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Study of the Problems of Technologizing of Industrial Complex of Russia

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Abstract
The development of the global economic system leads to the fact that modern production is becoming more technological and capital intensive, requires highly skilled labor and cannot provide work places for a large number of low-skilled workers. In addition, each high-tech work place creates several additional work places in other industries. Many technologies that were first used in industrial production were later used in other industries, increasing their efficiency and competitiveness and thus ensuring the overall economic development. Scientific research and development for the industry are becoming more transdisciplinary; hybrid research areas as well as cross-disciplinary technologies appear.
All this happens under the formation of the sixth technological structure in the world economic system. It is characterized by the development of nanotechnology, IT-technologies, a sharp decline in energy and materials production. This is the reason why the world's hi-tech-trends, such as software engineering, additive production, robotics, development of new materials for a specific product, which gives it unique properties, appear.
The main problem is that the Russian industrial complex is not ready for unconditional acceptance of these global technological challenges for the most part organizationally, not economically. We need a simple and well-defined organizational and economic mechanism of technologizing of domestic production. Despite the current economic difficulties, there are enough sources of such technological transition funding. They are: entry into the large-scale investment and infrastructure projects on a national scale; participation in projects of field development of the leading oil and gas companies; the programmes of innovative development and R&D programmes of state companies, industrial state programmes; subsidies and grants of development institutions; private funds of enterprises, etc.
This issue is extremely important and urgent but the Russian scientific community, by all accounts, currently is only moving from the generalization of the problems of the domestic industry technological backwardness to the development of the methodological basis of the Russian industry technological transition in the framework of clearly marked in recent years, promising areas and the availability of internal challenges and obstacles. It is important to emphasize that for some countries the current global trend is technologization but for Russia this trend can be classified as catching-up technologization that determines various subtleties of its scientific results.

Keywords
Technologization, industrial complex, technological structure, technological transition, innovations.

Introduction

A holistic vision of the problem of technologization of the industrial complex of Russia in the innovative transformation of the Russian economy.

Technologization of the industrial complex of Russia takes place in the framework of development in the global economic system of the sixth technological stage, characterized by the development of nanotechnologies, IT-technologies, a sharp decline in energy and materials production. This is the reason why the world's hi-tech-trends, such as software engineering, additive production, robotics, development of new materials for a specific product, which gives it unique properties, appear.

The randomness of the selection of the above mentioned global technological trends in industrial production is confirmed by the forecasts. Thus,

the software market for computer engineering, according to experts, will increase by 8.5 % per year; global sales of industrial robots will grow at least 5 % a year; the growth rate of additive manufacturing exceeds 25 %. About 80 % of innovations in leading industries and sectors of the economy are based on the introduction of new materials and production technologies (Russian Federation in figures, 2015).

Russia is far behind in these areas. Thus, the average global density of industrial robots equals 62 robots to 10 thousand people working in the industrial sector. In comparison, in Russia 2 robots account for the same number of people employed in the industrial sector. Russia's share in the total number of operating in the world additive manufacturing systems is only 1,4% (Russian Federation in figures, 2015). Scientific and technological achievements are a bit better in computer programming and engineering as well as in the creation of new materials; but still the level of Russia in these areas is not comparable with the world one. Moreover, there is no critical necessity for the development of internal need that is understood as the need of national organizations in these developments.

1. Methodology

1.1. Scientific background to the study of technologization of the industrial complex of Russia

The foundations of modern understanding of technologization were laid by Th. Schumpeter. In the book "Theory of economic development" he shows its key role in the economic development of society. He believes that technologization should be understood as innovation in production and non-production sphere of technological, organizational and economic nature. According to Schumpeter, there are five cases of implementation of new combinations of production factors: 1. Implementation of a new good which is still unknown to consumers, or the creation of new quality or another good. 2. Introduction of a new (virtually unknown in this sphere of activity) method of production which is based on the new scientific discovery and can represent a new method of the relevant goods' usage. 3. Development of a new market where such sphere of activity has not been presented yet, regardless of whether this market has existed before or not. 4. Obtaining a new source of raw materials or semi-finished products, regardless of whether this source has existed before or it has simply not been taken into account or considered unavailable, or it will be created in the future. 5. Carrying out appropriate restructuring, for example, ensuring a monopoly position or undermining the monopoly position of another business entity (Schumpeter, 1982, 452 p).

Th. Schumpeter accordingly gave a detailed description of organizational and technological activities affecting the nature and speed of the economic system development. Organizational and technological activities are aimed at: the creation, organization of production and sales of radically new products or products with new consumer properties; the creation and application of new (or upgrading of existing) technologies of production, distribution and use of products; the application of structural, financial and economic, personnel, informational and other innovations providing either cost savings, or the growth of production volumes and sales of marketable products in the process of their development, organization of production, production and distribution.

The theory of "long waves" developed by N. Kondratieff explains the idea of technologization in collaboration with economic downturns and upturns. The essence of this theory, in its most general terms, can be described in the following way: every major technological shift leads to the creation of numerous large and small innovations and opens up new areas of capital application; rapid accumulation of capital in new industries leads to long-term economic growth; increase in production of new products leads to market saturation, and the demand for new products falls sharply; the amount of capital involved in new industries during the period of active expansion of production becomes excessive; there begins a long depression, which can be overcome only as a result of the next technological breakthrough.

There exist two approaches which consider a specific mechanism of primary catch-up technologization.

The first approach is presented in the study of G. Mensch and A. Kleinknecht, who believe that the deterioration of the enterprise condition creates incentives for the development of new technologies. On the contrary, when an enterprise prospers there is no need to change anything seriously in already-established production. G. Mensch indicates that the end of prosperity of old industries increases the tendency of capital owners to invest in new products and technologies. Despite the fact that the profit in the depression phase is small, the owners see less risk in investment of capital in

changes than in investment of capital in old products and technologies or debt obligations (Mensch, 1979, pp.60-74). A. Kleinknecht stresses (Kleinknecht, 1987, 235 p.) that during the prolonged economic crises the transition of an industrial enterprise from the strategy of profit maximization (which it adheres to in a period of prosperity) to the strategy of minimization, depending on the market conditions, takes place. As long as the existing products and technologies bring substantial profit, the tendency to the development of new technologies is low, as production activities are always associated with risk. When there comes a prolonged crisis and prospects in traditional industries deteriorate, the risk of the emergence of new technologies stops being an insurmountable obstacle, as any other alternatives can be even more risky. The overall conclusion which can be done on the basis of this scheme is the following: the largest number of emerging basic technologies evolves in the period of heavy and prolonged depression.

The second approach was developed by G. Clark. From his point of view, a prosperous industrial enterprise, which is confident in the prospects of expansion of the market and profit growth, shows increased organizational and technological activities (Clark, 1981, pp. 308-322). In case of difficulties the company is not engaged in technological changes.

Therefore, the bulk of the primary emerging technologies is implemented in the period of long-term improvement of conditions.

The target reference point is the development of theoretical and methodological and practical aspects of technologization of enterprises of the industrial complex of Russia. It actualizes the concept of technologization of enterprises as global and national challenge to the modern innovation economy; the spread of elements of the new technological stage in the sectors of the domestic manufacturing industry; monitoring of technologization of enterprises of the Russian industrial complex.

The concept of technologization of industrial enterprises of manufacturing industry should be understood as the way of a system organization of production and economic activities of enterprises, based on bringing the used equipment and technologies in line with global technological stage and market conditions. The differences from the periodic replacement of equipment and technologies that companies used to implement and implement generally are:

1) A significant tightening of the requirements for technical and technological content of the production process in recent years.

Some time ago or even today there existed (or still exist) a machinery and equipment for manufacturing of products through traditional machining; we used (or still use) such automation of production processes as relays and switches; and the standard materials used in production were (are still) metals and plastic. In the future everything will change greatly: additive production and laser processing will be used for manufacturing of products; industrial robotics and sensor systems will be an integral part of production processes; composite materials will be used widely.

2) In today's Russia such system work has never been performed.

Some private initiatives in this field can not form a critical mass of different advanced domestic production of high technological level, complementing each other. The creation of such "high-tech cluster" in the present conditions can be realized only upon the development of organizational and economic mechanism at the national level, which will be subdivided into sectoral and regional levels as well the level of enterprises.

The choice of manufacturing industries for priority technologization is explained both by the presence of "chain" of added value in these industries (which increases the competitiveness of the country) and the changes in institutional conditions for domestic enterprises in 2014-2015 (which include devaluation of the ruble, sanctions and decline in oil prices). The combination of these factors leads to a quite logical turn towards the manufacturing sector in state priorities of the economic development of Russia.

Now the average age of the equipment in manufacturing industry in Russia is 12 years. Depreciation of fixed assets equals 45%. In a number of strategic industries (machine tools, electronic industry, pharmaceutical, medical industries) the share of imported equipment and products reach 80%, and in some cases it is even 90%. In most cases almost all Russian equipment is old (Industry of Russia, 2014).

At the meeting of the Presidium of the Presidential Council of the Russian Federation on economic modernization and innovative development of Russia "On the development of new production technologies" in September 2014 the following perspective (from the point of view of world

trends) technological directions were identified: additive technology, new materials, industrial automation and robotics (The solutions as a result of the meeting of the Presidium of the Council under the President of the Russian Federation on economy modernization and innovation development. About development of new manufacturing technology, 2014). These directions can be considered clear benchmarks for technologization of the manufacturing enterprises of the Russian Federation

1.2. Justification and disclosure of the content of the technical and technological approach to the study of technologization of the industrial complex of Russia

The main tasks of technologization of the industrial complex include:

1. Disclosure of the technical and technological approach will allow to obtain fundamentally new results while studying the processes of technologization of industrial enterprises. The essence of the technical and technological approach is that technologization is considered as a non-isolated reproduction process, but a process which is included in the technical and technological cycle of an industrial enterprise.

This approach has its own unique features: 1) it is based on the reproduction interpretation of technologization which is inextricably interlinked with the development of the industry; 2) target orientation of management on the resource requirements of the technologization process, namely, quality information and technical support at all its stages aimed at improving the competitiveness of manufacturing industries; 3) taking into account special priorities, principles and functions of management of development of the enterprise technologization; 4) information flexibility which suggests that the processes of technologization are formed, first, on the basis of the specificity and dynamics of the factor influence and, second, from the signals of deviations from the desired reproduction path; 5) versatility in application in relation to enterprises of various branch affiliation; 6) predetermination by the conditions of modern technological evolution; 7) the ability to reduce fragmentation and segmentation in the methodology of the subject area of the research.

The approach will allow to: 1) formalize technologization as a key process of technological policy of industrial development in Russia; 2) identify the specificity of catching up technological modernization; 3) synthesize the effect of macro- and micro factors; 4) give economic evaluation of the integrated result of technologization of manufacturing enterprises.

2. Disclosure of the multifaceted content and expansion of multi-orientation of implementation of technologization in domestic manufacturing industry in the framework of the priorities of the Russian scientific and technological complex development are focused on solving new problems associated with the development of a new technological stage. In this connection, it is advisable to identify institutional constraints to the development of modern production technologies. The first constraint is the strong presence of the state in the industry. A high role of the state in the industry and a huge amount of public order determine the attitude of industrial enterprises to innovations, the need for production renovation and introduction of new technologies. In Russia the state creates innovative development by means of using the administrative resource, although international experience shows that private companies introduce innovations more readily and more efficiently. If an industrial enterprise has a government order it means that this company doesn't actually need new technologies. The situation is different with private enterprises which “serve the market” and, therefore, need new technologies.

In addition, there is a dilemma: on the one hand, the state recognizes that its objective is to increase the number of jobs in the country; on the other hand, it also stands for an active introduction of innovations, which leads to an increase in production efficiency, increase in the level of automation, and, accordingly, the release of workers. The introduction of production technologies leads to the decrease of dependence on a large number of low-skilled labour resources, and increases the dependence on a small number of highly qualified employees. It means that it will be necessary to release a significant number of low-skilled workers; and this invariably causes social tensions, which the state is also trying to control.

The second constraint is connected with a high level of monopoly. The use of new production technologies enables an enterprise to gain a com-

petitive advantage by improving manageability, speed and efficiency of production processes. In developed countries, the main investor in research and development is the industry, whose share in the total cost of private business in this area is 60-90%. Such significant amounts of investment in R&D are explained by the desire of companies operating in a competitive environment, to reduce their costs. In Russian conditions, when there are practically no competitors in some industrial sectors, it is extremely difficult to motivate entrepreneurs to innovative behavior.

The third constraint is related to the fact that national proposals of technological innovation for the introduction in the industry are very limited. Currently 62% of Russian enterprises do not see the possibility of using domestic equipment and raw materials instead of imported ones because of the lack of the former. Herewith, 35% of enterprises have a claim relating to domestic equivalents (Russian Federation in figures, 2015). Under these conditions, in some cases it is easier and cheaper for the Russian industrial enterprises to buy foreign scientific and technical production. In addition, one more serious problem is connected with the fact that manufacturers just do not have enough information about domestic developments.

The lack of incentives for the introduction of industrial technologies is the fourth institutional constraint. Inflexible fiscal policy, high social insurance burden, and administrative barriers contribute to the reduction of investments of Russian manufactures in innovative technologies. If the burden on manufacturing business is further increased, especially the compulsory social insurance payments, enterprises will push innovations in the residual financing principles even stronger. In addition, investments in own or purchased innovations carry certain risks, which also reduces the motivation to free up more funds for them.

The innovation policy which followed supports so-called "garage" innovations, the main consumer of which is small and medium-sized business. In this regard, there is an urgent need to develop a mechanism which will allow to stimulate large enterprises so that they invest in R&D and introduce innovative technologies.

This leads to the conclusion that for the effective development of innovations in the Russian industry it is necessary: firstly, to create favorable conditions, and secondly, to concentrate efforts and resources on the priority (in terms of global technology trends) directions.

3. The argumentation of the content and the development of directions of realization of organizational and economic mechanism of the technologization of manufacturing enterprises in the conditions of economic constraints open up new fields of research connected with processes of technologization of both manufacturing enterprises, and enterprises in various industrial branches.

2. Study results

The expected results will be focused on two areas:

The first result is associated both with the expansion of theoretical knowledge and obtaining new data about the processes of technologization of manufacturing enterprises. It is expressed in the development of a new scientific concept of technologization of manufacturing enterprises, which develops the theory of the organization and the general theory of modern management. The increment of scientific knowledge is based on the justification of the specific of technologization of manufacturing enterprises, which lies in the transformation of traditional subject matter, object, goals, objectives, principles, functions and technologization tools in accordance with the value and target guidelines of the organization of industrial production, focused on solving the production problems of the manufacturing industry. The concept will be based on technical and technological approach to the formation of modern technologization processes, quantification and parametric methods that underpin the assessment tools. In aggregate, it can improve the quality of managerial decisions in the subject area of the research, allowing to establish a quantitative determination regarding the quality characteristics of technologization of manufacturing enterprises, as well as determine the parametric ratio of technologization parameters and management of manufacturing system of manufacturing enterprises. The developed concept of technologization of enterprises as a global and national challenge for the modern industry will find its application in the theoretical and methodological substantiation of the spread of elements of the new technological stage in the sectors of the domestic manufacturing industry (additive production, digital production, robotics, etc.).

The second result is focused on the theoretical and methodological basis of the principles and mechanisms of regulation of technologization of manufacturing enterprises from the viewpoint of a

dynamic system process. This process includes management actions which are aimed at the organization, analysis, planning, forecasting, regulation, control over the formation and direction of the technologization impact on the performance of the manufacturing enterprises; and are designed to provide enterprises with optimal income in the current and future periods. To achieve this result we propose a model of monitoring of technologization of manufacturing enterprises of the Russian Federation in the conditions of economic constraints. The proposed monitoring will be based on the study carried out by A. Bogdanov on the conditions and factors ensuring the equilibrium of systems. According to his study, the highest form of organization is "the triune organization of things, people and ideas". The violation of equilibrium of the system may lead to its negative or positive change. The first means destruction, the second - means its development. This very fact determines the degree of a stable state of the system (Bogdanov, 1989, 304 p.). The processes of technologization need to be constantly monitored, assessed and forecast from the perspective of the direction of their development. Monitoring of technologization of manufacturing enterprises based on key economic indicators allows to assess the current state of the enterprise from the position of, first of all, microeconomic situation by calculating the values of these indicators which were formed during a specific reporting period (Miller, 2013, pp. 105-113). Such monitoring can be called monitoring of the main technologization process. Meanwhile, integrated assessment of technologization also involves tracking future mega- and macro-economic trends, economic, social and political aspects of the enterprise development. Thus, it is advisable to monitor the preventive process of technologization. Monitoring of preventive technologization process should be understood, above all, as monitoring of "the future periods", tracking the most probable directions of the future enterprise development in order to adjust the current development strategy. If monitoring of the main technologization process operates according to the system "current development - future development", i.e. the results of today's period allow to generate proposals for improving the functioning of the enterprise in the future, it means that monitoring of preventive technologization process uses a system of "future development - current development"; in other words, it tracks forecasted potential future options in order to develop preventive measures to prepare the enterprise for both prospective changes in the external business environment, and the formation of technologization processes. The dynamic development of the manufacturing enterprises implies that they should conduct not just monitoring of preventive and main processes, but also monitoring of technologization consequences for manufacturing enterprises. It can be noted that performance of modular technologization monitoring lies primarily in the fact that it gives the opportunity to focus not only on the problems of technologization processes, but also on the ways of their solving, which, in addition, saves costly time for making forward-looking strategic decisions regarding the enterprises of the manufacturing sector. A characteristic advantage of the proposed monitoring tools is the ability to draw conclusions on the technologization implementation, which allows an industrial enterprise to strengthen its competitive position; increase its attractiveness; increase efficiency of utilizing its potential and the quality of organizational and administrative methods of management; as well as comprehensively approach to the justification of investment in technologization taking into account risk factors.

Conclusion

In order not to fall out of the world "industrial-innovative train" it is vitally important for Russia to move from labor-intensive industries to more innovative industries with high added value. To achieve technological safety and integration of national economy into the world one at leading levels one should stimulate the development of our own innovation-oriented manufacturing industry and develop "cross-cutting" technologies that can be applied in different industries. Within the framework of public-private partnership such factors as support of the development of advanced production technology, training of workers, providing access of manufacturing enterprises to financing on attractive terms are required.

It is necessary to reverse the situation where expensive loans, inflexible tax burden, the decline in domestic demand lead to the fact that many domestic manufacturing enterprises are on the edge of survival, rather than are competitive; as a result the demand for domestic development is not growing.

Consequently, the main areas of the use of the achieved results will be: updating the content of state programmes towards adding some subprogrammes (sections) on technical re-equipment

in accordance with the aims of the new technological stage; granting in contests of development institutions some activities aimed at supporting research in the field of digital and additive manufacturing, robotics and new technologies.

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