TASKS FOR TETRIS MATERIALS. (IGOR KAIKOV)

Introduction

All of the following tasks are given in a simplified, adapted form. We have chosen as examples the simple technical systems which are familiar to all. We have solved real problems of mechanical engineering that may be used as the educational materials to many of the principles and rules of TRIZ. However, for the purposes of this course, these examples should be subjected to such a significant adaptation and simplification that they may give the students the wrong idea about the substance and the level of complexity of real problems.

We believe that this simplified form, without corresponding descriptions of the problem situation, its transformation from a fuzzy situation into the correctly set problem, is inappropriate and even harmful for the purposes of this course.

In later versions of the given educational textbook we will give real customized production problems with corresponding explanations of the methods of transition from the diffuse situation to the formulation of the problem.

In the present course we limit the description to educational examples. They are analyzed in detail, with comments and tips (help) and possible (test) answers. However, students have freedom to analyze the problem independently and find solutions in accordance with the rules of TRIZ.

Note that as a rule you can come up with the same solution in different ways, using various tools of TRIZ. The tool, which would seem to you personally as most effective, depends on the type of problem, and the level of your knowledge and skills. Ability to use various tools of TRIZ is one of the conditions of success in solving real problems. It is worth to remind, that one of the goal of TRIZ is a theory, is to provide thinking skills such that the problem solver becomes able to create his/her own solving tools.

Inventive problems are nonlinear problems in many senses. Therefore, during solving them, sometimes it is worth a look in the encyclopaedia, reference books, learning more about the history of the development of a technical system...

When you have solved the problem, do not stop there. Think - what are your shortcomings or the disadvantages of solutions suggested by the authors in the textbook? The famous 18-th century French naturalist Georges Buffon (Buffon, Georges-Louis Leclerc, (1707-1788) finished each his article or book with a list of unsolved problems. It gave a fresh and broad perspective on the problem, attracting new researchers, made it easier to take the next step.

Good Luck!

1 Problem (a crash-proof key)

1 Problem Situation

The locks with flat keys that are represented on Fig. 1, 2, 3, are often used in locks of drawers, wardrobes and doors (Fig. 3). The top part of a key, that we hold to turn into a keyhole, is called «a head». The low part of the key that is put into a keyhole in order to open or close a lock, is called «a barb».

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Fig. 1.
http://www.ps.com.ua/file.php?id=14u5.gif

Fig. 2.
http://keyservice.tomsk.ru/upload/avtorussia.JPG

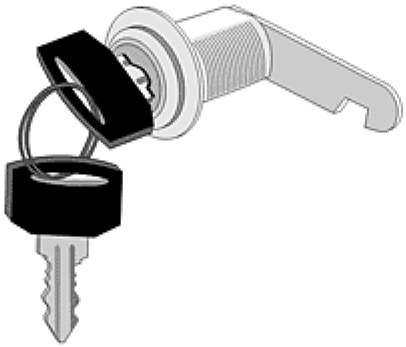

Fig. 3.
http://www.keyservice.ru/pics/keys/

A key is thin, light and takes up little space in a pocket or a bag. However it has a significant disadvantage. If we accidentally hit a key left in a lock, it could break. Then it is difficult to draw a broken part from the keyhole. And besides, it is difficult to unlock a door or a drawer of a table. In this case we have to break a lock, and sometimes things in which it was inserted: a door, a drawer. In order to escape this unpleasant situation, it would be good to have «a crash-proof key ».
Come up with a design of a key that will not brake even at strong pushes. Let the other things as a table or a door, a lock remain unchangeable… It is necessary to modify only a key. And more precise it is necessary to modify «a head» of the key.

* Typical Mistakes (made before the problem solving)

There are some typical mistakes that trainees make when they solve this problem. The most significant mistake is to iterate through the options: and what, if we do so… and if we do otherwise? Do not try to «guess» a solution. Following the rules during the training is more important than to find an answer. The analysis of a problem that is conducted correctly under the rules is more useful and effective than an accidentally found answer. Besides, think over what solutions would be offered by trainees that do not know the rules of TRIZ. Some typical incorrect steps are listed below.

1. Usually it is proposed to make a key with harder materials, as a special steel.
2. To change a key profile, replacing a flat key on a key with a round or another profile that has greater durability/strength. Of course, then it would be necessary to modify a lock.
3. Warning signs to be careful and not to touch accidentally a key, inserted into the keyhole. each time remove the key after the unlocking and locking and not leave it sticking in the lock.

We leave you to find weaknesses of each as a training job. Afterwards, please apply TRIZ rules for your better solution.

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2 Prompt-1

IFR:
The key protects itself from a breakdown in a moment when we accidentally push or touch it with force. However, the key preserves the ability to perform its function – to unlock and close a lock.

3 Prompt-2

Contradiction 1:
The key must be broken, since force is applied to it; and the key must not be broken in order not to change a lock or a door.

4 Tool

IFR
The key protects itself from a breakdown in a moment when we accidentally push or touch it with force. However, the key preserves an ability to perform its function – to unlock and close a lock.

Contradictions:

Contradiction 1:
A key must be broken, since force is applied to it; and the key must not to be broken in order not to change a lock or a door.

Comment 1:
Is a key always broken when we apply force? When we open a door and turn the key into the keyhole, we apply force to it. If force is applied in the correct direction, the key is not broken, and performs its function, i.e. opens a lock. It is necessary to check this Technical System (TS) with the Law of Harmonization (see: LTSE – The Laws of Technical System Evolution).

Contradiction 2:
The key must be broken in order to transform the applied force to the work at an accidental push; and the key must not be broken in order not to change a lock and a door.

Comment 2:
Now, if accidentally applied force does not break the key during a push and turns it into a key-hole, then the key would not be broken, «energy» of the push will not work on a breakage of the key, but on its turn. But it appears a new problem - unwanted closing-opening of the lock under random hits. Sometimes such undesired opening-closing of the lock can be much more dangerous in its consequences than a breakage of the key.
The analysis must be conducted by identifying as many relevant contradictions as possible, in order to have a more detailed profile of the ideal solution.

Contradiction 3:
The key must rotate under random hits to avoid breaks; and the key must not rotate under ran

dom hits to avoid to open or close the lock.

Contradiction 4:
The key must stick out of the keyhole in order we can use it (to rotate, close and open the lock, remove); and the key must not stick out of the keyhole in order not to be pushed and broken.

Contradiction 5:
The «head» of the key should be long in order to turn the key and open the lock, and the «head» must be short in order not to break the key during a random applied force.

"Tongs" Model

1. IS – Initial Situation description: Undesirable (negative) situation (Negative Effect – NE). What would we like to change?

If you accidentally push a flat key, left in the keyhole, it breaks down. It is essential that a flat key, inserted into the keyhole, does not break at any random push.

2. Imagine that magic wand is in your hand (MDR):
The key itself protects against breakage at a time when we accidentally push, touch it with force. However, the key retains the ability to perform its function - to open and close the lock.

3. Barrier (Contradiction) that prevents us form overcoming the negative effect (NE=IS) and obtain the MDR:
The key is to rotate at a random push in order not to be broken, and the key must not rotate at a random push in order not to open-close a lock in moments of random pushes.

According to the ARIZ logic (chapter 3 of the handbook) it is necessary to identify the operational space and the operational time of the contradiction. Then the separation principles can be applied to overcome the contradiction itself (chapter 5).
Indeed, the conflicting requirements in this case can be separated in space, since different behavioural characteristics of the key are requested, as a function of the direction of the applied force (a torque to open/close the lock, a side force when accidentally hit).
Two inventive principles emerge as relevant to implement the separation:

Inventive Principle № 1: "Segmentation"
A) Divide an object into independent parts.
B) Make an object easy to disassemble.
C) Increase the degree of fragmentation or segmentation of an object.

Inventive Principle № 15: "Dynamics"
A) Characteristics of an object (or outside environment) must be altered to provide optimal performance at each stage of an operation.
B) Divide an object into elements capable of changing their position relative to each other.

5 Possible solution
The «barb» and the «head» of the key are connected by a hinge. When the key is rotated in the lock, the hinge remains unmovable, since the rotation of the «head» and the «barb» fit in this case. They move as a single entity. This result is achieved by means of harmonization, fix cou-

pling of two parts when such force is applied.

However, if we apply force to the «head» of the key, and this force is directed perpendicularly to the axis of the key, the «head» turns over the «barb» on a hinge. The fix coupling of two key parts is absent in this case (Fig. 4).
Compare: the metal bracelet of clocks is bent well in one direction, when the links of the bracelet move relatively to each other on hinges. And it remains hard, if you put your strength so that links are not moved on hinges. (Fig. 5).

Fig. 4. (Photo by Kaikov I.)

Fig. 5. (Photo by Kaikov I.)

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