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IDENTIFICATION AND UTILIZATION OF THE MOST EFFICIENT RESOURCES AMONG THOSE AVAILABLE

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Abstract

Resource Analysis is a well-known TRIZ tool that was originally developed as a part of the Algorithm of Inventive Problem Solving (ARIZ). It is widely used as an independent TRIZ tool or in combination with some other tools (e.g., Function Analysis, Function-Oriented Search, etc.) for problem identification and idea generation.

Nowadays, many publications are available concerning resources in TRIZ. However, most of these publications describe how to reveal and classify resources, but not how to select the most suitable ones. Generally speaking, everything around us can be used as a resource for problem solving, but is there a way to select the "right" resources? What approach should we use to avoid having to test each resource one-by-one?

In this paper, we have tried to develop an approach for choosing the necessary resources directly. We propose applying the Advanced Function Approach (AFA) to develop search patterns for identifying and modifying available resources. Another aspect of the current research is the modification and utilization of different types of voidness, which is a freely available resource.

Keywords: Resources, Advanced Function Approach, Voidness.

1. Introduction

The concept of resources is one of the fundamental origins of TRIZ. That is why Resources and Resource Analysis are required topics to be learned for Level 1 MATRIZ certification [1].

Resource Analysis was originally introduced as a part of the Algorithm of Inventive Problem Solving (ARIZ). The following definition is given in ARIZ-85C [2]: "Substance and Field Resources (SFR) are substances and fields that already exist or may be easily obtained according to the problem conditions." Yet there are no practical recommendations on how to identify resources or on how to make sure a resource list includes only effective resources, while excluding unnecessary ones. This means that the processes of selecting resources and solving problems depend solely on the problem solver's erudition and experience.

At the present time, Resource Analysis is widely used as an independent TRIZ tool or in combination with some other tools (Function Analysis, Function-Oriented Search, etc.) for problem identification and idea generation. There are some articles in TRIZ literature that contain recommendations concerning the Resource Analysis procedure. Generally, however, they are about how to identify a great number of available resources, but do not contain practical recommendations on how to select workable resources from all of those available.

The main objective of this paper is to provide a function approach for identifying resources. The general idea is to identify resources to be included in the list based on their functionality, as well as their availability in space and time. This approach has been developed through practical experience and applied in numerous innovative projects.

2. Literature Review

"*When I decided to select resources for solving scientific problems, I obtained a whole list of phenomena, substances and fields - from the center of the Earth to the center of the Sun*"
Voluslav Mitrofanov [3]

Many good examples of elegant solutions developed by using different resources are presented by Vladimir Urazaev [4]. In his research, Urazaev surveys patents and describes interesting examples of solving problems by using various resources.

Most publications concerning resources in TRIZ literature focus on understanding the role of resources and the identification and classification of as many resources as possible. As a result of this attention to resources, the term 'Inventive Resources' was developed in TRIZ. Boris Zlotin and Alla Zusman [5] define Inventive Resources as:

- Any substance or anything made of a substance (including waste) that is available in the system or its environment.
- An energy reserve, free time, unoccupied space, information, etc.
- The functional and technological ability to perform additional functions, including properties of substances as well as physical, chemical, geometric and other effects.

Zlotin and Zusman developed a checklist for readily available resources and suggested a way to reveal hidden resources [5].

Alexandr Gasanov gives a classification of resources and suggests an algorithm for revealing resources [6].

Sandra Mueller surveys different approaches for classifying resources both inside the field of TRIZ and in strategic management [7]. All the approaches she surveyed are used for revealing the maximum number of resources to subsequently solve a problem, either technical or in management.

Alexandr Bushuev attempts to quantitatively evaluate and compare technical and physical contradictions by employing a vector analysis of resources [8]. He evaluates the resource-intensiveness of different physical quantities and, based on these values, compares the potency of dual conflict in physical and technical contradictions.

Val Kraev, in his lessons, describes a resource approach and gives many colorful examples of resource application, specifying the features of different types of resources and ways they can be applied [9].

Gennadiy Ivanov describes an improved and more practical procedure for identifying resources in his ARIP (Algorithm of Engineering Problem Solving) [10].

Of course, there are more publications available concerning resources in TRIZ, but those mentioned above are the most complete as they summarize previous experience. Again, all these publications describe how to reveal and classify resources, but not how to select the most suitable.

Therefore, in this paper, we have tried to develop an approach on how to choose the necessary resources directly.

3. Advanced Function Approach for Resource Analysis

Function Analysis, as defined in modern TRIZ, is an analytical tool that identifies functions, their characteristics, and the cost of System and Supersystem components [11]. The goal of Function Analysis is to identify disadvantages of the system such as harmful functions, insufficiently or excessively performed useful functions, and excessive cost of components. As was proposed recently, the wrong place and time for performing functions and the absence of required useful functions can also be identified using Advanced Function Approach (AFA) [12].

AFA was introduced in 2010 at the TRIZ Future Conference conducted by European TRIZ Association (ETRIA) [12]. At that time it was shown how utilizing the spatio-temporal parameters can further enhance such a powerful analytical tool as Function Analysis for Engineering Systems. Since then, AFA has proved its practical efficiency in dozens of TRIZ projects.

In this paper we propose applying AFA to identify Substance-Field resources. The suggested algorithm for evaluating resources is as follows:

1. Identify the problem to be solved.

2. Formulate a search pattern in the following format: without complicating the Engineering System and adding additional harmful effects, the X-element must [perform a function].

3. Specify the time and space where the function is needed.

4. Formulate function requirements for the potential X-element.

5. Search for the X-element as a Function Carrier inside the considered ES and its nearest supersystem. At least one of the following conditions should be satisfied:

- The X-element already performs an identical or similar function on the Object of Function

- The X-element already performs an identical or similar function on another object

- The X-element performs any function on the Object of Function or, at a minimum, simply interacts with the Object of Function

6. Describe the idea(s) for the solution.

7. Identify and address the Adaptation Problems required to implement the idea.

The example below was taken from an actual consulting project which was aimed at developing a new product for moisturizing human skin, and which would identify some alternative systems for existing body lotion. One of the sub-directions here was a new delivery system for the moisturizer: a packaging and/or application procedure.

At that time, the Advanced Function Approach for Resource Analysis had not yet been formalized, yet we can see its influence at the idea generation stage.

In this project, a human's daily activities were considered as a technological process. Skin moisturizing was included as one of the operations in the process. Existing body lotion was considered to be the ES involved in the operation.

The traditional application of the lotion is to spread the lotion over the skin. The inconvenience related to such application procedure can be defined as the necessity for the consumer to perform additional actions.

So, we have a problem: how to apply lotion all over the body's skin without additional actions by the consumer?

The search pattern would be: without complicating the Engineering System and adding additional harmful effects, the X-element must deliver lotion all over the skin.

Time and space would be specified as follows: time – anytime where access to human skin exists; space – upper skin layer.

Function requirements for the X-element were stated as follows: "amount of additional actions required from the consumer" and "skin surface area processed per time unit."

All ESs involved in the human daily activity process were considered to be supersystem components and potential X-elements (see Figure 1).

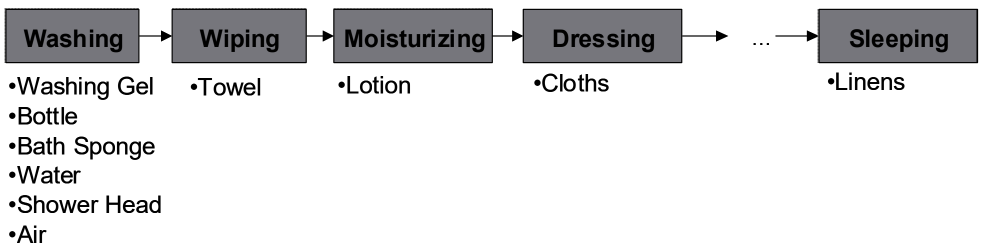

Figure 1. Identifying possible resources for moisturizing human skin

A number of supersystem components were recommended as a potential delivery system for a moisturizing product. For instance, shower gel, water and shower head can be components at the washing stage; a towel can be a component at the wiping stage, bed linens can be a component at the sleeping stage, etc.

What is important here is that we did not list and classify all possible resources; instead, we were focused only on the resources with the required functionality.

4. Application of void

As is mentioned in Part #4 of ARIZ, void is an important resource which is always available, cheap and can be mixed with substances. However, the function of void cannot be formulated since it is not a material object.

This is why we recommend that void is necessarily checked as a possible resource. When AFA is applied, void may be interpreted in different ways: void as an empty space or void as a time interval in which no functions are performed.

A good example of utilizing void to develop a new conceptual design for an electric machine is shown in [13]. It should be noted that when we analyse and improve simple ESs, the ideas and final solutions are hard to find because of the absence of system resources. Often, in such situations void is a perfect resource, as shown with the example below (see Figure 2).

The problem is: how to lock a nut in place permanently? The nut should be tightened and stay in place. No additional components (e.g., nut lockers) can be added. In such a situation, there are not many resources. However, void is always available. The idea for permanently affixing a nut is as follows: a cut is introduced on the side surface of the nut (as shown in Figure 2) and when the nut is fastened in place, a hammer can be used to hit and compress the nut, which will damage the nut's thread and, thus, it will be impossible to dislodge the nut.

As mentioned in [14], void allows an object to increase the number of functions it can perform. When void is utilized, it resolves the following contradiction: additional components should be added to the system in order to increase the number of its functions, but the additional components should not be added in order to keep the system cheap and simple. Void does not add any cost or complexity to a system.

In the same research [14] practical recommendations on how to introduce void to different objects can be found.

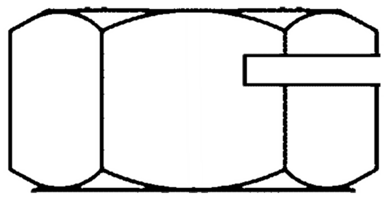

Figure 2. A nut which locks itself

5. Conclusions

Here we have combined and verbalized an approach that could be used for solving inventive problems by searching and evaluating resources. The main idea behind the approach proposed is that we need first to understand what function is required from a resource, where and when it is required, and then we will be able to identify the most suitable resource among the many available. In another aspect of the described approach we use void as a resource in a systematic way. It is not possible to identify void itself using functional criteria since void is not a material object. However, as demonstrated above, it is possible to add void to the other objects and increase their functionality.

Acknowledgements

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