

## УДОСКОНАЛЕННЯ ТЕОРЕТИЧНИХ ПІДХОДІВ ФУНДАМЕНТАЛЬНИХ ТА ПРИКЛАДНИХ ДОСЛІДЖЕНЬ В ІННОВАЦІЙНОМУ ПРОЦЕСІ

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**Визначено етапи інноваційного процесу на підприємстві. Детально розглянуто та проаналізовано фундаментальні та прикладні дослідження у межах інноваційного процесу. Визначені недоліки існуючих послідовностей реалізації фундаментальних та прикладних досліджень на практиці. На основі опрацьованих джерел запропоновані удосконалені послідовності проведення фундаментальних та прикладних досліджень на підприємствах.**

**Ключові слова:** фундаментальні дослідження, прикладні дослідження, інноваційний процес.

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## IMPROVEMENT OF THEORETICAL APPROACHES TO FUNDAMENTAL AND APPLIED RESEARCH IN INNOVATION PROCESS

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**Stages of the innovation process are defined. Fundamental and applied research was considered and analyzed in detail in the context of the innovation process. Shortcomings of existing sequences of realization fundamental and applied researches in practice are uncovered. On the basis of studied sources an improved process of carrying out fundamental and applied research at the enterprises was proposed.**

**Key words:** fundamental research, applied research, innovation process.

The process of innovation development and implementation in businesses of all areas of activity is the key to the successful operation and competitiveness of the products and services. Therefore, it is necessary to make the process as efficiently as possible, following the conditions and parameters of a particular company.

According to researchers such as A. Greenev [0], A. Koyuda [0], T. Lepeiko [0], S. Ilyenkova [0], and others an innovative process consists of the following steps: fundamental (basic) research – applied research – development – implementation. Some researchers [0, 0, 0, 0, 0, 0] add to the innovation process complementary steps that characterize the life cycle of innovation, namely growth – growth slowdown – decline in sales. For best results, carrying out of all these steps should be properly organized, and essence of each stage should be as much as possible clear.

In 2012, the amount of the overall costs associated with fundamental research, applied research and development work in Ukraine came to 10 bn. UAH [0]. In comparison, Germany has spent more than €50 bn [0]. In 2012, 26.1 % of the total cost was directed to accomplish fundamental research, which by 95.0 % was financed by the state and local budgets. The share of the costs of applied research accounted for 20.5 %, almost three quarters of which was financed by the state and local budgets and by 14.8 % by the business sector. To perform development it was directed 53.4 % of the total costs, which by 38.1% were financed by foreign firms, by 28.1 % by the business sector, and by 13.7 % by budget funds [0].

In 2011, the cost of fundamental research in Germany accounted for 4.9% of the total, applied research – for 50.1%, and development for – 45.0% [0].

Analysis of the literature [0-0] has shown that the least studied among stages of innovation process is the stage of fundamental research. It makes difficult to understand the essence of fundamental research (as part of the innovation process) by innovators and to create a truly disruptive innovation. This may be due to the fact it is commonly thought that the financing and organization of fundamental research should be the prerogative of the state because of high costs and risk of zero result and low level of commercialization of the results of fundamental researches. However, at the enterprise level of some industries the elements for such researches are required because the use of such researches, first, potentially provides ultrahigh profitability, and second, improves the efficiency of innovation activity at the later stages.

The order of the fundamental research consists of theoretical and search researches [0, 0, 0, 0, 0]. Results of theoretical studies are scientific discoveries of the laws and regularities of the world development, the rationale for new concepts and the creation of new theories. The object of search research is a question of synthesis of applied theories, the establishment of scientific principles of design, engineering, construction and operation of enterprises, identifying opportunities for new products (machines, devices, systems, facilities, technology, new energy sources), the creation of the new features of the materials and their connections. But the entrepreneurs are not always satisfied with the realization of these processes because they need to use the ready-made models (or the description of the sequence of actions for the implementation of fundamental research), and not to be “pioneers” in how to carry out this process in practice, especially effective. Therefore, more concretized model of the sequence of fundamental research is required.

For example, the American researcher Kendra Cherry [0] proposes to divide the fundamental research in the following steps:

- Step 1 – Forming a Testable Hypothesis
- Step 2 – Devise a Study and Collect Data
- Step 3 – Examine Data and Reach Conclusions
- Step 4 – Report the Findings of the Study

Such a description of the process is well perceived because it fixes attention on the core elements of fundamental research, but it still requires additional specification that provides us V. Gerasimov, L. Minina and A. Vasiliev [0]. According to these scientists, the process of fundamental research has to be considered in the following succession [0]:

1) at this stage, the authors propose to realize the preliminary hypothesis advancement, perform the statement of the problem by examining the existing scientific potential. At this stage, the ultimate goals of research and the possible ways of achieving them are defined; requirements and restrictions imposed on the verification of the hypothesis are established;

2) here it is necessary to create a procedure of establishing the truth of the hypothesis: to define the final result, to identify the factors which contrary to achieve the result, and the reasons for these contradictions; to establish the conditions under which can be obtained the perfect result; to work out the program of experiment which is essential to determine how to resolve contradictions by changing the object of research. For this purpose, a mathematical model of the studied phenomenon is created;

3) the organization of the experiment. The task of this stage is the establishment of the correspondence of the initial hypothesis to the objective course of the process. Work on the organization of the experiment, in some cases requires the creation of unique scientific equipment, measurement systems, and the like;

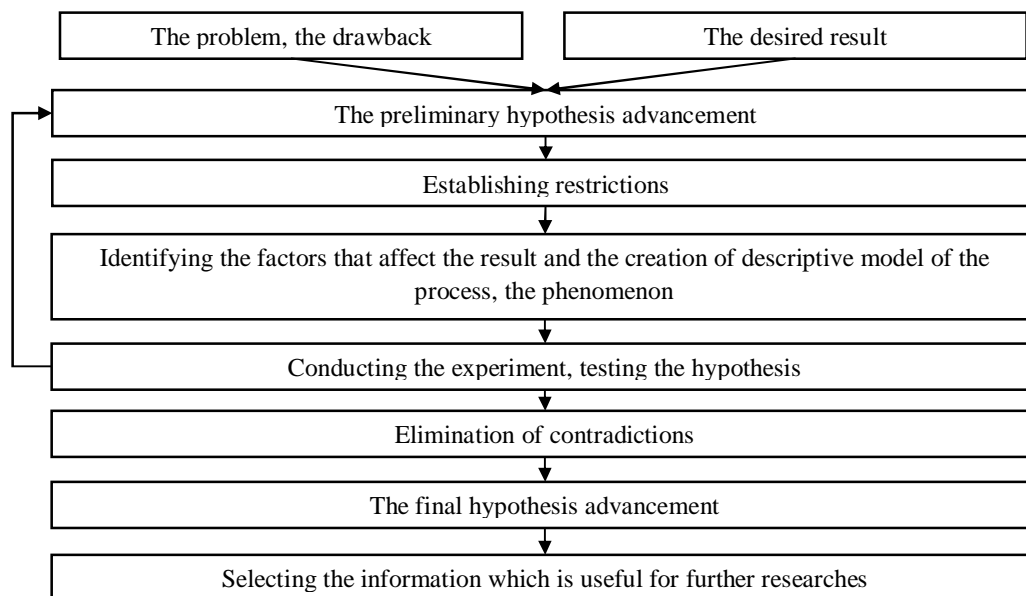
4) theoretical studies are carried out at this stage, which consist in specification of the preliminary hypotheses taking into account the results of an experiment or analysis of the model, and in the formulation of the new provisions of the scientific theory;

5) in the final stage is selected information for later use: to conduct applied research.

The proposed definition of the action sequence is intended for the use of industrial enterprises, which in turn gives rise to a number of drawbacks. At the first stage, scientists put the users of their sequence of fundamental research into the limits of the existing scientific potential, what contraries to the essence of

fundamental research because fundamental research means to find something new, previously unknown to science. At the second stage, they offered to make a mathematical model of a preliminary hypothesis, but as we know, not all can be precisely described by mathematical models, for example, the effect of new drugs on the human body (it is possible to express with the chemical reactions) or the movement of bodies in outer space (expressed with the physical laws).

Basing on a critical analysis of scientific literature has been offered an improved workflow process of fundamental research (Fig.).



*The process of fundamental research*

Its feature is that it is meant for using by companies in all areas of activity. The prerequisite for fundamental research at the enterprise level should / could be existing drawbacks or areas of concern in products, technology, organization, and also the desired result in a particular area of activity of an enterprise. Next various hypotheses are formed about how the problem or the drawback can be solved, or else desired result can be achieved in something, such as creating product which has no analogues in the world. The authors believe that the first hypotheses are formed, even if they are unrealistic, extravagant, eccentric, and only after that certain restrictions can be established. Hypothesis and restrictions are agreed with regard to each other. Then you need to consider all the factors which in any way affect the carrying out of hypothesis and the achievement of result to formulate at the most precise model of behavior (operating principle) of the studied process or phenomenon. After that the necessary research are conducted according to the model to confirm or refute the proposed hypothesis. If the hypothesis turns to be false, then you must go back to identify appropriate one. If the hypothesis was confirmed, the next step involves revision and search for ways to improve it, and then the final hypothesis is formed. Then an important moment in the process of fundamental research comes that is the choice of information that can be useful for further fundamental or applied research. If the results of the research are not suitable for the needs of the enterprise, it can give or sell them to the other companies or research organizations.

Analysis of the works of scientists [0-0] has showed that the process of applied research is also poorly conceived, because not all scientists consider significant to specify it in detail as part of innovation process as such. Even if the applied research process is worked out in detail, it is mainly expressed by generalized models. All of this is a definite impediment to the innovation management, since managers have to go “to the touch” during making decisions about the innovation process. Therefore the construction of the process model of applied research would greatly facilitate the work of innovation managers and make it less risky and more effective and sufficient.

World experience shows that only a few fundamental research are realized into the development, design and manufacturing. Up to 90% fundamental researches have a negative result. Of the remaining

10% not all have a practical outcome. The main purpose of fundamental research is the knowledge and the development of scientific process, the study of the theory of matter [0]. Applied research has the different focus: it is the reified knowledge used in various technologies, as a result of which new machinery, equipment and systems are created. Applied research turns smoothly into the development and designing, and then, into the implementation into production. Applied research determines the direction of applied use of the knowledge gained in the course of fundamental research. Its result is new technologies, materials and systems.

A. Tychinskii proposes to consider the process of applied research as a sequence of two stages [0]: a scientific-research phase and experimental-design phase. These two phases represent the essence of the research because any research consists of the advancement of some assumptions, the establishment of its opportunities, conditions, limitations, and then, the confirmation it with the help of the experiment. But this consideration does not reflect the specific character of applied research, which is based on the fundamental ones and is carried out for the further development and implementation into production.

More detailed sequence is given by O. Starovoitenko [0], which includes the following steps:

1) development and affirmation of the requirements specification. To this stage the author includes not only the development of specification, the methods and the outline of the research, stages and the reliability evaluation of the research, the determination of effort, personnel, the estimate calculation and contract project, but also informational preparation, predictive evaluation of value, costs, results and effectiveness;

2) theoretical research. The author determines the advancement and substantiation of the hypothesis at this stage. Also, according to the hypothesis factors and phenomena are classified, their analysis is carried out, the plan and options for solutions of mathematical and physical models are formed, variants of decisions are substantiated;

3) experimental phase. According to the author, this stage is associated with the experimental verification of the truth of the hypothesis and the existence of the process model;

4) summarizing and evaluation of the results of the research work. In the final step it is needed to determine which information obtained in the course of the research, may be useful for future research, outlook and opportunities of the confirmed hypothesis.

This model does not take into account the analysis of existing researches, what is unacceptable, because the analysis helps to reduce the costs of research, in case of the existence of the solution of the current problem, and it is only required to modify. Also, a preliminary analysis may provide with additional information or ideas for the research, if there are no ready-made solutions. G. Goldstein has corrected this defect [0] by inserting between the development of the requirements specification and theoretical research the stage of selecting the direction of research.

The most detailed model of applied research is represented in the Brief economic dictionary [0]. Applied research includes the statement of the problem, the preliminary analysis of the available information, conditions and methods of solving problems of analogues, planning and organization of the experiment, the experiment, analysis and summarizing of the results, the implementation of the results into production. The main drawback is the lack of a separate phase of the theoretical research, as the authors consider it as part of the analysis process of existing models. This step is necessary to make in a separate category, where the selection of the relevant information from existing solutions, the revision and carrying in the model own ideas could take place to achieve the desired result and problem solving.

Based on the analysis of the literature [0-0] a workflow process of applied research was proposed, which consists of the following steps:

- identification of the problem, the drawback in the product, in the technology or in the organization of the enterprise;
- preliminary analysis of the existing solutions of the problem, the selection of information that can be useful;
- preliminary hypothesis advancement of the problem solution;
- carrying out the theoretical research on the proof of the truth of the hypothesis, model building of the solution;

– carrying out the experiment to finally test the hypothesis. If the hypothesis is false, then it is necessary to return to the hypothesis advancement stage and to think up a new hypothesis taking into account the shortcomings of the first one;

- evaluation and summarizing of the results;
- revision and construction of the final hypothesis;
- practical application of the results.

Such a detailed consideration of the process of applied research will be useful to managers' activity related to the organization of the innovation process, as it represents a plan, the implementation of the points which enables businesses to operate more efficiently.

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