

New professions emerging out of the development of robotics

Nuevas profesiones emergentes del desarrollo de la robótica.

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ABSTRACT:

The relevance is determined by the issues arising with the development of the modern labour market, caused by the rapid introduction of robotics into all spheres of the economic life of society. The primary objective is to study the development of the global labour market in the conditions of the fourth industrial revolution. The purpose is to illustrate and justify the prospects of emerging professions in the labour market associated with innovative economic development through the introduction of robotics. The main methods of investigating the issue were to provide an overview of international experience in implementing robotics in the economy and emergence of new professions in the global labour market, and assess the possibilities of its adaptation to the Russian economic practice. The research utilizes the methods of ascertaining and forming experiment, expert assessments, strategic forecasting of trends of labour market development, analysis of professional employment of the population in the economy. The research provides for arguments that confirm the increasing need for planning the prospects of the development of the labour market in the context of robotics. The research demonstrates the existence of objective conditions for the emergence of new professions that functionally related to the processes of technological development, virtualization, and digitalization of the economy. The research briefly outlines international experience of forming a high potential new professions portfolio that is also characterized according to strategic development forecasts of economy and labour market.

Keywords: labour market, new professions, emerging professions, professional education, additional training of personnel, digital economy

RESUMEN:

La relevancia está determinada por los problemas que surgen con el desarrollo del mercado laboral moderno, causado por la rápida introducción de la robótica en todos los ámbitos de la vida económica de la sociedad. El objetivo principal es estudiar el desarrollo del mercado laboral global en las condiciones de la cuarta revolución industrial. El propósito es ilustrar y justificar las perspectivas de las profesiones emergentes en el mercado laboral asociadas con el desarrollo económico innovador a través de la introducción de la robótica. Los principales métodos de investigación del problema fueron proporcionar una visión general de la experiencia internacional en la implementación de la robótica en la economía y el surgimiento de nuevas profesiones en el mercado laboral mundial, y evaluar las posibilidades de su adaptación a la práctica económica rusa. La investigación utiliza los métodos de evaluación y formación de experimentos, evaluaciones de expertos, pronósticos estratégicos de las tendencias del desarrollo del mercado laboral, análisis del empleo profesional de la población en la economía. La investigación proporciona argumentos que confirman la creciente necesidad de planificar las perspectivas del desarrollo del mercado laboral en el contexto de la robótica. La investigación demuestra la existencia de condiciones objetivas para el surgimiento de nuevas profesiones que se relacionan funcionalmente con los procesos de desarrollo tecnológico, virtualización y digitalización de la economía. La investigación resume brevemente la experiencia internacional de formar una cartera de nuevas profesiones con un alto potencial que también se caracteriza de acuerdo con las previsiones de desarrollo estratégico de la economía y el mercado laboral.

Palabras clave: mercado laboral, nuevas profesiones, profesiones emergentes, educación profesional, capacitación adicional del personal, economía digital.

1. Introduction

One of the labor market theory basic patterns is the statement about the correspondence of its development tendencies with the substance and direction of the transformation of the economy. The cause-and-effect relationship between these processes has been convincingly proved in works of many scientists,

both classics of economics and contemporary scholars alike; who justified that transformation of the professional employment structure is driven by demand in new labor resources that have new professional competences.

Real economic practice confirms the validity of theoretical studies of the dependence of the labor market professions portfolio on the actual workforce needs of the economy.

However, since professional staff training, by definition, is unable to satisfy the current needs because of its longevity, it is evident that its reform should be carried out taking into account the expected changes in the staffing requirements driven by strategic directions of economic development.

That fact has been pointed out by many researchers, in particular, Thomas Frey in his report "Two billion jobs will have disappeared by 2030" at the TED conference (2012); speech at an economic forum at the University of Virginia in May 2016. Frey is convinced that in less than two decades, 50 percent of professions will disappear as unnecessary, and many conceptually new vacancies will appear.

Recently, journalism and various specializations in economics were considered the most popular and promising professions in the labor market. Presently, according to Forbes magazine, in a couple of years' time these professions will become redundant in the United States after that in Europe, and then the trend will spread to Russia ("Journalism and Economics: The Tangled Webs of Profession, Narrative, and Responsibility in a Modern Democracy").

The proof for that is given as part of the new directions of economic development: digitalization, technologization, virtualization, etc. The integrator of sorts for these directions is the implementation of robotics, rapidly developing in economically developed countries, effectively competing with people in the areas of manufacturing and services.

For example, robots with artificial intelligence have already been introduced in Japan, which resulted in the reduction of the number of vacancies as workers are naturally exposed to fatigue, "emotional burnout" syndrome and other factors of "deterioration" of work capacity, that are not inherent in robots.

Given that, the arrival of robotics is primarily associated with the reduction of labor intensity. It is expected that in the future manual labor will be performed by robots rather than people.

In order to manage the robots, human "online" operators will be used, the main requirements for whom will be patience and the ability to work with large amounts of information. This means that real conditions are forming in the labor market to reduce the level of unemployment among the elderly, adolescents and disabled persons, as that work can be done remotely.

Many works (e.g., Butenko et al., 2017; Egozaryan and Maimina, 2018; Klimenko and Maimina, 2017; Kupriyanovsky et al., 2016; Timofeev and Lebedinskaya, 2016; Stelten, 2013) refer to biology, IT, robotics, chemistry, and management as promising areas of professional occupations.

It should be recognized that in modern-day Russia there is no large-scale implementation of robotics in production. However, this does not mean that soon there will be no new professions in the country under the influence of the increasingly global economy and incremental development of information technologies.

The hypothesis of this research was to identify new professions that are emerging in the international labor market under the influence of implementation of robotics and to form a high-potential professions portfolio, demand for which will be increasing with the development of artificial intelligence and the digitalization of the economy.

The purpose of this research is the justification of the prospects for new professions in the labor market relating to the innovative development of the economy through the implementation of robotics.

The objectives of this research are as follows:

- To present arguments urging the need to develop prospects for the development of the labor market in the trend of developing robotics;
- To prove the statement about the existence of objective conditions for the emergence of new professions that functionally related to the processes of technologization, virtualization, and digitalization of the economy;
- To summarize the international experience of forming a high-potential professions portfolio, to specify it by types of professional employment and to outline their characteristics according to the strategic forecasts of the development of the economy and the labor market.

2. Literature review

Every year in the world there are fewer tailors, miners, security guards, lawyers, office workers. They are replaced by automated systems and flexible models of employment and remote work solutions.

It is believed that if the automotive industry continues to develop at the same pace, in 10 years' time there will be little or no need for training of drivers, machinists, conductors, tractor operators, handlers (PAS 3000: 2015 Smart working. Code of Practice. BSI 2015).

According to V. Nikitin's estimates (2017), with a robot working 20 hours per day and changing/switching

operators controlling them, in the long term the need for robots will amount to 8.6 billion items, including 2.4 billion in the production sector of the economy (table 1).

Table 1
Calculation of the number of robots

Main production areas	Labor allocation, %	Need for labor, bln. working hour per day	Level of robotics in production, %	Quantity of robots, bln. pcs.
Extraction of raw materials	20	60.75	0.7	2.1
Production, including energy, foodstuffs	20	60.75	0.8	2.4
Recycling	5	15.19	0.8	0.6
Transport and transportation	20	60.75	0.7	2.1
Services (security, science, healthcare, safety, information, research, and communication)	30	91.13	0.2	0.9
Miscellaneous	5	15.19	0.5	0.38
Total	100	303.75	X	8.6

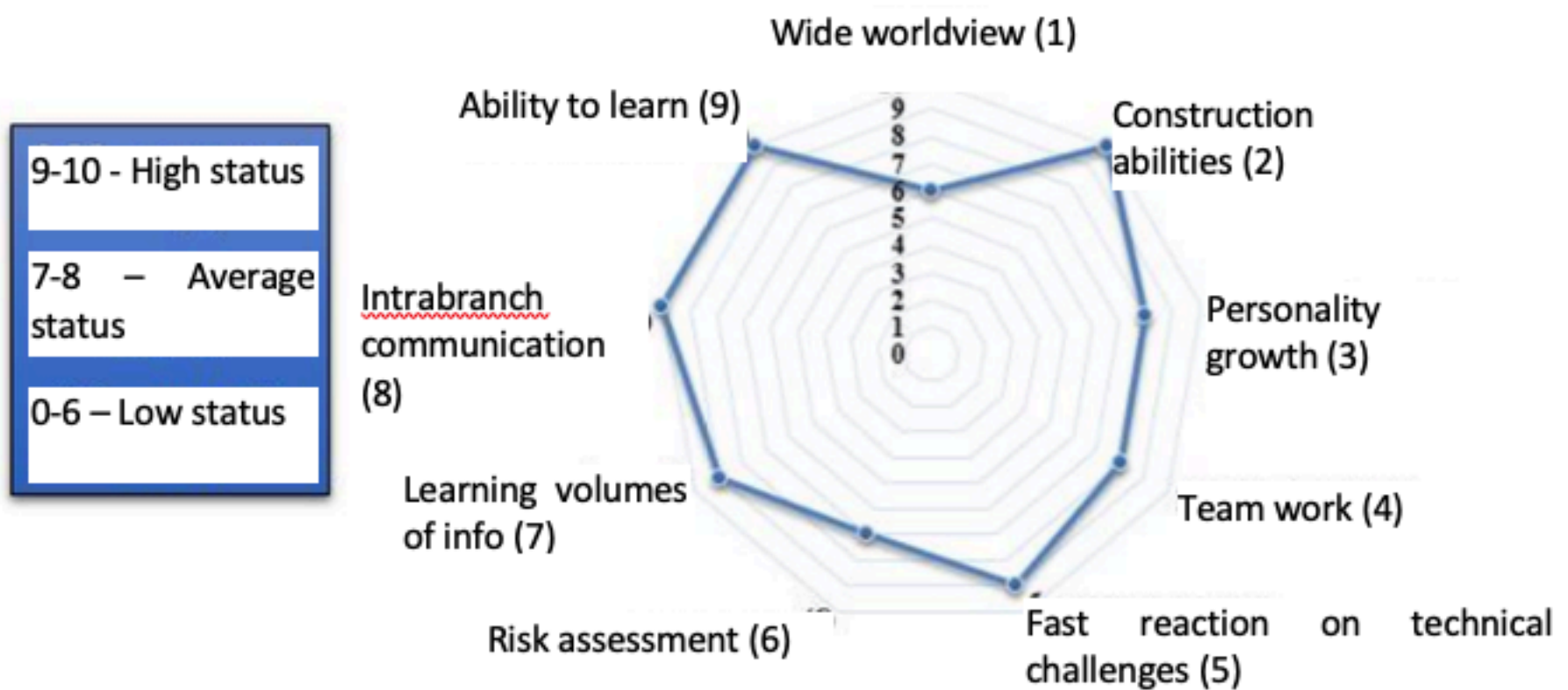
As a result, by 2024 there will be a growing need for professional staff in the areas of training relating to information and telecommunication technologies with relevant competencies – up to 800 thousand people per year, and the share of the population with digital skills will increase up to 40%. (Order of the Government of the Russian Federation dated 28 July 2017, No. 1632-r) (table 2).

Taking into account the high potential of professions with digital competencies, researchers (Shatilo and Kopkova, 2017) have put together a profile of a digital age worker (figure 1), his/her main characteristics being: broad outlook, ability to learn and create, ability to work in a team, focus on personal growth, ability to assess risks and promptly make managerial decisions.

Table 2
Performance in human resources and education by 2024

Criterion	Indicator
Number of graduates of educational institutions of higher education in the areas of training relating to information and telecommunication technologies	120,000 people per year
Number of graduates of higher and secondary professional education, possessing competences in the field of information technology at the world average level	800,000 people per year
The share of the population with digital competences	40%

Figure 1
Profile of a digital age employee



The high potential of demand for workers in “digital” professions is also confirmed by the research by Polevanov (2017), who has predicted an increase in demand by 2024 from 8% (system administrator) to 24% (web developer) (table 3).

Table 3
Demand in professions by 2024

Profession	Increase in demand by
Web developer	24%
Analyst in computer science	21%
Analyst in information security	18%
Software developer	17%
Expert in data analysis and processing	16%
System administrator	8%

The above examples of the forecast calculations of the demand for professions relating to information and telecommunication technologies confirm a high potential in a growing demand for them in the labor market. At the same time, researchers (Ageev et al., 2017) also draw attention to the threat of new risks of sustainable development of the labor market caused by the technological development of the economy, drawing up a map of technological risks for the Russian Federation (table 4).

Table 4
Map of technological risks (for the Russian Federation)

Level	Technological risk
1	Long rejection of IT systems, ineffective development of domestic digital and information applications
2	Offering employment opportunities and other assistance to a large number of citizens who have become unemployed as a result of the introduction of various technologies replacing human labor
3	Potential cybersecurity breaches
4	The inability of large-scale IT programs to provide for expected benefits
5	New “breakthrough” technologies weaken competitiveness (e.g., small businesses will not

It is worth noting that, in the age of digital technologies, jobs that do not accept human substitution technologies (e.g., social workers, choreographers, therapists, surgeons, psychologists) will be those least affected.

3. Materials and methods

The main methods in this research are the review of the international experience of introducing robotics into the economy and of the new jobs emerging in an increasingly global labor market, as well as assessing possibilities for its adaptation to Russian economic practice.

The research utilizes the methods of ascertaining and forming experiment, expert assessments, strategic forecasting of trends of labor market development, analysis of professional employment of the population in the economy.

The development of digital platforms and their broad reach reinforce the tensions underlying institutional and scientific change. The key advantage of these platforms is speed: rapid dissemination of the results of preliminary preparation and response to pressure for publication, as well as publisher's motivation to profit [Swist, T., Magee, L Academic publishing and its digital binds: Beyond the Paywall towards ethical executions of code].

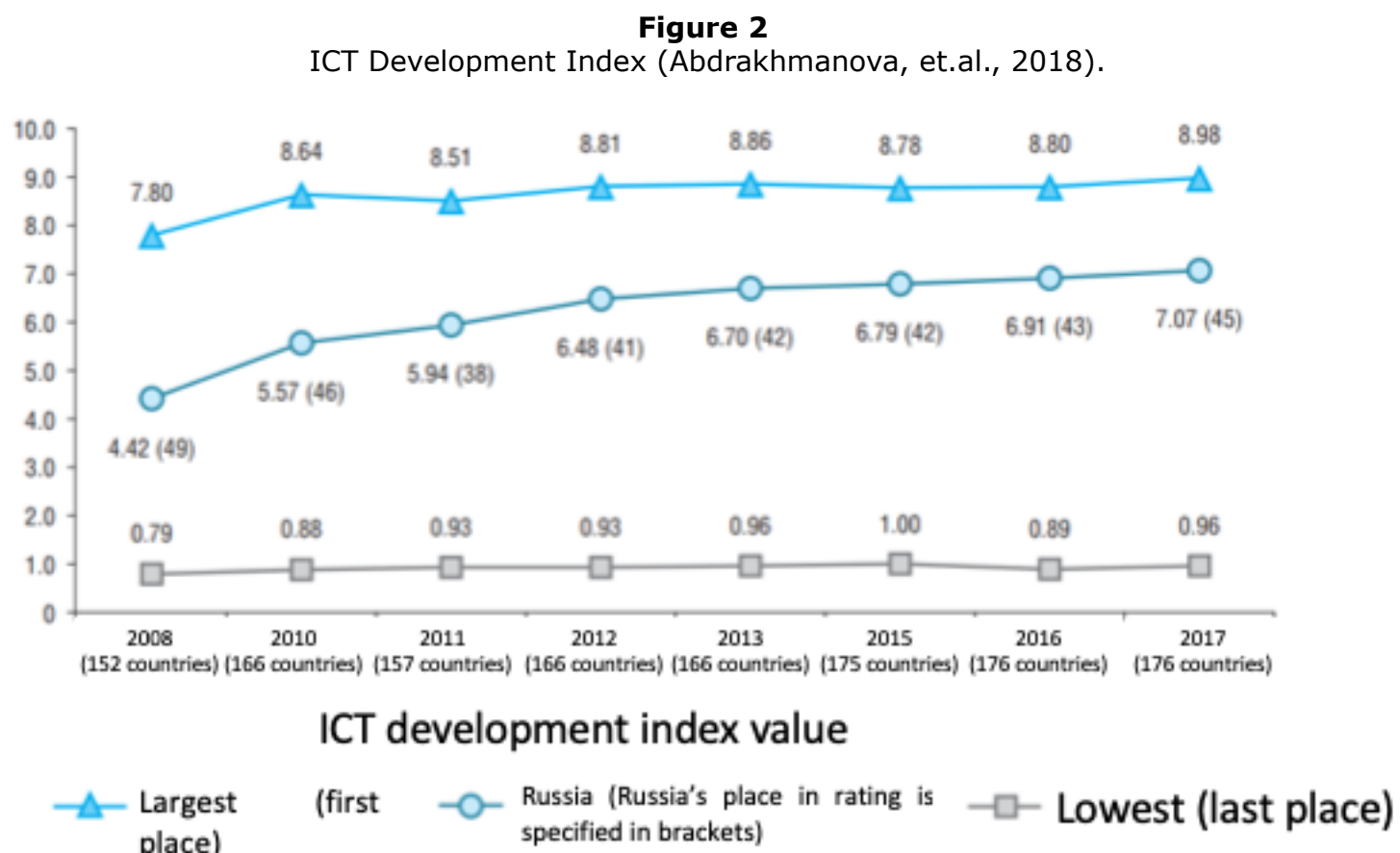


Table 5
Dynamics of the population of the Russian Federation at the age of 15-72 years and its distribution according to the status of participation in the labor force (thousand people) (SSC, 2018)

Years	Population aged 15-72 years, total	Including			Persons who are not part of the labor force
		labor force	of it		
			employed	unemployed	
2010	111533	75478	69934	5544	36055
2012	110222	75676	71545	4131	34546
2014	109505	75428	71539	3889	34076
2017	110775	76588	72324	4264	34187

Today, the following problems can be identified in the labor market:

1. Often the quality of the labor force becomes critical, for workers are characterized by an inadequate level of their

- knowledge, skills, and competencies, as well as difficulties in improving their skills.
2. Balancing the demand and supply of labor is the essential task of the state employment policy, and one of the primary mechanisms for solving this problem is the direct interaction of organizations and educational organizations.
 3. The shortage of qualified specialists should entail a comprehensive system of reproduction of specialists, which will provide for balanced training in the system of in-house training, as well as the development of additional and continuing professional education.
 4. 62% of NGO graduates and 55% of SPO graduates cannot compete in the global labor market, and 80% of graduates from technical universities have an unsatisfactory quality of vocational training (Tkachenko, 2014).

The above problems suggest the prospects for the further development of the labor market:

1. It is necessary to take active measures to promote the professions and specialties that are in demand in the global labor market and their attractiveness for young people.
2. It is necessary to continually forecast the demand of employers for labor and the proposals of job seekers for employment, to determine the needs of organizations for promising personnel, to improve the mechanism for determining orders for the training of qualified personnel for all levels of professional education.

This research is based on our many years of experience working in the system of higher professional education in Russia, as well as on our analysis of information from organizations of the real sector of the economy that interact with our educational organization as part of the process of professional training, retraining, advanced training, and additional professional education of personnel.

4. Results

Christopher Pissarides, Nobel Prize Laureate in Economics, has noted the following areas where robots will not be able to replace humans in the next 20-30 years completely: medicine, education, real estate, households, hospitality (hotels, restaurants, and tourism management, entertainment industry) and personal services – babysitting, nursing and other professionals that robots are unable to substitute for both practical and ethical reasons (“UK's Nobel economics laureate Christopher Pissarides warns chancellor: don't axe jobless benefit”).

According to the US labor market data, currently the most popular and highly paid profession is a doctor, and it will remain so for the next years. The lack of doctors these days is estimated at tens of thousands, and their average annual salary is more than 200 thousand US dollars. On the other hand, medical education is one of the most expensive as well as time-consuming. Studying at a medical faculty might cost a total of 300 thousand US dollars and will take eight years (first a general bachelor's degree and special education in a school of medicine after that). There is even more to it: newly-made physicians must take an internship that lasts from three to six years depending on specialization (“The most highly paid profession in the world”).

According to the estimates of the German Federal IT Association, there is an acute shortage of IT specialists in Germany, and the number of open vacancies in this field increased by 5 percent only in 2013, and this trend will continue to develop with time. That said, this trend is relevant not only for Germany but the whole world: based on the results of “The Digital Talent Gap” research, in which over 130 senior executives from all over the world were surveyed, Capgemini Consulting noted that 90 percent of the world companies lack competent staff in the area of computer technology (“Short of Skilled Hands, Germany Looks South?”, May 2013).

The British shortage occupation list includes IT professionals, entrepreneurs, healthcare workers, high school teachers, nannies and cleaners, economists with local (British) education, plumbers, builders, sales managers and engineers (UK Tier 2 Shortage Occupation List).

In Japan, it is IT professionals (developers, network engineers, network administrators, ERP specialists, etc.), architects and designers, sales specialists (sales representatives, sales consultants, freight forwarders, etc.), management personnel, engineers and related that are in the most significant demand (“Jobs in Japan: List of Sought-After Ones”).

In the People’s Republic of China, according to statistical data, 85% of foreigners work in international companies, therefore in the future it is expected that the most in-demand jobs will be translators, English teachers, marketing and sales specialists, programmers, IT managers, designers (“Changes to the Work Permit Application for Foreigners in China”, April 2017).

In African countries, jobs in the areas of services and entertainment, healthcare, construction, mining, and education (“Staff retention in African universities”) will continue to be highly popular, whilst in Latin American countries these will be the teacher, university lecturer, lawyer (“Global perspectives on teacher”).

Amongst the popular areas of entrepreneurship in Europe, in the future, it is expected that demand will increase for jobs in IT, engineering, advertising technology, ecology, and biotechnology (“Social entrepreneurship | European Tradition,” March 2013).

The above examples of forecasts of the prospects of various professions in the country and continental aspects serve to evidence a clear-cut pattern: the higher a country’s level of economic development, the higher the demand there for jobs relating to information and telecommunication technologies.

5. Discussion

So, having reviewed various sources containing alternative lists of high-potential professions for different countries ("Research careers in Europe"), we have arrived at a generic list of jobs (Top-20) formed by the development of technology, virtualization, robotization and digitalization of the economy and put together the characteristics of these professions.

1. *Virtual reality designer*. Experts predict a significant growth of the market of VR-devices. In the next 7-8 years, it will probably exceed 45 billion US dollars. Millions of people will spend most of their free time in virtual reality devised by new-generation designers; create virtual offices for remote negotiations, museums, municipal institutions, etc.
2. *Developers of robotics ethics* or lawyers specializing in robotics ethics. They will act as intermediaries between humans and artificial intelligence. The tasks of these specialists will include the development of ethical norms, according to which robots can exist among humans. The need for that profession is due to the possible emergence of "bad" machines that may intentionally harm people.
3. *Virtual guides and digital commentators*. Do you experience catharsis when you contemplate works of art in museums or art galleries? Experts believe that very soon virtual tours will substitute up to 80% of real visits to cultural objects. This is where digital commentators and VR-guides will come in handy.
4. *Biohackers*. They are amateurs who conduct their research in the field of molecular biology, using the open data of the scientific community. It is assumed that soon biohackers will advance to a new level and as freelancers; they will be able to help scientists search for ways of treating the most complicated diseases.
5. *"Internet of Things" (IoT) Analysts*. Household appliances and electronics are increasingly equipped with their software so that these devices can exchange data among themselves without human intervention. The "Internet of Things" (IOT) will already require modernization in 5-8 years' time: in developed countries, specialists capable of analyzing data and looking, for example, for new methods of integrating household appliances into uniform systems for "smart houses" will be in demand.
6. *Space guide*. Scientists say that by the beginning of the 2030s space tourism will become quite affordable for wealthy people. So the guides will be in demand who will accompany travellers in flights to the stars. While at the early stages of it is spacemen who will be able to do that job, in the future the respective specialization may appear even in "ordinary" universities.
7. *Personal data coordinator*. Neurointerfaces that connect the human brain with a computer will become widely spread in 3-4 years' time. We will be able to "record" memories, plans, and thoughts, and distribute them in social networks – share with friends and other users. The task of a personal data coordinator will be to merge the data into the general information flow and adapt it to it.
8. *Expert in the restoration of ecosystems*. By 2030 or so, the Earth's resources might be significantly depleted due to the considerable growth of population. It is not only about non-renewable natural resources, but also flora and fauna. In this situation, engineers will be required to restore the environment. In particular, they will be able to "revive" extinct species of animals and plants using previously collected genetic material.
9. *Engineer for the development of permanent power supplies*. In the next 5-10 years, the transition to sustainable energy can be completed – on the entire planet, solar and wind energy will be used as the primary source of energy. The only problem is the impossibility of using the devices in cloudy and windless weather. Therefore, developers of permanent power supply devices will become especially popular.
10. *Body-designer*. Bioengineering should make a breakthrough by the middle of the 2020s. In the future, a person can easily change tissues and even organs. The possibilities of medicine and plastic surgery will help people become what they would like to be, and body designers will be able to translate the desires of a particular person into models that surgeons will follow in the course of their work.
11. *City-farmer*. It is someone who will be engaged in the green landscaping of megalopolises. It is possible that in the future large cities will be able to provide themselves with vegetables and fruits; they will be grown right on the roofs and facades of skyscrapers.
12. *Molecular nutritionist*. "Larisa Dolina's Diet" may not help not only because of the anti-scientific basis but also due to the individual characteristics of your organism. Soon, we will be able to lose weight at a molecular level; nutritionists will study our structures in the smallest detail and will be able to create unique programs for weight loss, weight gain or retention.
13. *Online Doctor*. Many laws on online consultations have already been adopted. Therefore the profession does not seem futuristic, even less utopian. In 4-5 years, the online doctor will be able to replace the majority of doctors practicing the excellent full-time reception of patients.

Today, both experienced and less experienced practitioners worldwide limit the scope of their practice, which can have detrimental effects on public health [Hellyer P., Radford, D.R. An evaluation of preventive dentistry: W(h)ither the profession?].

1. *Space tourism manager*. Whereas American researchers make a note of space guides, "Skolkovo" focuses on specialists who will organize flights to the stars. Managers in this industry, according to forecasts, will be in demand within 15-20 years.
2. *Digital linguist*. The task of such a specialist is to adapt the language of machines to a human, make it more understandable and "alive." Digital linguists will work with online translators, search engines and other robotic devices that "talk" with a human.
3. *Reconstructors*. Most of the iconic buildings, monuments of history and architecture, will very soon reach emergency condition. The task of specialists in the reconstruction of these facilities is to create a project by which the building will cease to be dangerous and at the same time preserve the value of the monument.
4. *3D-printing Designer*. This profession will be mainly in demand for construction, where 3D technologies are

widely used even today. While it is only separate elements and building materials that are printed, in the future, it will be possible to create whole buildings using individual printers.

5. *Household robots developer*. The profession already exists today and in the future will continue to gain popularity. Experts believe that by 2030, people can completely get rid of their housekeeping duties; machines will be charged with all household work.
6. *Financial trajectory designer*. He will help you not make mistakes in building a career, having developed an individual plan for achieving success. As such, it is an expert who will be able to create an algorithm of climbing a career ladder for any person.
7. *Coach for mental fitness*. They will be as charismatic as those useless modern-day trainers, but at the same time will help people advance intellectually, for example, by mastering speed reading, developing phenomenal memory, etc.

One of the widely recognized innovations in the field of education is MOOCs (Massive Open Online Courses), which can be used as an effective means in organizing the professional training of managers in companies within the walls of the university (Saveleva et.al.).

6. Conclusion

To sum up, apparently the situation will be developing in several directions as follows:

1. Professions that have lost their popularity in recent years will return. Thus, farmers and agronomists will be in demand not only on land but also in water. Due to modern-day developments, it is already possible today to build sunken gardens and farmlands.
2. There will be new directions that are no longer considered fiction but have not yet established a clear framework. These are activities related to robotics, healthcare, space exploration, production of useful resources.
3. Traditional professions will stay but will change. Thus, the profession of a teacher will not disappear, but it is likely that schools and other educational institutions will. Classes will be broadcast online to a large number of students at once.
4. Some professions will virtually disappear though. For example, interpreters will no longer be in demand given the level of development of modern technologies that allow translating texts from one language to another independently. Further improvement of existing applications will make it possible to achieve an ideal transfer of the meaning of source information. Successful testing of devices that perceive the sound transmission of information with its subsequent translation will make simultaneous interpreters redundant and so on.

It is necessary to emphasize that all the forecast changes in professions above will require enhancements of the system of professional retraining of personnel, bringing its contents and technologies up to date and in line with the requirements of the emerging digital economy.

We believe that the main objectives of qualitative retraining of personnel should be:

- Decrease in unemployment amidst introducing artificial intelligence into the production of goods and services;
 - Formation of social and labor relations and social partnership in the digital environment;
 - Training of workers in new professions with the aim of adapting to changing the working environment in the age of the digital economy.
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