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DEVELOPING PRODUCTION TECHNOLOGIES IN THE CONTEXT OF GLOBAL TECHNOLOGICAL CHALLENGES

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Abstract: *The article substantiates writing a methodology to study the present condition and development of production technologies at Russian manufacturing enterprises in the context of priority scientific and technological development of Russian economy. The basic methodology used in the study are system and process approaches that are applied to the scientific and practical material of general systems theory, organization theory, as well as engineering and technological approach. The scientific concept of production technologies development at manufacturing enterprises is aimed at identifying the multifaceted nature of technologies and expanding multiple use of new technologies in domestic manufacturing industry within the framework of priorities for the scientific and technical complex of the Russian Federation. A business model that can provide achieving of the task, affect the technology orientation of a manufacturing enterprise and the choice of an acceptable business decision is proposed and substantiated as a practical implementation of the concept of production technologies development. The main applications of obtained results will be adjusting the content of state programs by adding subprograms (sections) on technical re-equipment in accordance with new technological mode; identifying the events aimed at supporting research in the field of digital and additive production, robotics, and new production technologies in competitions held among institutes for the development*

Key words: *production technologies, manufacturing industry, technological development, model, concept, assessment.*

INTRODUCTION

Holistic vision of the development of production technologies.

The need for fundamental studies assessing the state of production technologies in manufacturing industry is determined by building theoretical and conceptual scientific foundation in the field of engineering and technological development of Russian economy. These theoretical research are aimed at proving feasibility of providing competitiveness and independence of our country through the system able to increase and fully use the country's intellectual potential. For the last 6-8 years, the gap separating Russia from key technological areas is undoubtedly a critical factor significantly hampering technological leadership and resulting in the loss of a significant share of technology market.

An important role in pursuing priorities for science and technology development should be assigned to manufacturing industry, which is able to provide a real increase in added value due to introduction of progressive innovative technologies and elimination of the technological backwardness of manufacturing capability. In this regard the development of a theoretical and methodological support to develop production technologies in the manufacturing industry of Russia becomes a fundamental task. It is necessary to add the technologies that are currently not developed and not used in the production activities of foreign companies to the list of key technologies. Undoubtedly, developing these technologies Russia is very likely to be able to secure its leading position as in the coming years not only technologies and equipment, which are universally

available, will be the main competitive factor, but also innovative ideas that can fundamentally change economy as a whole and the process of its development in particular.
At the same time, the introduction of advanced technologies in the industrial sector of Russia is an absolutely necessary and correct step leading to progress.

1. THEORETICAL RESEARCH

Theoretical substantiation of the current state and main directions of research in production technologies.
Most modern theories on production technologies as a factor in development of production explain differences in the availability of technologies for international trade based on these technologies. Some theories explain changes in technologies and their impact on the results of international trade. These include the technological gap model by Michael Posner (Posner, 2006) according to which countries can have temporary monopolies on production and export of goods by developing new technologies.
Among foreign research it is worth mentioning the technical change model by John R. Hicks (Hicks, 1998), which says that technical change should be considered as labor-saving, capital-saving and neutral. Capital is intended to replace labor due to labor-saving technical change. Labor productivity inevitably increases with capital-saving technical change. Neutral technical change suggests reducing the amount of capital and labor per production unit.
The strategic characteristics of engineering and technological, innovative development of Russian economy are examined in the works of A. Varshavsky (Varshavsky, 2017), N. Komkov (Komkov, 2017) and I. Frolov (Frolov, 2007), V. Klochkov (Klochkov, 2017), H. Shepard and E. Dandon (Shepard & Dundon, 2006), V. Varfolomeyev (Varfolomeev, 2013) and many other modern economists.
The problems of technical modification and revamp of production, the innovative potential of industry are viewed in the works of G. Kleiner (Kleiner, 2017), O Turovets and V. Rodionova (Turovets & Rodionova, 2016), Y. Gerasina (Gerasina, 2016), A. Streltsov (Streltsov, 2016) and others.
Given the current state and the main directions of world scientific research on production technologies in manufacturing industry, the world's major scientific competitors involved in developing theory and practice of close to production technology issues are the following countries: Germany and Japan are at the top of the list as the countries focusing on studies about providing key industries with manufacturing equipment.
The USA, China, Italy and Switzerland hold rather strong positions in research of manufacturing equipment; the United States due to its technological advances is the leader in high technologies and has achieved great results in study of integrated electronics technologies.
The US, Japan, Germany, Britain, France are leaders in studying clean technologies.

2. RESULTS

Interrelation between production technologies and global technological challenges
At present, the important factors influencing the development of production technologies at Russian manufacturing enterprises are as follows:

1) enhanced influence of world technology trends on production technologies in Russian manufacturing industry under existing sanctions regarding the purchase of a wide range of foreign high-tech equipment and advanced technologies.
2) development of production technologies in the Russian Federation is marked by lack of mutual interest shared by all parties involved in the process: there is no competitive domestic market for technologies and equipment; due to high risks businesses mainly plan their activities for 1.5-2 years in advance; the education system is either “not shaped” or only partly shaped for modern and prospective technologies, etc.

The key problem of Russian manufacturing industry is reluctance to face global technological challenges both economic-wise and business-wise. Thus, over the past five years the share of businesses carrying out technological innovations in the manufacturing industry of the Russian Federation has increased by 0.9% (Science, Innovation…, 2019), which cannot be considered satisfactory in comparison with foreign competitors.
At the same time, current economic difficulties, the lack of sources for financing technological transitions are counter-balanced by all-Russia major investment and infrastructure projects, projects related to the oil and gas fields developed by large Russian companies, innovation development programs, R & D, industrial state programs, subsidies and grants of institutes for development, internal funds, etc.
However, it is possible to solve this problem due to large-scale technological update of Russian economy.
There exist real conditions and opportunities for developing manufacturing industry.

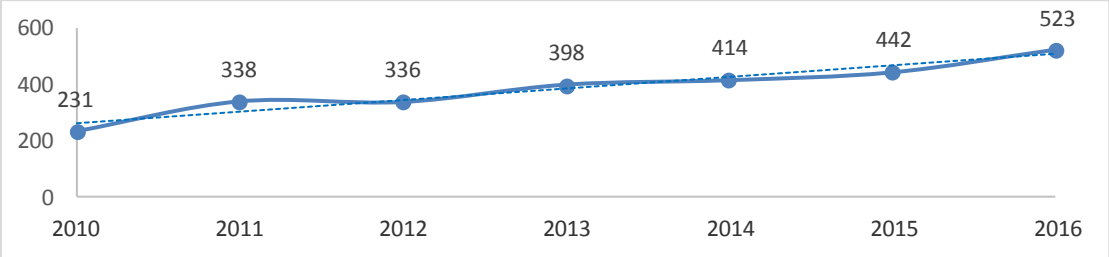
According to the Federal State Statistics Service, we can trace increasing stability in the number of advanced production technologies developed in the manufacturing industry of the Russian Federation (table 1, picture 1).

Table 1. The number of advanced production technologies developed in the manufacturing industry of the Russian Federation, units

2010	2011	2012	2013	2014	2015	2016
231	338	336	398	414	442	523

Source: Technological Development of Economic Sectors / Federal State Statistics Service, (2019). - http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/ru/ statistics / economy development / #

Picture 1. The number of advanced production technologies developed in the manufacturing industry of the Russian Federation, units



Source: Authors' research

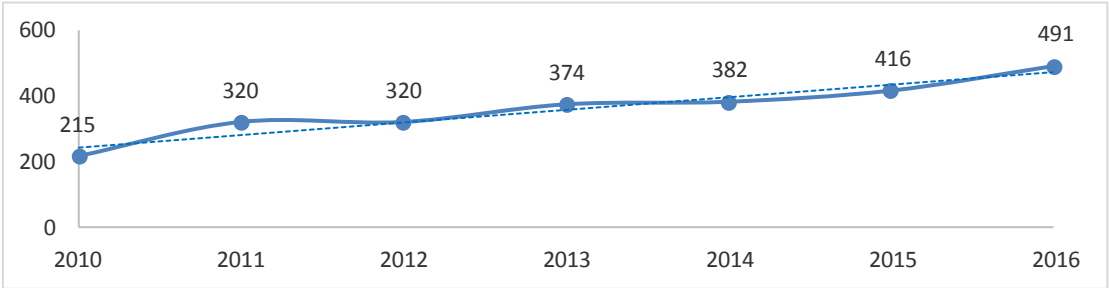
The positive trend is almost a double increase in the number of advanced production technologies new for Russia and developed in the manufacturing industry of the Russian Federation (table 2, picture 2).

Table 2. The number of advanced production technologies new for Russia and developed in the manufacturing industry of the Russian Federation, units

2010	2011	2012	2013	2014	2015	2016
215	320	320	374	382	416	491

Source: Technological Development of Economic Sectors / Federal State Statistics Service, (2019). - http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/ru/ statistics / economy development / #

Picture 2. The number of advanced production technologies new for Russia and developed in the manufacturing industry of the Russian Federation, units



Source: Authors' research

We can trace unstable dynamics regarding the number of fundamentally new and advanced production technologies developed in the manufacturing industry of the Russian Federation, but in general, the trend is positive. For example, for the past five years, the number of technologies has increased by 16 units (table 3, picture 3).

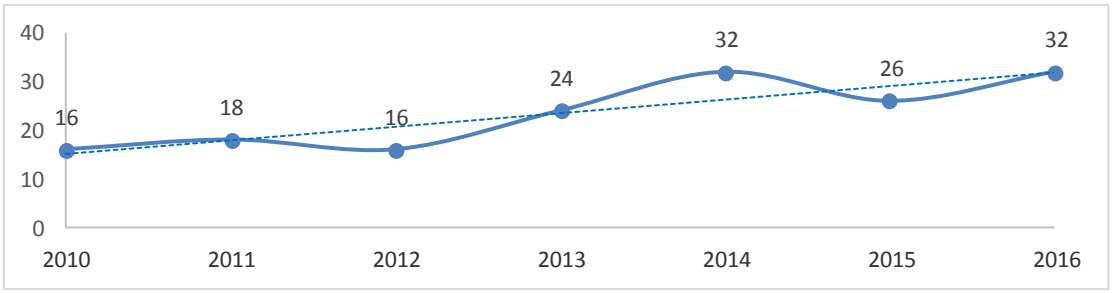
Table 3. The number of fundamentally new advanced production technologies developed in the manufacturing industry of the Russian Federation, units

2010	2011	2012	2013	2014	2015	2016
16	18	16	24	32	26	32

Source: Technological Development of Economic Sectors / Federal State Statistics Service, (2019). -

http://www.gks.ru/wps/wcm/connect/rosstat_main/ rosstat/ru/ru/ statistics / economy development / #

Picture 3. The number of fundamentally new advanced production technologies developed in the manufacturing industry of the Russian Federation, units



Source: Authors' research

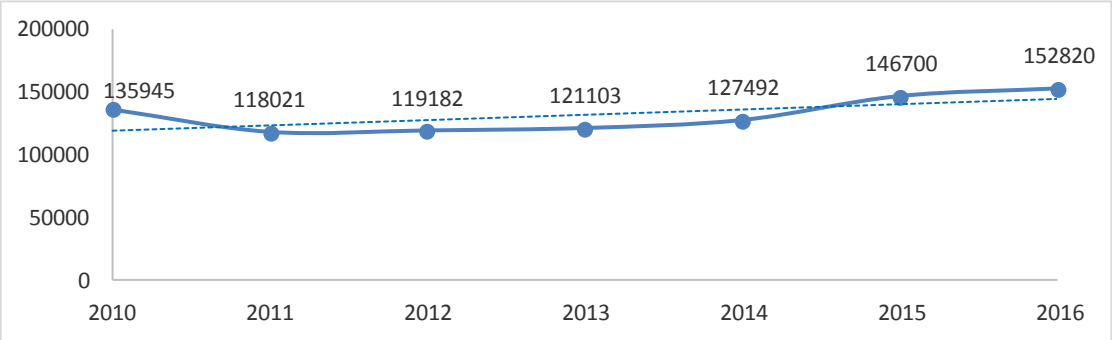
However, regarding the number of advanced production technologies used in Russian manufacturing industry the indicator values do not exceed more than by five thousand, which proves the willingness of enterprises to extensively use these technologies in their activities (table 4, picture 4).

Table 4. The number of fundamentally new advanced production technologies developed in the manufacturing industry of the Russian Federation, units

2010	2011	2012	2013	2014	2015	2016
135945	118021	119182	121103	127492	146700	152820

Source: Technological Development of Economic Sectors / Federal State Statistics Service, (2019). - http://www.gks.ru/wps/wcm/connect/rosstat_main/ rosstat/ru/ru/ statistics / economy development / #

Picture 4. The number of fundamentally new advanced production technologies developed in the manufacturing industry of the Russian Federation, units



Source: Authors' research

The technological factor is becoming the determinant factor of economic growth, a convincing argument for supporting the state's economic policy, a key element of the production competitiveness. At the same time, an increase in production of high-tech goods meeting the requirements of a competitive market helps to stimulate the corresponding technological shifts in related industries thereby providing increase in technological level and changes in the structure of employment and production.

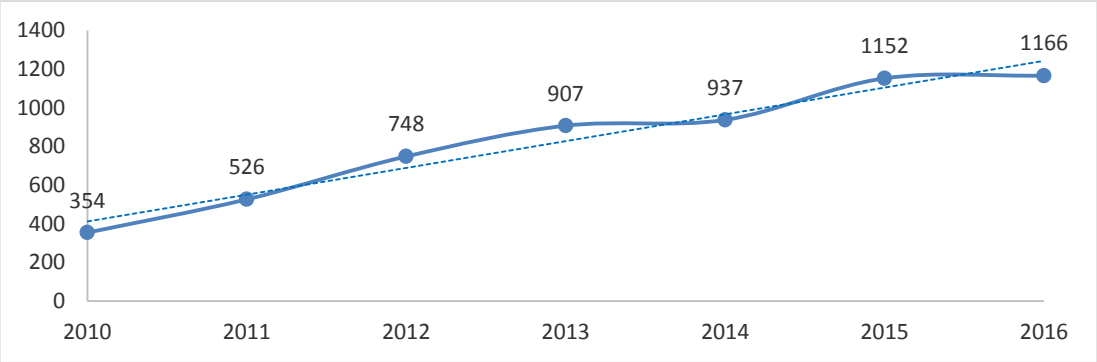
In this regard it worth mentioning the great number of nanotechnologies implemented on the territory of the Russian Federation (table 5, picture 5).

Table 5. The number of nanotechnologies used on the territory of the Russian Federation, units

2010	2011	2012	2013	2014	2015	2016
354	526	748	907	937	1152	1166

Source: Technological Development of Economic Sectors / Federal State Statistics Service, (2019). - http://www.gks.ru/wps/wcm/connect/rosstat_main/ rosstat/ru/ru/ statistics / economy development / #

Picture 5. The number of nanotechnologies used on the territory of the Russian Federation, units



Source: Authors' research

4. DISCUSSION

Conceptual approach to the study of production technologies.

Most researchers clearly recognize the need for a technological component in determining the parameters of economic growth (Schumpeter, 2008; Schwab, 2016; Tsvetkov & Sukharev, 2017). However, very often, questions arise when we are trying to measure the share of technological factor, clarify the technological structure of the economy, identify the dynamics of technological mode and its life cycle, determine the interrelationship between civilization and technology development, the role of government institutions in shaping the technological policy of the industrial complex of the country. New methodological approaches, holistic vision of the scope and subject matter of the research are needed to answer these questions.

Since such issues are extremely important, rather than stating the technological backwardness of the Russian manufacturing industry the representatives of the Russian scientific community should focus on methodological substantiation of the technological transition of the domestic industry in the context of current key trends and existing domestic and global challenges.

Consequently, the scientific concept of production technology development can provide the solution to the problems related to the lack of modern Russian business model of production technologies development in domestic manufacturing industry. The initial objective and logical foundation of such concept should be a thesis about the competitiveness of the industrial sector of the country's economy determined by the level of technological development and the availability of highly qualified staff. In turn, the development of production technologies means the dynamic systemic process of organizing production activities based on use of equipment and technologies that best meet the global technological mode and the requirements of a competitive market.

Thus, the key objective is to develop the concept and methodology of building a model of production technologies development in manufacturing industry of the Russian Federation in the context of priority scientific and technological development of Russian economy. In this regards the goal-oriented tasks are as follows:

1. Substantiating the concept of production technologies development as an objective process and the current stage of global economic system development related to studying the possibilities of using key elements of new technological mode such as digital production, additive manufacturing, robotics, etc. in manufacturing industry.
2 Building production technologies development model specific for Russia and representing a contradictory process taking place under the influence of specific external and internal factors.

Methodologically wise it is advisable to apply an engineering and technological approach, the purpose of which is explained by four reasons.

Firstly, at modern industrial enterprises there are objective prerequisites for creating favorable conditions to implement production technologies in the fields of expertise of parties involved. Reducing resistance to these positive processes or completely eliminating such resistance is possible only through the efforts of industrial enterprises themselves, their affiliated companies, as well as representatives of governmental authorities. However, the development and promotion of new technologies has certain functional characteristics and is associated with the conditions and approach chosen in regard to providing and implementing technologies.

Secondly, the existence of general and special functions of regulating the processes of production technologies development. General functions suggest developing a strategy of industrial technologies, and setting a goal and objectives. Special functions mean that parties involved in production technologies development focus not only on traditional areas of production and economic activities (primary production, auxiliary production), but on carrying out technological innovation.

Thirdly, it is advisable to split the development of production technologies into five key specific stages such as creation of a database of production technologies development; search for partners ready to be involved in the development of production technologies; evaluation of the synergy of production technologies development; business negotiations; the process of implementing technologies.

Fourthly, the ability to track changes in applying production technologies. Traditionally, this is achieved by comparing planned and achieved quantitative indicators of the implemented technologies (Ashby, 2009). Special indicators to a great extent showing characteristics of technological growth strategy at industrial enterprises are used as evaluation criteria of technology use in manufacturing industry.

At the same time, there is lack of research on production technologies development in manufacturing industry and the role of these technologies in shaping the strategy of scientific and technological development of the Russian economy.

This can be explained by a number of reasons: the absence of uniform methodological approach to defining production technologies and recognizing the real necessity of their application in modern Russian economic science.

The current development of Russian economy is characterized by clear disproportions of engineering and technological relations in most industries. As a result, it is common practice that scientific research do not pay much attention to technological component, its functions and role in the development of the economy. Thus, the existing theoretical approaches in the study of production technologies make an important contribution to understanding its essence, purpose and prospects.

However, these approaches only partially reveal the specific character of its functioning, as well as its impact on the economy. It is an engineering and technological approach one should use to provide the conditions for creating Russian model of production technologies development in manufacturing industry, the model allowing to show the innovative potential of production technologies development (A. Miller & M. Miller, 2016).

CONCLUSION

Therefore, the study showed that as to industrial enterprises at present there is no single systemic approach to the development of production technologies, which does not allow for organizing an effective system of engineering and technological policies focused on global technological challenges. At the same time, the development of production technologies is a dynamic creative process. Planning development of production technologies means that all efforts of enterprises, analytical methods and management techniques should be aimed at achieving one common goal, that is, to help enterprises to comply with the priorities of scientific and technological development. To achieve this goal, one has to fully use all methodological and procedural approaches allowing to achieve planned results by improving the feasibility and efficiency of plan at the stage of designing basic production and technological processes as well as methodological procedural tools to economically assess the influence of production technologies on production activities in manufacturing industry.

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SUMMARY

The expected results correspond to the current trends in global economy, are in line with the global priorities of the engineering and technological transition in production and economic activities of industrial entities, and represent the concept of production technologies development which complements the theory of neoinstitutionalism thereby contributing to the substantiation of modern scientific base of economic research on global level. The results consist of theoretical substantiation of the content and development of steps to implement a business model for production technologies development in manufacturing industry within the framework of sanctions and provide a list of fundamentally new areas of research on production technologies development in manufacturing and other industries.

The article focuses on the need to build a new scientific concept of developing production technologies in manufacturing industry, a concept aimed at identifying the multifaceted content and multiple use of production technologies in domestic manufacturing industry within the framework of the priority scientific and technological complex of Russia. The proposed concept of developing production technologies in manufacturing industry reveals the goals and objectives of production technologies, organizational and economic procedure providing the development of production technologies, methodological basis for building a system of production technologies in manufacturing industry in the context of a dynamic external environment. The difference of the proposed concept is in: 1) integration of systemic and process-oriented approaches as the basis for achieving the development of production technologies; 2) providing the possibility of incorporating quantitative economic indicators into the system of production technologies development. The proposed concept develops the basic elements of organization theory, engineering and technological design of structures, tools for organizational changes at industrial enterprises. The concept will be based on an engineering and technological approach of designing modern processes to develop production technologies, quantification and parametric methods, which form the basis of assessment tools allowing to design a procedure for evaluating the effectiveness of developing production technologies as a set of measures closely related to time, resources and executioners. This concept is aimed at solving applied problems related to the rationality of expenditures with regard to development of production technologies, incentives for personnel to implement the technologies efficiently. The procedural approach used to assess the effectiveness of developing production technologies at enterprises consists of assessing resource constraints to implement the planned strategy of developing production technologies; determining economic performance

as a result of developing production technologies at industrial enterprises and distribution of economic outcome among the participants depending on their share in the implementation of production technologies.

A business model for developing production technologies in manufacturing industry (as a set of interconnected elements) and procedures for its rational use based on criteria (obligatory and sufficient) and on the targeted use of functions and principles revealing the impact of engineering and technological factors, with the interests of manufacturing industry in the field of technological innovation taken into account is built as implementation of the concept of developing production technologies. The business model will allow to: 1) determine the role of production technologies development in the general system of technological policy; 2) reveal the significance of the factorial effect of the external and internal environment of the manufacturing industry on obtaining the economic results from developing production technologies; 3) get an idea of the elements in the internal system of production technologies at manufacturing enterprises. The proposed business model can provide the achievement of the task, affect the technological orientation of manufacturing enterprise and the choice of acceptable organizational decision to implement the development of production technologies.

The possibility of achieving planned results is preconditioned by revealing the multifaceted content and multiple use of production technologies in domestic manufacturing industry within priorities of developing science and technology complex of the Russian Federation aimed at solving key issues associated with the development of new technological mode.