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Manpower Support for Digital Technology Implementation Processes in Industrial Enterprises

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Abstract*: *Today's rapid advances in digital technology are resulting in a transformation of the future labor market. Given the ever-increasing use of digital technology, the resolving of complex production objectives may well result in job cuts, changes in personnel requirements, and new areas of activity emerging as a result of digital transformations. Issues related to manpower support for the implementation of digital technology are setting new objectives not only in terms of fostering the competencies of the future but also in terms of organizing a business and training and retraining a workforce at the level of both the industrial sector and the national economy at large.The paper describes some of the new trends in the labor market associated with job robotization and analyzes a set of factors influencing the rate of workforce engagement in the robotized production process. The authors suggest that boosts in entrepreneurial activity in light of the extensive implementation of digital technology in production are associated with not so much job cuts due to automation as with new vistas of opportunity that the digital era is offering.The paper explores the role played by the state in resolving the objectives of ensuring social stability in a climate of the digitalization of the economy. The authors highlight some of the key skills that representatives of "high-risk" occupations may need to acquire nowadays. This may help design appropriate educational strategies aimed at guarding this group of workers from the undesired effects of production digitalization.

Index Terms*: *digital technology, industrial enterprises, manpower support, labor market, entrepreneurship, social effects.

I. INTRODUCTION

Technological progress is leading to all-out automation and digitalization of production and imminent shifts in the structure of employment. Technologies, including digital ones, have always been in a close relationship among each other, facilitating technological changes, boosts in labor productivity, gains in economic growth, and the creation of creating demand for new sought-after competencies, and giving rise to new challenges which are causing changes in human resource policy and existing approaches to making labor markets sustainable, adaptive, and efficient. In this regard, in implementing digital technology in the production process, industrial enterprises may need to take account of actual changes in manpower demand [2]. New technologies have already replaced human labor in many industries, leading to personnel releases in various sectors. Artificial intelligence has helped to considerably expand the potential of industrial robots to adapt to the outside world and ever-changing production conditions [3]. Currently, some of the major drivers of transformations in the labor market include robotics, artificial intelligence, computer-assisted instruction, 3D nanotechnology, biotechnology, and genetic medicine. These areas of the development of science, machinery, and technology are not likely to develop in an isolated fashion but are expected to supplement, and combine with, each other. It is changes across these areas that the labor market is going to have to react to straightaway in the near future [4].

II. METHODS

To assess the effect of implementation of new technology in high-tech enterprises within Russia's military-industrial complex, the authors carried out an analysis of views elicited in numerous surveys, questionnaires, and working group meetings on issues related to the effect of digital technology on the manpower potential of industrial enterprises.

The study's methodological basis was grounded in research works by Russian and foreign scholars devoted to issues of digitalization of high-technology production and their effect on the financial performance of organizations. The work employed a set of research methods, including the systemic approach, methods of financial-economic analysis, methods of logical, comparative, and factor analysis, and the expert assessment method.

In writing this paper, the authors drew upon particular methods of strategic management of companies to put together forecasts of the development of the digital economy within Russia's military-industrial complex [3].

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III. RESULTS

A. The effect of digital technology on the model of management of an industrial enterprise

It may, above all, be preferable to implement digital technology in production in science-driven and high-technology sectors of industry, which are better developed in terms of technical and technological support for production and have highly skilled personnel in place. Lagging sectors of industry which do not have in place most of the digital skills required to do the job may, in implementing digital technology, experience a powerful destructive effect. Digital technology is altering the model of management of present-day industrial enterprises. It is being transformed from a means of supporting a business into a means of boosting the effectiveness of production in industrial enterprises and their management. Big data, cloud storage and compute resources, and the Internet of Things are opening the way to new approaches in decision making and the design of new business models for smart systems, and are making it possible to fully automate technological processes [5].For instance, the Internet of Things is helping stimulate smart production in the power industry. Smart grids, which run using the Internet of Things, are making it possible to monitor the distribution of electricity across infrastructure (and the overall condition thereof), detect emergency situations, prevent power outages, as well as stimulate the use of effective pricing mechanisms in the power sector [6, 7].

The rapid development of new industrial technologies, like 3D printing or additive layer manufacturing, and their combination with other digital technologies may help change the situation in industry through the integration of design, production, and supply. Currently, 3D printing is mainly employed to manufacture models of spare parts. However, as the spectrum of printing materials expands, the accuracy of surface finish improves, and the quality of finished products gets better, the role of these technologies is going to grow. Already now these technologies are being widely employed in the area of medicine and bioengineering to manufacture implants, prosthetic devices, and even organs for grafting [8].

B. The effect of digital technology on personnel requirements

In implementing digital technology in the production management system and the actual production process, there arises a social-technical contradiction: humans are getting surrounded by an increasingly greater number of machines, while, at the same time, there is increasing the value of human contact.A key trend in the labor market today is departure from existing working styles. If before it was human workers who were asked to perform unvaried operations and follow specific rules and instructions, now one can see that robots are actually outdoing humans in performing this kind of functions. Therefore, today a potential worker is expected to be independent, be capable of finding their way quickly through new circumstances, and have the ability to put up with change [9].As there emerge and develop in a climate of digitalization of production various new products, processes, and business models, there will emerge new types of jobs.There is a possibility that not all new jobs will match standard full-employment models. Some may take on nontraditional forms, like, for instance, part-time working days and on-demand work. Emerging technologies are making it possible to divide the work process into smaller operations within the framework of global digital production, with work objectives taking on a more fragmentary form and increasingly more employees performing nonstandard operations throughout the business.New jobs require new skills and competencies. The digitalization of production and the need to work with large amounts of data are stimulating the demand for specialists with analytical thinking skills, which currently exceeds not only the actual supply but the supply potential offered by the systems of education and vocational training.Knowledge and skill shortages may be a serious concern for many companies today, preventing them from getting their desired return on investment in digital technology. Shortages of highly qualified specialists are already (or may soon start) being felt by companies in the process of digital transformation of the business (Figure 1).

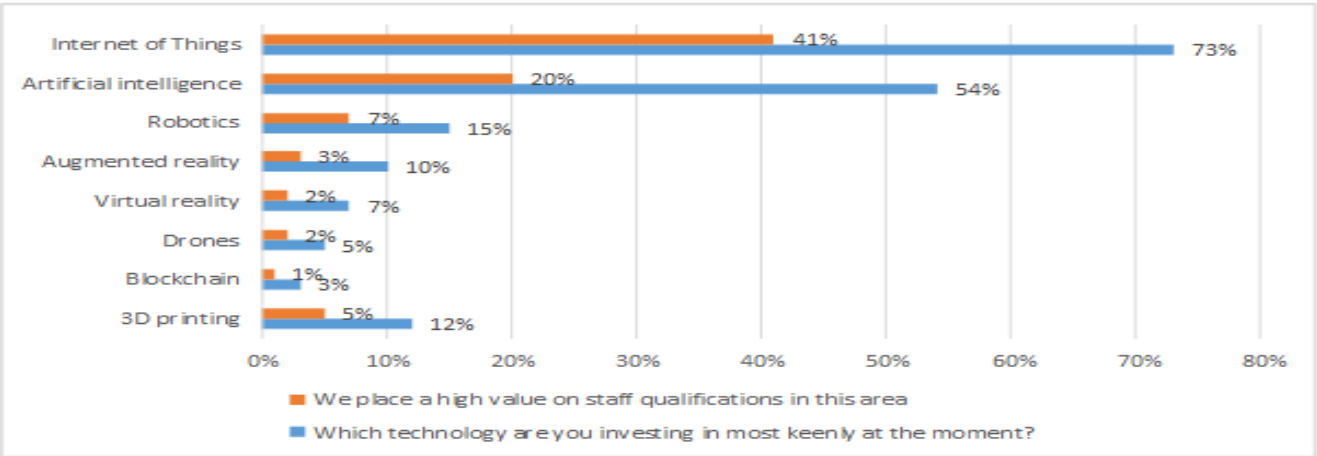

Fig.1. The degree of shortage of qualified personnel in the area of cutting edge technology. Data from PricewaterhouseCoopers [10].

An employee of the future will have to possess whole different competencies as opposed to an average present-day staff member.

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Humanity is in for the biggest changes within the labor market since the time of heavy industrialization. The present generation may need to not only be ready for innovation themselves but also start providing proper instruction to the growing Generation Z, present-day schoolchildren, or else the latter may fail to be sought-after as a workforce in the future.

So, just what are some of the key competencies the Generation Z may need in the future and what will be important in 15–20 years from now for those who are willing to stay competitive and sought-after in the labor market? (Figure 2).

The labor market needs modern specialists with a solid sense of direction in the digital environment who know how to utilize the latest technology both at work and in everyday life [11].

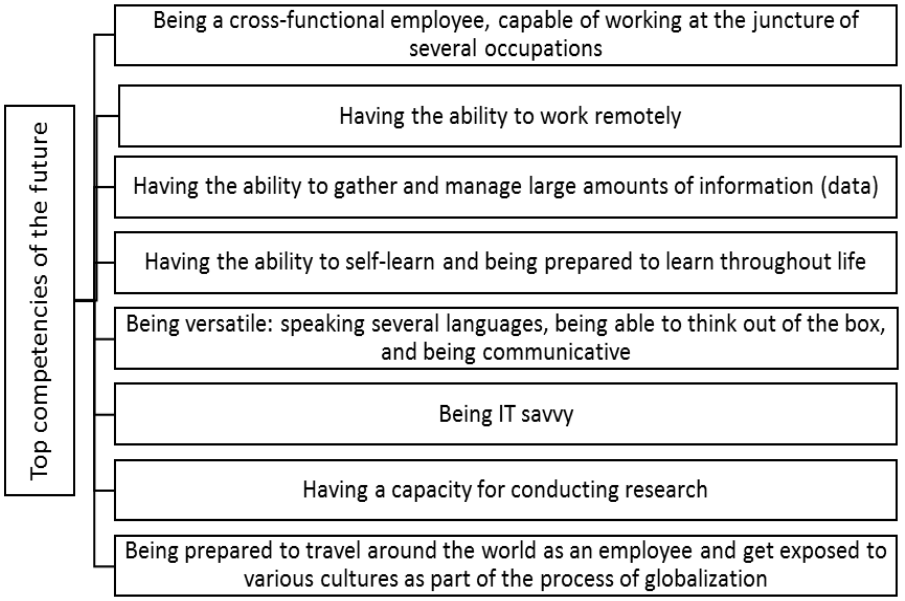

Fig. 2. Top competencies of the future.

C. The effect of robotization of production on staffing in industrial enterprises

Robots will, doubtless, occupy a central place in logistics and manufacturing and help boost the safety, pace, accuracy, and output of production processes. The implementation of robots in production will provide an impetus for the economic development of industrial enterprises, but it may also increase social inequality and change the workforce composition of enterprises within the defense industry. The implementation of digital technology in industrial production will lead to transformations in the labor market and will result in the total disappearance of certain occupations, although in Russia the development of robotization has progressed at a considerably slower pace than in the rest of the world.

Based on data from the International Federation of Robotics (IFR), the latest estimated annual shipments of multipurpose industrial robots are well over 300,000 units, with the number projected to be over 500,000 and the total worldwide stock of operational industrial robots projected to reach the level of three million units in 2020 [12].

Russia is trailing behind other nations in the pace of robotization, its robot density being minimal at the moment – 1 robot per 10,000 workers. To compare, the figure is 530 in South Korea, 305 in Japan, and 69 as a global average. Russia's average annual sales of robots are 500–600 units, or 0.25% of the global robotics market.

In 2017, global industrial robot sales increased by 31% relative to the previous year. The figure reached a new level in 2017 – 387,000 units. China posted the largest growth in industrial robot sales – 58%. Industrial robot sales in the USA increased by 6%, while sales in Germany grew by 8% relative to 2016. These are the initial findings of the IFR's World Robotics Report 2018 (Figure 3) [13].

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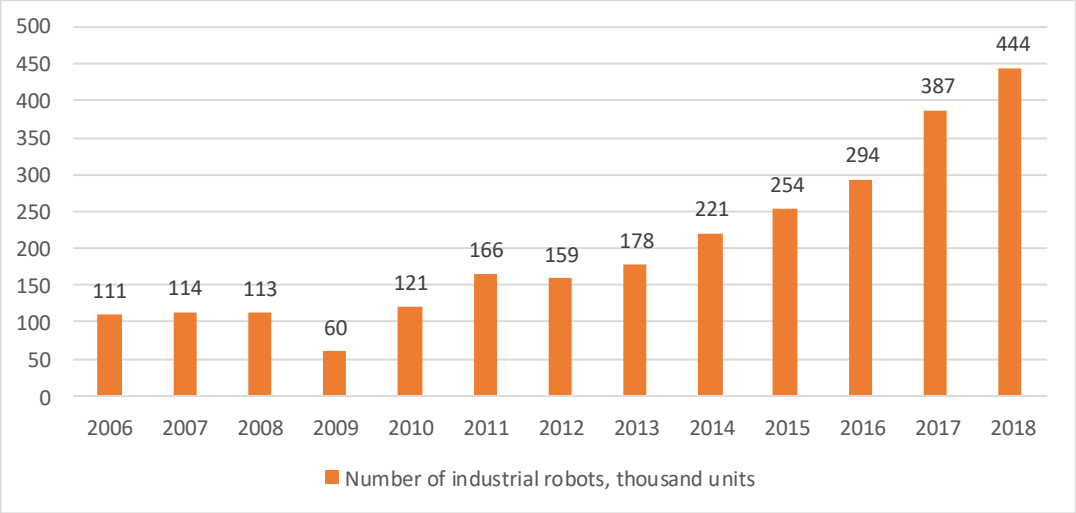

Fig. 3. Development of robotics around the world in the period 2006–2017.

Based on the results of a worldwide Automatica survey of 7,000 employees in seven countries (USA, China, Japan, Germany, France, Great Britain, and Italy), nearly 70% of employees believe that robotics and automation offer the opportunity to qualify for higher skilled work [14].

Some believe that job automation and robotization should not be regarded as a threat to employment. A positive effect from the process is expanded entrepreneurial potential for businesses, which can be perfectly illustrated by the following consideration: the automation of production helps ensure flexibility in resolving a wide spectrum of tasks which can be performed by robots, with a focus on improving the overall quality of a product and reducing the time it takes to get it into the market.

The Association for Advancing Automation's white paper entitled 'Robots Fuel the Next Wave of U.S. Productivity and Job Growth' provides statistical data on performance across a wide spectrum of manufacturers. The document reveals how and why increases in robot use may be linked to boosts in the employment rate. The findings are in sharp contrast with the view that increased robot use leads to higher unemployment levels [15].

In the period 2010–2015, the US industry installed around 135,000 of new industrial robots. The principal driver in that race to automate is the car industry. During this same period, the number of employees in the automotive sector increased by 230,000. With companies doing their best to stay competitive in the market, there has been a continued focus on the implementation of digital technology and robotization and automation of jobs with a view to boosting labor productivity and increasing the number of jobs that can create additional revenue for them. Robotics is helping companies locate new talent – especially, technology-savvy individuals who are interested in a long career, which may definitely help boost a company's production volumes.

One of the most pressing issues facing business leaders today is how to bridge skill gaps in filling a job role. Robots are optimizing the production process more than ever today, helping boost companies' competitiveness in the global arena, while performing monotonous, dirty, and dangerous operations, which should help companies create higher skilled and safer jobs, in doing which workers will use their intellect rather than their muscles. With that said, robots not only can help boost a company's production volumes, without it having to purchase additional computer numerical control (CNC) machines, but can also help increase the capacity of existing machines by as much as 30% [16].

D. *The effect of digitalization of production on the workforce development system*

The digital economy's new requirements for the competencies and psychological portrait of the nation's workforce may require overhauling existing education policy and working out new approaches to the training of instructors who will be engaged in fostering human capital based on new professional skills, organizing work, and implementing new methods of management.

The Russian Federation needs more college graduates with the skills and competencies required for the digital economy. Furthermore, it is imperative that one has the motivation to master new areas that are sought-after in the digital economy.

In a climate like this, it is important to continually engage in learning and develop one's skills, keep track of changes to one's occupation, and adapt to new trends in the development of the labor market [17].

To be successful in modern-day society, future generations of workers will have to start acquiring digital skills in early childhood, and from then on keep learning throughout life. One will have to change job once every 5–10 years.

If before most people were ready to retire at the age of 50, now many around that age tend to actually just start putting their career plans into effect. Pretty soon, we may well start coming across students who are no youth anymore.

Already today, we are witnessing a trend of shifting from classic education toward workshops, which do not provide the learner with a body of new knowledge on a particular fundamental discipline but enable them to acquire a set of practical skills required for a certain occupation as fast as possible. Learning is increasingly taking on an amusing form: nonmainstream lectures, workshops, play-based learning, etc.

E. *The effect of digitalization of the economy on staff recruitment*

The development of digital platforms helps organize the labor market and transform existing employment mechanisms. Employers and employees are increasingly meeting online. In recent years, one has witnessed the emergence of recruitment online services which connect those looking for work with those looking for recruits across a variety of areas [18].

Wide use in the recruitment process has been made of test-based talent assessments. Accordingly, most of today's tests may need to be designed factoring in the needs of the digital economy.

II. DISCUSSION

A. *Which occupations will disappear and which occupations will be recreated?*

It goes without saying that the development of machine learning, robotics, and artificial intelligence is going to lead to major changes in the human resource structure of industrial enterprises. If before it was low-skilled work that machines took away from humans, they now seem to be aiming at man's mental activity.

Faced with the threat of disappearance today are many intellectual, team-based, and analytical occupations which involve performing routine standard operations (e.g., in transportation, in office work, or in the services sector).

Technological changes may lead to greater inequality and social division amongst the population. What may be considered a major concern for humans today is not just the disappearance of jobs but also a polarized labor market, reduced social mobility, and growing digital skills' gaps. The polarization of job opportunities is most likely to hit the middle class, so-called white collar workers, with social division expected to increase based on a widening digital chasm between those fitting into the technological process and those actually unable to catch up with the former.

A mathematical analysis helped draw up a list of occupations that are the likeliest to disappear under the digital economy (Table 1): various clerks, machinery and equipment operators, lab equipment operators, inspectors, testers, sorters, order takers, as well as various laborers and repairmen.

A study suggests that only 9% of jobs are at risk of total automation, while 25% may undergo substantial changes due to the automation of 50–70% of relevant production operations [19].

Based on a report published in the American Economic Review, mankind is in for the total disappearance of the occupation of driver over the next 20 years, which may result in the slashing of 74% of all logistics jobs [20].

The development of cutting-edge technology may also eliminate the occupation of taxicab driver. In 10 years' time, taxicabs may become partly, if not fully, autonomous, while by 2033 taxis will have become fully self-driving.

Table 1. Obsolescent and New Occupations in the Context of the Digital Economy

Obsolescent occupations	Likelihood of getting automated, %	Safe occupations	Likelihood of getting automated, %
Lumpers	99	Emergency dispatchers	0.3
Underwriters	99	Fire dispatchers	0.3
Seamstresses	98	Interior designers	0.4
Data entry operators	99	Motivational coaches	0.6
Brokers	99	Computer systems analysts	0.7
Call center agents	97	Logistics specialists	1.2
Printing assistants	97	Marketing specialists	1.4
Sawyers	96	Engineers	1.4
Burnishers and polishers	97	PR managers	1.5
Office secretaries	96	Graphic artists	1.5
Cooks	96	Environmental specialists	1.8
Postal service clerks	95	Photographers	2.1
Custodians	94	Attorneys	3.5
Couriers	94	Managers	3.7
Bricklayer masons and cement finishers	94	Forest officers	0.8
Accountants and auditors	94	Stylists	1
Assembly line workers	93	Restoration artists	1.6

The most common occupations in the labor market today are sales assistants, retail cashiers, lumpers, custodians, and drivers. However, cashiers and sales assistants are facing serious competition – from self-checkout machines, which are expected to replace these occupations in the near future as a result of the development of the digital economy.

For instance, in 2017 Amazon launched the first cashier-less supermarket. Checkouts have been replaced with sensors which record the items they pick up and charge them to an Amazon account, letting customers walk out of stores without queuing. However, the need for sales assistants will remain. According to forecasts, technological devices will not be able to fully replace sales clerks across all sectors of retail over the next 5 years, with the ultimate shift to automation in the area expected to take place no sooner than 20 years from now [21].

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The next occupation which may be removed by the digital economy is security guards (there are around 1 million security guards in Russia at the moment). Pilot projects have already been carried out to test robot cops and security robots carrying an electroshock baton.

Among the other occupations that may disappear soon are teachers and translators. The latest smartphone can translate from and into as many as 500 languages – and, arguably, do so even better than the average instructor at a Russian college. With the implementation of neural networks, machine translation has become more meaningful and in-demand. In March 2018, Microsoft released an algorithm for translating news from Chinese into English which provides near-human level performance in translation.

With the development of the digital economy, there will soon be no need for sports referees. By registering a certain event in a sports match, machines will help avoid officiating mistakes and resolve controversial situations based on video replays and the reconstruction of critical events (e.g., in tennis or soccer).

Some may find this hard to believe, but it is a fact that it is possible today to even replace the occupation of programmer – and that is considering the fact that it is programmers who actually stood at the origins of all-out computerization and artificial intelligence, which can create programs today no worse than humans can.

The process of creation of new jobs is polarized between the highly-skilled group and the low-skilled one. Subject to elimination are, above all, jobs that require a medium level of qualification and involve performing routine operations. Creative occupations are more resistant to the impact of the digital economy, and may survive eventually.

Having said that, not all occupations can be replaced with artificial intelligence or robots. The greatest potential for survival is with jobs that cannot be automated, systematized, and algorithmized, are not associated with pre-configured behavior, and cannot be described using linear logic.

Immune to job cuts are likely to be those with strong intuition, assertive individuals who are good at managing a team, proactive, out-of-the-box thinkers, creative managers, as well as those engaged in the area of arts and handicraft. Teamwork, emotional intelligence, rational appeal, and empathy will play more important role in the future.

For instance, it has been established that the actual process of communication between a doctor and a patient is crucial to the success of the therapy. If before it was enough just to be a professional, now even a well-qualified engineer or researcher will hardly get by without the use of proper interpersonal communication skills.

Thus, the digital economy and digitalization of production are causing certain occupations to disappear, but they are also creating new jobs higher up the skill ladder and new occupations. The digitalization of production is driving up the demand for IT industry workers and specialists in the area of blockchain technology and cryptocurrency. With ubiquitous informatization increasingly drumming up the demand for this kind of specialists, one should expect them to be among the most sought-after in the labor market in the years to come.

A new potential occupation is virtual habitat design, which could assist a person wearing a VR helmet with the personal styling of a scene. A robot ethics attorney could provide legal counsel regarding the proper treatment of “iron people”. A biohacker could receive an order for revitalizing the body. Or one could have to entrust an archive of digitalized thoughts and memories to a personal content curator.

Some sources also mention specialists in embryo surgeries, dream visualization, online investigations, and holographic teleportation, as well as molecular dieticians, digital tailors, and space tourism guides [22].

B. *Government regulation of the human resources market*

Manpower transformations taking place in a climate of implementation of digital technology may be highly painful for the population, much in this respect depending on the actions of the authorities. Given the substantial effect of technological transformations on society, the nation’s leadership may need to obtain reliable preliminary figures which will be used to forecast the effect of technological changes and work out a relevant policy in the areas of science, technology, innovation, and workforce development. In this regard, it is important to factor in, in developing forecasts of the development of science and technology and implementation of digital technology, relevant manpower support for those processes [23].

‘The Digital Economy of the Russian Federation’, a program signed into law via the Resolution of the Government of the Russian Federation No. 1632-r of July 28, 2017, envisages a set of activities related to the provision of manpower support for digital technology implementation processes, including the development of educational and vocational regulatory documents and requirements for describing a set of key competencies related to the digital economy, with efforts already having been put into pilot-testing them. Among the key objectives to be achieved by 2020 are the following ones: to fully provide with relevant resources and ensure coordinated activity across all establishments and mechanisms of general, vocational, and extended learning in the interests of the digital economy, as well as design sound personal development paths and properly appraise candidates’ competencies for the digital economy. The government is planning on having in place by 2024 a continually upgradeable manpower potential for the digital economy, with a focus on ensuring high levels of digital competence among the general population.

In the West, there have been calls for curbing robotization via the introduction of a special tax for each robot employed. However, nations that have resisted the digitalization of the economy appear to be losing out to countries that have not embraced that kind of measures. Back in the day, the countries of Europe and the US would curb the development of genetic technology and keep it confined to the research lab for ethical reasons – whereas the Chinese, meanwhile, just went ahead and started to test the achievements of genetics on people. As a result, today the US is significantly trailing behind China in the development of genetics.

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III. CONCLUSION

The implementation of digital technology in the economy helps create new opportunities for work, better labor productivity, education, and wider professional qualifications. With that said, it is necessary to take account of the needs of socially unprotected groups, with a focus on creating for them new opportunities for professional growth. The use of digital technology is transforming the relationships between workers and the work they do and between working conditions and tools for the job. Digital technology is changing the structure and principles of work, existing business processes, and the way added value is created today.

The development of the digital economy requires creating the right conditions for preparing a workforce and enhancing the education system. This should result in the creation of a labor market that will rely on the needs of the digital economy and a motivation system that will encourage employees to acquire new competencies based on those needs. Meeting the digital economy's manpower demand will help achieve a sustainable, adaptive, and efficient labor market and provide the preconditions for ensuring social stability in regions in a climate of production digitalization.

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