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How to Formulate Crazy Problems

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Some men see things as they are and say – why?
I dream things that never were and say – why not?
George Bernard Shaw

Abstract

In order to improve the system, one needs to find the resources inside the system or in its environment – an inventive problem cannot be solved without this. If resources are insufficient, the solution will be weak, or it will be a compromised solution. In the case of the absence of resources, they can be taken from a different, alternative system. An algorithm of working with two systems simultaneously should be proposed. Moreover, the "conceive the unconceivable" tool improves the system even when you don't succeed in solving of the inventive problem. It is possible to apply two tools at once – both combining alternative systems and "conceive unconceivable." High efficiency of the methodology is confirmed by real examples from the practice.

Keywords

hybridization, combining alternative systems, conceiving the unconceivable, portrait of solution

1. Search for resources

The current situation in problem solving can be briefly described with the following words of my favorite fantasy-writers: "Mankind never goes at the problems which it is not ready to solve. This is true, but it is painful." (Arkadii and Boris Strugatsky, "Malish", 1971). In reality, first, material conditions for solving the problem have to appear, then the problem can be recognized and solved. For example, only after the invention of gun powder, was it possible to think of creating rockets for both fireworks and military applications.

However, as a rule, the opposite statement is not true. It is not necessary that the problem is recognized immediately after the appearance of conditions sufficient for its solution. For instance, in the author's opinion, a meniscus telescope, conceived by D. Maksutov in 1941 and nowadays widespread all around the world, could have been proposed when astronomic optics was a nascent science because the simple principle of meniscus systems was already available for understanding during the times of Descartes and Newton. [1].

One can see similar cases very often: valuable inventions are decades or centuries late; sometimes they appear when they are no longer needed for anyone. Is it possible to eliminate, or at least reduce this "idle" time?

What is the source of the appearance of inventive problems? According to Genrich Altshuller, the origins of the technical and physical contradictions, and consequently inventive problems, is the law (pattern) of non-uniform development of systems (http://www.altshuller.ru/triz/zrts1.asp).

When an inventor improves a system, he has to make sure that there are resources for resolving the contradiction inside the system or in its environment. If there are resources, early or later, the problem will be solved. If they are insufficient, one has to be satisfied with a compromise, so that the contradiction is not resolved, but only reduced, smoothed out.

For example, Maksutov conceived his so-called "school" telescope (meaning telescope, possessing high enough quality, and at the same time affordable enough for any school) in the twenties of the last century. In order to protect the short, 10-12 centimeters in diameter, pipe from abrupt temperature changes, from being penetrated by water vapor and fingers of curious kids, he needed to place a protective window made from optical glass around it. However, the high price of this glass was prohibitive (because of the requirement of low price for the school telescope). But without a protective window, the lifetime of the telescope could not be very long. For more than thirteen years, Maksutov was not able to solve this problem.

In his book *Astronomic Optics* (1948) [2], Maksutov mentions that before World War II, it was production of thousands of school telescopes was planned in one of the Moscow suburbs. It looks like a happy end for this inventor. But, in his book he clearly calls this success "doubtful," and the fortune of his invention "sad." Why? Exactly because there were no necessary resources in the system, and he was not able to resolve the contradiction "glass for protective window has to be both high-quality and inexpensive".

2. Paradox problems

It is possible to aim for and obtain required resources if we take them from another system, which can be selected according to the simple rules. It has to:

- Carry out the same primary function, as the initial system;
- It should not possess the deficiencies of the initial system.

The peculiarity of this approach is the formulation of "**alternative contradiction**", which is related to both systems. The paradoxical inventive problem contains the sum of advantages of both systems, and in fact, it is the "**portrait of solution.**" In this case, it is easy to obtain a real solution, and oftentimes, the solution is obvious. It is not necessary to take care of the deficiencies of both systems, because they disappear in process of the work. This is a serious advantage of this case. One of the first articles on this subject was published by "TRIZ" magazine in 1990 [3].

The rules of working with this methodology are described in an algorithm [4].

Where we find an alternative system, from which we want to obtain the necessary resource? I will describe the most frequent cases from my practice.

2.1. The system, in which the deficiency has to be eliminated, is the only one, i.e. there is no other place to take the resource, which is required for its improvement.

In this case, it is recommended to consider the same system at an earlier stage of its development. For example, knives with narrow blades are utilized for shaving in modern electric shavers. These knives cut hair well, but they shave very small area. That is why two, three, and even four blades are used. The design is complex and expensive, but manufacturers are still proud of their products.

A couple decades ago shavers with gyroscopic and spring drives had gone away from the market. These shavers had only one head and knifes with wide blades that shaved wider areas than the areas shaved by the more expensive modern models. At the same time, these shavers were simple and inexpensive. But they had their own disadvantage: they did not shave well, and therefore, were not able to keep up with the competition.

The paradox, obtained from the alternative contradiction will look the following way: blades of knives of the shaver head have to be **narrow** (in order to cut hair well), and they has to be **wide** (in order to shave a big area). The answer described in report [5].

More than 20 variants of design were developed based on the idea of solution, US patent 6,584,691 was published in 2003 [6].

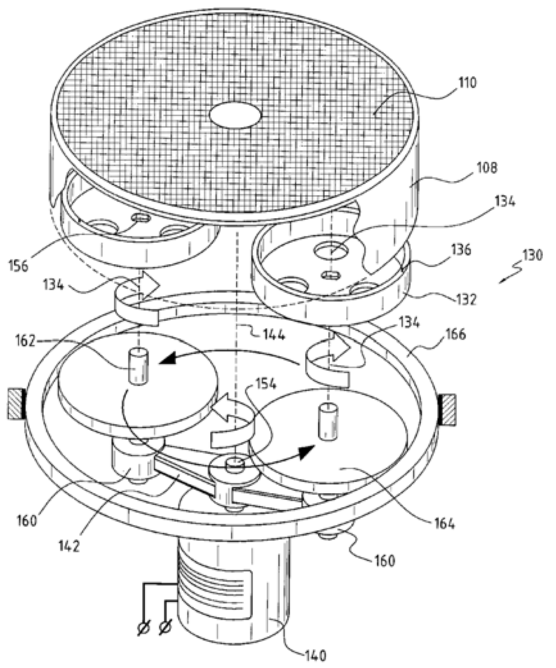


Figure 1: Electric shaver having orbitally moving blades

2.2. Except for the initial system, which we want to improve, there is one system, developed for the same goal, and this system has none of the deficiencies of the initial system.

For example, during training on TRIZ and Value Engineering in Tbilisi (Georgia, 1989), one of the participants told about his problem. The mechanical robot arm, serving high-speed stamping process, was designed for placement of the PCBs into required place, but it had some problems to grub the PCBs if they were slightly inclined inside their container. They tried to apply the pneumatic suction device, which would take and hold the PCBs even from its inclined position, but this device did not provide the required precision for placement of the PCBs into the receiving device. The stamp broke regularly and required repair. After three month of unsuccessful attempts to stabilize one or another device, they decided to arrange a manual supply of PCBs into the stamp.

The problem, obtained based on the alternative contradiction sounded the following way: the robotic arm has to have a **suction cap** (in order to conveniently grasp any PCBs, even if they are inclined) and the robotic arm has to be **purely mechanical** (in order to place the PCBs into the stamp precisely). The answer was nearly obvious, and installing and tuning the hybrid device into the industrial cell took less than two hours. This case is described in great detail in this article [7].

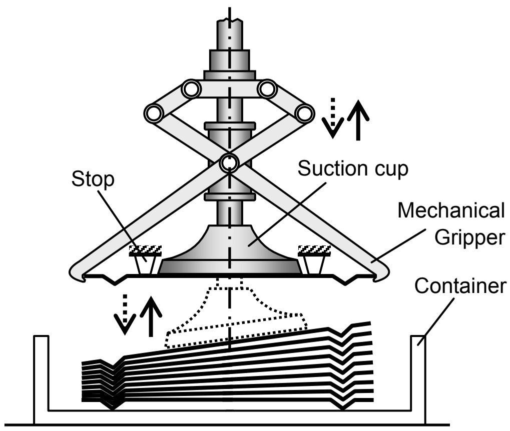


Figure 2: Pneumatic-mechanical robotic arm

One more example. It is easy to obtain the straight ribs of the body of a meat grinder by casting, but in the process of operation, they press the meat and squeeze juice out of it. Spiral ribs do not press the meat, but casting this type of body is much more complicated. Combining resources of these two variants resulted in the idea of wedge-like ribs that work much better than spiral, and casting these ribs is much easier than casting straight ones [8].

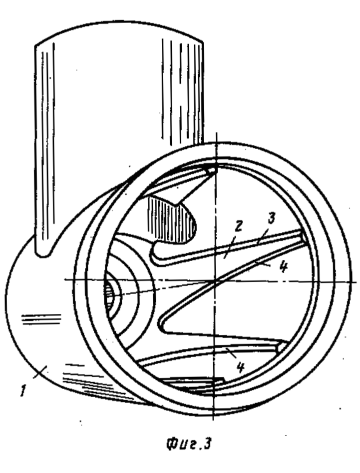


Figure 3: Wedge-like ribs on the body of meat grinder (Certificate of invention of USSR № 1353506, 1987) [9].

2.3. Except for the initial system, which we want to improve, there are few other systems which can carry out the same purpose. As a rule, among these systems, there is one, which does not possess the disadvantage of the initial system.

For example, we want to improve a nail, to reach better execution of the function "to hold details." The same function can be executed by a bolt and nut, rivet, screw or glue. Holding connected details can be made a few times better with very little complication of the process of production of nails and without changing the way it is applied. For this, one can choose one of the alternative systems, for example a screw, and use its resources.

The technology of screw production can be improved using the resources of the "nail" technology. It is possible to create a variant of the final system, where advantages of both systems are combined [10].

2.4. Except the initial system that we want to improve, there are many (tens) systems, intended for the same goal, but they have a very small functional differences.

For example, we want to improve heat transfer through the smooth wall of pipe and prevent formation of scaling on the wall. This can be done through increasing the turbulence of flow by one of the multiple existing methods: applying twisted tubes, inserting various static mixers into the tube, making ribs on their surface, producing a rough surface on the walls, covering the surface of the walls with thread, etc. All these variants can be considered one "integrated prototype", i.e. "an additional device for strong turbulization of the flow in the pipe." Applying any of these methods will cause the hydraulic resistance of the system to grow and increase the price of the heat exchanger.

An alternative contradiction can be expressed in the following way: the pipe surface has to be smooth, and the flow inside has to be laminar or weakly turbulent (in order to provide low cost equipment, low hydraulic resistance and low power input for pumping liquid) and the pipe has to contain special devices for strong turbulization of flow (in order to provide high heat transfer and prevent formation of scaling on the wall). A solution for this contradiction is described in this example (process of solution is written under the Algorithm of Combining of Alternative Systems (version 1998) [11].

I ought to mention others, more complex variants of combining systems.

2.5. Simultaneous combining of both resources and structures, and technological processes.

For instance, electrical machines at the Leningrad Electrical Engineering Plant were manufactured differently than they were manufactured at the "Sachsenwerk" factory (Dresden, former DDR). The advantages of the different approaches were successfully combined, and it was possible to eliminate most shortages (a publication is in process).

It is a pleasure to mention that it was possible to improve two solutions that are still utilized in electrical machine building at once. The author of one solution is Thomas Edison, who proposed to produce a laminated core assembled from many thin sheets, instead of monolithic core design, for the electric machine (Great Britain Patent № 1385; 1880 г.). Author of the other solution – Hiram Maxim (inventor of the famous machine gun) proposed to make channels inside the laminated core (Great Britain Patent № 1392; 1880 г). Our solution is protected by a certificate of invention of USSR № 1259421, (1986) [12].

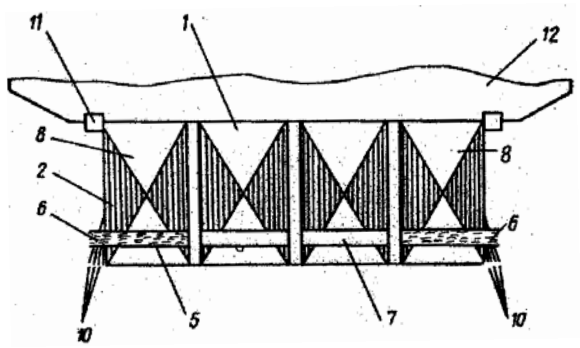


Figure 4: Laminated core.

The process of searching for a solution is described in the book [13].

2.6. At first, the resources of two alternative systems are combined, and then, a resource is used for combining with a third, initial system.

An object substantially improved by this process is the simple hand washstand, known in Russia for hundreds years [14].

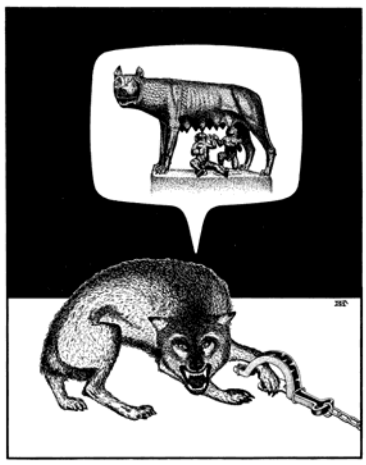
2.7. Consecutive (multistep) combining.

A result obtained after combining two systems is not final. It is used for further combining with one of the prototypes, or with a foreign system; the process can be repeated many times. The Algorithm of Consecutive Combining (Hybridization) of multiple systems was developed by Valeriy Prushinskiy [13]. T-square (1995) and fence (2001 – 2003) were selected as examples [16].

2.8. Combining of advantages of non-technical systems.

How to combine the pluses of different approaches to technical consulting was demonstrated in 1995-1997 [17].

This example is based on the experience of creating cartoons, and participating in international contests (1975 – 1980). (Publication is in process of preparation).



Vladimir Gerassimov, URSS

Figure 5: Picture from contest "Umoristi a Marostica" (Italy, 1977).

What is common to the above-described cases? They describe existing systems, or at least it is clear, how to produce these systems. But what to do in the case when there are no existing systems from which we want to take the necessary resource? I.e. the system is not yet invented. Should we wait until it is invented in the distant future? There is a simpler way out.

3. "Conceive the unconceivable" tool

In his book *Algorithm of Invention,* Genrich Altshuller wrote, "The inventor has to step over the word "impossible" and forget about it. Sometimes, even this is sufficient to nearly automatic ally obtain a new technical idea." (http://www.altshuller.ru/rtv/rtv1.asp).

Actually, when we set up the problem, it is not clear **how to obtain the solution**, but in practice, it is always clear, **what we can gain**, if we solve the problem. This can be used as an opportunity to trace the consequences of a **hypothetical, not yet existing solution**. The name of this method is "Conceive the inconceivable."

For example, for many years D. Maksutov was not able to come up with the solution for making cheaper the optic glass for a protective window of his school telescope. Without this window, his favorite device was different, not as he wanted it to be. He was not able to jump over this barrier. One day, due to whatever particular circumstances, he was able to tell himself: "I don't know how to obtain this glass, but let's assume, that I already have it. What would happen?" and all difficulties disappeared. He knew a lot about the properties of optic glass because he was a professional, but before this time, he never thought about what would happen with telescope if the protective window was in fact installed on the tube. An insurmountable barrier disappeared, and after only two hours of simple reasoning Maksutov obtained his idea of for the meniscus telescope.

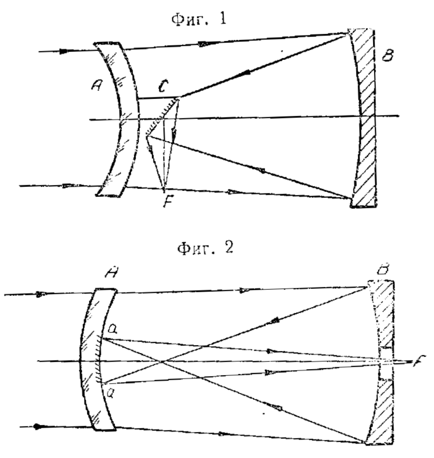


Figure 6: Meniscus telescope
(certificate of invention of USSR № 65007).

The diameter of its tube could be substantially increased. Powerful instruments for serious astronomic inventions are expensive, which is why his invention was highly appreciated both by the specialists all over the world, and by the government of state. The problem of the school telescope was resolved. These telescopes were produced by various factories for many years. Though production was unprofitable, these telescopes were sold to schools at an affordable price [18].

Based on Maksutov's experience, I applied the "Conceive the unconceivable" tool purposefully. I was involved in resolving the problems of large synchronous electrical machines at my job in 1986. Efficient technology for impregnation and following thermal curing of coils of small machines was developed by our plant. However, this technology was not applicable to large machines, because a big enough impregnating tank was lacking. Increasing the size of the impregnating tank was not economical. We formulated the problem: a big rotor (3.6 m in diameter) has to be entirely placed into the smaller size tank (2,6 m in diameter) without cutting the tank.

With sound understanding of facts, this problem had no solution. Factory specialists traced the consequences of a hypothetic answer instead. Through this approach, they resolved multiple problems for this type of machines, including weight reduction, improvement of ventilation, alleviation of starting conditions, reduction of expenses for insulation, increase of reliability. One of the prospective solutions eliminated the impregnation of the rotor by the compound, while keeping all the above-mentioned proposals. This case is described in great details in this article [19].

One of the solutions received inventor's certificate for invention in 1989 [20].

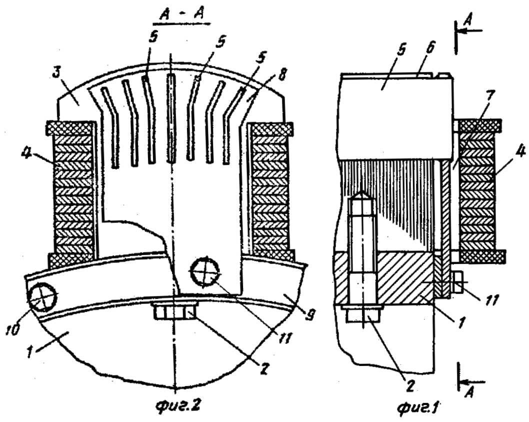


Figure 7: Rotor of synchronous electric machine
(inventor's certificate of USSR № 1451802).

An example of successful nature's application of this approach over 150 million years ago was described in the story "Conceive the unconceivable" in 2005 [21].

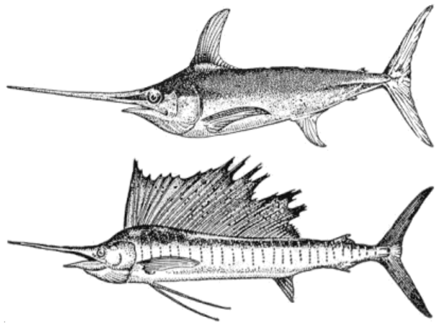


Figure 8: Warm-blooded swordfish and sailfish.

The presentation of the "Conceive the unconceivable" tool was proposed in 2005 at International TRIZ Conference (S-Petersburg, Russia) [22].

4. Resources from virtual reality

Which shortages of existing situations in inventive problem solving would I like to change? First of all, many valuable solutions are very late. Second of all, when they finally appear, they appear in wrong place, not where they are required, and therefore, it is difficult to implement them. For instance, the chances of implementing a new shaving head [6], which is half a century late and appeared "off side," are unreal. Huge amounts of funds and human power were applied to support old complicated and expensive designs, and it is very hard to sacrifice them.

Other similar examples are described in the article "Correct slide" (2010) [23].

Cardinal changes to the situation can be achieved if two instruments can be applied together: the combining alternative systems method and the "Conceive the unconceivable" tool. In this case, the problem includes the sum of advantages of the two systems, but one of them is "made up," that is, not yet existing. It doesn't matter that this system does not yet exist and may never exist in reality in the future. In other words, in order to take resources from virtual reality, one has to formulate a "crazy" enough problem.

This subject was presented at the International Conference "Three generations of TRIZ" and the TRIZ Developer's Summit (S-Petersburg, 2006) [24].

In 2007, the report was presented at the TRIZ Summit – 2007 (Moscow) [25].

In most cases of practice one can meet two variants:

4.1. The initial technical system is real, and the alternative system is hypothetical i.e. this system does not exist in real life (for example, due to economic reasons), but in principle it is clear which properties it would possess in the case of its existence.

For instance, a knife of the meat grinder can be substantially improved, if it uses the resources of another "absent" (crescent-shaped) knife. This example is described according to the algorithm of combining of alternative systems (2010) [26].

4.2. The initial technical system is real, but the alternative system is a fantastically impossible one. There is no such system and it is impossible to make it.

However, this does not prevent the use of its resources for improving initial system. For example, this approach was applied to improving the position sensor of a regulating control mechanism of a nuclear reactor. Two sensors were taken to create an alternative pair: the American one (absolutely simple and reliable, but requiring high expenditures when constructing a nuclear power station) and the Soviet one (which has a reduced height, and is cheaper to construct, but is more complex and less reliable). [27]. (Follow-up publication is being prepared).

The "crazy" problem can be formulated in the following way: the American sensor (the sensor is around 4 meters long) must have zero length i.e. the final goal is reducing the size of the device, while keeping its high reliability.

In the process of work, the alternative sensor was proposed as a pair for the American sensor. It is impossible to produce this sensor, because it has negative height (this reminds me of the humorous problem of Paul Dirac about splitting the catch between fishermen when the correct answer, from mathematical point of view, is "negative two fish"). The final sensor, obtained as a result of this process is reliable (as the American one is), and it has a smaller height than Soviet one (in principle, its height can be reduced to zero). For many years, these sensors worked without any failures in Russia and other countries.

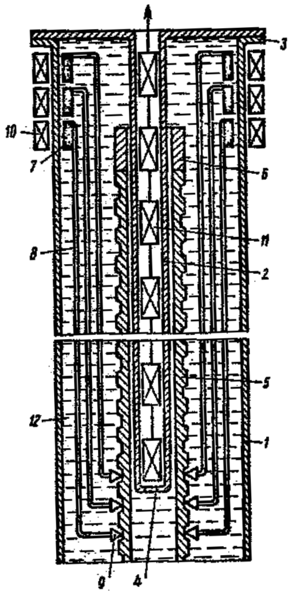


Figure 8: Mechanism of control of nuclear reactor (Patent of Russian Federation № 1012708 and Patent of Ukraine № 7112) [28].

One more example is the working organ of the industrial dyeing machine. In order to improve the operation of the existing, very **real** working organ, a **fantastic** one was used as its pair (it is hanging in space without support, and multiple tons of dye erupt from it, and it is impossible to create this supply of dye because of the high speed of the imaginary fabric).

In this case, at the beginning, the "crazy" problem was formulated. Then, combining resources for two alternative systems, one of which is fantastic, gave us the opportunity to obtain an amazingly simple and efficient solution.

5. Prospective of approach

Let's go back to the statement of the Strugatsky brothers, cited at the beginning of this article. Yes, if there are conditions for solving the problem, in most cases, they will not be explicitly stated. I agree that it is **painful**, because many excellent solutions are delayed for tens and hundreds of years. But I cannot agree with the statement, that this **has to be true**. Practice proves that if one raises a paradox, problems that initially seem counterintuitive, unconventional, and even crazy can be greatly improved.

As a matter of fact, this approach is analogous to the time machine, which gazes into the future. However, in our case it is possible to watch virtual reality, take the required resources for it, and apply them here and now.

The described approach is applicable to improving both simple systems, for example [7], [9], [11], and quite complex ones, for example [12], [19], [28]. Through this process, when more non-trivial and even "crazy"" problem arise, a stronger result can be obtained.

I am grateful to my colleagues L. Kozhevnikova, D. Kucharavy, V. Prushinskiy, A. Prushinskaya, and A. Zakharov for helping me to accomplish this work.

September 2010.

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