The Innovative Methods to Find and Solve Problems

― The Proposal on “Two types of Redesigned Contradiction Matrices” for TRIZ Beginners ―

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The Purpose of this Research

In order to define each problem and create ideas, “Two types of Redesigned Contradiction Matrix(RCM)2 as one of effective TRIZ methods for TRIZ beginners are developed.

The content of the presentation

1. **Introduction**
2. **Defining the real functional requirement**
   - Mind process
   - Task /Functional requirement/Mechanism/ Structure
   - Effect of TRIZ application to the mind process
   - Rethinking functional requirements
3. **Methods to create solutions**
   - Redesigned Contradiction Matrix1(parameters of performance)
   - Redesigned Contradiction Matrix2（parameters of shape and design）
   - Integration of inventive principles
4. **Application of two types of redesigned contradiction matrices**
   - Guideline to use each parameter
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5. **Conclusion**

1. Introduction

Background

***It 's hard for TRIZ beginners to use TRIZ as one of problem solving methods.**

What we want to do

***We would like to introduce highly-valued TRIZ methods without any obstacles to master for TRIZ beginners. Through application of developed TRIZ methods to real cases, new TRIZ may become "innovative problem-solver ".**

The report

***Explanation about how to understand issues**

We mainly separate way of thanking about product development and improvement activities as described below.

1)Stage of thinking about functional characteristic

(Upstream stage of product development)

2)Stage of thinking about shape and design parameters of product

(design stage to embody product)

We developed "Redesigned Integration Matrices" to be suitable for each stage.

2. Defining the real functional requirement

2−1 Mind process

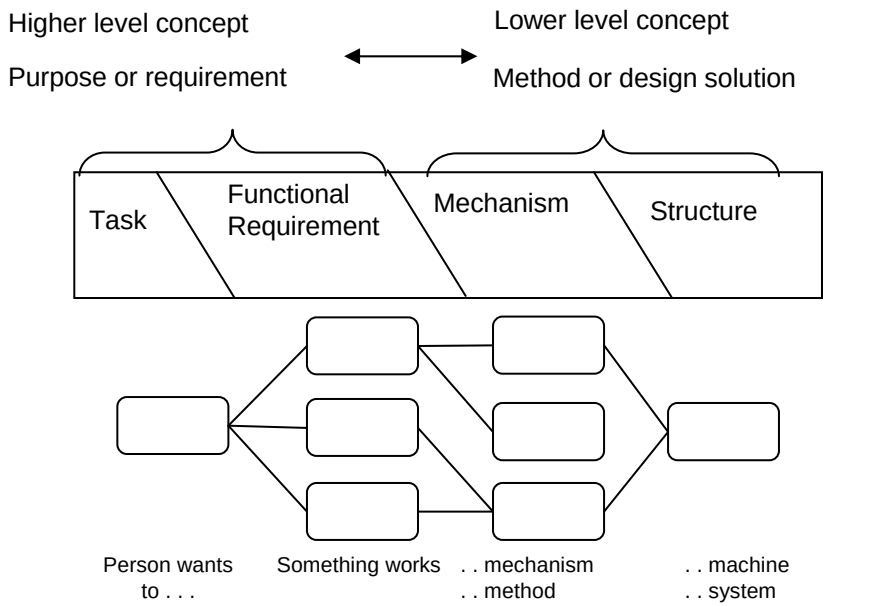
Figure 1 shows our mind process when we want to accomplish goal. We call the tree diagram showing the mind process the expansion of thoughts diagram.

The tree diagram proceeds from left to right in the sequence of task, functional requirement, mechanism, and structure.

The diagram can have more than these 4 levels.

Elements to the left express higher level concepts of purpose or requirement, whereas, those to the right show lower level concepts of method or design solution.

Fig.1.
Expansion of Thoughts Diagram



2-1-1 Task

Task

The task expresses what we want to accomplish.

Quality control calls it the Voice of Customer (VOC).

In most cases, the subject of the task is human, like in "(a person) wants to ... or needs ..."

- **VOC is often an abstract concept.**

Difference between task and problem

Task is "what is desired" whereas a problem is "what is not desired."

Task is "something to achieve" and a problem is "something to solve."

As problem in the highest level makes narrow range of ideas, task should be on this position.

2-1-2 Functional requirement

To accomplish the set task, we now want to invent something.

The abstract task cannot directly lead to an invention.

We need to clarify what function is required for the invention which is" functional requirement".

・A single invention consists of a number of functional requirements.

→ By using a tree diagram, like Figure 1, clarifies them.

・For functional requirement, the subjective in most cases, is what we are about to invent.

Example : "(Machine) that can ..." or
"(Circuit) that is ..."

2-1-3 Mechanism

Mechanism

Mechanism meets functional requirement.

Setting one mechanism for each functional requirement is ideal, however, reducing cost or miniaturization may have one mechanism meet multiple functional requirements, that is to kill two birds with one stone.

Mechanism devised to satisfy one functional requirement often fails to meet others.

It is rare to satisfy all functional requirements easily.

Selecting mechanism, that is postulating a design solution, can lead to problems or discrepancies for the first time.

2-1-3 Mechanism

This is the reason for our statement in section "Task" that task should be set to the highest level of requirement instead of "problem".

・Starting from problem or discrepancy has already postulated the design solution or method, and would hinder the finding of other design solutions or methods.

・Working in only the right half of the expansion of thought diagram narrows the range of idea generation.

While we are working in the mechanism stage, we are merely collecting parts for the solution.

Once all mechanisms are on the desk, we select good ones to compose the overall structure.

In other words, a structure is an overall design solution that is well balanced assembly of mechanisms.

2−2 Effects of TRIZ application to the mind process

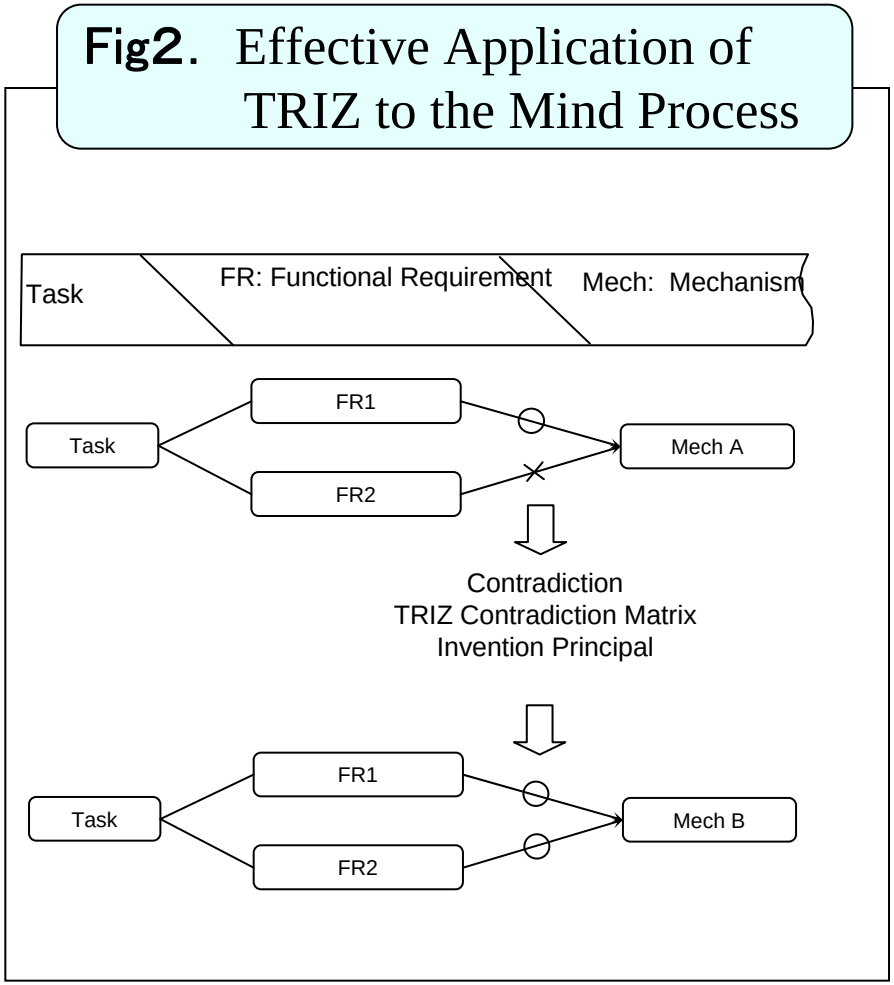
Figure 2

Assume we have designed "Mechanism A" to meet Functional Requirement 1. This Mechanism A, however, blocks Functional Requirement 2.

→ Contradiction occurs

TRIZ contradiction matrix works well.

The contradiction between functional requirements 1 and 2, leads us to select the invention principal using the contradiction matrix and we can come up with a new solution, "Mechanism B".



2−3 Rethinking functional requirements

There are, nevertheless, situations when TRIZ does not solve discrepancies.

We have to spare much efforts when using TRIZ,

in defining the functional requirements, that is in defining the contradiction.

・When contradiction is well defined, the odds for solving it are fairly high.

・ We need to rethink the functional requirement 1 and 2 if they are correct.

Example of the functional requirements

Example :「 Micro-tweezers 」

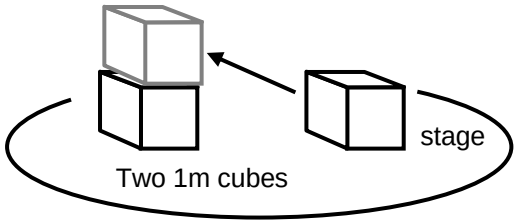
Task :「 “To develop a tipped tool to stack 1 micro-meter cubes using a joystick and viewing with a microscope.” 」→ Fig.3(a)

Since the task is to manipulate tiny objects, tweezers immediately come to mind with functional requirements of “Pinching (Close Tips)” and “Releasing (Open Tips).”

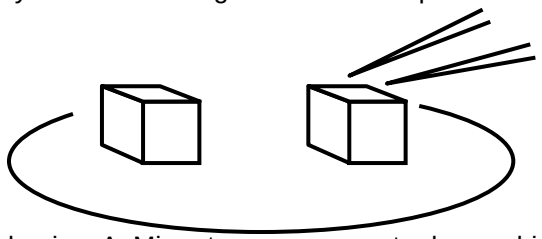
Say we built micro-tweezers shown in Fig.3(b).

These micro-tweezers can close its tips to hold the cube up, carry it to the target location, and open its tips, however, cannot release the cube that gets stuck to a tip.

Fig.3
What is the optimum tipped tool?



(a) To develop a tipped tool to stack 1 micro-meter cubes using a joystick and viewing with a microscope



(b) Mechanism A: Micro-tweezers cannot release object

When an object size is this small, its surface area to volume ratio is so large that surface force of sticking or static electricity is much greater than volumetric force of gravity.

Example of the functional requirements（continued）

Example：「Micro-tweezers」（continued）

We can apply the contradiction matrix in an effort to resolve the contradiction between the 2 functional requirements of “Pinching (Close Tips)” and “Releasing (Open Tips),” however, such an effort is highly likely to fail.

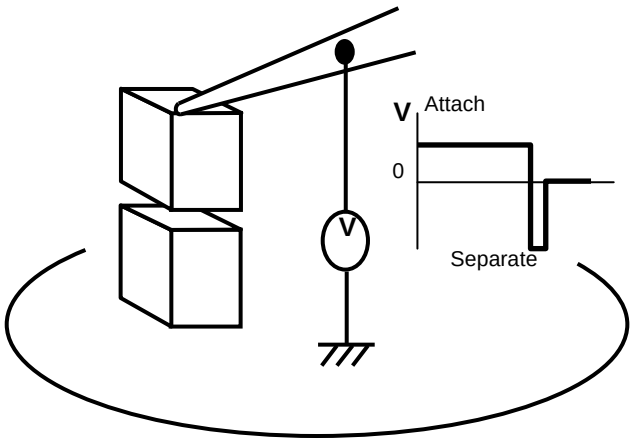
Figure 3(c) shows a design solution to this task.

It applies voltage to a dielectric bar to hold the cube with static electricity. Applying pulses of reverse voltage to the bar will release the cube.

This design solution has no parts that close or open.

The functional requirements that we had first set were misleading.

Fig.3
What is the optimum tipped tool?
(continued)



(c) Mechanism B: Dielectric bar attracts and repulses

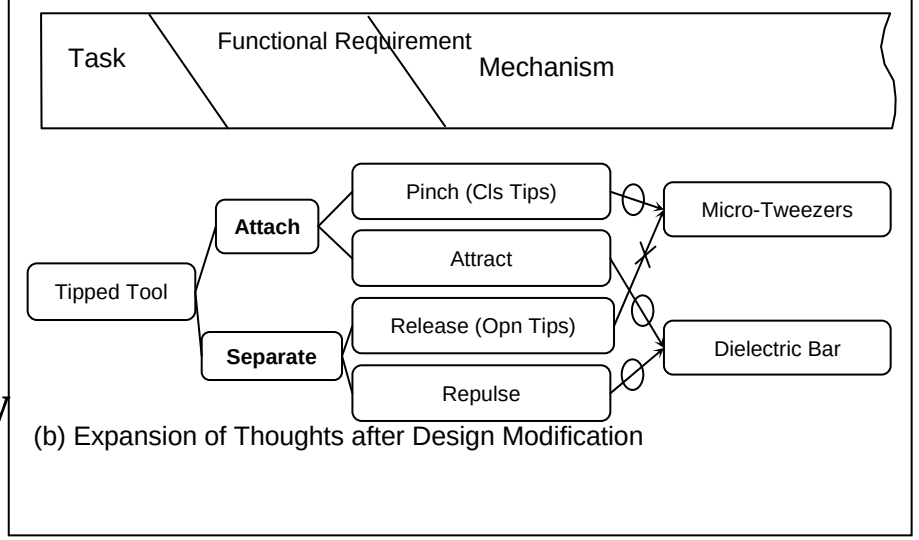
The expansion of thoughts diagram in Figure 4 explains this case

The expansion of thoughts diagram started as shown in Figure 4(a).

When TRIZ fails to find a solution, we suggest to rethink the functional requirements themselves.

Maybe the functional requirements of Pinching (Close Tips) and Releasing (Open Tips) are more like methods. How can we express what we want to accomplish in higher level concepts?

Fig.4 Rethinking High Level Functional Requirements



(b) Expansion of Thoughts after Design Modification

Then we realize that the function we really want is the higher level functional requirement of "To attach the work to the tool and later separate it."

We then discover that if attaching and separating objects meet the task, then "Attraction and Repulsion" can suffice our goal. The new functional requirements of "Attachment and Separation" lead us to realize that the expressions like close, open, attract or repulse are more like mechanisms (methods) rather than functional requirements.

Furthermore,
if we aim at the great invention of optical tweezers, we have to rethink the first set task of "To develop a tipped tool."

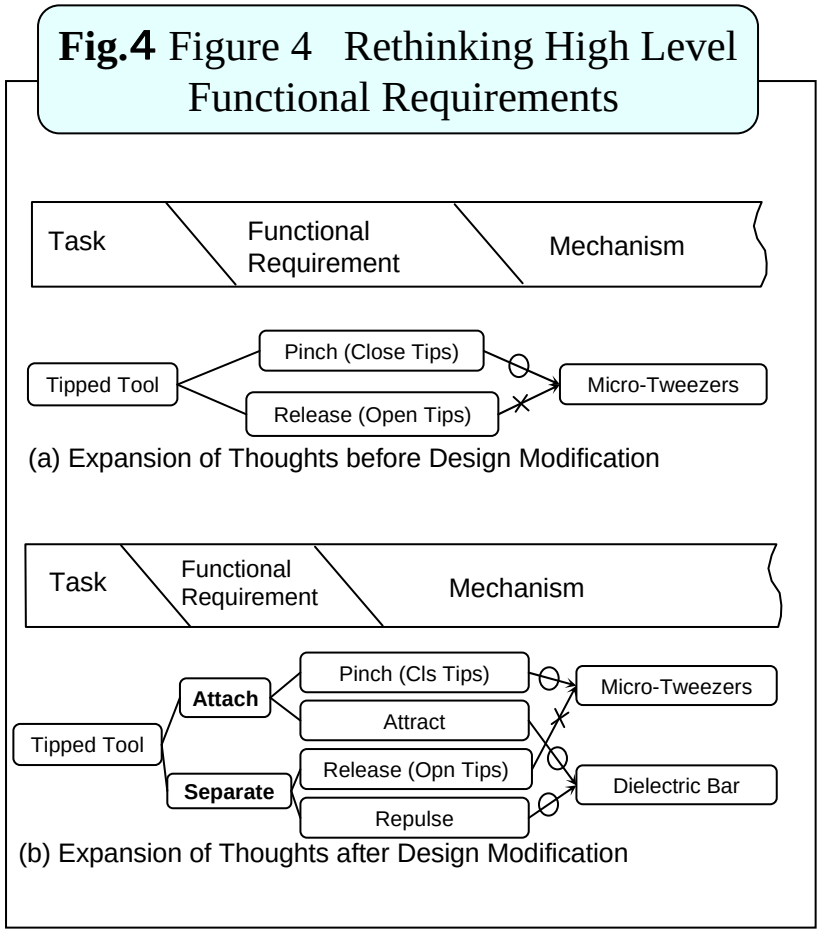
We may not need a tipped tool.

Optical tweezers has no tipped tool.

As we showed in this case the following strategy proves effective:

If TRIZ cannot find a design solution, go back to rethink the functional requirements and the task, reset those higher level concepts and then reapply TRIZ to find the design solution.

Fig.4 Figure 4 Rethinking High Level Functional Requirements



3. How to Create Solution Proposals

Based on "Contradiction Matrix(CM)" with 30 parameters , it' s usually utilized solution method to select some appropriate principles from "40 principles" to create ideas in the way of TRIZ thinking.

It 's very tough job for TRIZ beginners to select the most suitable parameter from 39 on "CM" after analysis of their real problem, even if they define "Functional Requirement(FR)".

In particular, it's very difficult for not only TRIZ beginners but some of skilled TRIZ practitioners to select an appropriate "improving parameter" and "worsening parameter " with selected improving one. Because each parameter on "CM" has a variety of level of abstraction.

On the other hand, most of them basically don't understand the difference between" 1 Segmentation" and "2 Taking Out", "10 Preliminary Action" and "11 Beforehand Cushioning" . Because they don't have enough knowledge regarding Altshuller's books. In a word, it looks like "big wall" to overcome when they try to study TRIZ .

3-1 Redesigned Two Types of Contradiction Matrices

Upstream stage of product development

We have to focus on "Functional Requirement(FR)" regarding system's function and each element and define a series of problems regarding "Functional Features(FF)" .

Design stage to embody product

We mainly have to focus on the problems (like weight, length, speed, power, temperature and so on) about concrete means to embody basic design proposals.

That's why we have to separate way of thanking about product development and improvement activities.

*** "STEP " to consider "Functional Features" on "CM1"**

*** "STEP" to consider "Concrete Design" on"CM2"**

Two types "CM" makes easier to select a pair of appropriate parameters.

3-1-1 Redesigned Contradiction Matrix1(RCM1) (Parameter regarding Performance)

In the case of consideration about Functional Requirement of system's function and each element like reliability, harmful effect, maintainability and so on, we recommend TRIZ practitioners apply "RCM1" at first.

"RCM1" shows 13 parameters (F1-F13) focusing on "Functional Features" from 39 defined by Altshuller based on reconstruction work.

Integrated parameters on "RCM1" acts as a guide to grasp roots of the problems easily and reach "applicable principles" finally.

Number between "Improving Parameter" and "Worsening Parameter "on "RCM 1" shows "Inventive Principle" and each number means "New inventive principle".

B1 to B4 show "Separation Principle s" for "Physical Contradiction(PC)".

- ***B1**: **Separation in Time**
- ***B2**: **Separation in Space**
- ***B3**: **Separation Between a whole system and its parts**
- ***B4**: **Separation in Situation**

Table1 Redesigned Contradiction Matrix1 (Parameter regarding performance) : RCM1

Improving Feature \ Worsening Feature				Performance											
				Reliability /Precision		Harmful Effects	Operability /Durability					Manufacturability	Amount/Loss		
				Reliability	Precision	Harmful Effects	Operability	Control Complexity	Maintenance /Repairability	Adaptability /Versatility	Durability	Manufactura-bility, Productivity	Amount /Loss of Substance	Amount /Loss of Information	Amount /Loss of Time
				F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
Performance	Reliability /Precision	Reliability	F1	B1,B2, B3,B4	3,10, 23,1	27,35,1, 40,26	27,17,40, 10,13	27,40,26	1,10,13,35	13,35, 12,24	1,35,3,25, 34,27,26,40	1,35,26,24	20,26,40,3, 10,35,24	10,26	10,30,4
		Precision	F2	5,10,1, 23,3	B1,B2, B3,B4	26,24,22, 10,35,3,33, 4,17,34	1,13,17,34, 3,23,26, 10,34,15	26,24, 3,	1,3,13,10, 25,27,35, 34,26,15	13,35,1	26,3, 27,40,10, 24	26,35,25,15, 1,13,17,34, 3,23	1,26,3,30, 10,16,31, 35,24	13,10,2,34,7 ,24,25,37	24,34,26, 3,15
	Harmful Effects	Harmful Effects	F3	27,24, 1,40,	26,33,23, 3,10,15, 4,17,34	B1,B2, B3,B4	1,25,26,24, 33,3,34	22,15,26, 40,1,20, 27,	35,10,1,22, 15,26,40, 31	35,10, 22,31	22,35,33,26, 31,17,1,40, 20,24,16	24,35,1,22, 13,15,	35,33,26,31, 3,24,1,22, 15,40,10	22,10,1, 20,26,	35,15,34, 1,22
	Operability /Durability	Operability	F4	17,27,12, 40,10,3,	25,13,1,34, 3,35,23, 26,10,15	1,25,26, 24,33	B1,B2,B3, B4,1,34,12, 3,26,13	34,27,25	12,26,1,3, 25,17,35,13, 24,10	34,1, 16,27,4, 35	26,3,12, 25,1,16, 10	1,5,12, 26,13, 35,	12,35,26,3, 1,24,13,10, 15,5	4,10,27, 22,35,33	4,26,10, 34,24,35, 30
		Control Complexity	F5	27,40, 26,12	26,24,3	22,15,26, 1,20	1,5,34,20	B1,B2, B3,B4	12,26,35, 10,	1,35	15,26,25, 24,35	5,26,10, 35,15	3,27,26,15, 1,10,24	35,33,27, 22	15,26, 3,10
		Maintenance /Repairability	F6	10,1, 26,13,35	10,2,13,1, 26,34,25, 24,3	35,10,1, 16,22,15, 26,40,	1,12,26, 27,10,24, 34,35,	35,10, 26	B1,B2,B3, B4, 35,1,13,10,	7,1,4,16, 26,35,	10,26, 27,4, 35,1	1,35,10, 27,26,13,3, 12,17,	2,26,10,25, 13,3,27,35, 34,	3,9,13,26,1	3,1,10, 25,26,
		Adaptability/ Versatility	F7	35,13, 12,24	35,5,1,10	35,10, 3,31	34,1,16, 27,35	1	1,16,7,4, 35,26,	B1,B2, B3,B4	13,1, 35,16	1,13,31, 35,26,	3,35,10, 1,13	7,3,10,26,37	35,26
		Durability	F8	10,1,13, 34,27, 26,40	3,10,26,24, 27,16,40	22,35,33, 26,17,1,40, 20,24,16	12,27,1, 26,10	15,26,24, 35,25,34,	26,10,27, 1,4,35	1,35, 13,	B1,B2, B3,B4	27,1,4,35, 10,17,14,15, 20,16,24	3,35,10,40, 31,26,27,15, 16,24	10	20,10,26, 15,16
	Manufactu	Manufacturability, Productivity	F9	1,35, 10,24	1,35,12,15, 10,34,26,3	24,1,22, 35,13	5,13,16, 1,26,7,10, 12,35,	26,10, 1,35,15, 27,	35,1,10, 3,25,27,26, 12,17,24	13,1, 35,26,	27,1,4,35, 16,10,15, 20,24	B1,B2,B3, B4,35,1,10, 26,24	35,23,1,24, 34,33, 26,10	3,24,15, 16,13,35, 23	35,26, 34,4
	Amount /Loss	Amount/Loss of Substance	F10	15,3,26, 40,10, 24,35	3,1,26,33,30, 16,34,31, 35,10,24	35,33,26,31, 3,40,24, 30,10,1,34,	35,26,10, 25,12,3, 1,24,15	3,27,26, 15,35, 10,13	1,3,10,25, 13,27,35, 34,26,24	35,3,26, 10,1	3,35,10,40, 31,26,27,15, 16,24	26,1,35,27, 13,3,34, 33,10,23	B1,B2,B3, B4, 26,3,10,24	24,26,35	35,24,15, 16,10
		Amount/Loss of Information	F11	10,26,23	25,17,37,1, 4,32,10	22,10,1, 20	27,22,35	35,33	2,10,17,13,	24,5,25,9	10	3,13, 23,35	24,26,35,	B1,B2, B3,B4	24,26, 3
		Amount/Loss of Time	F12	10,30,4	24,34,26, 3,15	35,15,34, 22,24	4,26,10,34, 24,35,30	15,26, 3,10	3,1,10, 26,	35,26	20,10,26, 15,16	35,26,34,4	35,24,15, 16,10,	24,26, 3	B1,B2, B3,B4
Energy			F13	15,20,10, 27,35,23,	3,1,	1,35,26,27, 10,22, 15,20	15,35,3, 1,22,	35,24,15, 16,25,3, 23	1,35,17,15, 26,27,7,23	35,17, 13,16	26,35, 15	1,4,26	34,23,16,15, 3,35,31,7, 25,24,5,26, 27,1,	15,10	35,24, 15,10, 3,7

(We arranged it on the basis of a contradiction matrix of Altshuller[4] again. The part of F11 referred to Matrix2003[5].)

3-1-2 Redesigned Contradiction Matrix2 (RCM2) (Parameter regarding Shape & Design)

Design stage to embody product

We have to pick up “contradictions“ focusing on shape and design parameters like weight, length, speed, power, temperature and so on.

Let us give you for instance,

In order to solve the contradiction

About “Improving strength” VS “Worsening Weight”, please use “table 2”

Number between “Improving Parameter” and “Worsening Parameter "on ”RCM 2” shows “Inventive Principle” and each number means “New inventive principle” like “RCM1”.

B1 to B4 show “Separation Principle s” for “Physical Contradiction(PC)”.

- ***B1: Separation in Time**
- ***B2: Separation in Space**
- ***B3: Separation Between a whole system and its parts**
- ***B4: Separation in Situation**

3-1-2 Redesigned Contradiction Matrix2 : RCM2
(Parameter regarding shape & design)

Improveing Feature \ Worsening Feature		Weight of Object	Length of Object	Area of Object	Volume of Object	Speed	Force /Torque	Stress or Pressure	Shape	Strength	Temperature	Illumination Intensity
		D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
Weight of Object	D1	B1,B2, B3,B4	15, 12, 26,34, 10, 1,35	26,17,24, 34,35, 30,13, 1	26, 1,40, 5,35,14	1,12, 15,24	12,10, 15,35,	10,35,40 13,26,15	10,14,35, 40,13, 26,14	26,27, 15,40, 1,10	26,20, 4, 24,15, 3,22	15, 1, 3,35
Length of Object	D2	12,15,26, 34,35,40	B1,B2, B3,B4	15,17, 4, 7, 10,40	7,17, 4, 35,12, 1,14	13, 4, 12	17,10, 4,26,	1,12, 35,14	1,12,10, 26,13,14, 15, 7	12,35, 26,34, 15,14	10,15, 3, 35,24,	3,25
Area of Object	D3	1,17,26, 4,30, 14,15	14,15, 4, 26, 7, 10,24	B1,B2, B3,B4	7,14, 17, 4	26,30, 4,34	15,30, 35 ,1,	10,15, 35,26,	5,34, 26, 4	3,31, 40,14	1,15,16, 35,24	15, 3, 13
Volume of Object	D4	1,26,40, 35,10, 15,14	1, 7, 4, 35,15, 14, 12,	1, 7, 4,17	B1,B2, B3,B4	26, 4, 24,34	15,35, 1,	26,35, 24	1,15,26, 4, 7, 35	10,14,15, 7,17	34,24,10, 15,35, 26, 4	1,13, 10
Speed	D5	1,26, 13,24	13,14, 12	26,30, 34	7,26, 34	B1,B2, B3,B4	13,26, 15,	26,15, 24,40	35,15,34	12, 3, 26,14	26,30, 35, 1	10,13, 15
Force/Torque	D6	12, 1,35, 15,13,26	17,15,10, 35,26,	15,10, 1,35	15,10, 12,35,1	13,26, 15,12	B1,B2, B3,B4	15,20, 10	10,35, 40,34	35,10, 14,27	35,10, 20	
Stress or Pressure	D7	10,35,40, 13,26,15	35,10, 1, 14,16	10,15, 35,25,	26,35, 10,24	26,35,	35,20	B1,B2, B3,B4	35, 4, 15,10	10,15, 3,40	35,24, 15, 1	
Shape	D8	12,10, 26,40, 15, 3	26,34, 5, 4,13,14, 10, 7	5,34, 4,10	14, 4,15, 22, 7, 1,35	35,15, 34,	35,10, 40	34,15, 10,14	B1,B2, B3,B4	30,14, 10,40	22,14, 15, 3	13,15, 3
Strength	D9	1, 12,40, 15,26,27,	1,15,12, 35,14,26	3,34,40, 26,10,	10,15,14, 7,17	12,13, 26,14	10,15, 3,14	10, 3, 15,40	10,30, 35,40	B1,B2, B3,B4	30,10, 40	35,15
Temperature	D10	35,22, 26,24, 3	15, 10	3,35, 24,15,	34,24, 40,15, 35,26,4	1,26, 35,30	35,10, 3,20	35,24, 15, 1	14,22, 15, 3	10,30, 22,40	B1,B2, B3,B4	3,30, 20,16
Illumination Intensity	D11	15, 1, 3,35	15, 3, 16	15, 3, 26	1,13, 10	10,13, 15	26,15,		3,30	35,15	3,35,15,	B1,B2, B3,B4

(We arranged it on the basis of a contradiction matrix of Altshuller[4] again.)

Table3.
Integration of Inventive Principles

Inventive principles originally consist of 40. But it's very difficult for TRIZ beginners to understand and master them.

Integration of Inventive principles with similar meanings

25 New Inventive Principles

	New No.	New Inventive Principles(25)	40 Inventive Principles	
A method of the segmentation/separation and combination	1	Segmentation/Separation	1	Segmentation
			2	Separation/Taking out
	5	Merging	5	Merging
	7	"Nested doll"	7	"Nested doll"
	26	Substitution・Replacement	6	Universality
			26	Substitution
			28	Replacement of mechanical system
			29	Pneumatics and hydraulics
A change of the shape	4	Asymmetry	4	Asymmetry
	14	Curvature	14	Curvature
	17	Another Dimension	17	Another dimension
A change of the viewpoint and thought	10	Preliminary action	9	Preliminary anti-action
			10	Preliminary action
			11	Beforehand cushioning
	13	"The other way round"	13	"The other way round"
	16	About	16	About
	23	Feedback	23	Feedback
	25	Self-service	25	Self-service
	27	"Cheap Short-living Objects"	27	"Cheap short-living objects"
	22	"Blessing in Disguise"	22	"Blessing in disguise"
	34	Discarding and Recovering	34	Discarding and recovering
A change of the materials	3	Local Quality	3	Local quality
			32	Color changes
	31	Porous materials	31	Porous materials
	40	Composite Materials	40	Composite materials
	30	Flexible Shells and Thin Film	30	Flexible shells and thin films
	33	Homogeneity	33	Homogeneity
A change of how to give energy	12	Equipotentiality	8	Weight Compensation
			12	Equipotentiality
	15	Vibration	15	Dynamization
			18	Mechanical vibration
			19	Periodic action
	20	Continuity	20	Continuity
			21	Skipping
A change of the state and characteristic	35	Parameter changes	35	Parameter changes
			36	Phase transitions
			37	Thermal expansion
	24	Intermediary	24	Intermediary
			38	Strong Oxydants
			39	Inert atmosphere

4. Application of Redesigned Contradiction Matrices(RCM)

4-1 Guide to Use Parameters on Matrix 1 (for reference)

About how to use "RCM"

We show the guide(see table4) regarding "F1-F13(parameters)" on "RCM1" with some examples about mechanics, electronics, software, chemistry, and business field as typical usage fields because of difficulty to select appropriate parameter from RCM1(see table1).

We are going to omit explanation about "shape & design parameters" on "RCM2" because of easiness to understand each parameter content.

Table4. Guide to Use Parameters[F1-F13] (about Performance)

				Common	Mechanical	Electric	Software/ Information system	Chemical
Performance	Reliability /Precision	**Reliability**	F1	Ability of processing aimed function.	Fewness of the trouble. Fewness of the unevenness of the movement.	Noise characteristics-resistant. Fewness of the malfunction.	Fewness of the bug. Stable data handling.	Stability/instability of materials. .
		Precision	F2	The degree of the accuracy. The degree that the work of the system is equal to a demand.	Processing precision Measurement precision. Assembling precision.	Electric processing precision.	Fewness of the data handling error.	Vice-reaction.
	Harmful Effects	**Harmful Effects**	F3	Affectability of harmful influence from the system outside or inside. Degree that a system has harmful influence to the system outside. (Include a problem to the environment.)	Fever. Noise. Vibration, Harmful product.	Electric shock. Outbreak of the electromagnetic noise. Bad influence to the human body.	Amount of the mistake of the data handling. Tolerance for the attack from the outside. Evil to others with the processing.	Stability for the temperature or environment(Robustness). Problem of the harmful thing generation by the process of manufacture. The toxic substance which rises from
	Operability /Durability	**Operability**	F4	The usability of the user. Degree and a range of the automation to function without human operation.	Usability. Simple operation. Operation to understand intuitively.	Base layout.	Plainness of UI. The number of input operation.	Easiness of the processing(surface treatment).
		Control Complexity	F5	Complexity in a process to perform to make it the output, the state that matched a purpose.	Numerousness of the preparation in machine tools	Speed of the transaction.	Simplicity of the algorithm. Little processing step	Temperature in the reaction and complexity of the control of time. Complexity of the handling of surface
		Maintenance /Repairability	F6	Complexity of the system and ease of the repair. (Include the number of element / parts and the number of interaction between element and part.)	Complexity of the system. Number of components. Resolvability and simplicity of the part exchange. Maintenance is free.	Complexity of the system. Number of components. Resolvability and simplicity of the part exchange. Maintenance is free.	Easiness for a bug. Independence degree of the module. Number of modules. Number of IO parameters.	Easiness such as washing characteristics. Easiness of adhesion.
		Adaptability/ Versatility	F7	Difference of the condition that can really happen. Compliance for the change. Flexibility of the use.	Flattery characteristics for an external factor. Adaptability for many kinds.	Compliance for the input signal. Adaptability to a wide range.	Adaptability to the condition change. Adaptability to different terms of use.	Adaptability with the adjacent thing.
		Durability	F8	Time before system breaking down. Toughness for the condition to change during a long term.	Time before a system breaking down. Stability for the external factor(Robustness).	Time before a system breaking down. Stability for the external factor(Robustness).	Time before breaking down. Tolerance of terms of use to change for long	Strength of materials. Easiness of deterioration.
	Manufactura	**Manufacturability, Productivity**	F9	Easiness of the production and the degree of a useful function to carry out in time.	Easiness of making of of the system. The quantity of the product.	Base layout. Assembling characteristics of system BOX.	Easiness of assembling of the module. Algorithm that it is easy	Easiness of making of. Number of the steps of the reaction.
	Amount /Loss	**Amount/Loss of Substance**	F10	Number of element of the system, the parts and a loss / waste.	Number of parts constituting a system	Number of electronic parts or electric parts.	Quantity of a necessary resource. Waste.	Number of kinds of the constitution compound. Quantity or change of the density.
		Amount/Loss of Information	F11	Quantity of the signal to treat and a loss / waste.	Mechanical reply. Signal.	Electric current and quantity of decrement of the voltage. Reply speed by the digital circuit.	Having a large quantity of processing data or not Kind and number to treat of data and parameters.	The change of the color. Optically-transparent degree.
		Amount/Loss of Time	F12	Operating time and degree of the non-efficiency(ex.waiting time) .	Operating time of the system. Setup time for system delay. Waiting time. Production baton time.	Time to start. Time to the end. Handling of electrical signal delay time.	Handling of data time	Time before reaching enough quantity of solidification and the coherency.
Energy			F13	Energy and the use efficiency to use when a system or an element does useful action.	Energy consumption in the system. Conversion efficiency	The decrement of the input electric current. Conversion efficiency.	Energy and efficiency that a resource uses.	Energy consumption in the system and conversion efficiency. Energy outbreak efficiency. Supplement efficiency of the Light or oxygen.

4-2 Examples of the Application

4-2-1 Case Example 1 : cleaner

Case Example1

By increasing suction power of cleaner

We try to solve the contradiction with "A:improving suction power" VS "B:worsening pick up power of trash on the floor "

■To apply RCM1(see table 1)

New inventive principle

A :Improving parameter F10:mass of material

B:Worsenning parameterF4:easiness of operation

35, 26, 10, 25, 12,31, 1,24,15

We want to describe some ideas(see next slide) we create by using selected inventive principles.

Case Example 1 : cleaner

New Inventive Principles	Idea

35.Parameter Change

***look for other parameters(like flow rate and current speed) to increase suction power >>>>Please move to "RCM2".**

26. Substitution

***Utilize gas fluid but air *cleaner based on magnetic attractive force**

***cleaner based on static electricity *combined application of water**

10. Preliminary action

***Control the balance between suction power and mobility after memorization of situation on floor in the house *Buoy dust by blowing before suction**

25.Self-Service

***automatic running cleaner**

12. Equipotentiality (balance)

*** being reversed with negative pressure>>>>making back-flow in interior portion of cleaner based on the airstream in the upper side of cleaner**

***Generate atmospheric pressure in the lower side of cleaner (making blowing unit)**

3.Local Quality

***change the air flow based on the location**

***change the air flow according to the quantity of dust**

1.Segmentation

***making the flow like nervation**

24.Intermediary

*** usage of roller made of adsorptive material**

15. Vibration（Dynamization）

*** decrease suction power a little for a moment when cleaner's nozzle stick to the floor by strong suction power**

“Improving suction power of cleaner”

About Contradiction “A:We want to absorb dust efficiently” VS

“B :Cleaner’s nozzle stick to the floor by suction power ”

■ **In the case of Altshuller’s matrix table**

A>>>> “26 Amount of substance” is selected

B>>>> ”33 Convenience of use” is selected

Inventive principle

35, 29, 10, 25

35 ,10 and 25 is extracted from RCM1 too and 29 is organized to new principle 26 on RCM1.

However, other principles(12,3,1,24,15) are not in RCM1. Therefore we can’t see these principles if we use conventional matrix table. That is to say, This table (RCM1) is very useful when we create a lot of ideas extensively

In particular, Cleaner with air cycle system focusing on decreasing emission and controlling suction power has been produced on a commercial basis . New cleaner (TOSHIBA VC-Z57) was developed by utilizing 12.Equipotentiality (balance) .

Case Example 2: lithium ion battery

Case Example2

We try to solve the contradiction with "A:improving high voltage and great capacity of battery" VS "B:worsenning deterioration of electrode

Point1 "A: Reliability" VS "B:Durability"

Point2 " A:Energetic performance" VS "B: Amount of substance

■ **Application of RCM1(see table 1) from point1**

Feature to improve A F1.Reliability

Undesired Result B F8.Durability

New Inventive principle

1,35,3,25,34,27,26,40

■ **By using Altshuller's CM**

Feature to improve A 27.Reliability

Undesired Result B 15.Durability

Inventive principle

2,35,3, 25

Inventive principle 2 at Altshuller's CM is same to new inventive principle1(see table3) at RCM1. But we can't see 34 of new inventive principle (Discarding and Recovering).

■ **Application of RCM1(see table 1) from point 2**

New Inventive principle

Feature to improve A F13. Energetic performance

Undesired Result B F10.Amount of substance

34,23,16,15,3,35,31,7, 25,5,26,27,1

■ **By using Altshuller's CM**

Feature to improve A 20.Energy spent by non-moving object

Undesired Result B 26.Amount of substance

Inventive principle

3,35,31

We can't see 23 of new inventive principle (Feedback).

34:Discarding and Recovering

In order to keep unchangeable basic structure of electrode by discharge and charge, it should be utilize transition metal oxide installed lithium ion as a negative electrode

23:Feedback

In order to prevent change of negative electrode, it should be supplied "what has changed".

5. Conclusion

All engineers working at any place have any problems to solve by applying many different methods. Therefore, we need to use "TRIZ" as "a highly-valued method" to get effective solutions without spending wasteful time.

On the other hand, TRIZ beginners face "Chinese Wall" to master TRIZ methodology. In order to overcome this wall(obstacle),they have to define "problems to solve" at first.

We selected "Contradiction Matrix (CM)" to define and solve problems because of the most understandable method for TRIZ beginners in TRIZ field.

That is why we developed "two types of Redesigned Contradiction Matrix(RCM)" for TRIZ beginners as previously explained.

TRIZ beginners should use "Two Types of RCM" based on "Step by Step thinking".

We hope that many TRIZ beginners actively use "developed RCM" to overcome "Chinese Wall".