Digital technologies in mechanical engineering: perspectives, risks

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Abstract. The relevance of the topic is justified by the rapid development of digital technologies in various spheres of life. The purpose of the article is to review the basic concepts associated with digital technologies. This phenomenon has found a place in almost all industries as an integral part of the final product. In this article, an overview of the basic concepts that explain the meaning of digital technology in engineering. The use of digital technologies in industry today for maximum automation of production processes, robotization, creation of deserted technologies - today it is a key vector of technological development of production facilities around the world, which determines their competitiveness. These technologies will be used directly by enterprises and organizations of machine-building, instrument-making and other industries. As a result of this, the economic effect of the use of new technologies will be the exponential growth of income, productivity growth, and as a result, the growth of competitiveness.

1. Introduction
The use of digital technologies in industry today for maximum automation of production processes, robotization, creation of deserted technologies - today it is a key vector of technological development of production facilities around the world, which determines their competitiveness (Galimova, Gileva, 2017).

These technologies will be used directly by enterprises and organizations of machine-building, instrument-making and other industries. As a result of this, the economic effect of the use of new technologies will be the exponential growth of income, productivity growth, and as a result, the growth of competitiveness. (Galimova, Gileva, 2017)

In Russia, the Russian Government Decree of 28.07.2017 № 1632-r "On approval of the program" Digital Economy of the Russian Federation" is in force.

The objectives of this program are:

- to create an ecosystem of the digital economy of the Russian Federation in which data in digital form is a key factor in all areas of social and economic activity and in which effective interaction is ensured, including cross-border, business, the scientific and educational community, the State and citizens;
- to create necessary and sufficient institutional and infrastructural conditions, eliminate existing
obstacles and restrictions for creation and/or develop high-tech businesses and prevention of new obstacles and restrictions in both traditional sectors of the economy and new industries and high-tech markets;
- to improve competitiveness in the global market of both individual sectors of the Russian economy and the economy as a whole.

2. Problem statement

Digital production is the concept of preparing production in a single virtual environment using tools (Gasov, Tiganenko, 1998):

- Formation of production structure (production composition of the product, list of operations, organizational structure);
- Planning of production processes;
- Verifications and assessments of processes in the virtual space;
- Modelling of material flows and logistics;
- Generation of documents (routes, operational instructions, control programs);
- Production Management (MES-systems).
- Reducing errors in real production:
  - early detection of errors;
  - bug fixing;
  - less set-up time.

At present, our country is at the stage of scientific and technological development, when completely new horizons of technological possibilities open up. With the development of technology, the number of measured and controlled parameters for managing production processes increases. Their processing is impossible without using a computer and special programs. The computer is a means of integrating different machines and devices that are not connected to each other in any way. Experts consider the process of computer integration, which has begun, to be the most important process in the history of mankind from the point of view of influence on the development of industry, thinking of people, their way of life. Today, it is already one third of the machines and devices are made with the possibility of connecting them to a computer.

The appearance of some new development in combination with already used technologies causes a new technological leap (camera - digital camera, phone - mobile phone, machine - CNC machine, etc.). To date, experts consider such technologies as IT-technologies and the Internet. It is the Internet that is associated with the concept of "Industry 4.0", which has become a kind of synonym for the fourth industrial revolution (Gasov, Tiganenko, 1998). Connecting to the Internet equipment and entire industries will not only make many processes more efficient, flexible and cost-effective, but will fundamentally change the traditional logic of production, when intelligent machines will independently, without human intervention, to transmit and receive through the Internet necessary information to work. One of the expected effects is the degree of production flexibility that is not available today and, as a result, the ability to produce a single product at the cost of mass production (Gasov, Tiganenko, 1998).

The expectations associated with "Industry 4.0" have been reinforced by government support in many countries. Thus, the German government, where the term "Industry 4.0" came from, defined this direction as part of the country's high-tech development strategy and allocated about €1 billion for its implementation (Belova, 2017).

Projects of "Industries 4.0." envisage active integration of new generation industrial robots into technological processes not only in production, but also in social and domestic environment of people's life (Belova, 2017).

Thus, by Presidential Decree No. 623 of December 16, 2015. "On the National Center for Development of Technologies and Basic Elements of Robotics", robotics is included in the priority areas
of science, technology and technology development in Russia and in the list of critical technologies of the country.

Robots in industry have been used quite actively in recent years. And that's no surprise at all. This equipment operates without breaks, holidays and weekends and is more cost effective. Whereas people get tired, sick, need breaks, rest and wages.

In most cases, production robots replace the efforts of at least a few specialists. They do not require constant monitoring of work and make the process better, faster and, most importantly, more permanent. If a person can make a mistake, be late or leave, the technique always functions unambiguously and ensures a really high performance.

Thus, investments in the acquisition of industrial robots are very promising and important for mechanical engineering.

For robotics as a dual-purpose sphere, the state approach is of fundamental importance, as it will find its continuation in education, research and implementation activities.

To assess the relevance of implementing the robot in the processing process, we give a number of advantages:

- Performance;
- Improved economic performance;
- Processing quality;
- Security;
- Minimizing the workspace;
- Minimal maintenance.

In today's world there is a rapid growth in the world of sales of industrial robots, which has no pronounced economic reason. In 2014, sales volume grew by 27% to 225 thousand robots per year. Now there are 1.5 million industrial robots in the world. At present rates, the world fleet of robots can double and triple in 5-6 years. By 2025, the world market for industrial robots may reach $24.4 billion, which corresponds to an average annual growth rate of 8.3% and is ahead of the economic development of all countries. By the year 2025, the world market for industrial robots may reach $24.4 billion, which corresponds to an average annual growth rate of 8.3% and is ahead of all countries' economic development figures. 15-25% of industrial and agricultural jobs in developed countries may be occupied by industrial robots (Belova, 2017).

| Table 1. Digitalization risks for mechanical engineering. |
|----------------------------------------------------------|
| **Risks and its characteristics** | **Protection methods** |
| Important information leaked to competitors. All modern production facilities use digital machines, which store a lot of important information. Bad security of such machines is fraught with the fact that the information can be "merged" with competitors or even removed. | To build an effective technology of information protection, which excludes losses due to various reasons and successfully reflects different types of threats. |
| Economic lagging behind the leading countries. Not all countries can "catch a technological wave." In this case, such countries may be outsiders in the competition, resulting in lower economic efficiency. | There is a need for systemic measures to stimulate growth in the domestic IT industry. We need to make more domestic companies and organizations able not only to develop technologies, but also to offer them to the market as a final, commercially successful product. |
| Unemployment. Robotizing industries and services increases | This problem is much more complicated, as the modern world does not stand still and everyone is... |
unemployment by an order of magnitude. Many of today's professions and competencies are disappearing for lack of demand. For example, a conveyor worker actively replaces a robot, which will lead to the disappearance of this profession in the future. Trying to use the latest digitalization technologies. However, most of the professions cannot be fully automated. Therefore, the battle between a machine and a person does not end with the latter being fired. Rather, he is changing his work tasks. There are more creative operations and fewer templates.

Lack of qualified personnel in IT sphere. This problem should be solved both at the level of educational institutions (educational courses at schools and universities), at the level of companies (corporate training), and at the level of the state (state programs of education development in the field of IT).

Technological risk. In order for the benefits of digital technology to fully manifest themselves, organizations in the real economy need to develop them in a balanced manner. In this respect, if one segment of real production works in accelerated rhythm and quality, i.e. in digital mode, and the other segment works in slow and poor quality, in the old way, then the result will be slow and unsatisfactory. The program "Digital Economy of the Russian Federation" has been developed. The program sets a task to implement 10 promising "digital" technologies (3.1.5.) and 30 projects with high commercial potential, which should balance all segments of real production.

3. Findings

Taking into account the new perspectives, the evolution of tasks solved by robotics at different stages of its development, which do not replace, but exist today in parallel, is interesting. Today, we are talking about the creation of a fundamentally new generation of robots whose capabilities should exceed those of natural abilities (mechanical, sensory, visual, intellectual, etc.). And here the main scientific and practical problem in the development of new robot technologies is to find solutions at the joints of previously isolated areas of knowledge, such as engineering and the subject area in which the robot is introduced (Belova, 2017).

General trends (mobility requirements, individualization, care for health, safety and comfort, etc.) also influence the development of industrial robotics. Not only the tasks that robots solve are changing, but also the nature of human-robot interaction. For example, the safety of a modern industrial robot can be achieved not only by creating a deserted production facility or isolating the robot. Already today, there are robots that are able to interact with humans, to change their behavior depending on the proximity of man. There are robots that can be used by the operator to set new tasks with the touch of a hand.

When the robot is used, productivity usually increases. Above all, this is due to faster movement and positioning during processing, and the ability to automatically work 24 hours a day without interruption or downtime also plays a role. If a robotic system is used correctly, productivity increases by a factor of several times or even an order of magnitude compared to manual production. It should be noted that with a wide range of products, constant changeovers, the need for a large number of peripheral equipment for different parts, productivity can also be reduced, making the process inefficient and complex.

By replacing a person, the robot effectively reduces the cost of paying for specialists. This factor is especially important in economically developed countries with high wages of workers and the need for large allowances for processing, night time, etc. If a robot or an automated system is used, all that is needed in a shop floor is an operator who controls the process and the operator can control several systems at once.
In case of initial purchase, a robot cell is a serious financial investment and the company is interested in its quick payback. Incorrect use of equipment and errors in its configuration and arrangement can lead to an increase in processing time or labor intensity of work, thereby reducing the economy of production.

Frequently the reason of introduction of technological system based on industrial robot becomes necessity of maintenance, set in the documentation on a product of quality of processing.

High accuracy of positioning of industrial robots (0.1 - 0.05 mm) and repeatability ensure proper quality of the product and eliminate the possibility of manufacturing defects. The elimination of human error minimizes operating errors and keeps repeatability constant throughout the production program.

The use of the robot is quite effective in harmful production that has an adverse impact on humans, such as in the foundry industry, cleaning of welds, painting, welding processes, etc. In cases where the use of manual labor is restricted by legislation, the introduction of the robot may be the only solution.

When working in the workshop, the perimeter of the working area is fenced with various devices to prevent a person from entering the robot's area of influence. The availability of security systems is the main and essential prerequisite for the safe operation of robotic systems around the world.

A properly packaged robot cell based on an industrial robot is more compact than a work envelope for manual work. This is achieved by a more ergonomic design of the robot's assembly chambers, the robot's small footprint, the ability to hang the robot, etc.

Modern industrial robots, thanks to the use of asynchronous motors and quality gearboxes, are virtually maintenance-free. Special stainless steel robotic models are available, e.g. for medical and food applications, high and low temperatures and in aggressive environments. This makes them less susceptible to the environment and increases the wear resistance of the equipment (Belova, 2017).

For example, HRL Laboratories employees have developed a special proceramic polymer. After "growing" the product with the help of digital technologies it undergoes pyrolysis process and as a result it becomes ceramic with uniform shrinkage and practically without porosity. The material becomes capable of withstanding temperatures of at least 1700°C. The authors of the research have developed not only a new material, but also a new process of growing the object in a liquid medium. The production of such materials is of interest for the manufacture of engine components, thermal protection systems, porous burners, electromechanical microsystems and electronic units. Fig. 1 shows the possibilities for the production of ceramic products with the help of 3D-printer. Production of such materials with the help of digital technologies has allowed increasing productivity and economic efficiency by several times.

4. Conclusion

To achieve the goals of the "digital economy of the Russian Federation" program it is necessary to:

- create at the industrial enterprise a single information space, with the help of which all automated enterprise management systems, as well as industrial equipment, production personnel can quickly and timely exchange information;
- use state-of-the-art software for production preparation, production management and resource management;
- computerize workstations and production equipment;
- create key conditions for IT training in mechanical engineering;
- establish an effective technology to protect information from leaks;
- establish a permanent mechanism for managing change and competences (knowledge) in the field of digital economy regulation;

Today there is a rapid development of digital technologies in various spheres of our life. Specialists and managers of companies understand that without the use of digital technologies they will no longer be able to successfully compete on both domestic and foreign markets.
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