Composite Technical Solutions as a Basic Basis for Formation of Innovative Technical Systems and Their Software Products, as Effective Equivalents of Complex Integrative Inventions

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Composite technical solutions, especially those containing fragments and components that are integrative inventions, have recently been increasingly referred to as smart technologies, smart materials, smart production, etc.

This kind of comprehension began with the definition of smart materials.

Of course, there is no formal definition of the catchy term “smart materials”. It is usually the name of materials that can change their properties under the influence of the environment. For example, there are so-called materials with shape memory.

For example, titanium nickelide wire (also called nitinol), when bent, returns its original shape after heating.

For the first time, these properties were applied in the medical devices in the last century, when performing operations to close the Batalov duct in the partition between the heart ventricles.

An umbrella was created from nitinol microplates on which an elastic silicone rubber case was stretched. In the folded state, the umbrella was fed along the catheter to the place of an open duct, and when the body temperature was reached, the shape memory returned the nitinol plates to the initial position. The umbrella blocked the duct and the heart disease was eliminated without surgery.

It should immediately be noted that, despite the freshness of the term itself, the effects associated with smart materials were discovered quite a long time ago.

For example, the shape memory effect was studied as early as in the 1930s, and the properties of nitinol were studied by Soviet metallurgists, Kurdyumov and Khandorson, in 1948 (although the alloy was named so because of its rediscovery in the 1960s by the Americans, but this is a completely different story).

We will focus on a special class of smart materials - self-repairing materials. This term means technical systems that can withstand structural failure due to mechanical impact.

The main requirement for such materials is that the “healing” of damage occurs without human intervention. There are a lot of mechanisms for such healing.

One of the ways to protect metal (for example, aluminum) parts is chromating - they are treated with special solutions, often containing chromic acid.

This treatment forms a thin layer that protects the metal from corrosion. The same layer serves as an excellent primer for subsequent painting or spraying. Chromating, however, involves hexavalent chromium. This material is considered hazardous to health, because, unlike, for example, trivalent chromium, it is relatively easy to penetrate into living cells.

However, in some industries, for example, aviation and aerospace, hazardous chromating is still used in the processing of aluminum alloys.

Among other things, this is due to the fact that, during operation, such a coating can heal minor scratches and damages within several weeks. Roughly speaking, chromium itself migrates to the scratch, filling and closing it. During such migration, the scratch, of course, will not close (commodity appearance of the product will be spoiled anyway), but the aluminum alloy substrate will be protected (worse, of course, but protected).

Thus, one of the tasks the chemists face is to create a coating that could replace the hazardous chromating. In late October 2012, scientists from the University of Nevada presented their prototype of such a coating. They came up with a molybdenum based coating. Scientists have also proposed a method of applying this coating on the surface of aluminum alloy AA2024-T6 used in the space industry.

During the study, scientists deliberately damaged the sample. Then, using several spectroscopic methods at once (for sure), they verified that molybdenum is present in the damaged area, that is, the coating is capable of self-repair. Scientists, themselves, say that their work is not yet completed - they are working to improve the coating formula. It is noteworthy that, before obtaining acceptable results, the researchers tried about 200 different compositions.

But smart materials and technologies today, first and foremost, include technical systems with complete recycling of consumables and without production waste.

One of the most important processes in modern chemistry and electrochemistry is the process of continuous regeneration in real time, for example, etching solutions in the production of electronic and microelectronic circuit boards.

When designing these kinds of composite complex processes, the most critical is the process of adjustment without the use of chemical reagents of the level of acidity or alkalinity in the solution undergoing regeneration.

In the last decade, methods and apparatuses have been invented for such a purpose.

Until today, this integrative invention has not been improved by anyone, or no one has managed to create something better.

Recently, combined compositional technical systems have also emerged. Their evolution is quite dynamic, and at each stage of development, all the technical systems used represent complex integrative inventions, having a number of consecutive elements of constructive and technological regeneration tied to the supersystem functional algorithm.

Figure 1. A duplicated technical system for a linear homogenization station of liquid fuel in the fuel system of an industrial boiler with a capacity of 10 tons of steam per hour.

The technical system is based on standard components, without composite materials and without reference to the production capabilities of equipment with digital program control.

As can be seen from the figure, the technical system also includes control measuring devices for monitoring pressure and flow in real time, but controlled with valves operating in manual mode.

Devices for homogenization are connected and work in parallel, mutually complementing each other.

Components and fittings of standard pipeline equipment are applied with their main purpose, which required several large dimensions, while maintaining the required performance.

Figure 2. A redundant technical system for a linear homogenization station of liquid fuel in the fuel system of an industrial boiler with a capacity of 10 tons of steam per hour.

The technical system is based on standard components, without composite materials and without reference to the production capabilities of equipment with digital program control.

As can be seen from the figure, the technical system also includes control measuring devices for monitoring pressure and flow in real time but controlled with valves operating in manual mode.

The devices for homogenization are connected and work in parallel, mutually complementing each other, but the larger scale of the figure shows the characteristic color of the pipeline valves, made of copper and copper alloys, which, in addition to high cost, leads to the need for regeneration, as stability, strength and durability of parts made of copper at high pressures and the presence of chemically active substances have much lower values.

The need to fundamentally transform traditional technical systems into composite technical solutions, with innovative structure and innovative functionalities and characteristics of the integrative invention that develops in the vertical and horizontal hierarchies, leads to the need to re-formulate the techniques and methods for a gradual transition from the basic (however the composite foundation of the existing technical solution or complex technical system) to a new technical solution and to the basic foundation and integrative invention structure.

Techniques and methods of transition from the created composite foundation of a new technical solution to the basic foundation of an integrative invention

As the first stage of modification of the technical system, we should call the stage of complex and consistent replacement of system components with more advanced ones adapted to work in a composite technical and technological cycle.

Figure 3. A modernized redundant technical system for a linear homogenization station of liquid fuel in the fuel system of an industrial boiler with a capacity of 10 tons of steam per hour.

The technical system is based on innovative and modified components, with the most use of composite materials and with reference to the production capabilities of equipment with digital program control.

As can be seen from the figure, the technical system also includes control measuring devices for monitoring pressure and flow in real time, but controlled with valves operating in semiautomatic mode.

Devices for homogenization are connected and work in parallel, mutually complementing each other, but, if necessary, can work separately in an independent operating mode.

Figure 4. A systematic modernized redundant technical system for a linear homogenization station of liquid fuel in the fuel system of an industrial boiler with a capacity of 10 tons of steam per hour

The subsequent modification of the technical subsystem and the technical supersystem are based on standard, but modified components, with the maximum possible use of composite materials, and with constructive and technological reference and adaptation to the production and technological capabilities of equipment with digital program control.

As can be seen from the figure, the technical system also includes automated control measuring devices for monitoring pressure and flow in real time but controlled with valves operating in semiautomatic mode and that can be included in the closed automatic system of control and monitoring with programmable controllers.

The devices for homogenization are connected and work in parallel, mutually complementing each other, but their technical capabilities and characteristics allow to optimize within the framework of the existing technical solution, taking into account supersystem demands.

The need to switch to combination technical systems, especially to systems related to the level of supersystems, requires optimization and fundamental directions for the development of the Theory of Inventive Problem Solving and the Algorithms of Inventive Problem Solving.

The following main areas can be distinguished:

1. The traditional phenomenon for the evolution of TIPS and AIPS is a general increase in the degree of algorithmization due to a more complete and deeper use of the objective laws of the development of technical systems, including first and foremost – combination complex technical systems (supersystems) with built-in programmable controllers and with higher-power controlling and modeling systems.

2. Significant strengthening of the "bridge" (causal connection) between physical contradictions and ways to resolve them.

3. Strengthening the information fund, strengthening the links between TIPS, AIPS and existing standards, as well as a software solution for preliminary estimate operations and system modeling and simulation in real time.

4. Transformation of the second half of AIPS (development and use of the idea found) into an independent algorithm using the latest software technologies and advanced features of modern computer and processor technologies.

5. Development of a new initial part (or a separate algorithm) to identify new tasks, including innovative tasks, with adaptation to the full simulation cycle.

6. Strengthening of general upbringing and general educational functions based on the latest techniques of system programming, modeling and simulation.

TIPS and AIPS should more vigorously and selectively develop the skills of concentrated, purposeful and logical strong thinking based on the advanced capabilities of modern computer technology.

7. Gradual integrative multilevel increase in composite universalism, composite interchangeability, mutual selective applicability and modularity in composite format.

Combination of functions and conversion of functional load between the local modules of the innovation system.

This perspective makes sense to be detailed.

A sequential step-by-step algorithm for the implementation of this task is proposed, of course, in a multifunctional version with maximum unification and full local interchangeability of all links and elements of an innovative technical solution.

PART 1.

1. FIRST STEP

Determine and formulate the final version of the generated idea and the ultimate goal of solving the problem of implementing this idea

What is the technical goal of solving the problem (“What characteristic of the object should be changed?” Is there a connection between the parameters of the task and the parameters of the innovation tasks already successfully implemented?).

What characteristics of the object can not be changed when solving the problem?

What is the economic goal of solving the problem and what commercial goal is pursued (“What expenses will decrease if the task is solved?”).

What are the (roughly) eligible costs?

What is the main technical and economic indicator that needs to be improved?

1-2. SECOND STEP

Check the bypass route. Suppose the problem cannot be solved in principle; which other — more general, well-known and already solved — problem must then be solved in order to get the required final result, if possible, an ideal final result?

(Use system analysis — the scheme of such an analysis can be based on the principles of an optimal and detailed strategy for patenting and licensing a developed technical system).

1-3. THIRD STEP

Determine the solution of which problem is more expedient — the initial or the bypass.

Compare the original task with the development trends of this branch of technology.

Compare the original task with the development trends of the leading branch of technology.

Compare the bypass task with the development trends of this branch of technology.

Compare the bypass task with the development trends of the leading branch of technology.

Match the original task with the bypass. Make a selection.

1-4. FOURTH STEP

Determine the required quantitative indicators.

1-5. FIFTH STEP

Introduce "time adjustment" to the required quantitative indicators.

1-6. SIXTH STEP

Refine requirements caused by specific conditions intended for the implementation of an integrative invention.

Take into account the implementation features. In particular, the allowed degree of complexity of the solution.

Take into account the intended scope of application.

PART 2. REFINEMENT OF PROBLEM CONDITIONS

2-1. FIRST STEP

Refine the problem using patent literature. Search by the US and European patent offices by ISSUED PATENTS, PATENT APPLICATIONS, and patent applications filed. Search the funds of the European Patent Office in subsections regarding the names of the authors of inventions, companies-applicants of inventions and by complex indicators and keywords.

How are (according to patent data) problems close to this one being solved?

How are problems similar to this one being solved in the leading branch of technology?

How are the inverse problems solved?

2-2. SECOND COMPLEX STEP

Select from all the options such an element that is most susceptible to changes, alteration, changeover, modification, optimization.

Note:

a. If all elements are equal in the degree of changes allowed, you should start the selection with a **fixed** element (it is usually easier to change than a mobile one).

b. If there is an element in the technical system directly associated with an undesirable effect (usually this element is indicated in the technical description), it makes sense to select it as the last.

PART 3. ANALYTICAL STAGE

3-1 FIRST STEP

Formulate the IFR (ideal final result) as follows:

- a. The object (take the element selected earlier).
- b. What it does.
- c. How does it do it itself.
- d. When does it do.
- e. Under what mandatory conditions (restrictions, requirements, etc.).

3-2. SECOND STEP

Make two figures or two models: "before" (before IFR) and "after" (IFR).

Notes:

- a. Figures can be conditional as long as they reflect the essence of "before" and "after".
- b. The "after" figure should coincide with the verbal wording of the IFR, and if possible, with the model.

3-3. THIRD STEP

In the "after" figure, find the element indicated at the previous stages and select the part that cannot perform the required action under the required conditions. Mark this part (with hatching, different color, stroke of contours, etc.).

3-4. FOURTH STEP

Why is this part not able to perform the required action?

3-5. FIFTH STEP

Under what conditions can this part perform the required action (what properties should it have)?

3-6. SIXTH STEP

What should be done in order for the selected part of the object to acquire the properties noted in the terms of reference?

Figure and models.

Supporting questions:

- a. It is necessary to show, in the figure and models, with arrows, the forces that must be applied to the selected part of the object in order to provide the desired properties.
- b. What ways can be used to create these forces?

3-7. SEVENTH STEP

Formulate a method that can be implemented in practice. If there are several such methods, it is necessary to select the most promising.

3-8. EIGHTH STEP

Provide the scheme of the device for implementation of the first method.

Figure, models.

Supporting questions:

- a. What is the aggregate state of the working part of the device?
- b. How does the device change during one working cycle?
- c. How does the device change after many cycles?

The effect of restrictions on the number of paragraphs of the invention formula on the possibility of reliable protection of composite technical solutions.

The proposed structure of the independent paragraph of a composite integrative invention formula, built on the basis of a composite technical solution within the framework of a composite technical system.

The first independent paragraph of the integrative invention formula is of most importance to the application.

The first paragraph of the invention formula should be extremely brief, and at the same time, consist of three parts.

The first part provides the commercial name of the technical solution, which should cover as large a commercial use area as possible, and at the same time, give an idea about the limits of distribution of the claims of the proposed technical solution, excluding advertising speech and paradoxical statements...

The second part of the first paragraph should describe the distinctive features, their aggregates, and interrelations known and used as basic ones for the realization of distinctive features.

The third part of the first paragraph should describe the distinctive features, their aggregates and static and dynamic relationships of the distinctive features with the basic known features that together achieve the ideal final result.

The proposed structure of the dependent paragraph of the invention formula, built on the basis of a composite technical solution

The subsequent dependent paragraphs of the formula should describe, in more detail, the distinctive features in the most general form possible. All subsequent paragraphs of the formula should disclose all possible uses of the distinctive features to form an effect and achieve the ideal final result. If the ideal final result can be achieved in some variations, and, is subject to the presence of different combinations of distinctive features with basic characteristics, all possible options should be specified in the subsequent paragraphs.

Each subsequent paragraph of the formula also consists of three parts, the requirements for each of them correspond to the requirements for the first paragraph of the formula.

1. Second independent paragraph of the invention formula
2. Paragraph dependent on the first and third paragraphs of the invention formula
3. Paragraph dependent on the first and third paragraphs of the invention formula
4. Dependent on the first and third paragraphs of the invention formula
5. Dependent on the first and third paragraphs of the invention formula
6. Third independent paragraph of the invention formula

If the object of the invention is a device or unit and is named, for example, the ... unit, it is desirable to have at least three independent claims, whatever the first item is, a unit for ..., a method of application and an associated method of ... manufacturing.

Third paragraph, - method of applying the ... unit;

Eighth paragraph, - the unit for ... and the associated method of its manufacture ...;

All of the above are just examples. Each technical solution has its own original features, and this may change the composition and structure of the invention formula paragraphs.

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