results of implementation of the curriculum.

The use of a single model (1) will provide the possibility of coordinated development of all artifacts of the basic educational program (working curriculum, work programs, evaluation Fund), as well as management of various types of support (personnel, logistics and training) and the process of implementation of the educational program (Fig. 2).

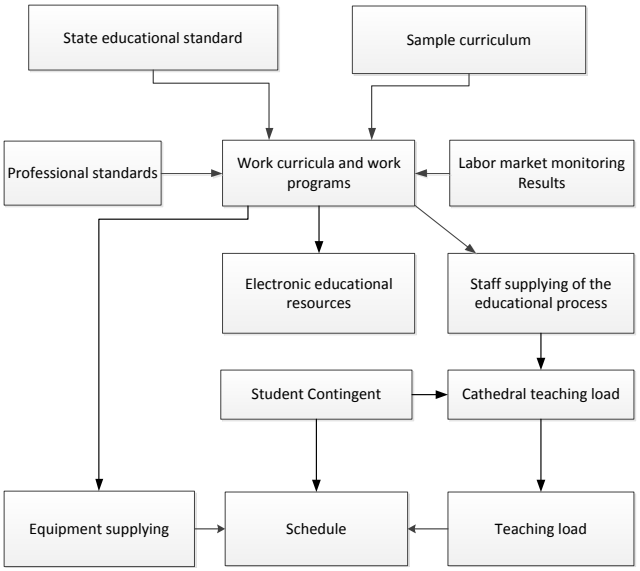

Fig. 1. General scheme of automation of curriculums life cycle management

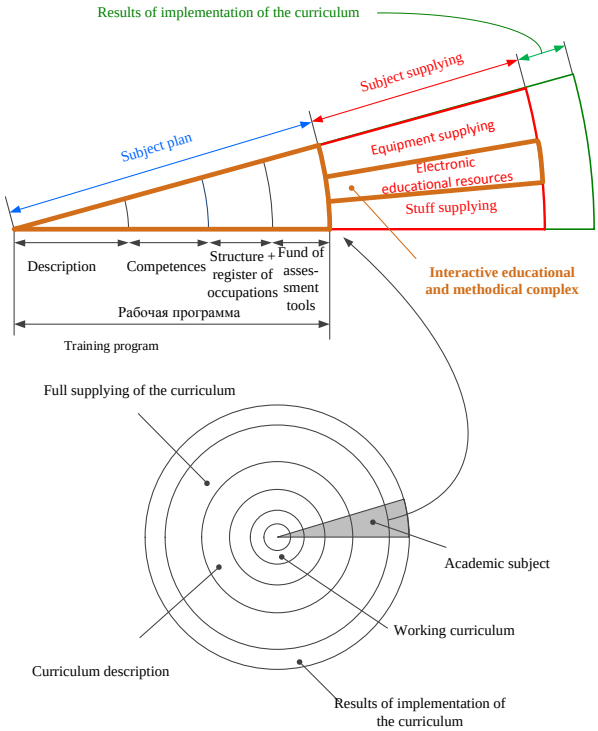

Fig. 2. Concentric model of the curriculum

Briefly consider the process of developing and managing the implementation of the main educational program.

- The choice of the professional standards and employment of generalized functions, the definition of activities and professional competences.
- Planning for the cohort and study groups.
- Determination of the list of disciplines, their complexity, as well as other types of educational activities. Definition of connections between disciplines. Distribution of disciplines and other types of educational activities by semesters. The development of work programs and the Fund of assessment tools (within a single concentric model of discipline)
- Planning of personnel support of disciplines.
- Planning of material-technical and educational-methodical support of disciplines. Formation of technical specifications for the creation (purchase) of the missing security elements.
- Calculation of Cathedral loads and load distribution between teachers of departments.
- Scheduling for the semester.
- Operational management of the implementation of the main educational program. Correction of artifacts obtained in the previous stages.

Within the framework of expression (1) the working curriculum, working curricula and the results of the current monitoring of the implementation of the main educational program (attendance, academic performance, etc.), some aspects of the A_I multidimensional model can be considered:

$$A_i = F_i(CM), \quad (2)$$

Given that the model (1) contains all the necessary and up-to-date information about all aspects of the main educational program (2), Most of the reports can be obtained only on the principle of "one button":

$$Report_i = ReportGenerator_i(A_i, Form_i), \quad (3)$$

where:

$Report_i$ – the report;

$Form_i$ – the report pattern;

$ReportGenerator_i$ – the report generator.

IV. Concept of Adaptive Educational and Methodical Complexes

Educational and methodological support of the main educational program implemented within the framework of the digital University must meet the following requirements:

- support for interactive forms of learning;
- support for all types and forms of classes (theoretical, practical, independent, individual, group, frontal);
- adaptation to the individual characteristics of students;
- ability to replicate the experience of leading teachers;
- modularity (the possibility of using the same modules in courses of different disciplines);
- support of concentric model of discipline course construction;
- availability of mechanisms for assessing the level of material assimilation [9-11] for current and intermediate certification.

Taking into account these requirements, the model of interactive educational and methodical complex can be presented in the following form (Fig. 3):

$$EMC = <D, M, Q, R> \quad (4)$$

where:

D – sections of interactive educational and methodical complex (theoretical part, exercises, etc.);

M – module, which is the main component unit of interactive educational and methodical complex);

Q – control and measuring materials;

R – connections between separate elements of interactive educational and methodical complex.

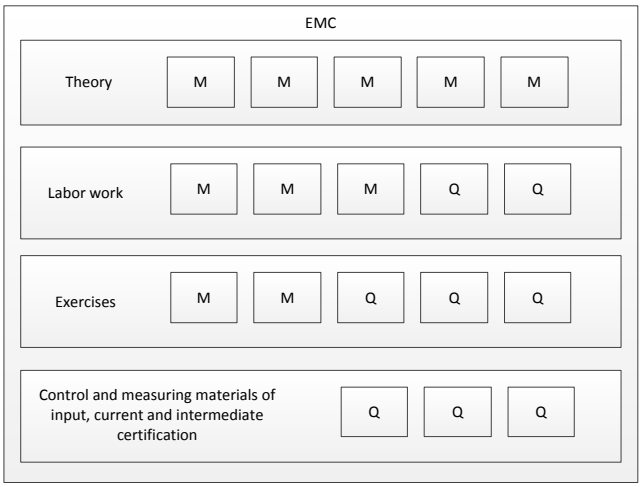

Fig. 3. Structure of interactive educational and methodical complex

A module can be represented by the following expression:

$$M = <T, MM, Q, R>, \quad (5)$$

where Q are tasks for self-examination mastering of the passed material;

MM – multimedia resource (image, video, audio);

T – text block.

The proposed model (4–5) provides the construction of interactive educational and methodical complexes from unified blocks. The same types of modules can be used in the creation of the theoretical part, laboratory and practical classes. Modules and test and measurement materials can be placed in the library and further used in the creation of other interactive teaching modules. According to the results of the entrance testing of knowledge, current and intermediate certification, a set of modules recommended for study by the student is automatically formed.

V. Conclusion

The concept of continuous information support of the life cycle of basic educational programs, presented in the article, is based on the use of multidimensional models that provide coordinated management of all processes, as well as a significant reduction in routine work. The proposed models are focused on the support of interactive forms of education taking into account the individual characteristics of students, as well as on the creation of a single library of electronic educational resources built on a modular principle.

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Training of Senior Scientific and Pedagogical Staff: Present State and Problems

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***Abstract*— Postgraduate training as the third level of higher education is the main institution in the field of preparation of candidates of science, which ensure the reproduction of senior scientific staff. Implementation of measures aimed at optimizing the network of dissertation councils, increased demands to organizations at which are created dissertation councils, as well as to the performance of research activity of dissertation council's members and quality of the presented dissertations. As a result, the number of defenses of dissertations for the degree of candidate of sciences in the period from 2015 to 2018 decreased from 12.5 thousand to 8.7 thousand defenses. At the same time was reduced the enrollment and graduation of graduate students. The paper aims to analyze the dynamics of the training processes and certification of candidates of sciences from the position of providing the economy with senior scientific staff.**

Key words*— *senior scientific staff; staff training; postgraduate training; defend of a thesis; dissertation council; admission to graduate school

I. POSTGRADUATE TRAINING OF SCIENTIFIC AND PEDAGOGICAL PERSONNEL

The number of graduate students reached a peak of 157 thousand people in 2010, including 108 thousand studying at the expense of the budget funds. At the end of 2017, this indicator decreased to 93 thousand students (a decrease of 41%), including 65 thousand trained at the expense of budget funds (a decrease of 40%). The maximum number of budget graduate students was observed in 2003 and was equal to 121 thousand students; the decrease of budget graduate students by 2017 was equal to 46%.

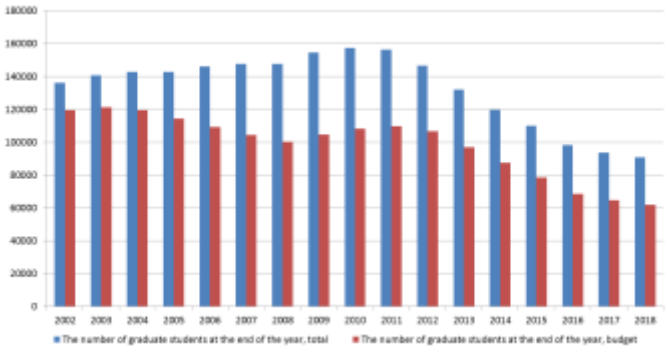

Fig. 1. Dynamics of the graduate students number

The maximum enrollment of graduate students was in 2009 and was equal to 55 thousand students. By 2017, the admission of graduate students fell to 26 thousand people (a decrease of 53%). The maximum graduation of students was observed in 2012 (35 thousand students) and it decreased to 18 thousand people by 2017 (a decrease of 49%). Graduation of budget students in the same years was equal to 25 and 13 thousand students, respectively (a decrease of 45%).

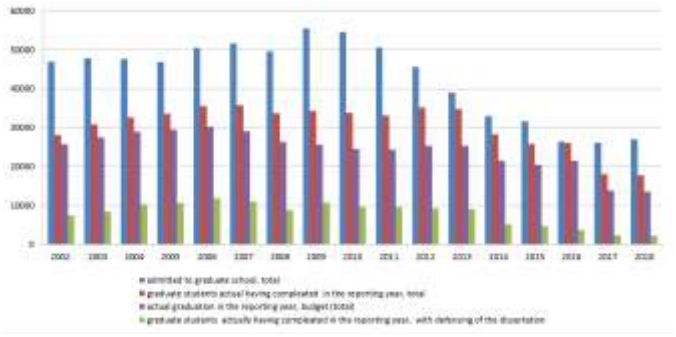

Fig. 2. Dynamics of admission and graduation of students

The analysis of graduate admission quotas proportion for 2014–2016 for educational and scientific organizations in the context of ministries and departments in relation to general graduation admission quotas showed the following. For organizations of the academic sector, the admission quotas have increased from 9% to 13%; for organizations subordinate to the Government of the Russian Federation, the number also increased from 12% to 16%. For organizations of the Ministry of Healthcare and the Ministry of Agriculture of the Russian Federation, this indicator has not changed significantly and remained at the level of 6–7%. For educational organizations of the Russian Ministry of Education and Science, the proportion of admission quotas decreased from 58% to 52%.

In 2017, 83 thousand graduate students, or 89% of all graduate students, studied at the universities. Budgetary admission (admission quotas) is equal to 60% of the total admission. Reduction of budgetary admission was in phase with the reduction in total admission.

Since the main reduction in admission quotas has affected educational institutions of the Ministry of Education and Science of the Russian Federation, the distribution of admission quotas in graduate school, taking into account the

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status of educational organizations: federal and national research universities, is as follows. The admission quotas for 10 federal universities and 29 national research universities under the jurisdiction of the Russian Ministry of Education and Science has increased from 5.0 thousand to 5.4 thousand in the same period, which corresponds to an increase in the share from 47% to 65%.

With such a redistribution of the admission to graduate school, 250 universities – classical, technical, pedagogical, and economic universities – suffered from two or more times less budgetary admission from 5.6 thousand to 2.9 thousand students. At the same time, the admission in universities under the jurisdiction of the Ministry of Healthcare and the Ministry of Agriculture of Russia, in the same period from 2014–2016 did not change.

10 thousand students, or 11% of all graduate students, studied in the academic sector in 2017. The admission quotas for organizations in the academic sector amounted 2 thousand students and did not change. At the same time, the proportion of admission quotas for organizations in the academic sector increased from 9% to 13%.

II. The Defense of Candidate Dissertations

During the past 10 years, the number of defense of candidate dissertations has reduced monotonously. The maximum number of defenses (23 thousand) was observed in 2011. The number of defenses dropped significantly and in 2018 was equal to 8.7 thousand defenses of candidate dissertations. At the same time, the proportion of people who defended their dissertation after graduate training monotonously increased from 64% to 78%. The 78% indicator includes "post-defense" of graduate students within four years after completion of postgraduate studies. Such an increase was observed for all awarded branches of science, with the exception of pharmaceutical and geographical sciences. It is important that in pharmaceutical and geographical sciences, the number of defense of candidate dissertations is only 1.5% of the total number of defenses of candidate dissertations.

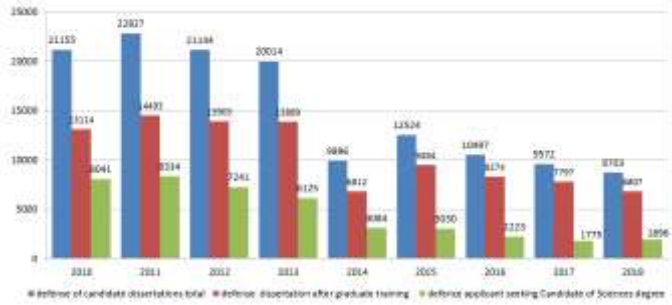

Fig. 3. Number of candidate dissertations defenses

The number of people who defended the dissertation after finishing graduate school reduces annually – from 8.3 thousand people in 2011 to 1.9 thousand people in 2018. The proportion also decreased from 36% to 22%. Such defenses are not widely spread in natural science, technical, and sociological branches of science, and are widely spread in medical, pedagogical, and legal sciences.

Fig. 4. The proportion of people who defended their dissertation after graduate training

Traditionally, the efficiency of postgraduate training is assessed as the ratio "graduation with the defense of the dissertation to general graduation". In 2018, graduation from graduate school was equal to 17.8 thousand, including 2.2 thousand with the defense of the dissertation, which corresponds to an efficiency of 12.4%. In previous years, this figure was 25–30%, but since 2014, it began to decline monotonously from 18.4% to 12.4%.

Traditional efficiency does not take into account the fact that some graduate school graduates defend their dissertations in one year, two or more years after graduate school. Considering "post-defenses", the value of performance indicators of graduate school by the criterion of "the number of defenses after graduate school with accumulation to total graduation" in period from 2000 to 2014 increased from 30% to 49%. For various scientific specialties, the efficiency of postgraduate studies taking into account "post-defenses" is in the range from 86% for graduate students in medical specialties, to 30% in "Earth Sciences" specialties.

Retention of graduate students during their studies is calculated through the indicator "admission of 3 or 4 years ago minus graduation of current year". This indicator is in the range from 35% to 48% between 2009 and 2016. In 2018, this indicator was equal to 45%.

In the statistics of the Federal State Statistics Service on work of graduate school there is no data on the number of graduate students by years of study, which makes it impossible to trace the dynamics of retention of graduate students by years of study. Since 2014, admission in the fields of training (the All-Russian classifier of specialties by education) replaced the admission to graduate school for scientific specialties (the All-Russian classifier of specialties of the senior scientific qualification). From 2014 to 2017, the Federal State Statistics Service published the information on the number of graduate

students by years of study with accumulation in scientific specialties and in areas of training. However, these data do not allow carrying out the analysis of retention by year of study, since they include three and four-year training programs.

TABLE I. THE STRUCTURE OF THE NUMBER OF GRADUATE STUDENTS BY YEARS OF STUDY

The number of graduate students at the end of the year	2014	2015	2016	2017	2018
1st year students, total in field of training	32859				
2nd – 5th year students, total in scientific specialties	87009				
1t and 2nd year students, total in field of training		60449			
3rd – 5th year students, total in field of training		49487			
1st – 3rd year students, total in field of training			82750		
4th – 5th year students, total in field of training			15602		
1st – 4th year students, total in field of training				91922	
5th year students, total in field of training				1601	
1 - 5 года обучения, total in field of training					90823
Total	**119868**	**109936**	**98352**	**93523**	**90823**

The overall efficiency indicator "graduation with the defense of a dissertation after the completion of the graduate school in 2018 (6.8 thousand people) to admission to graduate school of 4 years ago in 2014 (32.9 thousand people)" amounted to only 21%. This indicator takes into account the retention and defense of dissertations after completing graduate studies for at least 4 years.

III. THE REQUIRED NUMBER OF SENIOR SCIENTIFIC STAFF

The following basic principles are used to predict the number and dynamics of senior scientific staff:

1. Ensuring the reproduction of senior scientific staff at the current moment within the framework of the Nomenclature of scientific specialties.
2. Ensuring the reproduction of senior scientific staff in accordance with the standards in the framework of the Nomenclature of scientific specialties.

As the quantitative indicators of forecasting is used the annual additional demand for senior scientific staff, defined as the number of workers with advanced degrees who must additionally enter the economy to ensure the planned volume of production of goods or services.

Calculation of annual additional need is based on the number of students, regulatory requirements for the degree of teaching staff and standard for the number of students to one teaching staff. The minimum required number of teachers with academic degrees, providing training for bachelors, specialists and masters in universities to reimburse the natural-age retirement for the university sector was equal to 4,250 candidates of sciences in 2016. Taking into account that full-time employees and graduate students of the university sector defended 7368 candidate dissertations, the higher education sector fully satisfies its own need for senior scientific staff.

The annual estimated additional need for senior scientific staff of the state and entrepreneurial sectors of science amounts 2170 candidates of science. According to the reports of the dissertation councils, in 2017, 1,351 full-time employees and graduate students of the state and entrepreneurial sectors of science defended candidate dissertations.

The analysis of the annual additional needs of the scientific sector in senior scientific staff shows that these organizations do not replenish the number of senior scientific staff themselves by defending dissertations by graduate students and employees working in the scientific sector.

IV. PROBLEMATIC ISSUES OF GRADUATE TRAINING

Among the problematic issues that need to be addressed are the aforementioned reduction in training volumes, which leads to the fact that the academic sector cannot reproduce their own scientific staff. They also include employment in the period after graduate school until the defense of the dissertation. Approximately half of the theses defense by postgraduate students takes place in the period after 1-3 years after graduation. We can increase this indicator (post-defenses) if we ensure temporary (up to three years) employment of these persons in the field of the dissertation at the university or scientific organization where the dissertation is prepared.

The outflow of candidates of sciences from science and education after the defense is problematic.

Based on the analysis of publication activity reflected in the resource eLIBRARY.RU, within five years after the defense of the dissertation in 2010, it turned out that only 10% of candidates of science have more than five publications, what means, they are really engaged in the development of scientific knowledge. Another 24% of candidates of science work in fields related to science and education, as they have from one to five publications. They are passive in publication activity, and, consequently, in scientific activity, but still maintain a high level of their qualifications. Thus, only a third of the candidates of science continues to work in the field of science and education. The remaining two-thirds do not publish any materials; therefore, their activities are in the field of management and other sectors of the economy.

One of the reasons for the emergence of problem areas is the low level of funding for graduate training. The basic by

head budgetary funding in the field of senior staff training for the training programs of scientific and pedagogical staff in graduate school of higher education organizations in 2019 is 102 – 135 thousand rubles, depending on the status of the field of training / specialty. These values for a graduate student do not differ from the costs for a bachelor / specialist / master.

The annual cost of graduate student training with full cost recovery at Moscow State University is equal to 420 thousand rubles, and at the Higher School of Economics – 489 thousand rubles, which is close to the real costs of a graduate student training.

V. Conclusion

The analysis of problematic issues of postgraduate training shows that it is necessary to implement a system of incentives that provide motivation for master graduates and specialists for admission and successful completion of graduate school, ensuring:

- Scholarship not lower than the average salary in the region;
- Employment on the dissertation profile for a period of 1 to 3 years between graduation from the graduate school and the defense of the dissertation;
- Guaranteed employment after defending a thesis with a salary of at least twice the average in the region.

Basic by head budgetary funding in the field of senior scientific staff training for training programs of scientific and pedagogical staff in graduate school for higher education organizations needs to be increased at least twice.

For universities under the jurisdiction of the Ministry of Science and Higher Education of the Russian Federation, it is necessary to increase the admission quotas for graduate school.

For the scientific justification of volumes and fields of postgraduate training, it is necessary to formulate a forecast for senior scientific staff in high-tech sectors of the economy: healthcare, nuclear industry, shipbuilding, aerospace industry, and state and municipal government.

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Improving the Process of Training Specialists in the Development of Program Documentation based on Automated Assessment of the Quality of Skills Formation

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***Abstract*— The article is devoted to solving the problems of assessing the quality of software documentation in the training of software developers. Various CASE-tools are widely used at present to improve the efficiency of the software development process, including the preparation of documentation. However, it is necessary to improve methods and means of automating the formation of software development skills that contribute to improving quality and accelerating the learning process. The methodology for assessing the quality of the generated software documentation (on the example of the software testing process) in the course of students performing practical tasks is considered. The methodology is based on the use of mathematical methods, in particular, expert assessment methods. The article also describes a prototype of a subsystem (which is part of an automated training system) used to assess the quality of practical tasks. The advantage of applying this methodology when training at an enterprise is the ability to increase the level of professional skills, speed up the process of adaptation of young employees, and also (when evaluating experienced employees to perform real tasks) improve the quality of the documentation itself.**

Keywords*— *automation of the vocational training process; program documentation; expert assessment methods; software testing

I. INTRODUCTION

It is known that in the process of developing software, in addition to the program code itself, various documentation is created [1, 2].

Quality of the documentation affects the next steps in software development. For example, if the formed software requirements contain significant shortcomings, then this will negatively affect the stages of design and implementation of a software product. Or, for example, shoddily developed testing plan and test-cases can contribute that a number of possible errors will not be detected in the program when it is checked.

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There are different approaches to improving the quality of program documentation. On the one hand documentation testing methods are used, which consist in verifying its compliance with a certain set of criteria [1]. The use of this type of testing allows you to identify and fix defects in the current version of the documentation.

Testing methods for program documentation and typical criteria for checking are described in detail in the scientific and methodological literature, for example [1, 2]. In particular, the work [1] describes the properties that qualitatively formed software requirements must have (completeness, atomicity, consistency, etc.), test cases (using a competent technical language to describe steps and expected results, maintaining a balance between specificity and generality, between simplicity and complexity, etc.), defect reports (in many ways similar to test cases). In [2], the desired characteristics of software requirements are presented, for example, uniqueness, completeness, and consistency.

On the other hand, there are many CASE-tools to reduce the complexity of the process of preparing documents by a specialist, and, as a result, the negative impact of the human factor [1, 2]. In particular, a brief overview of such tools (for example, software products for compiling test cases and defect reports) is presented in [1].

The level of professional competencies of a specialist (whose responsibilities include the development of this documentation) significantly affects the quality of compilation of program documentation. For example, in order to correctly describe the steps of the test case, the expected results of the test case, the essence of the defect identified in the program, it is necessary to form appropriate skills with the specialist. The use of CASE-tools allows only partially automate the preparation of documents.

An urgent task is the development of automation tools and appropriate algorithms that allow us to assess the quality of practical tasks when training specialists in the skills of developing software documentation. The solution to this problem should be based on the development of computer

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technologies used to automate the training process, accelerating this process and contributing to the improvement of its results [3–6].

II. METHODOLOGY OF AUTOMATED ASSESSMENT OF THE QUALITY OF EXERCISES IN TRAINING DEVELOPMENT OF SOFTWARE DOCUMENTATION

A methodology of assessment the quality of carrying out practical tasks (exercises) has been developed when training beginners in the development of software documentation. The methodology can be used in the course of training of students of higher education and secondary vocational education institutions, as well as in-company training of employees. It is assumed that the instructor (expert) prepares an exercise aimed at the development of program documentation, which is then performed by a group of trainees. An example of such a task could be the development of a set of test cases for a small software system, such as a software module for automatic distribution of the training load in the department.

Application of the considered methodology provides implementation of the subsystem of automated training system (ATS) used for professional training of software developers [6]. The methodology of assessment the quality of execution of practical tasks includes the following steps:

Step №1. The instructor defines many quality indicators for assessment of the document prepared by the trainees: $A = \{a_i \mid i = \overline{1, N}\}$, where a_i – a separate quality indicator, N – the total number of indicators.

In particular, the instructor can use the quality indicators (criteria for testing software documentation) discussed in the literature on software development [1, 2] (as mentioned in the Introduction above). The teacher's choice of indicators largely depends on: the specifics of a particular software system; regulations and traditions of the organization carrying out the training process (especially in internal training); personal experience in software development.

Let's review an example. To evaluate the quality of the exercise related to building a set of test cases, the instructor selected the following quality indicators (based on the properties of the quality test cases given in [1]): a_1 – use of a competent technical language in the description of steps and expected results; a_2 – maintaining a balance between specificity and community; a_3 – maintaining a balance between simplicity and complexity; a_4 – being able to detect errors in the program with a high probability; a_5 – following a sequence in the description of steps and expected results (relative to the purpose of the test case); a_6 – no unnecessary actions in the description of test-case steps.

Step №2. For each i-th quality indicator, a weight w_i is determined, which indicates the importance of this indicator in assessing the quality of the document prepared by the trainee during the exercise.

The instructor sets the input data from which the system then automatically calculates the weights. The instructor can manually adjust the values.

Weights can be calculated both by direct evaluation and by paired comparisons [7, 8].

Using the direct evaluation method, each quality indicator is mapped to a numerical value on a specific scale: $B = \{b_i \mid i = \overline{1, N}\}$, where b_i – value associated with i-th indicator. The higher the value b_i, the more important i-th indicator is when evaluating a particular exercise. The choice of scale depends on the teacher 's knowledge of the features of the compared indicators, as well as on the required accuracy of measurements.

The formula used to calculate weights w_i is: $w_i = b_i \Big/ \sum_{i=1}^{N} b_i$. Continuing to consider the example above (step №1), we compare the values of b_i quality indicators (on a 10-point scale): $b_1 = 6$, $b_2 = 9$, $b_3 = 7$, $b_4 = b_5 = 10$, $b_6 = 8$.

Where $\sum_{i=1}^{N} b_i = 6 + 9 + 7 + 10 + 10 + 8 = 50$, and weights of indicators are equal: $w_1 = 6/50 = 0{,}12$; $w_2 = 0{,}18$; $w_3 = 0{,}14$; $w_4 = w_5 = 0{,}2$; $w_6 = 0{,}16$.

Using the method of paired comparisons, preference of each quality indicator is established by comparison of all possible pairs of indicators [7]. Initially, a matrix of paired comparisons of indicators is formed, which we will present as $C = (c_{ij})$, where c_{ij} – numerical estimation of preference of i-th quality indicator over j-th, where $c_{ij} = 1/c_{ji}$, $c_{ij} \neq 0$, $i = j = \overline{1, N}$. On the basis of matrix C the weights of quality indicators are calculated:

$w_i = v_i \Big/ \sum_{g=1}^{N} v_g$, where $v_i = \sqrt[N]{\prod_{j=1}^{N} c_{ij}}$.

A teacher's choice of the most preferred method in each particular situation depends on a number of factors. In particular, if it is easier for the teacher to organize all quality indicators immediately [7], then the method of direct evaluation should be chosen. Otherwise, it is more rational to make a pair comparison of indicators, but in this case it will be necessary to obtain more data from the expert.

Step №3. A training group is given a document development exercise. Trainees perform it in a certain time.

Step №4. At the end of the exercise, the instructor reads the document created by each of the trainees and evaluates it according to the established quality indicators.

For each of the indicators, the score is displayed on a line [0;1] (when the screen forms are filled in for clarity, the score

is displayed in the form of interest), where 0 (0%) means that the document does not comply with the quality indicator, and 1 (100%) means that the score is fully compliant.

The results of this step represent the matrix $D=(d_{ki})$, where $d_{ki} \in [0;1]$ – assessment of the document created by the k-th trainee ($k=\overline{1,M}$, and M – number of trainees in the group) by i-th quality indicator.

For this example, assume that the following matrix is obtained from the assessment of the exercise by a group of five trainees for the six quality indicators above:

$$D=\begin{pmatrix} 0,6 & 0,7 & 0,65 & 0,45 & 0,85 & 1 \\ 0,35 & 0,65 & 0,5 & 0,3 & 0,6 & 0,25 \\ 0,75 & 0,7 & 1 & 0,95 & 0,8 & 0,85 \\ 0,6 & 0,5 & 0,75 & 0,9 & 0,55 & 0,45 \\ 0,35 & 0,15 & 0,5 & 0,1 & 0,1 & 0,45 \end{pmatrix}$$

Step №5. Quality indicator weights w_i' are calculated based on the spread of estimates obtained in step № 4. Weight w_i' for the i-th quality indicator, the more the rating d_{ki} relative to this indicator [7]. Calculation of w_i' values allows to take into account actual results of assessment of documents created by group of trainees.

The process of calculating the weights w_i' can be represented by the following sequence of actions [7]:

5.1. Calculation of average estimates for each i-th quality indicator by formula: $d_i = \sum_{k=1}^{M} d_{ki} \Big/ M$. For the example of matrix D above (step № 4), the values of d_i will be:

$d_1 = (0,6+0,35+0,75+0,6+0,35)/5 = 0,53$; $d_2 = 0,54$; $d_3 = 0,68$; $d_4 = 0,54$; $d_5 = 0,58$; $d_6 = 0,6$.

5.2. Calculation of variation values for each i-th indicator by formula: $R_i = \dfrac{\sum_{k=1}^{M} |d_{ki} - d_i|}{M \cdot d_i}$. For the reviewed example:

$$R_1 = \frac{2 \cdot |0,6-0,53| + 2 \cdot |0,35-0,53| + |0,75-0,53|}{5 \cdot 0,53} \approx 0,272;$$

$R_2 \approx 0,319$; $R_3 \approx 0,229$; $R_4 \approx 0,57$; $R_5 \approx 0,352$; $R_6 \approx 0,433$.

5.3. Calculation of the sum of the spread values by formula: $R = \sum_{i=1}^{N} R_i$. For the reviewed example: $R \approx 2,175$.

5.4. Calculation of weights w_i' directly by formula: $w_i' = \dfrac{R_i}{R}$. For the reviewed example: $w_1' \approx 0,125$; $w_2' \approx 0,146$; $w_3' \approx 0,105$; $w_4' \approx 0,262$; $w_5' \approx 0,162$; $w_6' \approx 0,199$.

Step №6. Calculation of generalized weights w_i'' of quality indicators by formula $w_i'' = \alpha w_i + \beta w_i'$, where α and β – coefficients reflecting the importance of weights w_i and w_i' respectively. Here $\alpha + \beta = 1$. The following values are used frequently [7]: $\alpha = \beta = 0,5$.

For the reviewed example (when $\alpha = \beta = 0,5$): $w_1'' \approx 0,122$; $w_2'' \approx 0,163$; $w_3'' \approx 0,123$; $w_4'' \approx 0,231$; $w_5'' \approx 0,181$; $w_6'' \approx 0,18$.

In fact, α and β determine the importance of each of the two types of quality weights (w_i and w_i') when calculating the generalized weight. The selection of α and β depends on different factors. In particular, in determining α and β, it is essential how reliable and accurate the weights w_i obtained by expert assessment based on the teacher's data. The selection of values α and β can also be done by analyzing the accumulated data on the document assessment process over a period of time.

Step №7. The system calculates the complex assessment of the document prepared by each k-th trainee by the formula: $L_k = \sum_{i=1}^{N} w_i'' d_{ki}$. The teacher can correct the automatically obtained complex assessment.

For the reviewed example: $L_1 \approx 0,7$; $L_2 \approx 0,43$; $L_3 \approx 0,85$; $L_4 \approx 0,64$; $L_5 \approx 0,25$.

The higher the complex assessment, the higher the quality of the prepared document. Thus, in this example, the best way to handle the exercise of the trainee № 3, the worst – the trainee № 5.

Step №8. It is possible to convert the obtained value of the complex assessment L_k into a 4-point scale widely used in the education system [9] (this step may be necessary, for example, if students of the educational institution perform the exercise).

For example, the conversion can be performed according to the following rule: $0,85 \le L_k \le 1$ – «excellent» (5); $0,7 \le L_k < 0,85$ – «good» (4); $0,5 \le L_k < 0,7$ – «satisfactory» (3); $0 \le L_k < 0,5$ – «unsatisfactory» (2).

The system initially converts to a 4-point scale automatically, and the teacher can then adjust the score.

Step №9. The teacher can prepare remarks and recommendations for the trainee on the drafting of the document aimed at improving its quality.

III. Subsystem for Automated Assessment of the Quality of Exercises in Training Development of Software Documentation

Functional requirements for the ATS subsystem, by means of which implementation of the above-mentioned procedure is

realized, are presented using the UML use case diagram [2] in Fig. 1.

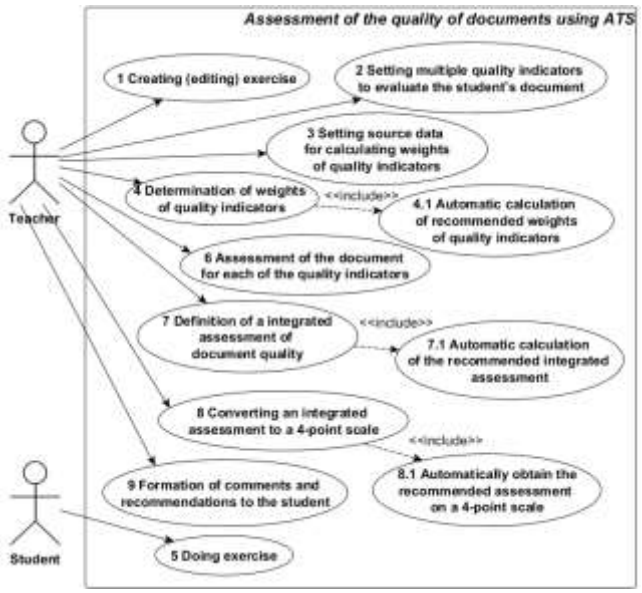

Fig. 1. Functional requirements for the ATS subsystem

Apparently on Fig. 1, the subsystem allows to calculate the values used at assessment of skills of the trainee recommended to the teacher.

Let's consider models of user interfaces of the created subsystem realized as the web application. The interface for definition the weights of quality indicators (in relation to exercise on development of set of test cases) is provided on Fig. 2. For each indicator the teacher selects value of importance from the revealing list (value from 1 to 10) with a possibility of manual entry. After clicking of the "Calculate" button on the screen the recommended value of weight which the teacher, if necessary, can change manually in a text box is displayed.

Quality indicator name	Importance of quality indicator	Quality indicator weight, %
1 Use of a competent technical language in the description of steps and expected results	6	12 (12)
2 Maintaining a balance between specificity and community	9	18 (18)
3 Maintaining a balance between simplicity and complexity	7	14 (14)
4 Being able to detect errors in the program with a high probability	10	20 (20)
5 Following a sequence in the description of steps and expected results (relative to the purpose of the test case)	10	20 (20)
6 No unnecessary actions in the description of test-case steps	8	16 (16)

Calculate

Fig. 2. Defining quality indicator weights

The interface for assessment of set of test cases created by the trainee is provided on Fig. 3. Having clicked a hyperlink "Go to viewing the created test cases", the teacher can study the made document. During the assessment process for each quality indicator the teacher selects a value from the list (from 0% to 100%) with the possibility of manual entry. After clicking of the "Calculate" button, the recommended values of complex assessment (on 100-mark and 4-mark scales) which the teacher, if necessary, can change manually are displayed. The text area for input of remarks and recommendations to the trainee on improvement of the document is provided.

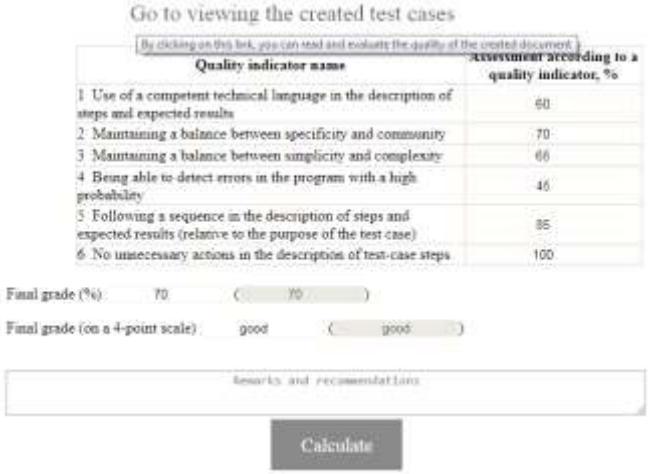

Fig. 3. Assessment of set of test cases

IV. CONCLUSION

The developed methodology allows us to formally (based on the use of mathematical methods) evaluate the quality of compiling program documentation during vocational training. The application of this methodology at the enterprise helps to increase the level of development of skills and accelerate the adaptation of a young specialist:

1) In the course of in-company training, tasks for the development of documentation are issued that are similar to the real production problems that are solved in this organization. The assignment is evaluated by a teacher with extensive experience in practical work on the preparation of documents.

2) At the initial stage of labor activity, the implementation of real production tasks (for some customers) is initially evaluated by a highly qualified specialist (for example, the head of a development team or a leading programmer). On the one hand, this allows you to assess the level of development of skills. On the other hand, a young specialist, based on a list of remarks, can improve the existing version of the document (which helps to improve the quality of the software product as a whole).

Perspectives of further researches in the field of automated scoring of quality of drawing up program documentation are:

1) Involvement of the group of experts for receiving scales of figures of merit and assessment of the document made by the trainee. This situation is possible, for example, when holding the student's Olympiad in higher education institution. As a result, application of methods of group expert assessment will be required [7].

2) Execution of the automatic analysis of documents for their preliminary estimate on some of indicators. For example,

implementation of search of phrases it seems "the large volume of data", "low speed", "high quality", "the evident interface" which can confirm incompleteness of work on the document, a possibility of its subjective interpretation [1].

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Artificial Intelligence Technologies in Higher Education Institutions: a Model of Adaptive Education

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Abstract— **The world economic system is on the verge of the fourth technological order, the transition to which is caused by the widespread introduction of information and communication technologies in all areas of development. The introduction of innovative digital technologies has led to the digitalization of the economic sphere and the formation of a new economic sector - the digital economy, which is the driver of the development of the entire economic system today. One of the main areas of the digital economy is using cloud computing, big data, the implementation of cyber-physical systems, as well as the development of artificial intelligence systems. Innovative approaches in economic development are modern challenges for the entire education system, requiring the training of highly qualified specialists who can solve problems arising at the present stage of development. The development of innovative digital technologies not only transforms the entire system of economic relations but also allows formatting new innovative approaches in education, opening up new prospects for development. The approaches and possibilities of using artificial intelligence systems in the higher education system are analyzed in the paper, in connection with which a large-scale study of the global artificial intelligence market is carried out: its key parameters in the field of finance, the pace of development are determined; the main leaders in this field are identified. The directions of the application of artificial intelligence systems were analyzed in this study, within which it was determined that the field of education is one of the promising areas of application of these technologies. In education, adaptive student learning is one of the most popular sectors for the introduction of the technologies under consideration: it allows setting an individual learning path for each individual, based on the analysis and processing of training data for each student using artificial intelligence systems. In this regard, the conceptual model of an adaptive learning system using these technologies is considered and analyzed in the article. On the basis of the received information, it would allow to raise the quality of training of specialists in higher educational institutions to a new level.**

Keywords— information technology management; educational process; systems with artificial intelligence; adaptive learning; modeling; higher education institutions

I. INTRODUCTION

One of the drivers of economic development is the technology of artificial intelligence, which allows to provide a solution to many problems related not just to the automation of technological processes, but also to the solution of problems, which only the person could perform.

Today, artificial intelligence systems solve complex tasks in management, creating unmanned production, while the control of all technological processes is assigned to these systems. The introduction of artificial intelligence systems takes place not only in production but also in the financial sector. For example, today attempts are made to exploit such technologies to analyze the cash flows of companies and, based on that, study prospects for development are determined in one direction or another. It can be recalled the announced program of introducing artificial intelligence systems into the work of the Russian bank – Sberbank, which involves replacing more than three thousand lawyers providing legal assistance to clients of a financial institution. Besides, service robots with elements of artificial intelligence are part of our daily lives, providing comfortable living conditions for each person.

In the future, the proposed concept of Industry 4.0 involves the formation of single information and cybernetic environment using artificial intelligence technologies for the existence of a single person, capable of providing comfortable living conditions with his or her requirements and wishes. [1–3]

Today, using artificial intelligence is included in the sphere of education. The first systems are created on the basis of these technologies in the field of proctoring when machines monitor the students' passing tests and tasks when they are passed in an electronic environment by using face recognition algorithms.

One of the areas in education is using artificial intelligence technologies in adaptive learning, the use of which allows determining the possibilities of forming an individual educational trajectory for each student. In this area, the study is just beginning to form, so the analysis of the problem is quite relevant and requires close consideration. [4]

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II. KEY RESEARCH FINDINGS

A. *Definition and directions of development of artificial intelligence technologies*

The development of artificial intelligence systems began in the 60–70s of the last century with the development of the first neural networks, heuristic programming methods and the development of situation control methods for large systems.

Currently, there is no unique definition of artificial intelligence. Artificial intelligence is interpreted on the basis of different approaches in different areas of modern science.

Artificial intelligence is an area of information technology from the standpoint of the information approach, the main task of which is the development of intelligent computer systems that can solve problems that were traditionally solved with the help of the human mind, for example, understanding the language, reasoning, solving problems.

At present, several directions in the development of artificial intelligence technologies are distinguished:

Neural networks are a mathematical model, as well as its hardware and software implementation, created in the image and likeness of biological neural networks;

An expert system is a computer system capable of replacing an expert person in various fields on the basis of knowledge base technologies and relevant algorithms;

A natural language processing system is an automatic information system that works with natural language to communicate with the user;

Fuzzy sets are the basic concept of fuzzy logic, in which instead of two values zero and one, the entire range is considered [0; 1];

Evolutionary methods and genetic algorithms are heuristic algorithms used for optimization problems, which are based on mechanisms similar to natural selection in nature;

A knowledge extraction system is a new innovative technology for extracting and processing large amounts of information obtained from global computer networks. [2], [5]

B. *Evaluation of the global market of artificial intelligence*

Artificial intelligence technologies are one of the drivers of not only the digital economy but also the entire economy as a whole. In 2025, the market for artificial intelligence would reach $ 103.7 billion (Fig. 1). [1], [4–6]

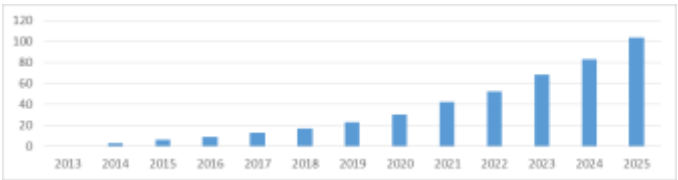

Fig. 1. The dynamics of the market for artificial intelligence systems, billions of dollars

The average annual growth rate of the global artificial intelligence market is about 30%, which is five times higher than the growth rate of the entire IT market.

One of the main areas of application of artificial intelligence is its use in video surveillance systems, which is explained by the achievement in facial recognition using technical vision. The volume exceeds three billion dollars in this area (Fig. 2). [3], [5–8]

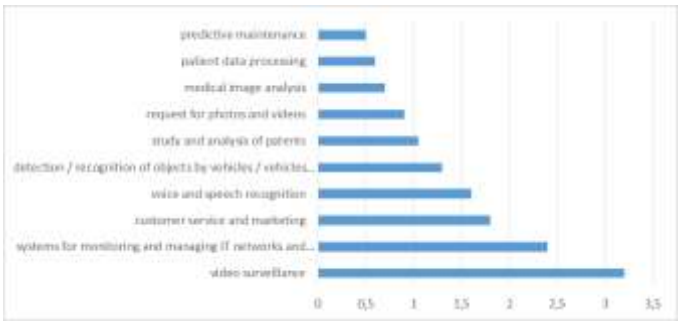

Fig. 2. The main directions of applying artificial intelligence, billions of dollars

One of the leaders in the application of artificial intelligence systems is the United States; its transaction volume exceeds $ 6.4 billion (Fig. 3). [9, 10]

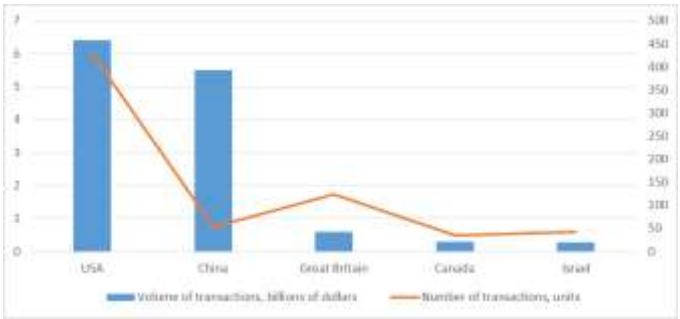

Fig. 3. Leaders of the global artificial intelligence market in 2018

The volume of the Russian artificial intelligence market in 2018 was about $ 20 million, which amounted to about 0.11% of the global market. In 2020, this indicator should increase to 0.8%.

C. *Analysis of using artificial intelligence in education*

Education is one of the promising areas for the use of artificial intelligence systems. It is possible to obtain the best indicators of increasing factor productivity through the introduction of these technologies. The education sector is among the five leaders in the ranking of promising areas (Fig. 4). [11]

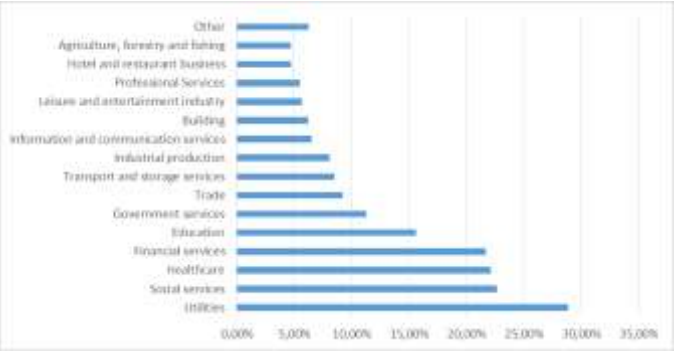

Fig. 4. Rating of industries in terms of increasing factor productivity through the introduction of artificial intelligence, percent

The global market for artificial intelligence in education would reach $ 3.3 billion in 2025 (Fig. 5). [3], [12].

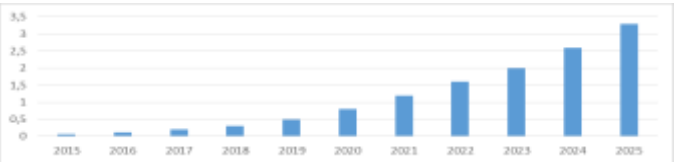

Fig. 5. Dynamics of the global market of artificial intelligence systems in education, billions of dollars

The main direction of the use of artificial intelligence in the field of education is proctoring – a system of remote monitoring of the behavior of the subject during the verification tests (Fig. 6). [13, 14]

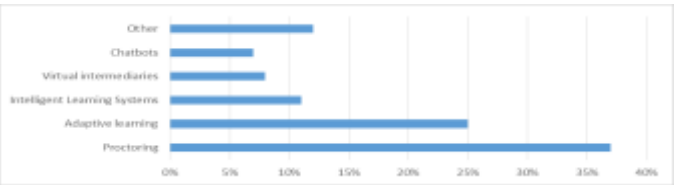

Fig. 6. The main directions of the use of artificial intelligence in education, percent

D. The model for the formation of adaptive learning based on artificial intelligence technologies

Today, artificial intelligence is the basis of innovative technologies that are beginning to form “smart manufacturing”, create “smart cities” and, accordingly, transform the sphere of education. More than a dozen years have been talking about the possibilities of using artificial intelligence technologies in education.

The basis of artificial intelligence in education is the main goal to make computationally accurate and explicit forms of educational, psychological and social knowledge that often remains implicit, that is, to present this knowledge in a formalized way, in order to analyze the results using computer programs and, based on the study, obtain an appropriate training model.

One of the areas of artificial intelligence is the possibility of forming adaptive learning environments that allow determining the individual trajectory of the student based on the analysis.

An adaptive learning environment is a digital one that adapts learning approaches and materials and explores the opportunities and needs of individual students.

The basis of artificial intelligence is the models and the modeling process. These models are real processes in the form of computer programs, on the basis of which one can make the corresponding calculations and forecasts.

Using artificial intelligence in education has to be based on three basic approaches:

- training process description (pedagogical model);
- description of the discipline (domain model);
- description of the learner (learner model). [6], [8], [11]

Each suggested model is a set of specific components, presented in Table 1.

TABLE I. THE BASIC MODELS THAT ARE BASED ON ARTIFICIAL INTELLIGENCE IN EDUCATION

Types of models	**Model basis**	**Model components**
Pedagogical model	Knowledge and teaching experience	“Productive failure” (allows students to research the concept and make mistakes before showing the “correct” answer)
		Feedback (questions, tips) caused by the student’s actions, which is designed to help the student improve their learning
		Assessment for determining the quality of the acquired knowledge
Domain model	Knowledge of the subject under study (subject examination)	Subject structure
		Filling and content sections of the discipline
		Subject approaches
Learner model	The student’s knowledge	Previous achievements and problems of studying an individual student
		Student's emotional state
		The student’s involvement in the learning process. For example, time-on-task, the time to complete the task, which is considered one of the most important factors affecting student learning and academic performance, can be defined as the amount of time the group spends in quality training

Let us imagine a model of adaptive learning based on artificial intelligence technologies, the structure of which has the following form (Fig. 7). [2], [12], [14].

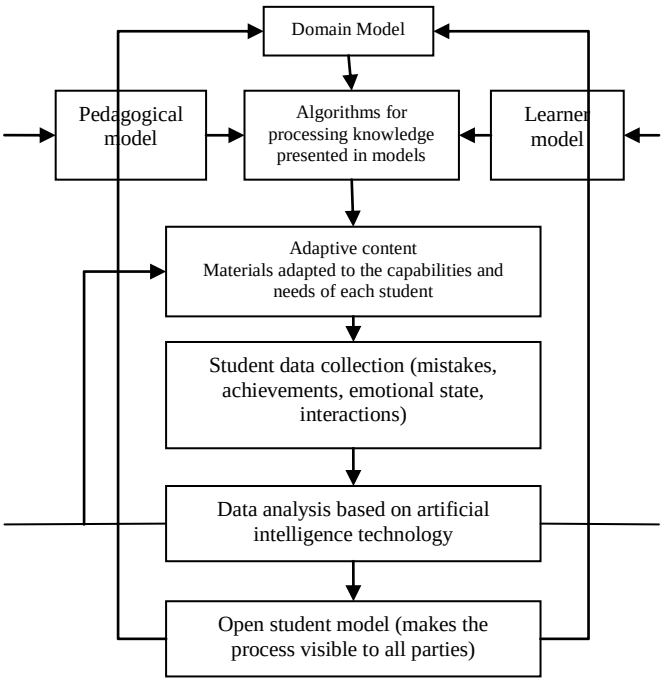

Fig. 7. The structure of the model of adaptive learning based on artificial intelligence technologies

This structure is based on the three basic models described above. Algorithms based on artificial intelligence systems provide content for a single student. In the learning process, the system handles the process of obtaining knowledge in the form of analysis of achievements, mistakes, emotional state of the student. Based on the collected information, a process of analysis of all the parameters of the learning process, on the basis of which self-training and improvement of the system.

The adaptive learning system based on the analysis of a large amount of information and artificial intelligence technologies can provide an individual education path for an individual student in each subject, taking into account his or her capabilities and abilities.

III. CONCLUSIONS

The development of the modern world is based on the mass introduction of information and communication technologies, which allow for a new qualitative leap in the development of the entire infrastructure surrounding a person, while the transformation would take place for a single individual. Innovative technologies in the field of artificial intelligence should provide such an opportunity.

Artificial intelligence systems are the driver of the development of the modern digital economy. The global market for these technologies is expected to reach $ 103.7 billion by 2025, while the average annual growth rate exceeds the growth rate of the entire IT market by five times.

One of the areas of application of artificial intelligence is the education sector, which, according to the possibilities of increasing factor productivity, closes the top five with an indicator of 15.4%. Moreover, the global market for these technologies in the field of education is expected to exceed $ 3.3 billion by 2025.

One of the main direction of using artificial intelligence in the field of education is the possibility of adaptive learning, which allows, on the basis of three basic models: the pedagogical model, the learner model and the domain model, using knowledge processing algorithms, to provide adapted content for each individual student, through training artificial intelligence systems based on the analysis and processing of large amounts of information. This will allow building an individualized trajectory of the student on the basis of his or her abilities and capabilities both for studying a particular subject and for the process of forming a specialist in a particular field, thereby moving away from the average approach to training that exists today and does not allow opening everything learner capabilities.

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Educational Process Digitalization: Introduction of Cloud Laboratory Complexes

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***Abstract*—Today's world is a dynamic system in which development is determined by the large-scale implementation of information and communication technologies permeating all spheres of economic development. The introduction of digital technologies has led to the formation of a new direction in the economy - the digital economy, the drivers of which is Industry 4.0 and Fintech. Today, the most innovative technologies in the development of the digital economy are big data, cloud computing, artificial intelligence, cyber-physical systems that determine the main directions of modern development. Digital transformation of economic development not only requires new specialists who are able to develop and introduce innovative technologies, but also dictates the need for new approaches in the educational process itself. The transformation of the education sector through the introduction of new digital technologies, in particular, cloud computing is analyzed in the paper. Cloud computing technologies are widely used in all areas of development, in connection with this, a study of the global cloud computing market is conducted, and its key parameters are analyzed: financial volumes, growth rates, development prospects. Particular attention is paid to areas of using cloud technologies in the educational sphere, priority areas were identified, and their further implementation was assessed. One of the main opportunities for the use of cloud technologies in the educational process is the introduction and use of modern training laboratories of various orientation using cloud computing. The cloud automated banking system BISquit was introduced at the St. Petersburg Polytechnic University of Peter the Great on the basis of the "Computer Technologies in Banking" laboratory. This system allows getting practical knowledge about financial institutions' operation within the walls of an educational institution. The creation and implementation of such type of laboratory in the educational process is discussed in the article.**

Keywords— information technology management; educational process; cloud computing; educational laboratories; automated banking system

I. INTRODUCTION

Today's world is at the threshold of the fourth industrial revolution, which involves the large-scale implementation of the most innovative information and communication technologies in all areas: industry, services, infrastructure, that is, everything that surrounds a person in his or her daily life. The formation of a new technological order implies the creation of "smart production", "smart cities", "smart medicine" and other areas in all spheres of development, but a distinctive feature of this digital transformation of our life is the synthesis of these areas into a single information field, allowing to solve problems in any direction due to a comprehensive analysis of the problem from all points of view for each individual. [1–4]

Such large-scale transformations require corresponding changes in the educational process, which should provide training of the highest-level specialists for solving relevant problems that are already emerging now for further digital development.

On the one hand, the digitalization of the world economic system requires the training of specialists in completely new areas, and on the other hand, it provides for new innovative approaches in the field of education itself. One of such approaches is the introduction of cloud computing technologies, allowing to provide a new quality level of education due to the scaling of educational processes, providing access to truly unlimited resources, in the form of modeling any business processes on computer capacities.

One of these opportunities is the creation of educational laboratories that use all the advantages of cloud technologies to organize the educational process, providing innovative approaches in the field of education.

II. KEY RESEARCH FINDINGS

A. Definition and classification of cloud computing technology

The concept of cloud computing originated in the 1960s, when John McCarthy, one of the specialists in the field of information technology, suggested that someday computer computing would be provided remotely using publicly available applications.

Cloud computing is a technology that involves the formation of software applications (computing clouds) that allow the user to access them through computer networks.

Today, there are three main types of cloud computing:

- Infrastructure as a service (IaaS) assumes computer capacity for the deployment of its software applications as remote access;

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- Software as a service (SaaS) involves the provision of software for use in their own purposes;
- Platform as a service (PaaS) implies the provision of a cloud infrastructure to a user for the deployment of their own or acquired applications that allow solving the tasks required with their help, in this case the user has access to some infrastructure configuration parameters;
- Business process as a service (BPaaS) involves the provision of a remote form of business process, allowing solving the problems facing the company;
- Security management as a service (SMaaS) requires that due to the cloud the user can solve a range of issues related to security.

Depending on the form of providing cloud computing, there are three types of clouds:

- Private clouds. This is a type of clouds, which involves the formation of a computing cloud within its organization and provides access within it, in which case the cloud is managed by the company itself;
- Public clouds. This is a type of clouds, which involves the creation of cloud capacity by a third-party organization and providing them to various companies as a third-party service. In this case, cloud management is available only to the organization that created it;
- Hybrid clouds are clouds that combine private and public cloud technologies. [2], [4], [5–7]

B. Evaluation of the global cloud computing market

Cloud computing is one of the drivers for the digitalization of the entire economy. By 2025, the cloud computing market is expected to reach $ 603.2 billion (Fig. 1). [3], [6], [8]

Fig. 1. The dynamics of the development of cloud computing, billions of dollars

As can be seen from the diagram the SaaS segment is in the first place, which is supposed to reach $ 229.7 billion by 2025. The average annual market growth rate is over 17.4%, which is 2.9 times higher than the total IT technology market.

Today, cloud technologies have found their application in almost all fields. However, the leading position was occupied by the healthcare sector in 2018, which accounted for $ 12.1 billion (Fig. 2). [1], [9]

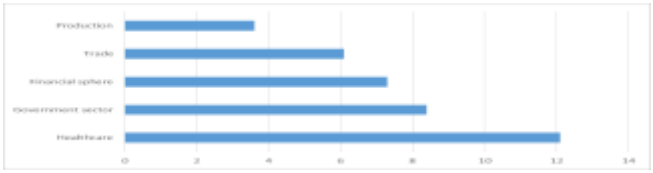

Fig. 2. The leading sectors on introduction of cloud computing, billions of dollars

The leader in introducing cloud computing is the United States whose volume is about 75% of the total market (Fig. 3). [5, 6], [10]

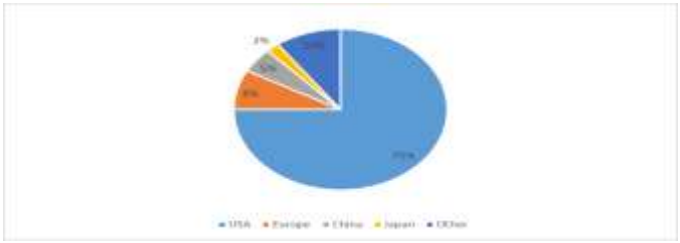

Fig. 3. Countries - leaders in implementing cloud computing, percent

Russia occupies a share of 0.3% on the global market and its figure will rise to 0.35% by 2020.

C. Evaluation of the use of cloud computing in education

Despite the large-scale introduction of cloud computing, the market for these technologies in education has not reached such impressive results as in other areas. Only in 2025, its volume can reach the figure of $ 1.1 billion (Fig. 4). [11–13]

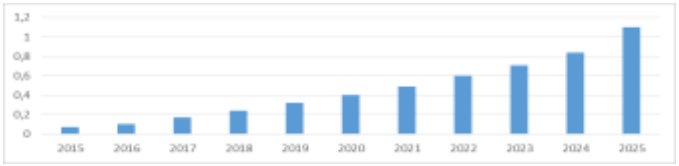

Fig. 4. Dynamics of the volume of the global market for cloud computing in education, billions of dollars

Using cloud computing technologies in education can be based on the benefits they provide:

- cloud computing can significantly save on the purchase, use, upgrade of software and hardware;
- security, resiliency and scalability of any processes using cloud computing;
- remote access from anywhere with Internet access.

The largest volume of using cloud computing in education belongs to ensuring access to computer programs that makes about 30% (Fig. 5). [7], [14, 15]

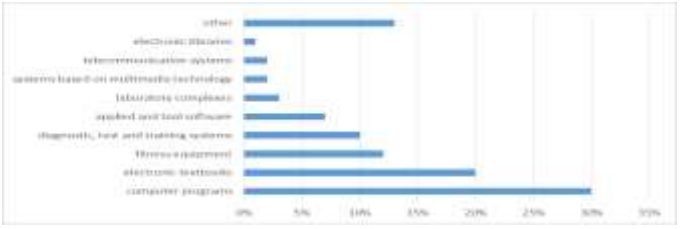

Fig. 5. Using cloud computing in education, percent

D. *Perspectives for the introduction of cloud laboratory complexes by the example of an automated banking system*

Laboratory complexes is one of the areas of using cloud computing in the field of education, which are not widely used today. However, their use is quite promising.

For example, in St. Petersburg Polytechnic University of Peter the Great, the laboratory "Computer Technologies in Banking" was created in 2005, which was based on studying the work of a financial institution based on the automated banking system "BISquit". The structure of the laboratory is shown in Fig. 6.

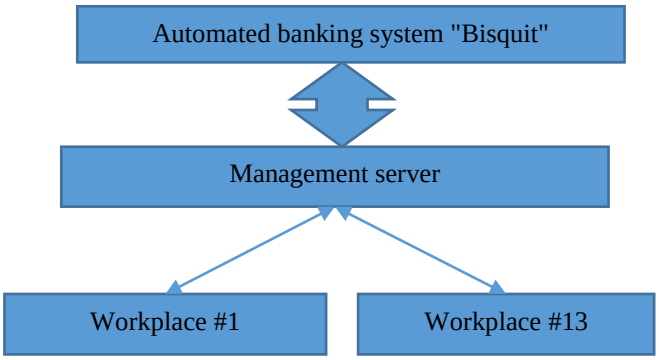

Fig. 6. The structure of the educational laboratory "Computer technologies in banking"

The laboratory consisted of 15 computers, one of which was running the Linux operating system, and that was where the automated banking system was located. The second computer had the network operating system Windows NT, whose task was to manage a computer network of thirteen workplaces, on which there was a simple Windows operating system. Workplaces were personal computers whose task was to provide user access to the banking system.

The bandwidth of the school laboratories was not very high due to limited workplaces, in connection with which it conducted practical training in two disciplines: Banking Information Technologies and Banking. The volume of performed practical exercises is presented in Table 1 with the full workload of the laboratory.

TABLE I. CRYPTOCURRENCY DEVELOPMENT STAGES

Discipline	Time for practical training from total amount, %	Result
Banking Information	50	Gaining practical skills in the automated banking system,
Technologies		introduction to the work of junior and middle management of the bank
Banking	25	Gaining practical skills in studying the operations of a financial institution; making economic calculations on the main operations of a credit institution

The restriction on the implementation of practical work turned out due to a small number of workplaces and a large number of students in groups. In this regard, they had to be divided into separate subgroups.

Accordingly, the laboratory was modernized in 2016: the automated banking system was transferred to a virtual machine. Virtualization is one of the foundations of cloud computing, which consists in creating an application model that offers some advantages over the original configuration, in particular, removing the restriction that exists in its original form.

As a result, the structure of the laboratory took the following form (Fig. 7).

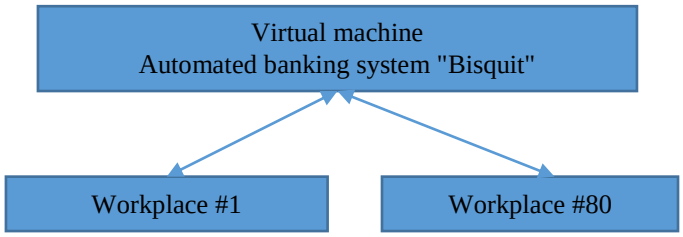

Fig. 7. The structure of the educational laboratory after modernization

As a result of the transformation of the laboratory, a private cloud was formed, allowing access to several computer classes at once. This increased the number of workplaces to eighty and greatly expanded the capabilities of the laboratory. It should be noted that the number of workplaces is limited in this case by the number of computers in laboratories connected to the computer network, and not by the capabilities of the virtual machine.

Because of increased traffic, the provision of the educational laboratory for other disciplines has increased (Table 2).

TABLE II. TIME OF PRACTICAL TRAINING FOR ACADEMIC DISCIPLINES AFTER THE MODERNIZATION OF THE EDUCATIONAL LABORATORY

Discipline	Time for practical training from total amount, %	Result
Money, credit, banks	50	Studying the structure of a financial institution, its goals and objectives
Audit of banks	100	Considering the issues related to audit of banks, introduction to the credit and deposit policies
Banking information	100	Gaining practical skills in the automated banking system,

Discipline	Time for practical training from total amount, %	Result
technologies		introduction to the work of junior and middle management of the bank
Banking	100	Gaining practical skills in studying the operations of a financial institution; making economic calculations on the main operations of a credit institution
Bank accounting	100	Studying of bases of accounting at financial institutions by concrete examples in the automated banking system
International Financial Reporting Standards	50	Studying of the basic reporting and document flow at financial institution

At the same time, the incomplete load on some disciplines is explained not by the shortage of workplaces, but studying of other questions within a course which are not connected with financial institutions.

In the future, there is a task to expand capabilities of the educational laboratory in the direction of access to the automated banking system not only on internal network, but also to provide full access on the Internet and to unite this laboratory with the electronic courses conducted on the Moodle platform. This can ensure full access to all opportunities of the formed system for all forms of education full-time, part-time, and to a greater extent correspondence

III. CONCLUSIONS

Modern development is accompanied by the mass introduction of digital technologies in all areas. Therefore, an innovative direction has emerged within the traditional economy – a digital economy, based on the creation of new business models through the introduction of information and communication technologies.

The formation of an innovative approach to the development of the economy requires the training of specialists who are able to provide new challenges in the modern world, and it allows to provide innovative approaches in the educational process through the introduction of digital technologies, one of which is cloud computing.

Cloud computing is one of the drivers in digital technologies. Its volume of the global market is expected to exceed 680.3 billion dollars by 2025, and it may exceed the market of IT technologies by 2.9 times by the average annual growth rate.

Healthcare is the market leader in cloud computing. In 2018, the volume of implementations was about $12.1 billion. The volume of the cloud computing market in education is supposed to reach $1.1 billion only by 2025.

One of the main directions in the field of education is access to computer programs, which is over 30%, electronic textbooks are on the second place, whose figure is about 20%, and third place is virtual simulators, with an indicator of 12%.

The introduction and use of cloud laboratory complexes are one of the directions in the field of education, the prospects of which are quite well illustrated by the educational laboratory "Computer Technologies in Banking", created at Peter the Great St. Petersburg Polytechnic University based on an automated banking system. Due to its modernization by virtualization banking applications and the formation of a private cloud, it was possible to expand the number of workplaces by 6.2 times. The configuration of the system itself was simplified, the number of disciplines and practical exercises that are based on the cloud laboratory complex were increased, and the amount of practical trainings grew by 6.6 times.

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Early Professional Orientation of Students: Interaction Mechanisms of HEI and Industrial Undertakings

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***Abstract*— Mechanisms of early professional orientation of students such as educational and on-site trainings, internships at high-tech enterprises, guided visits and presentations of enterprises, job fairs and career days are considered.**

Keywords— career; early professional orientation; interaction mechanisms; HEI; industrial enterprises; engineering personnel

I. INTRODUCTION

Currently, a system formation process of engineering personnel trainings for modern industrial enterprises is active in Russia. Today, engineering personnel are understood as not simply university graduates, but unique specialists with general cultural and professional competencies, which are necessary to perform specific production functions that meet modern professional standards. In a gradual convergence of educational and professional standards, the modern system of engineering personnel trainings is characterized by the multi-level trainings, multivariate educational approaches, strengthening of a role played by employers in engineering personnel trainings, increasing practical orientation level of higher education programs, high standards for the state accreditation of HEI education programs, conditions creation for professional and international accreditations of education programs, organization of federal and regional centers for graduates and working professionals competences evaluations [1].

At the same time, almost all employers, especially representatives of large Russian high-tech enterprises of the electronic profile, which participated in the importance assessment of professional competencies when developing the Federal State Educational Standards of new generation, prefer graduates with advanced fundamental and general education. The fundamental professional and appropriate special education under rapidly changing priorities in science and technology, and, as a result, under rapidly changing product ranges in industrial production, directly affects the independent and fast acquisition of the necessary new knowledge by graduates, quick adaptation of the graduates to new specific types of professional activity and, ultimately, their successful professional careers [2].

The successful professional careers of HEI graduates in their direction (specialty) of trainings are the main and natural assessment criterion of graduates trainings quality by employers. In this regard, it is reasonable to start the graduate professional career while educational process and not after the graduation. Many industrial undertakings realize the importance of their direct participation in new engineering personnel trainings and provide this opportunity. Let us consider interaction mechanisms of HEI and industrial undertakings in a context of an early professional employment of students.

II. TRAININGS OF STUDENTS AT ENTERPRISES

The most important cooperation part between HEI and industrial undertakings is on-site training of students, and thus, the interaction system organization of HEI and main trainings bases, which are enterprises where students are allowed to work in accordance with their direction of trainings. An agreement on students on-site trainings should be signed up between the HEI and enterprise. The HEI unit, which is responsible for the students on-site trainings organization, develops the trainings plan and individual tasks, while the enterprise negotiates these documents and provides on-site training places. Together, the HEI and enterprise make a trainings schedule. This is the most traditional interaction mechanism, but it is still relevant. On-site trainings at enterprises eliminate a contradiction between HEI traditional trainings and students interests. This partnership scheme is beneficial for everyone: the enterprise, which allows students to work during trainings, has an opportunity to see undergraduates at work, and the HEI, to a certain extent, fills the gap in existing trainings. At ETU "LETI", for example, about 90% of students who are citizens of the Russian Federation conduct trainings at regional enterprises. Unfortunately, enterprises often cannot provide this opportunity for citizens of other countries.

III. INTERNSHIPS

In contrast to trainings, internships are not an integral part of the education process. Enterprises hire interns as ordinary employees. However, interns working schedule may differ from that established in organization, it can be either flexible or part-time, which is convenient, for example, for master's degree students. As a general rule, enterprises provide students with internships for some merits: winning the competition, etc., since the internship is one of the types of additional professional education of specialists and it is carried out to form and practically consolidate professional knowledge and

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skills acquired as a result of theoretical trainings. Internship may be paid.

IV. Course projects and thesis preparations

On the one hand, course projects and thesis preparation are one of the forms of students research work, and on the other, thesis preparation should be considered inextricably connected with the organization of pre-degree practical trainings. Therefore, bachelor's or master's thesis preparation at the enterprise meets this enterprise interests and becomes a good motivation to continue this work. The enterprise also has time and opportunity to evaluate this candidate for a vacant position, and to get an idea of the training level at the HEI in general.

V. Guided visits and presentations of enterprises

At the very beginning of acquaintance with a field of professional activity that students have chosen for themselves, it is important to engage them and show development prospects of the industry where they can apply their professional skills. The regular guided visits to the city enterprises within the social partnership framework can be considered as the first stage of the students professional orientation, which forms a positive time perspective related to their future profession [3].

The presentations of enterprises are also of great interest to students, especially if the target audience is correctly selected, so that the direction of students trainings is consistent with the enterprise working direction. For example, at ETU "LETI" more than 20 guided visits and presentations of various companies are held annually. The following companies and enterprises are the most successful among students: JSC Alfa Bank, Group of Companies "Diakont", LLC Titan Engineering, Group of Companies "TwinPro", NRC "Kurchatov Institute", JSC Oceanpribor, JSC "RRI" Electronstandart", State Unitary Enterprise "TEK SPb", JSC Ravenstvo, JSC Compressor, RAIDIX, PJSC MTS, Group of Companies "Rakurs", CJSC Rielta, Business Incubator "Ingria", JSC Technopark of Saint Petersburg, Special Design Bureau "Kontur", Procter & Gamble, LLC Doctor Web, Elmos Semiconductor AG, JSC NII TM, JSC Coulon, JSC "VNIITVCH", Webim and others.

VI. Job fairs holding

Job fairs unite interests of employers, HEI and graduates. In recent years, not only graduates, but also undergraduate students, attend job fairs and career days at HEI. For participation in such events, HEI must select enterprises that provide better working conditions, namely the regional market leaders in the directions of HEI trainings. At job fairs, human resources department representatives of potential employers conduct interviews, advice students on available job opportunities, and offer graduates places for on-site and pre-degree practical trainings. Job fairs remain one of the most important directions in strengthening partnerships with employers.

Job fairs that are held in the interests of one partner also have a good effect. Thus, for 4 years in a row, ETU "LETI" has held job fairs for PJSC Gazprom. In 2019, 17 subsidiaries of PJSC Gazprom offered job opportunities and places for trainings for students and graduates of ETU "LETI".

VII. Creation of job portals

The above mentioned interaction mechanisms require an information support such as the HEI own job portals, posting on the HEI website information about enterprises that are regional market leaders, etc. The job portal at ETU "LETI" was launched in 2016. The job portal purposes are to increase the graduates competitiveness in the labor market, implement the "Early professional employment" program for ETU "LETI" students, and increase the HEI attractiveness. The job portal creation necessity was due to the change of methodology for calculating of the indicator "Employment of graduates" in 2016 according to instructions of the Ministry of Education and Science (based on the Pension Fund of the Russian Federation data). The main objectives of the job portal are listed below:

- Creation of the modern service of employment opportunities that is convenient for students and industrial partners of the HEI
- Modernization of systems of students trainings and graduates employment
- Increasing the number of partners for trainings and graduates employment
- Carrying out regular activities aimed at stimulating graduates employment

After three years, the job portal has proven its relevance. 22 specialized enterprises, which have working direction consistent with directions of students trainings of the HEI, are constantly presented on the job portal. The benefits are listed below.

<u>For enterprises</u>

- Selection of employees not only in the interests of large enterprises, but also in the interests of small and medium-sized businesses
- Selection of highly qualified personnel in the particular technical field
- Ability to recruit employees on-line and save time
- Selection possibility through trainings and internships at enterprises
- Availability of relevant labor market information in the particular technical field

<u>For students</u>

- Selection of vacancies in the direction of training on-line
- Possibility to find a place for on-site trainings
- Possibility to find a future employer before graduation
- Review of the specialized enterprises of the region

- Understanding individual chances and value in the labor market
- Establishing professional contacts

For HEI

- Possibility of internal monitoring of graduates employment
- Possibility to monitor demands for trainings directions in the labor market to quickly adapt education programs to the employers needs
- Attraction of applicants, as well as the formation of the competitive situation
- Ability for foreign graduates to use the job portal to maintain professional contacts
- Ability to create international and Russian associations of the HEI graduates based on the professional community

VIII. Role of units of professional orientation and employment

The HEI units of professional orientation and employment are in constant contact with industrial enterprises to implement interaction mechanisms. They find a balance between interests of departments and industrial enterprises. The interests of higher educational institutions are to increase their competitiveness in the educational services and scientific products market by improving the quality of graduates professional trainings and teaching personnel advanced trainings. The interests of enterprises are to increase the competitiveness of their products and services by improving the quality of personnel. However, in the process of interaction between HEI and enterprises there is a third party, namely students and graduates, since the quality of professional trainings determines their competitiveness and relevance in the professional labor market. Therefore, at the HEI units of professional orientation and employment it is necessary to have employees familiar with the HEI educational programs and working direction of the specialized enterprises.

IX. Conclusion

The steady trend of an early professional employment exists today within the framework of strategic cooperation between the HEI and industrial enterprises. Students themselves tend to get professional orientation earlier, and try to get information about the labor market as soon as possible. The enterprises, which are interested in new personnel, are also ready to participate in the process of young specialist formation and trainings in accordance with their needs. The developed mechanisms allow providing industrial enterprises not only with qualified, but also with professionally adapted personnel.

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Analysis of Changes of the Content and Forms of Organization of the Educational Process in the Conditions of the Introduction of Emergent Technologies

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***Abstract*— The influence of modern innovative technologies on the content and forms of the educational process is considered. The necessity of interdisciplinary knowledge is substantiated, which is important not only for training specialists in areas related to the development, selection and implementation of new technologies, but also for all specialties, since it helps to navigate the predicted new complex, mobile world of emergent technologies.**

Keywords*— *interdisciplinary knowledge; advanced industrial technologies; learning content; educational process; forms of realization of the educational process; emergent technologies condition

I. INTRODUCTION

The development of industry in the condition of the introduction of new innovative advanced production and digital technologies, requires prompt personnel training of the necessary qualifications.

The active development of innovative advanced production and information (digital) technologies has a significant impact not only on industrial production, transport, the economy as a whole, but also on all spheres of human life. These technologies cover almost all spheres of science and production – from technical and technological (big data, cloud technologies, etc.) to information processing and transformation technologies (artificial intelligence models, cognitive modeling), creation of analogues of organs of living organisms (3D printing, robotic systems, artificial organs and other results of biotechnology and genetic engineering), etc.

All mentioned types of innovations are united by the integrated use of technology. Therefore, at a certain stage of development, the direction of NBIC technology (nano-, bio-, info-, cognitive technologies) took shape, and the concept of NBIC-convergence arose. At the same time, in mathematics, the term "convergence" means only integration (from Lat. Convergo – bring together). And although at present there are attempts to interpret this term in an expanded manner, other terms appear [1]. In foreign works, the term "emerging technologies" is often used (from emerge – appear) [13] which means the emergence of new properties as a result of the combination of technologies. The term emerging technologies implies that new results are expected from their use, changes in the level of technological and social development of production, in society, and in the technological progress.

Various concepts of streamlining emergent technologies are emerging. Recently, the social sphere has also been added to the mentioned NBIC technologies, and the term NBICS technologies appeared. The concept of cyberphysical systems (Cyber-Physical System – CPS) arose, based on the integration of computational resources and physical processes (in their expanded understanding, including biological, chemical and other processes) in order to achieve the emergence of fundamentally new opportunities for creating CPSs. To streamline the history of technology development, concepts of technological way of life, industrial revolutions arose.

It should be borne in mind that innovative technologies can have both positive and negative effects on all areas of socio-economic systems. Therefore, it is necessary to carry out their analysis and make decisions on the appropriateness of their choice for a particular enterprise (organization), taking into account the usefulness and consequences of their outreach, which is important to consider when determining the content of education almost in all specialties.

II. ANALYSIS OF THE INFLUENCE OF EMERGENT TECHNOLOGIES ON THE CONTENT OF EDUCATION

New technologies have no analogues, and it is almost impossible to find experts who could evaluate them on the basis of traditional methods of expert evaluations. We need new methods for making decisions on their choice for specific enterprises and organizations. Therefore, a number of new disciplines are needed in which the types and characteristics of technologies, the methods of artificial intelligence, predicative (predictive) analytics, statistics, methods of mathematical linguistics, studying the problems of computer analysis of big data, the synthesis of natural languages, and others are studied.

It is necessary to study hardware (servers, data storage systems, client systems, network equipment); operating systems and system software (virtualization, automation, basic resources management tools); binding software, etc.

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But along with this important information about new "fantastic" technologies, methods and means of working with them, it is important to understand a number of problems arising from their use, which significantly change not only production processes, but also the person's living conditions in the emerging new environment.

The concept of one of the ideologists of the third industrial revolution P. Marsh [2] is based on the fact that after the departure of production from leading countries, both fundamental scientists and knowledge go into the third world. At present, it is necessary to return production to developed countries, not mass production, but combination of expensive and cheap production technologies within the framework of hybrid strategies, to develop new "industry niches", production in which requires complex technologies. K. Anderson [3] predicts that in the near future everyone will be able to create a 3D model of the necessary thing using a design program (or download a finished program) and "print" it on a home 3D printer. Thus, the development of individual and hybrid production is predicted, the principles of organization of which differ significantly from mass and even serial production. Therefore it is necessary to change the content of education both in the specialties that ensure production processes, and in the field of organizational management.

The ideologist of the fourth industrial revolution, K. Schwab predicts: "At the beginning, the listed innovations will develop separately, but "the critical moment will soon come when they begin to develop, layering and reinforcing each other, representing an interweaving of technologies from the world of physics, biology and digital realities" [4, p. 9]. Thus, in the near future, a person will have to live in a rapidly changing world. Moreover, according to K. Schwab, in its scope, volume and complexity, "The Fourth Industrial Revolution has no analogues in the previous experience of mankind. New technologies unite the physical, informational and biological worlds, are capable of creating, on the one hand, enormous opportunities, and on the other – a potential threat" [4].

In order to navigate in this complex, constantly changing world, it is necessary to understand the laws of its functioning and development. Therefore, familiarization with interdisciplinary knowledge, and in particular with the theory of systems, is useful for almost all specialties. The open system concept can help.

It is known that the term "open systems" was proposed by the Austrian biologist L. von Bertalanffy as the basic concept of the organismical approach he was develop to the study of biological objects and processes [5]. Recently, this term has been proposed to be used in computer science as well – the concept of an open information system (OIC) has arisen.

In open systems, constantly exchanging mass (matter), energy and information with the environment, unlike closed systems (isolated from the environment), regularities appear that contradict the second principle of thermodynamics. In accordance with this beginning, the general course of physical events in closed systems proceeds in the direction of increasing entropy. At the same time, in open systems according to L. von Bertalanffy, "... the introduction of negentropy is quite possible," that is, a decrease in entropy; and "... such systems can maintain their high level and even develop towards an increase in the order of complexity" [5, p. 42].

L. von Bertalanffy actually discovered a new regularity in open systems – "the ability to withstand entropic (system-destroying) tendencies and exhibit non-entropic tendencies", which opposes the second law of thermodynamics.

To understand processes in the condition of the introduction of emergent technologies, the main difference between open systems and closed (isolated) systems is important: according to Bertalanffy, an open system reaches a state of mobile equilibrium, in which its structure remains constant. But unlike ordinary equilibrium state, this constancy is maintained in the process of continuous exchange and movement of matter [5, p. 42].

In parallel with the research of L. von Bertalanffy, in the period of the 1930s, the Soviet scientist E. Bauer investigated one of the features important for understanding the process of the development of living systems – the fundamental disequilibrium of living systems, i.e., the desire to maintain stable nonequilibrium and use energy to maintain oneself in a disequilibrium state. E. Bauer explains this by saying that the structures of living cells at the molecular level are pre-charged with "excess" energy that is excessive in comparison with the same inanimate molecule, and the body does use energy from outside not for work, but to maintaintion a nonequilibrium structure [6].

Thanks to the law of L. von Bertalanffy and the principle of E. Bauer, the system shows: the ability to withstand entropy (destroying the system) trends, to show the ability to adapt to changing environmental conditions and interference, both to external and internal, the ability to develop options behavior and change, if necessary, self structure, while maintaining integrity; ability and desire for purpose-setting.

These features have a variety of manifestations. On the one hand, these include properties useful for the existence of the system, its adaptability to changing environmental conditions, but at the same time, these features cause: irreducible indeterminacy, non-stationary parameters, instability of the system, unpredictable behavior.

Studies have shown that, thus, the development of an open system occurs: 1) due to the exchange of information, energy, material components (i.e. the openness of the system) with the environment and 2) due to the active elements that initiate own innovations and ensure the interaction of innovations.

Features of open systems are due to the presence of active elements that stimulate the exchange of material, energy and information products with the environment and display their own "initiatives", an active principle. Owing to this, in such systems the regularity of increasing entropy is violated and negentropic tendencies are observed, i.e., self-organization itself, development.

The role of active elements in an open system is countertalkative. Thanks to the active elements of the open system, which initiate innovations and their interaction, a new quality arises, i.e., a regularity of emergence appears, which is the main non-entropic tendencies that counteract the law of in-

creasing entropy in closed systems (i.e., the second law of thermodynamics), which ensures the development of open systems according to L. von Bertalanffy. At the same time, due to initiatives of active elements and innovations, problems of maintaining stability, the ability to withstand unwanted results that may arise from the joint implementation of heterogeneous innovations arise. Research conducted in the theory of innovation has shown that any innovation disrupts the normal functioning of enterprises and organizations, creates a situation of "creative destruction" according to J. Schumpeter [7]. And the entropy, which were considered a manifestation of disorder, on the contrary, stabilize the state of the system, since the minimum energy state to which the entropy processes lead is the most stable.

The regularities of the theory of systems help to understand these contradictions, to evaluate the degree of manifestation of entropy and non-entropy tendencies.

It is necessary to develop management models for the sustainable development of enterprises and organizations in the condition of introducing and using innovations, especially fundamentally new emerging technologies.

When managing the development of open systems, the problem arises of a comparative analysis and selection of innovative technologies, taking into account their features, capabilities, usefulness and consequences of their implementation. This is beginning to be realized and models are being developed for choosing and managing the introduction of innovations (for example, [8–10]), training personnel for working in the new information environment [11].

In developing these models, methods and models of system theory are used. In particular, it is proposed to apply 3 methods for organizing complex examinations based on the information theory of A.A. Denisov [12]:

1) a method for assessing the significance of H_i innovation, based on the assessment of the degree of purpose-compliance:

$$H_i = - q_i \log (1 - p_i'), \quad (1)$$

where p_i'– the probability of achieving the goal when using the technology, and q_i – the probability that the evaluated technology will be implemented and / or used;

2) a method of comparative analysis of the evaluated components during the initial period of their implementation by comparing the changes of the information estimates over time, based on the use of two methods of assessment – probabilistic method (1) and deterministic method:

$$H = \sqrt[\gamma]{\frac{1}{n}\sum_{i=1}^{n} J_i^{\gamma}}, \quad (2)$$

where J_i – information about the innovation, n – volume concept about measurement-covering innovation parameters;

γ – averaging parameter. When $\gamma = 1$, that means $H_i = J_i / n_i$.

3) a method for assessing situations, taking into account the mutual influence of the evaluated components, described by information equations in statics and dynamics:

$$H_i = H_{ii} + H_{ij}, \quad (3)$$

where H_{ii}, – the own importance of technologies in the absence of other technologies affecting its value; H_{ij},– change in the relevance; of the *i*-th technology in the presence of the *j*-th.

To manage the development of artificially created, and in particular, cyberphysical systems, it is important to rethink the essence, the state of the prospects for the development of the concept of open systems. Therefore, acquaintance with interdisciplinary knowledge, and in particular with the theory of systems, is useful for almost all specialties.

III. Analysis of new forms of educational process organization

Problems of education are discussed at the International Forum of Innovative Development "Open Innovations", regularly held since October 31, 2012, which is considered to be a global discussion platform dedicated to the latest technologies.

In development of the form of distance education, it is planned to create a common online platform that will allow the use of artificial intelligence technologies in training, and create a system that provides students with access to a second (digital) profession, i.e. specialty, which will be in demand in the conditions of introduction of innovative technologies.

Such tasks were set on July 11, 2019 at the 7th International Forum "Open Innovations", in "Skoltech", where the first day of the program was devoted to education. Russian entrepreneurs, scientists and managers discussed the problems of modernizing the Russian education system to increase its competitiveness.

In the process of preparing and holding the forum, the correspondent of the "Snob" journal Arina Kryuchkova talked with its participants and learned four rules for the formation of the future [https://snob.ru/entry/179824/], which, in our opinion, are controversial:

1. *Education will become a regular service, and its result will be guaranteed.*

At the same time, it is proposed to conduct individual tests, select teachers that are suitable according to the psychological characteristics, and group students according to their personal goals.

Comments. The task of striving for individualization of training has always been posed, and teachers, as possible, try to solve it with the help of individualization of tasks on term papers. However, for the time being, the current load standards of university teachers do not help. It is advisable for the Ministry of Science and Higher Education to try to develop necessary regulatory and methodological materials. This will improve the quality of education, but in any case, education cannot be considered a "regular service", and the result is guaranteed.

2. *Education will almost completely go online.*

The General Director of the the University 20.35 Vasily Tretyakov is sure of this. According to him, in the future, the student will view lectures in the recording, learn using games

in virtual reality and take testing on the network. Further recommended systems will work with this information: they will either offer a graduate a suitable field of activity, or build a further development trajectory. This will allow people to more effectively reveal their own potential.

3. *Schools and universities will disappear.*

The fact that students will begin to gain knowledge bypassing educational institutions is sure of the scientific director of the Institute of Education at the Higher School of Economics Isak Frumin. In the near future, pupils and students will not need to appear in the educational institution, they will be able to receive all the information directly from the teacher at home. For example, according to I. Frumin, many studies show that lectures are the most inefficient format of instruction. So, at the Higher School of Economics, a decision has already been made to switch to video lectures and offer students independent study and work in groups, while retaining the best lecturers.

As for home education, I. Frumin emphasizes that learning involves interaction, and therefore this form of training can be uncomfortable. However, the rapidly developing means of communication are successfully solving this problem.

Comments. Of course, the planned creation of a single online platform will allow dozens of Russian universities to use artificial intelligence technologies in training, to receive information about new technologies, or even get a second profession (digital profession).

At the same time, the main problem is the established patterns of education: if older people cannot refuse libraries and physical media (paper textbooks), then it is premature to talk about abandoning schools and universities. It is necessary to gradually look for new forms of organization of the educational process.

Universities and schools solve not only the problem of knowledge transfer, but also the problems of education and personality formation, which becomes even more relevant in the context of introducing unpredictable "fantastic" technologies. The transformation of universities and schools is inevitable, but extinction is unpromising.

4. *Pupils themselves will manage their education.*

Comments. Students have the right to manage their education. They can offer their own topics for course works and degree works, choose a form of education process on the basis of individual plans. At the same time, it is known that there are few such willing, creative-minded students. Most are conformists, preferring to work by analogy or borrow information from previous works. The scientific-research system for students in universities helps to shape the desire to manage their education; in schools there are extracurricular activities such as scientific clubs and technical sections.

IV. CONCLUSION

The analysis of the influence of emergent technologies on personnel training and educational system allows us to conclude that the main influence is exerted by the integrated use of technologies to obtain fundamentally new results. Therefore, taking into account the fact that new, often seemingly fantastic, opportunities obtained as a result of combining technologies are still not well understood. This statement also applies to understanding the consequences of the creation and widespread adoption of such technologies, and it is advisable to account the regularities of system theory to explain the appearance of emergent properties of a system, a number of new disciplines are needed in which the types and features of technologies are studied, as well as methods of systems theory, artificial intelligence, engineering, models of analysis for and the choice of technologies. It is also necessary to search for new forms of organization of the educational process.

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Conceptual Framework of Effective Interaction Between Employers and Universities on the Basis of Competence Approach

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***Abstract*—The given article is devoted to topical issues of searching the effective forms of partnership between employers and educational institutions. Actualization of innovative development on the background of the technological modernization of the economy, involves the growth of scientific interest in the study of new phenomena that determine the functioning of the labor market in both the individual regions of the country and as a whole in the context of description and systematization of factors that directly affect the efficiency of the industrial enterprises. Each technological change leads to a change in the characteristics of professions and employment. Digital economy requires the employee to obtain a specific set of competencies, which, at first glance, are not even peculiar to his profession. In this connection, the development of conceptual framework of interaction between employers and universities for the purpose of finding forms of strategic partnership on the basis of professional competencies formation, will help to identify a set of skills and knowledge necessary for the development of future employees to obtain the desired position.**

Keywords—competency-based approach; partnership; labor market; partnerships; industrial enterprises; education

I. INTRODUCTION

The key features of the emerging innovation economy are new technologies and products that are created in digital form. Modern technologies have overlapping zones of influence, interact with each other in a complicated manner, form the basis of an emerging economy and refer to intellectual resources owned by various organizations, individuals and society as a whole. Implementation of the digital economy concept is based on the following operations with the intellectual resources: reproduction, use, exchange, purchase and sale. Thus, there arises a need for training highly skilled personnel of new formation, capable of working in the conditions of digital economy, taking into account the trend of intellectualization of professions, as well as current requirements of employers, including the development of management skills, digital competences, skills in communication and training throughout the whole life. Such requirements are directly related to the problem of matching between the education market and the needs of business and organizations. Taking into account the fact that modern enterprises form their own competency model, which may include both common and individual characteristics, caused by industry's particularities, it is necessary to develop such forms of partnership that result in training highly-demanded professionals capable of working in modern conditions.

The purpose of the study is to offer improved forms and interaction methods between industrial enterprises and educational institutions in the context of the formation of competitive specialists, taking into account the trend of intellectualization of professions, and also taking into account the current requirements of employers.

II. METHODS OF RESEARCH

In the process of research methods of theoretical generalization, calculation of the production function, methods of statistical and historical groupings, monographic, abstract-logical, as well as methods of socio-economic research, graphic interpretation of the received information were used.

III. ANALYSIS OF FACTORS OF INDUSTRIAL DEVELOPMENT IN THE REGION WHERE UNIVERSITIES AND ENTERPRISES OPERATE

An interaction between universities and enterprises can be developed within the frameworks of scientific and technological activities and implementation of the obtained results in industry which significantly reduces the innovation cycle and promotes innovative development of enterprises, industries and territories on the basis of activation of innovation potential in both universities and enterprises [1]. Besides, in conditions of digital transformation the human potential becomes the key production factor, which makes it necessary to develop forms of cooperation between employers and higher education institutions in the preparation of highly qualified personnel demanded by modern economy [3]. The aim of the present study is to determine the particular factor having the greatest effect on the innovation development of industry in the region with universities and enterprises in order to find the most effective direction of their interaction. The solution of the above task is obtained by calculating the production function. Basing on the given results it will be possible to propose effective forms of cooperation between educational and industrial sectors.

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The present study has been carried out on the materials of Southern Federal District. Innovative and industrial clusters, enterprises and higher education institutions, including universities, federal, regional divisions of leading metropolitan universities, are presented in the district. All these elements interact as part of the innovation process, generate and implement innovations, at the same time developing the district economy.

All factors of production perform in cooperation. In order to provide maximum production outputs with minimum inputs, required is a certain combination of production factors, which is achieved by constructing a production function [6].

If to present all the factors of production in the form of labor, materials and capital inputs, the production function can be mathematically represented as follows:

$$Y=A*Lb*Ka,$$

where: Y is the total production (a real value of all goods produced in the given year);

L is the labor input (number of employees engaged in research and development);

K is the volume of invested capital (a real value of machinery, equipment and buildings, as well as investments in fixed capital);

A is the total productivity of factors;

a and b are the elasticity of labor and capital, respectively (these values are determined by available technologies).

If the sum of constants a and b is equal to one, then it is assumed that such a function has a permanent effect of economies of scale. The Cobb-Douglas model is possible to apply for any particular company or industry. In this case, "a" is the portion of total inputs spent on the capital, and "b" is the portion spent on the labor costs. The Cobb-Douglas models may also contain more than two variables. Within the framework of the present study, added has been the third variable “I”, that is the given industry enterprises’ innovation activity, and calculated are the coefficients reflecting the efficiency of each production factor contribution, represented in Table 1 below.

In order to reduce the received values to a single scale, the [0,1] interval, we perform the normalization of data after the calculation of each block according to the formula:

$$((x-x\_min\ )(d\_2-d\_1))/(x\_max-x\_min\ )$$

where x is the value to be normalized, [x_max, x_min] is the maximum and minimum value of the interval, [d1, d2] is the interval which the x value will be reduced to.

The key activities of enterprises operating in the Southern Federal District are the following: software development, IT-consulting and other related services, production of computers, electronic and optical devices, wholesale and retail trade, manufacturing of electrical equipment. The most important industries, which determine the District rank in the Russian economy, are the sectors of information and communication technologies.

Thus, having identified the present study peculiarities and the key activities of the Southern Federal District, the production function has been calculated, as well as the obtained coefficients have been normalized. After that, we obtain the following results (Table 1).

TABLE I. COEFFICIENT OF THE PRODUCTION FACTORS USE EFFICIENCY

Coefficient / Sector	a1 (capital)	a2 (labor)	a3 (innovations)	a0 (total productivity of factors)
Software development, IT-consulting and other related services	0.09	0.22	0.25	0.16
Production of computers, electronic and optical devices	0.09	0.109	0.25	0.14
Wholesale and retail trade	0.146	0.236	-0.014	0.04
Manufacturing of electrical equipment	0.05	0.25	0.08	0.1

In order to highlight the sectors and dominant production factors, it is necessary to look at the maximum values. For example, in almost all studied sectors of activity the key factor is labor. The labor factor is presented in the process of production by labor of the highest qualification employees. The labor and other factors of production initiates the production process as such. It is also important to know and understand that the labor factor of production activity is manifested not only in the number of employees and labor costs, but equally in the quality and efficiency of the labor, in the labor output [7]. Actual calculations take into account not only the labor expended, but also its productivity.

A significant role of innovations in the efficient use of production factors in the sectors related to information and communication technologies should also be noted. A small portion of expenditures on innovations in the medium and low technology sectors, operating in the region, should be mentioned.

It should be noted that in the sectors with a sufficiently high level of one of the dominant factors, the calculation of the production function has shown an effective use of a production factors combination, see Fig. 1.

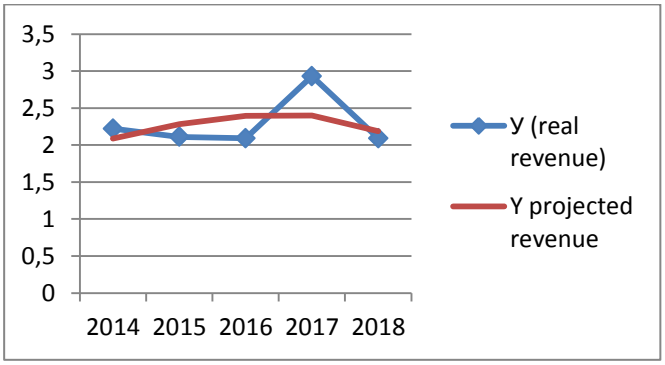

Fig. 1. Comparative analysis of estimated Y and real Y profit in the sector of “Software development, IT-consulting and other related services”

Basing on the calculations, we can conclude that the availability of highly qualified personnel is the key production factor for the Southern Federal District now. In this connection it is rational to find such forms of interaction between employers and universities that will result in forming the competences demanded by the new labor market.

The competence model of education, that is a compilation of university, employer and personal qualities of the graduate himself, aims at providing the effectiveness of modern graduates and the guarantees of high level of education. As noted by T.A. Razuvaeva, the structure of competence consists of the following:

1. activity component, that is a set of skills and modes of action;
2. cognitive component, a body of knowledge on the implementation of certain actions;
3. motivational component, since the implementation of competencies takes place in a variety of activities to solve the theoretical and practical problems;
4. experience, an integration of the learned by students individual actions, ways and methods of solving problems into a single unit [8].

In essence, the competence approach presupposes the formation and development of core competencies providing the university graduate with a successful social adaptation and functional tasks performance [9]. Mastering the educational programs, the graduate acquires basic knowledge and skills that should be developed further and supplemented with professional competences, which are then transformed into intellectual capital of the enterprise [2, 5]. Therefore, in order to form the demanded competencies, the scientific and educational processes must be adapted to the changing needs of employers. This corresponds to a form of partnership implemented by means of the employer's participation in the formation of the educational program. The employer shares his opinion on demanded competencies, which should be formed in the student. All the above data together with the basic disciplines, as well as the personal qualities of the graduate, the so-called soft-skills, are taken into account when preparing the university curriculum. The changes in the labor market lead to the fact that experts need knowledge in not only their professional field, but also the related fields. This determines the need to develop a system of additional vocational education and training for both university staff and employers [4]. The formation of project teams for working on projects in subject areas proposed by employers should be effective. For example, the formation of project teams consisted of trainees studying different subject areas provides an interdisciplinary interaction and formation of competences in different areas.

IV. SUGGESTIONS AND RECOMMENDATIONS ON THE RESEARCH RESULTS

The knowledge, as the primary productive force and the main productive resource, serves as the fundamental basis of the new economy, thus, the human potential becomes a key factor in production processes. The necessity to find effective forms of interaction between employers and universities is caused by the fact that the training of the specialists demanded in the labor market is impossible without the participation of potential employers. The priority form of cooperation between employers and universities is the cooperation in forms and methods of highly qualified specialists training on the basis of competencies required by employers. We propose to develop the following forms of cooperation between employers and universities: involvement of employers in the development of educational programs; joint implementation of research projects; involvement of students in solving specific scientific and engineering issues in practical training and preparing graduation qualification works on demand of enterprises; targeted training in popular areas; implementation of training programs for employees; organization of training for researchers and lecturers at enterprises.

The interaction between enterprises and universities on a regular basis will enable universities to constantly monitor emerging technological and market trends, determine the list of competencies demanded in future. This will lead to the development of university competences and make it more competitive.

CONCLUSIONS

Development of forms of interaction between universities and employers in the process of preparing graduates with the competencies needed at the present stage of the digital economy development will provide enterprises with highly qualified staff, and, in their turn, enterprises will use the scientific potential of universities.

An active involvement of employers in the scientific and educational process will ensure the implementation of the educational model which allows creating individual trajectories in students training through the introduction of various forms of project and research work in cooperation with enterprises. This will ensure the formation and development of professionals through their integration in the modern business environment by means of the unique teaching methods that are adapted to current market conditions. The development of forms of cooperation between universities and employers will allow bridging the gap between the needs of the industrial sector for highly qualified personnel and capabilities of universities to prepare such personnel.

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European Experience of University Business Cooperation for Sustainable Development

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***Abstract*— The article is devoted to the role of cooperation between universities and business in achieving Sustainable Development Goals. The programs and innovative strategies of the European Union aimed at stimulating cooperation are analyzed and presented. As a result, it was concluded that the "triple helix" is the most promising model of cooperation, the principles of which are the basis of the European programs "Knowledge Alliances" and "Knowledge and Innovation Communities".**

Keywords*— Sustainable Development University Business Cooperation; Knowledge alliances; Knowledge and Innovation Communities (KICs)

I. INTRODUCTION

On September 25, 2015, Member States Of the United Nations adopted the 2030 Agenda for Sustainable Development. The agenda was designed to improve the life quality and the future for all people around the world. Achieving the Sustainable Development Goals (SDGs) requires the joint efforts of governments, business, civil society and the entire population of the Earth.

Achieving the SDGs requires the full participation of all stakeholders: business, the general public, educational institutions, civil society and each person. [3]

Sustainable Development Goals cover three dimensions: economic, social and environment. Moreover, the social sphere has the largest share, it covers 52.44% of the SDGs, the economic sphere – 27.25%, and the environment – 25.31%. [4]

A University is one of the actors in achieving the SDGs. It provide and develope necessary experience, knowledge and skills for students so that in the future they can make both individual and collective decisions at the local, regional and global levels, which will contribute to improving the quality of life without harming the environment. In this context, a University directly or indirectly affects the achievement of all 17 SDGs. However, university education mostly covers the following Goals:

- SDG 4 – Quality education;
- SDG 8 – Decent Work and Economic Growth
- SDG 9 – Industry, Innovation, and Infrastructure. [3]

II. EUROPEAN STRATEGIES AND PROGRAMS FOR SUPPORTING UNIVERSITY BUSINESS COOPERATION

After the economic crisis of 2008, the pace of economic development in European countries decreased and level of unemployment increased. In the SDGs, these indicators are given a special place, as they are directly related to many other indicators and goals. One of the ways to solve this problem and create the conditions for sustainable economic development is to build a new economic strategy based on knowledge, the so-called "Knowledge Economy". This strategy is included in the European program of economic development "Europe 2020". It involves significant changes in the training process and in the higher education system as a whole. [7]

The modern paradigm of the "Knowledge Economy" development strategy in Europe is based on stimulating the development of innovation and innovative entrepreneurship, which is not possible without close cooperation between universities and business.

Universities are holders of knowledge. Business has the necessary material and technical basis for putting this knowledge and innovations into practice. Considering of these facts one of the directions of European economic policy is to stimulate various aspects in cooperation between universities and companies. [11]

Thus, according to the "Economics of Knowledge" strategy, three main stakeholders are involved in education:

- public authorities interested in improving the quality of education, reducing of unemployment level, improving the social environment and the development of the city / region / country, etc.;
- HEIs that are also interested in improving the quality of education, as well as in increasing the demand for the university, attracting additional funding, developing scientific activities, etc.;
- business whose interest is increasing productivity and efficiency, attracting highly qualified staff and accessing to the research base of universities, etc. [2]

Such a model of interaction is called the "triple helix" and is one of the priority areas for the development of the "Knowledge Economy". Ideally, University Business Cooperation (UBC) should be supported by authorities. [1]

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State support can be provided at all levels: from local to interregional and international. Thus, in the European Union there are a number of programs that provide financial support for University Business cooperation in various aspects.

- The program "Horizon 2020" (2014–2020) and its successor, "Horizon Europe" (2021–2027) – research and innovation frameworks, major EU programs that specifically support research and innovation. The programs support:
  - key areas to support research and innovation and their targeted impact;
  - European partnership;
  - international cooperation.

The program provides financing by a wide range of tools and measures, such as supporting and financing public and private partnerships, as well as specific tools that support research and innovation in small and medium-sized businesses.

"Horizon" is an open program, in which an organization can take part from almost any state. However, participants in the EU Framework Program are divided into three types:

- Members of the European Union (EU MSs);
- Associate Participants (AP): Albania, Israel, Iceland, Liechtenstein, Macedonia, Montenegro, Norway, Serbia, Turkey, Switzerland, Bosnia and Herzegovina, Faroe Islands, Moldova, Ukraine, Georgia;
- Third countries (Not EU MSs and APs).

Russia belongs to the category of countries that can participate in Horizon projects, but are not eligible for financial support from the program budget. [7]

- The COSME program, with an annual budget of € 2,298 million, offers tools that support the creation and expansion of companies, especially with a view to expanding research activities with universities. [8]
- The Erasmus + program aims to support collaboration in education, vocational training, youth, and sports. The program integrated such previously existing programs as: The LifeLong learning Programme, The Youth in Action programme, The Erasmus Mundus Programme, Alfa, Edulink, Tempus и другие. [6]

A. Knowledge Alliances

A significant program under Erasmus + is the Knowledge Alliances program, which creates international consortium, that include universities, employers and authorities from different countries and even regions with the goal of intercultural and inter-institutional knowledge exchange. The overall goal is to help strengthen Europe's innovation potential, promote cooperation between universities and business, and support the modernization of higher education systems in Europe. In addition, the activities of the "Knowledge Alliances" are aimed at:

- development of new, innovative and multidisciplinary approaches to education,
- stimulating entrepreneurship and entrepreneurial skills of university graduates and company employees,
- knowledge exchanging and join investigation.

The consortiums participating in the Knowledge Alliances program receive a grant, the maximum amount of which can reach 700,000 euros for 2 years and 1,000,000 euros for 3 years. Each consortium must consist of at least six independent organizations from three countries participating in the Program, including at least two universities and two companies (state or private enterprises, including social enterprises). For example, in 2019, 31 consortiums received funding.

In addition to them, the consortium may include:

- Research institutes;
- State authorities at local, regional or national level;
- Education institutions;
- Association of educational, training or youth institutions;
- Business association;
- Accreditation, certification or qualification body. [9]

The activities of consortium can be carried out in various fields: education in general, medicine and healthcare, information technology, entrepreneurship, social activities, engineering, ecology, textiles, etc.

B. European Institute of Innovation & Technology

A unique European initiative is the European Institute for Innovation and Technology (EIT). This is an independent organization of the European Union, whose activities are aimed at increasing the competitiveness of Europe by stimulating the development of innovation, entrepreneurial skills and the support of new ideas. The Institute's activities are funded by the Horizon 2020 and Horizon Europe Programs' Funds.

Within the framework of the institute, Knowledge and Innovation Communities (KICs) were created. Such Communities are partnerships whose activities are aimed at enhancing the interaction between business, universities and research centers. Communities work in Innovation hubs. Currently there are more than 50 hubs. They are distributed throughout the territory of the European Union in order to increase the influence of the European Institute of Innovation and Technology.

KICs operate in eight areas (Fig. 1). [10]

As part of Horizon Europe program, it is planned to create two new Communities of Knowledge and Innovation:

- The first one will be focused on the cultural and creative industries; its' opening is planned in 2022;
- The area of the second Community has not yet been determined; its' launch is planned in 2025.

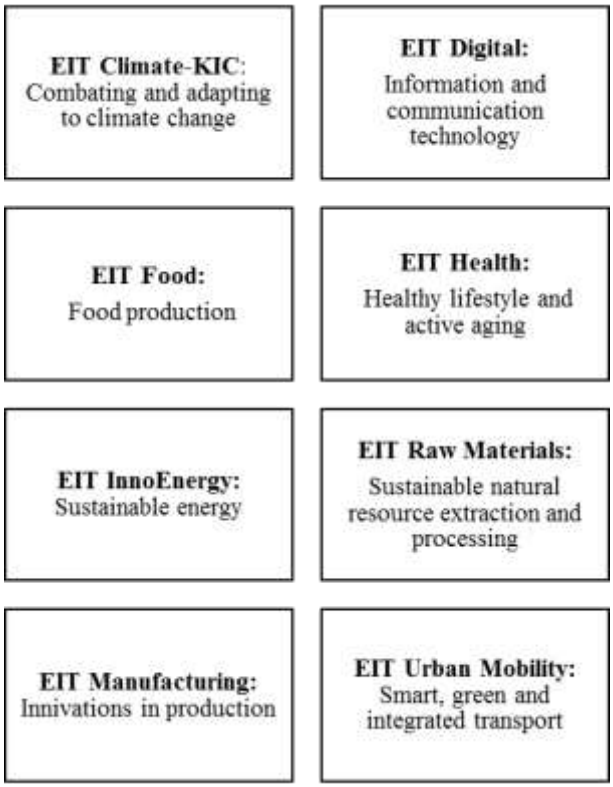

Fig. 1. Areas of KICs activity

In addition, Communities will also develop links with Smart Specialization strategies, an EU initiative to stimulate economic growth and create jobs that allows each region to identify and develop its own competitive advantages. It is planned to involve more universities, enterprises and research organizations at the regional level in the network.

Moreover, during the period from 2021 to 2027, the European Institute of Innovation and Technology will provide support in financing, expert knowledge and training at 750 universities, which will allow them to develop economic activities in the field of their interests. Most of the funding will go to universities from countries with low innovative potential. [5]

III. CONCLUSION

Universities, business and government are among the main actors in accelerating the development of innovative processes in the Knowledge Economy. In a modern knowledge-based economy, the need for cooperation between the three actors has particular importance. This process is extremely important for high-tech sectors of the economy, which, in turn, are the locomotive, source and generator of innovation. In addition, innovations contribute to sustainable growth of the economy as a whole, creation of new jobs, employment and the achievement of Sustainable Development Goals.

Thus, the main tendencies in innovations in education and economy in Europe are:

1. Formation of "Knowledge Alliances", uniting universities, companies and other organizations with the aim of developing entrepreneurship and innovative activity in any field;
2. Creation of Knowledge and Innovation Communities (KIC), aimed at introducing and developing innovations in eight main areas.

These initiatives are being actively developed and supported by European funds, so there are reasons to conclude that such models of interaction between universities, business and government will become a solid foundation for the sustainable development of Europe.

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Structural Transformation of Staff Educational System for Nanoindustry

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***Abstract*— The necessity of transforming the training system in the development of high-tech industries is shown. The decisive role of the state in the structural transformation of the training system for high-tech industries is established on the example of the nanoindustry. A number of solutions to provide personnel for nanoindustries developed by the *RUSNANO Group* are presented.**

Keywords— nanotechnology; online education; educational system effectiveness

I. INTRODUCTION

Creating the conditions for economic growth and productivity based on new materials and technologies is a common goal of economic development. Along with the increasing use of technological innovations in the economy, it is necessary to focus on structural transformations in the training management system for the regional economy during the digital revolution. And especially for those sectors of the economy in which a country or region has a comparative advantage. One of such high-tech industries is the nanoindustry, in which our country has both a serious fundamental backlog and substantial practical experience.

Nanomaterials and nanotechnologies are relatively new scientific and production content that required special attention at the turn of the 2000s. This focus was mainly on the investment aspects of developing new materials; with unpredictable risks of their use associated with nanoparticles and nanocompounds; with the lack of the possibility of creating a universal regulatory framework and standards for the nanoindustry. Thus, the reaction of society to the development of nanotechnology (including investment, the creation of legal norms and recommendations) is a marker of the state of the digital economy, which determines how to solve other similar problems.

Like any new activity, the development of the nanoindustry required structural changes in the training management system for the corresponding scientific and production sectors of the economy. Obviously, without a systematic approach to managing the training of relevant personnel, our country will not only not solve the problem of the transition to innovative development, but will further consolidate its growing lag behind the leading world economies. Until now, the lack of a holistic concept of the state system for the development of human resources and the training of scientific personnel, based on the presentation of this system as a complex and multifactorial management object, puts this problem in a number of particularly acute.

The subject of this work is an integrated training management system for high-tech industries based on the example of the nanoindustry. At present, there is no analysis of such an object of management, nor are the processes of development of modern methods and mechanisms for managing it observed; as a result, there is a lack of a concept, methodology and conceptual practical development of a system for managing the development of human resources for targeted impact in the high-tech sector of the economy in order to obtain given characteristics. The current management is characterized by the absence of a goal-setting education system in the field of nanotechnology, the lack of feedback from the professional community, and, as a result, the small influence of the digital society environment on its structural component, namely, the educational cluster.

II. PROBLEMS AREA OF ACTIVITY

The current state of the educational component of the innovative development of the country is characterized by insufficient development of a systemic worldview in the management of the training system. For the nanoindustry, this, in particular, is manifested in the following.

- There is no single stratified management system for training personnel in the field of vocational education, which does not contribute to the development of the personnel potential of the industry.

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- The education system is quite closed (both in the industry. And in the regional aspect). This, on the one hand, is due to the uneven distribution of the production base, geographically distant from educational organizations. On the other hand, this is a reflection of the fact that the top management of industrial enterprises is not able to qualitatively form an order for educational organizations for promising labor resources.
- Low competitiveness of higher education, as well as secondary professional level, due to the insufficient level of use of advanced scientific developments in the educational process. This is a consequence of the inertia of the teaching staff's thinking, reflecting their general "aging", lower social status, and limited mobility.

Thus, one of the main tasks of creating an innovative economy, the economy of new materials and new technologies, is the task of providing it with new personnel at all stages of its implementation. This means that it is necessary to generate teaching staff to create human resources for high-tech production. This process of parallel reproduction of the personnel potential of a high-tech digital society is proposed to be solved within the framework of portfolio educational technologies using the example of project activities in the nanoindustry.

The general goal of the management system for developing the human resources potential of the nanoindustry is to integrate all levels of education, science and high technology production in order to prepare competitive scientific and production personnel at the level of world qualification requirements and their effective use for the development of the economy of a digital society, including solving social problems, strengthening defense and security, outstripping the development of priority research and new technology-oriented and the knowledge economy, while maintaining continuity of scientific and pedagogical schools.

The implementation of portfolio technologies for the reproduction of human resources in high-tech industries, such as the nanoindustry, should be carried out in the vector field of the following factors (***F***) according to the classical principles (***P***) of System Theory.

F1 – conducting fundamental, search and applied research of interdisciplinary knowledge. ***P1*** – the principle of integrity and completeness is manifested in the completeness of the knowledge involved to achieve the goals.

F2 – interaction with the environment for the development of competitive innovative projects both at the national and interstate levels in a given industry. ***P2*** – the principle of scientific and economic feasibility involves the use of all available resources to achieve the planned result in a given time interval with minimal resource costs.

F3 – close cooperation with the manufacturing sector, as with the end user of the educational product; with the prospect of developing this area to the level of the customer of the education system. ***P3*** – the principle of social responsibility means making decisions in the field of managing the personnel potential of the industry based on social priorities.

III. Concept of Structural Transformations of the Management Educational System

From the point of view of the general theory of systems, the development of the management system for the staffing of a high-tech industry over time is the process of increasing its organization in achieving the set goals for its functioning. Moreover, these goals themselves are dynamic, changing depending on the conditions in which the control system operates. The development of this system is naturally manifested by an increase in the amount of information (*I*) circulating in the system and accumulating in its thesauruses. The increase in the information capacity of the control system is aimed at increasing the efficiency, and therefore, at reducing the energy (*E*) and labor (*T*) costs, reducing the regression indicators, decreasing the entropy (*H*) (increasing the degree of organization of the system):

$$\left\{\frac{dI}{dt}>0;\frac{dE}{dt}>0;\frac{dT}{dt}>0;\frac{dH}{dt}<0\right\}$$

The fulfillment of this condition is an indicator of the successful development of the personnel management system. We take into account the dynamic nature of the state of the personnel management system (Educational Center) in the following model. Denote:

D_t – simulation step (time interval from time t_i to time t_j);

N_{ti} and N_{tj} – the number of students at time t_i and t_j;

PB_{Dt} is the rate of the stream that sets the input flow of students to the Learning Center during the interval D_t (from time t_i to time t_j);

OT_{Dt} is the rate of the stream that defines the output stream of students who have not completed training and have not received the appropriate competencies during the interval D_t (from time t_i to time t_j);

OB_{Dt} is the rate of the flow that sets the graduates from the Learning Center during the interval D_t (from time t_i to time t_j).

Then the number of students in the Center is described by the following relation

$$N_{t_j} = N_{t_i} + D_t \cdot (PB_{D_t} - OT_{D_t} - OB_{D_t}) \quad .$$

The effectiveness of the Educational Center from the point of view of the employer:

$$E_{t_j}^{B} = \frac{OB_{D_t}}{PB_{D_t} + OT_{D_t}} \quad .$$

The efficiency from the point of view of the Educational Center:

$$E_{t_j}^{E} = \frac{N_{t_i} - OT_{D_t}}{N_{t_i}} \quad .$$

Then the objective function of the Educational Center:

$$z(E^B) \to \max.$$

The indicated flow rates in the state model of the personnel management system can be described taking into account the importance of various parameters:

- orientation of the training system on the result,
- concentration of resources and funds at growth points (about 50 supporting organizations, including the sites of qualification assessment centers in the nanotechnology industry – Universities: FEFU, NSTU, KNITU, LETI, SPbGTI (TU) and Voronezh State University),
- a networked organization of relationships between training institutions (including early career guidance on the basis of the Sirius Educational Center, the Quantorium technology parks, the means of the Stemford online educational platform, etc. [1, 2, 3]).

Table 1 presents the types of functions of the flow trend model in the training system for the nanotechnology industry, depending on the expected changes in the importance of its parameters.

TABLE I. FLOW TREND MODELS

#	Intensity importance dependent on time	Waiting for the dynamics of judgments
1	$y(t) = \alpha$	Relative weight does not change
2	$y(t) = a_1(t)+a_2$	Constant increase in one type of activity in comparison with another
3	$y(t) = b_1 \log(t+1)+b_0$	Fast increase (decrease) followed by a slow increase (decrease)
4	$y(t) = c_1 \exp(c_2 t)+c_3$	Slow increase (decrease) followed by rapid increase (decrease)
5	$y(t) = d_2 t^2+d_1 t +d_0$	Increase (decrease) to maximum (minimum) and then decrease (increase)
6	$y(t) = e_1 t^n +\sin(t+ e_2)+ e_3$	Oscillation with increasing (decreasing) amplitude as a function of *n*

The greatest increase in the effectiveness of ΔE^B application of a given educational technology is observed at the stage of its development (see Fig. 1).

At an early stage in the development of educational technology, its effectiveness is low due to insufficient practical development of a new educational technology. Also, the effectiveness of its application tends to attenuate even with the "exhaustion" of the current educational technology.

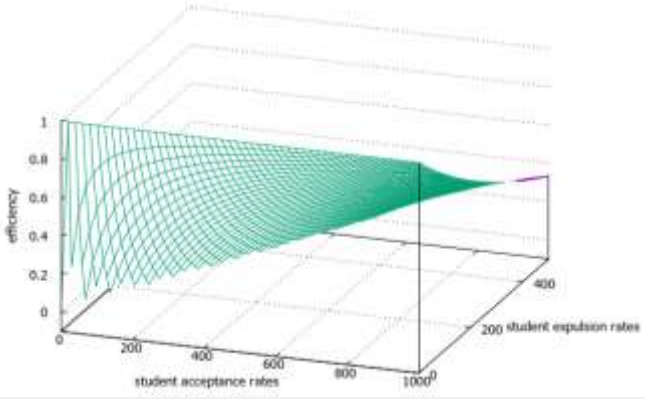

Fig. 1. The effectiveness of the Educational Center for flow models No. 2 (according to Table 1)

At the same time, the "dying" technology manifests its protective properties in the creation of control systems of structural elements that are ultimate in power or in size. Such "gigantomania" at the limit of the possibilities of obsolete educational technology, however, is not cost-effective either in terms of building management competence or in terms of practical implementation.

Here we are dealing not just with a regularity of an economic nature, but with the fundamental universal law of decreasing entropy in closed systems with irreversible processes occurring in them. Obviously, any socio-economic system of any dimension can be specialized just like this type of system. This law is implemented in all cyclically developing systems and only for large periods of time, which is true, for example, for long-wave economic cycles (such as Kondratyev's cycle [4]).

Thus, in the role of a closed system, we can consider the technological structure of the economy. The information technology for managing a large closed-loop system is improved in every specific Kondratyev's cycle on the basis of an invariable technological principle. However, with the achievement of a certain level of development of the management system, the cost of its new structural changes grows in proportion to the large degrees of growth in its effectiveness. Therefore, the profit from additional capital investments in the reform of the management system under the same other business conditions will be less than the profit from the previous investment of the same amount of capital in solving the same problem. This means that at the end of each economic cycle of the development of society, a structural restructuring of the economic management systems at the macro level is necessary, the priority of which is to support new knowledge-intensive sectors instead of traditional capital-intensive branches of the economy.

As the training management system approaches the maximum level of development, its effectiveness indicator becomes insensitive to changing employer demands, which makes the system closed and, according to the above law of increasing entropy, makes it unprofitable [5].

Nevertheless, the transition to the next technological level of economic development is a consequence of reaching the ultimate level of development. This shows the dialectic and source of development of the economic life of society: it makes sense to continuously develop the high-tech sector of the economy, despite the fact that at some stage the costs of its fundamental and production support will exceed the current effect of its use. Therefore, in most cases, a market (spontaneous) balancing of supply and demand for high-tech resources is impossible. This means that objectively there is a task of state regulation of knowledge-intensive industries. This problem is solved by the creation of mechanisms of continuous, purposeful and at times tough state intervention in the economic life of society. Such "pressure" is strategically justified and pays off at the following technological levels of economic development. In the field of nanotechnology, the relevant mechanisms took place within *RUSNANO Group*.

IV. *RUSNANO GROUP* STAFF SOLUTIONS

Obviously, the task of training personnel for the nanotechnology industry requires ensuring the acquisition of such competencies that will allow one to operate both in the field of intellectual content of the fundamental knowledge of nanotechnology and in the field of project management at the level of their investment, technical and technological components. The tool for quick response to the lack of competencies of specialists in the nanotech is the educational projects of the *RUSNANO Group* Fund for Infrastructure Educational Programs (for example, [1]).

At present, the scientific and pedagogical community of 60 universities and 10 scientific organizations with the support of the Foundation have developed and are implementing 182 educational programs. Based on the materials of these programs, 80,000 specialists of enterprises and students were trained in nanotech specialties, 78% of whom work in the field of innovation. 4 leading universities (MIPT, MISiS, NRNU MEPhI, RANEPA) and 20 companies (OCSiAl, MapperLithography, InEnergy, R-Sensors, etc.) train specialists in the field of technological entrepreneurship with industry specifics.

The development of technologies, production processes and, therefore, personnel requirements required the systematization of documents and qualifications that industry workers need. In the National Council under the President of the Russian Federation for Professional Qualifications, 63 professional standards have been developed and approved. Manufacturers, as well as representatives of the scientific and educational community, have the opportunity to participate in the development of professional standards and thereby influence the creation of personnel infrastructure for a new industry. The Council's activity plan is publicly available on spknano.ru.

The *RUSNANO Group* school league has been created, which includes more than a thousand schools and twenty resource centers in which the Foundation supports the development of science education, conducting, together with Moscow State University and the Agency, strategic initiatives for olympiads, scientific and educational and career guidance programs. Digital learning technologies have been developed for this target audience. The basis of their functionality is providing access to new knowledge and, first of all, high-quality content in the field of advanced technologies by means of educational platforms edunano.ru and stemford.org [6]. They contain special courses for wide audiences, and especially for schoolchildren – as a promising personnel resource. The Talent and Success Educational Foundation, in partnership with and with the support of the Fund for Infrastructure and Educational Programs (*RUSNANO Group*), developed and implemented a special model program for continuing education for children, focused on the study of the natural sciences and the foundations of nanotechnology, developed. Program content and modules are freely available on the website https://sochisirius.ru/news/2985. Projects and programs focused on the school audience have the goal of making the student interested in acquiring competencies in demand in the nanoindustry. The model of the technopark associated with the method of organizing the innovation process – the transformation of new knowledge into a new product, is called upon to become the cultural source of such competencies.

CONCLUSION

Digitalization of the economy is associated with innovations in high-tech industries, which determines the structural restructuring of the training system for these industries. It is fundamental to take into account the universal law of non-decreasing entropy in the development of socio-economic systems. Using the example of nanoindustry, the necessity of state regulation of the educational system is proved. A number of decisions on providing personnel for the nanoindustry developed by the *RUSNANO Group* are presented. The package of solutions is distinguished by the integration of various educational technologies into a single cross-age technology for training personnel for nanotechnology.

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Personnel Policy in Terms of Sustainable Development of the Region

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***Abstract*— Today, one of the most important tasks in the Russian Federation is an acceleration of the economic development pace, the introduction of promising innovative projects in all spheres of production and services. In this regard, the need for highly qualified specialists is growing. It is impossible without continuous improvement of the system of education and quality its improvement. The article discusses relevant issues of highly qualified personnel training for the solution of problems in accordance with the socio-economic priorities of the development of North Ossetia-Alania. The role of regional science in terms of training perspective highly qualified personnel for the branches of the regional economy is shown. The main directions for improving the processes of training within the educational space and the innovation system of the republic are identified. The problem of personnel training for high-tech industries is one of the most relevant problems for modern socio-economic systems of any scale: from continuing education programs for industrial and production personnel of individual enterprises to strategies and training programs for personnel in regions and the state as a whole.**

Keywords— innovation; personnel training;, regional economy; educational organizations; practice; investment

I. INTRODUCTION

In the context of globalization processes, in Russia the main strategic goal of national security providing is to ensure sustainable economic growth, the achievement of food security, creation of the necessary conditions for scientific and technological development, etc. All that will allow standing against domestic and external threats beforehand.

The development efficiency of modern high-tech industries of enterprises in various sectors of the economy depends directly on the quantitative and qualitative parameters of training in educational institutions at different levels. [6] In the long-term perspective, investments in the training and advanced training of high-tech personnel are strategically more important for the economic systems of modern industrialized regions compared with investments in innovative fixed funds and technologies.

In particular, in the opinion of A. A. Rabtsevich, one of the most general indicators that make it possible to assess the focus of the educational system of a certain level of personnel training for high-tech industries is the share of technical graduates in the total number of graduates of organizations of higher professional and secondary specialized education [4].

II. METHODOLOGY

North Ossetia is a multinational outpost of the state system in the center of the multimillion Caucasus, which has a cultural and historical foundation with rich nature and a high potential for the development of culture, education, healthcare, agriculture, industry, tourism and creative industries.

Further development of the region's economy depends on clearly defined goals, formed tasks, determination of targets and evaluation of the effectiveness of strategic development documents. So, in the Strategy of socio-economic development of the republic until 2030, the following priorities for the further development are defined: development of leading industries; agribusiness development; development of the sector of innovative industries (industry, information technology, biotechnology); infrastructure development (road network, energy).

As it is known, achieving strategic development goals for each of the identified priorities depends on the availability of qualified personnel. [7]

Young people are the main innovative potential of society and one of the most vulnerable groups in the labor market due to their age, socio-psychological and professional characteristics. The level of youth unemployment depends on many factors: the level of development of the region, its economic potential, the characteristics of the demographic situation, and the training system.

In 2018, over 4,000 people were recognized as unemployed in North Ossetia-Alania. To reduce youth unemployment, a set of specific measures to regulate the sphere of employment have been developed and implemented. Last year, Employment Promotion Program for 2014–2024 and the Program for Additional Measures to Reduce Tension in the Labor Market in 2018 worked in the Republic of North Ossetia-Alania. The programs included a combination of long- and short-term measures, the purpose of which is an achievement of effective, optimal employment of the working population in the region. The efforts were aimed not only at the unemployed people but also at the employees of organizations, including those who were threatened with dismissal. This means that work on

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workforce quality improvement and preservation of jobs is underway.

In 2018, the Employment Service sent 219 graduates of institutions of higher and secondary vocational education for an internship to gain experience for further employment in organizations experiencing a need for personnel. Graduates of higher professional education – 87 people, secondary – 46 people, under the guidance of 118 mentors among them.

The list of specialties for which the internship is organized: architect, lawyer, economist, accountant, computer center technician, dentist, public relations specialist, manager, machine operator.

By the end of the Program, 47% of the planned number of internships were employed. The number of citizens aged 14 to 29 years old received state services for vocational guidance (4.200 people), psychological support (610 people) and social adaptation (637 people).

In the Republic of North Ossetia-Alania, North Ossetian State University after K. L. Khetagurov (NOSU) is one of the oldest educational and scientific complexes of the North Caucasus Federal District. In 2017, NOSU won the competition of the priority project of the Ministry of Education and Science of Russia "Universities as centers of the space for creating innovation" and received the status of a university center for innovative, technological and social development of the region.

The rapid development of information and communication technologies and the widespread use of the Internet have led to a qualitative change in the educational technologies used in the world. The most popular model is the blended learning model. Along with full-time education, it widely uses electronic teaching aids: online courses, interactive workshops and laboratory work, computer modelling tools and simulators.

Modern Russian universities are gradually becoming centers of innovation, creation of new technologies and new sectors of the economy and the formation of a high-quality social environment in their region. Universities create new educational programs, apply new standards in teaching and use new technologies, launch joint scientific and technological projects, carry out research and development. As a result, the quality of education in the country is growing, the professional level of personnel is improving. All of that is a prerequisite for the successful modernization of the country's economy.

The key task of North Ossetian State University is the solution of applied research problems in the interests of the region and the implementation of research results in the economy and social sphere of the Republic of North Ossetia-Alania. Priority areas of efforts are identified, based on an analysis of the potential, competitive advantages and strategic development goals of the Republic of North Ossetia-Alania until 2030.

The development strategy of North Ossetian State University, implemented with the help of the Roadmap, involves the implementation of a system of measures aimed at reforming the educational, research and international components of the university. The university competitiveness development program has made it possible to improve qualitatively cooperation with foreign universities and companies, which as a result allows the student to participate in scientific and educational projects around the world.

The education of a specialist and the realization of his mental and creative potential cannot always take place within the framework of the university. International cooperation with universities in the world is a kind of accelerator in the educational process; it also expands the boundaries of knowledge. Such cooperation develops the student professionally; gives a huge amount of opportunities to achieve goals; opens up many doors. The involvement of students of Russian educational institutions into the international community will provide an opportunity to withstand global challenges for graduates, increasing the level of educational mobility, competence and competitiveness. International cooperation between universities is a kind of catalyst in the process of education as a university as a whole, and the student individually. Note that at the end of the training process, the graduate enters the market of opportunities in search of employment. And it is beneficial for the employer to have among its employees those who, in addition to the main characteristics, have a wide breadth of views, innovative thinking, which is acquired through the experience exchange. For universities, international activity is of advantage in terms of expanding contacts, friendships, improving the quality of education in Russia, creating an image as a research center, increasing its relevance and universality for future applicants.

Like all Russian universities, North Ossetian State University, participating in international rankings, is interested in cooperation with foreign universities. Such cooperation allows increasing the number of summer and winter schools, attracting foreign students, which leads to an increase in the university budget and its positive perception by foreign companies. As a result, it becomes possible to graduate students, who are in demand for foreign labor markets. The student's interaction, both with Russian teachers and with foreign ones, allows forming a specialist who is ready for communication at different levels.

III. RESULTS

As part of the implementation of strategic partnership work programs, NOSU developed and carried out a set of joint activities in the form of scientific seminars in which participants present their projects, plan joint activities and undergo short-term intensive internships in the advanced laboratories of partner universities. The results of internships are agreements aimed at fulfilling efficiency indicators. The internship plan includes such events as preparing joint publications in SCOPUS, coordinating courses for inviting professors from partner universities, preparing applications for joint projects and attracting foreign students.

The development and implementation of international network of educational programs is an important tool for the internationalization of the university and increase its competitiveness in the global market for educational services, as it provides important advantages for the university, expressed in the development of the internationalization of the

university; improving the quality of education; increasing the competence of teachers; attracting additional financial extra-budgetary funds to the university's budget.

The project "Personnel training for the education system", implemented by the Ministry of Education and Science of the Republic of North Ossetia-Alania since 2018, is aimed at attracting young teachers and developing human resources.

The project "Personnel training for the education system", approved by the order of the Ministry of Education and Science of the Republic of North Ossetia-Alania dated December 14, 2018 No. 1108, is aimed at implementation of a training system for the education system of the republic.

Within the framework of the project, systematic work was organized to develop continuously the professional skills of the education system employees, the content of continuing education programs is being substantially updated.

The basis of the project is the formation of conditions (system) for the continuous and systematic training of teachers, including through the use of new forms of career guidance, modern digital technologies, the formation and participation in professional associations and competitions, experience exchange and best practices, attracting employers to advanced training of teachers, including the forms of internships, the introduction of an effective mentoring system.

The project is aimed at improving the social status of teachers and educators, which will become an additional incentive for attracting young and ambitious specialists, improving the quality of education in general. The project implementation period is 2019–2024. As a result, a system of training young specialists and developing human resources will be created.

The activities of the regional project "Personnel training for the education system" are being implemented by stages. The work on the creation of a system, that will form personnel for education, has been carrying out by the Ministry of Education of the Republic for several years already.

Agency for Strategic Initiatives has developed the project "Personnel of the Future for the Regions", and plans to implement it in 2019–2020 in 23 constituent entities of the Russian Federation. A project under this name starts in the Republic of North Ossetia-Alania. This is not a platform exclusively for excellent students or public figures, but it is a platform for convinced patriots, which are sure of their possibility to change something around.

The project is aimed at the formation and development of leadership teams from active, ambitious and caring students who are able and willing to join to the design and implementation of social and economic projects important for their region.

There will be formed leadership teams consist of talented students from 14 to 17 years old. The teams will work under the guidance of mentors and tutors.

Participation in the project will give children the opportunity for social and professional attempts in various sectors of the economy and social sphere, regional and municipal government at key enterprises of the republic.

Today, despite their young age, children can think critically and can objectively evaluate the surrounding realities. This is a completely different generation, capable of radically different decisions, and the project is aimed at an influx of fresh ideas and forces. Specialists and experts from various departments of the Republic of North Ossetia-Alania are ready to supervise the project participants, nurturing personnel for North Ossetia. The initiative will be implemented in several priority areas for the region: tourism and recreation, the development of energy, industrial, transport, logistics and agro-industrial complexes, the production of building materials, medicine, education, IT technology and the socio-cultural sphere.

Moreover, the regional initiative "Personnel of the Future for the Region", solving its tasks, will help in the implementation of several federal programs of the national project "Education": "The success of every child", "Digital educational environment" and "Social activity". Indeed, it will become a productive mechanism of career guidance. It is worth paying attention to the result of a survey conducted by the NAFI analytical center last year, according to which more than a half of Russians say that the school didn`t help them decide on their future profession. Then what motivated admission and labor activity can we talk about? And thanks to the project children will have the opportunity of professional attempts in various sectors of the economy and social sphere, regional and municipal management at key enterprises of the republic, as well as internships in production.

High schoolers will have open access to a digital educational platform where they will take online courses on leadership, project management, self-presentation skills, and creative thinking. They will meet new friends who may become their future partners in some projects.

Each participant will have the opportunity to implement their educational program, as well as the chance to take an internship at enterprises of North Ossetia. The initiative will end with the defence of team projects, the winners of which will be able to realize their ideas.

Assistance in the formation of an individual educational program for the most motivated and successful participants in the project will continue after its completion. Thus, in addition to viable projects that are designed to solve real problems in the socio-economic sphere of North Ossetia, in 2020 the republic should receive a certain register of promising personnel. How effective this initiative is one can see by the example of 7 pilot regions, where it was launched in April last year.

IV. CONCLUSION

Today an improvement of personnel training and the formation of human potential for most countries are priority tasks. The quality of education in the country is growing, and the professional level of personnel is improving. The Russian Ministry of Education and Science is making great efforts to increase competitiveness in the global market for Russian education in general, as well as for individual universities.

The integration of domestic science in the global processes of scientific and technological development will increase the efficiency of Russia's participation in the international division of labor in the scientific and technical field; promotion of Russian scientific developments on the world market; increasing the attractiveness of national research facilities, research programs and projects for foreign investors. All this contributes to a qualitative change in Russian educational and industrial institutions, the development of the economy of the Russian Federation, the involvement of scientists. In other words, it contributes an increase to the level of development of the entire state and citizens individually. While improving ourselves, we are developing Russia and the whole world.

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Training of Skilled Personnel under the Conditions of Digital Economy

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***Abstract*— The new era of digitization is accelerating, giving people not only great opportunities but also the problems associated with the transformation of the current system. The development of the digital economy in the coming years will significantly change the structure of the Russian labor market. This will cause a significant increase in their staffing with specialists of appropriate qualifications, the calculation of the needs of which should correspond to the real demands of the labor market. The article describes the main trends in the development of the system of training and advanced training under the conditions of the digital economy. The paper provides the directions of the labor market development and modernization of the Russian education system based on the study of domestic and foreign experience.**

Keywords— economy; information sharing; digitization; labor market; training system; distance education; innovation technologies; platforms

I. INTRODUCTION

Under the conditions of globalization, the world is becoming more and more technological. Moreover, economic relations are becoming more complicated, and the virtualization of the economy is increasing. The global economy is turning into a large-scale digital world and global network market. It is the digital economy that is a powerful accelerator for innovation, growth and social well-being.

The need to ensure the digital transformation of the country's production and social processes is reflected in the national program Digital Economy of the Russian Federation and is considered as an urgent task of accelerating the economic recovery. The essence of digital transformation is the integration of modern information technologies in all aspects of business activity, which ensures the transition to the information society and Industry 4.0. [9] At the same time, the characteristic features of the development of information technologies should be taken into account: outstripping rates concerning the development of society; multiple changes in information paradigms during the generation life cycle; rapid expansion of potential applications. Nowadays, we can only give separate examples of such applications with successfully integrated information technologies. Digital Economy of the Russian Federation program sets the task of mass use of information technology in almost all areas of public activity, paying particular attention to regional digitalization.

According to experts of the World Economic Forum among the consequences of the Fourth industrial revolution will be global changes in the labor market associated with the replacement of human labor by mechanized labour. If in 2018 in 12 sectors covered by an expert report, on average 71% of the total working time was occupied by people and 29% by machinery, then by 2022 the percentage will have changed: 58% of the work will be performed by people and 42% by cars. Due to the development of this trend, it is expected elimination of 75 million traditional jobs and creation of 133 million new ones. As a result of the automation of production, workers will move into the service sector, where “human” skills are required, and strengthen the IT sector, which is rapidly becoming a key factor in the development of the economy, and which will need to be served.

II. METHODS

The task of personnel training for the digital economy (which is framed in an independent Federal Project) is set within the frame of the national program Digital Economy of the Russian Federation. [2]

In accordance with this program, personnel and education should be distinguished among the basic areas of the digital economy. It is noted that today the number of graduates and the content of educational programs do not meet the requirements of the digital economy. At all levels of the education system, there are not enough personnel who can work in a digital economy. In this regard, it is necessary to provide:

- creation of key conditions for personnel training for the digital economy;
- improvement of the educational system, which should provide the digital economy with competent, highly qualified personnel;
- the formation of a fundamentally new labor market, which should be based on the requirements of the digital economy;
- creation of a motivation system so that the personnel are motivated to acquire the necessary competencies and participate in the development of the digital economy of Russia.

Technological progress influences the lifestyle and nature of work of economically active citizens. Foreign researchers

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claim that soon the labor market will fundamentally change, the lifestyle and nature of work will change, so it is necessary to prepare for the periodic retraining and career guidance of personnel will be required to maintain a high level of development. [5]

According to the World Economic Forum studies, about 65% of children going to primary school today will have the jobs which do not exist yet. Education should consider these trends, adapt to the needs of the market and the characteristics of future workers, and train future workers in gaining skills which will be most demanded in the labor market afterwards.

In prospect, specialties related to science and technology, engineering and mathematics, will be in the most demand. However, today only theoretical training for new specialists is not enough. According to the studies of Harvard University scientists, the greatest demand in the labor market is for employees with social skills in team communication. They should know and fulfil the functions of management consulting, be able to build human interaction and also combine artificial intelligence with human communication based on moral principles of behavior. The machines must work for a person but not against him.

III. Analysis

Unfortunately, the training of specialists in higher education institutions sometimes lags behind practice. Economic based on knowledge and technology depends on the ability of educational process rapid restructure and formation of new competencies and qualifications that will be more in demand on the labor market. The training system should be arranged so that there was a possibility of retraining and adaptation of acquired skills. Also, currently, technical innovations require collective production skills and high social skills among workers in these industries. Acquired skills will be constantly changing.

Economics of even the most developed countries have already changed, but the education system has not, with rare exceptions. Some skills are required, and people with other skills are entering the market. This gap is growing wider and is typical for absolutely all countries. Therefore, people are either forced to educate themselves, getting the necessary skills, or they are trained by entrepreneurs, companies, based on their tasks. At the same time, the rate of technological development is only accelerating; new professions are constantly appearing. Within the framework of the Federal project "Personnel for Digital Economy", a whole block of measures that allow training specialists faster has been laid. However, the successful implementation of this approach requires the coordinated work of a number of departments, including several ministries.

Currently, special attention should be paid to youth education, as they will have to take jobs that do not yet exist. One should start with traditional training, but it must be adapted to the specific needs of the economy and take into account the characteristics of the millennium generation. The learning process should be organized so that it could be implemented at the level of individual groups of students. This will allow using new technologies and developing and instilling a culture of communication between students. Trainees should not be passive listeners but should integrate ideas themselves and prove their significance. Teachers in this process should play the role of a master and mentor, a kind of network manager, guiding students while they pass certain stages of training and form their knowledge base, communication experience and receive technical and social skills.

Foreign experts believe that the most effective form of training today is not the lecturer's verbal discourse, but PowerPoint or Keynote presentations, as well as case solutions and case problems. It is important to create a trial and error method so that students can evaluate the correct choice and principles of selecting the best result. Currently, leading universities in Russia are already working on such a system of education, but in general, the level of teaching in Russian education has yet to be increased in order to meet the best international standards. This requires the introduction of uniform standards of training and the adoption of state programs, the allocation of funding for the retraining of teachers. For example, Korea adopted a long-term program for the development of the education system until 2030, which implies both the introduction of new education standards and the need to introduce simulation models and innovation technologies as tools for educational process structuring, as well as using a monitoring system of the results to adjust this process.

The system of professional retraining requires close contacts with employers. Companies and organizations that attract graduates should not only provide them with jobs but also participate in the formation of the educational process, as well as develop their professional development programs for their personnel. They should develop incentive systems to retain employees based on increasing their interest in the results of their work. At present, developing retraining programs is especially important, as more and more people are becoming freelancers, i.e. self-employed, and can afford additional education. In the United States about a third of 53 million employees are now freelancers and according to studies conducted by American scientists their share will grow by 2020.

Now technological progress is perceived ambiguously by different segments of the population. The older generation tends to see it as a threat to themselves; only 40% of young people feel fear and are afraid of losing their jobs as a result of the introduction of new technologies.

IV. Results

With the growth of technology, the service sector is growing, new jobs are being created. It requires specialists with a high level of competence on several important issues. Therefore, it is important to take into account the importance of education, which should provide the digital economy with the necessary number of labor personnel that can easily operate with information at any given time [6].

Today, the domestic educational space is rapidly growing and expanding due to the development of the digital environment: electronic textbooks are created, electronic

library systems are formed, educational platforms appear and develop, the number of mass open online courses is measured in the thousands, and the number of their consumers – in the millions. Distance education has already firmly entered our lives.

Without the development of human capital, intensive growth of the main progressive structures is impossible: technologies and the complete informatization of society. It is obvious that its development will lead us to the creation of an adequate model of the country's economic growth and constructive cooperation between the state, business and civil society. And human capital needs special "growing" tools, the main of which are educational technologies used in the state.

The decisive role is played by the higher education system, combining educational and scientific activities, capable of providing not only targeted training and retraining of personnel, but also the scientific and production basis of digitization. The existing system of higher education in the field of information technology is heterogeneous in its capabilities in different regions and areas of activity. Under these conditions, it is advisable to formulate such tasks and strategic areas of higher education that will maximize the achievement of the results and pace of digital development of regions set by the national program "Digital Economy of the Russian Federation".

The education system will undergo serious changes at all levels. First of all, due to the widespread introduction of new educational technologies. It is they that allow removing the restrictions associated with the possibilities of age, health, as well as with the place of residence. The development of such tools has begun on the initiative of domestic universities and has been ongoing for quite a long time. In 2015, leading Russian universities established the National Open Education Platform, which hosts online courses created by the best teachers of these universities. The network interaction of educational organizations helps to improve the quality of education, i.e. students get the opportunity to study through lectures of professors from Moscow State University, Higher School of Economics, MIPT or NUST MISiS.

In 2017, the Ministry of Education and Science of Russia launched the priority project "Modern Digital Educational Environment in the Russian Federation", the purpose of which is to create conditions for systematic quality improving and expanding lifelong education opportunities for all categories of citizens through the development of the Russian digital educational space. [7]

The serious problem of the effectiveness of training organization in higher education is the process of employing graduates from low-budget institutes and colleges. Currently, a steady tendency of obtaining decent jobs by representatives of leading national and international institutions has been formed. Graduates of leading universities will easily be able to find work in their specialty after graduation. Today, it is necessary to develop systems of "social elevators" for the poorer sections of the population, to provide for the possibility of obtaining a secondary education at the expense of the company or on a budgetary basis, but under certain conditions. An important role in this system is played by distance education, which may be accessible to the general population. However, the experience of distance learning shows that students need to have basic knowledge and skills in order to complete an online education course successfully. Therefore, distance learning should be built as a second higher education or as continuing education courses. Online learning has its advantages and disadvantages over traditional forms of learning. It provides an opportunity to learn from world famous professors and to attract additional students to the training system. This system has now reached an international level, but obtaining an online education does not guarantee the employment of students after completing the course. In practice, it is difficult for them to wrest out of their residence and find a decent job. In these problems, the participation of the state and employers, and not just educational institutions, is necessary.

The main purpose of the Modern Digital Educational Environment project is the implementation of the online courses into the universities` educational programs, singling them into separate disciplines and assessing them by grades. In the next three years, the project should cover an extensive part of the areas of training of higher educational institutions both in terms of undergraduate and graduate programs. It is planned that in six years more than 10 million people a year will be trained in open online courses [4].

The portal online.edu.ru, created as the part of the project, brings together educational content located on 39 platforms; the total number of online courses available in the portal registry exceeds 1100 items in dozens of areas of training. Currently, the number of registered students has exceeded 700 thousand people who have attended online resource courses over 4.5 million times.

New educational technologies are not restricted by online courses. Today, methods that make it possible to build a personal educational trajectory for each student based on the big data analytics (the so-called "digital footprint" of the student) come to the fore.

V. CONCLUSION

The development of innovation technologies leads to high labor mobility within the global economy. Therefore, it is important to consider that not only knowledge exchange is necessary, but also the outflow of trainees and students is possible in cases where the level of national higher education does not meet international standards, as well as when graduates of higher educational institutions cannot find work in their specialty.

The development of innovation technologies will increase the availability of various forms of education and enhance professional skills. Probably the system of two and four years of study in higher education will change as a result of the fact that higher education will be in demand for new or related professions, as well as for workers who are in the middle of a career path.

The use of new sectorial platforms for employment in the future, as well as an increase in the number of employees without permanent employment, will lead to an increase in the

use of digital systems and software that manage complex workflows based on tasks that are solved on demand.

Innovation technologies now allow individual users to enter global markets. In the future, this may lead to the fact that workers will independently make the transition from the category of labor suppliers to the category of owners of a certain capital. Thus, even novice lawyers will be able to attract resources independently in the market and form their law firms that will interact with other users through platform systems.

In order to meet the new needs of the labor market, higher educational institutions should provide structured and quality education, which is likely to require a revision of the student curriculum and reduction of study hours in applied disciplines. At the same time, the students should develop the basics of conceptual design and entrepreneurship, as well as social behavior skills that can prepare students for independent activity as micro-entrepreneurs in the innovation economy.

The indisputable advantage of digital technologies is the ability to ensure that each person acquires new knowledge and competencies at any stage of professional development, which is very important in a rapidly changing world.

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Education and Business in the Industry 4.0

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***Abstract*— Under the conditions of Industry 4.0, much attention is beginning to be paid to such trends of the modern economy development as competitiveness, innovation, labor productivity, knowledge economy, and the digital economy. The purpose of the study is to analyze and propose the most effective mechanisms of interaction between higher education institutions and companies that would allow achieving a synergistic effect. The scientific novelty of this study consists in examining the essence of economic processes currently operating in the world economy through the prism of the features of higher education, and in developing a number of recommendations, including on building intellectual capital and building close ties between education and business that would allow on the one hand, to increase the competitiveness of enterprises, and on the other, the competitiveness of higher education institutions in the world market. The paper presents the following research methods - systemic method, statistical method, graphical method, analogy method.**

***Keywords*— human capital; education; business; Industry 4.0; world economy**

I. INTRODUCTION

Nowadays, in the era of the fourth industrial revolution, when digital technologies have transformed entire industries, social networks platforms and streaming services have changed media and entertainment, and e-commerce giants have overtaken retailers, it is especially important for companies to become more sustainable and create new, high-tech well-paid and interesting workplaces.

Within the framework of Industry 4.0, not only the production process, but also the services sector that is related to manufactured products is fundamentally changing. At the same time, people are started to be seen not only as carriers of demand and creators (manufacturers) of goods and services, but also as the core of qualitative changes and transformations in the knowledge economy and the modern digital economy.

And if during the third industrial revolution 80% of the company's value was attributable to tangible assets, now more than 80% of the value of modern companies is occupied by intangible assets, which include intellectual property, brand value and company employees (human capital) [1].

Also, the development of modern digital technologies has led to the forefront of the interoperability of man and machine (makes possible to contact via the Internet; assures transparency of information and the ability of systems to create a virtual copy of the physical world) and technical assistance of machines to man (in combining large amounts of data and performing a number of unsafe tasks for humans; the ability of systems to make decisions independently and autonomously).

II. MATERIALS AND METHODS

Comparison of modern international leading companies can be carried out according to various parameters, among which are the volumes of revenue and profits, as well as market capitalization (Table I) [2, 3].

TABLE I. TOP-10 WORLD COMPANIES BY VOLUME OF REVENUE, PROFIT AND MARKET CAPITALIZATION, MLN. USD, 2019

Company name	Country	Sector	Volume, mln. USD
BY REVENUE			
Walmart	USA	Total sales	514 405,0
Sinopec Group	China	Energetics	414 649,9
Royal Dutch Shell	Netherlands	Energetics	396 556,0
China National Petroleum	China	Energetics	392 936,6
State Grid	China	Energetics	348 903,0
Saudi Aramco	Saudi Arabia	Energetics	355 905,0
BP	Great Britain	Energetics	303 738,0
Exxon Mobile	USA	Energetics	290 212,0
Volkswagen	Germany	Automotive	278 612,0
Toyota Motor	Japan	Automotive	272 612,0
VOLUME OF PROFIT			
Saudi Aramco	Saudi Arabia	Energetics	110 974,5
Apple	USA	Technologies	59 531,0
Industrial & Commercial Bank of China	China	Finance	45 002,3
Samsung Electronics	South Korea	Technologies	39 895,2
China Construction Bank	China	Finance	38 498,4
J.P. Morgan Chase	USA	Finance	32 474,0
Alphabet	USA	Technologies	30 736,0
Agricultural Bank of China	China	Finance	30 656,5
Bank of America Corp.	USA	Finance	28 147,0
Bank of China	China	Finance	27 225,2
BY VOLUME OF MARKET CAPITALIZATION			
Microsoft	USA	Technologies	905 000,00
Apple	USA	Technologies	896 000,00
Amazon.Com	USA	Consumer Services	875 000,00
Alphabet	USA	Technologies	817 000,00
Berkshire Hathaway	USA	Finance	494 000,00
Facebook	USA	Technologies	467 000,00
Alibaba	China	Consumer Services	472 000,00
Tencent Holdings	China	Technologies	438 000,00
Johnson & Johnson	USA	Healthcare	372 000,00
Exxon Mobile	USA	Energetics	342 000,00

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In the table, one can see that while the Top-10 companies in terms of revenue are mainly representatives of the energy and automotive sectors; the top 10 companies in terms of profit there are mainly representatives of the financial and technology sectors, then the Top-10 companies in terms of market capitalization are represented by digital high-tech companies, the most striking Industry 4.0 representatives. At the same time, there are a number of companies (Saudi Aramco, Exxon Mobile, Apple, Alphabet), which are presented in several ratings at once. At the same time, the leading rating companies are registered in the member countries and partners of the Organization for Economic Cooperation and Development (OECD).

The study also revealed the following pattern – the place of most countries and OECD partners in terms of gross domestic product (GDP) by the level of gross domestic product per capita is closely related to the level of innovation and the level of education, which indicates the dependence of these indicators. In cases where these values do not coincide, in general, the largest deviation arises in terms of GDP per capita, which is possible with a heterogeneous population in OECD countries and partners (Table II) [4–6].

TABLE II. Dependence of the GDP level per capita of the population on the education level and the global innovation index

Country	Place of a country in ranking		
	GDP per capita	The level of education	Global Innovation Index
Australia	12	8	23
Austria	8	18	20
Belgium	13	15	27
United Kingdom	16	11	5
Hungary	30	31	39
Germany	11	9	9
Greece	31	35	44
Denmark	9	3	6
Israel	21	17	17
Ireland	2	12	10
Iceland	7	13	13
Spain	22	27	28
Italy	20	29	29
Canada	14	9	18
Korea	23	20	11
Latvia	32	29	33
Luxembourg	1	27	12
Mexico	35	61	58
Netherlands	6	8	3
New Zealand	19	7	21
Norway	4	5	19
Poland	29	28	38
Portugal	27	35	31
Slovakia	25	31	34
Slovenia	26	19	32
USA	5	6	4
Turkey	33	61	43
Finland	15	11	8
France	18	21	15
Czech Republic	24	22	24
Switzerland	3	8	1
Sweden	10	8	2
Estonia	28	18	25
Japan	17	19	14
Brazil	36	67	69
China	-	69	22
The Russian Federation	34	35	45

Moreover, if we consider the Top-3 clusters according to the Global Innovation Index, presented in patent and scientific activities, then of particular interest are the collaborations between clusters, universities and other companies that can achieve a synergistic effect (Table III) [7].

TABLE III. TOP-3 CLUSTERS BY GLOBAL INNOVATION INDEX VERSION REPRESENTATED IN PATENT AND SCIENTIFIC ACTIVITY, 2019.

Place	Name	Scientific publications			PCT procedure applications		
		Field	Share, %	Partnership organization	Field	Share, %	Partnership organization
1	Tokyo - Yokohama	Physics	9,22	University of Tokyo (13,82%	Electricity and equipment	9,86	Mitsubishi ectric (7,83%)
2	Shenzhen - Hong Kong	Engineering	10,81	University of Hong Kong (17,23%)	Digital communicatio ns	38,39	Huawei (25,76%)
3	Seoul	Engineering	7,53	Seoul National University (16,10%)	Digital communicatio ns	16,63	LG Electronics (18,71%)

In this regard, for successful operation of companies in the era of Industry 4.0, it is necessary not only to follow the traditional methods of production and sale of goods and services, but also to carry out the following activities [8]:

- to attract new talents and build the necessary skills and competencies for the company;
- to get practice on working with integrated contracts, create joint innovative enterprises, including with higher education institutions;
- to effectively introduce new approaches to innovation and to integrate new technologies into existing work processes;
- to develop suitable options for using digital models, as well as to apply additional technologies that will be more financially attractive;
- to study market changes and hedge risks to identify new products and services, as well as the most competitive market segments;
- to include comprehensive change management programs, flexible organizational structures and flexible working methods in its activities.

It can also be noted that the role of education and universities is growing all over the world, which are also undergoing changes:

- universities are more active in collaborating with high-tech companies, as they are forced to look for alternative sources of financing. In turn, enterprises thus reduce the volume of independent basic research in favor of cooperation with universities in the framework of projects that are important for their competitiveness;
- to increase their competitive advantages, universities are becoming a platform for the concentration of world experience, including through the development of projects for the implementation and commercialization of the knowledge created;

- to meet modern trends, universities integrate formal and non-formal education, create creative spaces and inter-university sites, and also use the project approach, personalization and digitalization in education;
- universities are gradually moving from a functioning model 1.0 to a model 4.0 (Fig. 1) [9, 10].

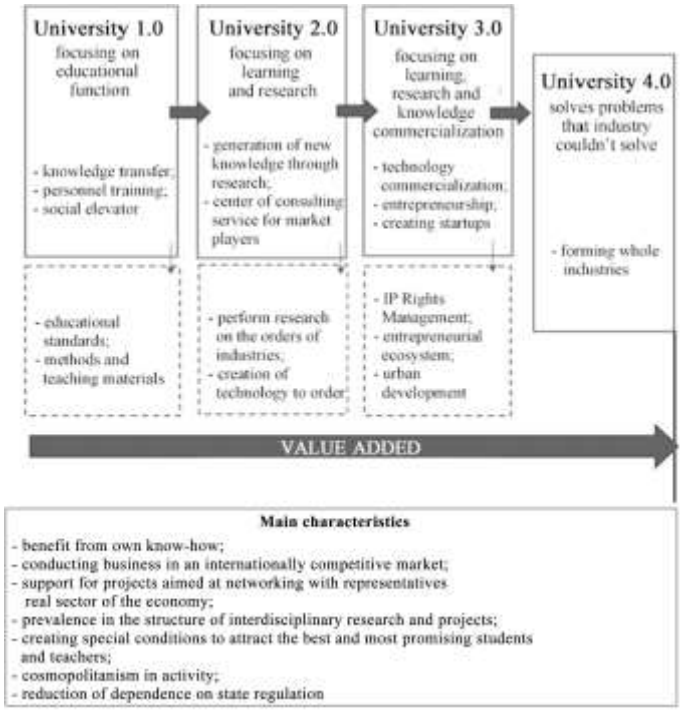

Fig. 1. Model of transition from University 1.0 to University 4.0

III. RESULTS OF RESEARCH

Due to the fact that at present it is possible to compare the duration of the technology life cycle and the duration of higher education, there is a threat of disappearance or partial changes in the professions for which training is currently being conducted. One of the problems preventing Russian universities from becoming leaders in world education is their strong conservatism, the rigidity of normative regulation of educational activities, as well as the practical lack of a student-centered approach in building curricula and personal educational routes. Among other things, there is low integration with industrial enterprises, with the exception of basic departments from enterprises that are located in a number of universities, including the Southern federal university.

In order to solve these problems, as well as for closer interaction between business and education in the era of Industry 4.0 and Russia's integration into the system of world economic relations, it is necessary to solve the following main tasks:

- to improve the system of regulatory, organizational and informational mechanisms for the formation and implementation of such integration activities;
- to create an integrated system of transition to the University 4.0 model based on interagency cooperation;
- to provide the needs of enterprises with the necessary personnel through the joint work of enterprises and universities;
- to prepare the professional development of personnel;
- to implement measures for career guidance on the basis of socio-economic information about the prospects for the development of regional economies, which will also allow for the search, selection and development of talents.

In Russia, the interaction of the University 4.0 (meaning such a university that combines consortia and clusters between higher education institutions with enterprises of the real sector of the economy) and Industry 4.0 is possible through the inclusion of the National Technological Initiative, the Agency for Strategic Initiatives, national projects, as well as national programs (for example, Digital Economics and Digital Industry).

Thus, a synergistic effect can be achieved, which will allow to develop the competitive advantages of all interacting parties (Fig. 2).

Fig. 2. Interaction between University 4.0 and Industry 4.0

Also among the projects currently available in this direction, the following can be distinguished:

1. The inclusion of the Russian Federation in an international organization that promotes vocational, technical and service-oriented education and training WorldSkills. Among the main projects, the following can be distinguished: holding championships for young specialists, creating specialized centers of competence, creating centers of advanced professional training.

2. Implementation of the project "Professional training 2.0", in this case the employers offer students to find solutions to real problems in various fields. Among them, in particular, business, tourism, education, medicine and other areas. Students, in turn, will be able to choose the direction of interest and write a scientific work. Those who

successfully complete the proposed task will be invited to an internship or even to work.

3. Creation of world-class scientific and educational centers. The union of educational institutions of higher education and scientific organizations, regardless of their departmental affiliation, with organizations of the real sector of the economy that conduct research of a world level, the result of which is the receipt of new competitive technologies and products and their commercialization, carrying out training of specialists for large-scale scientific and technological tasks in the interests of developing branches of science and technology according to the priorities of scientific and technological development of the Russian Federation.

4. Intensification of interaction between institutions of higher education, scientific, commercial and non-profit enterprises. The idea of cooperation between commercial organizations and universities receives a large number of supporters, since it allows to solve many issues, including questions of the demand for graduates, which is also an important aspect when choosing an educational institution.

To train well-educated and qualified personnel for Industry 4.0, a developed system of vocational education is necessary, based on technology transfer and the exchange of innovative culture between universities and Companies through joint participation in clusters (for example, the Tourism Cluster of Rostov Region, "Southern Constellation" cluster with the participation of Southern Federal University), the joint use of intellectual property (through the participation in the activities of the Center for Collective Use of South Federal University), work in the framework of employer-sponsored education (including the provision of practical training and internships, the use of simulation training methods, the provision of practice-oriented cases, the participation of a company representatives in the educational process, professional accreditation of educational programs, etc.), the participation of companies in university events (including professional tournaments, Hackathons, Forums) [11].

IV. CONCLUSIONS

Thus, we can conclude that in the modern global and digital world, the competitive advantages associated with the abilities, capabilities and speed of self-development of countries, organizations and people come to the fore.

In the Industry 4.0 and the transition of higher education institutions to the University 4.0 model, the role of the university is being strengthened from the position of integrator of scientific, educational and industrial environments, the boundaries between professional and academic spheres become less obvious, as well as formal and non-formal education begin to blur while personalization of education strengthens. Thus, education and business should become inseparable for this period and unite efforts to train personnel for the modern economy.

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The Problem of Quality Management in Higher Education: Contrasting Views of the Teacher and the University

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***Abstract*— The problems of quality management of higher education in Russia are considered. There are two system levels of quality – at the macro level (branch of higher education) and micro level (University). Based on the analysis of higher education, the objective components of the quality of higher education at the macro level, including the structure of training of employees with higher education in areas of knowledge and levels of education, are revealed. It is shown that for mass higher education required by modern society, the quality of the University means the quality of its educational environment. The basic requirements for the educational environment of the University, which set the main directions of its improvement, as well as possible ways to improve the criteria and approaches of education authorities to control and manage the quality of mass University are formulated.**

***Keywords*— higher education; quality; management; field of knowledge; level of education; mass and accessible education; profile of higher education; educational environment; individualization of education; innovations; criteria**

I. INTRODUCTION

The transition of the Russian economy to market relations has revealed some problems that can be attributed both to the General state of the Russian education system and to the vocational school.

Rapidly changing market conditions; its uneven saturation: the shortage of some specialists, with an excess of others; unstable demand for specialists from employers; the elimination of state regulation of the labor market and the distribution of graduates; increased competition due to the increase in the number of non-state educational institutions and the expansion of paid education; low efficiency of educational processes due to the use of outdated teaching methods, all this predetermines the revision of approaches to quality management of modern education.

Meeting this ambitious challenge requires long-term interventions that may not always be limited to education systems. In particular, it is necessary to provide for the possibility of adapting educational programs and qualifications obtained as a result of their implementation to the requirements of the world labor markets; to expand training in the main world languages; to improve educational management, information activities and marketing; to promote the mobility of students and teaching staff and their employment.

But of particular importance for increasing the competitiveness of Russian professional education is, of course, improve its quality, so in the coming years it is expected first of all to fully combine education and scientific research, to upgrade the educational program of vocational education in General, taking into account the current state of science, scientific ideas about the world and practices.

At the institutional level, a key role should be given to the development and use of mutually acceptable criteria and mechanisms for the assessment and validation of the quality of vocational education, some elements of which are present in the well-functioning national quality assessment systems of a number of countries, such as France, Sweden, Denmark, the United Kingdom and others.

In recent years, there has been an ongoing debate among specialists as to which strategy should develop Russian education in the XXI century, which criteria for the quality of education are the most optimal and can provide the expected high results, and which methods and tools should be used in the process of managing the quality of education.

II. ANALYSIS OF APPROACHES TO THE DEFINITION OF "QUALITY OF EDUCATION"

The problem of the quality of education is one of the Central problems in modern educational policy and science, because it is connected with the solution of a set of tasks aimed at personal development, its preparation for life in a rapidly changing and contradictory world, a person with high moral aspirations and motives for highly professional work.

In the pedagogical theory and activity it is more and more realized that ignoring or belittling of a role in educational programs, practice of educational process of any element or type of the content of education causes huge damage to interests not only of the individual, but also all society which progress is directly connected with quality of education.

The phrase "quality of education" in the early 90-ies of XX century, first appeared in Russia in the Russian Federation Law "On education" (1992 and 1996), in an article on state control over the quality of education, which gave rise to a large

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number of different practices such control, initiated the development of relevant theoretical concepts, becoming a basic factor of stable growth of interest of scientists to this problem. Currently, the total number of publications on the quality of education is in the thousands.

In a generalized form, the quality of education is defined as a set of its properties and their manifestations that contribute to meeting human needs and meet the interests of society and the state.

At the same time, according to some researchers, graduates should be considered, on the one hand, as consumers (of information that they receive in an educational institution), on the other – as suppliers of their own knowledge and skills to the employer.

In addition, the results of education can be evaluated for different objects (children, teachers, school, University) on different parameters, in different dimensions and at different levels. And each time we are talking about different results. This determines the narrower (or special) content of the quality of education.

The quality of education of a specialist is carried out in the process of mastering the historically established content of material and spiritual culture. The formation of subjectivity is provided by the historically established system of education, and at the subsequent stages of personal development-by real life and specific professional activities. The quality of education is a personal feature necessary for a person to carry out a particular activity, including professional.

The quality of vocational education as a whole consists, on the one hand, of individual qualities, and on the other - is a system designed to solve specific professional problems. Therefore, the main link between the individual parameters is a standard professional task.

The main parameters of the quality of vocational education can be summarized as follows:

- mastered by a specialist fundamental models of solving professional problems;
- acquired skills and experience necessary to solve professional problems and elementary professional problems;
- skills of using research methods in the development of projects to solve problems in the professional sphere.

Thus, it is possible to identify the following characteristics that reveal the content of the concept of "quality of professional education" in scientific and applied aspects: cultural and historical conditionality, complexity, consistency, interdisciplinarity, focus, standardization, subjectivity.

III. STATE OF THE PROBLEM OF EDUCATION QUALITY MANAGEMENT

The state of the problem of quality management of modern education is determined primarily by environmental factors, namely the socio-economic conditions of the subjects, the most important component of which is the labor market.

The world of work is changing radically, and much of the knowledge that students acquire during their initial training is rapidly becoming obsolete. Continuous and interactive partnerships with the productive sector are essential and should be integrated into the overall objectives and activities of educational institutions. Vocational education has not escaped the scope and urgency with which the need for educational reform to meet economic needs has manifested itself at the political level.

The world Bank A. Adams, D. Middleton and Seiderman in his article in the UNESCO journal "Prospects. Education issues" rightly point out: "closer coordination of economic and educational policies, as well as diversification of funds allocated for vocational and technical education should be complemented by measures to improve the flexibility of state training structures, their effectiveness. If employment opportunities are available after training and if education is linked to employment, the impact of vocational school may be higher than that of the General education system."

The program of development of professional education of Russia, which is the main conceptual document in the field of professional education, interprets the tasks in the same direction. As the main objectives of development, it defines-providing a given quality of education, improving the competitiveness and professional mobility of graduates in the labor market. In terms of market being in a constant state of change, planning, professional education and training cannot maintain its mechanical nature. From a simple calculation, vocational education planning becomes a complex equation that must take into account many factors that differ in their predictability.

Planning is an integral element of the quality management process of national education, which is generally defined in the national literature. Thus, considering learning as a management process, the following functional components of pedagogical activity are distinguished:

1. Targeting – acts as a process of designing the personality of the student, educated, or the formation of a model of the future specialist.
2. Information – includes the content of training and education.
3. Forecasting – is the prediction of near and far psychological learning outcomes in certain conditions of its implementation.
4. Decision-making is aimed at choosing the best ways of individual and collective influence on the personality.
5. Organization of execution-associated with the implementation of educational plans, programs and pedagogical decisions.
6. Communication – represents various forms and ways of interaction of participants of educational process.
7. Control – involves assessing the actual results of training and education in different time intervals.

8. Correction – means elimination of undesirable deviations and changes in mentality and behavior of participants of educational process.

All the constituent elements of management form a single functional system of training, in which the system-forming factor is the purpose of training and education, which are oriented and which are subject to all other management functions. In turn, under the management of graduate quality, some researchers understand a constant, systematic, purposeful process of influence at all levels on the factors and conditions that ensure the formation of the future specialist of optimal quality and the full use of his knowledge and skills.

In theory, everything looks quite clear, but in practice the formation of the future specialists of Russia in the classic educational institutions and often using technologies and practices of education which have developed in the past centuries and promoting conflict educational reality, the study of stereotypes of students, teachers and administrators relative to each other and relative to their educational experience.

The internal contradictions of the reality of education are due to the fact that the subjects of the educational process – administration, teachers and students, coexist in a single space and time, but most often do not have common goals, needs, motivations and social practices. The discontinuity of information, communication and disciplinary space and time reduces the effectiveness of the educational process, prevents the value dialogue of generations, inhibits the formation of a new corporate culture of the University. Parallel coexistence of two interpretations of the educational process – as the exchange of services and as communication "teacher-student" – distorts its perception by all subjects, retains the dominance of traditional learning technologies over innovative ones.

At the same time, two conceptually different strategies constantly face in the discussion field of the problems of modern education: modernization of Russian education on the Western model or development and multiplication of national features of the education system.

Supporters of Western standards of quality of education consider the student the main consumer of educational services, which reverses the classical concept of the purpose of vocational education as a secondary socialization of the individual, giving him social and role knowledge and value orientations.

The whole system of foreign approaches to the problem of quality management in the most concentrated form is presented in the concept of TQM – Total Quality Management (Total quality management), which has its expression in the international quality standards ISO 9000 series. These standards provide terms and definitions, procedures for the development and implementation of quality systems in organizations and institutions, methods of quality management of main and auxiliary processes, etc. The methodology of the theory and practice of quality management is based on management in the field of material production, without taking into account the specifics of education.

As a result, education as a social institution and the teacher as his personal embodiment lose the original meaning of their existence. The teacher acts as a personalized service, but not as a teacher and educator.

Some authors express categorically that the americanization of society, which we see in most countries, can lead to the destruction of science and culture of modern humanity in Russia. The threat of an age of ignorance seems very real. Bureaucracy and administration begin to triumph, destroying education, science and culture in General. Students as a specific social group, which has its own political will in the system of existing power relations, now degrades. This layer of civil society needs state support programs and, in principle, cannot exist without this support. The widespread commercialization of public education results in the reduction and destruction of this important social group.

Given the current situation, I would like to note that the officially stated goal of assessing the quality of education and its maintenance at the level of set standards does not detract from national traditions, rich experience and priorities of the Russian education system. The concept of quality of Russian education should be based on the analysis and synthesis of the best achievements of world and national science and practice. UNESCO, in particular, emphasizes that the development of education cannot be realized within rigid or imposed structures, that there is a failure of development strategies based on mere copying or imposing models, that more and more people and institutions are coming to realize that in all regions the direct adoption of foreign concepts and values and the disregard of regional and national cultures and philosophies have negative consequences for education.

The duality of modern social and scientific consciousness contributes a significant amount of uncertainty to the development of the concept of Russian education and its content, damages the quality of education at all levels: from school to higher education.

III. THE PROBLEM OF ASSESSING THE QUALITY OF EDUCATION

The task of assessing the quality of education is no less difficult today. Traditionally, the assessment of the quality of training of students and graduates is carried out by means of control, with the help of various control tasks, questions, practical tasks. Means of control are developed on specialties taking into account the principle of continuity of professional education and future professional activity. Teachers develop tasks on the basis of system-structural didactics, taking into account the following levels of assimilation: recognition; reproduction; reproduction of application; synthesis. However, in these tasks, as a rule, do not reflect the methods of determining the level of readiness and ability of students to apply their knowledge in practice.

It is no secret that the Russian state standards of higher and secondary vocational education are based on General theoretical rather than practical training aimed at the ability to act in a specific professional situation. In the national state standards there is no description of connection and sequence of realization of separate disciplines with the qualification characteristic of the graduate. The state does not set integral

goals and objectives for traditional discipline. The purpose of the discipline is, in fact, not the formation of needs and skills in the future to use its scientific content, but only the factual assimilation of scientific information, most often - at the level of memorization. The student in this case is required to attend lectures and a clear answer to the examiner in the program.

The level of development of theoretical knowledge by a student is set by teachers, based on their subjective ideas about the control of learning outcomes, and not on the integral ideas about the qualification of a specialist. As a result, fundamental models and methods of training are broadcast, due attention is not paid to the use of theoretical knowledge as a methodological tool for a holistic study of certain professional situations. Pedagogical and scientific activity of teachers is poorly connected with the future professional activity of graduates.

The student has a superficial idea of the relationship of training and the main professional tasks that he will have to solve in his professional activity, the content and forms of self-training, methods of organizing the educational process, the system and criteria for external evaluation of knowledge, which he first encounters only when applying for a job.

While in most European countries there is a development of national systems of external assessment of the quality of education, in Russian educational institutions efforts are aimed at creating an internal system of assessment of the quality of training.

IV. CONCLUSION

The analysis of domestic literature shows that the basic procedures for assessing the quality of the educational process are characterized by such features as: a) a wide range of indicators to assess the qualitative characteristics; b) the use of evaluation scales; C) the use of expert procedures; d) the use of weights for individual indicators, tests, tasks, other methods of didactic control and methods of pedagogical analysis and diagnosis. Currently, it is necessary to change the paradigm of assessing the quality of education from General theoretical to practice-oriented, which meets the needs of the modern labor market, provides guarantees of demand, competitiveness of the future specialist. At the same time, the main changes must occur, first of all, at the value level of the main subjects of the educational process: teachers and students who need to develop new forms of cooperation and get rid of stereotypes.

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University Information Environment: the Case Study

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***Abstract*—The paper considers the issues of digitalized control of the university. The causes for the low efficiency of university digitalization development are revealed. Among the main issues are patchwork digitalization and ignoring the principles of modern quality management systems. The concept of designing an effective university information environment based on the philosophy of universal quality management, the methodology of integrated information systems, the principles of an active operator, adaptability and the human-system approach are described. The paper presents the university management information system tested at 20 universities in Russia and Ukraine. The system is useful not only to the university, but also to enterprises, since (1) it provides a higher quality of training, allowing creating "training paths" with production specifics taken into account, and (2) guarantees access to information about a future specialist.**

Keywords—control systems; information systems; university; information environment; digitalization; automation; ergonomics; e-learning; adaptation; quality control

I. INTRODUCTION

The rapid progress of information and communication tools has sparked a surge of interest in:

- Information technology management higher education;
- Training digitalization.

Digital technologies for *lifelong learning* are spreading [1].

Computer training has evolved from "episodic use of technical tools for training and knowledge control", as well as from systems such as "Dean's office" or "Department" (50s – 90s of the 20th century) to the development of unified information environments of universities, for example [2, 3]. Moreover, both stationary computers and mobile devices of the educational process participants are accessing the universities information environments and controlling the relevant processes [4, 5].

Universities are increasingly introducing technologies for managing the activities of teachers, staff, as well as *e-learning* and *blended* systems for the educational process organization [6, 7].

II. PROBLEM ANALYSIS AND RESEARCH GOALS SETTING

University activities digitalization has become a global trend; enormous resources are allocated for the creation of new technologies, for example [3], but the return on efforts and capital investments (in the sense of a stepwise improvement in management quality indicators and the educational process efficiency) often do not meet the expectations of the educational process participants [8, 9]. The existing hypothesis "Total automation of all existing processes in a university and the accumulation of relevant information in databases can significantly increase the university activities efficiency" is not only not working in practice, but also is harmful. New digital tools, communication channels, and advanced technologies implemented without a thorough system analysis, can lead to an avalanche-like increase in the number of issues, for example, [8, 9] and in the risks of various threats to people's safety, for example [10].

The goals for the presented work are:

- Analysis of the causes for the low efficiency of higher education institution information management systems;
- Description of methodological and scientific-practical principles for university information systems building, based on many years of work in development, implementation and operation of such systems.

III. INFORMATION ENVIRONMENT AS A UNIVERSITY ACTIVITY QUALITY MANAGEMENT TOOL

A. Justification of the Research Concept

The work is based on:

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- A summary of our 26 years of experience in researching automated university management systems:
    - Review of literary sources describing university management systems in Europe, North America, Australia [1, 3–11] and others;
    - Inspection of acting systems – Ukraine, Russia [2, 12-17], and others;
- Generalization of the own experience [13] in university management systems development and implementation for more than 20 higher educational institutions;
- Methodology of Total Quality Management (TQM) [11,13,14] specifically adapted to higher educational institutions activities;
- Methodology of the "active operator" and the human-system approach to process control in ergotechnical systems [12, 18];
- Methodology of "adaptive systems" [18] (in terms of adaptation in the features of all types of operators working in the complex hierarchical human-machine system "University") [13].

B. Analysis of the main problems of existing systems

The main problems of existing systems are:

- Pr1 – "patchwork automation" with many heterogeneous systems and subsystems, which are often duplicating each other's functionality, working in the interests of specific departments, and may even need operators to work in different subsystems;
- Pr2 – data duplication and inconsistency (as a result of Pr1);
- Pr3 – ignoring the principles of the process approach, process automation "as is";
- Pr4 – lack of full integration of the "Administration" and "Teaching" subsystems (as a result of Pr1);
- Pr5 – lack of moral and pragmatic interest of staff and teachers to work with the proposed tools;
- Pr6 – low quality of the digital training resources, lack of efficiency in content management;
- Pr7 – low development of adaptation mechanisms to the characteristics of the system operators – students, staff, teachers;
- Pr8 – low efficiency and quality of process tracking and presentation of the whole complex of necessary information in the university portal system (schedule, digital log books, ratings, etc.), issues with supporting mobile devices interface;
- Pr9 – focus on powerful software environments, which are usually designed for industrial information systems (such as SAP R3), with the hope of "adapting" the environments to university specifics someday in the future, which, as a rule, is rarely possible, especially for outsourced software developers;
- Pr10 – lack of both interest and process continuous monitoring by the leading manager;
- Other.

Today almost all higher educational institutions report the success of digitalization and e-learning, but for many it is simply a tribute to fashion and the digitalization is often inefficient. The haphazard accumulation of low-quality electronic resources is much more harmful than even an old paper textbook and a traditionally oriented teacher.

For TOP universities that have made a breakthrough in digitalization, now comes a period of new strategies development for advanced adaptation to the technological Digital Revolution.

C. Methodology for creating and operating the information environment

Based on the analysis, the we propose the following methodological principles:

Mp1. Focus on the use of Total Quality Management (TQM) philosophy. Among the basic principles of TQM [11, 13, 14]:

- Customer focus;
- Staff involvement;
- Process approach;
- System unity;
- Strategic and systematic approach;
- Continuous improvement;
- Factual decision making;
- Communications.

Mp2. Integration. Integrated Automated Control System (ACS) is distinguished by the design method that ensures the consistent achievement of goals, each of which cannot be achieved through the local use of individual types of ACS. In mechanical engineering, an integrated ACS (IACS) includes:

- Computer-Aided Design (CAD) systems;
- Automated systems for production technological preparation (ASPTP);
- Production ACS (PACS);
- Automated Process Control Systems (APCS).

Similar processes should be automated in a university management system, which in the general case consists of two global subsystems: "University Activities Management", "Teaching Process Management".

Thus, in an integrated ACS:

- Both global subsystems should be implemented within a single system (information environment);
- Comprehensive digitalization should cover all stages of the life cycle of all functional elements of all subsystems.

Mp3. Adaptability. The requirement for adaptability is relevant due to massive refusal of students to work with digital software tools that are uncomfortable for them personally. The essential characteristics of the trainees and the environment should be promptly taken into account for each dialogue session. At the same time, the adaptation should be carried out for:

- Modalities;
- Complexity of the material;
- Algorithms for human-machine interaction;
- Student motivation;
- Available time resource;
- Student functional state.

Mp4. Ergonomics. A digitalized university essentially becomes a polyergatic information system with different types of operators (managers, administrators, teachers, attendants, students, etc.).

Nowadays unfortunately, most of the university operators work under stress conditions, high workload and cognitive discomfort. Therefore, we believe that special ergonomics departments or ergonomic support sectors should be created at universities as a part of digitalization services that would professionally deal with ergonomic quality problems.

Such services should provide:

On the university management tasks level:

- Information environment optimization based on the principles of a "distributed authority" system, certification of workplaces for operators and software, elimination of "patchwork automation" [23-27];
- Automation levels optimization for each specific task [13];
- Tasks optimal distribution among performers [13, 21];
- Optimization of interface solutions for operators' workplaces, taking into account their psychophysiological characteristics and functional responsibilities [12, 13];
- Interfaces assessment, workload analysis, application queues, work intensity, stresses, work and rest regimes, etc.) [13, 16, 17];

On the e-learning management tasks level:

- Development of engineering-psychological and design requirements for content [19, 20];
- Content assessment and modernization of electronic training modules [19];
- Development of technologies for providing individual training paths [12, 22, 24];
- Monitoring the functional state of students [12, 16, 19];
- Providing mechanisms for adapting the information system to the preferences and psychophysiological characteristics of students and current environmental parameters [12, 19];
- Implementation and ergonomic analysis of the "intelligent agents" system performance efficiency [19].

D. Implementation and approbation

Initially, the methodology was used in developing and implementing (under the technical guidance of Ph.D. Klimenko A.V.) the system "Computer Management of a University" [13] at Sumy National Agrarian University and Kharkiv National Academy of Municipal Economy.

Decisions and approach efficiency approval allowed to extend the experience in developing university automation systems in more than 20 universities in Ukraine and Russia (Moscow, Belgorod, Kharkov, Kremenchug, Vinnitsa, Zhytomyr and others, including Lomonosov Moscow State University).

The fundamental differences of the implemented systems are:

- Holism of the hierarchical system of management, control, information, and training functions with taking into account the needs of all structural units (rector, vice-rectors, academic departments, planning and financial departments, human resources department, dean's offices, departments to dormitories, etc.) with the comprehensive workflow automation and automatic generation of all types of orders, statements, protocols, etc.;
- Automatic generation of all types of schedules with an extensive system of accounting capabilities and on-line informing the participants of the educational process;
- Flexible adaptation to the specifics of the university, as well as individual requests and psychophysiological characteristics of users.
- Possibility for enterprises (employers) representatives to participate in organization and control of all elements of the educational process.

IV. CONCLUSIONS

High efficiency of automated university management can be achieved by focusing on the use of the methodology of Total Quality Management by ensuring the properties of integration, ergonomics, and adaptability.

The proposed technology can be useful in developing the information environments for modern universities and will be the basis for training specialists quality management systems, as well as will ensure (on the basis of the cybernetic models) close "university – enterprise" cooperation, focused on the specialist training model design, meeting the requirements of a particular production.

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Business Model as an Effective Concept for the Development of Strategic Thinking Skills of Managers in Universities and Enterprises Partnerships

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***Abstract*—The article is devoted to the problem of applying a business model for developing strategic thinking skills in a partnership between universities and industrial enterprises. The strategic thinking is a key competence of enterprise managers in modern conditions. However, there is still no complete clarity on how to develop it. The tasks of developing strategic thinking of managers can be successfully solved through design and application of business models. The use of strategic partnerships between universities and enterprises in this process allows us to improve the quality of training and ensure its relevance to the Russian business practice. The article proposes an integrated approach for the strategic thinking skills development based on the use of business models. The process model was developed and tested in the training groups of the masters of management and practicing managers. Positive dynamics was revealed in the development of strategic thinking skills, as well as an increase in the level of student satisfaction. The results of this work can be interested for business education, and may also be useful in management practice for strategic sessions holding.**

Keywords—business model; strategic thinking; business education; case studies; universities and enterprises strategic partnership

I. INTRODUCTION

The strategic thinking of managers is a key factor of effective management in various industries, and its value is growing steadily. At the same time, only a small part (23%) of managers has strong practical skills of strategic thinking. The underdevelopment of strategic thinking is called among the main factors leading to the bankruptcy of companies and decrease of the business efficiency [1]. The results of a survey of Russian employers showed that the strategic thinking of managers is among the most relevant and demanded competencies (an average score of 4.5 out of 5) [2, 3]. However, there is still no complete clarity on how to develop these skills.

The use of business models of existing enterprises in the educational process allows us to successfully solve the problems of formation and development of managers' strategic thinking skills. The strategic partnership of universities and industrial enterprises in this process contributes to an increase in the quality of training, its relevance to Russian business practice, and the solution of enterprise problems [4]. Case studies help to find approaches for solving managerial problems and developing research and training activities. These cases should be based on the problematization of managers' work experience and researchers' academic interests. Thus they can be used both in business practice and in the educational process.

II. STATEMENT OF THE RESEARCH PROBLEM

Modern business education does not pay due attention to the practical skills formation of the strategic thinking. This is partly due to the complexity of research on the strategic process itself as well as the cognitive and socio-behavioral aspects of managerial activity. Business transformations in the time of the external environment volatility lead to radical changes in the business models of enterprises. The business models of successful enterprises are of great interest to business scientists and practitioners. However, these business models are poorly represented in the practice of strategy training for managers.

The purpose of the article is to develop a process model for training managers in strategic thinking skills based on the use of a business model as a conceptual and analytical tool and to

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test it on the basis of a case study of the real existing company. We have used the case of Russian company called the Pobeda LSR JSC (part of the LSR Group) as an empirical basis for the study. This company is successfully operating in the construction materials market in the northwestern region of Russia.

III. Research methodology

We have used the following methodological basis of the study: the concept of a business model; strategic, process, competence and situational approaches; a case study design. Our case study covers the ten-year period (1997-2007) of the LSR Group's leadership strategy implementation (Pobeda LSR JSC) in the Russian construction materials market [5, 6]. The data collection and analysis for the case study was carried out on the basis of the methods of structured interviews by top managers, employee surveys, observation, analysis of primary documents and other company materials. A longitudinal study was conducted in 2006-2008 and 2013-2014.

The phenomenon of strategic thinking was initially considered in the literature mainly from the point of psychology as a special cognitive ability. However over the past ten years, an increasing number of researchers have interpreted it as a unique set of competencies of strategic managers. We consider strategic thinking as a special, complex type of intellectual managerial activity, the implementation of which depends on a set of competencies. The implementation of the competency-based approach involves the use of strategic thinking competencies: a set of skills and abilities that affect the development of strategies, business models and strategic actions that lead to effective business [7].

It is known that best results of trainings for the Russian students and practice managers required the case analysis developed on the basis of successful companies and the Russian business practices. Therefore, the situational approach (case study) was the basis for the development of strategic thinking skills. The process approach for the strategic thinking development has included the implementation of a certain sequence of individual and collective cognitive actions that unfold in time and in a specific context. The learning process should be based on an integrated approach based on competency, situational and process approaches.

The starting point in the learning process is to determine the essence of the business model. In modern literature, there are three main positions of scientists that reflected the economic, operational and strategic levels of its understanding. The first of them focuses on the financial and economic aspects of activity. The second one focuses on internal business processes and operations. We adhere to the third (strategic) position, which focuses on the strategic aspects of the company's business. It is based on the following understanding: "A business model is a brief description of how a set of interconnected elements that reflect decisions in the field of strategy, structure and economic activity of an enterprise will be used to create a sustainable competitive advantage in certain markets" [8].

Different authors in the structure of the business model propose to consider a different number of components: from four to eight. As a basis, we have taken the structure (integrative framework) [8]. It includes six components that reflect a set of decisions at three specific levels: the "foundation", the "proprietary", and the "rules" level. The first component reflects the factors associated with the supply of value to the consumer and answers the question "How will the company create value?" The second component describes market factors. Its main question is "For whom will the company create value?" The third component characterizes the factors of the internal capabilities of the company and answers the question "What is the source of the company's advantage?" The fourth component reflects factors related to competitive strategy "How does the company position itself in the market?" The fifth component characterizes economic factors "How will the company make money?" The sixth component reflects factors related to the goals and ambitions of business owners.

If the first ("basic") level focuses on what the company is doing, the second ("own") level shows how company does it. The first level is sufficient to reflect the essence of the business model of any company. The second characterizes the features of the business model of this particular company. At the third level ("rules"), a set of guidelines and rules governing the implementation of decisions at the first two levels of the model can be indicated.

IV. Research Results and Discussion

The process model of training in general can be represented as a structured process that includes five main stages that reflect key issues and actions for understanding and discussing the business model.

Stage 1. Analysis of the external environment.

Question: What are the threats / opportunities?

Action: conduct a SWOT analysis.

Assessment: threats / opportunities.

Stage 2. General characteristics of the business model.

Question: What is the existing business model?

Action: analyze the structure and main components of the business model.

Assessment: qualitative / quantitative assessment of the main components of the business model.

Stage 3. Identification of competitive advantages.

Question: What are company competitive advantages and what are its sources?

Action: identify sources of competitive advantage.

Assessment: competitive advantage.

Stage 4. Checking the business model for compliance and sustainability.

Question: What is a relation between the elements and the sustainability of the business model?

Action: analysis of the relation between the elements of the model and the competitive strategy, stability analysis.

Assessment: compliance / non-compliance, sustainability.

Stage 5. Generation of ideas.

Question: How can company use opportunities / decrease the threats level to create value; create / maintain / enhance competitive advantage?

Action: developing ideas for creating value, building up a competitive advantage.

Assessment: necessary resources, degree of readiness for changes.

TABLE I. DESCRIPTION OF THE BUSINESS MODEL OF JSC "POBEDA LSR"

Components Native	Basic Level	Own Level
Component 1. Value factors	Product manufacturing (Ceramic Brick); Standard offer; Wide range of assortment; Deep assortment coverage; Direct sales; Sales through intermediaries	Product with delivery (on orders, just in time); High quality product; Over 40 types of bricks and ceramic products; Direct Sales (B2B): construction companies; Sales through intermediaries (B2C): construction bases, hypermarkets, dealer clubs, the brick center retail chain
Component 2. Market factors	B2B and B2C market (corporate and individual clients); Regional market (St. Petersburg and Leningrad region); Wide market coverage: -construction companies, -individual developers; Relationship building (B2B)	Managed development (growth): retention of regional market share and seizing opportunities for growth (regional expansion) B2B (80% of the market), B2C (20% of the market); Close trusting relationships on a long-term, mutually beneficial basis (for corporate clients)
Component 3. Internal capabilities	Own production / Operating systems; Mass production; Modern equipment; Advanced technology	Production specialization (in factories); Total capacity - 290 million bricks per year; Innovation in operating systems; High efficiency of factories capacity utilization; Production planning optimization; Effective marketing and sales system; Accepting orders on the internet
	Raw material base; Intangible assets; Investment resources	Own clay pits; Brick brand, trademarks ("Ceramics", "Rauf"); Access to corporate investment sources; Administrative resource
	Developed network of cooperation and partnership; Key role in business network	Joint implementation of orders for complex projects; Complete set with various types of building materials
	Strong corporate culture; Personnel motivation systems	Promoting innovations and entrepreneurship (at all levels); Provision of employees: - professional career growth, - social protection programs, - salary is above industry average
	High professionalism of management; Qualified engineering staff	Sharing knowledge, information and best practices; Policies for the hiring and retention of valuable employees
Component 4. Competitive strategy factors	High quality product; Wide range of products; Image of the "company with which it is convenient to work"; Stability / reliability	Differentiation is achieved through: - high quality product; - variety of assortment; - stability, reliability, uninterrupted supply; - offer a comprehensive solution to customer problems (a wide range of building materials)
Component 5. Economic factors	Permanent income source; Large production volumes; Flexible prices; High share of fixed costs in the total cost structure; Average cost; Average rate of return	Product sales (95% of revenue); Delivery and related products (5% of revenue); Price level (between high and medium); Economies of scale; Profitability growth
Component 6. Growth factors	Growth Model	Focus on business-compatible growth opportunities

Table I illustrates the application of the previously described structure (integrative framework) to the study of the characteristics of the business model of "Pobeda LSR". The "Pobeda LSR" has a logical and effective business model that allows it to maintain high business growth for many years. The company became the leader in the regional market with 69% market share ten years after its entering the construction materials market of the North-West region of Russia. "Pobeda LSR" was able to overcome the difficulties of the economic and financial crises in 1998 and 2008, and the construction industry crisis in 2004, which for other companies were the serious tests of survival.

There are several factors at the heart of the "Pobeda LSR" business model: the leader strategy, emphasis on the use of growth opportunities, including mergers and acquisitions; focus on value proposition, mass market and innovation. The first (basic) level in the table gives a general description of what the company does with its resources and capabilities. This level reflects the company choice of possible alternatives for answering a standard set of questions in relation with the six components of the model. So, the table shows that on the basic level the company offers a product (ceramic brick) and

services (product delivery) with a prevailing focus on the product (95% of revenue), using primarily direct sales, as well as sales through intermediaries. The company has a wide coverage of the B2B and B2C market, own mass production, access to sources of raw materials, a developed network of cooperation and partnership, etc.

The second (own) level of the model reflects the specific features of the business model related to innovation, key competencies and internal capabilities. It characterizes the company's ability to create and use unique combinations of several business model components, which ensures the company's competitive advantages.

For example, innovations in value proposition ensured the production of high-quality products and on-time delivery, a wide range of assortments (over 40 types of bricks and ceramic products of various profiles, sizes, grades and colors). The unique characteristics of the operating system, due to the introduction of a number of process innovations, have led to stability, reliability and uninterrupted supply, as well as to significant increase in product quality, optimization of operational-production planning, acceptance of orders on the Internet, etc. Marketing innovations related to market segmentation have allowed company to develop differentiated service functionality and unique offers for each target segment. Brick brand development, the introduction of two brands ("Ceramics", "Rauf"), organizational and process innovations in the field of marketing and sales contributed to a flexible pricing policy, improving the quality of customer service. As a result, the company have used the economies of scale, increased product profitability, and increased sales.

The experimental verification of the operability and effectiveness of the proposed process model was carried out using the experimental method in the both master students in management and practicing managers training groups. The results showed that the use of the business model learning approach can significantly clarify the manager's strategic thinking and facilitates the process of building managerial skills. The experiment in the training groups showed positive results in comparison with the control group in the development of strategic thinking skills and the level of student satisfaction.

V. CONCLUSION

The study showed the effectiveness of the business model as a conceptual and analytical tool for developing managers' strategic thinking skills. We have shown the implementation of the integrated model to educational process on the basis of the competent, situational and process approaches. We have developed and tested the process model that includes five main stages, which allows developing managers' strategic thinking skills on the real company business model basis.

The results of the study are interesting for both universities and enterprises in the conditions of strategic partnership between them because this educational approach can improve the training quality and its relevance to business practice. Moreover it can be useful for solving the enterprises problems, and developing strategic thinking of managers. The results of this work can be used both in modern business education and in holding strategic sessions for managers.

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Online Course as a Tool to Ensure the Quality of Training Highly Qualified Personnel: Problems and Prospects of Use

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***Abstract*— Nowadays online education is developing rapidly and gradually replacing the traditional format of education. This is due to a number of fundamental advantages of online courses: a geographic accessibility, a convenient training format, and low cost. These advantages allow enterprises to train their specialists at the best universities educational programs without interruption of production process, in the convenient time and place, and also save money for such training. At the same time, statistics show that even on the leading online education platforms, the number of students who successfully complete their online courses is extremely small. This is due to a number of shortcomings and limitations of online learning. The paper presents the results of a study of the Russian student's online learning experience and attitude. The research results allow us to identify the limitations of online learning and offer special measures to overcome them in order to improve the quality of training of highly qualified personnel.**

Keywords*— *educational services market; training formats; online learning; online course

I. INTRODUCTION

The digitalization of information and communication technologies is rapidly transforming various markets for goods and services. It affects the educational market in all its segments: from preschool to higher. A study conducted in 2017 by a group of analytical and research companies (East-West Digital News, Public Opinion Fund, Netology Group, Internet Initiatives Development Fund, VB Profiles, comScore, etc.) showed that the Russian market of online education and educational technologies has serious prospects for development. So, the researchers expected a significant increase in the share of the online educational services market on the five-year planning horizon (from 1.1% in 2016 to 2.6% in 2021) and more than double market growth in absolute figures (from 20.7 billion rubles in 2016 to 53.3 billion rubles in 2021) [1].

According to researchers, the field of higher education is one of the leading in terms of digitalization. Nowadays it is in third place in terms of online programs penetration (1.8%) after additional school (2.7%) and additional professional education (6.7%). A significant increase in the online segment is also expected in the field of higher education on the five-year horizon (to 4.4% by 2021) which means the huge sales increase in this segment.

II. STATEMENT OF THE RESEARCH PROBLEM

Large Russian universities are actively developing online educational products. So, in 2018, 74 training courses were launched by Russian universities on the Coursera online platform. 52 of them are in Russian and 22 are in English. In total, Coursera currently has 275 online courses and specializations in Russian and English developed by Russian universities [2]. Today, 417 online courses of sixteen leading universities of the Russian Federation are posted on the Russian domestic platform called "Open Education". This online platform has eight founders: Moscow State University, Peter the Great St. Petersburg Polytechnic University, St. Petersburg State University, National University of Science and Technology "MISIS", National Research University Higher School of Economics, Moscow Institute of Physics and Technology, Ural Federal University and Saint Petersburg State University of Information Technologies, Mechanics and Optics. In addition to these founders the "Open Education" platform today offers online courses from other Russian universities: Bauman Moscow State Technical University, National Research Nuclear University MEPhI, St. Petersburg Electrotechnical University "LETI", Samara University,

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Tomsk State University, Tyumen industrial University, Tyumen State University and Russian University of Transport [3].

Representation of university courses on an online platform has serious advantages. Firstly, it contributes to a significant geographical expansion of the target audience of the university, providing the opportunity to get access to the educational product for students from the most remote ends Russia and the world. Secondly, the online platform provides the 24x7 availability of the educational product for the target audience. These advantages lead to an increase in the university's audience, and also in students' loyalty, as well as the popularity and university's brand reputation development in the educational services market.

The highlighted benefits are also relevant for students. Online courses provide an opportunity for students from remote regions to study the best educational programs of the best professors from the best universities, independently determining the mode of study. In addition, the universities' online courses provide students an opportunity to receive not only the necessary knowledge and skills, but also a certificate of attendance at a leading university, which is highly rated by potential employers [4, 5]. However, at the same time, as practice shows, online courses have a number of significant drawbacks. Online education is not interactive; it does not take into account the level of education and the individual characteristics of the student's perception. The format of online education imposes serious restrictions on the duration and the amount of information provided, i.e. the information content of the educational course is reduced. In addition, the online learning format requires the student to be highly motivated, self-discipline, ambition and good time management skills. However some students do not have the listed qualities. Therefore they cannot complete the online course and pass the final exam successfully. In this regard, the student's results and learning outcomes of online courses are generally lower than for traditional ones.

III. Research Results and Discussion

The subject of our research is the study of the attitude of Russian students to online courses. Having studied their experience of online learning, we were able to identify both its positive and negative sides.

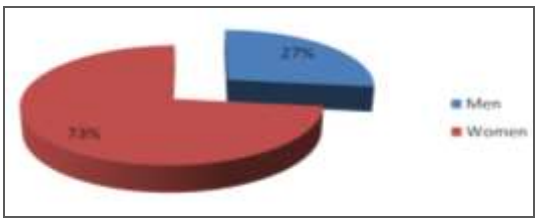

Fig. 1. Distribution of respondents by gender

We interviewed 256 people, of which 27% were men and 73% were women (Fig. 1). At the same time, 79% of the respondents belonged to the age cohort from 18 to 35 years old (Fig. 2). 66% of the respondents had online learning experience, 34% did not have such an experience (Fig. 3).

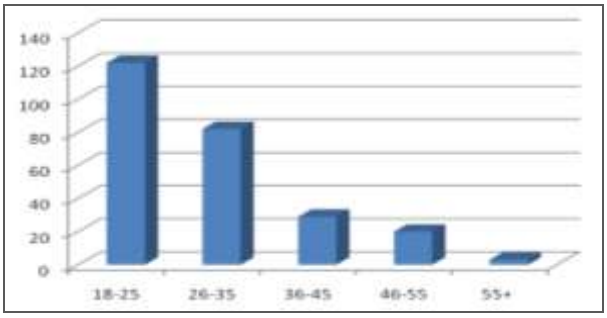

Fig. 2. Distribution of respondents by age

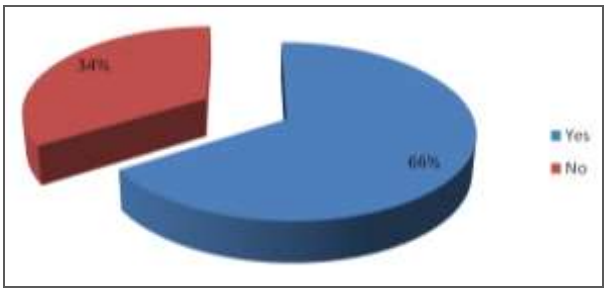

Fig. 3. Distribution of respondents' answers to a question about their online leaning experience

In the group of respondents who had experience of online learning, 81% reacted to innovation positively, 16% neutrally and 3% negatively (Fig. 4).

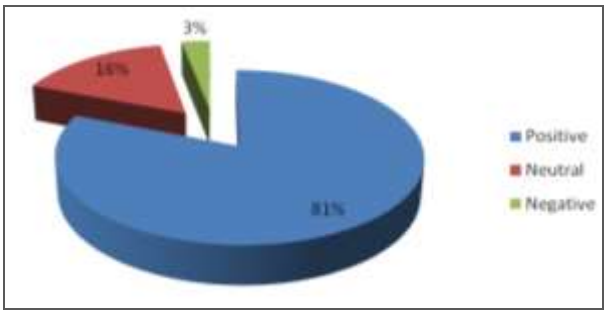

Fig. 4. Distribution of answers of respondents that have online learning experience to a question about their attitude to innovation

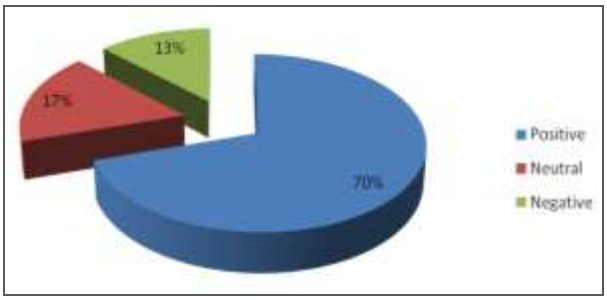

Fig. 5. Distribution of answers of respondents with no online learning experience to a question about their attitude to innovation

In the group of respondents who did not have online learning experience, 70% of respondents expressed a positive attitude to innovation, 17% – neutral, and 13% – negative (Fig. 5).

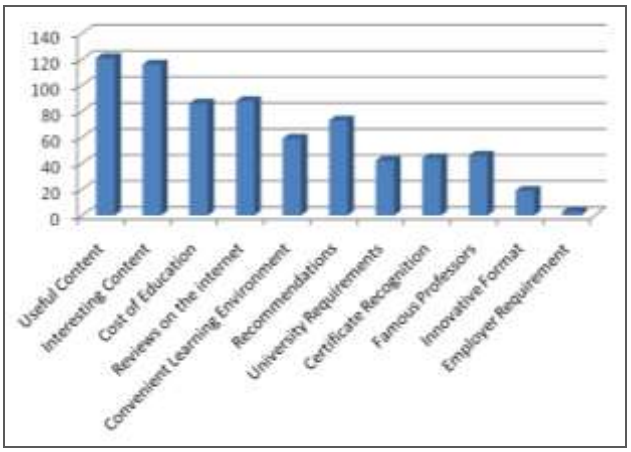

Fig. 6. Online course selection criteria

The criteria for choosing an online course (based on a survey of respondents who had experience of online learning) are presented in Fig. 6. The main ones were the quality of the content (its usefulness and interest), the cost of training, as well as feedback from students who had already attended this course.

The requirements of the university or employer, the certificate recognition, the fame of professors and the innovative format of learning played a much smaller role in the consumer choice of online courses.

It is important to note that the majority of respondents metioned certain difficulties in the process of online learning (Fig. 7). For instance about half of the respondents with online learning experience (49%) noted the difficulty in concentrating on the subject of study due to the lack of teacher control; approximately the same number (47%) of respondents noted technical problems that arose during learning.

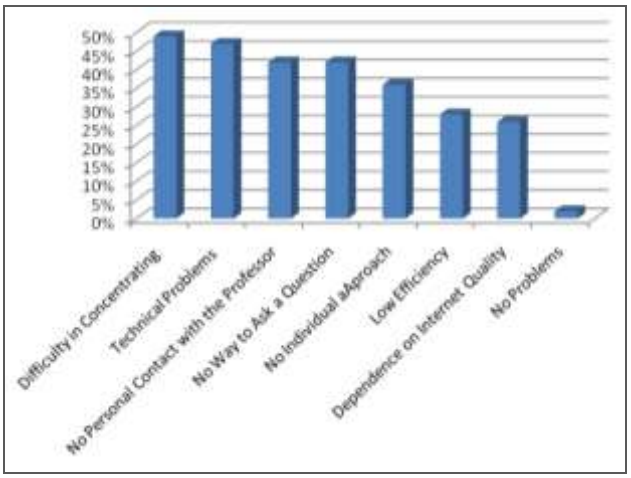

Fig. 7. Respondents difficulties with online courses

Also important negative factors were the lack of personal contact with the teacher, the lack of the ability to ask questions (42%), and the lack of an individual approach (36%). In addition, respondents noted low online learning outcomes (28%) and internet dependence (26%). Only four people replied that they had no difficulties in completing the online courses. Despite the difficulties described above, the majority of respondents (64%) were satisfied with online learning (Fig. 8).

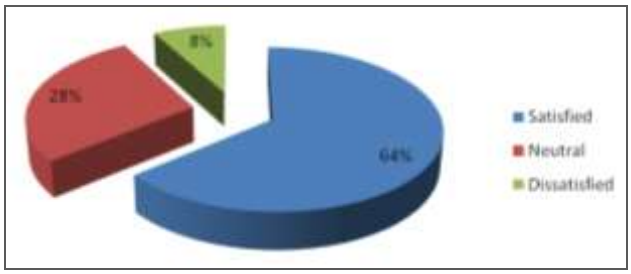

Fig. 8. Online learning satisfaction rating

Among respondents who did not have online learning experience, almost all respondents (97%) knew about such educational format (Fig. 9). This is not surprising, since the online education market is now not only rapidly developing, but its development is actively discussed in the media and social networks, occupying a significant part of the information space.

Thus, despite the knowledge of the existence of online learning, many respondents refuse to use it. Why is this happening? In order to answer this question, we asked respondents to explain the reasons for not using online courses. The results of the responses are presented in Fig. 10.

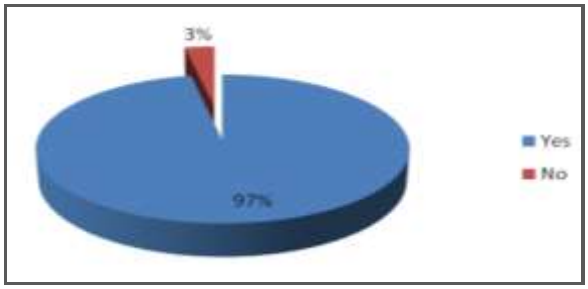

Fig. 9. Distribution of respondents' answers to the question about knowledge of the online learning existence

It turned out that 23% of respondents do not see the need to use online training; 21% were unable to find suitable courses; 18% generally do not trust online learning, 12% prefer the traditional offline format. Finally, 6% of respondents simply have difficulties in using the modern educational technologies.

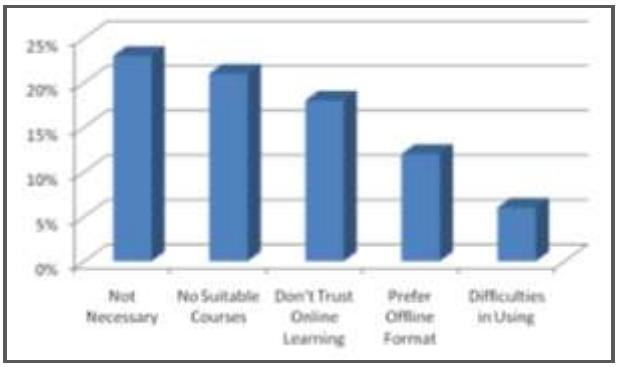

Fig. 10. Distribution of respondents' answers to the question about the reasons for refusing online training

IV. Conclusion

The results of our study showed that in general the modern online learning format satisfies Russian students. However, it has certain disadvantages that must be taken into account when developing this educational format. The main ones include the difficulty of self-organization of work, technical problems and lack of contact with the teacher. The presence of these problems leads to the three key problems. Firstly, many potential users refuse online courses at all. Secondly, a significant part of stidents who started an online course quits studying on the different stages of learning process. Thirdly, the satisfaction of students who successfully completed an online course is reduced.

To overcome these negative consequences, it is possible to offer a set of recommendations. Among the main recommendations for developing online courses and increasing their attractiveness for the target audience, our respondents expressed ideas about introducing the practice of individual work with the teacher (for example, the ability to ask questions and get detailed teachers' explanations on them; receive teachers' feedback on the results of the course assignments; teachers' explanations of students mistakes made in solving problems and cases with giving right solutions, etc.). The second important point is the clarity of the instructions for working with the online course. This will help students evaluate the amount of work in advance and understand the course requirements. And finally, the third is the motivational part. The online course must include a particular explanation on what specific knowledge and skills can be received by student trougth passing each part of the course, and how student can to apply it in the future.

Thus, in addition to high geographical and time accessibility, high-quality and interesting content, well-known teachers and a convenient study format, the online course should include the individual interaction with students, offer effective tools for their motivation, and develop clear instructions for users.

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Students' Soft Skills as a Factor of their Professional Competitiveness Improvement

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***Abstract*—This paper discusses the issues regarding the soft skills needful for a future career. Therefore, a deep analysis of the best soft skills training practices both Russian and foreign was made. The paper shows scientific and innovative methods and mechanisms developed for the improvement of soft skills within the framework of modern educational technologies.**

Key words—soft skills; occupations of the future; competitiveness; labor market

I. INTRODUCTION

Digital revolution, tangible in every developing segment of modern society, has led to the emergence of a new type of economy - knowledge-based economy. The results of the new type economy have comprised by now a significant part of the national GNP of BRICS countries. Thereby, in recent decades, the labor market has undergone permanent changes regarding the nomenclature and content of qualification requirements for potential employees, the paradigm of professional competencies and general cultural knowledge of both industry specialists and future graduates. Acceleration of technological development leads to the fact that students of universities and colleges are often lagging behind in respect of getting the necessary qualifications. The way people make global and situational decisions in the personal and professional spheres as well as the manner how universities create programs and how organizations hire and train employees is changing. The central place in this ever-changing socio-economic picture of the modern world is occupied by updated knowledge; they are the basis and driver of the development of the social and economic life of individuals and entire countries.

The consequence of technological, sectoral and economic transformations is that lifelong learning, as a means of providing employment opportunities, as well as professional and career growth, has replaced education for life.

The development of the knowledge-based economy created new incentives for people to acquire certain skills through education, due to the fact that there is an established correlation between the level of education and the position of the employee in the labor market, which demonstrates that a higher level of education helps to avoid unemployment and to hold the job in case of recession. So, Figure 1 shows the relationship between the level of education and the level of employment of people aged from 25 to 64 in respect of a country and a partner of the Organization for Economic Cooperation and Development [1]

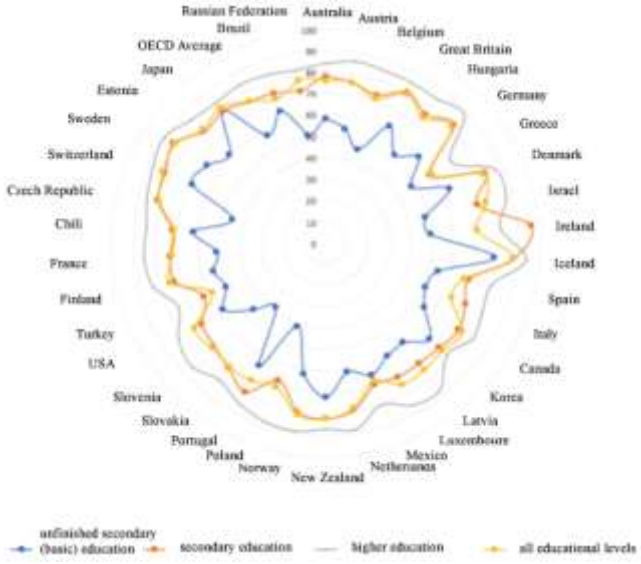

Fig. 1. Occupational level of OECD countries of the age range of 25-64 in terms of education (2016), %

So, we can conclude that the highest percentage of employment is reached by people with higher education (with the exception of Ireland, where employees with secondary education prevail).

However, high personal and professional competitiveness cannot be guaranteed only by professional development of a person and updating of special, so-called hard skills. The latter should be understood as (hard) academic skills acquired by a specialist, which mean an expert level of special professional competencies, knowledge of the methods and procedures necessary for the successful performance of official duties.

One of the many consequences of the processes of digitalization and globalization of the world has become supertechnologization, structural integrity and complexity of the tasks to be solved, which in turn required the involvement of not individual specialists, but groups of professionals from different areas of knowledge and working on the problem not always in one the same room, enterprise, city and country. Appeared a necessity to work in team, and as a result, to

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communicate, recognize and understand emotions, make decisions and implement them, control time and labor.

Thus, the competitiveness of a specialist is determined not only by professional competencies and the "hard" skills underlying them, but by "soft" skills as well.

In recent years, the phenomenon of "soft skills" has been the focus of attention of many scientific disciplines: pedagogy, psychology, sociology, management theory.

In the most generalized form, "soft" skills are, firstly, a set of certain personal qualities: responsibility, discipline, self-management and, secondly, managerial skills: communication, in particular, the ability to listen and to hear; teamwork, emotional intelligence, time management, conscious leadership, problem solving skills, critical thinking skills. [2]

II. MATERIALS AND METHODS

The analysis of Federal State Educational Standards shows that to a certain extent the substantial part of "soft skills" coincides with the content of general cultural (GCC) and general professional (GPC) competencies of existing educational standards for bachelor and Master programs. Nevertheless, the presence of such competencies among the requirements for the development of academic disciplines cannot always guarantee the development of students' soft skills at a sufficient level. On the one hand, this can be explained by their relevance to general cultural, or rather, by their irrelevance to professional competencies. But it is precisely the development of professional competencies – hard skills are the skills teachers and students make their efforts to, they are in the center of attention, control of measurement and evaluation. On the other hand, the nature of soft and hard skills speaks of their close relationship and interdependence. In recent years, in world leading universities, vocational education has focused on the development of soft and skills in their unity [3]. In (Table 1), an approximate list of competencies and the number of disciplines forming soft skills is presented on the example of master's programs in the subject area of 38.04.02 Management that are implemented at the Southern Federal University (SFedU).

TABLE I. THE LIST OF COMPETENCIES AND THE NUMBER OF DEVELOPING SOFT SKILLS COURSES PRESENTED IN AN EDUCATIONAL PROGRAM OF HIGHER EDUCATION IN THE SUBJECT AREA OF 38.03.02 "MANAGEMENT» ON THE EXAMPLE OF SFEDU

Competencies	Number of disciplines
the ability to use the basics of philosophical knowledge to develop a worldview position (GCC-1)	3
the ability to analyze the main stages and patterns of the historical development of society for the development of a civic position (GCC-2)	2
the ability to use the basics of economic knowledge in various fields (GCC-3)	45
ability to communicate verbally and in writing in Russian and foreign languages for solving problems of interpersonal and intercultural interaction (GCC-4)	4
ability to a teamwork tolerantly perceiving social, ethnic, religious and cultural differences (GCC -5)	35
capacity for self-organization and self-education (GCC -6)	46
the ability to use methods and techniques of physical education to ensure full social and professional activities (GCC-7)	
ability to use first aid techniques, methods of protection in emergency situations (GCC-8)	1
possession of skills in the search, analysis and use of regulatory and legal documents in professional activities (GPC-1)	16
the ability to find organizational and managerial decisions and the willingness to bear responsibility for them from the social significance prospective of the decisions made (GPC -2)	21
the ability to design organizational structures, participate in the development of human resources management strategies of organizations, plan and carry out activities, distribute and delegate authority, taking into account personal responsibility for ongoing activities (GPC-3)	17
the ability to conduct business communication and public speaking, conduct negotiations, meetings, business correspondence and to realize communications via electronic facilities (GPC-4)	21
Skills in preparing financial statements, taking into account the effects of various methods and methods of financial accounting on the financial results of the organization based on the use of modern methods of processing business information and corporate information systems (GPC -5)	24
knowledge of decision-making methods in managing the operational (production) activities of organizations (GPC -6)	12
the ability to solve the standard tasks of professional activity based on information and bibliographic culture using information and tlecommunication technologies and taking into account the basic requirements of information security (GPC -7).	13

A change in the educational paradigm, a transition to a two-level system of training and a significant redistribution of the teaching load and a reduction in classroom hours in favor of independent work of students led to a transition from a translational (linear) model of training – classroom lectures to forms of an interactional model – case study method, project teaching method, modeling and simulation. [4]

There are a number of methods that contribute to the development of students' soft skills. Among them, there are the case study method, the project teaching method and the interactive techniques that imitate the real professional activity. Let us consider them in more detail.

The case study method is one of the most effective training methods, the essence of which is to solve the case, the substantial part of which, in turn, is a real economic or business problem. Students get acquainted with such a problem and find an independent solution during a collective discussion in mini-groups. In addition to professional competencies, when solving a specific case, the participants of the educational process develop such "soft skills" as self-management, managerial skills, communication skills, teamwork, emotional intelligence, problem solving skills.

The method of project teaching involves the selection and use by students of a certain set of educational and cognitive techniques that allow them to independently solve a particular educational problem and get a tangible result. The project teaching method involves the use of a wide range of techniques and methods and allows you to develop such skills related to

soft skills as communication and teamwork skills, problem solving skills, skills of informed leadership.

One of the effective learning methods that are widely used to form both professional competencies of students and soft skills are interactive technologies that imitate real professional activity. A business role-playing game and management decision simulation allow students to master professional competencies in the context of imitating of future professional activities. The use of this training technology allows you to actualize professional knowledge, as well as to increase the level of cognitive motivation in mastering the skills of professional communication, to improve the level of critical thinking [3].

III. RESULTS OF RESEARCH

Currently, employers are beginning to pay more attention not to the specific education received by the graduate, but to the skills and competencies that he possesses. For example, the Atlas of new professions, developed by the Agency for Strategic Initiatives, is built taking into account related and cross-professional skills that allow a person not only to be highly effective in professional activities, but also, if necessary, to change his sphere of activity (even changing the industry), while maintaining his relevance.

Among the over-professional skills highlighted by experts, the following are noted: environmental thinking; project management; systemic thinking; work with people; work in an uncertain environment; programming, robotics, artificial intelligence; artistic creativity skills; multilingualism and multiculturalism; intersectoral communication; customer focus; lean manufacturing [5]. We can see that at most a greater number of the listed cross-professional competencies either repeat soft skills, or can only be obtained if they are sufficiently developed.

The development of soft skills and professional competencies should be inseparable. So in (Table 2) the basic soft skills and methods, due to which they can be developed are presented [6].

TABLE II. SOFT SKILLS AND METHODS OF THEIR DEVELOPMENT AT THE UNIVERSITY

Name	Methods
Sociabilty	• project teamwork on real cases; • participation in pitch sessions and student events; • participation in conferences, forums and outdoor events
Teamwork	• any kind of teamwork • business role-playing games; • simulation games;
Leadership	• project teamwork on real cases; • any kind of teamwork; • business role-playing games;
Creativity	• case-study; • business role-playing games; • simulation games;
Time-management	• project teamwork; • Internet-baesd teaching

Also, among other things, universities and third-party organizations offer students a wide range of programs and additional activities, participating in which during training they can develop both soft skills and professional competencies.

For example, the Russian Federation is currently actively involved in WorldSkills programme, which promotes vocational, technical and service-oriented education and training. Among the main projects, the following can be distinguished: holding championships for young specialists, establishment of specialized centers of competencies, establishment of centers of advanced professional training.

Also in our country, the project “Professional internships 2.0” is being implemented these days. The project includes, among other things, the student work contest “Professional internships”, the form of participation here is to write a scientific paper to solve a real business problem. In case of successful pass of the offered solution, a student may get an invitation to an internship or further work at a Company. Besides there functions an all-Russian base (aggregator) of internships, which allows students to look for places to undergo practical training directly in their specialty and get additional job opportunities immediately after graduation.

At the same time, universities also have experience in creating their own laboratories for the development of soft skills among students. For example, “Soft Skills Laboratory” operates at Southern Federal University, it was created to help young professionals (students and university graduates at the start of their careers) to become more competitive in the modern labor market by developing their soft skills that are in demand among employers [7].

The work of the Laboratory is built so that to take into account the following stages: assessment of the level of development of soft skills by means of testing; elaboration of an individual development plan taking into account the test data; drawing up a training program based on a matrix of courses, including 19 courses for 11 soft skills (Fig. 2).

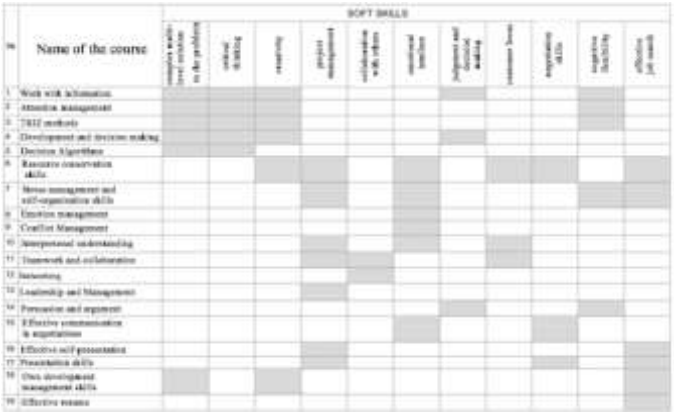

Fig. 2. Matrix of courses for the development of Flexible skills within the framework of the “Soft Skills Competency Lab”

At the same time, the studentы can develop their soft skills not only within the framework of these courses, but also by

taking part in the activities of “Tochka kipeniya” created at the university. Participation in events is also reflected in students’ accounts of Leader-ID platform, which allows to maintain a digital portfolio for the development of soft skills and professional competencies.

IV. Conclusions

Thus, it can be stated that every year, especially in connection with changes in technology and the economy, the role of soft skills both in the process of professional development and the success of employees and in life increases. According to recent studies, 93% of employers pay the most attention in the selection of personnel precisely to the presence of soft skills and competencies.

This is also confirmed by the fact that according to the World Economic Forum, by 2020 the most demanded competencies will have been: the ability to solve complex problems, critical thinking, creativity, people management, coordination and interaction skills, emotional intelligence, judgment and speed of decision-making, client-focusedness, negotiation skills, cognitive flexibility. [8]

At the same time, it is proved that the higher a person ascends the career ladder (for example, according to experts in the professional field, an employee success depends on soft skills by 85%), the more important role the soft skills of a person begin to play [9]. That is why the largest number of trainings and blocks in continuing education is devoted to the development of soft skills.

Thus, we can conclude that soft skills can be developed in all areas of educational activity, since full-time study allows you to simultaneously work on the development of both professional competencies and soft skills through a combination of full-time presence and distance education technologies, as well as through the constant necessity to establish contacts with fellow students and teachers, to defend projects and interact in groups [6].

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Technological Development of Russia: HR Policy, Digital Transformation, Industry 4.0

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***Abstract*— The article discusses the technological development of Russia in terms of personnel policy, digital transformation of the economy, and the promotion of Industry 4.0. The perspective directions of economic development are considered: personnel and education; formation of research competencies and technical groundwork; information infrastructure, exchange of technology and theoretical knowledge.**

Keywords*— *digital transformation; personnel; education; Industry 4.0; quality of life; priority sectors of the economy

I. INTRODUCTION

The basis for the development of public administration, business, the social sphere and society at the present stage is the digital economy, capable of ensuring national security and independence of Russia, as well as providing new opportunities for citizens of the country.

Digital transformation is taking place on a global level, and for Russia it is an inevitable and urgent process, which is mentioned at the highest level of the country in the form of the terms "robotics", "artificial intelligence", "unmanned vehicles", "electronic commerce", "big data processing technologies", "Fifth generation data networks", "Internet of things communications technology".

Digital technologies are becoming more multifaceted every day and are more active in all areas of our lives. The true digital revolution has already embraced both small and large businesses. Behind the technological breakthrough of companies is the future of the economy. Russian industry also intends to rely on digital transformation. Breakthrough developments in areas such as artificial intelligence, nanotechnology and others lead not only to the creation of new market segments, but also to a radical change in existing business models. The combination of increased Internet penetration, mobile devices, the development of data analysis, the "Internet of things" and machine learning is changing the expectations and demands of consumers. The integration of these technologies into the business and operational model is not a competitive advantage, but a necessary condition.

An integrated approach of state policy in the field of transition to digital platforms will undoubtedly contribute to a technological breakthrough, which in turn will have a huge effect both for business and for the competitive advantages of the country's economy as a whole. The ongoing changes will automate most of the processes and focus the state's human resources on change management. In the coming decades, automation will have a significant impact on the labor market, and digital platforms will create new employment opportunities and increase labor productivity.

The Ministry of Industry and Trade of the Russian Federation presented a model of digital transformation of industry, which includes three areas:

1. digital transformation of manufacturing industries;
2. creation, integration and development of platforms of the state industry information system (GISP);
3. creation a regulatory environment for digital transformation of industry.

The creation of GISP will allow the development of the following platforms:

- platform for effective investment in industry;
- platform for the creation and development of production of industrial enterprises;
- a platform for selecting a set of government support measures, their receipt and monitoring the achievement of project performance indicators;
- platform for the production and promotion of industrial products in the domestic market;
- platform for promoting products on the foreign market, increasing export volumes;
- platform for the analysis and forecast of production development based on objective statistical data.

These services will improve the current state of GISP in the amount of 150 thousand users – an active GISP audience, up to 268 functional interaction services G2G, B2G and B2B.

II. RESULTS

Global trends in the development of digital technologies affect the international community directly or indirectly, since the growth of labor productivity in one country (company) widens the gap between participants, reducing the competitiveness of other, technologically lagging countries and companies. "The creation of systems for processing large amounts of data, machine learning and artificial intelligence"

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along with the transition to advanced digital, intelligent manufacturing technologies, robotic systems, new materials and design methods is considered by the Strategy for Scientific and Technological Development of the Russian Federation as the main technologies for innovative development that ensure timely response RF on the big challenges of global change. [5]

Digital transformation is a factor in global economic growth. According to analytical studies, Russia's digitalization will increase GDP by 2025 to 9 trillion rubles [4]. This fact may be affected by:

- digital platforms;
- digital ecosystems;
- deep analytics of large data arrays;
- Technology Industry 4.0.

Digitalization contributes to a sharp increase in labor productivity. On November 1, 2018, President V.V. Putin held a meeting in the Kremlin with an asset of the Eastern Committee of the German Economy, representatives of the largest German enterprises – top managers of the largest companies such as Siemens, Volkswagen, Knauf, Daimler and others. During the meeting, the Russian president told them about the digital economy program in Russia, and the German side, in turn, expressed interest in developing joint initiatives in this area. Putin said that much is being done in Russia for the country's dynamic technological development. The Digital Economy program has been launched, within the framework of which it is planned to increase labor productivity by 30% by 2024.

The concept of "Industry 4.0" was created in Germany, therefore, cooperation with representatives of the world economy will allow us to adapt the scenarios of "Industry 4.0" to the Russian specifics. The German-Russian Economy Digitalization Initiative (GRID) brings together commercial and public sectors in the digital economy and industry 4.0. The main objective of the initiative is the introduction of the best European practices in the fields of digitalization and innovation in the Russian economy in order to increase its competitiveness. The exchange of experience between participants in the digital field will also help improve the quality of German-Russian products and increase their market share.

Thus, the joint interaction allows us not only to accelerate the development of innovative technologies in Russia, but also allows us to reduce the time from development to the introduction of innovations in production, which gives impetus for further development in all areas. That is why global partnerships and innovations are of particular importance. In this regard, GRID is an effective tool for adapting best practices in the field of digitalization of the economy.

Companies that have successfully implemented the Industry 4.0 concept no longer have to choose between higher gross revenues and higher profits – they can improve both indicators simultaneously. The concept of "Industry 4.0" will lead to the formation of a new competitive environment and radical changes in traditional industries.

A key institution in the digital economy is the renewal and development of the personnel of the education system. According to the Rosstat demographic forecast, the population will decrease, and automation will mitigate the consequences of this process, and digitalization will help improve the quality of life of citizens. In these conditions, “digital” personnel are a strategic asset of the state.

The Russian Federation is not yet one of the leaders in digitalization, but managed to create large digital companies that have achieved fame. These include: MailRu Group, Yandex, Kaspersky Lab, and many others. The digital economy in the leading countries accounts for 10.9%, while in the Russian Federation only 5% of GDP. Obviously, the challenge is to double the digital economy in the Russian Federation.

However, the digital economy of the Russian Federation is characterized by digital inequality – imbalances between regions in the development of digital technologies. But at the same time, the country has a fairly well-developed ICT infrastructure, and digital services are available to most of the population.

In June 2019, the Analytical Center under the Government of the Russian Federation published an analytical report “Current Development of Projects in the Field of Digital Economy in the Russian Regions”. [5]

The survey showed information on the needs of the regions in digital technology. Data on the priority sectors of digital transformation is necessary for the effective implementation of support measures for the introduction of digital technologies in the economic and social sectors in Russia.

The analytical center conducted a survey of regional executive authorities (ROIV) of Russia. Information was requested about:

- the existence of a regional program for the development of the digital economy;
- priority for the region end-to-end digital technologies (SCT), planned for implementation;
- priority sectors for the region in which the first implementation of digital technologies is planned;
- a landmark project for the region in the field of the digital economy, which is under implementation or has been implemented.

A prerequisite for the digitalization of industries is to achieve a high level of informatization and automation. On this basis, the regions, in addition to programs and projects in the field of the digital economy, also indicated programs and projects in the field of developing information infrastructure and implementing automated information systems (AIS).

Based on the results of the survey conducted from April 30, 2019 to May 17, 2019, responses were received from 79 constituent entities of the Russian Federation:

- in 34 regions, a regional digitalization program has been developed or is under development;

- 45 regions participating in the survey reported that there is no regional digitalization program and the development process has not begun.

Most of the regional projects in the field of the digital economy are being implemented in areas similar to the federal projects of the national program "Digital Economy":

- Information Security;
- information infrastructure;
- digital technology;
- normative regulation of the digital environment;
- personnel for the digital economy;
- digital government.

As a priority for the implementation of SCT, most regions noted big data (80% of the regions surveyed) and wireless technology (63%). Also popular industry centers included the industrial Internet and the Internet of things (53%), neurotechnologies and artificial intelligence (47%), distributed registry systems (43%), virtual and augmented reality technologies (30%), new production technologies (28%) and components of robotics and sensorics (27%). Also, the following SCT and subtechnologies were noted as priorities by a number of regions: quantum technologies, cloud technologies, technologies for secure information interaction, predictive analytics. It is also worth noting that regions active in the digital economy (Moscow, the Republic of Tatarstan and Bashkortostan) are characterized by the choice of a variety of SCTs with a significant number of areas of digitalization.

The range of spheres and industries that the regions chose as priority for the implementation of digital technologies is quite wide, so for some of them enlarged groups have been formed. For most regions, priority areas and sectors are:

- healthcare (75% of the regions);
- urban environment (75% of regions);
- personnel and education (66% of the regions);
- transport and communications, including wireless and digital mobility (61% of the regions);
- Housing and utilities and energy (56% of the regions).

Also, the regions identified agriculture and forestry, culture and tourism, state and municipal services and management (including digital government), construction and industry as priority sectors.

Russia's readiness is reflected in the development of wireless technologies and broadband Internet in almost the entire territory of the country. It should be noted that the Russian Federation is a pioneer in the development of the next generation of 5G mobile communications, which is a new opportunity for developing user services and connecting more devices. 5G will allow you to connect a large number of different devices to the mobile network – from household appliances to industrial equipment. Massive machine communications will be used in projects of a "smart" city, a "smart" home, and other intelligent monitoring systems. 5G will also allow performing remote medical diagnostics and performing surgical operations remotely, remotely control production equipment, control drones in scenarios most sensitive to data transmission delays, etc. 5G technologies are needed to implement the most futuristic services, such as:

- remotely controlled production equipment;
- tactile Internet – remote medical diagnostics, surgical operations using robots, etc.
- fully functional automated transport system;
- drone control in scenarios that are most sensitive to data transmission delay. [6]

All leading countries are working to create public policy to stimulate the deployment of next-generation networks, recognizing their strategic importance for acquiring national technological leadership on the world stage.

Digital technologies make it possible to launch the mechanism of socialization in such areas as comfortable and safe cities, an increase in the number of highly skilled specialists, and an improvement in the business and investment climate.

At the state level, promising directions for the development of digitalization are: reforming the educational infrastructure, financing applied research and digital entrepreneurship, retraining and additional education, addressing the priority tasks of digital development of industries, developing digital infrastructure, and actively promoting it, exchange not only technologies and theoretical knowledge, but directly the experience of introducing innovations, optimizing them for the needs of the economy and building new ecosystems.

The opportunities for transforming the digital economy are also being transferred to companies in such areas of development as: developing a culture of innovation and mastering new technologies, using the world experience of the most successful companies, mastering the technology Industry 4.0., Cooperation with other participants in the digital ecosystem, creation of "digital universities" on the basis of companies. The labor market is changing and requires that specialists have not only the most advanced competencies, but also that there are many. Everyone should have both practical skills and knowledge – this will allow them to find their place and receive decent wages. That is why the development of new professional standards and methods for training specialists at various levels, taking into account the international experience of WorldSkills, becomes especially urgent.

In Russia, there is an urgent need to invest in the national economy, to adapt and introduce modern technology. Leading positions can be taken only with the cooperation of the state, business, constant interaction with technological and scientific communities and external partners.

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Analysis of Emotional Intelligence for the Intellectual Capital Growth

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***Abstract*—The study of factors of organizational intellectual capital development is based on the analysis of both rational and emotional components of internal organizational processes and external communications with partners and customers. The analysis of emotional intelligence shows a number of positive effects that should be used in planning business processes. Socio-psychological methods of interrogation and tests give unstable results, the emotional intelligence assessment needs repetition to obtain significant and valuable conclusions or requires additional methods such as interviews, as implemented in the presented study. The article shows the correlation between the type of employment and the emotional intelligence of employees. Recommendations are given on the use of the analysis of emotional intelligence for the development of organizational processes in a company and the improvement of the organization's intellectual capital management system based on the inclusion of both cognitive-rational elements of knowledge, including formalized data and practices, in the analysis of intellectual capital, and affective and emotional elements that determine organizational components of intellectual capital and improvement of business-processes.**

Keywords— intellectual capital; ethics; emotional intellect; precarization; types of employment

I. INTRODUCTION

Assessment and development of the intellectual capital of a company is based on an analysis of institutional and innovative components [1] and often is limited with this structure. The institutional capital of the organization assumes the existence of existing relations, corporate social capital [2] and a culture that determines the nature and effectiveness of internal and external communications [3]. Innovative capital is considered as the ability and willingness of a company to change in response to the requirements of the market and society, the requests of internal and external clients and partners [4], and various stakeholders.

The analysis of emotional intelligence as an integral part of the organization's intellectual capital is based on the methodological possibility of a) formalizing questions on the ability to manage affective processes and the respondent's awareness of his emotional behavior, b) quantitative assessment, c) recognition and management based on the data obtained. The data obtained by the researchers [4, 5, 6] about the relationship between the level of emotional intelligence and the ability to manipulate the interlocutor and the negative correlation between the coefficient of emotional intelligence and the level of ability to recognize lies, allow us to approach the development of differentiated tools for analyzing emotional intelligence for the purpose of assessing the intellectual capital of an organization and developing proposals for using modern analysis tools in order to improve knowledge management in the organization, taking into account the various forms, in particular, the choice by employees of "constancy" of work, i.e. full-time or part-time, freelance and other forms of precarious work. This article describes the implementation of the emotional intelligence scores to understand the differences between full-time office workers and agents as their ability to create the additional value for the company.

II. EMOTIONAL INTELLIGENCE AS A SUBJECT OF ECONOMIC AND MANAGERIAL RESEARCH

The affective elements of communication and decision making are a complex resultant of signals that is formed by an organism for the quick development of a significant volume of data from the external environment. For mastering by machine tools, today the content of emotions is encoded and decrypted by a person and is set to the artificial intelligence by the expert training. At the same time, emotions are complicated for the human rational comprehension due to the huge amount and

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complexity of information to be logically built into a chain of deliberation that allows machine leaning tools to digitalize them and to use emotions as the subject for data mining.

A. Affective components of intelligence

The rationalization of modernized society and the post-modernization response to the modernity' over-rationalization determined the shift of interest in up-to-date research from the cognitive aspects of knowledge management in their quantitative form to the study of knowledge in the whole cognitive, affective and behavioral aspects with the integrity of qualitative and quantitative methods. Modernity as a society type with its differentiated, rational and structured approach, according to E. Giddens [7, 8], allowed humans to transfer some of the most time-consuming routine tasks to computers. Exemption from routine operations revealed that "we too often tackle the dilemmas of the 20th century, having at our disposal an emotional repertoire adapted to the needs of the Pleistocene" [9]. Studies of the organization of neural-psychic activity of various biological species and of the human brain made it possible to find out the basic mechanisms of information processing and decision-making by the human conscience. Nevertheless, neural networks, imitating the work of the brain, do not bring us closer to understanding how emotions work as an independent phenomenon in decision-making and acting by a living organism, since computers were built as homogeneous computing capacities, and neural networks were created as a set of perceptrons that can be linked to any network by the will of the developer. While the amygdala in the mammalian brain is an independent part of the brain that specializes in the formation of emotions and social relations and on quick sorting of information as a danger detector that regulates the body's readiness for instant reaction; in a similar way, emotions and affective components in modern organizations form the basis of communication efficiency, internal (empathy and mutual understanding within the work team for collective action), and external (the ability to understand the clients, perceive and relay their needs and expectations).

Studies revealed [10] that employees with higher indicators of emotional intelligence demonstrate a smoother and faster movement up the career ladder and higher sales, but a lower ability for independent activity and for recognition of false information in interpersonal communication. In the surgical separation of the amygdala from the mammalian main brain, a living organism loses the desire to compare itself with others, build competitive relations or cooperative links, and is not able to perceive its own and other people's position in the hierarchy of a group or community [11].

It can be concluded that intelligent systems for searching, processing and analyzing information rely on the unity of the space of logical reasoning, while emotional intelligence treats and processes signals that indicate danger, and helps to ensure safety and survival based on the reaction of the organism itself and on the basis of group actions. The organization as a collective actor has to measure the emotional intelligence to improve its functioning.

B. Emotional Intelligence Analysis and Corporate Intellectual Capital

From the point of view of business process management, analysis of the emotional sphere allows managers to provide:

- personnel management and career planning, taking into account the interaction between people in the company;
- prevention or reduction of risks associated with the human factor;
- improving the external communication of the business with participants in the value chain, primarily partners and customers the direct negotiations and interpersonal communication take place with, which plays a decisive role for them to decide on collaborative strategy and cooperation with the company, identification with the corporate value proposal through the acquisition and use of its product, and etc.;
- better distribution of human resources according to the structure of organizational business processes and the value chain: people with higher emotional intelligence are more effective in group interactions, people with less developed emotional sphere are able to show better results in offline work outside the team and in analytical tasks.

The assessment of intellectual capital in corporate management and entrepreneurial activity includes not only the assessment of patents, trademarks, and customer reputation, but also relies heavily on the assessment of the overall business reputation of the company and its ability to evolve in accordance with feedback from the external environment.

If the analysis of "weak signals" from the external environment has long been the subject of intellectualization by the economic and business analysis systems (business intelligence), the analysis of emotional intelligence so far takes its place only in rare studies of corporate relations, which seems insufficient way to use this notion and the measurement tools that can produce additional help for the growth of the intellectual capital of a company.

C. Correlation of components of emotional intelligence and type of employment

Socio-psychological research based on tests shows the relationship of emotional intelligence and the choice of a permanent or precarious type of employment. Thus, in a study conducted with the participation of the authors [12], a positive correlation was found between the level of emotional intelligence and the productivity of employees of a real estate agency. The interesting differences were revealed due to the analysis of the features reflecting the employee's choice between the degrees of "sustainability" of their employment.

This measure of sustainability is reflected in the choice between the roles of a full-time office employee and an agent. The agency as a specific activity can be considered as an extremely unstable, precarious form of employment, since the agent is not socially protected, does not receive payments due to vacation or illness, is not integrated into an organizational system for formal or informal support or help in the case of any

problems outside of direct professional interaction with the agency. So, opposite signs of correlation were found in understanding one's feelings and emotions (element No. 1 of emotional intelligence) and noticeable differences in the awareness of the emotions of others (element No. 3) (respectively, lines 1 and 3 in Table 1):

TABLE I. CORRELATION BETWEEN EMOTIONAL INTELLIGENCE AND PRODUCTIVITY LEVEL BY EMPLOYEES' CATEGORIES (PEARSON CORRELATION)

Emotional intelligence components	Productivity by categories	
	Office staff members	*Agents*
Understanding of oneself, awareness of one's emotions	0,269	-0,152
Self-control	0,072	0,014
Awareness of the emotions of others	**0,562**	**0,389**
Relationship building	0,083	0,121
Emotional Intelligence	0,235	0,128

Compiled by the authors

The only significant correlation revealed in the study reflects an indicator of awareness of other people's emotions, while this indicator is significantly higher (0.562) for full-time office employees who are integrated in the systemic regular communications within the organization and in interactions with various types of clients in the office than agents (0.389).

The free interviews that followed the tests, permitted to fid out that full-time office workers note the specific ability of agents to manipulate, which, it would seem, contradicts the data on a lower level of emotional intelligence. However, these assumptions indirectly confirm the data obtained in a number of studies [13, 14], which revealed an inverse correlation between the manipulative properties of a person and a measurement of emotional intelligence and, at the same time, an inverse correlation with the competence of recognizing lies and false behavioral patterns.

Based on the data obtained, it is possible to preliminary formulate the hypothesis that full-time employees have a higher ability for empathic interaction with clients and partners, but a slightly lower ability to build efficient productive relationships than employees engaged in precarious forms of labor relations. Although the correlation indices obtained in this study are low, the different signs of the obtained correlation values and differences in the levels of correlation are to be verified further, to test the hypothesis.

III. ANALYSIS OF EMOTIONAL INTELLIGENCE AS A FACTOR IN CHOOSING THE DEGREE OF PRECARIZATION OF EMPLOYMENT

The high correlation between the emotional intelligence and productivity of employees is important for the management of human resources, it is necessary to point our the significance of this conclusion for the development of intellectual capital management of a particular organization. This results relates to the different approaches to be implemented to attract employees with different types of emotional intelligence to different forms of labor relations. The adaptation of the structure of employment to the different kinds of the emotional intelligence of the people involved can be highlighted as a specific subject for the research and management of the growth of a company intellectual capital.

A. Rational and Emotional Intelligence as a Subject of Behavioral Research

Behavioral research is seen as a tool for quantifying the qualitative phenomena of cognition, thinking, and decision making. So, the role of "social intelligence" is to determine the body's ability to predict in interpersonal interaction, the competence of "acting reasonably in human relations" [15, 227], and, from a behavioral perspective, this factor can be measured. It is also interesting for companies to comprehend the results of evaluating emotional intelligence from the perspective of transactional analysis in order to creativize labor as the basis of the value chain in the knowledge economy, to develop the gamification approaches and to expand the use of the creative abilities of the humans involved.

If creativity often relies on the development of divergent thinking, but the building effective organizational relations requires convergent thinking, it is advisable to combine human resources engaged in stable labor contracts with high social integration and security (convergent thinking) and precarious, "unstable" forms of contracts, design work, orders (divergent thinking). The analysis and measurement of the emotional intelligence can be used as a tool to improve this combination.

B. Emotional intelligence as a formalized component of the company's intellectual capital

The intellectualization of everyday life, including the assessment of emotional intelligence for business purposes, provokes the specific ethical issues based on a humanistic search for identity and personal development, in particular, for the transition from manipulative techniques of interaction to genuine being and interpersonal contact. In this regard, the question arises of the possibility and admissibility of applying the assessment of emotional intelligence to the development of the intellectual capital of a company.

In particular, three groups of questions arise:

- financial and economic issues of accounting, ie accurate assessment of the relationship between indicators of emotional intelligence and the company's ability to increase its market value based on the development of communications due to the correct distribution of workers with different indicators of emotional intelligence on different functions;
- technological tasks are associated with pattern recognition, emotions and reactions and machine learning, which can be used for automatic online monitoring of the behavioral characteristics of specific employees in order to subsequently offer them various forms of employment;
- ethical problems are associated with the need to take into account the will of the employees themselves – for example, if a particular individual would like to develop certain qualities, for example, the ability to integrate into the team, how appropriate it will be to offer him precarious work in which he is more effective due to his personal characteristics , thereby questioning his right to personal choice.

The issues mentioned are both narrowly economic and managerial in character, and ethical and regulatory in nature [15]. If the technological capabilities of continuous monitoring are already implemented, which puts a person in a situation of lack of choice (the modern world is almost completely riddled with digital counterparts, video surveillance and face recognition systems, etc.), then the regulatory aspects so far remain only subject of discussion.

Finally, the analysis of emotional intelligence, of course, can be useful not only for training within organizational structures, but also for improving the educational system, the learning processes organization at high schools as well as at universities.

IV. Conclusion

Intellectual capital at the macro level of the region and the state and at the micro level of the company is based on both rational and emotional-communicative elements, which determines the humanization of the economy. Digitalization already allows you to train "smart" devices and "smart" environments to respond to human gestures and facial expressions, neurocommunications will directly transmit feelings and emotions [16] to interlocutors. But issues of using data, for example, control over the assessment of the level of emotional intelligence of a particular employee of a company [17], should be decided taking into account the rights to the citizen's private life, free will and choice, and the preservation of personal information.

It is assumed that data on emotional intelligence will be used to expand opportunities and deepen the degree of self-realization and effectiveness of a person, but it is also necessary to consider the socio-economic, managerial, political and cultural consequences of studying emotional intelligence as a component of the intellectual capital of the individual, not just the region or company.

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Forms of Employment of Highly Qualified Industry Professionals: The Impact of Labor Precarity on Intellectual Capital

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***Abstract*—The development of the labor market and increased mobility of human resources allowed companies to move to a wider application of flexible management methods. The proliferation of new forms of employment has led to both positive results related to the expansion of opportunities for individual self-realization and the growth of independence and responsibility for personal, professional and socio-institutional growth, as well as to the negative consequences, especially precarization. Unsustainable employment, instability of income and of the sphere of activity, precariousness of employment as a form of structuring time and as a source of satisfying needs reflect the negative aspects of precarization, which today directly affect the sphere of education. Investing in human capital, primarily in the formation of an individual, is based on the long-term reasoning, and the unpredictability of return on investment (ROI) casts doubt on the formation of highly qualified personnel, especially in the field of changing high-tech industries with rapid innovative growth. The spread of partial employment, freelance, projects' work, the implementation of point orders under one-time contracts in the field of highly qualified industrial personnel increases the risk of loss of interest of the country's population in the formation of skills and knowledge, especially in engineering and technical fields with high requirements for cognitive practices, which is threat to the growth of intellectual capital of industrial enterprises, the region and the country as a whole.**

Keywords— self-employment; precarization; employment; high-qualified specialists; intellectual capital; industry

I. INTRODUCTION

The emergence of new forms of employment is reflected in the economic, managerial and social sciences in the form of expanding the terminology of models (gignomics, gift economics, we economy, etc.) and regulatory and political processes (participatory management, precarization of labor, etc.). The expansion of terminology reflects the multidimensional nature of the changes that occur in society during the rapid development of technology.

The production technologies are changing and approaches to management methods are evaluating with the use of labor and natural resources, accounting and goal-setting. E.g., if in the XX century industrial production relied on high-qualified workers, today complex routine operations are successfully carried out by robots [1], and the competence of personnel is embodied in the adjustment, reconfiguration, repair and rapid modernization of equipment.

The need to rethink the forms of employment of highly qualified specialists [2] is caused by both a rapid update of technologies and economic models of attracting the human resources [3], the professional experts to implement new kind of working activity, primarily associated with the development of intellectual capital of a company, industry, region or country.

II. PRECARITY OF SKILLED LABOR AS A THREAT TO THE GROWTH OF INTELLECTUAL CAPITAL

New forms of employment, on the one hand, meet the interests of citizens and the values of individual freedom, private human rights to make an independent choice of working conditions, time and place of work, the subject of efforts, projects and tasks, which will subsequently become part of the portfolio and resume.

On the other hand, the differentiation of employees and their removal from organizational business processes, the abolition or weakening of social protection and integration into the team, the fragmentation of labor lead to de-qualification of a person outside the socio-professional community and socio-psychological de-adaptation, which causes negative consequences for human potential of a company or a region, for the physical health and intellectual capital.

A. Evolution of forms of satisfying industry's human resource requirements

Mass industrial production with long payback periods for fixed assets, sophisticated and expensive machinery equipment, and rare technological modernization required constantly employed labor resources for efficient operation. The relation between the costs of material resources and human labor was in

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favor of the "materialized" labor in the machines and buildings. The physical objects were requiring the constant knowledge of the specific particular needs of equipment, the adaptation of a new worker could produce not only the additional costs but the catastrophic damage due to stop of production.

Long-term and perpetual labor relations were beneficial for the business until the innovative change of technology was fast enough to allow the change of busy human resources, since to train "old" personnel was comparable in cost to the adaptation and corporate socialization of new personnel.

At the same time, over-exploitation of the workforce led to a rather rapid depletion of the region's labor resources, which led employers to reduce working hours, improve working conditions, introduce social protection and develop investment in human resources. With the increasing complexity of engineering and technical work, enterprises were forced to provide not only the physical presence of the employees, but also stimulate their intellectual contribution, introduce programs to satisfy the social needs of employees and various forms of compensation management.

The development of the service sector as a third sector of the economy has led to a decrease in the importance of providing permanent workers in industry. As a result, full-time work for the entire working day regulated by law has become less suitable for the needs of employers than non-standardized work, including part-time work and the conclusion of contracts for specific work, free lance or short-term employment.

B. The effects of employment precariousness in industry

Part-time work and work under short-term or one-time employment and service contracts removes the employee from a number of state protection components: paying vacation pay and various benefits, reducing the length of service for a pension (e.g., when concluding a 10-month contract instead of a year, the length of service is reduced by 1/6 part), a decrease or lack of support during a period of temporary disability, etc. The reduction or lack of social protection of precarious workers is complemented by increased stress and the diseases they cause, the poorer health reduces the quality of the physical human capital of the region and the country and increase the charge on the medical services and regional healthcare system.

Uncertainty in terms of obtaining a stable income leads to a decrease in the profitability of investing in education, which reduces the willingness of young people and their families to invest resources, primarily a time resource, in the intellectual capital of individuals [4].

A reduction in investment in intellectual capital and stress at work worsen health capital. This leads to the fact that part-time employment, beneficial for the employer, provided that the employee's full-time labor contribution is paid in part, becomes less profitable if the employee decides to give partial commitment instead of the full contribution to the labor, in terms of volume of work, and, what is even worse, a simultaneous decrease in the quality of labor. E.g., job sharing ("partial work" shared between several employees for a part of the rate with alternate presence at work [5]) has the opposite effect for the employer: a business expects to receive, e.g., a quarter of the volume of work while maintaining its quality, paying a quarter of the salary fee, but receives a quarter of the amount of work with quality reduced.

While in the service sector, a decrease in quality may be less noticeable, since the quality of a service in most cases is perceived simultaneously with the process of providing a service and its effect is preserved only in rare sectors (for example, finance), then in the industry there is an increase in rejects or insufficiently well conceived out engineering and technical solutions that affect the subsequent stages of product consumption – for example, if the CNC machine is not made well enough, the buyer of the machine will receive low quality products, and will not return for the purchase, will be looking for another manufacturer [6].

Reducing the competitiveness of industrial enterprises in the local and global markets due to insufficient staff involvement is a key problem of precarity of labor for business, which leads to the intention of manufacturing enterprises to hire employees at the full-time contracts, to increase their loyalty, and to invite freelancers only for such one-time jobs [7] that do not concern commercial and technological confidentiality.

C. Intellectual capital of the self-employed

While freelance is quite widely developed in the creative industries (marketing, art, etc.), highly qualified experts in industrial sectors, as a rule, represent a key resource for enterprise competitiveness, and employers strive to keep them as the key value added factor in the enterprise.

At the same time, sometimes highly qualified specialists themselves, having expert competence and a wide range of knowledge, prefer the precarious type of work on their own terms, which is due to follow their personal preferences and to maintain their right to use their personal intellectual capital at their own discretion [8]. The economic interest in the monopoly over the zone of uncertainty of an expert with unique knowledge and competence has led to the spread of the practice of inviting highly qualified specialists to design work with self-planning of tasks and even goal-setting, which is reflected in the status of self-employed.

Self-employment, in this case, is the form of using intellectual capital that is beneficial for the most highly qualified expert, since it is associated, along with low social security, with low payments to the State budget – instead of 13% of personal income tax and 30% of social contributions that the company pays for the employee, the self-employed person pays 4 or 6% (depending on whether the customer is an individual or legal entity) from the payment of their labor. These rates apply if the self-employed person receives less than the maximum of 2.4 million rubles per year.

The project use of an independent self-employed specialist, who is looking on his own for projects to take part and orders to carry out, who can work simultaneously for several organizations, allows the employer to access the unique intellectual capital of the self-employed, but at the same time raises the question of maintaining company loyalty and confidential data [9] of the organization.

III. FREEDOM OF CHOICE AND AGILE EMPLOYMENT AS VALUE

Modernization and post-modernization of society [10] and the growth of basic needs satisfaction have formed a scale of values in which the most powerful motives are freedom of self-realization and an innovative type of behavior, mobility and flexibility. Independence and willingness to bear responsibility for themselves and their decisions, which are characteristic not only for labor, but for entrepreneurial behavior, are the most important competence that forms secondary and higher education. Industry receives graduates who prefer to plan their time and set goals, determine the place and schedule of work.

A. Flexible employment as a measure of employment

Surveys of students completing graduate courses in the spring of 2019 (the total number of respondents was N = 181) showed that masters of engineering and technology are less interested in the new forms of employment than the masters at social, humanitarian and economic areas. The composition of the respondents included 68 undergraduates in engineering and technical areas of study, including IT and physics, 113 – ethical and humanitarian (cultural studies, philosophy), social, economic, managerial areas (including advertising, sociology, etc.). The survey showed the following results (Table 1):

TABLE I. EMPLOYMENT FORM AS A CRITERION FOR THE CHOICE OF JOB BY THE MASTER STUDENTS

Prefer to find a job after university as...	**Graduate students**	
	Humanitarian and social areas	***Engineering***
Full-time staff member	43.4%	85.3%
Part-time staff member	42.5%	5.9%
Freelancer	23.9%	17.6%
will develop my business	1.8%	1.5%
I do not know yet	13.3%	1.5%

Compiled by the authors

Significant differences were found in the number of options chosen – graduate students in engineering areas in the majority chose only 1 option from the proposed list (11.8% of respondents chose 2 options), while among the humanitarian. social and economic and management areas, almost a quarter of respondents (24.8%) noted 2 options. 13.3% of students in social and humanitarian areas did not decide on the choice yet.

Although the vast majority of graduate students completing engineering specialties (85.3%) will choose the standard form of employment (full-time), but 17.6% (8 persons) indicated the possibility of working in freelance, with only 1 undergraduate indicating both these options, the remaining 7 chose freelance in conjunction with part-time or their company.

The perception of oneself in the structure of the labor market as an employee reflects the removal of undergraduates from their type of economic behavior (labor, project, contract or business) (Table 2), with the exception of entrepreneurs:

TABLE II. SELF-IDENTIFICATION OF QUALIFIED SPECIALISTS IN THE STRUCTURE OF THE EONOMIC BEHAVIOUR

What do they plan to become in the labor market...	**Graduate students**	
	Humanitarian and social areas	***Engineering***
Employee	69.9%	54.4%
Project Manager	18.6%	38.2%
Self-employed	9.7%	5.9%
Entrepreneur	1.8%	1.5%

Compiled by the authors

Only 3 undergraduates who have chosen the development of their own company exactly indicated their role in the economic system (entrepreneur).

Thus, only 54.4% of graduates of engineering and technical master education believe that they will be employees (more than 90% of them indicated that they plan to become full-time or part-time full-time staff members of enterprises, see Table 1).

A significant part of those who chose their future freelance work chose the role of a project manager (like almost a quarter of those who plan to become a full-time employee): 38.2% of graduate students in engineering and technology, while at the same time, among social and humanitarian ones only 18.6% of respondents think so, and even fewer (9.7%) plan to be self-employed (although 23.9% of graduates in these areas were going to work on freelance).

The noted confusion in the self-identification of future high-qualified specialists completing graduate studies reflects an understanding of the danger of precarity of work in the minds of undergraduates, in this regard, even if the respondents look at the prospect of freelance with interest, they are not ready to take responsibility for the fullness of the work. Self-employment is considered not as an attractive form of reducing the tax burden, but primarily as an unstable, unreliable and unsustainable form of employment that does not guarantee satisfaction of needs and return on investment [11].

The results of the analysis allow us to put forward a number of hypotheses that need to be clarified in the further research:

- Freelance is considered by master students as a form of additional earnings, and not the main form of employment, since it does not allow a specialist who has recently graduated from a university to receive a return on money and time invested in education quickly enough to cover costs;
- graduates of social and humanitarian areas are more willing to work on third-party orders, but prefer to take less responsibility on themselves [12] than graduates of engineering and technical magistracy (applying for full-time positions of employees, they perceive themselves as project managers rather than employees);
- self-employment is perceived as a precarious form of return on investing in intellectual capital and enjoys cautious interest of citizens. Digitalization of the economy increases the transparency of the labor market [13], which is likely to lead to an increase in the

predictability of return on investment and, accordingly, an increase in interest in self-employment;

- Enterprises are expanding the involvement of experts, highly qualified specialists in new forms of employment with caution, since they perform functional roles crucial for the innovative growth of enterprises. In this regard, the differences between the masters of engineering and social sciences and humanities are associated not only with the personal characteristics of students, but also with job expectations.

The issues of obtaining a higher education of the second level (master's degree) are quite clearly associated in the students' minds with investing money and time resources in intellectual capital, which should bring income in an acceptable time frame and target volume, otherwise, undergraduates are not even ready to enter the master's budget programs (free of payment for them), to avoid losing two years [14].

If the macroeconomic problem of intellectual migration ("brain drain") requires regulatory measures on the part of the state [15], then the microeconomic issues of maintaining confidential information within the enterprise, maximizing employee involvement in business processes and the loyalty of highly qualified personnel need managerial solutions that allow managers "to tie" the employee to the enterprise in order to ensure a monopoly on intellectual capital.

IV. Conclusion

The influence of labor precarity on the growth or degradation of intellectual capital is manifested in a reduction in mass investment in education, and at the same time, in the growth of the interest of unique highly qualified experts in fixing a monopoly on the individual's intellectual capital through self-employment and freelance.

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Improving the Courses of Educational Programs on Information Security Smart Grid

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***Abstract*—Smart Grids (SGs) represent a new concept in the development of electric power infrastructure in a digital economy. Existing courses, educational programs in such a situation do not always meet the requirements of the new concept and do not allow the formation of the necessary new competencies. This article provides recommendations for improving educational activities based on the risk analysis of the electricity company and compiling a competency map for an educational program for training personnel in the field of security risk management for SG.**

Keywords—certified courses; educational program; skills approach; professional competences; Information Security; intellectual power company

I. PROBLEM STATEMENT AND ITS RELATIONSHIP WITH THE MOST IMPORTANT SCIENTIFIC AND PRACTICAL OBJECTIVES

Specialists who wish to improve their qualifications and professional level and study, within the framework of certified training courses, information security (IS) problems in the field of innovative electric power, should become owners of professional competencies and the ability to master working methods related to basic principles, conceptual approaches and information technologies used in multilevel information protection in organizations. These competencies should correspond to the types of professional activities that the certified courses program is oriented to. At the same time, competencies should be consistent with the innovations of an enterprise operating based on the Smart Grid concept.

In this regard, the problem arises of determining the goals of improving the professional level of students, selecting the content of teaching materials of the educational process, assessing educational results and matching competencies with the modern level of activity of enterprises and organizations in the field of information security in the electric power industry based on the Smart Grid concept.

The aim of the article is to improve the courses of educational programs in information security based on ensuring the completeness and complexity of the competencies of graduates in the field of IS Smart Grid management.

II. COMPETENT APPROACH TO TRAINING SPECIALISTS IN THE FIELD OF INFORMATION SECURITY MANAGEMENT

The concept of a "skills-based approach" (or "competency-based approach") has become widespread in connection with the solution of problems of improving the education of Russia, as well as the transition to the implementation of federal educational standards of higher education. Curriculum on a skills-based approach can be considered as a set of principles, goals of education, selection of the content of education, organization of the educational process and assessment of educational results.

In this regard, the implementation of the skills-based approach to training specialists in the field of information security management and the study of trends in this area will allow domestic information security specialists to increase their competitiveness.

Of interest is the vector of development of training in the field of information security management, which is based on the following courses: CISSP (Certified Information Systems Professional); CSSLP (Certified Secure Software Lifecycle Professional); CISM (Certified Information Security Manager); CISA (Certified Information Systems Auditor).

The training materials for these courses have been tested at Bauman Moscow State Technical University, at Financial University under the Government of the Russian Federation when conducting appropriate certification courses for information security specialists [4].

A graduate of the courses should have professional competences: to know the basic methods of information security management, be able to improve methods of information security, have the skills to assess the effectiveness of information security in organizations. At the same time, the following seven main sections can be distinguished in certified courses [4, 5, 6, 9, 12]: IS management; secure access; network security; cryptographic information security; development of safe programs; modeling and conformity assessment; business continuity and recovery.

In Smart Grid information systems, which are an innovative field, this knowledge and skills, together with their ability to adequately and successfully apply them, can be formed only directly when solving the corresponding problems in the framework of practical activities. They cannot be fully acquired in the course of obtaining education, since in educational institutions there are practically no tasks from the real practice of managing information security of modern companies, including Smart Grid. It should be noted that the threat and risk are determined not abstractly, but relatively specifically protected resources [4, p. 9]. However, this paradox is partially

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solved by the creation of pilot laboratories, the development of cases, the widespread use of simulation of the main and supporting and auxiliary business processes.

The focus of production of something new in the electric power industry is shifting in modern conditions to the creation of innovative smart grids. The introduction of the Smart Grid concept provides for the development of smart grid technology and means a fundamental reorganization of the electric energy services market [2, 10]. Federal Grid Company of Unified Energy System (FGC UES, PJSC) is one of the largest enterprises in the electric power industry, rendering services in the transmission and distribution of electric energy, in connection to electric networks and in the collection, transmission and processing of technological information, including measurement and accounting data [13].

A network operating on the basis of the Smart Grid concept is able to detect the damaged area itself, de-energize it and automatically power consumers who are briefly left without power. Controllers with freely programmable logic implement algorithms for configuring power supply schemes for various emergencies and provide network automation.

The methods of creating information systems cannot be separated from the main goals of entrepreneurial activity and cannot be unrelated to environmental influences and limitations [3]. To effectively use information systems, an entrepreneur must understand the socio-economic risks and limitations of technology development, implementation and use of systems (Fig. 1).

Business information systems should reduce risks by increasing the effectiveness of managers' actions, based on mathematical models of risk optimization and methods for managing cyber risks at various levels [8, 10, 11].

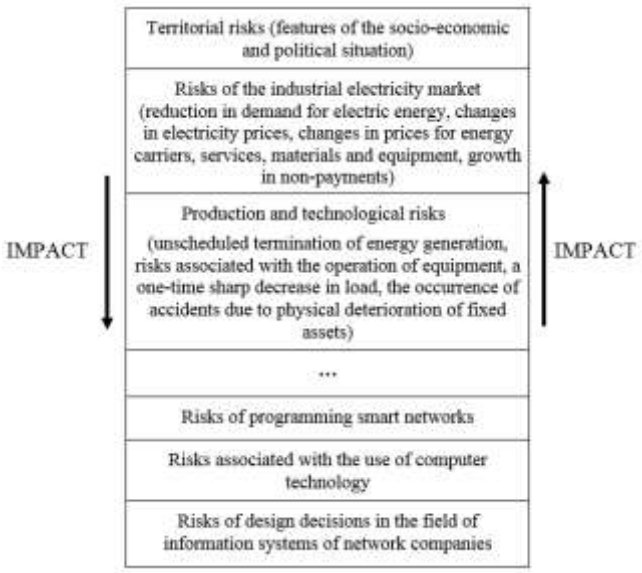

Fig. 1. The scheme of the relationship of risks of enterprises of the electric power industry

III. MAP OF COMPETENCIES OF SPECIALISTS IN THE FIELD OF INFORMATION SECURITY OF AN INTELLECTUAL NETWORK

The shortage of specialists in the field of information security, who in the digital economy are ready to solve the key tasks of the coming decade, is focused on innovative products and the creation of new markets and the globalization of companies. Systems for training specialists for information security management should begin to train specialists with knowledge and competencies in several subject areas who can work with both internal and external risks, both operational and IT risks (cyber risks) and are able to anticipate future transformations.

The main subject of the study is the need to analyze exactly what competencies and qualifications are needed to ensure the information security of companies and how this will affect the training system for its personnel. For the world's leading electricity companies, innovation is an important source of income. New technologies bring energy companies not only new opportunities but also create new threats and risks. Therefore, the introduction of a new system of smart metering devices (Smart Meters), allowing remote transmission of energy consumption data of a client, has opened up many new ways of theft of electricity [7].

The competency clusters and processes are identified on the basis of the analysis of the interaction scheme of the power company divisions in the operational risk management system and their IS risks (cyber risks), based on expert estimates and taking into account the competence clusters used in the practice of leading companies from the standpoint of information security of the smart energy network [1].

The operational risk management system in an electric power company consists of the following elements: operational risk management services (ORMS); a specialized unit of the organization that performs IS risk management procedures (IS service); divisions – owners of the organization's business processes and divisions supporting the organization's business processes (centers of competence); classifiers used in the operational risk and information security management system; an event database containing information on operational risk and IS risk events and losses from all types of risks; benchmarks of the electricity company and a system of measures aimed at improving the quality of the management system; automated information system.

In Fig. 2, which reflects the interaction of company departments in the context of the integration of information security risks, the following conventions are adopted:

1 - the information security service (ISS) ensures the identification of IS incidents (IS risk events) and the identification of sources, threats and vulnerabilities of the threat (attack) implementation, the identification of business processes, systems affected by the incident, makes an immediate response to the incident in accordance with the procedure established by the company and transmits information about the incident to the business unit and to the ORMS;

2 - business units respond to an incident: they suspend business processes, block accounts, etc. and transmit the consequences of the incident to the ORMS;

3 - the operational risk management system determines the extent and degree of impact of the incident (IS risk event) on other risks and business processes, classifies the incident according to the operational risk methodology and reflects it in the event database;

4 - the operational risk management system determines, together with business units and the operational risk management system, incident losses (IS risk events); defines measures to minimize other risks depending on the realized risk of information security;

5 - the business unit provides information on losses in the ISS;

6 - the information security system determines the effectiveness of measures to ensure an immediate response to an incident (IS risk event);

7 - ORMS, structural divisions, and the information security service organize activities aimed at minimizing the consequences of the implementation of IS risk (cyber risk) and other types of risk;

8 - the information security service evaluates the effectiveness of measures to minimize the risk of information security (cybersecurity risk) and the level of residual risk.

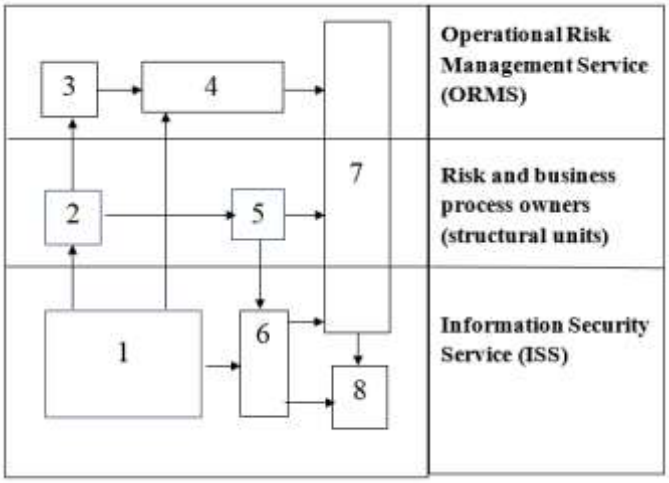

Fig. 2. Information security risk management scheme as part of operational risks

Taking into account the considered scheme and the competency approach proposed in [1], we present a map of the competencies of specialists in the field of information security of an intellectual network.

A. Leadership, organizational and managerial competencies of an information security officer.

A.1. It owns modern models of organization of the company and can independently organize the process of ensuring information security.

A.2. It can act as a qualified customer of research and development.

B. Employee competencies in terms of communication and coordination in the external ecosystem.

B.1. It can maintain effective communication with experts to identify promising areas of development.

C. Technological and special professional and sectoral competencies of employees in the field of intelligent power grids.

C.1. It can determine long-term directions for development (electric power technologies).

C.2. Understands the directions of the development of the professional field can determine new tasks in his field and evaluate the means of solving them.

C.3. It can solve new problems in the professional (technological) field.

C.4. It can solve complex problems in the professional (technological) field.

C.5. It can provide standardization of new technologies and solutions.

D. Cognitive competencies of an employee.

D.1. It can evaluate the achieved level of knowledge, formulate the need for new knowledge in the field of information security, evaluate the methods of their receipt and the results obtained.

D.2. It can determine and develop ways to obtain new knowledge in the field of information security, evaluate the results.

D.3. It can create new knowledge on the subject of activity (including technical and regulatory knowledge).

E. Employee competencies.

E.1. Search and discovery of new business opportunities (identifying business opportunities).

E.2. Search and discovery of new risks: operational, information (cyber risks).

E.3. Assessing the prospects of new business opportunities (evaluating business opportunities).

E.4. Assessment of new operational, informational risks (evaluating of cyber risks).

E.5. Decision making, responsibility for the consequences of decisions (decision-making).

E.6. Identifying and solving problems.

E.7. The ability to think in a new way (innovative thinking).

E.8. Effectiveness of communication with different partners (communication).

F. Vision of the future, long-term forecasting, and determination of long-term strategic goals by an employee.

F.1. It can determine the direction of development of the sphere of consumption of company products and services, as well as infrastructures for 15–20 years and set long-term goals.

F.2. It can determine the direction of technology development in the field of the company for 15–20 years and set long-term goals.

This map shows what competencies are necessary for the implementation of the processes of an electric power innovation company. At the same time, the distribution of managerial, technological and entrepreneurial competencies is uneven. This map also shows the place and importance of the company's technological competencies to ensure information security.

The processes of changing the composition of the required competencies and qualification structure for managing and ensuring innovative activities in the context of digitalization and information security acquire a special role at the stage of transformation of electric companies.

IV. Conclusion

The considered approach to the formation of competencies allows you to:

- ensure the completeness and comprehensiveness of the composition of competencies, since this composition of competencies, will be associated with the regulation of information processes and business processes of the company and fully comply with its description;
- represent competencies in educational programs in the form of a tree with a hierarchical multi-level structure and in the chronological sequence of their implementation, according to the chronology of the implementation of relevant processes to ensure information security;
- to supplement, based on the study of new business processes of successful enterprises, a set of competencies of graduates taking into account the focus of the educational program on new specific areas of knowledge and activities.

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Formation of the Engineering Staff Training System for Military Shipbuilding in Leningrad Higher Education Institutions (1920–1930)

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***Abstract*—As a result of the cataclysms caused by the First World War, the Civil War, the revolution, and the intervention, shipbuilding enterprises lost qualified engineering staff. The state staff training system required the reorganization. Historically, Leningrad was the leading research center of the country, where the country's leading educational institutions were located. Therefore, the city became the place for organization of training system for military shipbuilding. Firstly, the Naval Academy established the Military Industrial Department, and then civilian universities and the Naval Engineering School started training staff for the shipbuilding industry.**

Key words—Naval Academy; Military Industrial Department; engineering staff; shipbuilding enterprises

I. INTRODUCTION

In 1920-1930 in the Soviet Russia was being created a socialist system of public education, was being formed a new intelligentsia, was being affirmed a Marxist-Leninist ideology, and life was being rebuilt on the background of the industrial transformation of the society. For one decade, the country's leadership had to endure not only revolutionary changes in absolutely all spheres of life, but also to withstand the Civil War, intervention, to unite the multinational republics in the Union, to stand such an exceptional events in history of mankind, as military communism, NEP, the struggle for an atheistic state and collectivization.

The revolution, the Civil War and the intervention of the former allied countries led to a huge drop in the level of staff training in all areas, and not only in military shipbuilding. The number of the old specialists was extremely small, and also they were not trusted and suspected of all kinds of hostile designs. Everyone urgently recognized the need for a hasty solution to the task of obtaining a sufficient number of engineering staff.

II. FORMATION OF THE ENGINEERING STAFF TRAINING SYSTEM FOR MILITARY SHIPBUILDING

Creation of the Soviet Higher Education started from the decree of the August 2, 1918 "On the rules for admission to higher educational institutions of the RSFSR." The decree eliminated the existing restrictions in pre-revolutionary Russia on the entry of workers and peasants to the universities. Now, every person over 16 years old, regardless of citizenship and nationality, gender and religion, could enroll to the universities without exams; documents about secondary education were not required as well. The advantage in enrollment was given to the workers and the poorest peasantry. However, the new admission rules did not give workers a real opportunity to study at a university, since they did not have a secondary education [1]. To solve this problem, everywhere, in all universities of the country, the government started creation of “rabfaks”, and in HEIs-preparatory classes in which representatives of workers and peasants could prepare for higher education.

Leningrad was rightfully considered as a research and production cluster of military shipbuilding. Not only the largest shipbuilding enterprises were concentrated in the city, but also civilian and military educational institutions that trained engineering staff for them. The leading role in training of highly qualified specialists was assigned to the Naval Academy.

May 10-16, 1929 in Moscow, the head of the Naval Forces of the Red Army R.A. Muklevich held a meeting at which a report was heard by the head of the Military Academy, Professor B.B. Gervais on the activities of the Academy [2, p. 10–11]. With regard to the activities of the Academy, the meeting adopted a decision, the main provisions of which were as follows: “The Academy needs to achieve a unity of understanding among the students of the role and construction of the Naval Forces; the work of the Academy should be brought closer to the actual conditions of the Red Army naval

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forces; Academy should provide all possible assistance to industry through the replenishment of naval specialists" [2, p. 10–11].

On June 17, 1929, the Military Naval Academy held an interdepartmental meeting on the issue of training engineers at the academy for the naval industry. The meeting recognized the possibility of starting in autumn of 1929 a one-year specialization of engineers in torpedoes, mines and trawls, in artillery fire control devices (7 people in each group) and in naval artillery installations. The following target setting was adopted: in the courses to train civil engineers for work in design bureaus and in the factories of the naval industry in design, creation, testing and delivery of samples of weapons [3]. Thus, it was decided to create a Military Industrial Branch in Military Academy.

The leadership of the academy adopted a meeting decision. Since 1929, for the first time, training for civilians – engineers for the defense and shipbuilding industries involved in the construction of ships – began at the Academy. So, on October 22, 1929, the Mobilization Department of the 2nd Division of the Supreme Council of the National Economy sent the chief and commissioner of the Naval Aviation Administration: "To implement the order of the Revolutionary Military Council, it is urgently proposed no later than October 31, 1929 years, to collect for the military production service outfit from the attached list of engineers and send 25 people to the Baltic Fleet crew for further deployment to the Military Naval Aviation the most satisfactory in social terms, by profession and corresponding to the requirements of target settings and training programs for engineers for the naval industry "[4, p. 16].

In his report of January 30, 1929, the head of the Military Aviation Administration informed the USSR Supreme Economic Council on Mobilization and Planning that the selection of civil engineers for the naval industry was over. 29 engineers had arrived and had been trained at the Academy [4, p. 16]. At the same time, the conditions for staying of civilian specialists (who were awarded the military rank of "Red Navy Engineer" - author's note) were difficult, a lot had to be done for the first time, the system was not debugged, and the students themselves had not even completed the initial training.

In order to solve this problem and in accordance with the decree of the Supreme Economic Council, the head of the Mobilization Industry Division of the Leningrad Regional Council of the National Economy has determined the procedure for sending young engineers trained at the Academy to military enterprises. Namely: to the plants of Mashtrest – 9 people, to the plants of Sudotrest – 8 people, to the factory of Ostekhbyuro – 9 people, to the plants of Orudatrest – 3 people. At the same factories, they implemented practical training. During their stay at the Academy (from December 1, 1929 to October 1, 1930), the above mentioned enterprises paid each of them an allowance in the amount of the 1st category of the technical tariff grid – 120–125 rubles per month [4, p. 42].

At the same time, in Leningrad in 1932, there were 32 industrial and research institutions engaged directly or related to the construction of military ships [5, p. 70–75]. Therefore, on June 13, 1932, at a meeting at the 2nd Personnel Sector of the People's Commissariat of Heavy Industry of the USSR on the issue of the Academy, the following resolution was adopted: "Until the normal graduation of engineers of shipbuilding, steam, diesel specialties at the Leningrad Shipbuilding Institute to keep those at the Academy [6, p. 155]. And already in September 1932, the commander of the Naval Forces of the Red Army and the chairman of the Strategic Missile Forces of the USSR approved the "Regulations on the HE of the Military Academy of the Red Army" [7, p. 128].

In accordance with the "Regulation ..." the goal of the Academy was to prepare specialist – engineers for enterprises and industrial institutions that fulfill the orders of the Navy. The target setting was the training of engineers for work in design and testing bureaus, in industrial plants.

During the existence of the HE of the Academy, according to the authors' calculations, graduates of the following technical colleges were enrolled: Leningrad Polytechnic Institute, Leningrad Technological Institute, Leningrad Electrotechnical Institute, Leningrad Technological Institute, Leningrad Boiler and Turbine Institute, Leningrad Engineering Institute, Moscow Mechanical Institute, Moscow Institute of Mechanical Engineering, Moscow Power Engineering Institute, etc. [1]

The number and specialization of students can be judged from Table 1.

TABLE I. SPECIALIZATION AND THE AMOUNT OF STUDENTS [1]

Specialty	**Quantity of students**						
	1929	**1930**	**1931**	**1932**	**1933**	**1934**	**1935**
Gun mount	4	7	12	15	-	-	-
torpedoed	10	10	12	15	-	-	-
minesweeping	-	8	12	15	-	-	-
Fire maintenance	4	17	12	-	-	-	-
mines	3	-	-	15	-	-	-
Naval arms	**21**	**42**	**48**	**60**	**41***	**44***	**15***
Military engineering	-	11	25	25	-	-	-
shipbuilding	-	4	12	15	42	35	-
total	**21**	**57**	**85**	**100**	**83**	**79**	**15**

* Since 1932, training of naval weapons specialists was carried out in a joint group

In total, based on archival documents according to the calculations of the authors, it was determined that 440 design scientists and highly qualified industrial engineers were trained at the Academy from 1929 to 1935. After graduation from the Academy, graduates were enrolled in the reserve of the Red Army and were sent to the engineering and technical posts at enterprises and institutions of military shipbuilding.

III. DEVELOPMENT OF THE ENGINEERING TRAINING SYSTEM FOR MILITARY SHIPBUILDING

However, this was clearly not enough. The Inspection of the Naval Forces of the Red Army working in 1932 at the enterprises of the military shipbuilding industry indicated that the majority of the identified shortcomings are the small number and extremely low training of engineering staff and the administration of the plants. This is eloquently evidenced by the plan for the need for engineering and technical personnel drawn up on the basis of the materials of the Leningrad group

of military shipbuilding factories, which was expressed in the following figures: 1931/32 – 207 engineers and 479 technicians, 1932/33 – 178 engineers and 669 technicians. In three years – 552 engineers and 1724 technicians [8].

After 1934, enrollment to the Academy had stopped. This was due to the fact that since 1934, the Academy began to carry out special recruitment for the faculty of Naval Weapons and Shipbuilding. Special equipment and they had a target setting for the training of design engineers [9, p. 64]. According to the special recruitment, citizens from the age of 21 to 30 years old, which graduated from ten-year schools, labor schools, technical schools, and four courses of universities and passed competitive entrance exams after special selection, were admitted. After entering the Naval Aviation Administration, they were in the position of cadets for 4–5 months, where they underwent initial military training, and after passing the corresponding tests they were enrolled in the students and received the rights and position of the commanding staff [10, p. 27]. Thanks to the special recruitment, it was prepared: in 1936 – 75 people, in 1937 – 189 people, in 1938 – 177 people. Total – 441 highly qualified specialists [9, p. 40]. In total, taking into account the graduates of Academy and special military equipment, the Naval Aviation Institute, according to the authors, there were prepared 881 design engineers, production engineers in the following specialties: artillery, mine and torpedo, shipbuilding, machine-building, and electrical engineering for enterprises and institutions of military shipbuilding. Many of them subsequently became prominent designers, managers and organizers at enterprises, and also became heads of departments and faculties of the Military Academy [3].

It should be noted that the training of specialists for shipbuilding in the 1920s was carried out in two directions:

- Higher military educational institutions – Naval Academy, Higher Naval Engineering School, both in Leningrad;
- Civil Higher Technical Educational Institutions – Leningrad Electrotechnical Institute, shipbuilding department of the Leningrad Polytechnic Institute.

A characteristic drawback of this training on the eve of the first five-year plan was that these areas were fragmented and did not have a unified system of training. In addition, for civilian technical colleges it was inherent:

- the small number of graduates, for example, the shipbuilding faculty of the Leningrad Polytechnic Institute from 1902 to 1930. A total of 453 engineers were graduated [1];
- the long duration of student training at the University of Higher Technical Education (6–8 years) [1].

At the same time, in the interests of the fleet, it was planned to prepare in civilian universities: the Leningrad Polytechnic Institute – 392 people (of which: the Shipbuilding Department – 242 people, the Mechanical Department – 150 people); Leningrad Technological Institute (Department of Chemistry) – 465 people; Leningrad Institute of Railway Engineers (water communications department) – 335 people; Leningrad Electrotechnical Institute (LETI) – 582 people). In total – 1779 people [11, p. 2].

Creation and further development of a training system for engineering and technical staff for military shipbuilding was largely facilitated by the constant attention on the part of state authorities both in the center and in the localities. So, for example, on January 7, 1929, at a meeting of the Leningrad Regional Committee of the All-Union Communist Party of Bolsheviks, the question of training specialists for industry at the Naval Academy [1] was considered, where it was decided to entrust the factions of the All-Union Communist Party of Bolsheviks to study the issue of providing military industry engineers, specialists who graduated from the Academy. At the same time, the Academy became a key structure in the training of highly qualified engineering staff.

IV. Conclusion

Thus, in the late 1920s – early 1930s, a system for training engineering staff for military shipbuilding was formed and began to develop. This system contributed to the following, firstly, providing enterprises, institutions and shipbuilding industry with specialists, without which it would be impossible to implement shipbuilding programs, including military and five-year plans for their implementation. Secondly, it was impossible to implement the multi-level training of engineering personnel of the highest qualification. Thirdly, the unified training of designers creating new types of equipment and weapons, and their specialists, which allowed the country's leadership to quickly, clearly and flexibly implement and adjust the policy of naval construction.

The uniqueness of this system was also in the fact that all its structural elements were located in one center - Leningrad. The leading enterprises, organizations and institutions of military shipbuilding were also located in Leningrad.

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Providing with Training of IT-Personnel for High-Tech Industrial Enterprises in the Digitalization of Social-Economic Systems

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***Abstract*—The paper is focused on studying issues of IT education, training IT personnel and implementing an IT career in the industrial and economic segment, taking into account the current paradigm of Industry 4.0 and preparation for the formation of Industry 5.0. The scheme of the implementing the stages of education and / or advanced training of employees in the digitalization of industrial and economic systems has been compiled and analyzed . We identified problems related to the lack of vocational education in the personnel elevator.**

Keywords—personnel digitalization; IT education; personnel elevator; digital economics; real sector of economics; Society 4.0 and 5.0; training highly-qualified specialists

I. INTRODUCTION

At the beginning of the XXI century, transformation processes of digitalization of all systems of society's life take place at the world level: in social-economic structures, in the industrial and financial sectors. In connection with these trends, it becomes essential to plan and provide with training of digital personnel with the competencies of high-tech specialists able to work in the new IT vector and to meet all the requirements of employers in the existing information technology space, in the exogenous and endogenous environment of the employee's workplace.

The paper aims to develop an career elevator for providing digital personnel for the IT industry, to consider all levels of education with examples of leading educational institutions in the areas of training highly qualified specialists which posess information and communication technology competencies and are in demand in today's labor market.

The research basis included tools and methods aimed at studying ergonomic processes in a tender with digitalization of personnel, especially, system-centric and environment-oriented approaches, as well as classic methods: a hypothetical-deductive method of scientific knowledge, a method of analysis and comparison and a method of graphical modeling.

Polemic issues regarding the planning and personnel training, the level of the education and the necessary degree of qualification have been conducted among scientists from time immemorial. The topic of studying digitalization of personnel is research worth and is presented in the works of both Russian scientists [1, 2, 3, 4, 5] and foreign authors [6, 7, 8, 9].

II. THE CONCEPT

This study combines such versatile components as: "man - technology – society". Thereby the authors are intended to consider the synergy of these subjects through the prism of a cognitive philosophy, namely to present the interaction of human resources, technological processes and social environment in the context two cycles of Society 4.0 and Society 5.0 since the main object of the present study is personnel and their vector of digital development in the industry 4.0 paradigm and the transition to Industry 5.0 (Table 1).

TABLE I. CHARACTERISTICS OF SOCIETY 4.0 AND SOCIETY 5.0 IN TERMS OF PERSONNEL DIGITALIZATION [11]

Depending on the work performed	**Society 4.0 (2011-2015)**	**Society 5.0 (2016 – now)**
Industrial Production staff	- Acting of an individual to optimize a workplace by means of applying the information and communication technologies. - Finding solutions to individual problems related to job search restrictions due to social-demographic characteristics.	- Modernizing the society through merging the cyberspace and the real world. - Developing the human labor on the global Internet, ensuring the processes of safe activities. - Lacking the socio-demographic barriers, no age / gender restrictions. - Ensuring human well-being in society through developing social, environmental, informational and economic potential of the real and financial sectors.

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Depending on the work performed	Society 4.0 (2011-2015)	Society 5.0 (2016 – now)
Administrative staff	- Human working with a computer on the Internet (Consistent, but not safe). - Emerging the informatization process in the workplace.	- Modernizing the society through merging the cyberspace and the real world. - Working via the Internet in a safe manner. - Operating new resources, among them information, which allows to reach a new level of development of society, technologies, etc. in general, and to develop the quality of life of an individual and his professional capabilities in particular.

After a comparative analysis of Table 1, we highlight the features of the fifth stage of digitalization of personnel: a new level of digital capabilities, a high degree of convergence of cyberspace and the physical environment, ensuring of sustainable economic growth and security processes of human interaction with the information space.

Because of the expansion of digital resources in modern society, it is possible to implement the priority projects to modernize the personnel system by introducing the information and communication technologies and artificial intelligence. The interaction of cyberspace and physical space gives a start in the development of an individual's dialog with a mass audience, with work in the information segment, with a large amount of data, a new level of human-labor capabilities with technical and technological support of the enterprise.

The best personnel development in the priority digital vector is impossible without the education and advanced training of specialists in the field of information and communication technologies.

By 2024, the Government of the Russian Federation intends to bring about a comprehensive digital transformation of the Russian economy and social sphere. For this purpose, it is necessary to develop at the legislative level the regulation and provision of digital technologies for real sector entities, to modernize the digital infrastructure, to implement digital practices in all key areas of the economy and public administration, as well as to organize personnel training for the transition period [12].

According to the Decree of the Government of the Russian Federation dated March 2, 2019 No. 234 The National Program "Digital Economy of the Russian Federation", there has been drawn up a scheme for implementing the education and advanced training system aimed at providing with highly qualified specialists in the field of digitalization. The scheme is presented in Fig. 1.

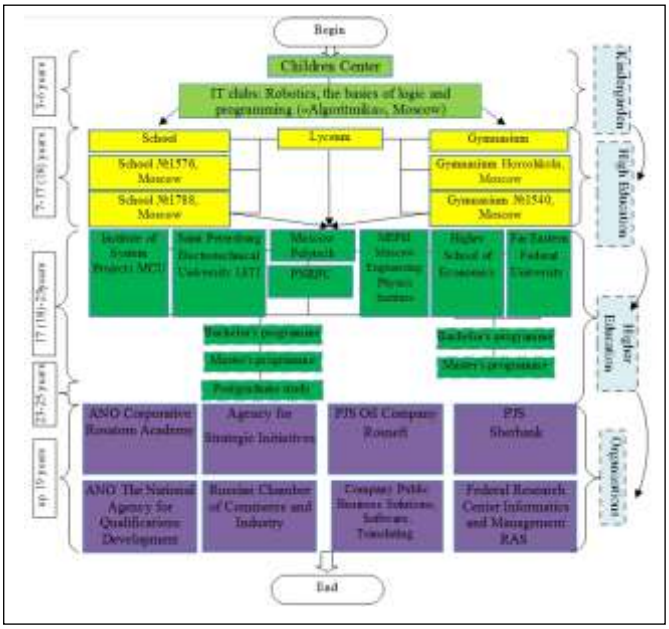

Fig. 1. A personnel elevator for providing high-tech industrial enterprises in the digitalization of social-economic systems with IT-workers[14]

Analysis of Fig. 1. allows us to conclude that at each stage of the education process, the personnel development begins in the aspect of its "digitization". An individual will be able to study and track the development of the digital economy and information and communication technologies, to interpret the data and to forecasts the development of social-economic processes, to develop and to apply in practice algorithms for working with a large volume of databases, to combine a programming language, mathematical modeling and social-economic processes when solving non-standard managerial tasks [13]. All these competencies are provided to graduates of leading higher educational institutions who in turn work in the fields of training bachelor, master and postgraduate students in the concept of training highly-qualified IT-specialists.

Among the popular training programs related to the IT industry, it is necessary to note: "Information Management Systems", "Information Systems and Technologies in Business" (St. Petersburg Electrotechnical University "LETI"); "Digital Innovation in Enterprise Management" (HSE); "Secure High-Performance Computing Systems" (NRNU MEPhI); "Applied informatics in enterprise management" (FEFU) as well as other master programs, for example "Conceptual design and engineering to improve energy efficiency" (PNRPU) [13].

There are the actual disciplines supported by partner enterprises: "Information systems and digital content processing technologies", "Information and automated information processing and management systems", "Information technologies in the media industry and design", "Augmented and virtual reality technologies in the media industry" ("Moscow Polytechnic University"). It should be noted a number of enterprises where the students of leading engineering universities of the country have a practical training. In the future these graduates are hired by these enterprises, so the following high-tech companies are already

providing themselves with IT-specialists: the state corporation ROSTEKH, JSC ROSELECTRONIKA, JSC Scientific Research Institute of Software, Concern Okeanpribor JSC, Scientific and Engineering Center of St. Petersburg Electrotechnical University JSC, Public Business Solutions, Software, Translating company, ABBYY and many other organizations (see Fig. 1).

Notable is that there is no stage of a vocational education, namely training at colleges and technical schools in the scheme, which, firstly, negatively affects the entire education and training system in the digital segment and, secondly, these graduates cannot acquire decent knowledge as IT-staff taking into account up to date and onrush technologies. The curricula of colleges and technical schools contain only basic disciplines related to information and communication technologies. The same problem is noted at the level of school education: it is significant for the most schools with the exception of specialized secondary education institutions shown in the diagram (see Fig. 1) where the students of primary classes obtain optional lessons related to new IT technologies and licensed software. These schools are attracting leading university employees to deliver the IT-subjects to high school students. A positive determinant of the lack of a level of a vocational education in a personnel elevator can only be the authorities' desire to stimulate high school graduates to enter the country's leading engineering universities.

III. Conclusion

The paper carried out an integrated approach of the stages of a personnel digitalization and a comparative analysis of Society 4.0 and Society 5.0. We have compiled and analyzed the scheme of the implementing the stages of education and / or advanced training of employees in the digitalization of industrial and economic systems. There were identified problems related to the lack of vocational education in the personnel elevator.

The paper aimed to fully and comprehensively formulate the opinions of specialists in the social-economic, industrial and educational sectors on the trends and prospects of digitalization of personnel at its various stages, to familiarize themselves with the main IT-curricula that contribute to the modernizing the personnel during automation and "digitization" of the workplace, as well as to acquaint with positive and negative factors in the existing training system.

This paper will be of special interest to the students whose future profession would be related to information and communication technologies, to specialists in the field of digitalization of personnel, to administrative and managerial personnel, and also to employees of the human resources department in connection with their responsibilities for finding applicants for vacant jobs and for advanced training of company employees.

The digitalization of personnel and the preparation of society for this program is the most important process in the modern world. The influence of digitalization trends leads to changes in all structures of the society. It was the national program "Digital Economy of the Russian Federation" that was especially developed to adapt to digital technologies and to improve digital literacy. The presence of highly qualified and educated IT-specialists in the country is an excellent opportunity for Russia to improve its position in the digital industrial and economic market.

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Monitoring System for the Demand of Specialists in the Sphere of Subsurface Management

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***Abstract*— The article shows a solution of the problem of employment of graduates by creating a geographic information system for monitoring of the available vacancies. The authors present a program for working with the Panorama cartographic system, in which was developed a geographic information system containing information on the current vacancies of the city of Kislovodsk.**

Keywords*— *employment; graduate; university; vacancies; geographic information system; staff training

I. INTRODUCTION

The problem of the "entry' of young specialists who have a higher education into the labor market is stipulated with social and psychological factors associated with the fact that graduates' ideas about the prospects of employment and future labor activity as a whole do not always coincide with the real situation and with the supply and demand ratio in the labor market. And the question is not only in the quality of training. The initial underperformance of career-guidance centers, low level of awareness of future applicants about various aspects of the chosen profession, social immaturity, and psychological unpreparedness for entering the labor market lead to a negative perception by employers of university graduates. The modern labor market is characterized by an increase in the gap between the labor claims of young specialists and the opportunities of the employer to satisfy them. Initially, the main requirement of employers for an employee is the presence of practical experience in the field of training. The absence of such an experience is the most common reason for denial of employment to a graduate. On the other hand, high salary requirements make it difficult to find a suitable job for young professionals [1].

II. FORMULATION OF THE PROBLEM

At the same time, it is quite difficult for a graduate to navigate among employers: it is difficult to find out about the employment and demand for specialists in his field. This in turn affects the choice of the profession for which the applicant is going to study. The analysis of this problem showed that to maximize the knowledge of the applicant and the graduate about various aspects of the labor market, it is effective to use geographic information systems. On the map, the graduate will be able to immediately see where the potential employer is located. Let us consider this issue in more detail.

III. THE SOLUTION TECHNOLOGY

Geographic information systems (hereinafter – GIS) are a new type of integrated computer systems that appeared at the end of the 20th century. [5]. Now they are the most promising and universal geodata control system. Nowadays cheapening of the technology and a significant increase in its computing power made it possible to use GIS in any area of everyday life. GIS is a a powerful and flexible geodata control system [1–6]. Its main advantage over conventional database control tools (hereinafter referred to as the CTCB) is that it has a structure as a DBCT, but it has a geo-referencing data in two or three dimensional space to a specific point on the ground.

In addition, GIS has a built-in spatial analysis system, which is not presentsd in a conventional CTCB. Elements of a geographic (archaeological) map are provided with semantics, whih can be analyzed. The most common definition for GIS is an automated information system designed to process spatio-temporal data, the basis of integration of which is a geographical information. We can also analyse the relationships between these elements. Most of all, GISs are convenient and useful in creating information systems of individual geographical regions. GIS data is divided into two categories:

- spatial data (locating);
- non-spatial data (specifying attributes).

The database of electronic maps has a hierarchical structure. At the lower leve it stores the information about individual map objects.

Objects can be combined into groups, layers and map sheets. The assembly of map sheets of the same scale and type makes up the area of work – a separate database of electronic maps. The description of an individual object consists of metric data (coordinates on the ground), semantic data (object properties), text reference data, illustrative graphic data and other data, including a unique object number through which is performed the logical communication with external relational databases (hereinafter referred to as the database) [7].

IV. THE PRACTICAL EXAMPLE

Panorama Design Bureau is the only manufacturer of vector maps in the Russian Federation with all the permissions to create large-scale maps.

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Professional GIS “Map 2005” is a universal cartographic system developed by the Panorama design bureau, which has the means to create and edit vector maps, perform various measurements and calculations, overlay operations, build of 3D models, process raster data, and prepare graphic documents in electronic and hard copy, as well as tools for working with databases. This environment is also compatible with international classifiers, which makes it possible to import and export cards from one environment to another. Fig. 1 shows the general GIS diagram of the city of Kislovodsk.

Fig. 1. Map of the city of Kislovodsk

Relational databases are most often used for storing, structuring and managing data in GIS, where common fields are used to link tables. When using such a geoinformation database, two databases are simultaneously loaded into the system. One can be launched by pressing the button general data, data on the city are displayed with an indication of demand (Fig. 2), which shows the level of employment in color, and when you click on each object, you can see which specialists are in demand at the moment.

Fig. 2. Demand in the city general statistics

The second is with the search for the vacancies through the employer button.

For the program to work, a monitoring software product was written. An example of a compilation project is shown in Figure 3.

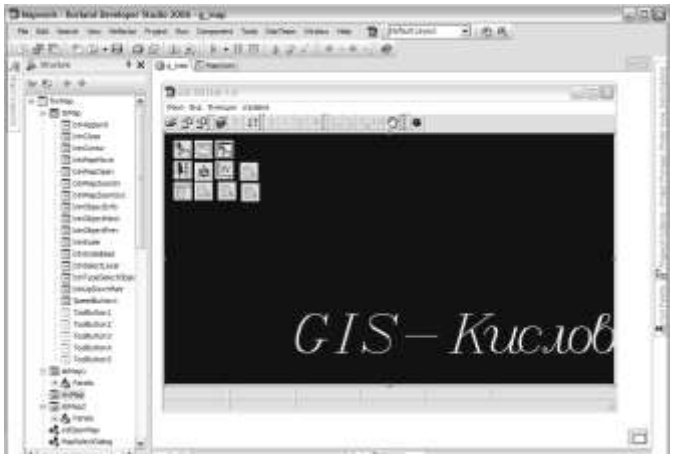

Fig. 3. Environment Monitoring Program in BDS 2006

V. CONCLUSION

The developed GIS allows to save significant time resources on the search for the necessary employment objects. The use of the developped technologies are such that even specialists without work experience, or with little experience in their field, can quickly get the information they are interested in.

The introduction of the developed program module in the employment center of the city of Kislovodsk allowed to get a fourteen percent increase in profits, due to the reduction of time for selecting a vacancy and in-time orientation of applicants to the training necessary for the industry. The algorithms and software systems obtained in this work can be applied in other industries [1–17].

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Forecasting of the Specialities Demand in the Sector of Mineral Resources of the Labor Market

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***Abstract*— The article observes the issue of forecasting and creating a predictive model based on data obtained as a result of expert evaluation. Authors introduce a calculation technique and implement an experimental calculation of the demand for one factor (specialty or group of specialty) within the framework of a general request of the labor market.**

Key words— staff training; employment; graduate

I. FIELD OF THE RESEARCH

We often face in practice with the task of forecasting random variables, whether it is a sharp drop in the demand for specialists or the opening of a new educational institution. This fact is a prerequisite for the application of probabilistic models. Probabilistic models allow us to calculate the probability that the future value of the parameter of the predicted process will be less than a certain number, for example, the probability that $y<y_i$

$$P_i = P(y < y_i).$$

The value ***y*** can lie within the limits $y_0 \le y \le y_n$ because $P(y < y_0) = 0$ and $P(y < y_n) = 1$

The distribution curve of the continuous random variable *y* shown in the figure is a graph of the distribution function $P(y)$. The distribution function exists for both continuous and discrete random variables and is a universal characteristic of random variables.

Knowing the distribution function, we can find the probability of a random variable falling on a given section by the equation $y_0 \le y \le y_n$:

$$P(y_i \le y \le y_n) = 1 - P_i.$$

For continuous random variables, is often considered the derivative of the distribution function of the form

$$f(y) = \frac{dP(y)}{dy},$$

or the distribution density of a continuous random variable *y*. The probability of a random variable *y* entering a certain section is shown by the equation

$$P(y_1 \le y \le y_2) = \int_{y_1}^{y_2} f(y)\,dy.$$

Thus, we can carry out prediction of the probability of an event when predicting the distribution functions considered. Moreover, in many practical cases, there is no need to characterize the random variable completely, and it is enough to predict only some distribution parameters (for example, mathematical expectation and variance).

In some cases, we can describe the data obtained during the process of observations of the predicted process by well-known distributions of continuous and discrete random variables, including normal distribution, uniform distribution, exponential distribution, Poisson distribution, and some others.

If the type and parameters of the named distributions do not change in time and a sufficient number of observations is available, then solving the forecasting problem does not cause any particular difficulties. We can construct an empirical distribution, solve the task of the theoretical distribution curve for a given empirical distribution choice, and carry out forecasting using the required accuracy. However, in practice, as a rule, the researcher has limited information about the process and, in addition, it is not always possible to guarantee the invariance of the form and distribution parameters. These conditions predetermine the use of more complex probabilistic models based on the latest achievements of probability theory. These most intensively developed areas of probability theory include, in particular, the theory of small samples and the theory of summing a random number of independent random variables.

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II. FORMULATION OF THE PROBLEM

The analysis of the forecasting object and the forecast background at the retrospection period (forecast base period) established that the system development process can be represented by a stepwise process (a sequence of jumps made at random times). The magnitude y_i is a random variable which behavior is described by the distribution law $f(y)$. The number of jumps *n* at the forecast lead-time is random, distributed according to the law P_n. It is required to determine the distribution function of the output parameter of the system *y*.

III. A NUMERICAL EXAMPLE

The traditional (main) analytical apparatus of probability theory and mathematical statistics is the apparatus of characteristic functions. It is known that if Y is a real random variable, then there exists a complex random variable $X = \exp\{itY\}$ (where $i = \sqrt{-1}$ – is an imaginary unit, and **t** is a real number).

The function of a view

$$\phi(t) = EX = Ee^{itY},$$

Where ***E*** is the symbol of mathematical expectation, and is called the characteristic function of a random variable Y. That means that the characteristic function of a random variable Y is the mathematical expectation of a complex random variable X.

The characteristic function is dimensionless, and the parameter *t* has a dimension inverse to the dimension of a random variable Y.

We use the main properties of characteristic functions to solve the problem, from the conditions of the solution of which we know that the output parameter of the system *y* depends both on the random number of jumps *n* in the lead-time period and on the random value y_i of each jump. Moreover, the random variables $y_1, y_2, ..., y_r, ..., y_n$ are independent, equally distributed and do not depend on the random variable *n*.

We assume that the Poisson's law can determine the number of jumps in the forecast lead-time

$$P_n(r = n) = \frac{\lambda^n e^{-\lambda}}{n!}, \qquad n = 0, 1, 2...$$

With a parameter λ, the relation $\lambda = \bar{n}$ is valid for the Poisson distribution.

The random variable *y* (the value of the jump) has a standard normal distribution $N(0,1)$ with parameters $m_y = 0$, $\sigma^2 = 1$ and probability density

$$f(y) = \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}}.$$

Thus, in order to obtain the distribution law of the output parameter, it is necessary to consider the distribution of the sum of the Poisson number of standard normal quantities.

Based on the multiplicative property of the characteristic function, the characteristic function of the sum of independent random variables is equal to the product of the characteristic functions of random variables, what means that if $y = \sum_{i=1}^{n} y_i$, then

$$\phi(t) = Ee^{ity} = \prod_{i=1}^{n} \phi_i(t),$$

We can write that the cumulative distribution function $F(y)$ of the sum of a random number *n* of random variables y_i is determined by the characteristic function

$$\phi(t) = \sum_{n=0(1)}^{\infty} P_n \phi_i^n(t),$$

Where $\varphi_i(t)$ is the characteristic function of a random variable y_i.

Below we consider the characteristic function of a standard normal distribution:

$$\phi_i(t) = \int_{-\infty}^{\infty} e^{ity} \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} dy = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-\frac{(y-it)^2}{2} - \frac{t^2}{2}} dy =$$

$$= e^{-\frac{t^2}{2}} \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-\frac{(y-it)^2}{2}} dy.$$

Since the integral looks like $\int_{-\infty}^{\infty} e^{-\frac{y^2}{2}} dy = \sqrt{2\pi}$, then $\phi(t) = e^{-\frac{t^2}{2}}$.

Hence, the characteristic function of the sum of the Poisson number of standard normal quantities has the form of

$$\phi(t) = \sum_{n=0(1)}^{\infty} \frac{\lambda^n e^{-\lambda}}{n!} e^{-\frac{t^2}{2}n} = \sum_{n=0(1)}^{\infty} \frac{\lambda^n}{n!} e^{-\lambda - \frac{t^2}{2}n}.$$

For definiteness, we exclude the case when $n = 0$ from our consideration. Then

$$\phi(t) = \sum_{n=1}^{\infty} \frac{\lambda^n}{n!\left(1 - e^{-\lambda}\right)} e^{-\lambda - \frac{t^2}{2}n}.$$

Based on the inversion formula

$$f(y) = \frac{dF(y)}{dy};$$

$$f(y) = \frac{1}{2\pi} \int_{-\infty}^{\infty} e^{-ity} \sum_{n=1}^{\infty} P_n \phi_i^n(t),$$

then

$$f(y) = \frac{1}{2\pi} \sum_{n=1}^{\infty} \frac{\lambda^n e^{-\lambda}}{n!\left(1 - e^{-\lambda}\right)} \int_{-\infty}^{\infty} e^{-ity - \frac{t^2}{2}n} dt.$$

After the integration, we obtain the desired distribution density:

$$f(y)=\sum_{n=1}^{\infty}\frac{\lambda^{n}e^{-\lambda}}{n!\left(1-e^{-\lambda}\right)}\frac{1}{\sqrt{2\pi n}}e^{-\frac{y^{2}}{2n}}$$

IV. CONCLUSION

As we have already noted, the methods of mathematical modeling are one the most general and at the same time quite strict forecasting methods. However, when we use them, we cannot predict changes in the nature of technology over time. The characteristics are defined as the result of optimization. However, we can predict the input data necessary for the functioning of the general mathematical model. We mean the prediction of exogenous variables, that is, those that are determined by dependencies, which are not a part of the main model, in contrast to endogenous variables (in particular, performance indicators of technology), which are the desired (output) variables of the main mathematical model.

We can make a prediction of input data to optimize the characteristics of the equipment, and sometimes the characteristics themselves, by one of the following methods, which differ in the scientific basis and the reliability of the forecasting results:

- compilation, according to well-known laws of nature of theoretical cause-and-effect mathematical models, which determine the predicted development processes and evaluate the parameters of these processes according to the history list and current state;
- manufacturing and testing of prototypes and experimental samples, as well as physical modeling;
- compilation of empirical dependencies according to the statistics of the history list and the present data, what is called the regression analysis and extrapolation.

Sometimes researchers also distinguish the expert assessment methods, but in most cases, experts themselves should use the above mentioned methods.

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Transformation of Training in the Digitalization of the Russian Economy

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***Abstract*— The article deals with the issues related to changing requirements for the organization and implementation of targeted training in the conditions of digital transformation of enterprises of the national economy.**

Keywords*— *digitalization; transformation; individual educational trajectories; online learning technologies

I. MODERNIZATION OF THE EDUCATIONAL PROCESS

Completion of the process of digital transformation of the national economy requires a large number of highly qualified personnel not only in the areas of training directly related to mathematics and computer science, but also specialists in other areas of knowledge, as well as having a wide range of professional competencies in the field of digital technologies.

Training of such specialists, in turn, requires a significant modernization of educational processes of higher educational institutions, aimed at individualization of educational trajectories of training, the use of modern digital technologies in the learning process and the accumulated experience of the best practices of the world educational community [1].

The basis for the modernization of the educational process of higher education institutions should be provided to each student the opportunity to form their own individual educational trajectory, allowing them to develop the necessary competencies for the successful implementation of future employment.

Providing the opportunity for students to form individual educational trajectories implies the presence of the following elements in the University:

- designer of individual educational trajectories;
- designer of the individual schedule of the student;
- subsystem of analysis of digital trace of a student based on the results of his educational and scientific activity;
- the presence of the University base of local acts regulating various aspects of student learning on an individual educational trajectory;
- digital portfolio of the student.

Below is a description of each of the above elements.

II. DESIGNER OF INDIVIDUAL EDUCATIONAL TRAJECTORIES

A. Design of the designer of individual educational trajectories

The designer of individual educational trajectories represents the information environment providing support of construction from space of activities of educational programs (modules, disciplines, profiles), trajectories of possibilities of training recommended to the student.

When designing the designer of individual educational trajectories, it is advisable to lay in it the possibility of using artificial neural network technologies that allow, in the presence of individual preferences of the student, as well as access to his digital portfolio:

- list of possible educational trajectories;
- possible maps of competencies acquired as a result of the choice of a particular trajectory;
- the list of educational activities available as an optional (recommended) for the development of;
- the list of recommended scientific supervisors of course and final qualifying works, Tutors or consultants from among the scientific and pedagogical workers of the organization;
- the list of places of practice recommended in the framework of a particular trajectory of training.

One of the main components of the designer of individual educational trajectories is the repository of the space of educational activities provided by the University to the student [2].

B. Repository of the space of educational activities

The repository of the space of educational activities should contain:

1) A structured description of the disciplines in the form of mathematical models indicating:

- the main parameters of the disciplines (modules) established by the normative documentation (description, keywords, membership in a particular educational track (part of the curriculum), prerequisites, postrequisites required for study,

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competencies formed in the process of learning competencies;

- additional parameters of disciplines (modules): ability to work in a team, ability to prepare and present research results, etc.

2) A structural description of electives, the format for the provision of information on which corresponds to the above description of the main disciplines (modules);

3) Matrices are formed by the student in the process of learning competencies;

4) A formalized description of professional tracks offered to students in the learning process, including;

5) Summary of teachers offering the student a discipline.

It is particularly necessary to emphasize that the repository should contain information not only about the courses offered to the student (disciplines, modules) developed by the universities themselves, but also provide the student with information about the courses of leading national and foreign universities in this field of knowledge, for example, Economics, posted on domestic and international open educational platforms such as Coursera, edX, FutueLearn, NPOED, Stepik, etc.

C. Implementation of the mechanism of individual educational trajectories

The implementation of the mechanism of individual educational trajectories requires the use of a fundamentally new approach to the formation of the schedule of classes (consultations), the transition from group scheduling schedule on an individual basis, taking into account the characteristics of each student.

In this paradigm, the final schedule for the educational organization will be formed not on the basis of the educational programs implemented with reference to student groups, but on the basis of the students choice of a specific list of disciplines studied in the semester and the teachers who provide them. With this approach, the number and magnitude of lecture flows is determined depending on the total number of students enrolled in a particular course.

Special attention in the implementation of the mechanism of individual educational trajectories should be paid to the formation of a subsystem for collecting and analyzing the student's digital footprint based on the results of his educational and scientific activity.

Information about the educational and scientific activity of the student, including samples of works performed by him, data on the time of the beginning and completion of the received tasks, the results of writing test tasks, etc., should be recorded in the personal account of the student. Analytical processing of this information will make it possible to formulate recommendations for the student to change the individual educational trajectory of his training, based on the results achieved.

The introduction of individual educational trajectories into the educational process will also require the adjustment of the existing legal framework in universities related to the organization and implementation of the educational process. In particular, educational institutions will need to develop and implement local regulations governing the recognition of the results of online courses, developed at the sites of open learning or other educational organizations, the procedure of organization and holding of the current, intermediate and final evaluation of students on individualized education programs, the rules of formation of the individual schedule of the student, formation of a digital portfolio of a student etc.

Another element necessary for the formation of individual educational trajectories of the student is a digital portfolio containing his achievements for the entire period of study.

The practical implementation of the digital portfolio will allow potential employers (primarily strategic partners of the University) to identify talented students with a set of competencies required for further employment at an early stage, to supervise and support them during the training period (including the provision of a place to practice and perform final qualifying work).

III. CONCLUSION

The development of higher education in the digital transformation of the economy – a new approach to understanding and shaping the learning environment and structure of educational programs, contents of education, results of educational activities and the role of the teacher, based on the development of all participants in the educational process of digital competences.

Digital competence-skills of effective use of modern technologies, including the organization and conduct of information retrieval, processing, analysis and synchronization using digital devices and modern software, critical perception of information, the ability to create multimedia content and organize digital communications, etc.

It should be noted that the level of digital competence of students is largely determined by the level of digital competence of their teachers.

In this regard, within the framework of training for the digital economy, the question of the need to increase the level of digital competence of teachers of domestic universities comes to one of the first places.

The professional competence of the teacher in the field of digital technologies include:

- use of digital educational resources in the work of students in the classroom and remotely;
- ability to create your own digital learning materials;
- organization of students ' work in the framework of network communication projects;
- ability to involve students in the process of self-setting goals and objectives of educational activities in the digital environment;
- the ability to identify and analyze the learner's successes, difficulties, and interests through the analysis of their digital footprints;

- the ability to individualize the educational process with the help of digital tools with a large number of students;
- be able to motivate students, including them in a variety of activities that allow them to develop the required competencies;
- be able to take an expert position on the competencies demonstrated to students in different activities and evaluate them using appropriate criteria [3].

The solution to this problem should be a large-scale program to improve the skills of teachers of domestic higher educational institutions (carried out in the form of training, retraining or internship).

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Features of Staffing for a High-tech Industrial Enterprise: Problems and Solutions

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***Abstract*— The education system is becoming global in nature, covering not only the traditional exchange of students and teachers, but also issues of cross-border investment and competition of universities in the global educational services market, participation and (or) initiation by employers of new educational programs, considering the changing requirements of professional standards, etc. A modern industrial enterprise is high-tech and the role of the technological factor is increasing. This makes special demands on his staffing. The existing education system often lags the increasing pace of technological change. This is due to both the conservatism of the system and its personnel, material and technical and information support. Therefore, the problems of training young specialists for the modern labor market are being updated. The purpose of the study: to identify the problems of the modern labor market for a high-tech enterprise and propose a solution to these problems based on increased interaction between these enterprises and educational institutions. Methodology: systemic, strategic, comparative and statistical analysis, questioning method.**

Key words*— *high-tech enterprise; educational program; technological changes; staffing; interaction problems; strategy

I. INTRODUCTION

The labor market is changing in modern conditions, which is associated with the increasing role of technological factors that change the structure of the economy and the structure of employment in the economy. The education system is more conservative, on the one hand, but at the same time often ahead of the labor market, on the other hand, not flexible enough, it does not always cope with its tasks. Therefore, coordinated actions of the high-tech sector of the economy and educational institutions in matters of personnel training are needed. As the educational system expands and becomes global, covering not only the traditional exchange of students and teachers, but also the issues of cross-border investment and competition of universities in the global educational services market, all participants in this process should reconsider their views on priorities and expected results [1]. With an actively changing technological mode, the gerontological factor has a significant impact on the dynamics of development, especially when implementing innovative strategies.

For technical universities, the problem of training is solved through the creation and active functioning of specialized departments at leading educational institutions. This allows enterprises to engage their specialists, from developers to chief engineers, in the educational process, to provide students with the opportunity to solve practical problems from the first year. For students who wish to take part in innovative development, students in the areas of economics and management have developed a certain informational vacuum that impedes their proper professional orientation. In this paper, the authors present the results of their research, their own conclusions and suggestions on this issue.

II. METHODOLOGY

As the information base of the research, scientific works in the field of developing the education system [1], training for the economy at the master's level [2, 3], statistical data on the development of the high-tech sector of the Russian economy and its staffing [4], own observations and studies were used authors on the issues [5, 6].

These statistics show a decrease in the innovative activity of Russian companies with an increase in the share of high-tech enterprises in the market, and, accordingly, in the number of high-tech jobs, but this is very insignificant compared to the advanced world level, borrowed, in most cases, foreign developments are used at domestic enterprises [4]. The reasons for this situation, among other things, are the insufficient interest of graduates of educational institutions to work at high-tech enterprises of the Russian Federation.

The need for changes in the educational process is noted by most interested participants in this process. Discussions about the effectiveness of education show a significant emphasis on its assessment, often by individual methods, for example, the model of M. Boldridge and OCAI [2], is not always justified for use, with a high subjectivity of the assessment itself. The problems of the prospects for the development of education are discussed at the level of problems of regulatory support of possible ways of this development [3], the rationale for lifelong learning [4], illustrations of unsuccessful experiments [5], or solutions to existing problems of interaction [6]. We have not identified systematic works linking the opinions of all participants in the educational process and the labor market. This

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article presents the results of a study by the authors based on surveys of various participants: students, teachers, employers, and management consultants. The study was conducted in two stages: questioning and discussion of the results with all participants together and separately.

III. RESEACH

The goal of a modern sustainable industrial enterprise is not only effective production activities for the creation and sale of products, but also in the development and implementation of a strategy that determines its place in the market. In most cases, we are talking about: a) the implementation of innovative projects aimed at developing and increasing the output of competitive products and services; b) the development of innovative potential, the formation of an innovatively susceptible environment and innovative culture.

With regard to the possible career guidance of students in areas of economics and management, we can talk about options for choosing the direction of educational and extracurricular activities. To understand the existing problems and ways to solve them, we developed a questionnaire and conducted a survey of interested market participants: students, employers, teachers and consultants, and obtained certain results.

In our study, we used the following types of innovations: product, organizational, technical, capital-saving and social. These types of innovations determine vocational guidance, and, accordingly, the choice of training profile.

A survey of students revealed their need for employers to participate in the learning process (more than 80%). Various forms of participation were offered by students: guest lectures, master classes, excursions, company training, an increase in practical classes, etc.

From the point of view of employers, the proposals for interaction are as follows: the development of basic departments, the selection of students for immersion in the professional environment in the process of joint events, participation in the admission campaign and various types of certification, joint development and updating of educational programs.

The teaching staff noted the importance of enhancing interaction with employers in various areas, but at the same time, the inflexibility of existing educational standards and their own lack of motivation in this process.

The consultants, guided by the world experience in the interaction of educational institutions with employers, put in the first place the development and implementation of joint educational programs.

The second stage of our study was a discussion of the results.

All survey participants agreed with our offer on career guidance for students - in the framework of educational practice or the discipline "Introduction to the specialty", take a questionnaire or write an essay on various types of innovations and their implementation in the market. This should help students to determine the profile of training in a timely manner. In addition, it will be interesting to show them these results at the beginning of training and in their choice of the theme of final works.

The participants in our study agreed on the demand for areas in relation to the given ranking of innovations (Table 1). A two-level education system allows undergraduate students, having gained a certain basic level of knowledge, to consciously stop before choosing a master's program.

TABLE I. THE RATIO OF THE DIRECTIONS AND TYPES OF INNOVATION

Innovations / Functionality	***productive***	***organizational and technical***	***capital-saving***	***social***
Economy	+++	+++	++	+
Management	**++**	**+++**	**++**	**++**
Personnel Management	+	++	+	+++
Trading business	+++	++	+	+
Finance	+++	+	+++	++
sociologists	+	++	+	+++
advertising	+++	+	+	++

These tables illustrate that each direction is differently correlated with different types of innovations, which can contribute to the choice of direction for students to study in the magistracy.

Further, a few identified deficiencies in the training programs themselves, noted by employers, should be noted. The organization of innovative (scientific and technical) activity along with the laws governing entrepreneurial activity is regulated by certain documents of the state standardization system (GOST). Graduates of an economic university often learn about this only once they get to the enterprise. This provokes negative consequences in relationships with colleagues and lack of motivation. Educational programs in economics and management for the high-tech sector should form the necessary competencies in this direction, which will increase the value of a specialist in the labor market.

The consultants note the importance of distinguishing interests and the possibility of applicability of existing skills or matching the type of student character, this is the life cycle of an enterprise's products. For the high-tech sector, it is presented, as a rule, in full (research and production associations), although it can be distributed among various market entities: universities, research institutes, design and engineering bureaus, etc. Unfortunately, today we must admit that the end-to-end system of the innovation process, starting from basic research and exploratory scientific work with the subsequent transition to applied and ending with the manufacture of prototypes with the setting of products for serial production, has largely turned out to be unsuitable for existing disparate business entities [6]. Nevertheless, future managers and economists need to know in advance which organizations to apply their knowledge to, and the university must timely adjust educational programs.

Separately, employers raised the issue of transforming the product life cycle in the new economic conditions caused by the development of public-private partnerships and technology transfer. Recently (starting from 2004), the transfer of technol-

ogies created at the expense of the state to the military-industrial complex has increasingly provided a multiplier effect, influencing the general situation in the industry.

An important role in this is played by the format of public-private partnerships. The state in the person of the customer with the participation of private investors within the existing life cycles forms new "organizational and technical" structures that replace the usual forms. Table 2 summarizes such successful practices. Separately, the consultants noted the phase of the "decommissioning and disposal" phase of the life cycle. Given the enormous relevance of this issue for the Russian economy, universities do not train specialists who are properly versed in the intricacies of managing this activity.

TABLE II. SUCCESSFUL PRACTICES AND STAGES OF THE LIFE CYCLE

Life cycle stage	***Idea***	***Examples***
Exploitation	Conducting education, training, retraining and certification of personnel	Learning Centers Areva, Westinghouse, GE
Production	Production of special materials, parts, fasteners, etc. (over 70% in the interests of the industry)	OKB KP - cables for special purposes, Red Banner (for Almaz-Antey)
Development	Testing complex	SP Technical Research Institute of Sweden
Justification	Production of prototypes, breadboard models, samples ...	LLC LAR Technologies -
Study	Information and analytical support of various processes and projects of the industry	Analytical Center RC ITAR TASS

All groups participating in the survey consider it necessary to explain to students the scheme of work of enterprises during the entire period of study in relation to various disciplines of the curriculum. One of the best techniques can be considered a process approach, when the presented activity of each structural unit is accompanied by a certain set of incoming and outgoing information. This allows the student to understand in more detail its flows. At the same time, it is important to explain to students that education is somewhat universal because differences in the activities of enterprises that solve various problems within the life cycle are similar in many procedures and processes.

Forming the interaction between the university and the industrial enterprise, one must always remember the monetary component. Since recently the outflow of schoolchildren from universities to secondary schools and the difficulties of several universities with filling out programs have intensified, we agreed with the offer of employers to acquaint students with a career growth map. By adding to this information, the primary matrix of the distribution of responsibility, it is possible to form an understanding among students of their possible determination of their place in the structure of a virtual enterprise (Table 3).

A separate issue is the accessibility of communication between the student – a possible employee of the enterprise with a possible employer. Employers believe that a student who is in the process of his own career guidance should be familiar with the tactics of developing a training system in industry.

TABLE III. THE MATRIX OF THE DISTRIBUTION OF RESPONSIBILITY

Buisness process/ functional	***Name of works***	***Directorate***			
		Commercial	***Technical***	***Manufacturing***	***Procurement***
marketing	Customer Search	■			
Work with customer	Application development	■			
	TCH issuance	■			
	Conclusion of an agreement	■			
	Opening outfit	■			
	Prepaid expense	■			
Design	Project development		■		
	Development of a set of RKD		■		
Technical training	CCI development		■		
	TD development		■		
Procurement	Procurement of materials				■
Production	Production			■	
	Quality assurance			■	
	The signing of the act of delivery			■	
Supply	Shipment	■			
	payment	■			

As an illustration, table 4 presents a typical program of one of the enterprises, which may have a role in the correct positioning of the graduate in the labor market.

TABLE IV. IMPROVING STAFFING IN THE ENTERPRISE

Event	***The timing***
Analysis of management personnel, their distribution in the nodal areas of work	Constantly
Determination of strategic directions for the training and continuing education of specialists and skilled workers	Annually
Determining the need for specialists and workers in accordance with the required level of knowledge, skills, the necessary level of development of special abilities and business qualities	Quarterly
Organization of multi-level vocational education.	Quarterly
Monitoring and solving the problems of the most appropriate use of graduates of educational institutions	Constantly
Preparation of events for staff development, planning and effective implementation of a business career, continuous professional development of personnel	Once a half year
Formation of a reserve of managers, personnel appraisal, certification of specialists, improvement of the mechanism for the selection and placement of personnel	According to a separate schedule

IV. Conclusions

Innovatively developing enterprises are actively looking for young people to implement ambitious plans. The problems of interaction between the real sector of the economy (industrial enterprises) and universities involved in training in the areas of economics and management are more pronounced than with technical universities. Changing the technological structure, technology transfer and other events in the real economy market are changing the basic organizational forms of production structures. As part of these changes, new previously little-studied stages appear, for example, disposal, which opens up prospects. On the other hand, it is worth remembering that changes should not lead to the breakdown of production and technological chains. The schemes of work (and management) of various enterprises in the life cycle of enterprises coincide in many respects. The student who has mastered the basic skills, easily adapts to various characteristics of the activity. For this, his training must be structured in a certain way.

Our studies allowed us to formulate some suggestions:

1) it is necessary to form the trajectory of students' movement according to innovative strategies of enterprises and types of innovations from the first courses of study on bachelor's programs;

2) include the basics of standardization in the curriculum for training managers, economists and financiers for industry;

3) inform students about the principles of development and training of personnel by industrial enterprises to encourage students to possible direct contact with a potential employer, given their standard training procedures.

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Adaptation of Managers and Specialists in the Conditions of the Arctic Region

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***Abstract*—The article explores the training system for managers and specialists as an element of the infrastructure of the Arctic zone of the Russian Federation (AZRF) and the necessary precondition for its successful functioning. Special aspects of the work of specialists in the Arctic region are analyzed, related to severe climatic, environment, and production conditions, underdevelopment of communication, infrastructure and logistics and high socio-psychological and emotional load. The structure and content of the work of specialists and production managers' efforts are revealed as the basis of curricula and programs for their preparation, retraining and advanced training. The examples of modern methodological developments that allow improving the educational process are given. The article cites as an example the experience of specific educational institutions in which managers of the various levels were inculcated with the special professional management skills and at the same time they were provided with the knowledge of a specialist in a particular industry. There is a critics of management of the existing training system and advanced training of managers, expressed in the unfounded unificationtion of economic universities and the termination of economic specialties at universities, in the framework of which professional managers were trained. The liquidation of the unique management school of Saint Petersburg State University of Engineering and Economics and the closing of the economic specialization at Murmansk State Technical University have been pointed as an example.**

Keywords—Arctic region; specificity of personnel policy; outflow of personnel; production manager; manager, labor content; personnel training system

A specific feature of the Arctic labor market is the chronic outflow of population. For example, as of January 1, 2017, the population of the Murmansk Region was 757.6 thousand people, while the outflow in 2016 reached 4.5 thousand people, and 1000 people in 2017. The situation is the same in other regions: the population of Magadan Region decreased from 550 to 150 thousand people; Arkhangelsk Region – from 1,550 to 1,150 thousand people, Komi – from 1,250 to 850 thousand people, Yakutia – from 1,100 to 950 thousand people, Chukotka – from 150 to 50 thousand people, Kamchatka – from 500 to 300 thousand people. And such dynamics, according to the regional government, will continue in the near future [6]. This trend poses a challenge to the leadership of the Arctic regions to create the necessary conditions for the retention of managers and specialists, on the one hand, and targeted training at universities.

Currently, there are about thirty universities in the system of specialists and managers training for the needs of the Arctic, of which only five are located in the Arctic region. Despite the fact that the number of students is about 61 thousand people, their specialization and quality of education does not fully meet the requirements of modern production [10]. The largest universities in the north of the Arctic that provide actual training of specialists for the Arctic region are the following: The Northern Arctic Federal University named after M.V. Lomonosov (NArFU), Murmansk Arctic State University (MASU), Murmansk State Technical University (MSTU). At the same time, the existing regional system of training of managers and specialists does not provide the level of knowledge and skills that allow for effective management of enterprises and organizations. This has determined the increased attention to the problem of training, retraining and advanced training of managers and specialists. It should be taken into account that the directions, principles, forms and methods of education of such a specific contingent are fully determined by the existing paradigm of economic development in the country and in the Arctic region [2]. As modern tools to integrate the efforts of teachers of various universities, we can note the network technologies, which have already spread in a number of universities, as well as technological platforms that allow combining the efforts of scientific and educational organizations to develop modern teaching methods.

The lack of special professional management training often leads to mistakes in the development strategy of higher education in the region. A good example of such an unjustified decision is the prepared merger order between MSTU and MASU, which has given rise to a great deal of criticism and debate about its underdevelopment.

This order did not take into account the fact that such merger is hindered by a number of federal regulations, starting with the Regulation of the Ministry of Education and Science of the Russian Federation approved by the Government of the Russian Federation, where the list of functions of the department does not include the provision of uniforms, meals

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and sailing practice as it is for students of Rosrybolovstvo. If such a function is given to the Ministry of Education and Science of the Russian Federation, another regulation prohibiting duplication of functions of state agencies will be violated. The Civil Code should also be taken into account, which does not provide for the reorganization of a legal entity in the form of changes in the jurisdiction. In addition, the Federal Law "On Education" allows for a decision to reorganize or close down an educational organization only on the basis of a positive opinion of the commission on the evaluation of the consequences [1].

The decision to close the Faculty of Economics and Management at MSTU, which provided training for highly qualified specialists and managers in the Arctic region, should also be recognized as a mistake. The Council for awarding degrees of Candidate and Doctor of Economics, which was functioning at MSTU, performed an important role of training of scientific and pedagogical staff, which was needed by the Kola Scientific Center of RAS.

The abovementioned mistakes in the management of science and higher education in the region testify to the underestimation of the role of managers in the creation of an effective management system and insufficient consideration of the specifics of managerial work. There is a long discussion in the specialized literature on whether a manufacturing manager should be a specialist in the industry in which he or she operates or not. It is very common to think that a professional manager does not care what industry to work in, because the principles, methods and technologies of management are common to any object of management. Other specialists express confidence that the manager must have a deep knowledge of the specifics of the industry, having passed all the steps in the hierarchy of the management pyramid [7]. The optimal balance of managerial and special knowledge in the content of a manager's work was established empirically and in this regard it is important to analyze the historical experience of training managerial personnel, as our country has gone through a rather contradictory path in this area, not always benefiting from mistakes and failures.

An equally dangerous consequence caused by modern Russian managers who ignore the most important principle of management related to the rational delegation of managerial functions. Their efforts to solve all the issues at the highest level of management have led to the practice of "manual management", when even the first leaders of the state try to solve all the issues independently and personally, from strategically important for the state to operational issues that are the responsibility of the lower level managers [2]. A situation occurs when at the lower levels of government no one takes responsibility waiting for the command from above, and the upper level due to overload can not anticipate or respond to external threats in a timely manner [11].

In this regard, the figure of a future manager, well educated, intellectual and creative, with analytical thinking skills and ready for compromises, is also of interest. A number of sources provide a list of attributes that such a manager should possess [15, 16]. In June 2008, the research center of the SuperJob.ru portal conducted an expert survey among 100 directors of enterprises in order to find out the main qualities of a top manager. Respondents were asked an open-ended question: “Please name three main qualities of a real top manager” [14].

According to the survey, the main qualities of top managers were professionalism, competence and intelligence (22%, 18% and 16% of respondents accordingly). A real top manager, in their opinion, must be able to "clearly and precisely define the tasks and organize the work to solve them", "apply their knowledge in practice", as well as have an analytical mind and a broad-based knowledge. A commitment and strategic thinking were noted by 16% of respondents. The importance of such qualities as responsibility and vigour was pointed out by 15% of respondents. Ability to convince, i.e. presence of leadership qualities, is considered necessary for a top manager by 12% of respondents. In the opinion of 11% of respondents, productive work in the position of a top manager is impossible without the presence of such a quality as resistance to stress overload.

Thus, it can be concluded that there are a number of fundamental problems in the training of professional managers in the Arctic Zones of the Russian Federation (AZRF) associated with the existing system of formation of a managers' reserve, focused on strict following the specific principles of teamwork, which clearly contradict the classical principles of scientific management, accepted around the world. Similar problems are also faced by the system of training of managers and specialists for the AZRF, which also is faced with the specific conditions of the northern territories: the desire of young people to leave the region, ignoring the interests of employers, the lack of calculations of scientifically-based need for staff of specialists and managers, weaknesses in the scientific-methodological, material, information and staff support of the educational process in the universities of the Arctic region. Taking these weaknesses into account and eliminating them will make it possible to increase the efficiency of the system of staff training, retraining and professional development in the AZRF.

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Risk Management in the Formation of Personnel Providing Investment Development of the Region (on the Example of the Far Eastern Federal District)

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***Abstract*—The article substantiates the need for risk analysis and management when developing educational programs for the training of specialists in newly formed industries in the Far Eastern Federal District. The possibilities of educational institutions to meet the needs of newly formed industries are settled, for example, a mining and processing plant in the Jewish Autonomous Region, a metallurgical plant in the Amur Region and a network of gas and oil pipelines laid across the territory of a number of Far Eastern entities. The main provisions on risk management in the training of personnel for newly formed industries are determined, and how this will affect the investment development of the regions.**

Keywords—investment development of the region; risk management; human resources; investments; mining and metallurgical industry; labor migration

I. INTRODUCTION

On today, the development of the Far East is a national priority. The necessary conditions are actively being created in the Far East for launching new industries and attracting investors at the moment. New areas of economic development of the Far Eastern Federal District are such areas as the formation of mining and metallurgy, oil and gas processing complexes. Strategic documents for the development of the mining and metallurgical industry have been developed and are being implemented ("The Strategy for the Development of the Metallurgical Industry of Russia for the Period Until 2020", "The Strategy for the Socio-Economic Development of the Far East and the Baikal Region for the Period Until 2025") [16].

II. THE MAIN PART

The development strategy of the geological industry until 2030 involves the development of mineral resource centers of economic growth. The cluster project in the iron and steel industry of the "Petropavlovsk-Ferrous Metallurgy" group of companies covers three distinguished mineral resource centers – Stanovoy, Amuro-Bureysky and Khingansky.

The primary resource base of the mining and metallurgical cluster being created in the Amur Region is the Kuranakhskoye titanomagnetite deposit and the Garinskoye iron ore deposit in the Amur region, the Kimkansky and Sutarskoye iron ore deposits – in the Jewish Autonomous Region.

The basis of promising industrial production will be iron ore concentrate of the producers of the Jewish Autonomous Region (Kimkano-Sutarsky mining-and-processing integrated works, Resources of Small Khingan) and iron ore enterprises of the Amur Region. According to preliminary calculations, by 2020 the production volume of these enterprises will be 3.1 million tons of iron ore concentrate, and from 2020 the volume will be increased to 9.6 million tons.

The key risk in the emergence of new industries is the lack of labor resources in the Far Eastern Federal District. Management of this risk is possible by creating a multi-level staff training system.

The development of a new industry in the economy of the Jewish Autonomous Region and the Amur Region, namely, the mountainous region, creates a new demand for qualified personnel in the field of mining. The existing structure of training professional personnel in the region did not imply training in these areas, since this was not necessary. At the beginning of the establishment of new industries for the region, the problem of staff shortages was solved by attracting personnel within the framework of labor mobility, shift work methods and using the capabilities of the "resettlement of compatriots" program.

According to the management of the Kimkano-Sutarsky mining and processing plant, more than 300 workers are required, more than 1,500 employees are employed at the enterprise. Currently, the company carries out labor activities

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as employees employed on the principles of permanent employment, and on a rotational basis.

The management of the enterprise initiated, with the support of the Ministry of Economic Development of Russia and the Agency for the Development of Human Capital in the Far East, in the Amur State University named after Sholem Aleichem discovered a new specialty “mineral processing”.

At the same time, tuition for a new specialty is financed from the funds of the Petropavlovsk-Black Metallurgy group of companies, it is also planned to attract funds from the federal budget to train specialists in the field of mineral processing. At the same time, the company uses additional incentives for students to pay scholarships at their own expense.

At the university, students will study general subjects. They will receive a significant amount of knowledge and practical skills in highly specialized subjects directly in the training center of the plant and on the basis of its chemical and analytical laboratories.

"The Petropavlovsk" group of companies, in order to solve the shortage of personnel for the newly formed industry, is training personnel on the basis of the established mining college in Zeya, Amur Region.

Educational programs are being implemented aimed at training demanded specialties for work in enterprises. Also, in Pokrovsky Mining College (Amur Region), training is being conducted in 46 specialties in demand in metallurgy. In polytechnic school No. 6, Obluchye, training is being conducted in the following specialties: mineral processing and mineral mining equipment repairman.

The current situation in the field of professional training has received the win-win format, that is, the company receives qualified personnel, the local population is guaranteed employment, enterprises are being established in the region that carry out economic activities with investment resources.

At the same time, the Agency for the Development of Human Capital in the Far East is actively contributing to the solution of the problem of attracting personnel by regulating the target numbers for admission to budget-funded places in higher and secondary vocational schools.

Another priority area for the economic development of the Far Eastern region is the construction and operation of gas and oil pipelines oriented for export to the Asia-Pacific Region.

Therefore, there also arises the need for training specialists in this field. At the first stage, workers from other territories of Russia are attracted on the basis of shift working methods, but at the same time conditions are created for training Far Eastern youth in the vocational education system. So, the Institute of Oil and Gas was created on the basis of the Far Eastern Federal University. At the Institute of Oil and Gas, students are trained in three specialties, graduates work at the main oil and gas facilities in the Russian Far East: ESPO-1, ESPO-2, LLC "RN-Primorsky Oil Refinery", LLC "Gazprom invest Vostok" and many others [15].

That is, the existing need for training the required specialties is conducted and fully provided for this industry by local personnel.

When substantiating the development of new industries, there is a risk of providing them with specialists; for the Far East region with its negative migration balance, this is the most acute problem. During the period of economic reforms, the Far East ceased to be an attractive territory for young people and highly skilled specialists. And to initiate the process of “new” development of this territory, program documents were developed, and specific measures were developed to attract personnel to the newly formed industries.

The main problem in providing personnel for new industries was the inconsistency of the existing system of training specialists with the needs that were formed in the labor market.

To solve these goals, the vocational training system, including higher and secondary institutions, was tasked with opening new areas of training. In the process of training new specialists, the enterprises themselves expressed their interest, providing financial support to students through a targeted training system, career guidance, scholarships for students, and financial assistance to educational institutions in creating production and training complexes.

Thus, enterprises contributed to reducing the risks of insufficient qualified personnel for their own production. The coordinating body was the Agency for the Development of Human Capital in the Far East, whose main functions are to analyze the needs of the region’s labor market with the necessary personnel, and provide their training.

III. Conclusion

The creation of new industries in the Far East, which began as a result of the application of new development mechanisms, put the issue of attracting and retaining the necessary labor resources in the macroregion, which requires changing existing approaches to creating social infrastructure and a comfortable environment for people's live. New points of economic growth in the Far East will not have the expected multiplier effect for the development of the macroregion, if their environment does not simultaneously provide for the comprehensive development of the territory - the construction of housing, kindergartens, schools, medical institutions, cultural centers, etc. [8].

Consequently, the creation of new industries will create conditions for attracting investment in the prospective development of this strategically important region for Russia.

Also, the Strategy for socio-economic development of the Far East and the Baikal region spells out the achievement of such a goal as the formation of the population and labor resources in the volumes necessary to solve the economic problems facing the region, improving the quality of human capital. And just the creation of new jobs in the open industries will achieve this goal.

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Implementation of the “Frugal Innovation” Concept in Training of Masters in Innovations

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***Abstract*— The article presents the main competencies formed during the study within the frames of the master's program in the field of "Innovations" in the conditions of the "Frugal Innovations" concept. Smart cost technologies are integrated into the disciplines of the master's program for trends in breakthrough growth strategies, in order to active iterative interaction, the wise use of production capacities and resources, to improve the development of environmentally friendly and resource-saving solutions, and to implement the cultivation of a cycle economy. The article lists the acquired competencies and annotations of disciplines on the trends of “frugal Innovations”**

Key words— frugal innovations; cyber physical system; digital transformations; commercialization of innovation results

I. INTRODUCTION

The dynamics of terms in the field of innovation are rapid. Until recently, the classification field of innovations contained 3-4 gradations: process, marketing, product, organizational. Now this classification field has at least 10 grades, including revolutionary innovations, pseudo-innovations, breakthrough innovations, technological innovations, improving innovations, open innovations, etc. Another gradation appeared – “frugal Innovation”. This innovation is associated with the usage of “smart costs” technologies simultaneously for all enterprise resources – financial, industrial, material, human, informational, etc. Frugal innovations are introduced both in a high-tech enterprise and in entrepreneurship. Frugal Manufacturing is no longer enough. It requires process management of the “factory of processes” based on the technologies of “Frugal Production”.

II. TRAINING IN THE FIELD OF TECHNOLOGICAL INNOVATIONS MANAGEMENT

Master programs in the direction "Innovation" in most cases are devoted to the study of current trends in technologies of business systems management. For example, the master's program in Innovation in St. Petersburg State Technical University of Peter the Great is being developed for masters of the Higher School of Cyber physical Systems and is called “Application of CALS-technologies in the management of innovations”, the master's programs in St. Petersburg State University-ITMO in the field of “Innovation” are devoted to the introduction of innovative technologies in marketing, innovative entrepreneurship, scientific communications, art and science, transport etc. The master's program in the direction "Innovation" is called "Management of Technological Innovation" and is dedicated to providing a multi-stage training system in the field of creating new products and managing innovative processes for high-tech industries. A high-tech knowledge-based enterprise is seen as a digital enterprise. The digital enterprise uses new digital infocommunication cognitive technologies at all levels of management to increase the efficiency of its activities. A digital enterprise is seen as a complex dynamic system, a cyberphysical system [1, 2, 3].

In the processes of digital transformations of i high-tech industries, technological innovations occupy a special place, since this type of innovation is associated with the development of new or improved technological processes. Due to the fact that the necessary and sufficient stage of digitalization at the initial stage is the informatization of the management processes of all enterprise resources at the same time the special role of technological innovations in the digitalization process occurs. Thus, the technology of transformation of measuring information about the cyber physical system – it’s technical and socio-economic subsystems – is initially changing.

The idea of the program is to prepare graduates for professional design and scientific activities in the field of development, implementation and maintenance of innovative projects for high-tech science-intensive enterprises in the context of digital transformations.

The relevance of the program consists in the training of specialists in the field of innovative design and technological entrepreneurship, as well as in creation of a personnel training system with engineering and managerial education on the orders of industrial enterprises, scientific and educational organizations and public administration institutions.

The readiness of graduates for the technological innovations life cycle project management will ensure the continuous management of innovation and the direct participation of graduates in the creation and promotion of high technology products in the context of technological modernization.

Students study modern and promising methods for managing innovative projects, methods and models for assessing the readiness, maturity of information and communication infrastructures of high-tech enterprises for digital transformations, technology for organizing start-ups in the context of open innovation, technology transfer technology and commercializing the results of innovative activities. A study of the technologies

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of "Frugal Production", "Process Factory" is being implemented.

Students are getting knowledge in the field of choosing the necessary composition of the digital enterprises infrastructure, business systems, ecosystems, corporate information system architectures, digital communication technologies, Internet of things, multi-agent systems management technologies, enterprise resource engineering and reengineering technologies, business analytics technologies, and methods examination of innovative projects, methods of conducting a technological audit.

The methods and models for assessing the competitiveness of innovative products, methods for calculating the cost and formation of the product market price, methods for assessing the expected profitability of new products are studied as masters' instruments for setting and managing the commercialization of the innovative activities results in the context of "frugle innovation" taking into account organizational and commercial risks, methods of financial and economic modeling of business processes [4, 5].

The department implements a research project "Research and analysis of cognitive technologies for assessing the innovative complexity of a digital enterprise."

Graduates of the program successfully work in the field of project management, development and implementation of IT services, corporate information systems, in IT consulting, digitalization of technological processes, optimization of business processes, business planning, production planning at the following enterprises: LLC Regul +, PJSC Signal, Committee for Energy and Engineering of the Government of St. Petersburg, St. Petersburg State Unitary Enterprise "St. Petersburg Analytical Center", PJSC "Techpribor", OJSC RNII " Electronstandart, Elektropult OJSC, Avangard OJSC, Almaz LLC, Techsnab LLC, RESTEC EXHIBITION ASSOCIATION, GAZPROM PJSC, MMS RADAR LLC, as well as for small and medium enterprises with the introduction of innovative technologies.

III. THE MAIN FEATHURES OF IMPLEMENTING THE CONCEPT OF "FRUGAL INNOVATIONS" IN THE MASTER DISSERTATION

To illustrate the features of introducing the concept of "Frugal Innovation" in the Master's program "Management of Technological Innovatios", we will present the competencies formed as a result and focus on competencies that contain knowledge, skills related to the "Frugal Innovation" concept. It is planned to attract undergraduates for studying the following topics:

1. Development of information and communication infrastructures of innovative entrepreneurship in various areas of business
2. Development of the domain-specific IP life cycle innovative projects
3. Examination of innovative projects
4. Methods and models for assessing the economic efficiency of innovative projects
5. Information systems and technologies for automation of innovation management of a high-tech enterprise
6. Formation of a high-tech enterprise development strategy
7. Risk assessment of scientific and technical products in the commercialization of research results
8. Managing technological innovation in service-oriented IP
9. Innovative entrepreneurship in the field of electronic business
10. Process management of cyber physical systems based on the technologies of the Internet of things, Internet of people, Internet services for a digital enterprise.

The final qualification work (dissertation) of undergraduates in the Innovation area should be a finished research work devoted to the problems of improving the mechanisms for creating, promoting, introducing and using innovative products, technologies and services in various fields of human activity. The work should contain an analysis of the problems of implementing business processes in the selected subject area, an assessment of possible solutions to them using the results of innovation, an analysis of the methods and tools used in choosing options for solving problems. The subject of research can be: the effectiveness of the implementation of innovative solutions in various, including new (non-traditional) areas of activity; assessment of the competitiveness of innovative products and services in relevant markets; profitability assessment for the developer of the costs of creating, manufacturing and launching new products on the market; selection of appropriate ways to implement innovations within the framework of the concept of "lean innovation", etc. An important emphasis should be on the consideration of economic, market aspects of innovation.

IV. THE MAIN TRENDS OF USING THE CONCEPT OF "FRUGAL INNOVATIONSES" IN THE EDUCATIONAL PROGRAM OF THE WESTERN UNIVERSITIES

Traditional innovation processes are characterized by high cost and are focused on the consumer segment, characterized by a high level of income. Products and services that are the result of these innovation processes rarely meet the needs of low-income customers, especially in B2B and B2C markets of developing countries around the world. Using the concept of "Frugal Innovation" will create and develop new markets for innovative products, which will lead to an increase of the population living standards and the socio-economic development of developing countries and, in particular, the Russian Federation.

The concept of "frugal innovation" has gained immense popularity in the countries of Western Europe and the USA in the last few years. Thus, in 2018, a joint educational program was opened by the Engineering School of the University of Santa Clara (USA) and the Department of Science and Technology Management of the Hamburg University of Technology (Germany), offering the study of disciplines in the following areas: determining customer needs based on project approaches, generation and testing of concepts, architecture of innova-

tive products and product planning for “frugal innovations”, motivational, strategic, and organizational aspects of “frugal innovations.” In addition, the Center for Lean Innovations was established on the basis of this master's program, carrying out research and implementation activities "Frugal Innovation through the provision of consulting services to enterprises in the high-tech sector of the economy. The Leiden University of Technology and the Roterdam University of Technology in September 2018 opened an educational The Lean Innovation program for sustainable global development, including theoretically oriented courses that explore the basic concepts of Frugal Innovation, methods for promoting innovative and inclusive technologies adapted to local conditions, and internships in developing countries (Uganda, India or South Africa). During the internship, students develop solutions related to Frugal Innovation. The program is aimed at students with any basic education, interested in working in an interdisciplinary environment. It is emphasized that the program is especially useful for students with a technical education, since it allows to acquire skills in the field of ensuring the applicability of technology in real-world conditions, taking into account political, economic and social factors.

The introduction of the “Frugal innovation” concept in the educational program allows not only to provide students with training in accordance with international trends, but also to train personnel for high-tech industries, taking into account the requirements of innovative product markets of developing countries.

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Approaches to the Assessment and Development of Digital Competence of Personnel of Innovative Industrial Enterprises

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***Abstract*—according to the recommendations of the European Parliament, computer literacy is recognized as one of the 8 key competencies of the 21st century. The article discusses the evolution of the concept of digital competence, its key components, characteristics, levels, types, approaches to assessment. The mutual influence of the development of digital competence of personnel and the evolution of the personnel function of the organization, as well as their influence on the criteria for the effectiveness of digital transformations of an innovative industrial enterprise, is analyzed. Approaches to improving methods for evaluating and developing digital competency are proposed.**

Keywords— digital competence of personnel; criteria for the effectiveness of digital transformations; innovative industrial enterprises; assessment methods; evolution of personnel functions

I. THE CONCEPT OF DIGITAL COMPETENCE

According to the recommendations of the European Parliament, in addition to communication skills on native and foreign languages, mathematical literacy and basic competencies in science and technology, learning skills, social and civic competencies, innovativeness and entrepreneurship, awareness and the ability to express oneself in the cultural sphere, computer literacy is recognized as one of the 8 key competencies of the 21st century. [1]

In the era of Industry 4.0, employees of innovative industrial enterprises have to take on new responsibilities, play new roles, strengthening existing and creating new knowledge and skills. The concept of digital competence of personnel has appeared, which includes the skills of ethical, responsible and safe interaction with innovative technologies and the information itself.

For the first time in 1997, Paul Gilster, an American writer and journalist, introduced the concept of digital competency. "Digital competency is the ability to understand and use information provided in a wide variety of formats and a wide range of sources using computers". [2]

According to [1], digital competency involves the confident and critical use of information for work, leisure and communication, based on the basic skills in the field of information and communication technologies: using computers for searching, evaluating, storing, producing, presenting and exchanging information, as well as communicating and participating in collaborative communities over the Internet. [1]

A. Ferrari (2012) proposed the following definition: "Digital competency is the set of knowledge, skills, relationships, abilities, strategies and awareness that are required for using information and communication technologies and digital media to perform tasks, solve problems, communicate, information management, cooperation, the creation and exchange of content, the accumulation of knowledge effectively, efficiently, appropriately, critically, creatively". [3]

In Russia, one of the significant developments in digital competence was the book with the results of a study by G.Soldatova "Digital Competency of Adolescents and Parents", 2013. She considers digital competence as the individual's ability, based on continuous mastery of knowledge, skills, motivation, responsibility, to effectively, critically and safely choose and apply information and communication technologies in different areas of life (working with content, communication, the technosphere, consumption), as well as its readiness for such activities; it is not only the sum of knowledge and skills, but also the attitude towards effective activity and personal attitude to it, based on a sense of responsibility. [4]

The Regional Public Center for Internet Technologies (ROCIT) annually evaluates the digital literacy index of the population of the Russian Federation. In the framework of this project, digital literacy is understood as a set of knowledge and skills that are necessary for the safe and efficient use of digital technologies and Internet resources. Digital literacy includes three elements – digital consumption, digital competencies and digital security, each of which also consists of a number of elements. Digital consumption means the ability to use Internet services for work and life, digital competencies are skills for the efficient use of technologies, and digital security is the basis of Internet security. [5]

II. SEVEN CHARACHTERISTICS OF DIGITAL COMPETENCE ARE STANDING OUT [3]:

1. Information management: the ability to identify, find, access, receive, store and organize information;

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2. Cooperation: participation in online communities, social networks, constructive interaction;
3. Communication and exchange of information through online tools, maintaining account confidentiality, security and network etiquette;
4. Content and knowledge creation: integration and processing of existing knowledge, creation of new knowledge;
5. Ethics and responsibility, knowledge and compliance with the legal framework;
6. Assessment and solution of problems: determination of digital needs, solution of problems using digital tools, assessment of the result;
7. Technical operations: using technology and media, performing tasks using digital tools [3]

The components of modern digital competence can be characterized as the following [3]:

1. Computer literacy is defined as "an understanding of the characteristics of a computer, capabilities and applications, as well as the ability to realize this knowledge." Simonson, Maurer, Montag-Torardi & Whitaker (1987)
2. Internet literacy refers to the skillful use of the Internet.
3. Media literacy – the ability to analyze and critically evaluate media messages and a media environment consisting of television, radio, newspapers, films and the Internet, as well as create media products.
4. Information literacy is defined as the ability to extract information, access it, understand it and use it.
5. Visual or imaginative literacy, or the ability to view, understand and use a large number of materials involving videos, icons and other imaginative means. (Eshet-Alkalai, 2004).
6. Operational skills – knowledge required when using digital tools [3]

Additional skills could be added:

7. The skill of relationships and communications in the digital community.
8. The level of responsibility when conducting activities in the digital space;
9. Motives and motivating intentions of digital activity and digital communications;
10. The speed and flexibility of making and mastering new digital solutions.

Following classification features to determine the types of digital competency could be consided:

1. By type of activity in the digital sphere (areas of life, benefits): professional activities, family tasks, leisure, personal development, creativity, communications, shopping, working with information, participation in public life, technical tasks;
2. By profession: digital competence of a programmer, accountant, teacher, etc.;
3. For the purposes of working with information: consumption of information to solve problems, creating new information.
4. By level of proficiency: basic, advanced, expert levels;
5. By age: digital competence of a teenager, senior citizen or middle-aged person;
6. According to the level of interaction with society: individual, characterizing the individual, and public digital competency, characterizing the society or organization;
7. By the nature of motivating intentions: destructive, neutral, positive digital competence;
8. Internal, aimed at solving personal problems and external, aimed at solving social problems, digital competence could be distinguished;

These features may intersect with the others, forming a kind of network segmentation of digital competence.

When considering digital competence in the context of an industrial enterprise during the period of digital transformation, according to [7], the skills necessary for innovative transformations are following: digital security, mobile technologies, business change management, Big Data analytics, cloud computing, Internet of things, business networks, integration product / service, databases and memory, entrepreneurship, social media, artificial intelligence, new interfaces, blockchain.

According to the professional standard [8], the generalized functions of the human resources management system are the following: documentation support for work with personnel, activities to of personnel, staffing activities, personnel development activities, organization and remuneration of staff, operational personnel management of the company's unit, strategic personnel management of the organization.

By integrating the skills necessary for digital transformation with the functions with the tasks of HR department, the components of the digital competence of employees of an enterprise in the period of innovative changes could be classify and considered both in relation to employees of the HR service and other employees of the enterprise as a whole, as follows:

1. Staffing – skills of employee recruitment software;
2. Employee development – skills of training and career path software;
3. Skills of accounting software for mobile workers and remote work;
4. Remuneration of labor – understanding of the principles of work of payroll and payroll software;
5. Performance appraisal – skills of performance appraisal software;

6. Skills of social communications within the organization: ownership of applications and software of internal corporate media.
7. Skills of professional software for one's workplace;
8. Skills of creating documents, presentations, spreadsheets, the use of other features of infographics;
9. Digital flexibility: the speed of adoption and development of new digital solutions;
10. Skills of big data analytics;
11. Skills in digital and cyber physical security;
12. Skills of strategic management software (for executives).

It is obvious that during the period of digital transformations, the level of digital competence of both HR employees and employees of the enterprise as a whole is a determining criterion, or metric, for assessing the level of evolution of personnel processes in an industrial enterprise. And since the "human resource" is the most significant resource of the enterprise during the transformation period, the level of development of personnel processes can be a leading indicator for assessing the effectiveness of digital transformations of an innovative industrial enterprise, and the digital competence of personnel makes a significant, if not decisive, contribution to this assessment.

To assess the level of digital competence of personnel, at the moment it is customary at enterprises to use the method of information questioning of employees regarding their ownership of software, applications, etc., by levels "I know, apply, create" using a point scale. [9]

It is proposed that the following principles could be introduced into the digital competency assessment process:

1. To proceed when compiling individual profiles from the integrated profile of the digital competence of the enterprise;
2. To identify the positions and digital competencies that are key to transformation;
3. To base while preparing the digital competency profile on the core competency profile of the position;
4. To consider the results as integrated with other HR metrics of digital transformation: involvement, level of responsibility for security, etc.
5. To carry out an assessment of digital competency on an ongoing basis.

III. DIGITAL COMPETENCE ASSESSMENT ALGORITHM:

1. Identification of key elements of digital competence critical for digital transformation;
2. Compilation of an ideal integrated profile of digital competence of the entire enterprise;
3. Determining the level of digital competence of the enterprise, corresponding to the states of "readiness", "not ready", "conditional readiness" of the enterprise for digital transformations;
4. Identification of critical for digital transformation job positions of innovative industrial enterprises;
5. Compilation of ideal digital competency profiles of key positions based on their core competency profile;
6. Compilation of a questionnaire to assess the digital competency of key positions;
7. Conducting a test survey on the focus group;
8. Making adjustments to the questionnaire, if necessary;
9. Survey, comparison with the reference profiles of key positions, and the ideal profile of the digital competence of the entire enterprise;
10. Integration of the assessment of the level of digital competence with the assessment of other HR metrics of the enterprise during the period of transformation;
11. Assessment of enterprise' readiness degree for digital transformation, based on the assessment;
12. Identification of steps to adjust and increase the level of digital competence, if necessary, or to begin the implementation of digital transformation;
13. Implementation of the intended steps;
14. Periodic monitoring of digital competency level;
15. Evaluation of digital transformation effectiveness.

The listed principles and algorithms undoubtedly as well determines the personnel competency model of a modern industrial enterprise.

In addition, as part of this work, a new approach is proposed to assess the effectiveness of the digital transformation of an innovative enterprise, as a set of BSC positions, taking into account the main directions of the National Index of Digital Economy Development [10]. For a comprehensive assessment of the effectiveness of the digital transformation of an innovative enterprise, it is proposed to use the model developed by the authors (1):

$$KPI_{int} = \sum_{i=1}^{l} w_i \sum_{k=1}^{n} w_k KPI_k (1 - p_k)$$
$$\begin{cases} \sum_{k=1}^{n} w_k = 1 \\ \sum_{k=1}^{n} p_k = 1 \\ \sum_{i=1}^{l} w_i = 1 \end{cases} \quad (1),$$

where w_k is the weight of the corresponding highlighted key performance indicator for the i-th position, w_i is the weight of the integrated key performance indicator for the i-th position, p_k is the average total risk for the corresponding highlighted key performance indicator of the i-th position, n is the number of identified key performance indicators for the i-th position, l is the number of positions. [11, 12]

To rank the weight of the corresponding selected key performance indicator by the i-th position (w_k) and the weight of the integrated KPI_i (w_i), a hierarchical model was developed using the T. Saati scale of relative importance according to the Fechner psychophysical law of indirect estimation. The developed hierarchical model, depending on the ranking of the interests of participants in innovative activities, the maturity level of the business processes of the innovative industrial enterprise, allows us to calculate the value of the weights (w_k, w_i) of key performance indicators for the i-th position of the BSC (KPI_k) and integrated key performance indicators for (KPI_i) by i-th position of the BSC, respectively.

Thus, the article discusses the concept of digital competence, its levels, characteristics, types. New components of digital competence and criteria for its classification are proposed. The key role of digital competence in the effectiveness of digital transformations, the principles and algorithm for assessing digital competence, as well as an approach to assessing the performance indicators of digital transformations of an innovative industrial enterprise are shown.

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Problem Solving as a Mandatory Requirement for «Quality Management» Specialist

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***Abstract*—Problem solving as a part of Quality Management System (QMS) requires special attention for effective QMS operating. Proposed competitive company formula demonstrates important role of skilled company staff. Overview of «Quality Management» specialist requirements and functional responsibilities verifies required problem solving skills. Short summary of the main problem solving methods.**

Keywords—problem solving; quality management; quality management system; improvement; specialist; skills; knowledge; methods; PDCA; 8D; DMAIC

I. INTRODUCTION

In recent years, major changes in company process management have been identified that is related with requirement to increase Russian products and service competitiveness.

Any company activity should be based on system and process management principles and basics, namely on quality management system as fundamental philosophy of company senior management as well as company operations in general, paying special attention to problem solving that requires timely changes in demanded skills and knowledge for qualified staff to sustain their competitiveness in labor market.

Manufactured products and provided services require robust problem solving, which is considered as fundamental background not only for company development but also for industrial and economic complex.

II. QUALITY MANAGEMNT SYSTEM REQUIREMENTS

Following is the list of ISO9000-2015 Quality Management System key principles:

- Customer focus;
- Leadership;
- People involvement;
- Process approach;
- Continual improvement;
- Factual approach to decision making;
- Mutually beneficial supplier relationships.

Mentioned above principles are based on continual improvement philosophy with important problem solving role in place. ISO9000-2015 terminology does not contain problem solving term, hence we introduce our interpretation:

Problem (Greek word "problema" – barrier, difficulty, task) – any deviation from expectation/requirement or any unwanted effect with unknown cause.

Consequently, applying to problem solving term we imply root cause searching and analysis, corrective and preventive actions implementation against identified and verified root cause (please refer to ISO9000-2015 for additional terms clarification, e.g. requirement, deviation and etc.)

There is one more item that should be emphasized related to ISO9000-2015 requirements – process approach deployment that include Do-Check-Act (PDCA), also known as Deming cycle. The core idea of this approach is based on continual improvement principles including problem solving algorithm that will be described below.

Thereby we may conclude that problem solving is integrated into key Quality Management System principles and require company special attention for effective QMS operating.

Considering company operations as a process that is a function of critical X factors we may refer to the following formula of competitive organization:

$$\mathbf{Y = f(X)}$$

where:

Y – competitive organization

X – critical factors that impact company competitiveness

Completing formula with major critical factors that impact company competitiveness we obtain the following formula:

Y (competitive organization) =

f (X_1/Mission and values, X_2/Strategy, X_3/Structure, X_4/Fixed capital, X_5/Product or service, X_6/***Qualified staff***, X_7/Business processes, X_8/QMS, … X_n)

By means of cascading we focus on qualified staff that is required for effective operations:

Y (Qualified staff) = f (X_1/Management staff, X_2/Purchasing staff, X_3/Sales staff, X_4/Production staff,

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X_5/***Quality management staff***, X_6/Logistics staff, X_7/R&D staff … X_n).

There is no doubt that fundamental background of competitive company is based on qualified personnel, in particular staff engaged in quality management, that require mutually beneficial education and development by Universities as well as organizations.

Moving forward we shall focus on the major functional responsibilities and requirements, required knowledge and skills for «Quality Management» specialists.

III. «Quality management» Specialist Functional responsibilities and requirements

In 2014 Ministry of Labour affirmed professional standard «Product quality management specialist» (Decree N 856n dated by 31.10.2014), that describes professional activities in product quality management, highlighting the main goal of this kind of activity:

«Development, analysis, implementation and assistance in Quality Management Systems, related to organizations of all types of business and any forms of ownership, covering all organization processes, engaged into quality continual improvement and aimed to increase company competitiveness». There are highlighted 20 types of economic activities in this standard that also include Electrotechnical scope.

Major functional responsibilities and requirements related to problem solving are identified below:

1 General labour function: quality management activities in product manufacturing and service providing

1.1 **Labour function**: analysis of root causes effecting product (service) quality deterioration, development of action plans aimed to eliminate identified root causes:

1.1.1 Analysis of defects effecting attribute and quantitative indicators deterioration related to product (service) serial life

1.1.2 Root cause analysis of defects effecting attribute and quantitative indicators deterioration related to product (service) serial life

1.1.3 Corrective actions development to eliminate defects effecting attribute and quantitative indicators deterioration related to product (service) serial life

1.1.4 Analysis of implemented corrective actions related to defects that effected attribute and quantitative indicators deterioration related to product (service) serial life

1.1.5 Reporting to Management based on analysis results of implemented corrective actions aimed to eliminate defects that effected attribute and quantitative indicators deterioration related to product (service) serial life

1.2 Required skills

1.2.1 Skills: to apply actual regulatory documentation in product (service) quality management.

1.2.2 Skills: to apply methods of product (service) qualimetric analysis

1.3 Required knowledge

1.3.1 Knowledge: principle methods of product (service) qualimetric analysis in product manufacturing and service providing

1.3.2 Knowledge: quality management principle in product manufacturing and service providing

1.4 Other requirements: activities aimed to solve analytical tasks applying wide range of actual solving methods

Mentioned above examples are linked just to one general labour function that demonstrates skills and knowledge requirements in problem solving for «Quality Management». Specialists. It is necessary to emphasize that problem solving skills and knowledge are required for all general labour functions within discussed profession.

IV. Main problem solving methods overview

4.1 Deming PDCA Cycle

First of all, we should highlight the common feature for the most known problem solving methods which is related to Deming PDCA Cycle, hence starting with its description.

Referring to Management literature PDCA cycle, also known as management cycle, is considered as continuously improving process that may be applied in any field of activity. The cycle consists of 4 steps or phases:

- **P – Plan:** problem identification (deviation from planned or desirable level); root cause analysis; potential problem solving steps; action plan to solve the problem.
- **D** – Do: planned actions implementation.
- **C** – Check: Control and monitoring of implemented actions effectiveness.
- **A** – Act: In case of identified deviations vs expected result there should be new PDCA cycle introduced.

Hereinafter we introduce problem solving methods classification based on root cause type:

1. **Special causes** related to unexpected changes that introduced negative effect. These type of problems are solved by means of 8D method (description will follow below).

2. **Common causes** are used to be in place for some period of time, not related to unexpected changes, but at some moment it was decided to eliminate them. Such kind of problems are solved by DMAIC method (description will follow below).

4.2 8D Problem solving method

This method is aimed to identify, correct and prevent from reoccurrence of identified and similar problems enabling to improve product or service.

8D Problem solving methodology (8 Disciplines or steps) is a structured method that consists of 9 steps referring to numbered D steps (D0-D8), which are related to 9 Disciplines in total.

8D Structure:

D0: Preparation. Problem solving initiation to proceed to 8D. Planning and implementation of Emergency respond actions to protect the Customer against the symptom.

D1: Team identification. Team members identification.

D2: Problem description.

D3: Interim containment actions planning and implementation against problem symptom. Verification of implemented actions.

D4: Root cause and Escape point identification. Identification of one or several Root causes and Escape points that explain the problem the best way. Root cause(s) verification.

D5: Permanent corrective actions. One or several actions selection against identified and verified Root causes and Escape points. Verification of planned actions.

D6: Permanent corrective actions. Implementation of chosen actions and their validation.

D7: Preventive actions. Identification, selection and implementation of preventive actions.

D8: Team and Individual Recognition. Final step.

In recent years, 8D process has widely spread out of automotive industry. Its application range is not limited by problem solving only but also extended to Lean and Continuous improvement actions enabling its application for any processes.

4.3 DMAIC Problem solving method

This method is usually applied to existing process management and improvement, also known as 6Sigma philosophy. Special attention is paid to defect rate and process variability reduction using DMAIC method that consists of 5 steps or phases with first letter of each step in its name:

***D**efine* – this step implies Client and requirements identification, also product and process selection that requires improvement including metric for improvement.

***M**easure* – within this step data about current status is collected, required or expected level is targeted, input and output variables are identified, measurement system should be validated.

***A**nalyze* – during this step the Team use data to identify key process input characteristics that impact on process outcome or result (filtering vital few characteristics from many trivial): most critical X factors identification, correlation analysis of Xs and investigated problem Y): Y (investigated problem) = f (X/critical Xs) where result Y is a function of Xs.

***I**mprove* – Improvement Action Plan is identified and implemented within this phase (Xs optimization in order to reduce defect rate or process variability). This step consists of critical Xs changes implementation identified in Analyze, enabling investigated problem (Y) be improved. Results verification and validation are also done during this phase.

***C**ontrol* – improved process documentation and monitoring, also confirmation of results sustainability.

Each problem solving method includes its specific tools that help to enhance problem solving process in an effective and efficient way.

Also it is reasonable to mention that each method requires its own format for completion that may be adopted by each company based on its needs and specifics.

Application of problem solving methods in Russia is on initial level reflecting Russian market specifics. This need is particularly urgent in electrotechnical companies that produce labor-intensive and sensitive products and services, validating special knowledge and skills requirement for specialists of this industry. Problem solving is considered as particular relevant discipline enabling to bridge professional market labor needs and highly skilled human resources education provided by Universities on Regional and Federal levels.

V. Conclusion

In order to summarize the following conclusions should be outlined:

1. Problem solving is actual and needed by most organizations with no reference to company field of activity.
2. Continuous improvement should be based on robust problem solving.
3. Company competitiveness significantly depends on qualified personnel.
4. «Quality Management» qualified staff should have knowledge and skills in problem solving.
5. Universities should be focused on required skills in order to meet market demand in qualified staff, in particular, knowledge and skills of problem solving methods and its specific tools.

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Application of the Quality Management Methods and Tools in the Operation of Electrical Equipment

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***Abstract*—The basic quality management methods and tools widely accepted in various types of international organizations are considered. These methods can be successfully used in today's environment in domestic organizations during the electrical equipment operation and the other product life cycle stages. Recommendations on the use of various management and engineering quality tools are presented.**

Keywords—quality management; quality management methods and tools; quality management and engineering methods

I. INTRODUCTION

The import substitution industrialization processes implemented by the Government of the Russian Federation provide the domestic electrical enterprises opportunity for rapid development. In this context, quality management tools should be actively used in Russian electrical industry enterprises to achieve strategic goals and increase their competitiveness.

Quality management is being increasingly implemented not only at domestic production plants but also in the other organizations of various fields. In Russia, the concept of quality traditionally comes down to product quality as one of its important components. However, understanding the quality in relation to the organization processes (quality management, production quality, etc.) is much more complicated and wider. Ideas for developing quality management solutions that require improving the production plants activities, processes, product quality and quality systems were actively developed by E. Deming, J. Juran, A. Feigenbaum, F. Crosby, K Ishikawa, G. Taguchi and other well-known specialists. Sustainable organization development is impossible without continuous improvement of management, processes, resources optimization, as well as without constant organization's personnel training quality management methods and tools. Russian enterprises lag behind their foreign competitors in implementing advanced quality management tools and methods, although this issue in our country has its own history, huge potential and has been developing since the beginning of the twentieth century.

II. MAIN PART

The current development of quality management means and methods in international practice demonstrates many concepts, methodologies and tools. There are various approaches in the literature to their classification. In any case, in this amount, as in any systematics, one can single out a specific upper level of quality management tools and methods, which includes so-called concepts (methodologies, philosophies, theories) and models, among which, as the most famous examples, we can list following [1]:

- The philosophy of "Total Quality Management" (TQM);
- Toyota Production System – TPS;
- The concept of "Lean Production" (LP);
- "Theory of Constraint" by Goldratt (TOC);
- KAIZEN concept;
- The concept of Six Sigma (SS);
- Problem Solving Methodology (Global 8D);
- Balanced Scorecard (BSC);
- Benchmarking;
- Business Process Reengineering (BPR);
- Models of quality systems based on international standards, including industry standards.

It's hard to argue with the number of expert's opinion [2, 3] that the trend on reengineering has now passed. Today, it has evolved from destructive power into one of the ways to organization restructuration.

Organizations successfully using various methods of quality engineering (engineering methods to improve quality) [4]:

- Statistical quality control, (SQC), including SPC – Statistical process control (GOST R 50779.40 and others); Selective statistical control (GOST R 50779.30 and others);
- Process capability;
- Risk management;
- Hazard analysis and risk assessment;
- Failure Mode and Effect Analysis – (FMEA);
- Methods of Geniti Taguchi;

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- Quality Function Deployment – (QFD);
- Failure Trees Analysis (FTA);
- IDEF, ARIS and other methods of process modelling;
- Q7. Seven “simple” quality tools (Ishikawa diagram, checklist, stratification, histogram, Pareto diagram, scatter (dispersion) diagram, control charts);
- N7. Seven “new” quality tools (program implementation process diagram, affinity diagram, tree diagram, matrix diagram, matrix data analysis, relationship diagram, arrow diagram);
- Brainstorming;
- SWOT analysis and many other tools.

In our opinion, the most suitable tools for electrical equipment operations are Q7, N7 and SQC.

An important factor for the effective application of management and quality engineering methods is the correct tools selection depending on the product life cycle stage.

With the increasing knowledge-intensive production and the transition to the creation of the project-oriented product, the products cannot be usually delivered without providing related services. It is not only about warranty service, but also about the other product operation stages where being serviced and repaired, and which is of the greatest importance among the life cycle the stages, both in terms of duration and cost.

Therefore, a high personnel competence in matters of selection, development and using of management and quality engineering methods is required. In accordance with this, managers and quality specialists should be well versed in the above methods of management and quality engineering. Each manager (and the quality manager too) must understand (must be competent) in basic statistical methods:

- Process algorithms (flowcharts);
- Ishikawa diagrams;
- Checklists;
- Histograms;
- Pareto diagrams;
- Dispersion diagrams;
- Control cards;
- Factorial experiment design, etc.

He should also be able to describe, maintain and improve the quality management system, diagnose it and decide:

- what variations are recognized as special and require actions from the higher level of management;
- what variations are recognized as common and require action from the senior management level,
- as well as lead teams with different educational levels, etc.

At the same time, it had to be recognized that there are problems in the domestic electrical industry with enterprise management associated with an ineffective organizational structure. Insufficient attention is paid to statistical quality management (SQC), statistical process control (SPC), experiment planning (DOE, design of experiment) and quality function structuring (QFD).

III. Conclusion

As already noted, the considered quality management and engineering methods can be successfully used in different combinations at each stage of the full product life cycle.

It should be emphasized that many of the above quality engineering methods and tools can be used in the enterprise's management system of any industry. However, some enterprises try to use quite sophisticated quality management and engineering methods, such as Six Sigma, Kobayashi's 20 Key Management, Taguchi methods, and to face with difficulties in implementing and supporting methods, and problems with finding significant resources.

If the enterprise’s resources are limited, for continuous improvement the management system processes, managers should first use the simplest, but effective quality management and engineering methods, such as: streamlining “5S”, seven “simple” quality tools, Kipling's method, Five Why? method, etc. Implementation of sophisticated management and quality engineering methods quickly leads to staff frustration and stop using these methods.

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