FORMING THE POTENTIAL OF SCIENTIFIC KNOWLEDGE IN APPLIED SCIENTIFIC ORGANIZATIONS

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Abstract: *The potential of knowledge formed as a result of the implementation of major fundamental scientific research and research developments of applied nature, creates a basis for the implementation of applied research and development work under contracts with enterprises and organizations and production of high technology products.*

Key words: *SCIENTIFIC KNOWLEDGE, SCIENTIFIC ACTIVITIES, SCIENCE-INTENSIVE PRODUCTS, SCIENTIFIC ORGANIZATIONS*

1. Introduction

The necessary conditions for the production of certain types of science-intensive products are a combination of the following factors: long-term demand, the potential of scientific knowledge, highly qualified scientific and industrial personnel and high-tech experimental equipment.

2. Results and Discussion

On the basis of the scientific activities analysis of applied scientific organizations specializing in metallurgical industry, and, above all, the largest federal scientific center, (FSUE) I.P. Bardin Central Research Institute for Ferrous Metallurgy, as well as National University of Science and Technology "MISiS", the products of scientific research institutes can be divided into three main types:

- major research developments, as a rule, carried out within the framework of state contracts involving extrabudgetary financing of industrial companies in priority areas of scientific and technological development of the Russian economy;
- scientific research developments of applied purposes performed by orders of industrial enterprises;
-production of science-intensive products ordered and financed by industrial enterprises.

Fig. 1 shows the main scientific and economic relations (customers and sources of financing) of a large Russian applied research institute, determined by the types of its activities.

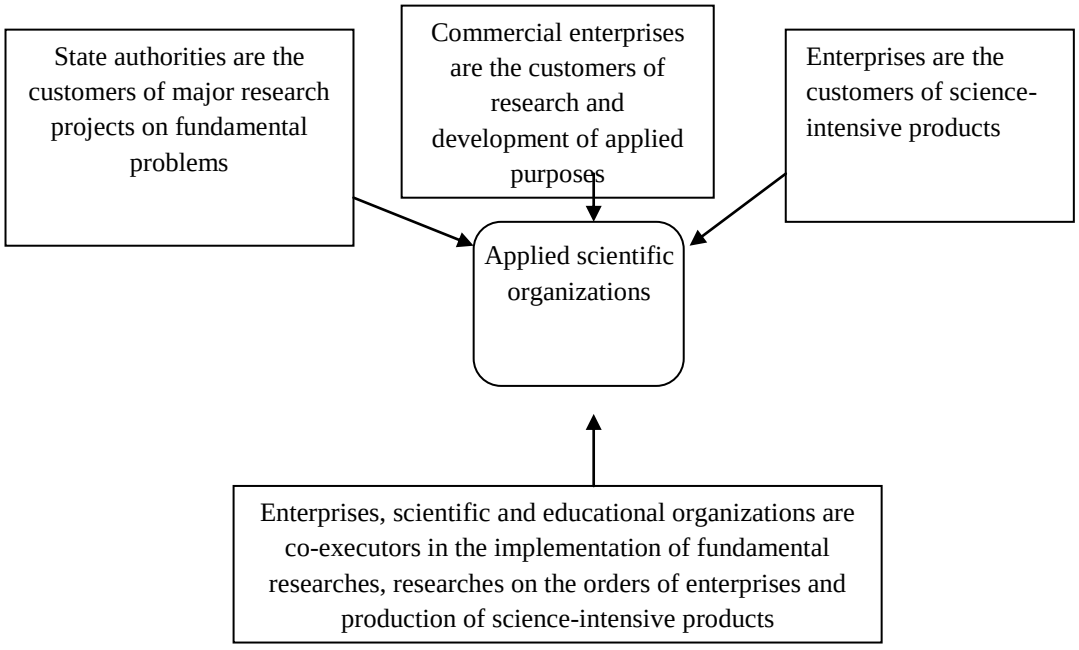

Fig. 1. *Scientific and economic relations of applied research institutes*

As it is shown in Fig. 1, scientific and economic relations allow large applied scientific organizations and research universities to develop scientific potential and new technologies and produce science-intensive products due to the availability of highly qualified scientific and technical personnel.

In this paper, the methodical and practical problems of science-intensive products production are studied, mainly based on the materials of (FSUE) I.P. Bardin Central Research Institute for Ferrous Metallurgy, as well as other major research centers.

The analytical evaluation of the activity of several large research institutes (I.P. Bardin Central Research Institute for Ferrous Metallurgy, RUSAL, CRISM "Prometey", etc.) showed that only as a result of carrying out major research and development work fundamental knowledge can be obtained.

At the same time, in the current circumstances, the implementation of major research projects on fundamental problems that create new knowledge is possible only with public-private financing.

As the analysis shows, even large Russian industrial enterprises that carry out innovative production development are not interested in paying for the risks caused by the implementation of fundamentally new developments, especially in the situation of limited capabilities of Russian machine-building enterprises to implement the developed innovations on new equipment [1].

They tend to get ready-made new technologies for the production of new products without investing for their development.

In Russian practice industrial companies order applied scientific organizations to perform a research, mainly related to the modernization of existing technological processes. This is the most demanding direction in terms of developments.

For instance, (FSUE) I.P. Bardin Central Research Institute for Ferrous Metallurgy performs a number of R & D activities within the framework of economic contracts with the leading industrial enterprises of the Russian Federation: PJSK "Severstal", OJSC "NLMK", OJSC "MMK", OJSC "Ural Steel", OJSC "Mechel". On certain issues cooperation with OJSC "VMC Krasniy Oktyabr", "Uralvagonzavod" and other enterprises, as well as with individual enterprises of foreign countries (Austria, Germany, etc.) is carried out.

In applied scientific researches, carried out by orders of industrial enterprises, previously accumulated knowledge is used, mainly in fundamental scientific researches. This accumulated knowledge can be considered as a certain potential of scientific organizations.

Research projects carried out on the orders of industrial enterprises, as a rule, has a narrow practical application and does not make a significant contribution to the creation of a large scientific potential of the research institute.

The conducted research has shown that the implementation of the most important innovative projects and projects of federal target programs allows major scientific research institutes to occupy a dominant position on a number of major scientific and technical problems.

In particular, a number of major innovative projects were carried out by (FSUE) I.P. Bardin Central Research Institute for Ferrous Metallurgy within the framework of public-private partnership in a consortium with leading research and design institutes and the largest metallurgical enterprises in 2008-2014. The results of the projects are development and adoption of modern technologies in order to create domestic competitive metal products and implementation of innovative development [2-4].

These developments have created a great potential of scientific knowledge for the implementation of scientific developments on demands of industrial enterprises, as well as for the production of various kinds of science-intensive products.

The following brief description of the results of the most important fundamental applied scientific developments shows the formation of technologies (the potential of scientific knowledge), which are the basis for the production of science-intensive products [3-7].

Thus, the development of microalloying elements in steel for pipes of strength category up to X100 (X70, X80, K70, X90) and testing of technological modes of smelting, deoxidation, extra-furnace steel processing, casting and deformation-heat treatment of steel in relation to existing and modernized equipment created the necessary scientific basis for the production of domestic high-quality plate steel for pipes used in the construction of main pipelines at a working pressure of 100-120 atm. and higher [4].

Within the framework of the project, compositions of steel, technology and normative-technical documentation for the industrial production of high-quality new generation steel strip with a unique combination of strength and viscoplastic characteristics for rolling thickened steel have been developed. They performed the successive implementation of production at the mill-500 of OJSC "Cherepovets Steel Mill" of strength category X70 (strength class K60) 20-40 mm thick, strength category X80 (K65) 15-30 mm thick, strength category X90 (K70) 10-20 thick (27) mm and strength categories X100 with a thickness of 10-20 mm for domestic main pipelines of high parameters. The efficiency of the developed technological solutions was confirmed in the course of full-scale tests with a pipe diameter of 1,420 × 27,7 mm of strength category X80 (K65) at the testing range of OJSC "Gazprom" in Kopeysk. During the tests, the pipe manufactured by CJSC "Izhora Pipe Mill" made from strips produced in "Cherepovets Steel Mill" PJSC "Severstal" showed high levels of resistance to extended parameters of ductile fracture in comparison with the products of leading manufacturers.

The "Magistral" project was carried out under a state contract with the Ministry of Education and Science of Russia, and in its implementation participated several companies: NRC "Kurchatov Institute" – CRISM "Prometey", FSUE I.P. Bardin Central Research Institute for Ferrous Metallurgy, OJSC "Cherepovets Steel Mill" and CJSC "Izhora Pipe Mill" (PJSC "Severstal").

However, if the results of the "Magistral" project were used in large-scale production, the results of the "Creation of technology, equipment and development of steel production using ultrasonic effects and plasma heating for the production of high-quality grades of rolled metal and galvanized sheet" were originally used for the production of low-tonnage lots by science-intensive products.

Within the framework of this project, test stands of waveguides and ultrasonic radiators were developed and manufactured. A highly effective design of a plasma torch has been developed. Likewise an experimental setup with two plasmatrons simulating the process of metal plasma heating in an intermediate ladle has been designed. An experimental stand which refines the technology of galvanizing and creates new types of coatings has also been created. Finally an experimental batch of cold-rolled galvanized steel was produced from high-strength two-phase steel in a volume of 100 tons with increased performance properties.

This first low-tonnage production volume was carried out by FSUE I.P. Bardin Central Research Institute for Ferrous Metallurgy, LLC "Alexandra Plus", LLC "Specmash" and PJSC "Magnitogorsk Iron and Steel Works".

The developments of the "Magistral" project were used to provide science-intensive services in the production of high-quality steel grades.

The results of the project "The creation of seamless drawn and electric-welded pipes production based on a new generation of high-performance steels and alloys" are the followings:

- development of smelting technology, extra-furnace steel processing, casting and hot deformation of a centrifugally cast tube billet of stainless steel 08CH18N10T;
- development of new corrosion-resistant steel 03CH17N9AM3 production.

According to the technology developed in the project, experimental batches of tube blanks of these steels 5 tons each were manufactured and they were realized as high-tech industrial products.

The developed metal products are intended for thermal and nuclear power engineering, shipbuilding and aerospace

engineering, chemical industry, oil and gas and military-industrial complexes.

Within the framework of the state contract, the OJSC "TMK", OJSC "RosNITI", (FSUE) I.P. Bardin Central Research Institute for Ferrous Metallurgy, JSC "Izhmetmash".

Depending on the size of demand and the complexity of technology, at the first stage science-intensive products are produced in scientific organizations. At subsequent stages with increasing demand they are produced as innovation production in industrial enterprises.

The development of large-scale technological researches such as "New Materials and Technologies of Metallurgy", the subprogram "Metallurgy", the State Program of the Russian Federation "Development of Industry and Enhancing Its Competitiveness", the program "Development of the Production of Rare-Earth Metals and Products based on it in the Russian Federation", provides systematic accumulation of scientific knowledge potential.

Although due to the conditions of the economic crisis, the timing of the implementation and financing of major scientific researches have changed significantly, but they remain in the long-term plans of scientific researches.

The accumulation of scientific knowledge potential is realized as a result of the development of large-scale scientific researches on energy and resource-saving technologies, new highly effective structural materials, nanomaterials, and special materials, including defense industry complex [8].

The most important investment projects were carried out, as a rule, within the framework of public-private partnership involving a number of large metallurgical enterprises, using both state and extrabudgetary funding.

The creation of a set of special prerequisites for the production of high-tech science-intensive products, including the formation of a large scientific knowledge potential and the acquisition of high-tech equipment is becoming increasingly important for scientific organizations in the context of a reduction in centralized financing for major innovative projects.

The increasing demand for high-tech industrial products with increasing economic interest of scientific organizations in the development of this direction makes it increasingly important to create such organizational and economic forms and methods that would help to optimize the conditions for its production.

Therefore, (FSUE) I.P. Bardin Central Research Institute for Ferrous Metallurgy for the purpose of developing new technologies and modern materials considers fundamental exploratory researches and developments in more than 20 areas including the followings:

- creation of new materials, including nanostructured, ensuring a high level of various performance properties of metal products (ductility, corrosion-resistance, elasticity, etc.);
- creation of new compositions of corrosion-resistant coatings, technologies of their production and methods of applying it to rolled, sheet metal, and other metal structures;
- development of high-strength sparingly-alloyed corrosion-resistant, cold-resistant, well-welded steels for lifting, mining and metallurgical equipment, including dual-purpose (for safe transportation, long-term storage and disposal of spent nuclear fuel and radioactive waste);
- development of non-conventional materials based on iron with increased (at least twice) consumer properties, including steels with protective coatings, particularly high-stamping, IF, hardened ultra-low carbon steels, reinforced steels with BH effect, high-strength micro-alloyed, two-phase and trip-steel for the automotive industry;
- creation of new steels and technologies for their production for trunk gas and oil pipelines, operated under extreme conditions, oil-grade pipes and tanks for storage and transportation of liquefied gas;
- development of modern materials, including fireproof and bridge steels, high-rise construction steels, for the production of modern fittings, bent hot-rolled and cold-rolled sections with a high level of performance for the building complex;
- improving of production technologies of complex alloyed stainless, heat-resistant steels and alloys for atomic and thermal power engineering, chemical industries, medical equipment.

The potential of knowledge generated as a result of the implementation of major fundamental scientific researches developments of applied nature, creates a basis for the implementation of applied research and development work under contracts with metallurgical enterprises and organizations and the production of science-intensive products.

The scheme of scientific knowledge potential building, including the main relationships with the sources of their creation and the main consumers is shown in Fig. 2.

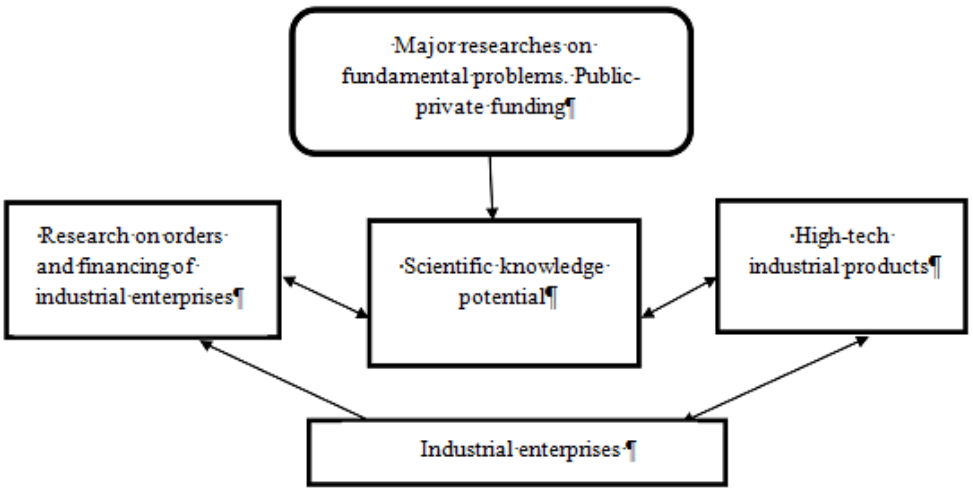

Fig. 2. *Scheme of scientific knowledge potential building in applied scientific organizations.*

At the same time the creation and development of the production of science-intensive products is becoming increasingly important on the basis of major fundamental scientific developments.

The creation and production of science-intensive products are determined by a complex of external and internal factors and conditions.

The main external factor is future demand for specific types of science-intensive products with high performance characteristics. The main internal factors are:

1. Scientific knowledge potential that can be used to produce science-intensive products;
2. Presence of highly qualified scientific and production personnel;
3. Presence of high-tech experimental equipment.

The optimal conditions for the production of certain types of science-intensive products are a combination of all these factors: future demand, potential of scientific knowledge, highly qualified scientific and production personnel, high-tech experimental equipment.

Thus, the three major resources are the potential of scientific knowledge, the availability of highly qualified scientific and production personnel, unique experimental equipment needed to create science-intensive products. The creation of science-intensive products includes the development of production technology on the basis of the results of previously performed scientific research and production in laboratory conditions, using equipment available in scientific institutions.

The development of production is viable in case when, after fulfilling several orders in the laboratory, a request comes in on a relatively constant production throughout a year or for a longer period.

Such development of science-intensive products production created in laboratory conditions may require the establishment of specialized business companies. Moreover, the production of high-tech science-intensive products requires providing the chain: from the formation of new knowledge to their embodiment in material form.

The combination of conditions and factors: systematically increasing demand of high-tech industries and especially companies of the military-industrial complex for hi-tech science-intensive industrial products, the available techniques for the production of certain types of products, the existence of separate research units successfully combining scientific researches with the production of science-intensive products, a great amount of experimental equipment create a certain foundation for practical development of this direction. That is why the substantiation of methods for creating conditions and backgrounds for the practical implementation of this direction is the key to the establishment of science-intensive products production.

Conclusion

The analysis performed on the dynamics of demand for a number of metal products types with a set of particularly high service characteristics revealed that such products, which are required in extremely small amounts - up to several hundred kilograms a year, cannot normally be produced even in special steel production plants due to the absence of special equipment, high technologies, scientific and technical personnel, and can be produced only in the conditions of an applied scientific organization.

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