



# Economic analysis of high-tech enterprises in modern conditions

## Análisis económico de empresas de alta tecnología en condiciones modernas

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#### ABSTRACT:

This article considers the generalized enterprise of the modern Russian innovation complex producing high-tech products in the aspect of its production and technological potential. Also, it singles out the possible negative dependencies of this potential on the deliberate or unintentional actions of the related parties, understood in a broad sense, which support or develop its production and technological potential, primarily in terms of fixed assets (their active and passive parts), combined with production technologies. Furthermore, it shows that it is expedient to optimize the relevant vulnerabilities through the implementation of strategic and tactical management decisions, including at the level of the enterprises themselves. This paper also introduces a typology of these internal corporate management decisions and establishes that they should be formed through the implementation of complex feasibility studies in the functioning of high-level intellectual systems of support for managerial decisions, implementing the basic functions of management (Novosadov et al., 2017). Also, it declares that the intellectual core of these systems should be the program implementation of mathematical models of functioning production capacities of enterprises.

**Keywords:** industrial production, enterprise, internal management, technological potential, suppliers, optimization of weakness.

#### RESUMEN:

El presente artículo toma en consideración las características de las empresas pertenecientes al sector de la alta tecnología en Rusia, así como los aspectos de su producción y su potencial tecnológico. Asimismo, destaca los posibles efectos negativos que puede tener dicho potencial como consecuencia las acciones llevadas a cabo por los diferentes actores que forman parte del proceso productivo. Además, muestra la importancia de la optimización y eliminación de vulnerabilidades a través de la implementación de decisiones tácticas y estratégicas a nivel de la administración empresarial. Este documento también introduce una clasificación de dichas decisiones y establece que estas deben tomarse mediante la puesta en práctica de complejos estudios que evalúen el funcionamiento de sistemas que las apoyen. A su vez, el artículo declara que la base intelectual de esos sistemas debe ser la aplicación programada de modelos matemáticos sobre el funcionamiento de las capacidades productivas de las empresas.

**Palabras clave:** producción industrial, empresa, administración interna, potencial tecnológico, recursos, optimización de debilidades

## 1. Introduction

It is well known and generally recognized that the enterprises of the modern Russian industrial complex are a critical component of the modern Russian economy in terms of national security, employment, financial and economic role and source of economic development in general. All these enterprises, primarily producing high-tech products, use in their production and economic activities quite numerous, expensive, and often scarce and hard-to-reach resources that serve to maintain and develop their basic production assets (Mitrofanova et al., 2017).

The enterprises under consideration have to operate in close enough interaction with the environment, which is not always favorable for them. A fairly representative example of such supply-side disadvantages are the so-called sanctions against a number of Russian legal entities that are currently being implemented by some countries. Due to the breadth of production cooperation, this affects the enterprises of the Russian industrial complex.

In general, this means that Russia's industrial strategy involves a number of significant structural changes in enterprises and industries, which increases the role of industrial enterprises, including aircraft manufacturing. There are new requirements for the level of management in them, where many aspects of production activities should be primarily of a market nature and meet modern concepts and approaches in the field of industrial enterprise management.

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## **2. Methodology**

Targeted programs for the development of Russia to reform high-tech industries in accordance with global trends included: the development of sectoral and inter-sectoral integration processes using dual-purpose technologies; the development of export potential of knowledge-intensive industries; the diversification of military production for the fabrication of high-tech, competitive civilian products; and the update of the management, production and technological capabilities of the industry, among others.

Some of the main organizational and economic problems of the development of knowledge-intensive enterprises of aircraft building today and in the future are: increasing attention to the long-term forecasting of trends in the development of industries, the definition and coordination of national goals, the expansion of the range of factors taken into account in the analysis of programs with a view to their fuller impact on the various links of the socio-economic system and the combination of methods of qualitative analysis with mathematical modeling in the substantiation of solutions to specific problems of the industry and areas of its activities.

The mentioned problems of high-tech industrial enterprises and the aviation industry are generally interrelated. However, in many cases, the identification of promising areas in managing the innovative development of aviation enterprises is decisive.

Studies have shown that the economic policies of developed countries, along with the regulation of macroeconomic factors, have become defined by micro-industry policies that prioritize technology development, investment, retraining and skills development. The main challenge for most of these countries is the problem of competitiveness and technological rivalry.

The acquisition of a high technological level of production is a consequence of government programs that develop critical basic and high-tech technologies based on a significant public funding. This has led to the gradual formation of a new, sufficiently flexible management system at the enterprises of the industry, which allows them to effectively overcome the emerging difficulties and eliminate many contradictions of development. Some distinctive features of this system are the diversity of forms and methods used, the lack of a single organizational mechanism permeating the entire economy, the presence of many intertwined links between individual participants in the production process and a large number of interacting management subsystems. The main key mechanisms are: market and competition, enterprise and corporate governance, as well as public administration.

Complex programs of development of high-tech branches of Russia use these tendencies of development in developed countries, in the activity of the enterprises dedicated to aircraft

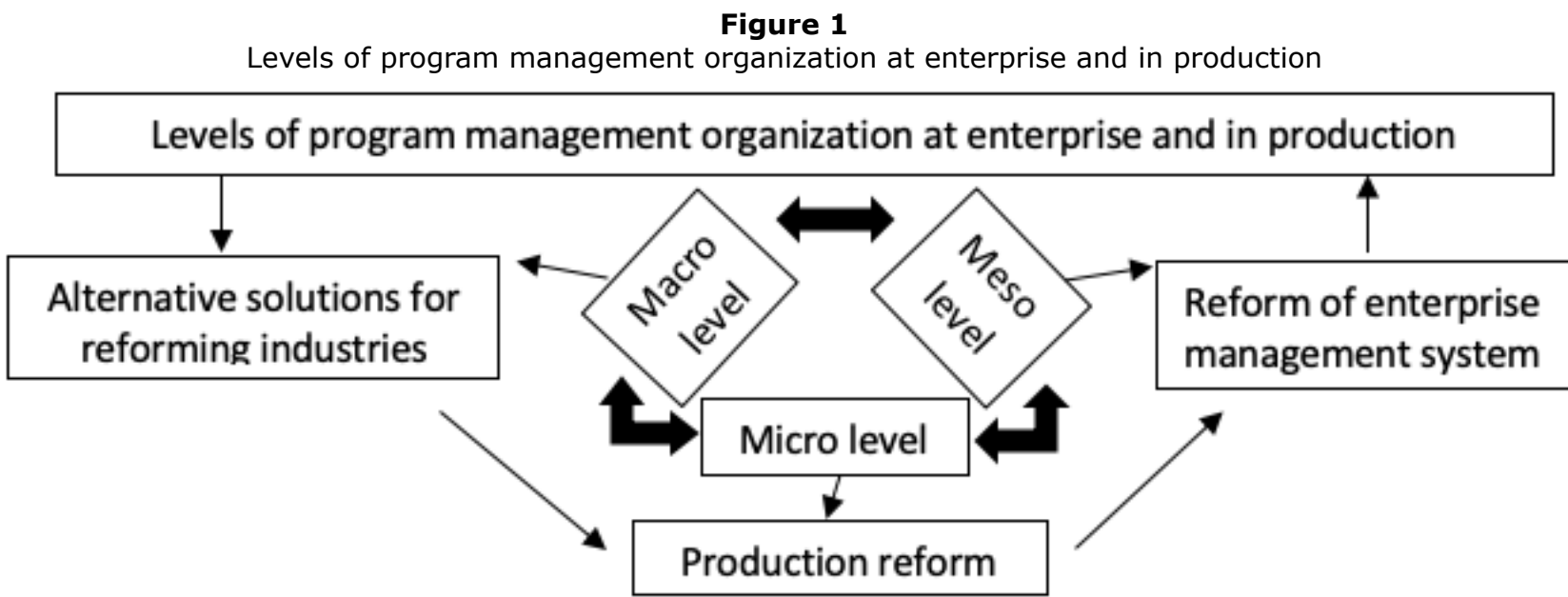
building, allowing to allocate the basic internal competitive advantages of the Russian aircraft products of military and civil purpose, which consist in its high technology intensity, safety and low expenses at manufacturing. The external advantages consist on the conditions of product sales, including: low price, methods and terms of payment and provision of maintenance services.

The basis of formation of the program organization of management at the enterprise and in manufacture, first of all, serves as a level at which there is a complex problem. This level determines the main three directions of solution (see Figure 1).

At the macro level, alternative solutions for reforming high-tech industries are based on basic innovations and technological methods of production.

At the meso level, the management of production enterprises includes the issues of changing generations of equipment and technology, organization of production, update of fixed assets, etc.

At the micro level, the issues of reforming production, update of models, modification of products/services, improvement of technological parameters and retraining of personnel are solved.



Structural transformations of enterprises and their production in high-tech industries, including the aviation industry, should be carried out in accordance with the levels of industrial policy of Russia (Table 2).

The first level is the macro level, which forms the strategies for reforming the industry. The concept of restructuring includes organizational changes based on a cluster of basic innovations. This is a scientific infrastructure comprising state research centers, flight test bases and test sites and corporate structures, covering the main developers of aviation technology and necessary for the production of competitive products. The main task of this level is the formation of the core of the military-industrial potential and its market infrastructure in integration with the civil industry.

The second level is the meso level, which forms the strategies of reforming the enterprises of the branches of industry. The concept of restructuring provides for the transformation of corporate structures of the basic innovation systems of high-tech aircraft, which ensure the change of generations of equipment, technology, organization of production and fixed assets on the basis of industrial and technological restructuring of enterprises.

Corporate structures of this level should be sufficiently diversified, have a state order in the scope of work, work on the domestic and foreign market for high-tech products (both military and civilian) and use civil-military integration via dual-purpose technologies. The economic and technological capabilities of corporate structures should ensure competitiveness in the domestic and international market.

An important point should be the principle underlying the concept of development of high-tech industries as a single interconnected complex, including civilian and military products, scientific, technical and industrial base, ground infrastructure and personnel training system.

**Table 2**  
Levels of structural transformations of innovative enterprises

Level	Concept of restructuring	Focus of the restructuring
Macro level	Changes based on the cluster of basic innovations and technological methods of production	Formation of the core of the military-industrial potential and its market infrastructure in integration with the civil industry
Reform strategy of the enterprise		Concentration of scientific and technical potential of the leading institutes of the industry and their experimental and technical base taking into account priority directions of development
		Formation of highly specialized enterprises on the basis of special production
Meso level	Change of generations of equipment, technologies, organization of production, renewal of the active part of fixed assets	Industrial and technological restructuring of enterprises
Reform strategy of the enterprise		In-depth military-civil integration with the use of military technologies
		Integration of manufacturers of high-tech civilian products with the core of defense enterprises with a network of manufacturing enterprises of small and medium-sized businesses
Micro level	Updating of models and modification of products, improvement of parameters on the basis of innovations	Solutions for products and services, determining their structure, volume, quality and competitiveness
Reform strategy of the enterprise		Technological solutions that form the technological profile of production, capacity, loading of equipment, the use of information technology
		Structural solutions that define the integration of production units in order to meet the needs of consumers

The third level (the micro level) is on the reform of individual enterprises and industries. The concept of restructuring these production enterprises is associated with the improvement of production management, updating models and product modifications and improving their parameters on the basis of innovations. Enterprises of this level mainly consist on factories and design bureaux associated with the development of individual units and devices for special purposes. Enterprises must be deeply diversified by types of products based on general technology development and production.

In practice, there are quite numerous situations when the maintenance of existing fixed production assets, and especially their development in terms of their production and technological component, occurs in the conditions of unrealizability of procurement, non-performance or improper performance of contracts for the supply of marketable products, which serves to transform the production and technological potential. Of course, commodity products here are interpreted correctly and broadly, including material objects, services, works, rights, information resources, etc.

As a result, rather serious crisis situations have arisen, and they are likely to arise in the future, which obviously cannot be successfully eliminated by the traditionally used archaic methods based on the behavioral empiricism of management personnel and the stereotypes of the paradigm of a posterior compensatory non-systemic intervention (Fedorova et al., 2018).

Problems with the supply of appropriate commodity products are initiated by random factors, circumstances of irresistible force and conscious actions of various persons. It is obvious that, on the one hand, it is physically impossible to achieve the absolute invulnerability of the production and technological potential of the industrial enterprise of Russia in terms of supply, because some naturalization of their economy organically contradicts the realities of the post-industrial society and poorly connects with the all-Russian macroeconomic crisis phenomena. On the other hand, it is inexpedient, since the costs of activities to minimize vulnerability may well prove to be devastating or even resource-insecure. Therefore, the idea of total import substitution, which is sometimes announced, is seen from the scientific point of view as vicious and practically unfeasible.

In this sense, it is undoubtedly seen as productive to transfer the long-established position on the expediency of rationalization, but not to minimize the level of risk: in our case, of course, we are talking about vulnerability. Therefore, this is the only productive method, the classical conceptual method (Grishchenkov, 2008). It is optimal, highly intellectualized management of weakness of the industrial and technological potential of Russia in terms of supply of related products to maintain and develop the main production assets (as well as inextricably connected with them or included in them technologies of high-tech production).

Of course, the disruption of the supply of commercial products of this type in may occur in fundamentally different conditions, including as a result of the actions of terrorists and military opponents, as well as the occurrence of natural, biological and man-made disasters. However, all of these cases were excluded from the scope of this study because of their significant specifics, although a significant part of these considerations can be applied directly or after processing (Novikov, 2018).

In view of the above considerations, for the sake of correctness of the constructions and their understanding, we note that these constructions in the considered object and subject area cannot be directly correlated with the toolkit of scientifically correct risk management, because the disruption of the relevant supplies does not allow a scientifically strict interpretation as random events. As a rule, they have an exclusively uncertain nature, and their mechanical reduction to random events will in general give rise to catastrophic managerial errors.

It should be noted that the problem of influence on the vulnerability of industrial and technological potential of the national industrial complex enterprises objectively exists and is distinguished for many levels and management bodies: for the level of the State, corporations, etc. There it is partially solved through the implementation of national and corporate target programs and their analogues. However, it is undoubtedly allocated for the enterprise level of the industrial complex, within the framework of the internal corporate management system. It is for this micro level that the following provisions are given.

Thus, it should be stated in general that the problem of orders and supplies of commercial products to ensure the maintenance and development of production and technological potential, being inextricably linked with investment and innovation management, is relatively poorly investigated (Glushak, 2011).

Therefore, the issues under consideration seem to be quite relevant.

We use as a basis some widespread resource representation of the potential of the enterprise as a set of resources that are used or can be used in the implementation of industrial and economic activities of this subject (Kraev et al., 2018). Naturally, the potential is considered both in terms of its availability and use, as there can be extremely strong differences. In accordance with the same categorical decomposition of the potential, we recognize that the production and technological potential is a set of resources that are used or can be used in the implementation of production activities (in this case, the production of

high-tech equipment). At the same time, in order to enter the boundaries of the study, we reduce this potential and exclude from it structural resources such as purchased components, materials, etc. Let us exclude also biased human resources, because the personnel provision of production is a huge independent sphere of research and management. Also, let us limit ourselves to the main production funds (first of all, to technological equipment and production areas, conditionally including engineering communications), including their information components (Nedelkin et al., 2017).

Then, under the vulnerability of the industrial enterprise's production and technological potential, we will understand the possibility of reducing this potential in terms of worsening the production conditions provided by the existing or expected to conclude contracts for the supply of innovative products under the influence of several factors (Mindlin et al., 2016). External factors lead to external vulnerability, while internal factors lead to internal vulnerability. It is obvious that the considered supply vulnerability is an external vulnerability. In the considered case such factors are insufficient (including zero) supplies of consumable goods. We emphasize the importance of the last part of the definition structure: the production and technological potential and its vulnerability can be assessed only in the context of a variety of types of commodity products and production and technological regulation, including decision-making technologies. The idea of measuring such potential and its vulnerability "in general" is scientifically groundless in principle, since the concept of critical components of production is axiomatic.

Let us now consider what can be seen in the reduction of the potential itself as a complex resource, i.e. vulnerability.

This can manifest itself in the transformations of the first level:

- physical reduction of resources (e.g. malfunction of some machines, unsuitability of production areas in terms of pollution or temperature-humidity characteristics, permissible loads on floor structures, etc.; or their physical absence, for example: lack of technological equipment for application of special paint and varnish coatings);
- reduction of the possible intensity of resource consumption (e.g., reducing the speed of machining parts, the need for multi-pass technological operations, additional intermediate machining of parts such as cooling, etc.) and, accordingly, the longer production cycle of marketable products, which reduces the speed of production of marketable products (Sozinova et al., 2016);
- deterioration of the quality characteristics of the produced innovative commodity products, including its characteristics of destination and reliability.

As a result, the implementation of this kind of vulnerability will lead to full or partial non-fulfillment of the supply contracts concluded, the non-conclusion of new ones or their conclusion on less favorable conditions for the enterprise.

However, the change in potential itself, as a rule, does not affect the interests of the subjects of management.

Therefore, the vulnerability of the production and technological potential should be assessed in terms of second-level transformations already directly correlated with the target interests of the management entities, in our case, the interests of the directors of industrial complex enterprises.

Accordingly, the main transformation of the second level, which are:

- reduction of the possible volume of production of innovative products or failure to comply with the conditions of priority orders such as the State defense order in terms of volume and timing;
- deterioration of the characteristics of the appointment and reliability of the produced innovative products or failure to fulfill the conditions of priority orders such as the state defense order for quality;
- deterioration of financial and economic results and the state of the industrial enterprise;
- deterioration of the image of an industrial enterprise.

It is advisable to correlate these second-level transformations with the goals of intra-corporate management, but, naturally, with the opposite direction. It should be noted that the first two goals are strictly integrated into the third due to the introduction of penalties for failure to comply with the terms of priority contracts for the supply of innovative products, and the fourth may be considered deferred.

The first two types of transformations of the second level reflect the specifics of the industrial complex, which is locked into critical components of ensuring Russia's national security, and not only military security (Novikov and Veas Iniesta, 2018).

Let us now consider what kind of supply factors primarily cause the vulnerability of the enterprise's production and technological potential of an industrial company for some arbitrary supply contract:

- failure to conclude a contract for the supply of commercial products;
- full or partial refusal to supply a new commercial product by a supplier in accordance with the existing contract or the termination of the existing contract;
- forcing a subcontractor to an unacceptable change for the enterprise price and other conditions of the current supply agreement;
- delivery of incomplete new commodity products under the current contract;
- delivery of new commercial products without technical documentation or with incomplete technical documentation under the current contract;
- delivery of new commercial products with low quality characteristics under the current contract;
- refusal of the installation/supervision of a new commercial product as provided for in the existing contract, its failure to complete or unacceptably low quality;
- refusal (in full or in part) to provide spare parts, consumables, after-sales service and copyright support under the current contract (Zolotukhina et al., 2017);

Of course, we do not consider options for hidden malicious deliveries of commodity products, as this is clearly a matter for separate consideration.

Let us consider how conceptually the management of the enterprise can influence the relevant situation.

We are going to consider that the following types of core intra-corporate management influences that fall within the managerial competence of the directorates of industrial enterprises are implemented:

- elimination or replacement of the source of supply shocks (for example, by creating a knowingly loyal supplier, by duplicating suppliers or creating their pool, etc.);
- removal of its delivery disadvantages (for example, at the expense of forcing it to perform properly the execution of the supply agreement);
- making the company insensitive to the supply adverse effect (for example, by introducing a production and technological alternative in the form of its own backup production).

Obviously, these management decisions are typical for:

- variability;
- complexity and synergy;
- significance of influence on the groups of state indicators and optimization;
- the non-triviality of the connection between managerial impacts and final results.

Accordingly, from among the known methods of management it is necessary to choose a method of complex feasibility study of managerial decisions, which provides for the use of information and advisory system of support of managerial decisions. That implements such typical functions of management as assessment of the current state of the object of management and the environment, forecasting, comparison, analysis and optimization of managerial decisions. This system should be based on a complex of developed mathematical models of the state of the control object as the intellectual core of this decision support

systems (DSS) (Novikov, 2018).

The proposed developments for evaluating the considered vulnerability have been applied quite successfully, including during the implementation of the following applied research both in the field of industrial production and outside it:

- in assessing the feasibility of introducing centers for the maintenance and reparation of two types of civil aircraft;
  - when evaluating the feasibility of combining the production and reparation of several types of aircraft engines at their manufacturing plants;
  - when evaluating the feasibility of implementing a number of regressive claims of insurers in relation to some of the virtually monopolistic producers of commercial products for production purposes;
  - when forming a number of projects and programs that are similar in content to federal targeted programs;
  - in the development of repair programs for several types of machinery at a number of industrial enterprises.
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### 3. Conclusions

From the above considerations it follows the following:

- 1) the production and technological potential of enterprises of the modern Russian industrial complex is subject to significant external supply disadvantages emanating from both its domestic and foreign established and prospective subcontractors. This creates unacceptable vulnerabilities;
  - 2) the vulnerability of this potential represents a possible deterioration of the components of the potential in terms of numerical volume and properties, which significantly affects its capabilities as a supplier of innovative marketable products in technical, financial, economic, and image aspects;
  - 3) among the specialized supply shocks, there are numerous and highly probable events of non-closing, non-prolongation and improper execution of contracts for the supply of commodity products in ensuring the maintenance and development of production and technological capacity;
  - 4) the level of the considered vulnerability should be optimized;
  - 5) to optimize the level of vulnerability, in particular, intra-company management should be organized and implemented (Dmitriev and Novikov, 2017).
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