

# Organizational Forms of Development of Scientific and Technical Products

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**Abstract.** The article proposes to use a new form - outsourcing project, as opposed to the traditional form of work under individual contracts, which includes work on several stages of the life cycle, for the development of complex scientific and technical products. At the same time, the calculation of the cost of works is carried out not by a direct cost method, but by taking into account an additional bonus, which includes transaction costs for entry for each stage of work, loss of profit in case of extension of the project execution time. Based on the analysis of 12 projects, criteria for selecting projects to be outsourced and outsourcing requirements were developed, the main of which is the coverage of life cycle stages. Input costs were calculated based on the minimum amount of time required to learn more the documentation for the previous stage.

## 1. Introduction

Scientific and technical products are the basis for the creation of technological and product innovations that determine the level of industrial development. The relevance of own developments of scientific and technical products is due to the need to maintain national security, including through the implementation of the import substitution program. Retrospective trends published in statistical collections and analytical reports [1,2] show that the process of development of scientific and technical products is slowing down and does not bring significant results. Thus, the number of organizations performing research and development decreased from 4564 in 1991 to 3944 in 2017 (and, in the total number since 2015, branches of educational organizations are included). Of the total number of organizations - 64% of the organizations are with a state form of ownership. Although Russia ranks 9th in domestic research and development spending, the gap in funding with top-ranked countries is significant: for example, compared to China, which occupies the 2nd place - by 10 times. The introduction of technological innovations lags behind the introduction of products, although without leading technological innovations the development of world-class high-tech products is impossible. Russia has been a technology importer for the past 10 years. The balance of technology payments for all types of agreements is negative. In 2017 the amount of excess payments for technology imports exceeded export revenues by \$2.1 billion (2.8 times).

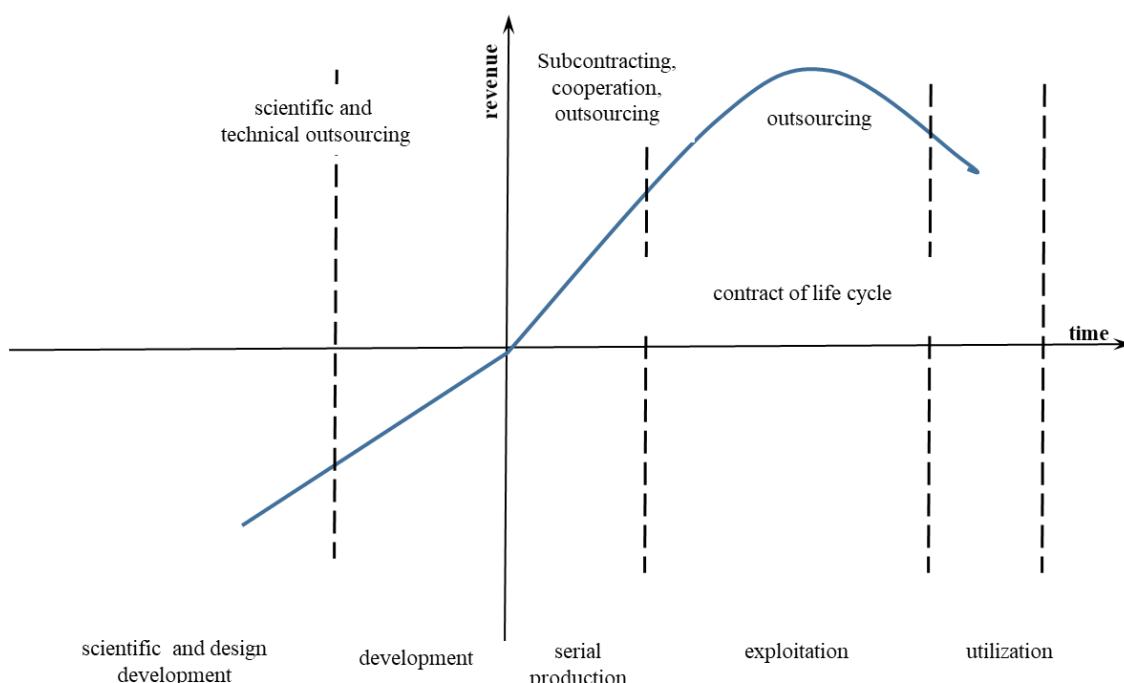
One of the reasons for this situation is the inefficiency of forms of organizational interaction in the development of scientific and technical products, long development times, which lead to moral ageing of the products at the design stages.

In order to solve the problem of choosing the most effective forms of interaction, it is necessary to determine the object of the study - scientific and technical products (STP) and to carry out the existing analysis of the existing organizational forms.

The concept of innovative, knowledge-intensive, high-tech products is widely used in scientific research. There are not many definitions of scientific and technical products and, mainly, they relate to regulatory documents, for example [3]. The general concept of "scientific and technical products" is the presence of a creative scientific component [4,5,6], and further detail of the concept in author and regulatory documents is given in a wide range from "codified knowledge" to "set of design and technological documentation."

For specification of an object of a research we will give an author's concept of scientific and technical products. According to us, the scientific and technical product is the result of scientific research of applied character having the different material embodiment on stages of life cycle and providing flowing or the postponed economic effect at the consumer. The scientific and technical products are based on basic researches, but have applied character and are the final stage of commercialization of innovations.

Now works on creation and implementation of scientific and technical products are carried out in two main ways: by own forces and on the basis of the contractual relations with external performers. Options of the contractual relations can be different, beginning from simple contracts on execution of research works, to more difficult long-term agreements. It is offered to use, for example, approaches of outsourcing for development (scientific and technical outsourcing [7]) or the contract of life cycle for production and service of STP. As appears from definition of scientific and technical products, at different stages of life cycle its material embodiment and a subject of the contractual relations can change therefore it is reasonable to consider organizational forms according to stages of life cycle of STP. In fig. the most common forms of interaction of the customer and performer on stages of creation of scientific and technical products are presented.



**Figure 1.** Application of various forms of interaction when creating STP.

There is no unity on classifications of life cycle stages of STP in both scientific and regulatory literature. Thus, ISO 9004-1-94 identifies the enlarged stage - development works, and according to state standard GOST SRPP 15.000-94, the development stage is divided into the following stages: sketch design, technical design, working design documentation, production and testing of the prototype, acceptance tests, revision of the design documentation and the prototype.

A number of researchers include basic research in the life cycle of SPT [9], as well as marketing [8.9, 10]. The classification of the technology life cycle is even less formalized, for example, [11] suggests starting the technology life cycle from the idea stage and ending with the dissemination stage.

In our opinion, the complete life cycle of the STP should include the development of the technology and the development of the product manufactured under this technology, its operation and disposal. Detail and wording of stages should correspond to existing GOST.

The threat of project risks forces both the customer and the contractor to "split" the works into smaller stages, which does not allow to achieve the set project goals within the specified time frame and leads to frequent adjustments of the types of works by stages. In addition, the contractor does not always participate in the discussion of the terms of reference of the entire project, does not have the opportunity, using his/her competence, to make improvements in the early stages. Therefore, the main task in the development of STP is to reduce the duration of early stages of the life cycle [12].

## 2. Task setting

We propose to consider a new organizational form - outsourcing project, which can be considered as a way of organization of works on creation and implementation of scientific and technical products during several stages of life cycle, based on strategic partnerships between the outsourcing operator and the customer, with transfer risks of project maintenance and additional profit to the outsourcing operator.

At the same time, it should be noted that the outsourcing project, due to what covers several stages of the life cycle, is close to the concept of a life cycle contract. That is, the outsourcing project contract is a kind of mixed contract of scientific and technical outsourcing and life cycle contract.

The effect of introducing the new form is to reduce transaction costs and lost profits by reducing the length of work.

As an experimental base, 7 projects for the creation of new industries, 3 projects for the creation of industrial products and a comprehensive project of the federal-targeted program "technology product" were taken. All projects have a development time of more than 2 years and a cost of more than 10 mln. rubles and cover several stages of the life cycle. For single-contractor projects, the actual time and amount of work was in line with the plan, although there were downtimes between the stages of entering into new contracts. For projects executed by different performers, the differences in plan/facts are significant. As an illustration, we will give the dynamics and cost of works on two projects with the largest deviations (Table 1).

**Table 1.** Execution of projects taking into account different contract performers.

Name of works	planned terms	Actual terms	Deviation from original price, %
<b>Federal Target Program "Development of Energy Efficient Technologies After-Time Period of Operation of High-Temperature Electrochemical Device"</b>			
1. test and design works "Development of manufacturing techniques of preparations of the combustion chamber"	2 years (2 quarter . 2014 - 4 quarter . 2015)	2,5 years (2 quarter 2014 - 2 quarter 2016)	-
2. . test and design works "Development	1 year (2 quarter 2017 - 2 quarter	1 year (2 quarter 2017 - 2 quarter 2018)	20

of manufacturing techniques and production of prototypes of combustion chambers”	2018)		
<b>3 State contract for creation of aircraft modification with new power plant</b>			
Stage 1 - Creating a New Motor	2 years (1 quarter 2017 - 4 quarter 2018)	3 years (1 quarter 2017 - 4 quarter 2019)	18% (Forecast)
Step 2 - Create a new air-screw	4 years (1 quarter 2017 - 4 quarter 2020)	Forecast - 2 years delay	33% (Forecast)
3 stage - mounting of the power unit on the airplane and carrying out certification	1,5 years (3 quarter 2019 - 4 quarter 2020)	Forecast - 2 years delay	-

An additional limitation in the development of STP by means of standard contract schemes is the competitive nature of their placement, where the price, determined through the labour intensity of the works, is decisive. And other types of costs, that actually reduce the gains at the original price, are not taken into account.

Similar to a life cycle contract, the legal status of the outsourcing project and the calculation of the value of such contracts must be determined.

### **3. Methodical approach to determination of contract price for outsourcing project**

To determine the cost of works performed under the outsourcing project contract, we will use the theory of transaction costs. According to D. North, transaction costs consist "of the costs of assessing the useful properties of the exchange object and the costs of securing and enforcing rights" [13], which can be grouped into four main groups. They are –the costs of searching for information, negotiating, contracting, measuring, property rights protecting, overcoming of opportunistic conduct. This view is shared by the following authors [14, 15]. Litvintseva G. P., Gakhova N.A. add to composition the costs of decision-making, the costs of integration and the costs of "politicization." Some authors include the cost of entering a particular area of activity as part of transaction costs [16]. We believe that in order to calculate the cost of the outsourcing project, it is sufficient to take into account the costs of maintaining and concluding contracts and to add the costs of entering the project, consisting in re-examination of the project documentation performed in previous stages, if the gap between stages is more than a month.

On the basis of expert survey of performers, the time interval of "entrance costs" - 1 week was established for the projects under analysis. The analysis of the project cost structure revealed that the main item of overexpenditure was "performers 'wages," which confirms the hypothesis of "entry" costs.

We offer the following method of formation of the contract price - outsourcing project for work on creation and introduction of scientific and technical products.

The first step is to calculate the cost of the work. We will assume that this cost is the same for the enterprise, in case of works performed in-house, and for the outsourcing project, although due to higher qualification, the labour intensity of the outsourcing is likely to be less.

The second step is to calculate loss of profits and transaction costs. In the process of creating scientific and technical products, the contracting enterprise gains such advantages as reducing the time for creating a new product, earlier its introduction to the market, obtaining additional profit in this regard, as well as avoiding the accompanying transaction costs for entering into contracts, entering into a project, etc.

For the selected projects listed in Table 1, no loss of profits calculation was made and transaction costs were calculated based on the following assumptions:

Time spent entering the project when work is delayed by more than 1 month - 1 week;

The additional costs relate to the item "wages with contributions."

Thus, for test and design works "Development of manufacturing techniques and production of prototypes of combustion chambers", the value of costs for an input was about 600 thousand rubles. The overexpenditure on the actual expenses when working by different performers made 1200 thousand rubles. Increase in contract price of works at the sum of costs for an input at simultaneous reduction of terms is possible.

The project outsourcing it is reasonable to apply use to projects with certain requirements:

1. A type of the project or a type of STP on novelty degree (a share of succession of the project no more than 50% of the works performed in the organization by own forces);

2. Duration and project cost (more than 2 years and worth more than 10 million rub);

For the choice of the outsourcer two groups of criteria are basic:

1. Rigid – observance of which is obligatory without exception [18,19,20];

2. Flexible – the quantity of stages of life cycle of STP covered the project outsourcing set on the customer's solution, first of all.

#### 4. Conclusions

In order to accelerate the development of scientific and technical products, it is necessary to use long-term partnerships (project-outsourcing) for complex projects, replacing the practice of carrying out separate research and development works.

In order to assess the effectiveness of the outsourcing schemes, it is proposed to take into account how many stages of the life cycle the contract with the outsourcing provider covers, as for each stage of work performed by different performers there are transaction costs "on entry," which are proposed to be calculated on the sum of the salary of the performers for a week period.

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