USIT Approach in Japan for Simpler and Powerful Process of Creative Problem Solving in TRIZ

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Why the penetration of TRIZ is slow?

[Nakagawa, ETRIA 2001]

Introduction of TRIZ in industrial practices is still in its infancy stage.

It is taking time not because TRIZ is poor, but because TRIZ is so rich.

Learners are requested to master them all or to depend on handbooks/software tools for applying TRIZ.

The way of thinking in TRIZ is very difficult to learn.

→ How to teach/learn/apply TRIZ in its essence in a much simpler and effective way is the main issue.

USIT (Unified Structured Inventive Thinking)

TRIZ

Simplified

SIT (Filkovsky, Israel) 1980s -
[ASIT: Roni Horowitz et al.]

New framework, enhanced

USIT (Ed Sickafus) 1995-

Reorganized

USIT in Japan (Nakagawa) 1999-

Essence of TRIZ:

Recognition that
technical systems evolve
towards the increase of ideality
by overcoming contradictions
mostly with minimal introduction of resources.
Thus, for creative problem solving,
TRIZ provides with a dialectic way of thinking,
i.e.,
to understand the problem as a system,
to make an image of the ideal solution first, and
to solve contradictions.

Toru Nakagawa at TRIZCON2001, March 25-27, 2001

TRIZ in the traditional way:

Principal Solution Generation Methods have their own analysis methods:

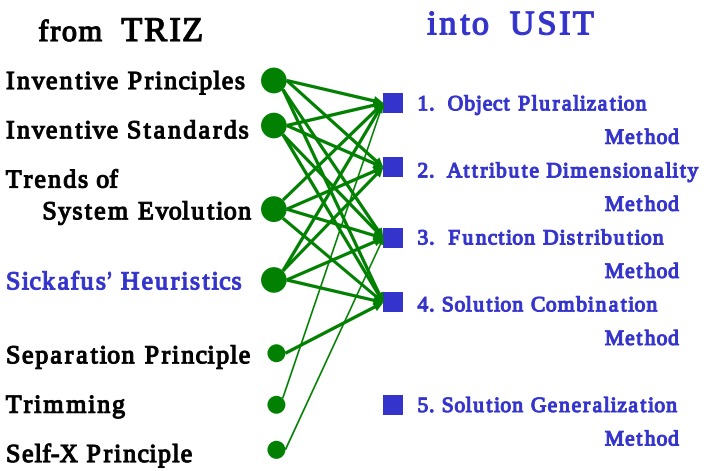
- Contradiction Matrix → Inventive Principles
- S-Field analysis → Inventive Standards
- ARIZ (for formulating Physical Contradictions) → Separation Principle

Separate analysis methods provide insufficient and narrow understanding of the problem.

→ Solution generation in TRIZ is not easy to understand and difficult to learn for beginners.

The separation of "analysis-solution pairs" is the root cause of the "TRIZ slow-penetration problem".

Reorganizing TRIZ Solution Generation Methods:



Reorganizing TRIZ Tools into USIT

[Nakagawa et al., ETRIA2002]

Solution Generation Methods:

Mapping of TRIZ sub-methods onto the five USIT methods.

We examined the implication and made 1-to-n mapping.

(Ex:) TRIZ Inventive Principle 3. Local Quality

[P3c] If two functions are to be performed by the same object but this causes problems, divide the object into two parts.

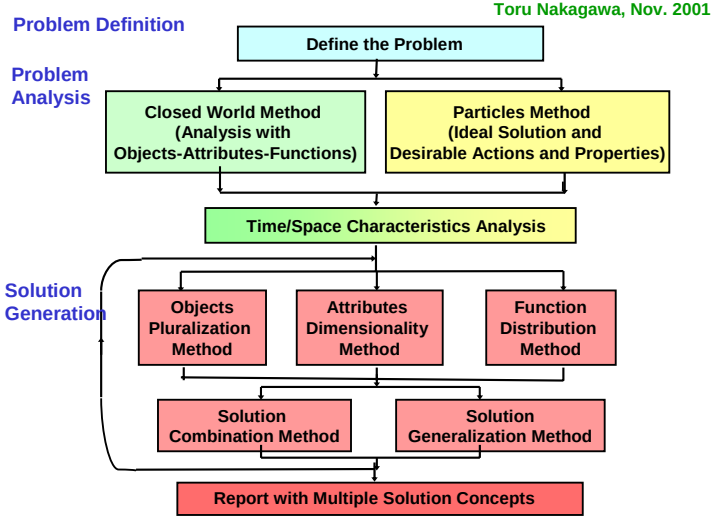
[P3d] Redesign your object and environment so that each part of the object must be in conditions proper for operation.

USIT Five methods

1. Object Pluralization Method
2. Attribute Dimensionality Method
3. Function Distribution Method
4. Solution Combination Method
5. Solution Generalization Method

USIT (Unified Structured Inventive Thinking) Flow Chart

Toru Nakagawa, Nov. 2001



Function and Attribute Analysis in USIT

	Purpose	Object of the Analysis
Functional Analysis (Closed-World Diagram)	Intention of the original design (How it should work)	Objects and Functions
Attribute Analysis (Quality Change Graphs)	Factors causing (enhancing) / preventing (weakening) the problem (difficulty)	Objects and Attributes

(1) Object Pluralization Method

(1a) **Eliminate** the Object (into **0**).
(Simplification, Trimming)

(1b) **Multiply** the Object (into **2, 3, ..., ∞**).

(1c) **Divide** the Object (into **1/2, 1/3, ..., 1/∞**). ⇒ See detail:

(1d) **Unify** multiple Objects into one.

(1e) Introduce a **new/modified** Object. ⇔ KB

(1f) Introduce an Object from the **Environment**.

(1g) Replace a solid Object
with a **powder/fluid/liquid/gaseous** Object. ⇔ KB

⇔ KB : Support with Knowledge-bases or software tools is useful.

USIT Solution Generation Methods (total 32 submethods)

(1) Object Pluralization Method

a. Eliminate
b. Multiply into 2, 3, ..., ∞
c. Divide into 1/2, 1/3, ..., 1/∞
d. Unify
e. Introduce or modify
f. Introduce from the Environment.
g. From solid to powder/liquid/gas

(2) Attribute Dimensionality Method

a. Deactivate a harmful
b. Activate a useful
c. Enhance a useful or suppress a harmful
d. Introduce a spatial attribute or vary in space
e. Introduce a temporal attribute or vary in time
f. Change the phase or the inner-structure
g. Attributes at the micro level
h. Properties of the system as a whole

(3) Function Distribution Method

a. Reassign to a different Object
b. Divide the compound Functions and assign them separately
c. Unify multiple Functions
d. Introduce a new Function
e. Vary the Function in space, use space-related Functions.
f. Vary the Function in time.
g. Detection/measurement Function.
h. Enhance adapting/coordination/control
i. With a different physical principle

(4) Solution Combination Method

a. Combine functionally
b. Combine spatially
c. Combine temporally
d. Combine structurally
e. Combine at the principle level.
f. Combine at the super-system level

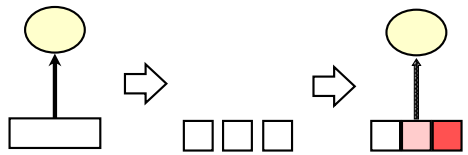
(5) Solution Generalization Method

a. Generalize/specify
b. Hierarchical system of solutions

(1c) Divide the Object (into 1/2, 1/3, ..., 1/∞).

Divide the Object into multiple parts (1/2, 1/3, ..., 1/∞),
modify the parts (slightly,
or differently for different parts),
and combine them for using together in the system.

P1 Segmentation
P2 Taking away
P3 Local quality
P15 Dynamicity

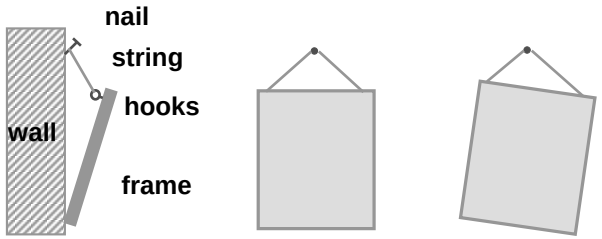


Usage of USIT

Example: "Picture Hanging Kit Problem"

"Devise a picture hanging kit preventing from tilting"

Ed Sickafus in the USIT Textbook (1997)
Extended by Nakagawa (2001); Further extended here.

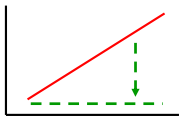


Attribute Analysis in USIT

Qualitative Change Graphs for Picture Hanging Kit Problem

Unwanted effect: tilting of the frame

(increasing relationship)



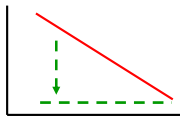
Objects and their attributes

frame: offset of the center of mass
frame: asymmetry in the shape

hooks: offset from symmetric position

wall: causing vibration

(decreasing relationship)



Objects and their attributes

Wall/frame bottom: friction

nail/string: friction

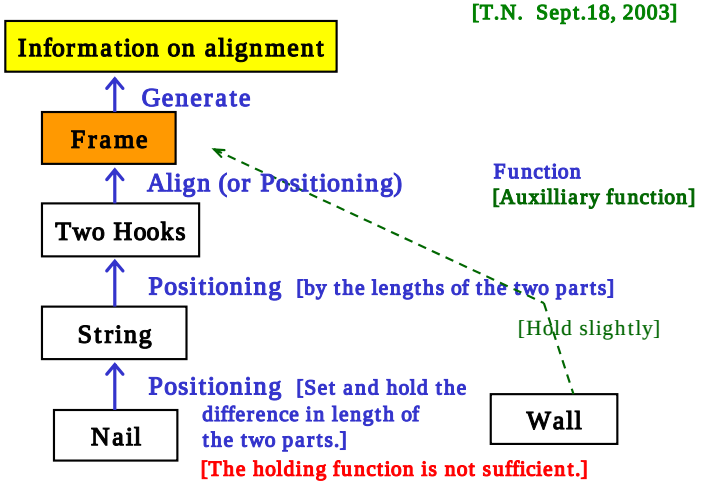
hooks: location adjustment

Green arrows show the requirement of qualitative change.

Functional Analysis in USIT

Picture Hanging-Kit Problem

[T.N. Sept.18, 2003]

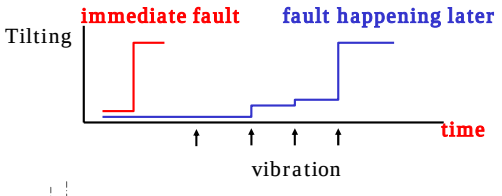


Space & Time Analysis in USIT

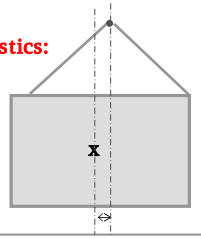
(c) Spatial/Temporal Characteristics Analysis

(Uniqueness Analysis)

Temporal Characteristics:



Spatial Characteristics:



Offset of the center of mass of the frame from the vertical center line made by the equilateral triangle of the string is the main cause of the problem.

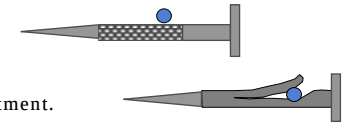
USIT Application:

(1c) Divide the Object (into 1/2, 1/3, ... , 1/infinity)

onto Nail:

(1) Make one half of the Nail slippery and the rest half rough to hold.

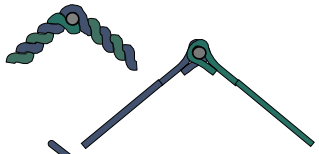
(2) Make a slit on the Nail to set the String tightly after adjustment.



onto String:

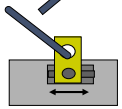
(3) Make the String with a twisted pair, and place the Nail in between.

(4) Cut the String into two halves and fix them onto the Nail.



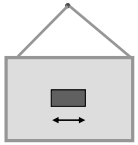
onto Hooks:

(5) Make the top part of the hook adjustable in its effective position.



onto Frame:

(6) Make a part of the frame movable horizontally to adjust the position of the center of mass.



Practices of training/Applying USIT

2-Day USIT Training Seminar in Japan

First morning: Introductory lectures on TRIZ and USIT
1.5 Days: **Group practice for solving problems with USIT**

Real problems are brought in.
Good for high motivation of the participants.
Engineering background knowledge is requested.
3 problems are solved in parallel; 3 to 8 members for each group.

5 Step-by-step sessions with USIT procedure:
Each session has:
Short lecture on the concrete way of the step;
Group practice in parallel (each group solves one problem);
Presentation by the groups to the whole members, for discussion.

All the problems have been solved successfully with 20to 40 conceptual solutions.
Every participant solves one problem in a group and understands all other cases through the discussions.

This idea can be generated in four ways in USIT:

(a) Object Pluralization Method

Divide the Nail Object into halves, change the smoothness of the two parts, and use them in combination.

(b) Attribute Dimensionality Method

Change the values of the Smoothness Attribute in parts of the Nail.

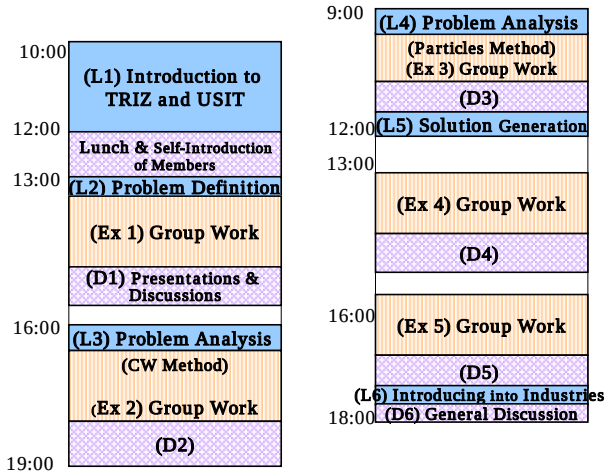
(c) Function Distribution Method

The Adjusting and Holding Functions of the Nail are re-assigned to different parts of the Nail.

(d) Solution Combination Method

The solution of making the Nail smooth for easier adjustment and the solution of making the Nail rough for better holding are combined in space by dividing the Nail.

USIT 2-Day Training Seminar (Sept. 2003, Nakagawa)



USIT as Evaluated in Japan

(1) USIT is much easier to learn than TRIZ.

➡ To bring up one or two USIT experts in a company, then to train many engineers in in-company training program.

(2) USIT fits well for group work.

➡ Joint team of 1-2 USIT experts and 4-6 engineers for problem solving

(3) USIT is applicable to real problems.

➡ To apply to real industrial problems at the concept-generation stage.

(4) Engineering details should be considered after USIT.

➡ The processes for after-USIT stages need further consideration, in relation to TRIZ software and other designing/quality methodologies.

Practices at Ford is an excellent model for introducing TRIZ/USIT.

How should we teach/learn/apply TRIZ?

TRIZ = Methodology + Knowledge Base

(Recommended Materials)

Methodology (a) : New view of technology

⬅ TRIZ textbooks (Salamatov) (Mann)

Methodology (b) : Thinking way for problem solving

⬅ Simplified TRIZ methodology (USIT) (USIT)

Kowledge Base : A collection of examples implementing the methodology (a) and (b)

⬅ Software tools (TechOptimizer) (CREAX)

Combination Methods of USIT and TRIZ Software Tools:

A. Solve the problem with USIT in a group work, then enhance/extend the solution ideas with TRIZ software.

B. Use USIT for solving problems in a group. Use TRIZ software for individual study and individual idea generation.

C. Use USIT for solving problems in group meetings. The group meet several times with 1-2 week intervals. Members use TRIZ software to enhance their ideas during the intervals.

Strategies for Introducing TRIZ into Industries

Hurry and Forcing	Steady Strategy (Nakagawa, Jan. 2003)	Slow-but-Steady (Nakagawa, Oct. 1999)
In a complete form of the whole TRIZ,	Understanding the essence of TRIZ,	Starting with the understandable parts of TRIZ,
Using the full ARIZ algorithm,	Using USIT Process for problem solving	Using USIT process (I.e. a simplified TRIZ),
Teaching system analysis, from the beginning,	Using USIT analysis & solution methods and TRIZ knowledge bases,	Using TRIZ data base and USIT, at the beginning,
With top-down leadership organization,	Authorizing and enhancing the grass-root organization,	With bottom-up grass-root organization,
Ordering to all/many employees,	By core groups of volunteer employees,	By groups of volunteer employees,
Changing current R&D style drastically,	Introducing into the current R&D activities,	Introducing into the current R&D activities,
Believing in its effectiveness,	Providing results by practices ,	Proving its effectiveness by ourselves,
Rapidly, extensively, and widely	Steadily, deeply, and widely	Without hurrying; steadily, and deeply