TECHNOLOGIES OF 4.0 INDUSTRY: IMPACT ON THE PERFORMANCE IMPROVEMENT OF INDUSTRIAL COMPANIES

ABSTRACT

On the one hand, the idea of the fourth technological revolution is conceptual, since it formulates an understanding of the changes that are in progress, and on the other hand, it is institutional, since it creates the foundation for a number of political initiatives generated and supported by government and business for improvement of research and development programs. Questions are considered:

- Where does the third industrial revolution end and the fourth begin?
- What are the distinguishing features and elements of 4.0 Industry?
- What changes are expected for industry and enterprise?
- What is the new needs of consumers?
- What changes are expected for industry and enterprise?

In the context of these systems, the concept of the fourth industrial revolution was first formulated as «4.0 Industry» (Schwab, K., 2016). Since the concept appeared, many scientists have become interested in it, they have gone deeper into studying of new industry aspects. Also critics point out that there is no revolution in the classical sense, that current changes are nothing more than deepened automation, and the term itself is just a trend name (Policy department A, 2016).

In order to apply this concept to the Russian realities and formulate specific initiatives for the industry development, it is necessary to answer the following questions:

- Where does the third industrial revolution end and the fourth begin?
- What are the distinguishing features and elements of 4.0 Industry?
- What changes industries and enterprises should expect?

4.0 INDUSTRY CONCEPT: CONCEPT AND MAIN ATTRIBUTES

To answer the question of where the third industrial revolution ends and the fourth begins we need clearly define the boundaries of «4.0 Industry». The concept has been intensively developed over the past few years, and now it is possible, basing on number of researches to study the required attributes and key technologies of «4.0 Industry». The table contains some definitions.

From previous revolutions, 4.0 Industry is distinguished by the following required characteristics:

- **Digitalization and vertical integration on the value chain.**
  - «4.0 Industry» provides digitalization and integration of vertical processes throughout the organization, from product development and procurement to production, logistics and service. All data on operational processes, their efficiency, quality management and operational planning are available in real time in a single information space, optimized for different platforms (Bauer H., Patz A., Veira J., 2016; Trachuk A. V., 2014).

- **Digitalization and horizontal integration of several value chains.** Horizontal integration goes beyond the

<table>
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<th>Definitions of «4.0 Industry» term</th>
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<tr>
<td>«4.0 Industry» provides pervasive digitalization of all physical assets and their integration into the digital ecosystem along with partners involved in the value chain</td>
<td>[4.0 Industry, 2016, p. 4-5]</td>
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<td>Industry digitalization through integration of sensing in the components of products and in production equipment, the use of cyberphysical systems, data analysis</td>
<td>[Industry 4.0: How to navigate, 2015, p. 10-14; Bauer H., Patel M., Veira J., 2016]</td>
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<td>The transformation of production, based on advanced technologies and involving the connection in a single system of sensors, equipment, products and IT systems along the chain of creation, value both within a single enterprise and beyond its limits</td>
<td>[Gerbert P., Loreau M., Flamand M. et al., 2015, p. 2-4]</td>
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<td>The key postulates of 4.0 Industry are the integration of physical elements of production and IT systems aiming to develop and use cyberphysical systems for production.</td>
<td>[Hertez J., Ovičkara J., 2016]</td>
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<td>Interconnection of information and communication technologies and production systems</td>
<td>[Meisner H., Iluz R., Auriaca J. C., 2017]</td>
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<td>The Industrial Revolution, based on cyber-physical production systems (CPPS), through which the physical and virtual worlds unite</td>
<td>[Schloepfer R. C., Koch M., Merkerof P. 2015, p. 3-9]</td>
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<td>Integration of all departments that create value, and other elements of the enterprise through digitalization. At the factory of the future, information and communication technologies are automated production technologies are fully integrated. All subsystems, including non-manufacturing within the enterprise, as well as external partners, suppliers, original equipment manufacturers (OEMs) and consumers are linked and consolidated into a shared network</td>
<td>[The Factory, 2016]</td>
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<td>Technological evolution, that suggests transition from embedded systems to cyber-physical systems. The paradigm shift from centralized to decentralized. Interaction of real and virtual worlds. Connecting embedded systems of production and «smart» production processes</td>
<td>[Industry 4.0, 2014, p. 8–10]</td>
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The article was prepared on the basis of the research results «Obstacles and drivers of structural changes in the Russian manufacturing industry», carried out at the expense of budgetary financing within the framework of the government task of the Financial University, 2017.
Key technologies are the basis of «Industry 4.0»; without them, it is problematic to implement all the previous capabilities. 4.0 Industry suggests that functional units within a separate digital ecosystem do not provide digitalization and integration. Without developed technologies it is problematic to implement all the previous attributes from a practical point of view [Geissbauer R., Schrauf S., Koch V. et al., 2014; Trachuk A. V., Linder N.V., Antonov D.A., 2014].

- **digitalized production processes**
- **digitalized control panels**
- **digitalized products and services**
- **digitalized goods**

Digitalization of goods involves the addition of existing products with intelligent sensors or communication devices that are compatible with data analysis tools. Thanks to this, the introduction of new methods of analytics, companies have the opportunity to obtain data on product usage and to refine these products in accordance with the new requirements of end users [Bauer H., Patel M., Veira J., 2016; Trachuk A. V., Linder N.V., Ubeiiko N. V., 2017].

**Technologies**

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- **new digital business models**
- **new revenue options**
- **new digital ecosystems**

**Platforms**

For example, Technomatix from Siemens PLM Software is a software platform family designed to automate the production solution in a three-dimensional space, simulation modeling, programming of industrial robots in offline mode, virtual commissioning of lines and analysis of collection taking into account dimensional deviations.

**Integration of IT systems**

In many companies, in Russia as well, information systems are not integrated or partially integrated. Also, it is extremely rare for manufacturers, suppliers and customers to integrate. 4.0 Industry suggests that functional units within a separate digital ecosystem do not provide digitalization and integration. Without developed technologies it is problematic to implement all the previous attributes from a practical point of view [Geissbauer R., Schrauf S., Koch V. et al., 2014; Trachuk A. V., Linder N.V., Antonov D.A., 2014; Linder N.V., Arsenova E.V., 2016; Trachuk A. V., 2013].

**Digital products and services**

Modern robots are tuned and designed to interact with each other and with employees, independently learn and optimize their own operations. For example, Kuka company creates autonomous robots that can modify and correct their actions depending on the next product on a line. Sensors and control panels allow them to interact with a person. ABB launches a YuMi robot with two manipulators designed to assemble products (for example, consumer electronics). Manipulators and computer vision allow robots to interact safely with people and recognize the details.

**Simulation (modelling)**

Virtual modeling of products, materials and processes is already being applied at the engineering development stage; in the future, its application will expand to simulate a full cycle of operational and production processes. These models allow us to create a virtual copy of real production involving machines, products, and employees. This will allow operators to test and optimize the equipment settings for the next product on the line model before making the change directly on the physical production. As an example, Technomatix from Siemens PLM Software is a software platform family designed to automate the production solution in a three-dimensional space, simulation modeling, programming of industrial robots in offline mode, virtual commissioning of lines and analysis of collection taking into account dimensional deviations.

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TRENDS IN THE MARKETS WITHIN THE FRAMEWORK OF THE 4.0 INDUSTRY

Investments growth and new technologies. 4.0 Industry implies a significant increase in investment in fixed assets and intangible assets. This can be seen if you allocate investments in the described technology 14.0. Fig. 3 shows the total investment of Germany [Hoffmann R., 2016], which in 2011 marked the priority of the country’s technological development.

Growth in the number of mergers and acquisitions and strategic alliances. As modern technologies develop at a phenomenal pace, companies do not have time to develop all the necessary competencies on their own. In the industrial sector, there is a trend towards an increase in the number of mergers and acquisitions (Fig. 4) [Technology, [s.a.]].

Fig. 4. The number of transactions in the market of mergers and acquisitions in the world with the participation of industrial high-tech companies [Technology, [s.a.]]

GROWTH OF THE DECISION MARKET FOR AUTOMATION SALES

An obvious consequence is the growth of markets and sales volumes of all the supporting technologies, which proves the dynamic development of 4.0 Industry. Fig. 5 shows the dynamics of growth in the volumes of the automation market [Global factory automation market, 2017]. Almost all sectors that create technologies in Industry 4.0 have demonstrated significant growth. A particular example is the dynamics of sales of industrial robots [Worldwide sales, 2017] (Figure 6). These and other trends largely shape the future of the industry, they should be taken into account both by the state and business. In addition, these trends indicate the growth of a number of markets, which creates new opportunities for companies seeking to find their niches.

Fig. 5. World dynamics of the volume of the industrial automation market, billion dollars. [Global factory automation market, 2017]

NEW MODELS OF FACTORIES

In the long term, Industry 4.0 will not only affect existing plants, increasing their operational efficiency through the use of breakthrough technologies, but will also lead to the formation of the next generation of organizational and technical models of plants.

Today, three main models are formed depending on the approach to meeting the demand [Industry 4.0: Howtonavigate, 2015] (Fig. 7).

Fig. 7. Three new models of plant organization

«Smart» automated plants are aimed at mass production of products with a low cost price. Key technologies: a full range of technologies in Industry 4.0 is applied throughout the entire production chain.

Case. Plant i3 (BMW, Leipzig) demonstrates a high degree of automation and robotics usage and application. «Smart» production is used to automate the entire production line, including the body, paint and assembly shops. The movement of products along the production chain is monitored in real time using radio frequency tags (RFID). Factory operators use mobile devices (tablets) to monitor production systems and process data. The management function is centralized in the head unit of employees who make managerial decisions, which act as a kind of “central nervous system” of the factory.

Customer-oriented factories tend to react quickly to market changes and suggest creating a personalized offer for the client in significant quantities at an affordable price. Key technologies: a full range of technologies in Industry 4.0 is applied throughout the entire production chain.

Case. Concern Siemens AG (Germany) has developed a digital copy of one of its plants by collecting data from sensors on equipment. This initiative allowed to reduce the time for setting up the equipment by an average of 80%.

These improvements in production significantly affect the financial performance of companies. The main effects resulting from the transformation of a number of industries both in foreign companies and in Russian companies are shown in Fig. 2.

Fig. 3. Germany’s total annual investment in the industry is 4.0 billion euros

CONCLUSION

In the article various definitions of the term «4.0 Industry», which has been used for more than 10 years to describe modern innovative approaches to the organization of production. In spite of the variety of interpretations, the term is well established, because according to the results of the analysis of sources, indications of 4.0 Industry were identified, with which according to exact explications.

Since modern technologies are based on modern technology, a short list of key technologies that provide the realization of the «4.0 Industry» concept in practice is formed, the directions of their use are given. The driver of production transformation is the desire to increase the efficiency and productivity of the enterprise, as demonstrated by the interconnection implementation of technology - the effect on production - the impact on financial results.»

Of course, any large-scale transformation of entire sectors of the economy has a significant impact on the associated markets, which is illustrated by a brief overview of the dynamics of sales of industrial robots, automation solutions, growth of transactions in M & A markets, and growth in investments. For further scientific research approaches to the organization of new plants are an interesting direction. The article considers
three perspective models of plants that provide technologies and examples of their use in specific companies. Nevertheless, the information given about the factories is related to the top level, primarily because detailed information about business processes, effects, production statistics is closed and for understandable reasons, leading companies do not distribute it. So, in the future it would be interesting to conduct an in-depth analysis of concrete cases of digital transformation of productions with subsequent generalization of the results obtained.

REFERENCES

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