Problems and prospects of mechanical engineering innovative development in conditions of the digital economy

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Abstract. The article identifies the main problems and trends in mechanical engineering in order to increase the competitiveness of its products by innovative type, discloses the nature of modern discussions on the enterprises’ technical development methods in the digital economy, proposes the strategic directions for industrial innovative development, which contribute to improving management efficiency of the machine-building complex.

1. Introduction
A low level of the machine-building complex development, which has been formed for the past two decades can be observed in Russia. The key reasons for this lag are: technological connections’ disruption, low rates of growth in production volumes, poor renewal of fixed assets and the range of products by machine-building enterprises. As a result, structural imbalances (relative to global trends) in the development of the basic industries of the third, fourth, fifth and sixth technological modes in the domestic industry have arisen [1].

The developed countries are currently assimilating the technologies of the sixth technological mode based on the formation of most global value chains using capital and highly skilled labor of industrial enterprises, which has led to a steady demand for technical sophisticated science intensive machines and equipment, innovative cultural and household goods.

The third and fourth technological modes prevail in domestic economy; they do not contribute to an increase in the products’ competitiveness and quality and only about 10% of industries belong to the fifth mode [1]. The key condition for the fifth mode is the involvement of Russian enterprises in the achievements of the digital economy and building a new reproduction system that exploits the achievements and basic technologies of the fourth industrial revolution. Such a transition is possible only on the basis of adapting the enterprises’ activities to the digital economy conditions.

The main feature of the fifth technological mode is the predominance of information and communication technologies, nano- and biotechnologies, genetic engineering, new types of energy and materials [2]. Moreover, it is the qualitative transformation of these technologies that determines the content and structure of human capital that will lead to the new technological order formation.

2. Purpose, tasks, research methods
The solution to this problem can be the development of a mechanism for economic and management coordination of all elements of such an innovation and investment chain as science-state-business. The purpose of the mechanism is to ensure the coordination of the machine-building complex enterprises’ interests in relation to their prospective technical and organizational development, taking into account innovative trends in the world economy [3].
The machine-building complex is currently characterized by high depreciation of fixed assets and a long period of return on investment. The main production assets are 70-80% worn out and more than 30% of the equipment was produced using outdated technologies [4].

The successful development of the latest (“disruptive” in relation to traditional) technologies as well as the formation of the valid digital economy in the domestic mechanical engineering industry is impossible until the influence of closely interrelated problems can be overcome, which can be distinguished into separate groups of problems that impede the machine-building complex development (Table 1).

Table 1. The main groups of problems impeding the machine-building complex development.

| Problems group                     | The problems characteristics                                                                 |
|------------------------------------|------------------------------------------------------------------------------------------------|
| Investment problems                | critical moral and physical deterioration of equipment and technologies; obsolete infrastructure of production facilities; low investment attractiveness of mechanical engineering lack of financial resources due to low production profitability; poor product quality. |
| Innovative challenges              | high production costs; low innovation susceptibility of industry enterprises; insufficient funding for research and development underdeveloped quality management system; lack of experience and resources to form an effective marketing policy; |
| Competitive problems               | insufficiently developed system of service and technical support of manufactured products throughout the entire product life cycle; unequal conditions of competition in the market with foreign manufacturers of similar products of machine-building enterprises slowness in the preparation and implementation of management decisions; |
| Management problems                | lack of subdivisions ensuring the production integration into a single economic space an acute shortage of qualified personnel due to relatively low salaries; decline in the prestige of engineering and working specialties [5]; ineffective personnel policy that does not contribute to attracting qualified specialists in the field of industrial production, scientific, technical and technological activities insufficiently developed system of industrial cooperation; imperfection of the legislative framework for state industrial policy, technical regulation, pricing for mechanical engineering products; ineffective interaction of financial and credit organizations and the real sector of the economy |
| HR problems                        |                                                                                               |
| Organizational and legal problems  |                                                                                               |

The reasons for the prolonged and deep recession in mechanical engineering are also the decline in the demand of enterprises for machinery and equipment of an investment nature and the decline in demand from the population for consumer goods due to a decrease in the purchasing power of the population and a sharp and prolonged decline in real incomes and living standards [6].

Against the background of the above-mentioned reasons, the factor of import substitution could not fully compensate the decline in production in mechanical engineering. The devaluation of the national currency and Western sanctions contribute to the development of import substitution, but the displacement of imported products from the national market and their replacement with equivalent Russian counterparts take a lot of time and cannot occur simultaneously. At the same time, the machine-building complex products’ profitability in Russia is lower than the average profitability for the industry as a whole and is significantly lower than the profitability index in extractive sector.

The enterprises themselves are not able to break this vicious circle, therefore, the formation and implementation of an effective industrial policy under the leadership of state economic management bodies is required [7]. It is necessary to formulate a strategy for the development of Russian mechanical engineering at the state level based on modern achievements in science and technology. It
should be a set of measures to solve the interrelated problems of mechanical engineering in technical, technological, personnel, financial and economic, legislative and other areas [8].

The state of the leading industries’ fixed capital was significantly influenced by the existing raw material direction of the domestic economy development. It resulted in stagnation and crisis in manufacturing sectors. Building a new system for the reproduction of fixed assets within the framework of the industrial policy formation and implementation should take into account these circumstances and change the existing proportions in the investment renewal of the machine-building complex fixed assets.

3. Modern discussions on the enterprises’ technical development methods in the digital economy

The current trend in the development of world mechanical engineering is the process of structural changes caused by deepening specialization in the context of globalization, in the form of foreign presence expansion, for example, in Asian countries (enterprises usually carry out large orders of medium-tech products). Short-run and individual production is under development in European and other industrialized countries. The main advantage of this trend is to ensure the ability of machine-building enterprises in industrialized countries to withstand market competition [9].

The authors analyzed modern discussions regarding the methods of technical development of the enterprises in the digital economy, which made it possible to identify the following trends in mechanical engineering:

- developed economies are increasingly specialized in innovative and highly skilled activities within global value chains, encouraging the developing economies to move towards the capital-intensive activities;
- increasing the effectiveness of the products’ manufacturing and shipment commercialization by introducing standards and long-term contracts, optimizing the relationships with consumers;
- the basis of innovative development in Russia is still big business, which is rather inertial today;
- a clearer state program is needed to ensure sustainable development of the machine-building industry;
- ensuring the mechanical engineering development is possible by means of the technical facilities’ continuous improvement and their complex automation, etc.

At the same time, the creation of organizational and economic conditions for increasing mechanical engineering efficiency is possible only on an innovative basis by significantly accelerating the development rate of mechanical engineering in the country, including intersectoral areas for the technological and structural reserves’ implementation in order to increase the production potential of the machine-building complex.

The research carried out by the authors and the positions of Russian and foreign experts considered indicate that the growth of any economic system is possible only with continuous investment in the renovation of existing fixed capital, and in the volumes exceeding its cost retirement and with its effective use.

It is well known that the primary reason for the sustainable development of an industrial enterprise is competitive advantages. Sustainable competitive advantage is a long-term significant benefit from the implementation of a unique strategy that is not applied by either existing or potential competitors, cannot be copied by them and is subject to strong influence from the external environment [10,11]. The analysis of the technological entrepreneurship functioning in mechanical engineering showed that startups achieve the greatest efficiency in which the main competitive advantage is the use of intellectual property.

However, Russia is hindered from taking benefits of its competitive advantages over Western countries due to: low efficiency of government institutions, insufficient innovation potential,
ineffective antimonopoly policy, the financial market underdevelopment, low competition in the markets for goods and services, lack of investor confidence in financial system. The situation is complicated by the insufficient level of partnership and cooperation of engineering enterprises producing interconnected products and the lack of flexible production complexes [12].

The main direction of the state economic policy in Russia in the field of technological entrepreneurship development is the creation of special regimes of technological entrepreneurship and special zones of technological entrepreneurship.

The implementation of these areas is possible with a combination of state support measures:

1) non-financial (special investment contracts; exhibitions, fairs, conferences, promotion in foreign markets; protection of the Russian manufacturers’ interests abroad; regulation of the industrial products’ public procurement; support for project consortia; development of engineering centers; standardization and technical regulation);

2) financial (Research and Advanced Development support), regional programs, technology parks and clusters, export lending; project financing; subsidizing interest rates and pilot lots of equipment; stimulating leasing; partial reimbursement of engineering, manufacturing and export costs; financing of development institutions.

Thus, the technological entrepreneurial structures’ creation activation in mechanical engineering contributing to the technical industrial re-equipment, will ensure the innovative and technological development of the national economy and increase competition between the manufacturers participating in the innovation cycle [9].

Nevertheless, the highest innovative activity of enterprises in the manufacturing industries and, first of all, in mechanical engineering has been observed in recent years. It should be noted that for the successful competition of Russian machine builders with Asian and European machine building companies, the rates of innovative domestic machine building development remain extremely low and do not give an opportunity to speak about overcoming the innovative activity stagnation in this industry.

4. Experimental part

The practical experience of Russian managers dictates the following directions for the strategic development of the machine-building complex enterprises: increasing the market share to realize the effect of “economies of scope”; production costs reduction on the basis of import substitution of the imported parts and assemblies that have significantly risen in price for the Russian manufacturers; struggle for each customer based on product quality control and a flexible and balanced pricing policy; improving the quality of service support at all stages of the product life cycle; delivery terms optimization; manufactured products’ structure optimization; growth in labor productivity by means of the equipment modernization and replacement, introduction of the advanced technologies, improvement of production management, the hiring of highly qualified workers of various working specialties, the workers’ qualifications improvement; implementation of an effective marketing strategy; concentration on certain market segments showing stable demand; holding Research and Advanced Development.

There are prerequisites for the mechanical engineering enterprises’ effective development in Russia today, namely: the presence of its own raw material base, its own energy resources; developed network of transport and energy communications; high potential of fundamental and applied science; stocks of intellectual property; the required educational level of the population; production potential and traditions [13].

It is necessary to develop an effective multi-level policy in the engineering industry, which should be adequate to the needs of the society and have a pronounced innovative development character. This is a rather difficult task and requires, first of all, the priorities determination for the sector’s
development. The study of this issue showed that the prioritization should be based on strengthening the role of the state in mechanical engineering development.

The state should create equal conditions for the development of all enterprises, a favorable competitive environment and eliminate many bureaucratic barriers. The industrial policy of Russia should determine the main, strategically important directions for the development of mechanical engineering, science and technology, taking into account global trends, as well as the industries, enterprises and groups of goods, in the absence of which the country will not be able to conduct the independent economic policy in the world community, will not be able to ensure social stability and opportunity for the successful life of the population.

To date, certain steps have already been taken in the formation of a strategy for the mechanical engineering development. Two concepts (machine tool and automotive industries) as well as some development strategies (aviation industry, oil and gas, road construction and utilities, energy, tractor and agricultural, transport engineering, mechanical engineering for light industry) have been developed in recent years [6,7]. But the adopted documents do not fully meet the requirements of systemacy due to insufficient coherence (among themselves and with promising national tasks).

At the same time, it is necessary to strengthen the import substitution policy, which will allow achieving: restoration of the production capacities volume at a high technological level; reduction of production costs due to existing resource-saving technologies; achieving price competitiveness on this basis.

The effective development of domestic engineering enterprises, according to Federal State Statistic Service (Russia), is hampered by such problems of high business activity as: uncertainty of the economic situation, insufficient demand in the domestic market, high taxation, lack of financial resources, insufficient demand in the foreign market, lack of skilled workers, competing imports, deterioration or lack of equipment (Figure 1) [1].

![Figure 1. The problems of machine-building enterprises’ high business activity manifestation.](image)

Ensuring positive trends in the manufacturing industries’ development is based on: an increase in economy fixed assets active part investment, which contributes to an increase in demand for industrial products and an increase in the environmental parameters of the economy; to the innovative and technological renewal of the manufacturing industries’ production apparatus, ensuring productivity growth; to the development and implementation of new technologies and materials increasing production competitiveness.

The change in the state industrial policy course and the shift in emphasis towards structural and strategic transformations in the domestic machine-building industry, the machine-building complex enterprises’ innovative activity revitalization made it possible to increase its investment attractiveness,
however, investments in fixed assets are insufficient to solve the problem of their renewal, especially in the conditions of high degree of their deterioration.

5. Summary
A comprehensive solution to the problems of the domestic machine-building enterprises’ strategic innovative development should include the following aspects: analysis of the machine-building enterprises’ strategic development innovative potential; the formation of a rational technology for the strategic innovative development of mechanical engineering enterprises; development of mechanical engineering enterprises’ innovative development strategy implementation guidelines [13].

The following directions of accelerating the development of the material base for the machine-building complex and its modernization can be distinguished: a comprehensive assessment of the actually preserved technological potential and its cost; selection of possible priorities for targeted financing of breakthrough technologies; implementation of a long-term program for training the highly qualified workforce in the context of systemic production modernization; formation of a long-term scientific and technical program for the mechanical engineering development on an innovative basis and the introduction of new technologies; improvement of search mechanisms, implementation and stimulation of the reserves use at the level of individual enterprises.

Thus, the modernization of domestic mechanical engineering in the digital economy should be understood as the qualitative transformations aimed at changing the technological mode, which ensure the satisfaction of individual and social needs in accordance with the new system of values and production standards based on innovations that optimally combine resource conservation and profitability level.

The integration processes development in mechanical engineering and the establishment of stable cooperation connections between the participants will allow solving a number of strategic tasks [12,15,16]:

- ensuring stable growth rates in the output of industrial, technical and consumer demand as well as saturation of the domestic commodity market, entering external sales markets;
- modernization and technical and technological renewal of the production base, as well as the development of innovative potential focused on the production of high-tech products with a high redistribution degree, including those that have no analogues in foreign practice [14];
- restoration of the destroyed production, technological and financial connections with the neighboring countries, development of integration processes and cooperation ties;
- development of corporate governance mechanisms based on the assets consolidation and a system of mutual participation in funds.

In the process of solving the listed tasks, real conditions for the machine-building complex transition to a qualitatively new level of sustainable growth, for the disclosure and maximum possible use of its strategic potential, for the formation and development of the national economy with a predominant share of high-tech industries that are science-intensive and resource-saving, as well as for increasing the institutional transformations’ efficiency are created.

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