

The Ideal of TRIZ

TRIZ as the Way of Life? Part 2

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Abstract

TRIZ could be applicable to every area including technological area and institutional area because TRIZ is an assemblage of methods consisting of changing one attribute, solving contradictions, segmenting and merging of attributes and objects, as I presented at the 4th Japan TRIZ Symposium. This paper surveys a concept of object, methods and thought of TRIZ. I will investigate the movement of objects of consciousness at the beginning process of barter as an example in the area which usual TRIZ does not deal with. And I will show unified four types of realization of every purpose and propose a radical thinking for enumeration.

1. Preface

TRIZ is an assemblage of methods consisting of changing one attribute, solving physical contradiction and technical contradiction and segmenting and merging of attributes and Objects, as I presented at the 4th Japan TRIZ Symposium.

This seems to mean that TRIZ could be a unified thought and method applicable to every action in every area to become formal basic of operational science.

This is the starting point. In this paper I will try to verify this and realize this dream. But I do not intend to touch any tools in TRIZ.

2. Life

2.1 Barter

Invention of tool brings about labor and technology. Invention of language brings about communication.

As same as tool and language, “barter” was invented at some stage of the history of human. What brings about “barter”? What “barter” brings about? We must answer these two questions.

Before the age of barter, human being does not have the consciousness of individual, community nor possessing. But common idea for you and us on next three items in representatives of each communities start institution of barter.

1. Recognition that my community has something and other community has another thing.
2. Image that we will give you something we have and you will give us something you have.
3. When, where and what quantity?

2.2 Life [TJ31]

Technology is an assemblage of matter and its movements. Institution is an assemblage of common idea and its movements including religion and sense of value.

Examples of institution: Politics, Economy, Family, Company

Intentional change (Resolving Differences) is executed via Technology and Institution.

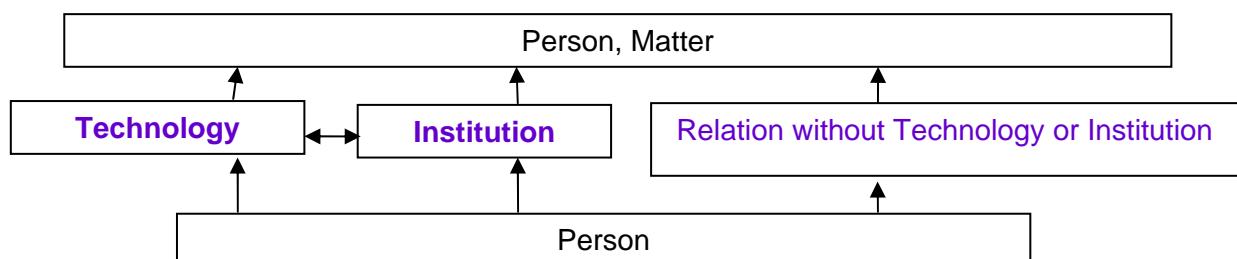


Fig.1 Human Life via Technology and Institution.

3. The Ideal Method of TRIZ

The ideal of the theory to recognize and change the world is that everyone can objectify everything one can recognize and one can change them by specifying one of possible types of change to fulfil proper purposes immediately. [TS1][TS2]

3.1 Object

Something important such as object should be viewed or defined from several points of view. The first view is to describe differences between something and other thing. This view is from outside. The second view is to enumerate kinds of something. This view is from inside of something. The third view is to describe inner structure of something. This view is also from inside. These three views are indispensable to make us recognize something, define something, enumerate kind of something and change something. And object is the one that is to be recognized, defined, enumerated and changed.

Anything recognizable is called **Object**. I recognize three kinds of Objects as follows. [TS2] [TS3]

1. **Matter: System Object**
2. **“Idea”: System Object**
 21. **Information of individual or common notion which is taken by physical entity**
 22. **My idea**
3. **Movement or Action: Process Object**

These are simple and my first and second view on Object. The third view will be shown later.

cf. Definition of Object by Fey

“A component of the system that is to be controlled, processed or modified (e.g, moved, machined, bent, turned, heated, expanded, charged, illuminated, measured, detected, etc.).” [TJF]

Good point of this definition is that it does not eliminate “idea” nor movement because “idea” or movement is “a component of the system that is to be controlled, processed or modified” by Transformation Principles U, P, M from outside or Transformation Principles D from inside or Operation Principle R. Another good point is that this definition has a hierarchical point of view. So practically object is system in some sense. This is as same as mine.

To control process or modify component of the system is what we want to do. Among something recognizable there is **component of the system to be controlled, processed or modified**. I can not control, process or modify the Sun. But I can recognize the Sun, so the Sun is an Object for me. Moreover it is difficult to check in advance something **is to be controlled, processed or modified** or not.

Let us summarize some other basic concept of my previous paper. [TS2] [TS3] [TS4]

Granularity is size, magnitude or scope in space and/ or time and degree of abstraction.

Density is density of inner structure.

Function is primarily meaning of Process Object, secondly meaning of attributes of Object.

Structure is granularity and inner structure.

Property or Attributes is content of Object with specific description. Property or attribute of Object should be grasped accurately and treated at adequate granularity.

We have three granularities of attributes in Object.

Attributes 1 is everything that concretely describe Object.

Attributes 1 includes attributes 2 in narrow sense and inner Structure.

Attributes 2 in narrow sense includes attributes 3 in most narrow sense which is difficult to change and state which is easy to change. [TS4]

Object has inner structure and attributes which produce function to the outside.

Structure is an assemblage of elements and their relations. Structure of something consists of the relation between the whole and itself and inner structure of something. The granularity of Object is a part of structure because it provides the relation between the whole. And density belongs to inner structure.

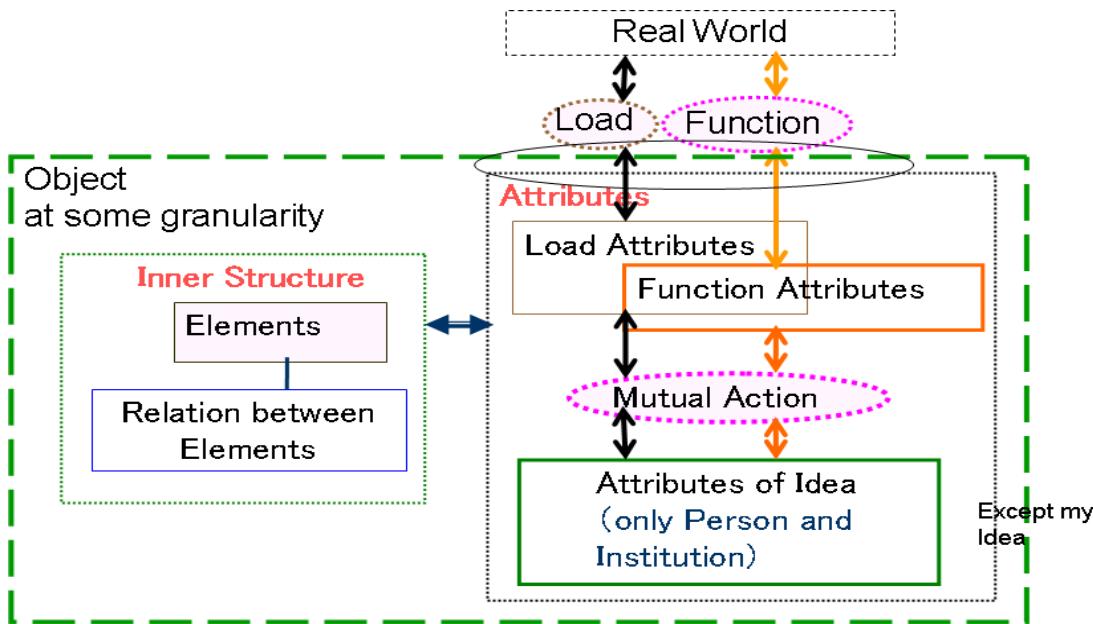


Fig. 2 Structure of Object [TS4]

3.2 Purposes of Resolving Differences

We have three types of viewpoint of purposes in resolving differences which is intentional change common in every area.

- 1) Make new function: Make new system or add new function to existing system
- 2) Solve issues: Solve problems in existing system
- 3) Idealize: Improve functions in existing system or realize existing functions with less resource

3.3 Elements of Realization

We have three types of transformation to realize purposes as follows.

- 1) Transform purpose into type of Object change
- 2) Transform type of Object change to the other type of Object change
- 3) Transform type of Object change into solution

We have some types of transformation to realize purposes

- 1) Transform purpose into type of Object change by each purpose

P- O1: Transform purpose into type of Object change within one attributes of one Object by each purpose. This is to change one attribute, delete or generate attribute or delete or generate Object.

- a) Purpose can be reached directly by a change of one attribute using existing environment
- b) Purpose can be reached by using causal relation

P- O2 (PC) -S: Handling Physical Contradiction. Transform purpose into Physical Contradiction with two values of one attribute of one Object.

P- O2 (TC) -S: Handling Technical Contradiction in advance. This is to transform purpose into Technical Contradiction with two attributes of one Object. This is an expansion of usual Technical Contradiction.

- 2) Transform type of Object change to the other type of Object change

- O1- O1:** Transform by law autonomously

Change of one attribute can cause deleting Object, generating Object or changing number of attributes according to the law of the mutual transformation of quantitative and qualitative changes or its first expansion. The law of the mutual transformation of quantitative and qualitative changes says that quantity of attributes and number of element can change quality of Object. This law is expanded as follows. First addition; This law is added to mean that change of element and inner structure can change quality of Object. By this addition we

obtain enumeration of factors to cause quality change of Object. Second expansion; This law is expanded to mean that change of attributes, element itself, number of element and inner structure can change quality or quantity of Object. [F09]

O1- O2: Transform by side-effect autonomously

O2- O2 (TC) -S: Handling Technical Contradiction to deal with side effects. This is to deal with side effects under environment of usual technical contradiction. Even making new function or idealization can cause side effects.

When Object is added, we must deal with side effect caused by added attributes of added Object.

When attributes are changed, we must deal with side effect of changed attributes.

When Object is deleted, we must deal with side effect caused by deleted attributes of the deleted Object.

3) Transform type of Object change into solution

O1- S: Transform type of Object change into solution within one value of one attribute of one Object. This type consists of three types. [TS3][TS4][TS5]

a. Transformation Principles U, P, M from outside



Fig.3 Object Transformation Principle U

Object 1 and movement can change attributes of Object 2 or Object 2 itself.



Fig.4 Object Transformation Principle P

Object 1 and Object 2 can change attributes of movement or movement itself.



Fig.5 Object Transformation Principle M

Object 1, Object 2 and movement continue to act each other.



Fig.6 Example of Transformation Principle P

Oxygen or burnable matter control fire.

b. Transformation Principles D from inside

Object Transformation Principle D: Change of inner structure consisting of elements and the relation between them can change plural attributes of Object, generate new Object and delete Object itself from inside.

The law of the mutual transformation of quantitative and qualitative changes or its expansion is available for Transformation Principles U, P, M, D. [F09]

c. Operation Principle R of replacing, adding or deleting Object

Object Operation R : We can bring in, bring out or replace Object or its element of existing single Object or Object in “Object 1- Process Object- Object 2 model” freely regardless they are existing or not. But usually this Operation Principle R is only available for technology.

O2-S: Transform type of Object change into solution within two attributes of two Objects

This is berried in the 40 Principles at present. The existing 40 Principles are classified into groups from viewpoint of function and structure as follows. [TS4] We must re-classify these from a view of number of attributes and Objects.

I re-classify the 40 Principles as it is to two super-groups and eight groups according to the structure of Object in the order of Principle group name, numbers of Principles, number of Principle. Many Principles are classified into different groups simultaneously although 31, 32, 37 are not included. .

The existing 40 Principles are fundamentally for the area of technology although they contain the contents applicable to institutional area in common and applicable to that analogically. So at least the Principle for institutional area should be constructed. [TS4]

Structure Principles Super Groups

- a) Basic Principles Group 5: 1, 5, 6, 24, 34
- b) Dynamic Principles Group 18: (3, 4, 6, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 35, 40)
- c) Structure Principles Group 7: (1, 2, 5, 7, 13, 24, 40)
- d) Replace Principles Groups 9:
 - Replace Element Principles (26, 27, 28)
 - Replace Environment Principles (29, 38, 39)
 - Replace by Attributes Change Principles (14, 30, 40)

Function and Attributes Principles Super Groups

- e) Plus Principles Groups 18:
 - Basic Plus Principles (1, 24, 35)
 - Function Plus Principles (6, 9, 10, 11, 15, 16, 17, 18, 19, 20, 21, 23, 25, 36)
 - Attributes Plus Principles (17, 35, 40)
- f) Minus Principles Groups 12:
 - Basic Minus Principles (2, 5, 34, 35)
 - Function Minus Principles (16)
 - Replace Minus Principles (26, 27, 28, 29, 30, 31, 33)
 - Attributes Minus Principles (33, 35)
- g) Equal Principles Groups 9:
 - Equal Problem Solving Principles (8, 11, 12, 34)
 - Equal Movement Principles (9, 10, 16, 23, 34)
 - Equal Attributes Principles (33)
- h) “Anti” Principles Groups 8:
 - Basic “Anti” Principles (13)
 - “Anti” Function Principles (13)
 - “Anti” Attributes Principles (4, 13, 39)
 - “Anti- Anti” Function Principles (8, 9, 16, 34)
 - “Anti- Anti” Meaning of Function Principles (22)

3.4 Realization

As a combination of these results we get four types of resolving differences which is intentional change common in every area.

1) P- O1, (O1- O1), O1- S

We can try this type at first for all purposes. This is to change one attribute, delete or generate attribute or delete or generate Object. A case of autonomous transformation by law O1- O1 may happen.

2) P- O1, (O1- O1), O1- O2, O2- O2 (TC), O2- S

If case 1) would cause side effects we should solve Technical Contradiction afterwards.

3) P- O2 (PC), O2- S

Solve Physical Contradiction in advance.

4) P- O2 (TC), O2- S

Solve Technical Contradiction in advance.

3.5 Example [TS2] [TS5]

We take a famous example of acid attack.

Cubes are placed in acid to investigate the effect of various acids on the cubes. The vessel that holds the acid and cube is corroded. Because the acid is so reactive, the vessel must be replaced frequently. Reduce the cost of replacing the vessel.

System Objects are

Cubes, Acid, Vessel(Attribute: cost, its value: C)

Process Objects are

Test of Cubes (Attribute: operating time, its value: t),

Hold Cubes (Field: Gravity, Surface Tension, Buoyant Force, Current

Corrode Vessel (Attribute: operating time, its value: t), (Attribute: rate of corrosion, its value: replace n times in t)

Replace Vessel (Attribute: cost of vessel, its value: C), (Attribute: cost of work of replace, its value: Cr)

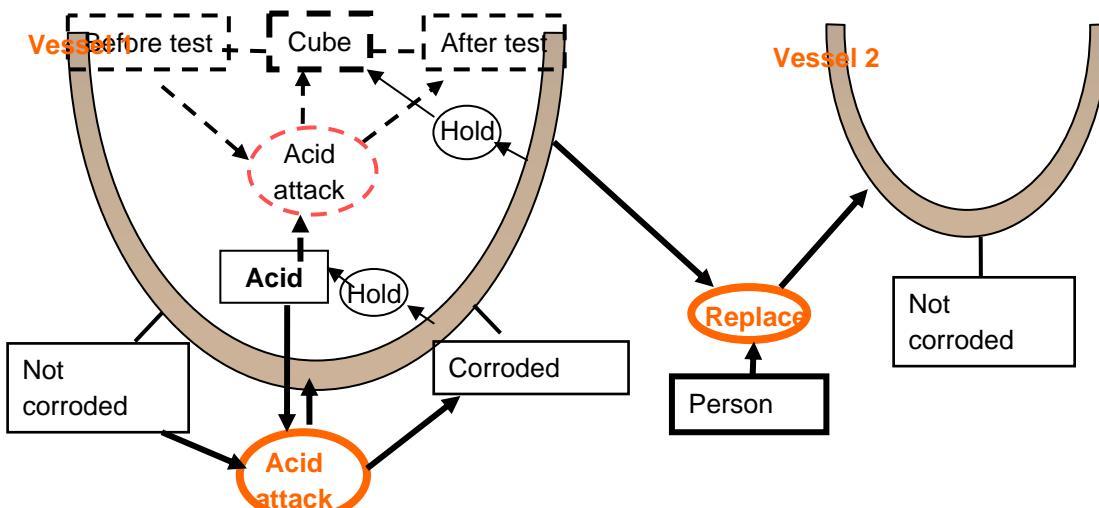


Fig.7 Acid Attack-1

Let us enumerate candidates of purposes.

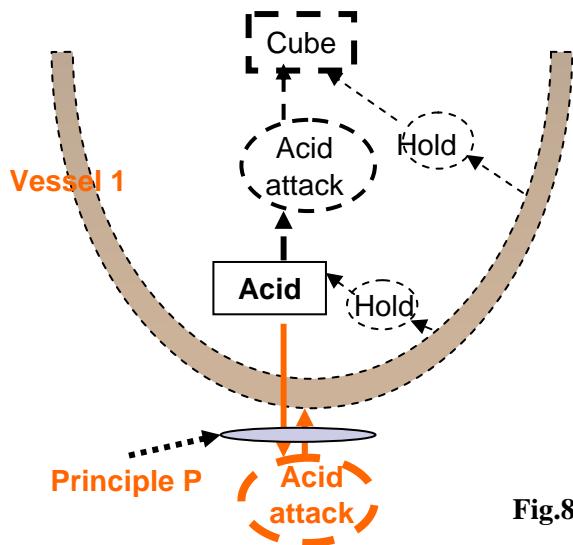
Examples of purposes are to

Minimize cost of replacement per unit time ($C + Cr$) n / t: 1

Eliminate Process Object that acid corrodes vessel: 2

Eliminate Process Object to replace vessel: 3

Example of solution is as follows. If we eliminated vessel to eliminate corroding vessel by acid using Principle P, we could not execute test of cube because of a side effect that vessel lost the function to hold acid and cube.



We can solve the technical contradiction at various granularities.

1. Test of cube vs eliminating vessel
 2. Holding cube and acid vs eliminating vessel
 3. Contact of acid and cube vs eliminating vessel
 - (4. Contact of acid and cube vs no contact of acid and vessel)
 - (5. Acid corrode cube vs acid not corrode vessel)
- This is a type of Realization 2.**

Fig.8 Acid Attack-2

3.6 TRIZ needs improvements

TRIZ needs improvements for spread to everyone and advance on next items.

TRIZ need proper attitude for Object, granularity, structure of Object and attributes.

TRIZ need proper attitude for Institution.

TRIZ have lack of logical exhaustiveness in object and method.

TRIZ need methods to synthesize. This paper does not deal with this.

TRIZ need to activate radical thinking for enumeration which dialectics and TRIZ originally have. In the next section we will discuss radical thinking for enumeration.

4. Radical thinking for enumeration

Thought is viewpoint, attitude and framework of method to decide details of method.

The ideal thought of TRIZ is radical thinking for enumeration which consists of two parts.

4.1 Outline of opposites

Table 1 shows outline of opposites which is components of movement. We have three types of opposites which are two attributes in each Object, two attributes in one Object and two values in one attribute depending on density of movement as follows.

0) Identity and Difference

In "Identity and Difference" opposites are two values of one attribute. This makes Physical Contradiction. TRIZ has Separation Principles to separate two values on several conditions. [LB] If two values of one attribute could not be separated state or attribute would change only itself at some granularity.

Example in objective situation:

A state and other state at the same time

Example of attitudes:

"To be or not to be"

11) Form and Content (Function and Structure)

In “Form and Content” or “Function and Structure” opposites are two attributes of one Object. Many examples are found in TRIZ.

12) Two attributes except Form and Content

Two attributes of one attribute of one Object or each attributes of two Objects can be opposites. This makes many types of general movement.

Figure 9 shows position of 0) Physical Contradiction (PC), 11) Function and Structure, 12) two attributes except Function and Structure and Technical Contradiction (TC). Technical Contradiction consists of direct opposites and indirectly related items which are not dealt as opposites in usual dialectics.

2) Each part of one body

This opposites is a special cases of type 12) which is called Unity. Each item can exists by itself and could reach higher level if opposites could unify.

Example in objective situation:

- History and Logic
- Recognition and Action
- Purpose and Mean
- Man and Woman

Example of attitudes:

- Objectification and Unification
- Possession and Belonging in Unification
- Emotion and Logic
- Viewpoint and Attitude
- Modesty and Criticism
- Spread and Advance

3) Mutually dependent two different recognitions

Example in objective situation:

- Part and Whole
- Phenomenon and Essence
- Concreteness and Abstraction

Example of attitudes:

- Granularity and Inner Structure
- Function and Granularity
- Definition from outside and inside

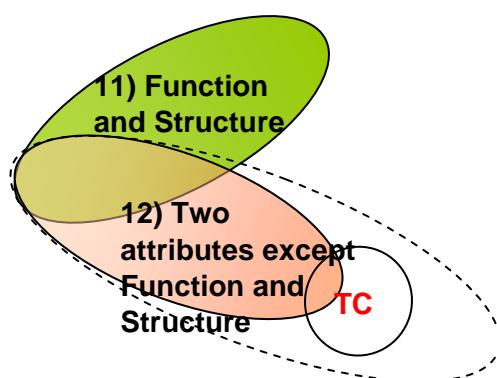


Fig.9 Position of opposites

Table 1 Structure of Contradiction

Real World and Attitude				Recognition
0) Identity and Difference Two values of one attribute	11) Form and Content(Function and Structure) Two attributes of one Object	12) Two attributes except Form and Content Two attributes	2) Each part of one body, Unity	3) Mutually dependent two different recognition
Physical Contradiction A state and other state at the same time To be or not to be	Function and Structure	(Including Technical Contradiction) Opposites of movement except Function and Structure	History and Logic Recognition and Action Purpose and Mean Man and Woman Objectification and Unification Possession and Belonging Emotion and Logic Viewpoint and Attitude Modesty and Criticism Spread and Advance	Part and Whole Phenomenon and Essence Concreteness and Abstraction Granularity and Inner Structure Function and Granularity Definition from outside and inside

4.2 Attitude at this moment

We have viewpoint and attitudes between real world and recognition. In this table viewpoint and attitudes are shown included in real world.

First part of radical thinking for enumeration is viewpoint and attitudes grasping movement to be changed at the moment and always keeping proper viewpoint and attitude; "to be or not to be", function and granularity, definition from outside and inside, modesty and criticism. This will help us act properly.

4.3 Radical thinking for enumeration

For second part of radical thinking for enumeration we need to take some time to enumerate candidates of image of recognition and change from among everything recognizable and changeable and to investigate possibility of extreme change radically.

1. Enumeration for viewpoint of thinking, granularity and value (and purposes which is concrete value) , types of thinking and thing acted by thinking

2. For systematic knowledge in situation- independent area, enumeration for Object, attributes, related thing, types of proposition, law, area and generation and improvement of proposition and law.

Example of improvement of law; The law of the mutual transformation of quantitative and qualitative changes says that quantity of attributes and number of element can change quality of Object. This law is expanded as follows. First addition; This law is added to mean that change of element and inner structure can change quality of Object. By this addition we obtain enumeration of factors to cause quality change of Object. Second expansion; This law is expanded to mean that change of attributes, element itself, number of element and inner structure can change quality or quantity of Object. [F09]

3. In situation- dependent area, according to the situation, enumerate granularity and value (and purpose which is concrete value).

For each granularity, value and purposes,

1) Enumerate attributes, Object and Object group,

2) Enumerate relation between attributes, Object and Object group,

3) Enumerate interaction between related things and ask for origin and logic of history,

4) Enumerate method to obtain Object change, enumerate method to obtain Object change, enumerate candidates of Object change,

5) Seek possibility of radical and extreme change for recognition and change. Changing attributes of Object includes change values of attributes, change attributes itself and change of inner structure. Especially extreme change to minimize attributes is to delete Object.

5. Conclusion

Trial for the ideal TRIZ is made. We get four types of method of resolving differences which is intentional change in every area. Object and structure of Object is important for TRIZ. Ideal TRIZ will make TRIZ very simple.

Radical Thinking for Enumeration to recognize and change the Real World is proposed. I noticed the contents of this paper and also previous papers are obtained by this thinking.

Lastly I express my deep gratitude to Dr. Ellen Domb and Prof. Nakagawa Toru for their comments.

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