STAGES OF SCIENTIFIC RESEARCH

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Abstract

The stages of research are least susceptible to any General formalization. The object is often given to the researcher by the background of the development of an enterprise or branch of science due to the continuity of scientific research and time constraints that the graduate student was involved in.

The study must be completed within a strictly limited time frame, and it must also be practically implemented. Unfortunately, the choice of research object is often sharply limited. Determining the choice are the needs of this branch of technology, the state of the question, and the capabilities of the researcher. The newer the object of research, the higher the probability of obtaining scientific results, although it may be at the cost of additional time and labor.

Keywords: research, model, criterion, task.

I. INTRODUCTION

The choice of model cannot be regulated by clear rules. Although there are Sciences that are almost entirely based on verbal models, it is clear that these models, describing the object of research in natural language words, can only be used in scientific and technical research at an initial stage and as auxiliary ones. The main reasons for this are the ambiguity of the verbal model, the possibility of its different interpretation, and the inability to perform analytical operations with speech elements.

Similar restrictions apply to graphic models, images of various types, block diagrams, graphs, and drawings. In some studies, it is possible to create graphical models that approach analytical ones, such as graph theory.

The analytical model of an object strictly uniquely describes its properties in terms of mathematics [1-7]. The number of analytical models for each given object can be quite large. However, some of them may be identical in terms of their fundamental capabilities.

However, analysis (or synthesis) in the time domain may be easier in some ways than in the frequency domain (or Vice versa).

The" universal” model of any device is a description of its elements using differential equations. The main difficulty in this case is that for the resulting nonlinear equations, there may be unknown ways to solve them.

The analytical model is the main model of scientific and technical research [8, 9].

The physical model of research is not an informational phenomenon, but a subject one, in contrast to all the previous ones [10-13]. This is a physical arrangement that is to a certain extent adequate to the object of research. A wide variety of physical models is possible.

However, they are clearly divided into two classes: reduced or increased ("scale») a model of the same physical nature as the object and a model of a different physical nature. An example of the first one is a laboratory model of a residential heating system. An example of the second is an electric circuit, where the currents and voltages are equivalent to the mechanical values of a metal truss. Physical models are based on the phenomenon of isomorphism in nature. Its essence consists in the fact that different values are in the same quantitative relationships.

II. METHODOLOGY

The main stage is to select the task of scientific research [14, 15]. It is possible to define four classes of main tasks quite clearly in relation to each object, but the choice of a specific research topic remains very uncertain. It is advisable to introduce the concept of the source of tasks in order to clarify the situation. The source of tasks is a generalized concept that applies to a wide variety of objects and areas of practical activity. It does not specify a specific task on a specific object, but it shows ways to define such tasks. Let's look at some of them:

- *Optimization by criteria*. Optimization is understood as the search for a way to reach the maximum (or minimum) a certain indicator (cost, weight, reliability, etc.). the optimization Indicator is called a criterion or target function.

We must distinguish between two types of optimizations: the parameters and the structure. A combined task is also possible. In the first case, the structure (device) of the object is set by the background, current practice, or other conditions. It is only necessary to set the optimal values of certain internal parameters of the system, at which the optimization criterion reaches an extreme.

In the second case, you need to determine the algorithm of the object and its structure, at which the criterion reaches the extreme. As a rule, structure optimization problems are more complex than parameter optimization problems. This follows from the fact that parameter optimization is essentially a problem of analysis, while the second class is a problem of synthesis of the required structure.

An important step in solving optimization problems is the selection of criteria. It can be found only by a meaningful analysis of the work of the object under study. In this case, mistakes may be made based on a mix of purposes and means.

A successful criterion must meet three main requirements:

- Show the user's intuitive or logical view of the quality of the systems;

- Be mathematically processed for analysis and synthesis purposes;

- Specify ways to build an optimal system.

This creates a very difficult task of multi-criteria optimization in relation to complex objects. You need to find parameters or a structure that allows several indicators to reach the extreme at the same time, such as reliability and cost. Such problems are usually unsolvable. However, modern optimization theory offers a number of ways to "round" and conditional solutions to the problem. You can aim for the extremum of one indicator at the specified limits of others. You can maximize (or minimize) a linear or non-linear combination of particular indicators. In this case, the problem arises of "adding up" various parameters that also have different psychological value. There are several ways to "circumvent" these difficulties, in particular the way to introduce a preference scale, and build a generalized desirability function.

III. DISCUSSION

The main danger of the optimization problem is the detection (at the end of the solution) of the incommensurability of the effort spent and the effect of optimization. However, the solution to such a problem is unlikely to indicate effective ways of improvement. The reason is clear: centuries of history without science have brought it to a certain ideal. However, it should always be borne in mind that a negative answer to a scientific problem can also be valuable and worthy of high praise, if the resulting solution is evidence-based and reliable. This follows from the fact that in the process of solving new models can be found and tested, new methods of solving can be studied, and very valuable side results that go beyond the topic are obtained.

In addition, a solution with a negative response closes the way for unproductive costs in the future.

- *Using new physical effects in the technique*. Here, the physical effect is understood as the dependence of one quantity on another, regardless of the area in which this dependence occurs. For example, if a substance were detected that changes color over a wide range when the applied voltage changes, this would be the discovery of a new physical effect.

The use of new physical effects in technology is a rich source of scientific problems and the construction of new devices and tools.

- *The implementation of untapped opportunities*. Built and operating instruments and devices are usually characterized by several parameters. They are rarely fully used by the device to the maximum limits allowed by the system design.

A significant feature of this task source is the ability to improve the efficiency of the existing system at a small additional cost.

This source of scientific problems is closely related to inventive activity. It also requires careful analysis of the ratio of additional costs and the resulting effect.

- *accounting for accidental impacts or interference*. Interference is caused by precisely unpredictable effects that are undesirable from the point of view of the device's purpose, but are unavoidable. Undesirable effects exist together with useful ones, which can be called signals by analogy with communication systems. It is clear that for the normal functioning of any system, the ratio of "signals" to interference must have a sufficiently large value.

It is important to realize that the quality and reliability of any system is not directly proportional to this ratio [1-4]. After a certain limit, further increase in it leads only to a senseless loss of energy and materials. However, even a not very deep analysis shows that in some systems such "excess" reserves reach unreasonably large amounts. This is partly because the calculation of the required "strength" is not made scientifically. Meanwhile, modern statistical theory (the theory of random effects) provides a rich scientific apparatus for the rational calculation of systems.

Accounting for random impacts is a rich source of scientific problems. At the same time, it provides a large space for the display of scientific erudition, which is important for qualifying studies.

If some researchers think that there is no interference problem in their field, it is because the "signals" in their systems have historically significantly exceeded the existing interference and have been forgotten about.

- *The solution of nonlinear problems*. Nonlinear devices are devices that do not apply the superposition principle. Strictly theoretically, all systems and devices are nonlinear. However, with weak influences they become linear with sufficient accuracy for practice.

All linear problems can in principle be solved precisely, since there is a single method for solving linear differential equations that describe them. The situation is different with nonlinear problems, since the solution of only some classes of nonlinear equations is known.

For this reason, there is a tendency to calculate and design many systems as linear. In practice, this means that they must be used for weak, perhaps medium, but involuntarily large impacts. However, using the same systems and devices in non-linear modes can give a significant practical effect.

The non-linearity of dependencies can manifest itself as both harmful and useful results [1-4]. However, due to the complexity of relationships in nature, there are not only losses or only wins. In this case, the transition to non-linear modes allows you to study their relationship and possibly get a significant economic effect. In some cases, switching to non-linear modes can lead to the opening of new opportunities.

- *Comparative study*. At present, there is a situation in which several different methods are proposed for solving the same problem in many fields of technology. So, to solve the problem of transmitting discrete information in the form of a sequence of letters, numbers, and any signs, dozens of ways are proposed that differ to a greater or lesser extent. A similar situation exists in other areas of technology. The question arises about the ratio of these methods and methods, whether there is a better or equivalent among them in terms of established indicators.

Every engineer or researcher who proposes a new method does not usually have the ability to really compare it with others. But what about designers and organizers of scientific and technological progress? Real systems are complex and expensive devices, and it is not possible to find the best one among them by alternating trials.

This leads to the problem of comparative research – which is a rich source of scientific problems. Its features – The need to search for rational comparison criteria and the requirement of sufficient horizons in the relevant field.

- *Using methods and methods of related Sciences.* Modern science tends to integrate as well as differentiate. On the other hand, experience shows that isomorphism is widespread in nature, that is, the use of the same laws in various external phenomena.

These two phenomena – specialization and isomorphism-lead to the fact that inventions, principles, and methods made and found in one field can often be used in another with great effect. History gives a number of examples of such mutual borrowing not only in similar Sciences, but also in fairly remote areas: biology and engineering, acoustics and electronics.

A specific feature of this source is the need to get acquainted with adjacent, or even remote areas. However, this familiarity in the first pairs of the search does not require much depth. A scientist with broad General interests, not confined only to a narrow field of specialization, often acquires such knowledge " by the way».

- *Generalizations*. Often there is a certain "anti-isomorphism", in which seemingly independent problems are solved, which then turn out to be varieties of one, more general problem. This process is natural for science and is often called development from the particular to the General or inductive method. There are also possible reverse processes for the appearance of a general solution, which is then detailed.

The presence of generalizations is a sign of high development of this scientific direction. However, sometimes this is not given importance, believing that the generalization is not a manifestation of new scientific information. This, of course, is incorrect. In addition, in modern conditions of increasing knowledge, generalization is a powerful tool for overcoming the " information explosion».

Generalization of private knowledge is a powerful source of scientific research, in particular, qualification theses, not only candidate's theses, but also doctoral theses.

- *Search for optimal and effective controls*. Any relatively complex system cannot function "on its own". It requires management, that is, instructions to change the parameters, and sometimes the device of the system, depending on the evaluation of the results of its work.

Management is called effective if it provides satisfactory results of the system. Optimal control is the one that provides the best results (under given conditions).

There may be cases when strict synthesis of the system simultaneously indicates optimal control. However, most often this is not the case. This is especially true in cases where the system has historically emerged earlier than the corresponding control theory.

For these reasons, the search for optimal and effective controls is a very promising source of scientific problems of great practical significance.

- *building equidistant systems*. The "moral" and physical aging of technical systems is a natural consequence of scientific and technological progress and temporary degradation of materials. However, who has not observed the withdrawal of devices and devices from use just because they stopped functioning several or even one part? Replacing this part is often very difficult technically. Sometimes it is simply missing. Sometimes it is a significant share of the product's cost. Then the latter is thrown into the landfill.

IV. RESULTS

The above explains the problem of building equidistant systems. Materials and technologies must be selected so that all parts (parts) become obsolete at the same time, and the product can be completely disposed of. The time of failure of the product (with a given probability) must be predictable. This will avoid accidents with probabilities tending to one.

It is clear that these sources of problems cannot exhaust all the possibilities for the development of science inherent in nature. Creative human intelligence can suggest other unforeseen.

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