Strengthening the 40 Inventive Principles

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Abstract

This article consists of 2 parts. The first part investigates the formulation of the 40 Inventive Principles, one of the classic TRIZ tools. We compare the 40 Inventive Principles from different TRIZ sources in English as described in books or software and point out the differences such as incompleteness of some principles, different words used in the translation to English etc. The second part consists of suggestions to read the 40 Inventive Principles in a different way. First an investigation is made of different approaches to get a more forward use trying to make the principles as less abstract as some of them are without fundamentally changing the 40 IP. We aim to simplify the application and strength of the 40 Inventive Principles by splitting them up into a resources part and recommendation part. Since language triggers thoughts, different meanings can create different interpretations. In order to get a more uniform language we suggest revised 40 Inventive Principles where the used terms are in accordance to a systemic view. Finally the split up is applied to an example.

Keywords

40 principles, resources, recommendation, operator

1 INTRODUCTION

The contradiction matrix is probably the most widely known tool in TRIZ. This link http://www.triz40.com/ contains the translated 'Altshullerian' matrix as a link that automatically gives you the different Inventive Principles.

Although Altshuller stated to have wasted a lot of time [1] on the contradiction matrix and some remarks were made to the 40 Inventive Principles [2] concerning overlap and the level of abstractness, the 40 principles still inspire many new starting TRIZ students.

Off course more modern tools were developed such as the Inventive Standards and ARIZ as an algorithm of inventive problem solving.

Some work on rearranging the principles has been done by Darrell Mann. The 40 Inventive Principles were rearranged to get the new overview [3], the matrix was fully reworked in 2003 [4] where several new combined Principles where added as also the number of parameters changed from 39 to 47. An interesting feature added in the new Matrix 2003 is a linear link between parameters and advised Inventive Principles.

2 COMPARING THE 40 INVENTIVE PRINCIPLES

On the consistency of the 40 Inventive Principles Todd & Domb [5] describe possible symmetries. When looking for text similarity between an IP and patents some obscure Inventive Principles were defined in [6]. The Inventive Principles were also grouped into a 5x3 matrix by space-time-interface entities in [3].

This article compares the Inventive Principles in different English TRIZ sources. Most of the Inventive Principles have subdivisions usually noted with a capital letter.

We will use the abbreviation "IPS" for Inventive Principle Subdivision.

The sources are:

A. H. Altshuller Forty Principles, Translated by Lev Shulyak. Technical Innovation Centre, Worcester MA., 1998 [12]
B. Invention Machine Co. Techoptimiser 3.0
C. Ideation Innovation Workbench, version 2.8.0
D. Darrell Mann, Hands on Innovation 2002 [3].
E. Ellen Domb (version 1997, 40 principles with examples) [14]

where A was logically chosen as a reference. Source A has 98 IPS

Although other sources could have been compared, we only wanted a limited number of sources and the list was chosen at random including of course Lev Shulyak version. Different comparisons on information, used words and meaning, technology and defined starting conditions, have been made within the different sources.

2.1 Regarding the information sources

7 IPS have been added to the reference (6,5 %)

43 IPS have additional information (40,2 %)

3 IPS are not mentioned by the others, id. completely left out (2,8 %)

3 other IPS are not mentioned by all the other sources (2,8 %)

An example is found in comparing principle 39. (see table 1). In total there are 107 IPS

IP	A	B	C	D	E
39	A. Replace the normal environment with an inert one	A Replace a normal environment with an inert one,	A. Replace the normal environment with an inert one	A. Replace a normal environment with an inert one.	A. Replace a normal environment with an inert one.
	B. Introduce a neutral substance or additives into an object	B• add neutral parts, or inert additives to an object.		B. Add neutral parts, or inert elements to an object or system.	B. Add neutral parts, or inert additives to an object.
	C. Carry out a process in a vacuum		B. Carry out the process in a vacuum		

Table 1: Differences in information.

2.2 Regarding word & meaning

39 IPS within the same Principle use different words eg. Object ≈system≈ structure ≈environment; stationary ≈fixed, …(36,4 %)

28 IPS within the same Principle use different meanings eg separate≈ single out, consolidate≈combine≈make (26,2 %)

An example is given in IP nr 1 (see table 2). Off course it should be stated that due to translations and probably the use of different dictionaries will explain the different meanings found. We could not trace which dictionaries the different sources used to translate.

IP	A	B	C	D	E
1	A. Divide an object into independent parts	A divide an object into independent parts	A. Divide an object into independent parts	A. Divide a system into separate parts or sections.	A. Divide an object into independent parts.
	B. Make an object sectional (for easy assembly and disassembly)	B make an object easy to disassemble	B. Make an object sectional	B. Make a system easy to disassemble and reassemble.	B. Make an object easy to disassemble.
	C. Increase the degree of an object's segmentation	C increase the degree of fragmentation (or segmentation) of an object	C. Increase the degree of an object's segmentation	C. Increase the amount of segmentation.	C. Increase the degree of fragmentation or segmentation

Table 2: Differences in meaning.

2.3 Regarding technology - undefined solution

We use "Technology" when a technical solution is proposed in the IPS. With "Undefined solution" we mean that no technical solution or the means to perform the solution has been proposed. For instance, if you have to divide a system into independent subsystems the only question that remains will be how to perform the division. What specific method will you use to divide the system? A principle is called "Undefined solution" if it is not clear which technology is used to divide the system. Some principles however suggest what to do and what technology to use. For instance nr 14B "Use rollers, balls, spirals, domes" and nr 18 "Use piezoelectric vibrators instead of mechanical ones. Yet we found most of the principles to stay on the abstract level on how to do it. 19 IPS can be considered as having a clear technology described (17,8 %), 88 IPS are abstract (82,3 %). Here we come to the conclusion that some degree of abstract thinking is required to use the Inventive Principles. It is left to the user to try to apply the abstract Principle to a given problem.

2.4 Regarding description starting condition –or only end condition

Some Inventive Principles describe the starting condition. For instance Principle 39a. "Replace the normal environment with an inert one" or 29 "Replace solid parts of an object with a gas or liquid. These parts can now use air or water for inflation, or use pneumatic or hydrostatic cushions." These examples indicate that the starting condition is defined. In the first case it is called a 'normal' environment. The second solids are the starting condition. 66 IPS have only a formulated 'end condition' (61,7 %), 31 IPS contain an initial condition (38,3 %). We conclude that the 5 sources can be considered as "3" versions: A and C are very similar such as B and E and D is different from the 2 former.

3 SOME LIMITS OF THE INVENTIVE PRINCIPLES

As soon as the technique is applied the user is 'trapped' to see only 2 conflicting parameters limiting the user to use both at its maximum (technical contradiction). Or one conflicting parameter where extremes are needed (physical contradiction). The general idea of an Inventive Principle should be that the user recognises a new direction to solve a conflict. The Inventive Principles should act as a 'click' enhancer stimulating the different possibilities in which to overcome the at-the-moment only unsolvable problem. A common way is to make the Inventive Principles less abstract is clarifying it with pictures, movies & examples. Many papers have appeared with examples clarifying what is meant with the Inventive Principle applied in a certain domain. An extended list can be found in the TRIZ Journal (www-triz-journal.com). The lack of knowledge in a specific scientific area however can hinder you to find a solution so we expect that many of the possible solutions are missed. The same is the case with differences in the understanding of the meaning of the words and the ability to think with abstract explanations. As soon as a possible new direction has been found the road towards the implementation can be a 'problem' too. It is what Goldratt [15] calls the Transition Tree, which is going from the Current to the Future Reality Tree. The solution can be clear but the changes needed to implement this solution can form another obstacle. The Inventive Principles lack implementation solutions on this part.

4 STRENGTHENING THE INVENTIVE PRINCIPLES

One other way we found useful is to view the 40 IP as resources for a certain problem. Most of the inventive principles could be seen to include a hint of what you should look for and how you should solve it. The part of the Inventive Principle that contains the way to solve it is the recommendation. A practical example will be given in the next paragraph. In this sense we split the 40 IP up into a resources part and a recommendation part.

From our point of view we also wanted to use uniform language. To split the 40 IP up into a recommendation and a resource part could be seen separate from trying to make a more uniform language in the 40 IP. For this reason the following example will not explicitly use the uniform language. For this reason we changed different words in our view to a more uniform word usage for many inventive principles. Some notion of care should be pointed out to the fact that this will include another interpretation of the IP. The fact that these changes give better results only come from the fact that we tested this out in a classroom setting, further experiments and comparison between the traditional matrix and the revised one could lead to proof that the revised matrix is easier and more direct to use.

We replaced 'objects' with "systems". A system is a broader term; it can be one object or several objects. Every problem needs a clear definition of what 'the system' is and where and when the problem is situated (operational zone and time). Of course this should be done by the user in advance.

We replaced the word 'Parts' with "subsystems". A subsystem is a part of the system. The words "Environment" and "surrounding" are changed with "Super Systems". A super system is everything that is not part of the system, but that could affect the system and thus has an interaction with the system.

The words "actions" and "operations" we changed with "processes". A process changes the state in which a systems is to another state e.g. it changes the attributes/properties of a object.

The words "Parameters" and "Characteristic" are changed into "properties".

A "factor" is a "function" or "property".

We also renamed the principles into a verb with or without an adjective. This gives a more active meaning, a forward use to the principles. The complete list can be found at www.p41.be.

5 EXAMPLE

Sometimes it is hard to define a contradiction. This source contains [7] a help to formulate the contractions. Recently V. Souckov [11] defined a sharper way to formulate the contradictions.

As an example of a contradiction we use the one formulated by Rantanen & Domb in Simplified TRIZ [13].

In 1994 the ship Estonia sank resulting in 852 deaths. After an analysis the conclusion was that a locking mechanism had failed. The simplified locking mechanism is shown in figure 1. We will not go into the contradiction formulation itself (which can be read in [13]) but start from the contradiction . The technical contradiction is between the reliability of the lock versus the ease to open en close the lock..

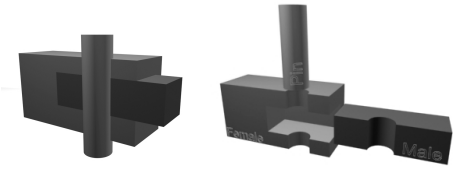

Figure 1: Example of lock open en closed.

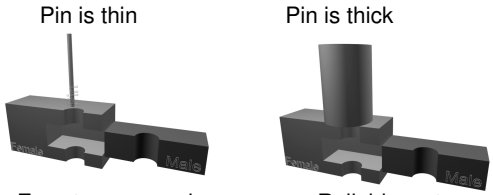

Figure 2: Technical and physical contradiction.

To solve the contradiction TRIZ suggests to use the following Inventive Principles:
17 other dimension
14 Curvature
15 Dynamization
10 Preliminary action

Inventive Principle 17 suggests:
1. If an object moves in a straight line, consider use of dimensions or movement outside the line
2. If an object contains or moves in a plane, consider use of dimensions or movement outside the current plane
3. Use a stacking arrangement of objects instead of a single level arrangement
4. Re-orient the object or system, lay it on its side
5. Use 'another side' of a given object or system

The 5 IPS's from IP17 contain a clue. The clues are formulated through the words plane, moving, dimensions, single level arrangement. Looking at the drawing we can define all the planes, sides, movement.

- There are 56 sides (pin, female male)
- There are 2 linear moves
- There are 28 planes

Beside the clues, IP 17 suggests what to do (operators)
1. If an object moves in a straight line consider use of dimensions or movement outside the line

So one example is to curve the 'line' of the male (Figure 3).

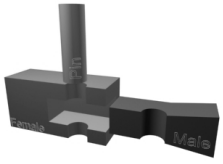

Figure 3: Curved male.

The next step is to adapt the whole design to deliver its function (Figure 4). This means that we need to change the female in opposite form. But this step is clearly a next

thing to do after applying the recommendation of the Inventive Principle.

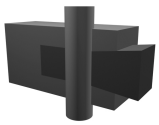

Figure 4: Impact of curved male on total design.

Other possibilities to change the line or movement of the subsystems are (Figure 5; not complete).

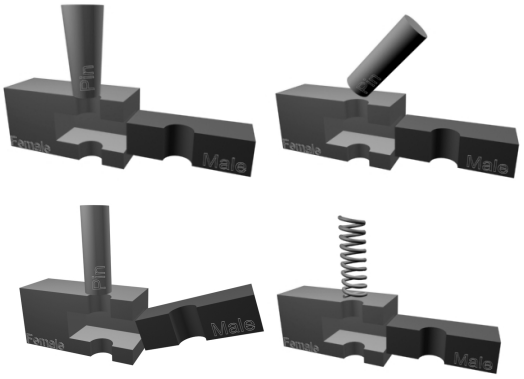

Figure 5: 4 different solutions of movement change and curves.

2. If an object contains or moves in a plane
   - (fe)male moves in a plane

consider use of dimensions or movement outside the current plane (Figure 6)

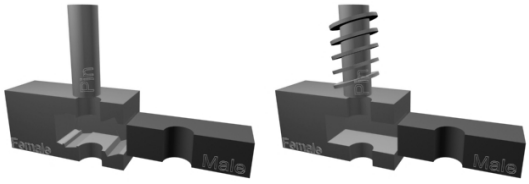

Figure 6: 2 different solutions plane change.

3. Use a stacking arrangement of objects instead a single level arrangement

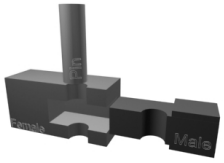

Figure 7: Stacking arrangement.

4. Re-orient the object or system, lay it on its side

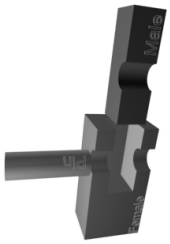

Figure 8: Reoriented lock.

This last solution is a strange one. The final drawing cannot be completed without knowledge of the super system.

5. Use 'another side' of a given object or system

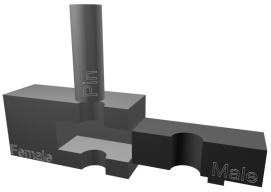

Figure 9: Key concept.

This solution (Figure 9) leads to a key concept

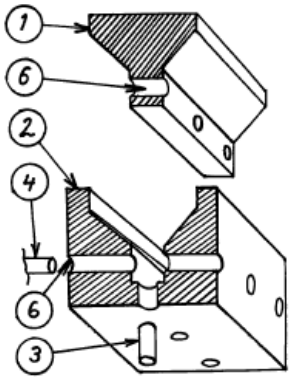

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Figure 10: Solution from US patent 5.875.658 25/9/1997 Locking mechanism for gates and hatches.

The example shows that splitting the principle up into a resource and recommendation part; the user can come to a step by step approach for finding the solutions.

If we take this further and rename the words as described to a more uniform manner the principle 17 could read something like:.

Principle 17. Use another dimension
Resources: Define all sides, directions of the system. Define distances (x,y,z) and angles (α, β ,γ). Define all planes. Define the arrangement with other systems.
Operate to:

A. Change a system from one to two- or three-dimensional space.
B. Use a multi-story arrangement of systems instead of a single-story arrangement.
C. Tilt or re-orient the position system, lay it on its side.
D. Use 'another side' of the system.

6 SUMMARY.

The comparison of the 40 Inventive Principles from different TRIZ sources in English as described in books or software results in minor differences such as incompleteness of some principles, different words used in the translation to English probably due to the use of different dictionaries etc. Technical solutions are hardly given so the Principles can be considered abstract.

A different approach to get a more forward use has been made trying to make the principles as less abstract as some of them are without fundamentally changing the 40 IP. The change has is on the level of words and organisation splitting it up in a resources part and a recommendation part. Finally the split up is applied to an example.

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