GB System of Inventive Principles

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Introduction

Both TRIZ specialists and users have had many encounters with the multitude of post-classic versions of TRIZ. All of them are based on the fundamental principles of classic TRIZ and, for the most part, use its toolkit. However, a non-specialist would have a hard time telling these various versions apart, especially since they all offer practically the same things. On the other hand, TRIZ experts hold the opinion that these many versions are incompatible with one another. So why do we need yet another version of TRIZ? Furthermore, why do we need a new toolkit?

The GB approach is not "yet another version of TRIZ", but rather a new generation of the process for solving "unsolvable" problems. The approach does not come up with creative ideas – instead, it extracts, documents, and uses the knowledge of the client's experts [1,2,3,4,5]. The new process inevitably required the creation of a new system of GB Principles. Although at first glance the GB Principles resemble the principles of Altshuller, they are fundamentally different in their functional characteristics.

Comparison of the problem-solving processes

Problem-solving using classic TRIZ or the many post-classic versions focuses on the search for one "successful" idea. Sometimes, this idea is accompanied by several "lower level" ideas, i.e. solutions to "secondary" or subsequent problems.

This process works well under certain conditions. The problem-solver must fulfill the following requirements:

- Be a specialist in both: the sphere of industry containing the problem and the method for solving such problems (in this case – TRIZ);
- Have the discipline to follow the long, step-by-step TRIZ process;
- Possess sufficient experience and training in applying TRIZ recommendations, and constantly maintain the necessary "mental conditioning".

If the problem-solver has limited knowledge of the problem containing field, they are unlikely to find a non-trivial solutions, which the experts could not discover earlier. It is doubtful that the solution will be accepted and implemented by the client.

If the problem-solver is unfamiliar with TRIZ or has limited knowledge of the system, they will not be able to fully use the recommendations of the TRIZ toolkit. Using TRIZ requires rather high levels of mental effort. Lengthy exercises, experience, and "trial and error" are the only things that can compensate for the lack of descriptions of "individual thinking algorithms" of each principle, each standard solution, or each step of ARIZ. That is the only way to develop intuitive knowledge about the correct application of the TRIZ tools. A month or two without daily exercises causes the user to lose that intuition and the "mental form" needs to be restored.

A lack of discipline will prevent the problem-solver from going through the entire route from a vague problem to a well-defined solution. The complexity of the process (for instance in ARIZ or some post-classic versions of TRIZ) increases, rather than decreases, the difficulty of work for the problem-solver – demanding a higher level of discipline.

These requirements and conditions seem to be compensated by the fact that TRIZ specialists are constantly improving in the use of their tools and work on the discipline required to fully utilize all the advantages of the method. Furthermore, TRIZ specialists, generally speaking, can understand the problem much faster than people who do are not trained in TRIZ.

Since TRIZ began to be implemented outside the USSR, the requirements for TRIZ users have been increasing. It is necessary to be a specialist in the field of the problem and TRIZ; be able to follow the process with discipline; and constantly practice in the use of the toolkit. Unfortunately, nobody has yet been able to create an "army of problem-solvers" that matches these requirements. There are many reasons for this: both personal and social.

In the course of a project, there is not enough time to "reconfigure" human thinking processes in order to develop sufficient skills and knowledge. On the other hand, most project participants only need to solve the problem at hand, and then return to their everyday activities.

If someone decides to study TRIZ on a more serious level, they are faced with other difficulties. It is relatively easy to teach a novice the basics of TRIZ through lectures and exercises. Turning that novice into a TRIZ specialist is, in turn, an art. The result usually depends on how well-versed the instructor is in this art and the TRIZ toolkit. The issue is that every TRIZ tool uses its own logic, problem analysis, and application technology; and not every TRIZ specialist has mastered all the tools equally. The instructor can successfully teach a user to use those tools, which they are well-versed in using.

The history of TRIZ toolkit development

Historically, all sciences started rather erratically. Man, with his inquisitive mind, would find patterns, in which he would look for a purpose, then turn them into some sort of system, which he could finally use. The same process lies at the beginnings of TRIZ.

Initially, Altshuller noticed certain patterns in the descriptions of solutions to technical problems in the patent fund. Using these patterns, he derived basic characteristics – the presence and resolution of contradictions – and created the first principles. Next, Altshuller started searching for ways to use them. In some cases they worked, in some they did not. After every failed attempt, a search for new patterns would begin – and they were found. New tools were discovered, which worked more successfully under specific conditions.

Thus, the TRIZ toolkit was growing bigger. Altshuller tried to combine various tools, creating various modifications of ARIZ. Many tools were created: principles, standard solutions, laws of evolution, ARIZ. However, attempts at creating a single, logical, and thorough method, which would systematically use all of the tools, were unsuccessful.

To an extent this result was natural. Each separate tool contains, to some extent, all elements inherent to the problem-solving process: goal development, situation analysis, search for possible solutions, and solution evaluation. The only problem is that in every tool certain steps are intuitive and, therefore, unpredictable. They are entirely dependent on the problem solver's personality, knowledge, experience, and paradoxical ways of thinking.

Due to this, each TRIZ specialist, through an empirical method, would find the most useful tool or set of tools, which they continued to use. On a large scale, we can observe this process among the many examples of post-classic TRIZ. Each TRIZ specialist creates their own version of TRIZ, which matches their qualities and abilities.

TRIZ faced some major issues with teaching the method also. For example, as of January 1, 2016, South Korea had 1200 TRIZ specialists trained and certified in MATRIZ (2/3 of all people certified in MATRIZ [6]); and yet all these specialists were not able to create an incredible growth of innovations. Many of them complained: "I have three certificates, attended many seminars, but still have not learned to solve problems on my own." It is easy to blame the students for not learning well. But statistics show the opposite: the problem is not the students, but the instructors. Specifically it is about what they teach, how, and to what end.

Therefore, there is a need for a TRIZ approach, which, on the one hand, would be able to solve the ever more complex problems; and on the other hand, would not require the problem-solver to "become a TRIZ professional" in order to find creative solutions. The problem-solver should have the skills to use the entire toolkit, but should not have to go through a lengthy and arduous process of learning <u>*each*</u> of these tools.

Basic Principles of the GB Method

Creating the GB method [7,8,9,10,11,12,13,14,15], we verbalized the problem-solving process and defined its steps. There are always only four:

1. Establish the Goal and define criteria for its successful completion.
2. Analyze the situation and build a visual model of the process for reaching the goal.
3. Search for ways to reach the established goal (ideas) and combine the ideas into conceptual solutions.
4. Evaluate the solutions, select a solution for implementation, and create an action plan.

What is relevant about this process? It is goal-oriented, organized, and logical. The process must be organized in order to meet these three requirements [16]:

1. Each step uses the knowledge and logic of the participants, rather than their intuition.
2. Each step clearly formulates the necessary results, as well as how and why they should be attained.
3. The results of a step should fully transfer to the following one for further work.

We found the optimal toolkit for each step of the process. The tools assist the problem-solver to complete each step successfully. Each tool performs a specific function and passes its results on to the next one. Subsequently, each step passes its results to the next one. This way, the participants arrive at the solution of the problem in an orderly and logical manner.

Advantages of the GB Method

The GB Method provides the users with the following advantages in solving "unsolvable" problems:

1. A thorough analysis of the problem situation helps localize it as a specific goal, focused on one function-to-modify. Therefore, the user can perform analytical work more efficiently and effortlessly.
2. Visualization of the structure of the problem situation as a function model, demonstrating the cause-effect relationships between functions, increases the effective collaborative work in the project team.
3. Focusing on a single variable function allows the team to generate ideas faster, more effectively, and with less wasted mental efforts (goal-oriented changes, or modifications, to resources).
4. The System of GB Principles helps create a practically exhaustive list of goal-oriented resource modifications (ideas). This reduces the risk of losing important knowledge elements, as well as widens the field of possibilities while searching for a solution.
5. In the GB Process ideas are combined into concepts. A solution optimal for the "here and now" is then selected from these concepts. This reduces the risk of losing an important (best) solution.

The GB Process Toolkit: System of Principles

Discovery

The GB Process was built around a "central" step: searching for solutions. The main principle of searching for solutions is based on a discovery by Sergey Malkin [17]: *Every solution is a combination of simple, goal-oriented modifications of resources involved in the function of the problem situation.*

Any discovery, once it is made, seems absolutely obvious, logical, and even trivial. Indeed – if you want to change the results of a problem situation, you must change something in the situation. It makes sense to only change those things, which are directly involved in the activity of the situation. Clearly, if the change is made to something not involved in a situation, it is unlikely to affect the situation. In TRIZ, we are used to substituting a vague "something" with the more specific term "resources". Another important fact here is: if the problem could be solved with one simple change of one resource, the solution would be discovered by the experts without the use of TRIZ. This further confirms the theory.

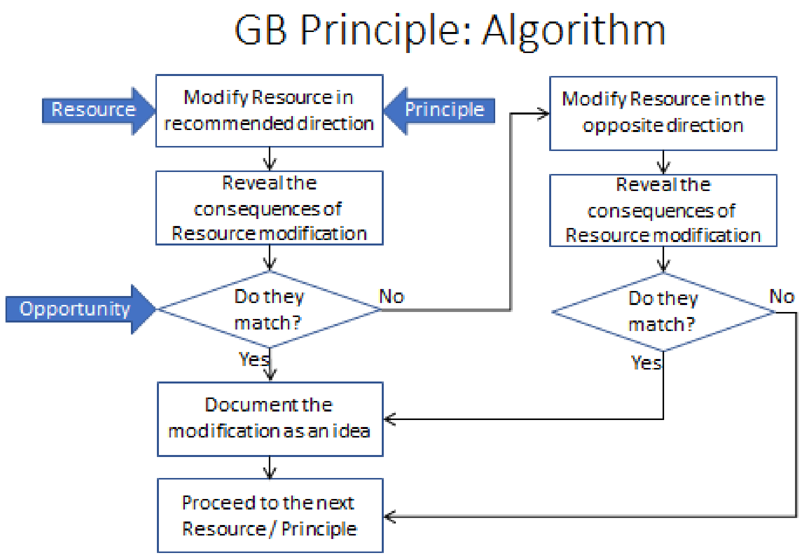
Conclusions

This discovery leads to three main conclusions:

1. A conceptual problem solution can be obtained by ***combining*** simple, goal-oriented changes to relevant resources.
2. Successful concept development requires a ***practically exhaustive*** list of these changes.
3. Hints (recommendations) should provoke a ***recollection*** of simple changes of each relevant resource and a ***review*** of whether or not their consequences work toward a set goal.

Result: the GB System of Principles

As we can see from these conclusions, each GB Principle gives recommendations for the same action: a goal-oriented, simple modification of one specific resource. Therefore, all GB Principles work following the same algorithm:



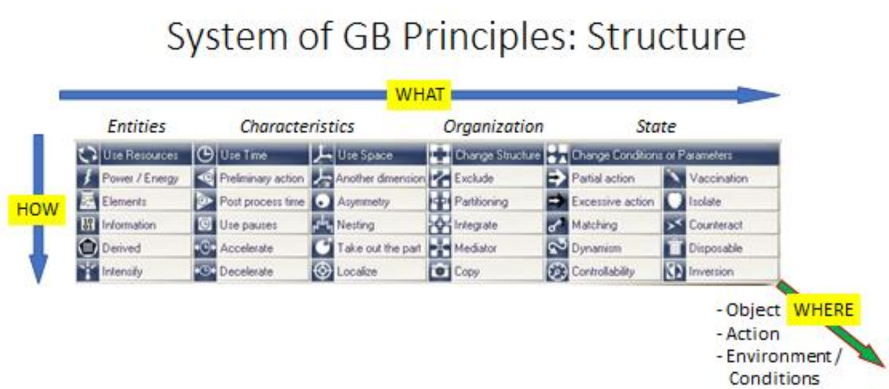
Pic. 1

To create a practically exhaustive set of simple resource modifications is possible through:

- Using each GB Principle with every resource of the corresponding type.
- Use **<u>all</u>** GB Principles in the course of work.

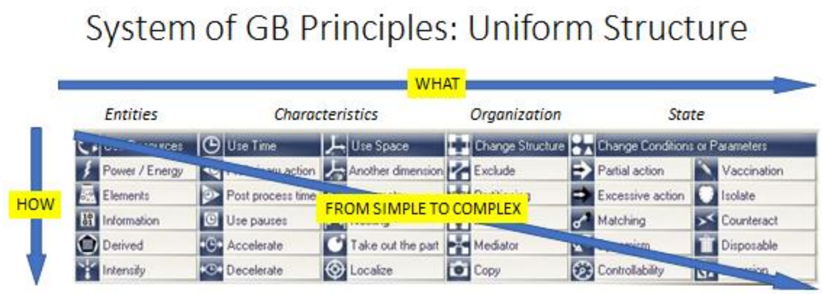
GB Principles are organized into a system [18], which reflects its primary requirements:

1. Offer recommendations for modifying the entire spectrum of resources (WHAT and WHERE).
2. For each resource type, offer a practically exhaustive set of possible, goal-oriented modifications (HOW).



Pic. 2

3. Offer principles in a certain sequence: “from simple to complex”, from “more familiar changes” to “less familiar”.



Pic. 3

As a result, we get a uniform algorithm for **<u>all</u>** of the GB Principles:

Pic. 4

The success of the GB method in real-world projects can be explained, in part, by the fact that the GB System of Principles is standardized for simple, uniform application. Through this standardization, the process of solving "unsolvable" problems gains the following advantages:

- Faster and simpler process of learning to use the GB System of Principles [19].
- A more comfortable application of the Principles in the course of a facilitated project [20].
- Easier revelation and application of knowledge.
- Increased chances of success, due to the practically exhaustive list of possible implementable solutions.

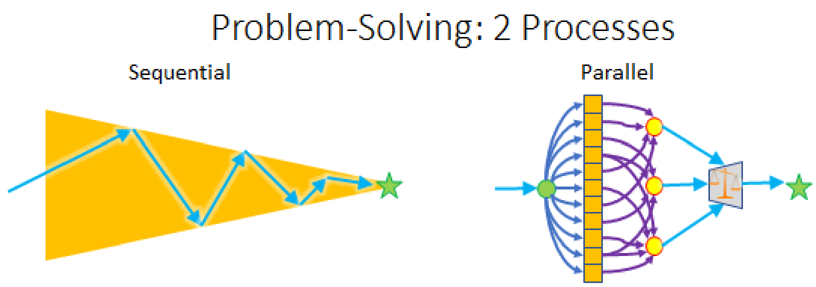
Comparing the toolkits of classic TRIZ and the GB method

We have, many times, been faced with a "simplified" approach to comparing the tools of the GB method with the tools of classic or post-classic TRIZ. Common comparisons use quantity ("You have only 30 principles, while classic TRIZ has 40.") as well as "quality" ("Your principles seem rather simple, compared to the principles of Altshuller."). We will often see comparisons based on the presence or absence of certain tools ("You don't even have an index of physical effects."). This kind of comparison – made outside the context of a tool's application in a process – is usually made for a single purpose: to "prove" that "my version of TRIZ is better than yours".

We will try to conduct an adequate comparison of "suggestions", used in classic and post-classic TRIZ, with analogous tools of the GB method and taking into account the extent to which these analogies are appropriate. The basis for this comparison will be a functional view of the tools, rather than an object-based one.

First, let us compare the processes, in which the tools will be utilized.

There are two known processes of problem-solving: sequential (used in classic TRIZ and its various post-classic versions) and parallel (used in GB):



Pic. 5

In a sequential process [21], the method's recommendations suggest an "initial" solution, which is far from the ideal (star). Then, through several iterations, this solution is improved and brought as close as possible to the ideal. Here, the principles (recommendations, operators, principles of resolving technical contradictions, principles of resolving physical contradictions, standard solutions) must suggest how to, in one step, find the complete solution to the problem. Next, the suggested solution is "polished" to be as close as possible to an Ideal Final Result (IFR).

In a parallel process – in fact, just like in the sequential – the problem analysis focuses the problem-solvers' attention on a "key" function [22]. Then, the idea generation step creates a practically exhaustive list of goal-oriented changes of the resources of the key function. At this stage, the problem-solving process is similar to the process of "parallel count" in a computer: until all "elementary" functions are completed, no further action is performed with the results. In a parallel process, the principles (suggestions) must remind the user which single, goal-oriented resource change to consider. Next, we proceed to build conceptual solutions by combining individual resource changes. Finally, we select a "locally ideal" solution, i.e. the best for the "here and now".

These key differences in the process of solving "unsolvable" problems determine the three main distinctions between the problem-solving tools of classic TRIZ and GB:

1. ***The purpose*** of the principles in classic TRIZ and GB is not the same. In classic TRIZ, a principle must provoke a creative thinking process. A GB Principle must help extract from memory, the latent knowledge of the expert.
2. ***The application*** of the principles is different. In classic TRIZ, the user must select the principles, which are most effective for solving a given problem. This selection is done with the help of a table of principles for resolving technical contradictions, an algorithm for the use of standards AIST, etc. In the worst case scenario, the user goes through every single principle until they find a satisfactory solution. In GB, ***all*** principles are used every time in order to extract practically all of the relevant knowledge.
3. Consequently, ***the results*** of the principle application are different. In classic TRIZ, after using the principles, the user gets a set of possible solutions to the problem. GB method, in turn, provides a practically exhaustive set of knowledge regarding goal-oriented changes to the relevant resources.

Therefore, comparing the principles of Altshuller and the principles of GB without considering these distinctions is, at the very least, incorrect.

Conclusions

The GB System of Principles is specifically developed for a fundamentally new process of solving "unsolvable" problems. Formulation of an implementable solution requires the knowledge of the client's experts, which they often do not associate with the current problem. This knowledge can be successfully extracted and applied through the use of the GB Principles.

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