Approaches to the clustering methodology in the rocket and space industry as a factor in the formation of a universal production model for the economic development in the space industry

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Abstract: Today, approaches and principles that have been retrospectively established in the rocket and space industry when forming vertically integrated structures created on the principles of corporate association or property merger need to be revised and reformed on the basis of new methodological approaches that take into account existing trends, including foreign trade, globalization, Russia's accession to the WTO and the use of a wide range of different sanctions against it, emerging sectors of high-tech economy enterprises and aimed at creating a future economic system. An analysis of more than a decade of experience in the activities of integrated structures in the rocket and space industry has revealed a number of negative trends, mainly due to the localization of the production of components for the structures of finished products within the integrated structure itself, which leads to the development of substations on their base and has a negative effect on the development of the production potential of the space-rocket industry as a whole, on the other hand it leads to an increase in the cost of the final product due to the increase in the share of overhead costs incurred on duplicate content in the space industry enterprises and fixed assets. Considering these circumstances, it is essential to revise the existing practice and develop new approaches to the organization of industrial cooperation based on multi-cluster principles in the rocket and space industry.

Key Words: multi-project task, integrated structure, cluster, universal economic model, multi-project organization of a cluster project

1. INTRODUCTION

Active structural changes in the rocket and space industry, which started at the turn of the 2000s, reformed the corporate structure of the rocket and space industry, introduced innovations into the model of administration interaction between government customers and industry, reducing the number of economic entities by integrating them into vertically and horizontally integrated structures formed on the basis of the principle of property association of land and property complexes of federal states unitary enterprises to be subsequently incorporated into the integrated complex of the parent company of the integrated structure, that is, the management of the integrated structure primarily as a property complex [1] and (or) the principle of corporate association, which involves the formation of the authorized capital of the parent company of the integrated structure including the shares of its subsidiaries, that is, the management of the integrated structure through the corporate management of the shares of its enterprises [2], which in itself reduced the time required to bring management decisions to the final executor and made the system less bureaucratic, but in the end did not achieve a result in the form of an increase in the efficiency of economic activity [3], [4].

The problem of increasing the efficiency of products manufactured by the space industry has not yet been fully resolved, and is often complicated by both general economic and external economic factors, which in turn are in discrepancy with the global trends in the integration development of high-tech sectors of the economy based on such principles as: organization a single scientific, technological and information space, the most efficient use of intra-corporate resources, especially NGOs related to innovative orientation, minimization and optimization of cooperative ties by building specialized research and production of agglomeration clusters with a universal level of specialization that can optimally respond to external changes without losing the achieved level of competitive advantages [5].

Today, the production efficiency of the rocket and space industry as an integral part of the domestic high-tech engineering production is characterized by the duration of the production cycle of rocket and space technology, [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], [31], [32] where a significant time phase falls on production processes implemented at 3-5 levels of cooperation, including mechanical processing products and increasing the range of products or reducing the time of their production leads to the need for the volume of capital investments, as well as the growth of depreciation charges on the fixed assets created at the expense of the budget of the Russian Federation or Roskosmos State Corporation as part of the technical reconstruction and re-equipment, or completion of the program of production of items for the production of items for which these funds were created, as well as their concentration mainly on the production of a certain type of product.

Disregarding this issue puts the rocket and space industry enterprises in the obviously unprofitable economic positions in determining the future pricing policy for finished products.

2. WAYS TO OVERCOME EMERGING ECONOMIC DYSFUNCTION

In the current economic paradigm, the role of finding ways to improve production efficiency and the rational form of industrial cooperation and subject specialization increases in order to reduce costs and increase economic profitability.

Overcoming the emerging economic dysfunction of the existing intra-industry cooperation ties involves solving the following main tasks:

– development of a scientific and methodological basis for evaluating the effectiveness of both existing and potential integration (cooperative) links of the enterprises of the rocket and space industry with economic entities inside and outside the perimeter of the activities of the Roscosmos State Corporation;

– preparation of information and reference resource on the main results of scientific and technical activities obtained in the framework of work in the field of research, development and technological work with the possibility of decomposing the result into components in order to further engage in economic circulation;

– development of a sequence of actions for the formation of a universal economic model of industrial clustering with the optimal parameters of specialization.

The solution of the tasks is aimed at economic reformatting of the existing integration relations from the focus of sustainable administrative and economic relations that have developed within the vertically integrated structures of the rocket and space industry, represented by a single mechanism for lobbying internal corporate interests in the intra-industry struggle for budgetary resources into the focus of creating clusters that take into account spatial production organization and synergistic effects from the interaction of cross-sectoral and regional industrial complexes.

A comprehensive solution to the task of overcoming the emerging dysfunction involves carrying out scientific and practical work related primarily to analyzing the results achieved by the avant-garde holding structures of the rocket and space industry, and comparing them with the results previously established in system projects for their creation, as well as identifying a divergence between the planned and actual effect, taking into account both the external and internal environment of functioning of each holding structure.

The result of this stage of work should be to identify the reasons for their discrepancies in order to further form a dynamic matrix model of changing factors, taken into account both in the current activities of the integrated structures of the rocket and space industry, and in its further planning.

Building a dynamic model of the matrix, due to the presence of many changing factors, should be the basis justifying management decisions for further reform (structural changes), aimed at changing the corporate and (or) industrial architecture of the rocket and space industry.

At the same time, the changing corporate architecture of the rocket and space industry must take into account, and subsequently, to active use, the factor of transfiguration, which involves participants in economic relations, providing results in the field of space activity and not having functionally dependent or general administrative and managerial relations with enterprises, Roscosmos, which in turn will create the conditions for a possible subsequent unification on the basis of cluster approach of business entities with a high level of competence in the space field, in a variation of forming an interim territorial production cluster focused on the implementation of specific innovation tasks.

Thus, the development of justifying algorithms to the solution of the primary task of building an effective corporate structure serving the full range of life issues of the rocket and space complex should be based on scientifically adapted methods and approaches of a universal nature, offering effective methods and solutions to the problems posed in the field of space activity.

One of such methods is approaching development of the rocket and space industry on the basis of territorial clustering and a temporary business association of research and production segments of various enterprises, without their corporate or property association.

3. CLUSTERING AS A FUNDAMENTAL FACT OF THE FURTHER DEVELOPMENT OF THE ROCKET AND SPACE INDUSTRY

In this case, clustering is one of the fundamental factors for the further development of the rocket and space industry, which by its nature is a self-adjusting competitiveness mechanism, expressed in building the optimal structure of intraoperative relations, ensuring a high level of transparency of industrial cooperation, which does not focus on the branch affiliation of economic relations entities.

An analysis of the activities of vertically integrated structures of the rocket and space industry showed the dependence of the existing holding company research and production industrial structure on the forms and methods used by the corporate organization of the production process that do not take into account the overall goal set when they were created – reducing production costs and cost of products manufactured by the rocket and space technology.

The construction of a universal economic model for the development of the space industry, ensuring functioning beyond the framework of industry-specific activities, should be carried out taking into account the parameters set by exogenous (external) and endogenous (internal) variables, while the role of fluctuating economic fluctuations should be minimized.

Obviously, the question of the inconclusiveness of the previously used approaches in the formation of a number of integrated structures of the rocket-space industry and the need to reform corporate architecture based on new methodological principles that involve building an effective economic model for the development of space activities, involving the wide use of structural and economic methods, simulation of the production cycle based on cluster cooperation ties and providing a minimum costs at a maximum ratio of the quality of basic tactical and technical characteristics of the future product.

The defining key exogenous factor in the development of the rocket and space industry is the current positive macroeconomic situation inside the country, which provides the Russian Government with an opportunity to formulate a budget for the development of the space industry at the expense of income from primary sectors of the economy. At the same time, the development strategy of Roscosmos State Corporation suggests a progressive transition to strengthening the role of endogenous factors, provided by the internal potential of scientific and technological development and the formed resource potential.

The need to take into account the endogenous factor in the formation of a universal production model of the economic development of the space industry is fundamental, since tangible and intangible assets (resources) created in the process of research, design and technological work constitute a significant share of the economic and scientific potential of rocket and space industry enterprises.

Taking into account the existing resource of logistical and intellectual capabilities of the rocket and space industry, the processes of further investment planning, which increase the efficiency and feasibility of further use of budget investments, become transparent .The emphasis is shifted to the falling out competencies of the participants of the multi-project task, and not to finance duplicate or redundant production capabilities of economic entities, which in turn allows modeling the economic space, creating high-quality synergistic effects not only in the space industry, but also in other sectors of the Russian economy.

The use of conditioned resource opportunities helps to optimize the cost parameters of the manufactured scientific and technical products, reducing its cost, development time and start of production, which ultimately will affect competitiveness in general, as the main factor contributing to the promotion of high-tech products to new markets.

Considering the above, clustering, as a fundamental factor in the further development of the rocket and space industry, should contribute to the construction of a universal production model that integrates a single management and technological potential that ensures the development of the space industry.

4. THE ORGANIZATION OF TEMPORARY CLUSTERS AS A WAY OF REFORMING THE EXISTING CORPORATE INSTITUTIONS

A possible scenario for the development of the rocket and space industry at the present stage is the reforming of existing corporate institutions by organizing temporary clusters, the main task of which should be the implementation of projects or their parts in terms of minimizing time factors and cost indicators caused by the financial interest of the performers in the cluster.

In this case, a cluster is understood as the optimal organization of production interaction of economic entities in order to obtain synergistic effects from this interaction and the ability to solve multi-project problems of both intersectoral and regional importance.

It is expedient to consider the cluster as an element of the created infrastructure association, which ensures the balance of the resource base used to effectively solve production problems, as well as a corporate tool that improves the efficiency of the integrated structure.

Cluster organization of economic interaction involves the process of organizing effective intracorporate relationships both within existing integrated structures and among potential participants in order to create competitive value-added products for rocket and space technology at all stages of its creation.

This approach should be based on certain principles applied both inside the rocket and space industry and in the outer interactions:

– Availability of the necessary qualified labor resources (main production workers, engineering and technical workers, designers, technologists) and their reserve in the region of enterprise.

– The territorial proximity of the basic production assets (production areas) and the possibility of their prompt replenishment.

– The presence of the main production equipment with the capabilities of the reserve of its use.

– Availability of technological readiness, proven technologies and types of work, including technological unification.

– Availability of necessary power capacities and their reserves.

– Availability of sustainable supply chains.

– The presence of scientific and technical reserves in the field of R & D and TR.

– Experience with new materials.

– Compliance with environmental and sanitary-epidemiological requirements of the law.

– Possibility of using the mechanism of outsourcing and operational involvement of co-contractors.

– The presence of a stable financial and economic situation and the absence of signs of bankruptcy.

– Understanding (state program and government order) about the possibility of a full return on investment and a proper level of profitability of the entire project, as well as a stable load of fixed assets after the completion of the project or providing sources for their support and maintenance.

Formation of the cluster concept of interaction between enterprises of the rocket and space industry provides for the creation or reforming of the principles of an innovation-oriented approach, ensuring the effective use of the results of scientific and technological activities as a tool to improve competitiveness and the subsequent transition to the creation of products with high added value of intellectual labor [7].

5. CONCLUSIONS

Summing up, it is necessary to say that at present there is a situation when the existing realities of planning targeted programs and determining the future development strategy for the industry as a whole require reassessing existing approaches to the formation of integrated structures in the rocket and space industry and developing new conceptual approaches to the organization of industrial cooperation, based on the needs of the formation of production associations based on multi-cluster principles, allowing to form universal production models in the space industry with the involvement of individual research and production segments of enterprises with relevant competences without their corporate or property combination, since disregarding this issue puts the domestic rocket and space industry in determining unfavorable economic positions on finished products.

Thus, the development of grounding algorithms for solving the primary task of construction of effective production-corporate structure serving the full range of life of the rocket and space complex should be based on scientifically adjusted methods and approaches of a universal nature, offering effective ways of solving the problems posed in the field of space activity, and one of such methods is the approach to the development of the rocket-space industry on the basis of universal production model matrix which can be formed from separate research and production enterprises as segments, taking into account the territorial clustering and manufacturing competencies.

Considering the above, the proposed clustering, as a fundamental factor in the further development of the rocket and space industry, should contribute to the construction of a universal production model of enterprises or their individual research and production segments, integrating a single management, technological and production potential that ensures the development of the space industry in the long term.

Formation of the cluster concept of interaction between enterprises of the rocket and space industry provides for the creating or reforming the principles of an innovation-oriented approach, ensuring the effective use of the results of scientific and production activities as a tool to improve competitiveness, with a view to the subsequent transition to the creation of products with high added value of intellectual labor.

REFERENCES

[1] * * * Federal law of November 14, 2002 No. 161-FZ (as amended on December 29, 2017) "On state and municipal unitary enterprises", Available at http://www.consultant.ru/document/cons_doc_LAW_39768/
[2] * * * Federal Law of 26.12.1995 No. 208-FZ (as amended on 07.19.2018) "On Joint-Stock Companies", Available at http://www.consultant.ru/document/cons_doc_LAW_8743/
[3] I. M. Murakaev and S. E. Tsybulevsky, Prospects for the development of high-tech industries of the domestic industry, taking into account the technological structure of the Russian economy on the example of the rocket and space industry, *Scientific and Applied Journal "Microeconomics"*, no. 2, pp. 29-32, 2017.
[4] S. E. Tsybulevsky, Ensuring sustainable innovative development of the rocket and space industry through the formation of its new corporate identity, *Bulletin of FSUE "TSNII Center"*, no. 3, pp. 104-115, 2016.

[5] E. A. Kuznetsova, I. M. Murakaev and S. E. Tsybulevsky, Modeling and visualization of organizational and economic processes of enterprises of the rocket and space industry, *Scientific and analytical magazine "Innovations and Investments"*, no. 6, pp. 155-160, 2017.

[6] V. G. Napreenko, I. M. Murakaev, S. E. Tsybulevsky and D. L. Kostenev, *Evaluation of the effectiveness of research and development in high-tech industries*, Publishing LLC MAKS Press, 2017.

[7] D. V. Kovkov, I. M. Murakaev, S. E. Tsybulevsky and D. L. Kostenev, *Issues of innovation development of the rocket and space industry*, Publishing LLC MAKS Press, 2017.

[8] V. F. Formalev, S. A. Kolesnik and E. L. Kuznetsova, Wave Heat Transfer in the Orthotropic Half-Space Under the Action of a Nonstationary Point Source of Thermal Energy, *High Temperature*, vol. **56**, no. 5, pp. 727-731, 2018.

[9] R. M. Kakhramanov, A. G. Knyazeva, L. N. Rabinskiy and Y. O. Solyaev, On the possibility of steady-state solutions application to describe a thermal state of parts fabricated by selective laser sintering, *High Temperature*, vol. **55**, no. 5, pp. 731-736, 2017.

[10] V. F. Formalev and S. A. Kolesnik, Analytical investigation of heat transfer in an anisotropic band with heat fluxes assigned at the boundaries, *Journal of Engineering Physics and Thermophysics*, vol. **89**, no. 4, pp. 975-984, 2016.

[11] V. F. Formalev and S. A. Kolesnik, On Inverse Coefficient Heat-Conduction Problems on Reconstruction of Nonlinear Components of the Thermal-Conductivity Tensor of Anisotropic Bodies, *Journal of Engineering Physics and Thermophysics*, vol. **90**, no. 6, pp. 1302-1309, 2017.

[12] V. F. Formalev, S. A. Kolesnik, and E. L. Kuznetsova, Analytical study on heat transfer in anisotropic space with thermal conductivity tensor components depending on temperature, *Periodico Tche Quimica*, vol. **15**, Issue 1, pp. 426-432, 2018.

[13] N. A. Bulychev, E. L. Kuznetsova, V. V. Bodryshev, and L. N. Rabinskiy, Nanotechnological aspects of temperature-dependent decomposition of polymer solutions. Nanoscience and Technology, *An International Journal*, vol. **9**, no. 2, pp. 91-97, 2018.

[14] L. N. Rabinskiy and E. L. Kuznetsova, An analytical and numerical study of heat and mass transfer in composite materials on the basis of the solution of a Stefan-type problem, *Periodico Tche Quimica*, vol. **15**, Issue 1, pp. 339-347, 2018.

[15] V. F. Formalev, Ek. L. Kuznetsova, and E. L. Kuznetsova, Mathematical modeling of the stefan's problems with the determination of the coordinates and the velocities of the dynamically moving borders of phase transformations, *Periodico Tche Quimica*, vol. **15**, Issue 1, pp. 377-389, 2018.

[16] S. A. Lurie, E. L. Kuznetsova, L. N. Rabinskii and E. I. Popova, Erratum to Refined Gradient Theory of Scale-Dependent Superthin Rods, *Mechanics of Solids*, vol. **50**, no. 2, pp. 135-146, 2015.

[17] V. F. Formalev and S. A. Kolesnik, On Inverse Boundary Heat-Conduction Problems for Recovery of Heat Fluxes to Anisotropic Bodies with Nonlinear Heat-Transfer Characteristics, *High Temperature*, vol. **55**, no. 4, pp. 564-569, 2017.

[18] L. N. Rabinskiy and O. V. Tushavina, Experimental investigation and mathematical modelling of heat protection subjected to high-temperature loading, *Periodico Tche Quimica*, vol. **15**, Issue 1, pp. 321-329, 2018.

[19] S. A. Lurie, L. N. Rabinskiy, P. O. Polyakov, S. A. Sitnikov and Y. O. Solyaev, Mechanical properties of Si3 N4 –based composite ceramics with nanosized porosity, *International Journal of Nanomechanics Science and Technology*, vol. **8**, no. 4, pp. 347-358, 2017.

[20] A. V. Babaytsev, M. V. Prokofiev and L. N. Rabinskiy, Mechanical properties and microstructure of stainless steel manufactured by selective laser sintering, *International Journal of Nanomechanics Science and Technology*, vol. **8**, no. 4, pp. 359-366, 2017.

[21] V. F. Formalev, S. A. Kolesnik and E. L. Kuznetsova, On the Wave Heat Transfer at Times Comparable with the Relaxation Time upon Intensive Convective-Conductive Heating, *High Temperature*, vol. **56**, no. 3, pp. 393-397, 2018.

[22] M. V. Prokofiev, G. E. Vishnevskii, S. Y. Zhuravlev and L. N. Rabinskiy, Obtaining nanodispersed graphite preparation for coating ultrathin mineral fibers, *International Journal of Nanomechanics Science and Technology*, vol. **7**, no. 2, pp. 97-105, 2016.

[23] V. F. Formalev, S. A. Kolesnik and E. L. Kuznetsova, Time-dependent heat transfer in a plate with anisotropy of general form under the action of pulsed heat sources, *High Temperature*, vol. **55**, no. 5, pp. 761-766, 2017.

[24] V. F. Formalev, S. A. Kolesnik, I. A. Selin and E. L. Kuznetsova, Optimal way for choosing parameters of spacecraft's screen-vacuum heat insulation, *High Temperature*, vol. **55**, no. 1, pp. 101-106, 2017.

[25] V. F. Formalev, S. A. Kolesnik and E. L. Kuznetsova, Nonstationary heat transfer in anisotropic half-space under the conditions of heat exchange with the environment having a specified temperature, *High Temperature*, vol. **54**, no. 6, pp. 824-830, 2016.

[26] V. F. Formalev and S. A. Kolesnik, Heat Transfer in a Half-Space with Transversal Anisotropy Under the Action of a Lumped Heat Source, *Journal of Engineering Physics and Thermophysics*, vol. **92**, no. 1, pp. 52-59, 2019.

[27] S. A. Lurie, Y. O. Solyaev, D. V. Lizunova, L. N. Rabinskiy, V. M. Bouznik and O. Menshykov, Influence of mean distance between fibers on the effective gas thermal conductivity in highly porous fibrous materials, *International Journal of Heat and Mass Transfer*, vol. **109**, pp. 511-519, 2017.

[28] A. S. Okonechnikov, L. N. Rabinskiy, D. V. Tarlakovskii and G. V. Fedotenkov, A nonstationary dynamic problem on the effects of surface loads on a half-space with a nanosized structure within the framework of the cosserat medium model, *International Journal of Nanomechanics Science and Technology*, vol. **7**, no. 1, pp. 61-75, 2016.

[29] V. I. Krasovskii, I. N. Feofanov, S. I. Rasmagin, D. A. Zadorin, R. A. Zakharyan, M. A. Kazaryan, L. L. Chaikov, N. A. Bulychev, A. S. Averyushkin and B. A. Garibyan, Non-linear optical properties of nanosized metal oxide particles obtained in plasma discharge in liquid phase under ultrasonic cavitation, *Proceedings of SPIE*, 10614, 10614OZ, 2018.

[30] E. V. Lomakin, S. A. Lurie, P. A. Belov and L. N. Rabinskii, Modeling of the localy-functional properties of the material damaged by fields of defects, *Doklady Physics*, vol. **62**, no. 1, pp. 46-49, 2017.

[31] N. A. Bulychev, M. A. Kazaryan, M. N. Kirichenko, B. A. Garibyan, E. A. Morozova and A. A. Chernov, Obtaining of hydrogen in acoustoplasma discharge in liquids, *Proceedings of SPIE*, 10614, 1061411, 2018.

[32] S. A. Lurie, E. L. Kuznetsova, L. N. Rabinskii and E. I. Popova, Erratum to Refined Gradient Theory of Scale-Dependent Superthin Rods, *Mechanics of Solids*, vol. **50**, no. 10, pp. 135-146, 2015.