The General Picture of TRIZ From the Viewpoint of Changing Objects —A Method of Resolving Differences Based on the Concepts of Functions and Process Objects Part 3—

Toshio Takahara ( )

Abstract

An important thing is only to make a necessary change on a necessary Object in some necessary way. If we could find minimum types of elements, by the combination of which we could reconstruct the original one in the area of Object and making changes, it could be said to obtain unified method of changing Objects. As a part of this study I investigate the types of changing Objects within two attributes and two Objects.

These studies make clear that TRIZ is an assemblage of changes of Objects consisting of segmentation and merging of attributes, segmentation and merging of Objects and change of attributes including handling "physical contradiction" and "technical contradiction".

Object has inner structure and attributes which produce function to the outside. From this point of view I classify the existing 40 principles in TRIZ into eight types of principles consisting of basic principles, structure principles, dynamic principles, replace principles, plus principles, minus principles, equal principles and "anti" principles.

1. Introduction

In my previous paper [1] I investigated the types of changing Object within one attributes and one Object and types of Object operation and transformation to find the unified structure of Resolving Differences consisting of making new function, solving problem and idealization which is dealt with separately in usual TRIZ.

Following the previous paper this paper also focuses on Objects change (hatched) in the next figure. For this study I investigate some application area.

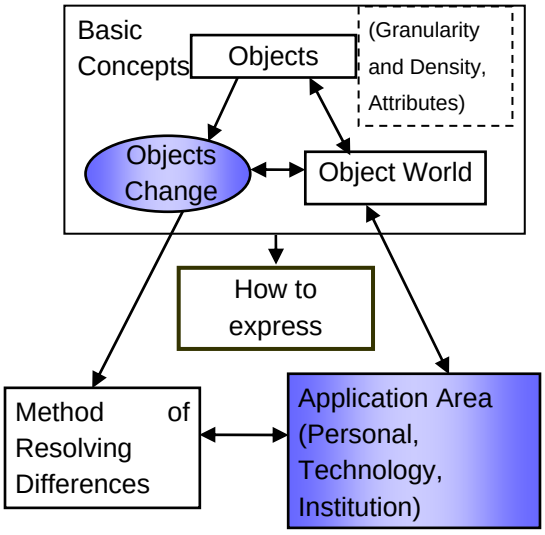

Fig. 1. Total Picture of This Paper

An important thing is only to make a necessary change on a necessary Object in some necessary way in application area, Object (especially thing to be operated in Object) and method to change. If we could find minimum types of elements of something at adequate granularity, 1) in which we can deal with the same type in the same way and in the different type differently, and 2) by the combination of which we could reconstruct the original one uniquely in the area of Object, Objects change and application area it could be said to obtain unified method of formal theory to change Objects in every application area.

As a part of this study I investigate the types of changing Objects within two attributes and two Objects in the technical area and institutional area. These studies make clear the general picture of TRIZ from the viewpoint of changing Objects. This also shows the way to apply TRIZ to institutional area.

Object has inner structure and attributes which produce function to the outside. From this point of view I classify the existing 40 principles in TRIZ into eight types of principles.

2. Types of Object and Object Changes

This chapter shows the brief summary of my previous papers. ***Some items are modified or added to the previous ones which are shown italicized.***

2.1 Object [1][2]

Object: Types of Object World

Object is something to be recognized consisting of followings.

1. Matter (Being): System Object
2. "Idea" (Being): System Object

21. Information of individual or common notion which is taken by physical entity

e.g.: Information on document

22. My idea

3. Movement or Action：Process Object

Granularity is scope or sphere in space and time.

Density is density of inner structure or degree of abstraction.

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.

Attributes 2 can be changed from outside of Object using Principle U, P or by changing inner structure of Object by Principle D.

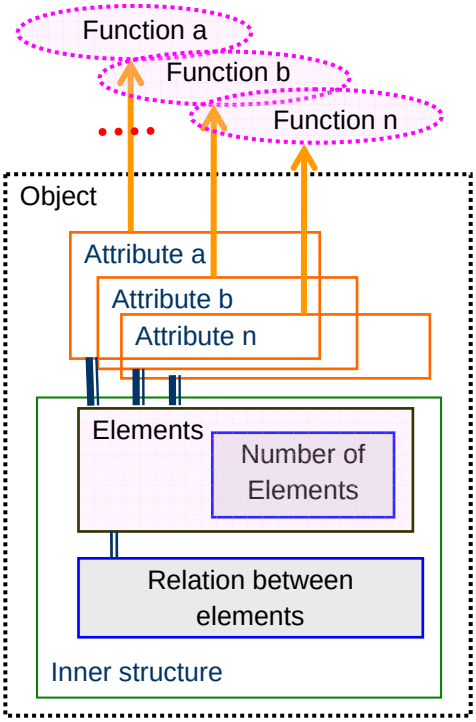

Fig. 2. Structure of Object

In Fig. 2 attributes is attributes 2.

2.2 Object Change [1]

Types of Object change within one Attribute and one Object are as follows.

1. Generate or delete Object *
2. ***Generate or delete attributes*** *
3. Change attributes of Object

1) ***No change of attributes***

2) Change attributes of Object not qualitatively （Change attributes of Object or inner structure do not cause qualitative change)

3) Change attributes of Object qualitatively （Change attributes of Object or inner structure cause qualitative change)

* To generate Object or attributes is to bring in to the stage of Object World. To delete Object or attributes is to bring out from the stage of Object World.

We have three types of Object Transformation.

Object Transformation: Principle D

Change of inner structure consisting of elements and the relation between these can generate new Object, delete Object itself ***and change plural attributes of Object***.

This is an expansion of the law of the mutual transformation of quantitative and qualitative changes.

On the contrary Principle U, P change attributes 2.

Object Transformation: Principle U (Fig.3)

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

Fig. 3. Object Transformation: Principle U

Object Transformation: Principle P (Fig.4)

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

Fig. 4. Object Transformation: Principle P

We have two types of Object Operation.

Object Operation A：We can operate existing single Object or Object in “Object 1- Process Object- Object 2 model”.

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.

Types of Object operation by person and each principles of Object transformation combines to make up a whole of changing Object as shown in the simplified expression in Fig. 5.

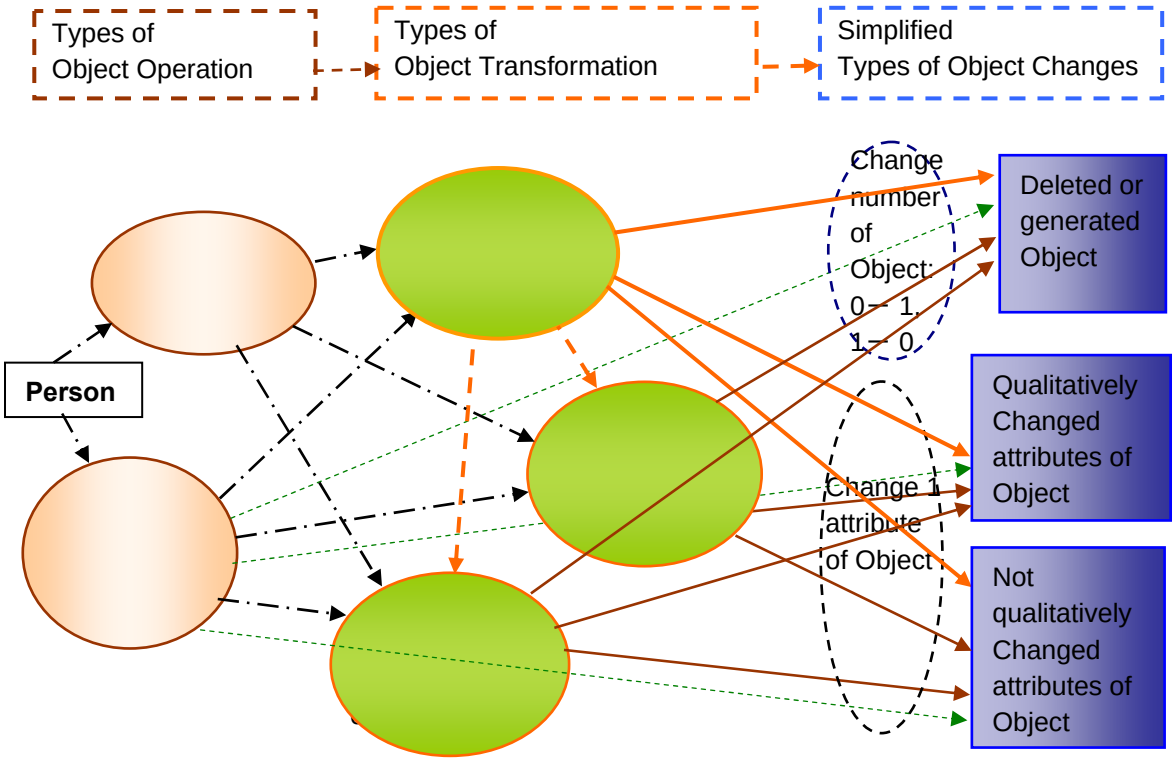

Fig. 5. Relation between Types of Object Operation, Transformation and Types of Object Changes
(Simplify and modify [1])

2.3 Resolving Differences [1]

We have three types of purposes; making a new function, problem solving and idealization. These three elements constitute Resolving Differences which is to change Objects intentionally.

The process of Resolving Differences connect types of purposes, types of Object Changes and types of Object transformation and operation and then fill the blank of logic between them as follows (Fig.6.)

In the first step we recognize the real world and the Differences depending on the situation to have one of the types of purposes.

The second step is to obtain the type of Object changes. ***This is to specify the position in the Fig. 8. "Types of Objects Change within Two Attributes and Two Objects" or in the Table 2. "Types of Objects Change and TRIZ" in this year***.

In ASIT [4] we only transform the type of purpose to the type of Object changes. In usual TRIZ this step replace the purpose set in the first step with the new means to realize the purpose. This could occur in the case of taking the prior means to resolve the cause of problem in problem solving. This step also includes obtaining knowledge about how to operate Object depending on the situation. In previous paper, the type of Object changes was studied on the condition that both number of attributes and Objects are under two.

The third step is to decide what part of Object to operate and how to operate.

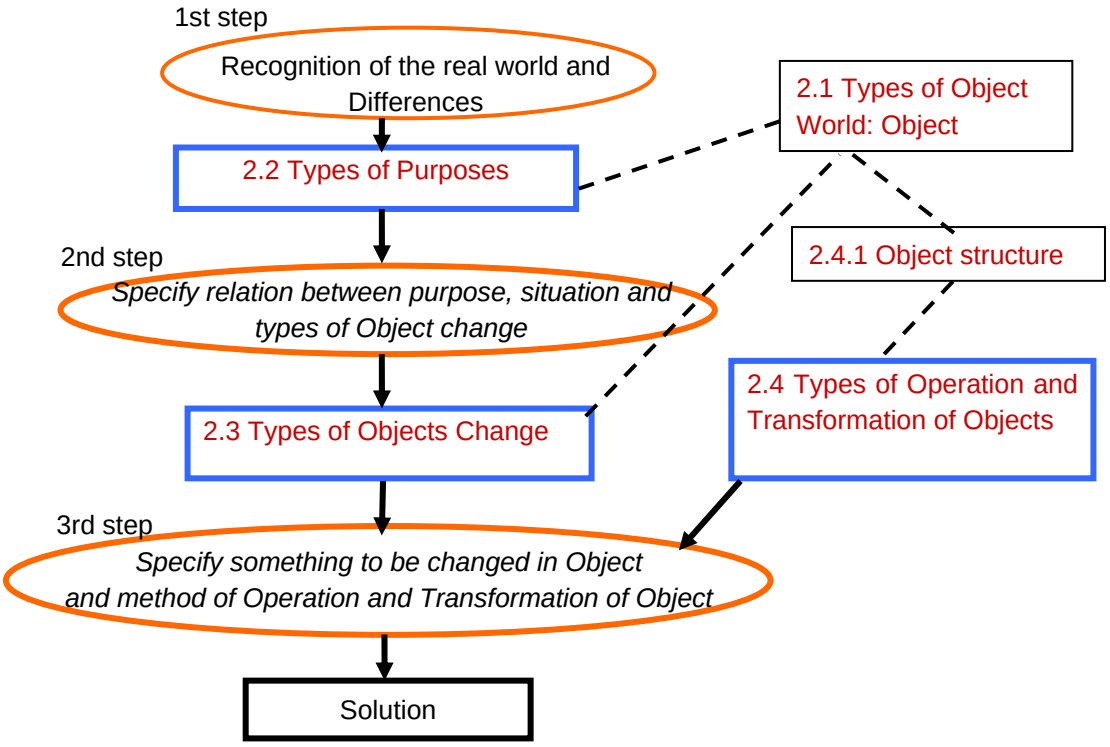

Fig. 6. Process of Resolving Differences (Modify [1])

3. Technology and Institution

Human being is characterized as having the indirect way of recognition and operation via medium. Mankind is the existence that has been accumulating these media. Thus until now we have had the vast accumulated indirect media called ‘‘culture’’ that is taken by the technical means and common concept in the area of technology and institution respectively. [2]

Technology is an assemblage of things between person and nature, processes of making them and using them.

Institution is an assemblage of common ideas between person and community, processes of making them and using them. We have four types of Institution as follows.

1. Type that both person and thing take common idea: **Institution of Exchange**
   e.g. language, money
2. Types that person takes common idea:
   Common Subject
   e.g. thought, philosophy, religion, moral
   System Institution
   e.g. nation, corporation, family
   Social Institution
   e.g. law, politics, economics

Generating object is realized by the principle of intermediary which means to appear on the stage of Object World or by changing inner structure of Object to generate a new Object.

The principle of segmentation consists of segmentation of attributes and that of Object.

The principle of merging consists of merging of attributes and that of Object.

The principle of universality adds attributes of Object.

The principle of discarding consists of deleting attributes, element of Object and Object itself.

Except these basic principles of changing number of attributes or Objects, there are many principles of changing attributes of Object. These principles are a part of the 40 principles in TRIZ. [8]

An example of movement of commodity that is a story of the birth of money is as follows (Fig.7). [7] Money is a typical example of Institution of Exchange.

First stage: Add attribute by bringing in a new usage of Object different from a usual usage.

One day when institution of money did not exist, a person had a useful thing. He or she wanted to exchange this to another useful thing. Adding exchange as institutional activity not technical activity to useful thing having an attribute of usefulness could bring in a new attribute to be exchangeable.

Second stage: Movement to transform attributes

Through early stage of exchange useful thing, the concept of exchange-value emerged little by little. At the same time useful thing become commodity little by little.

Third stage: Segmentation of Object into two Objects

These processes of the differentiation of commodities into commodities and money are summarized by Marx as follows.

“We saw in a former chapter that the exchange of commodities implies contradictory and mutually exclusive conditions. The differentiation of commodities into commodities and money does not sweep away these inconsistencies, but develops *a modus vivendi*, a form in which they can exist side by side. This is generally the way in which real contradictions are reconciled. For instance, it is a contradiction to depict one body as constantly falling towards another, and as, at the same time, constantly flying away from it. The ellipse is a form of motion which, while allowing this contradiction to go on, at the same time reconciles it.” [7]

Generally speaking change is an assemblage of intentional change that is Resolving Differences, unintentional change and autonomous change without human activity.

Movement of technology was conformed to the law of movement of matter which has no purpose itself. And change to achieve purpose in technology is performed on purpose by Resolving Differences using cause- effect relation according to the movement of matter. We can also make use of knowledge of contradiction as technical trend in TRIZ.

On the contrary movement of institution was conformed to the law of movement of institution grasped at granularity as autonomous. And change in institution is carried out by mixture of unintentional activities and Resolving Differences.

In the process of exchange shown as the example, almost all persons were even unconscious of the purposes to improve the attributes of exchange which is quickness, quantity and easiness of exchange. But as a result of long history these purposes were entirely achieved. They resolved contradiction unintentionally.

In institution movement of institution is to realize purposes intentionally or unintentionally. In institutional area change is also achieved by intentional change or Resolving Differences using cause- effect relation as an element of whole movement. We can make use of knowledge of contradiction.

In institutional area we must continue to ask for what is common idea to be, continue to ask for the method and continue to verify input, purpose and result of action. Because in the middle of the process of making common idea, making people don’t know the mechanism and result of the process.

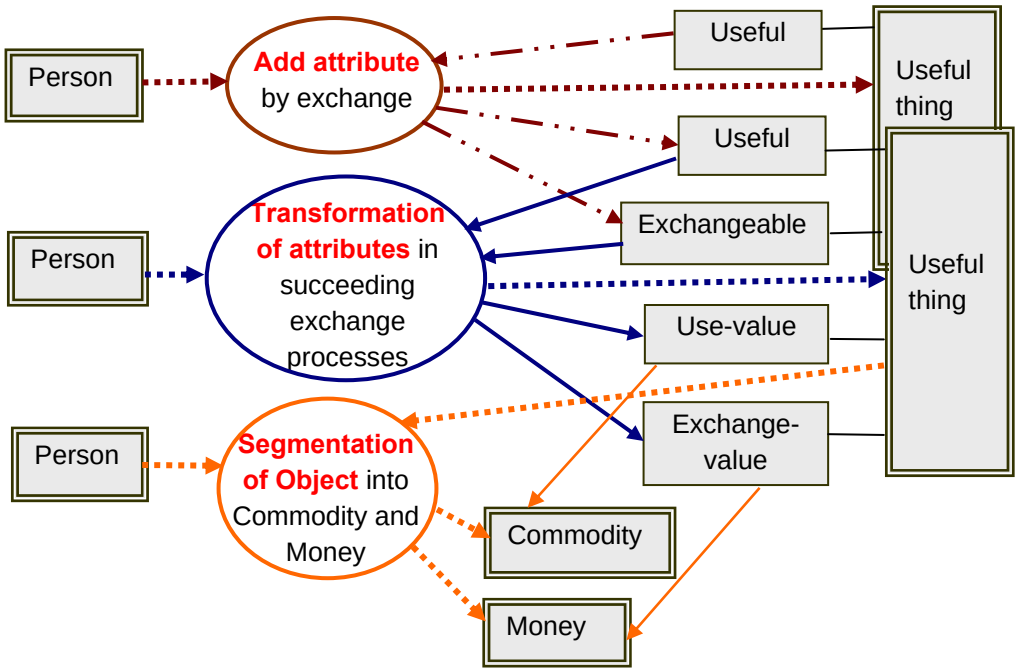

Fig. 7. Birth of commodity and money

4. Framework of Types of Objects Change within Two Attributes and Two Objects

4.1 Framework

We have come to the step to discuss types of Objects change within two Attributes and two Objects. Objects changes have hierarchy or granularity consisting of **change of number of Objects, change of number of attributes and change of attributes** with pure formality shown in Fig.9. But from the viewpoint of means to realize changes in TRIZ we should see this at somewhat different granularity which is **to change using the basic principles, resolving contradiction and simple changes** with some overlaps.

Objects changes have hierarchy consisting of change of number of Objects which is shown in the right side of the figure, change of number of attributes in the middle and change of attributes in the left side. And change attributes has three types of change which is no change of attributes, qualitative change of attributes and not qualitative change of attributes. As in the same way as in types of Object changes within one attribute and one Object, qualitative change of attributes means that change attributes of Object or inner structure cause qualitative change in Object. And not qualitative change of attributes means that change attributes of Object or inner structure do not cause qualitative change in Object.

4.2 Basic Principles

Changing Objects using the basic principles are to change of number of Objects and change of number of attributes. Basic principles are ***Principle 1 Segmentation*** in segmentation of attributes and Object, ***Principle 5 Merging*** in merging attributes and Objects, ***Principle 6 Universality*** in adding attributes, ***Principle 24 Intermediary*** in generating Object and ***Principle 34 Discarding*** in deleting attributes and Objects in the 40 Principles in TRIZ. This is shown in Table 1.

Among them, Segmentation of Object are also treated as resolving contradiction which is explained later.

Table 1. Types of Number Change and Basic Principles of TRIZ

Types of Objects Changes		Means to realize in TRIZ
1) Change number of Object 0/ 1, 1/ 0	11) Generate Object	Principle 24. Intermediary
	12) Delete Object	Principle 34. Discarding
3) Change number of attributes 1/ 2, 2/ 1	31) One attribute to two attributes 311) Add attribute	Principle 6. Universality
	312) Segmentation of attribute	Principle 1. Segmentation
	32) Two attributes to one attribute 321) Delete one of the two	Principle 34. Discarding
	322) Two merge into one	Principle 5. Merging
5) Change number of Object 1/ 2, 2/ 1	51) Segmentation of Object	Principle 1. Segmentation
	52) Two Objects to one Object 521) Delete one of the two	Principle 34. Discarding
	522) Two merge into one	Principle 5. Merging

4.3 Resolving Contradiction

Contradiction is direct principal mutual movement between opposites. Opposites consist of two values of one attribute, two attributes in one Object or two attributes in each Object. This means that movement occurs in the form of two values of one attribute, two attributes in one Object or two attributes in each Object.

Resolving contradiction has many granularities and types according to situation. The first granularity is that it allows movement of contradiction to go on when it seems to be difficult to realize. In the second granularity it improves attributes of Process Object of contradiction. The third granularity tells us that it causes a fruitful result.

From these viewpoints we survey the types of resolving contradiction as follows.

A. "Allow contradiction to go on" type

This is to "develop a form in which opposites can exist side by side" [7]. This includes the other types (Fig. 8). This type forms the base of all contradiction.

A1) Type 1: Mutually exclusive conditions of two values in one attribute lead to movement or change. (*211) in Table 2*)

e.g. elliptic movement, linear movement

In this type we have no change of values or attributes.

A2) Type X: No change of two values of one attribute separated. (*212) in Table 2*)

Also we have no change of values or attributes in this type. Usually this type has not been dealt with resolving contradiction. But in TRIZ "physical contradiction" which has two values in one attribute is resolved by "separation principles". [5]

A3) Type Y: No change of two attributes in each Object. (*412) in Table 2*)

Also in this type we have no change of attributes. But movement goes on. Usually this type has not been dealt with resolving contradiction.

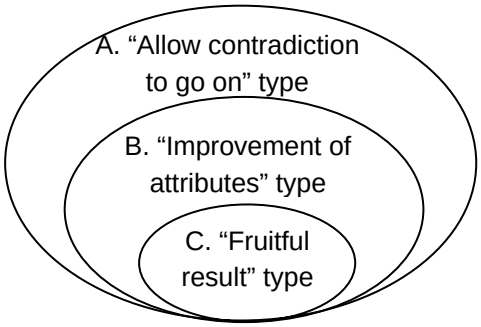

Fig. 8 Granularity of Resolving Contradiction

B. "Improvement of attributes of contradiction" type

On the base of type A we have some special type that attributes of Process Object of contradiction meets some requirements. This type includes type C as the special case.

B1) Type 2: Meet two values of requirements of two attributes simultaneously. (*422) in Table 2*)

In TRIZ "technical contradiction" is not necessarily contradiction. 421) Not qualitative change of attributes to meet two values of requirements simultaneously that is not caused directly or by principal movement is not contradiction.

B2) Type 3: Transformation of two attributes to the other attributes. (*432) in Table 2*)

I guess that this is especially important in institutional area. We need further study on this.

e.g. Movement to transform attributes that the concept of exchange-value emerged little by little trough early stage of exchange useful thing. [4]

C. "Fruitful result" type

Type 4: Segmentation of Object. (*51) in Table 2*)

At least in system institution (e.g. corporation) and social institution (e.g. law, politics, economics) what Object to segment seems to be the only solution of contradiction and the rest of problem is only to decide how to segment it. The reason is that segmentation of Object can make epoch-making improvement on attributes of the original movement of contradiction when movement is developing rapidly which have been actually taken place in institutional area. In fact the form of Fig.9 itself shows the importance of segmentation.

On the contrary segmentation of attributes (*312) in Table 2*) is not resolving contradiction although it is important.

Dissolving contradiction by merging opponents (*522) in Table 2*) can occur. This can be taken place in developing environment or in shrinking one. The former can be a transitional stage toward a new segmentation of Object.

4.4 Simple Changes

Remaining is to change attribute of one Object not qualitatively and transform one or two attributes qualitatively.

232) Transformation of attribute to the other attributes and 431) Transformation of attribute to the other attributes if not contradiction are issues to be studied.

**: How to handle changing two values in case of 22), 23) is to be studied.*

4.5 Re-classify the Existing 40 Principles

The 40 Principles are the means to change Objects.

Following the paper [3] or Darrel Mann [6] 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.

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)

Structure Principles Super-Groups deal with inner structure or structure of Object World at various granularities.

Function and Attributes Principles Super-Groups deal with function and attributes of Object in Fig.2. And here attributes means attributes 2.

Needless to say how to apply these Principles depends on granularity of Object. And difficulty is in the situation that viewpoint to settle the granularity, formulation of issues and solving process are decided at the same time as same as another issues.

5. Types of Objects Change within two Objects and TRIZ

Table 2 and Fig. 9 are the relation between two granularities showing how types of Objects change within two attributes and two Objects corresponds to means to realize change in TRIZ. Among them 11), 12), 22), 23) were already treated. [1]

It is important that we have Fig.9 and Table 2 as that applicable to every area including technology and institution,

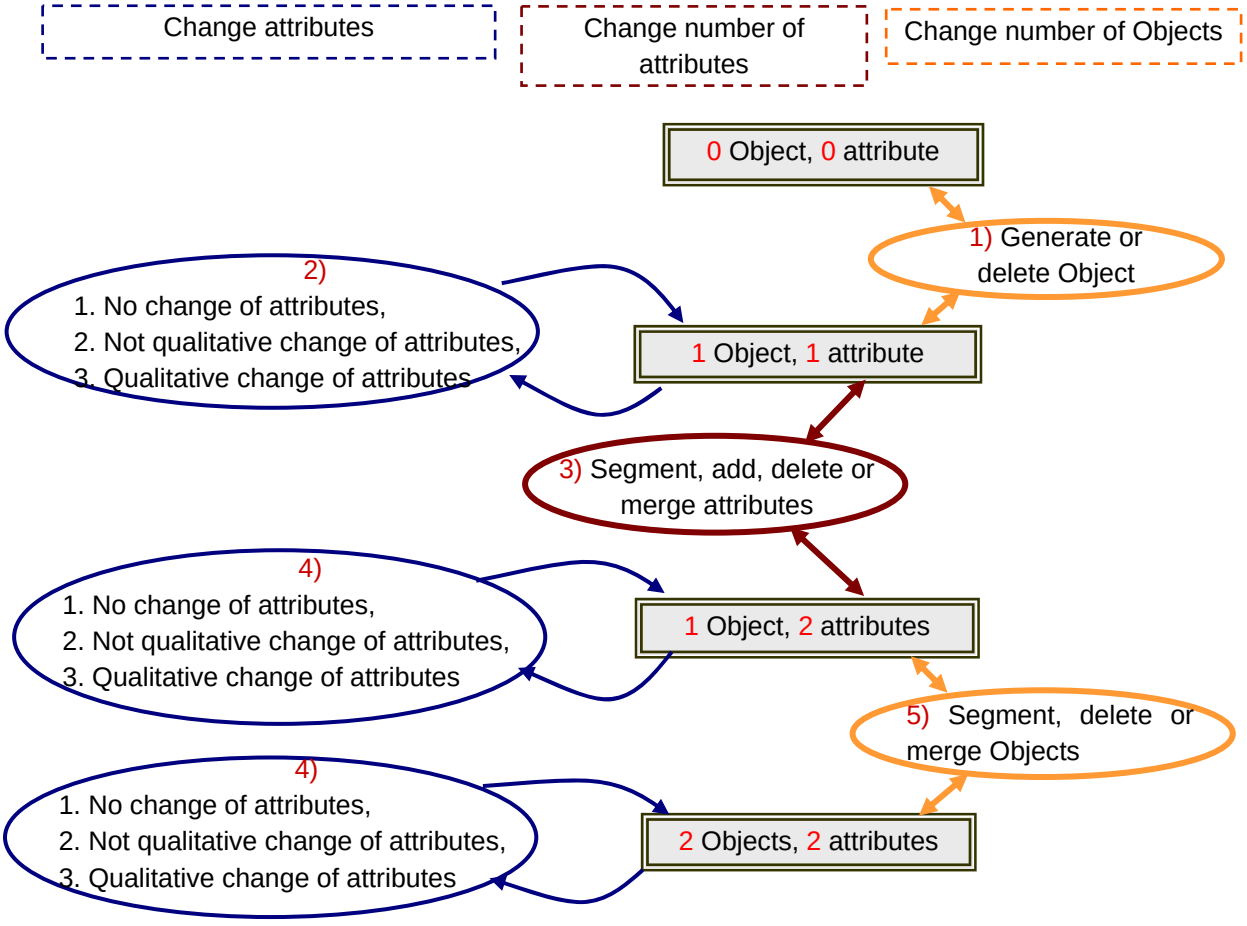

Fig. 9. Types of Objects Change within Two Attributes and Two Objects

Table 2. Types of Objects Change and TRIZ

Types of Objects Changes		Means to realize in TRIZ, Type: Contradiction, (Comments)
1) Change number of Object 0/ 1, 1/ 0	11) Generate Object	Principle 24. Intermediary
	12) Delete Object	Principle 34. Discarding
2) Handling one attribute *: two values in case of 22), 23): to be studied*	21) No change of attribute 211) Mutually exclusive conditions of two values in one attribute lead to movement	"Physical Contradiction" in TRIZ: Type 1
	212) Two values can be separated	Separation of P.C. in TRIZ: Type X
	22) Not qualitative change of attributes	Many Principles in TRIZ
	23) Qualitative change of attributes 231) Delete attributes	Principle 34. Discarding
	232) Transformation of attribute to the other attributes	(Transformation of attribute to be studied)
3) Change number of attributes 1/ 2, 2/ 1	31) One attribute to two attributes 311) Add attribute	Principle 6. Universality
	312) Segmentation of attribute	Principle 1. Segmentation
	32) Two attributes to one attribute 321) Delete one of the two	Principle 34. Discarding
	322) Two merge into one	Principle 5. Merging
4) Handling two attributes	41) No change of attributes 411) Not contradiction	(Movement goes on)
	412) Contradiction	(Movement goes on): Type Y
	42) Not qualitative change of attributes Meet two values of requirements simultaneously 421) Not contradiction	"Technical Contradiction" in TRIZ
	422) Contradiction	"Technical Contradiction" in TRIZ: Type 2
	43) Qualitative change of attributes Transformation of attribute to the other attributes 431) Not contradiction	(Transformation of two attribute to be studied)
	432) Contradiction	(Transformation of two attribute to be studied): Type 3
5) Change number of Object 1/ 2, 2/ 1	51) Segmentation of Objects	Principle 1. Segmentation: Type 4
	52) Two Objects to one Object 521) Delete one of the two	Principle 34. Discarding
	522) Two merge into one Dissolve contradiction by merging opponents	Principle 5. Merging
6) Handling two attributes	Same as 4)	

7. Conclusion

Types of Objects changes within two attributes and two Objects are examined on the studies about institution.

These studies made clear that TRIZ is an assemblage of process elements consisting of segmentation and merging of Objects, segmentation and merging of attributes and attributes change including solving "physical contradiction" and "technical contradiction" from the viewpoint of Objects change. Also we could find that we can apply TRIZ to every area including institutional area not using logic of analogy with some modification.

We need further study on

1. How inner structure of Object decide attributes, Structure of contradiction in Institution,
2. How type of purposes and situation decide types of Object changes, (This is to specify the position in Fig. 9 or Table 2 from the type of purposes and situation.)

How types of Objects changes select Principle U, P, D and decide how to use them

and

3. “40 Principles” or equivalent in the area of Institution.

So this paper did not solve any issues but could be said to make clear a little bit about the structure of issues.

I express my deep thanks to NAKAGAWA Toru and Ellen DOMB who read my previous paper and send me heartfelt comments which gave me a power to live and energy to write this paper.

References

My previous papers on TRIZ as [1][2][3] can be read in “TRIZ home page in Japan” as
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Presenter's Profile

TAKAHARA Toshio graduated from Waseda University in 1968. At FUJITSU and its subsidiary company he had been worked as a system engineer. He met TRIZ in 2001. After retired from the company in 2002, as also retired from technology, his interest is in formal theory using TRIZ and application to institution especially common subject. You can read his previous papers on TRIZ in “TRIZ home Page in Japan” in Japanese and in English thanks to Prof. NAKAGAWA.

Email: takahara-t@m.ieice.org
Home page: http://www.geocities.jp/takahara_t_ieice/
(Under construction and almost in Japanese)