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Extension of USIT in Japan: A New Paradigm of Creative Problem Solving

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http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/

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Outline of Talk

A special feature of understanding TRIZ in Japan (cf. the World) is to understand TRIZ in an easier and unified way.

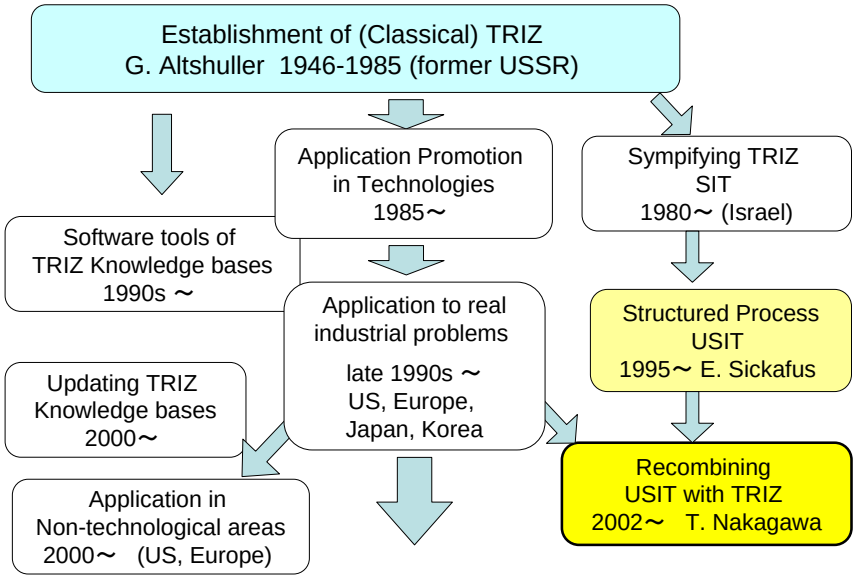
This was mostly led by the introduction and extension of USIT in Japan. I am going to review the history of USIT in Japan in its philosophy.

(1) We introduced USIT (developed by Ed Sickafus) into Japan, 1999.
USIT is 'An easy-to-learn TRIZ'

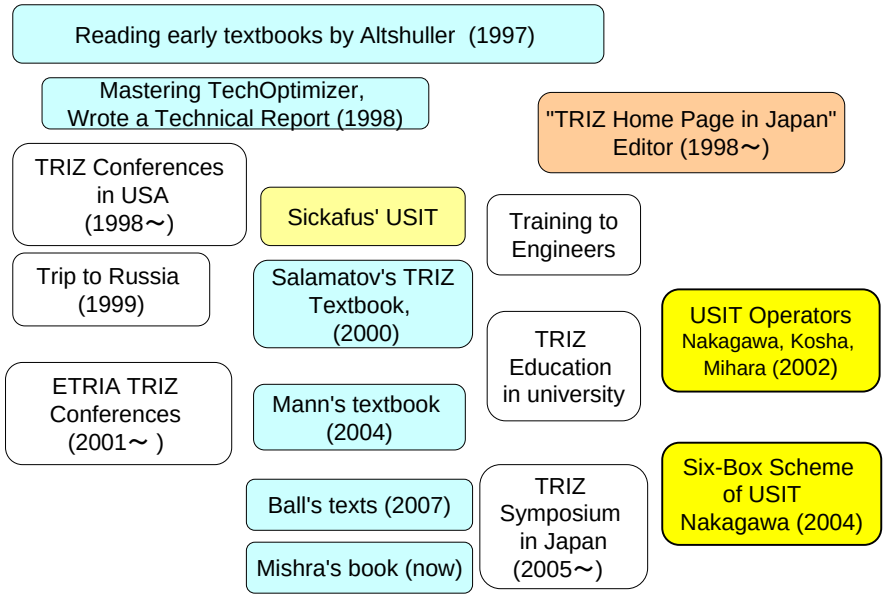
(2) We constructed 'USIT Operater System' for solution generation, 2002.
All the solution generation methods in TRIZ were reorganized.
USIT is 'A Next generation of TRIZ'.

(3) We recognized 'Six-Box Scheme of USIT' , 2004.
USIT gives 'A New Paradigm of Creative Problem Solving'.

Overview of TRIZ (and USIT) World History



Nakagawa's Personal History in TRIZ & USIT



(1) Ed Sickafus developed USIT and we introduced USIT into Japan.

1995 Ed Sickafus (Ford, USA) has developed USIT.

USIT = Unified Structured Inventive Thinking

Referred to Israeli SIT (a much simplified version of TRIZ)
and also to TRIZ.
USIT Textbook (1997).
Training engineers and industrial projects in Ford.

1998 Sickafus presented a paper at First TRIZ International Conference in USA.
Nakagawa learned USIT Textbook.

1999 Nakagawa paticipated at Sickafus' USIT 3-Day Training Seminar.

Overview of Sickafus' USIT

(a) A consistent whole process for problem solving.

Problem definition → Problem analysis → Solution generation
(TRIZ has multiple big methods working in parallel, not consistent.)

(b) Problem Analysis: Analyze systematically with basic concepts

Consistent use of "Objects-Attributes-Functions" concept.
Analyze the characteristics in Space and in Time.
(On the basis of 'Closed World Method' of SIT)
(Also related to TRIZ concepts of Operational Spece and Operational Time)

(c) 'Particle Method' for obtaining an image of Ideal system

Use magical agency 'Particles', which can behave as you want and which can have properties as you desire.
(A modification of Altshuller's Smart Little People's Modeling.)
A tree diagram of Desirable Behaviors of the Particles (i.e., Ideal system).
List up Desirable Properties of the Particles (i.e. Ideal System)

(d) Solution Generation with 4 Basic Methods (+ 2 complementary)

- Dimensionality: Change the Attributes in terms of dimension.
- Pluralization: Multiply or Divide the Objects.
- Distribution: Rearrange the Functions onto Objects.
- Tansduction: Link a Function to another Function.

- Uniqueness: Utilize the characteristics in Space and in Time.
- Generify: Generalize a Solution.

(Following SIT, but slightly re-grouping/extending the methods.)

(e) Aims at generating multiple useful solutions to real problems, quickly.

Does not put much stress on 'Inventions', in contrast to TRIZ and SIT.

(f) Main purpose: To guide the thinking process of problem solving.

Does not depend on Handbooks, Knowledge bases, Software tools, etc. , in contrast to TRIZ.

(g) Short term training: 3 Days of USIT Training

1st Day: Overview lecture + Practices with small textbook problems
2nd Day: Group practices for solving 4 real problems brought in by the participants.
3rd Day: Group practices for solving 4 more real problems.

-- The USIT Training Seminar conducted by Sickafus was intensive, active, and useful.

We introduced USIT into Japan (1999 -)

Nakagawa: Introduced USIT into Japan.

"TRIZ Home Page in Japan"

A detailed report of the whole USIT procedure.

Two USIT case studies (Made by Nakagawa at Sickafus' Seminar)

Trials of applying USIT in Japan

In-house USIT 3-Day Training (Jul. 1999 -)

Open, multi-company USIT 3-Day Training (Jan. 2000 -)

organized by Mitsubishi Research Institute.

Nakagawa: **"Slow-but-Steady" Strategy for Introducing TRIZ**

by using easy-to-learn TRIZ (i.e. USIT)

Pioneers in TRIZ in Japan understood USIT gradually.

Application of USIT were tried in several companies.

E.g., Fuji Photo Film Co., Fuji Xerox Co., Ricoh, etc.

(2) We constructed 'USIT Operater System' for solution generation (2002)

Main issue in the initial stage of USIT promotion:
Solution generation methods were difficult to learn & apply.

Only brief explanations; intuitive and practice-based application;
difficult to explain logically due to its nature of solution generation.

- Built a look-up table between 40 Principles and USIT 5 methods: (Kosha)
- Rearranged all the TRIZ solution generation methods individually into the USIT 5 solution generation methods, and then they are reorganized into a hierarchical system: (Nakagawa)

==> 'Reorganizing TRIZ Solution Generation Methods into Simple Five in USIT', (A System of USIT Operators)

Toru Nakagawa, Hideaki Kosha, and Yuji Mihara:
ETRIA TFC 2002, Strasbourg, France, Nov. 6-8, 2002.

Reorganizing TRIZ Solution Generation Methods into USIT

Nakagawa, Kosha, Mihara (2002)

Mapping individual sub-methods in TRIZ onto the five USIT methods with 1-to-n mapping.

For Example:

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.**

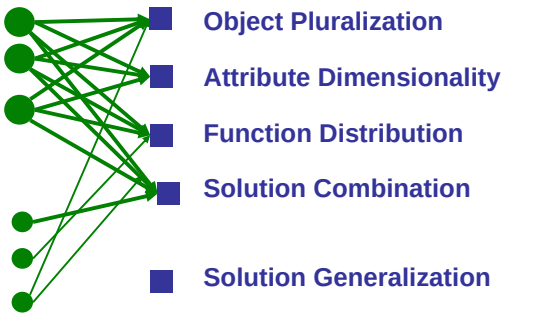
[P3d] **Redesign your object and environment so that each part of the object must be in conditions proper for operation.**

USIT Five methods

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

Then all the sub-methods are hierarchically rebuilt in USIT.

TRIZ methods for Solution Generation → **USIT Operators (5 Main-, 32 sub-methods)**



USIT Operators are categorized with the items to apply.
The first three correspond to the three basic concepts to analyse the present system.
Solution Combination is the key in the Separation Principle.
Solution Generalization is not clear in TRIZ.

USIT Operators

Nakagawa, Kosha, Mihara (2002)

(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 ⇔ KB
f. Introduce from the Environment.
g. From solid to powder/liquid/gas

(2) Attribute Dimensionality Method

a. Deactivate a harmful attribute
b. Activate a useful attribute ⇔ KB
c. Enhance a useful or suppress a harmful attribute
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 ⇔ KB
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

An example of USIT Operator sub-method

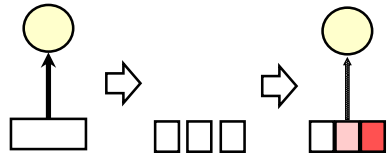
(1) Object Pluralization Method

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

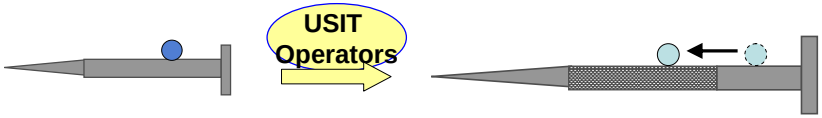
Divide the Object into multiple parts (1/2, 1/3, ..., 1/∞), modify the parts (slightly, or differently for different parts), and combine them for using together in the system.

TRIZ Inventive Principles which brought this sub-method:

P1. Segmentation
P2. Taking away
P3. Local quality
P15. Dynamicity



Application Example: Picture Hanging-Kit Problem



(a) Object Pluralization: Divide the Nail into halves, change the smoothness of the two parts, and use them together.

(b) Dimensional Change in Attribute: Change the values of the Smoothness Attribute in parts of the Nail.

(c) Distribution of Functions: The Adjusting and Holding Functions of the Nail are re-assigned to different parts of the Nail.

(d) Combination of Solutions:

The solution of making the Nail smooth for easier adjustment and the solution of making the Nail rough for better holding

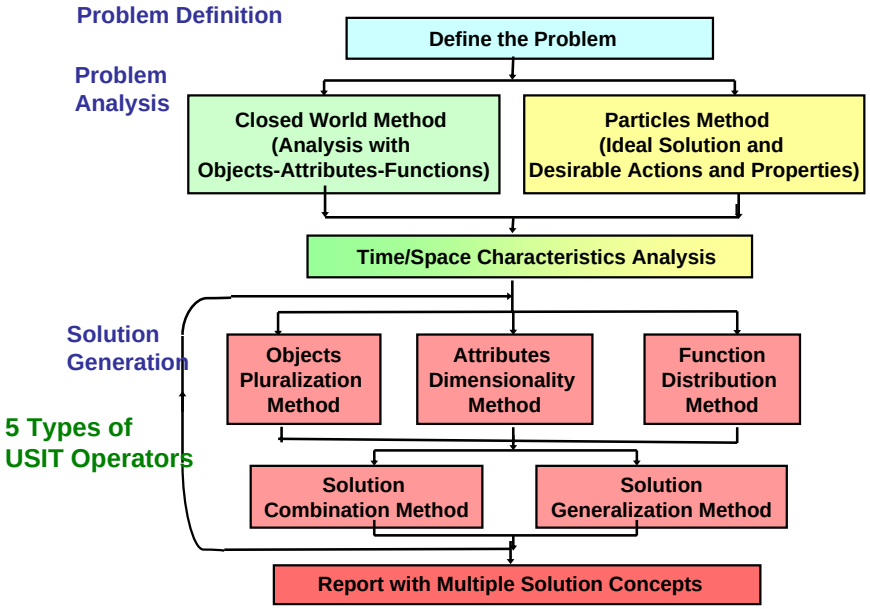
(d1) are combined in space by dividing the Nail.

⇒ (d2) are combined in time. **[Most essential interpretation.]**

Intended redundancy makes the solution generation easier.

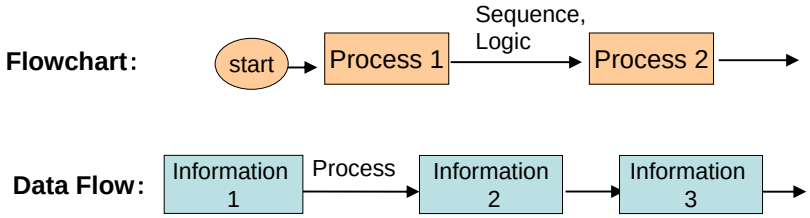
Flowchart of USIT

Toru Nakagawa, Aug. 2001
used until Sept. 2004



(3) We repesented USIT in the Six-Box Scheme

Nakagawa represented the USIT procedure in Data Flow Diagram. (Sept. 2004)



Facts well known in computer science:

Data Flow describes the in/out and intermediary information as requirements.

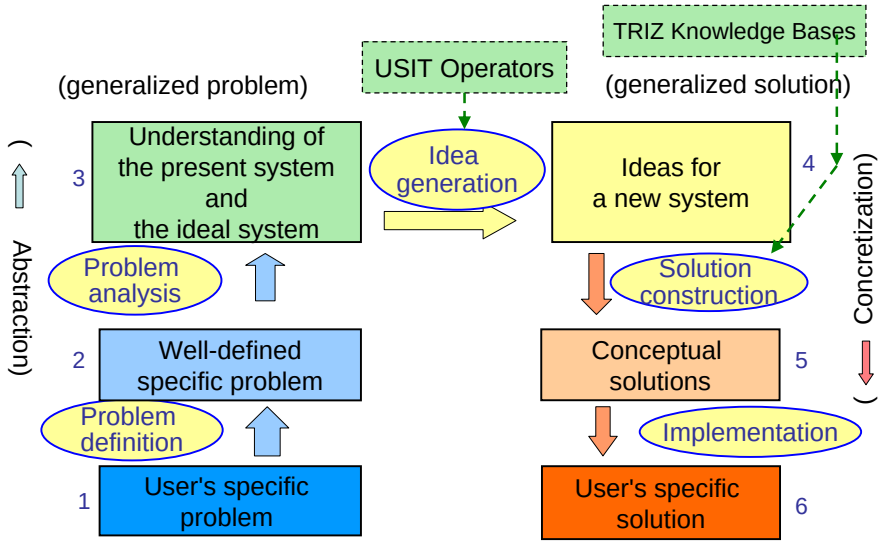
There may be different methods (How) for achieving such requirements (What).

Flowcharts try to describe the means (How) to perform.

The information to be handled are implicit, not specified explicitly.

Data Flow representations are more basic and stable than the Flowcharts.

Six-Box Scheme of USIT: Data-Flow Representation



Description of the Six-Box Scheme of USIT :

Box 1: **User's specific problem:**
The problem recognized in the real world.

Box 2: **Well-defined specific problem:** (Start of the problem solving in USIT)
Unwanted effect, Task statement, Sketch,
Plausible root causes, Minimum set of relevant objects

Box 3: **Understanding of the present system:**
In terms of Objects-Attributes-Functions, Space and Time
Understanding of the ideal system:
Desirable behavior and Desirable properties.

Box 4: **Ideas for a new system:**
Pieces of core idea for improving and changing the system.

Box 5: **Conceptual solutions:** (Goal of the problem solving in USIT)
Solutions in the concept level constructed around the core ideas.

Box 6: **User's specific solutions:**
Solutions implemented in the real world.

Description of the Six-Box Scheme of USIT (continued):

1→2: **Define the Problem:** Select the problem with the real-world criteria.
Usually through discussion.

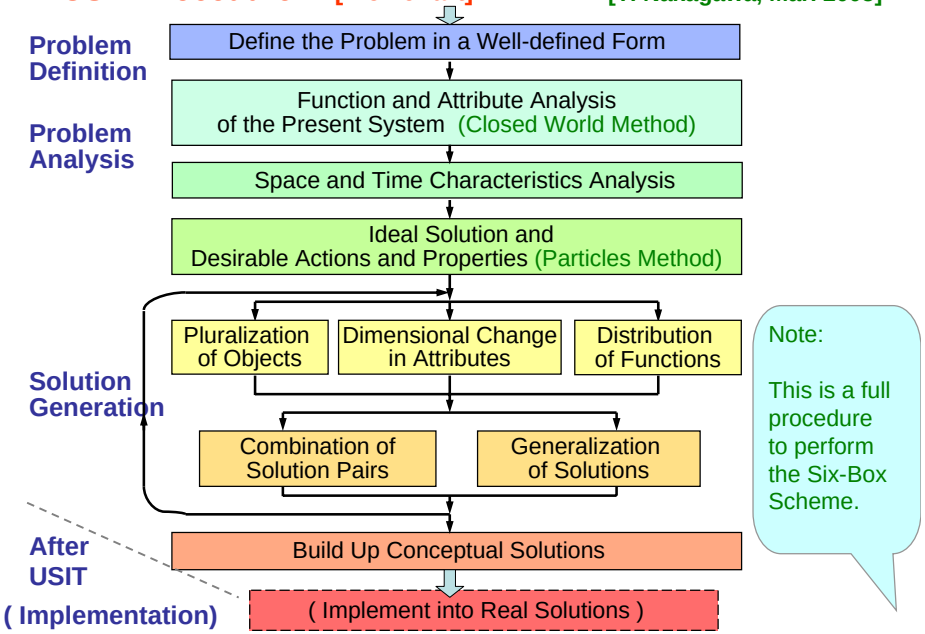
2→3: **Analyze the Problem:** Function analysis, Attribute analysis,
Space and Time Characteristics analysis.
Particles Method for understanding the Ideal system.
(Standard set of analysis (=abstraction) methods independent of the fields.
Not a mapping to any model given from outside.)

3→4: **Generate Ideas:**
In theory: Apply USIT Operators onto the system components or solutions.
In practice: Ideas are coming out during the analysis stage in USIT,
and during the consideration of the hierarchical system of solutions

4→5: **Build Conceptual Solutions:**
Construct solutions around the core ideas.
Scientific and technical capability related to the subject is necessary.
Knowledge bases in TRIZ are useful for supporting this stage.

5→6: **Implement specific solutions:** (Real World activity after finishing USIT)
Evaluate & select the conceptual solutions.
Designing, experiments, and implementing into real products/processes.

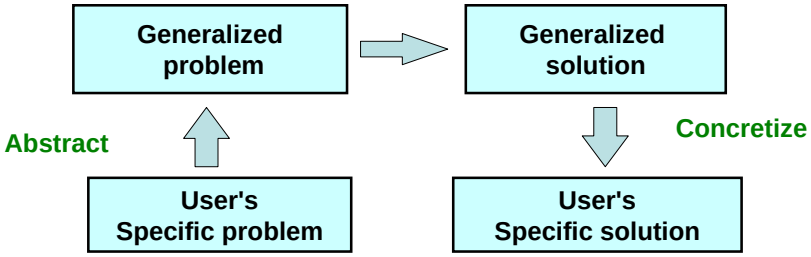
USIT Procedure [Flowchart] [T. Nakagawa, Mar. 2005]



(4) We realized that Six-Box Scheme in USIT is A New Paradigm for Creative Problem Solving.

Basic Scheme for Problem Solving:

Four-Box Scheme

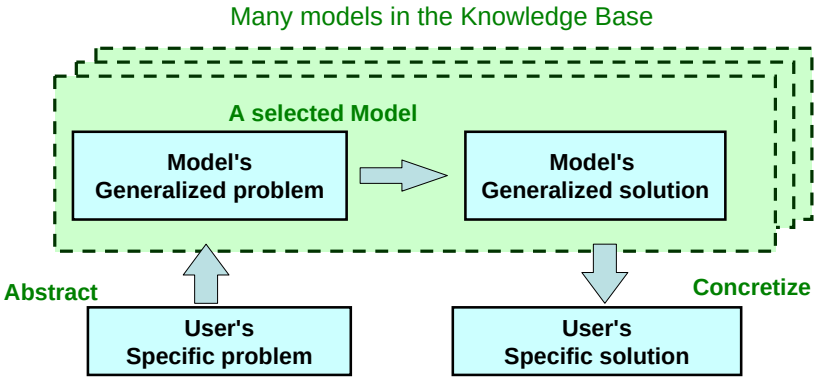


The contents of the boxes in the Generalized World depend on the fields, models, and problems. --> No further general explanation.

Many models exist in parallel. (As shown in the next slide)

Science & Technologies (Many models, specialized in areas)

==> (Traditional) TRIZ (**Across areas**, but many separate tools)

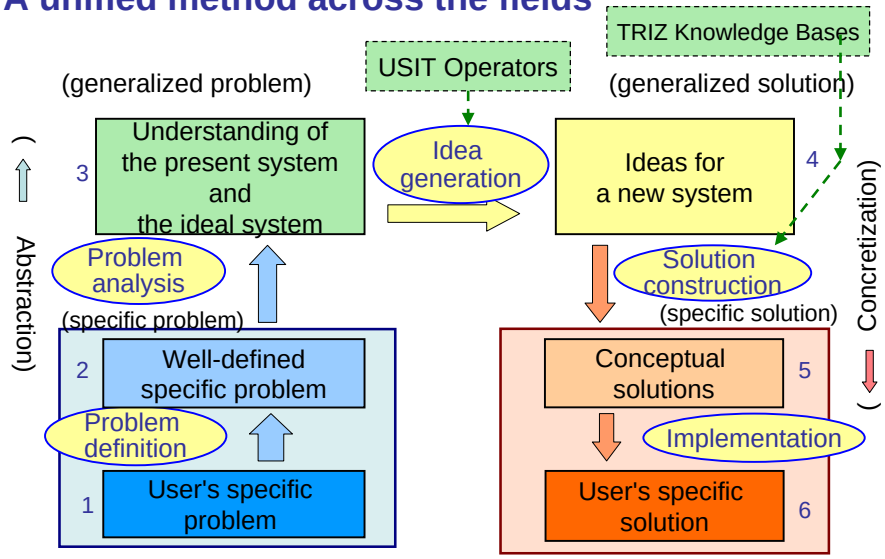


Many models ==> How to select one ? How to abstract ?

Six-Box Scheme of USIT

A New Paradigm for Creative Problem Solving

A unified method across the fields

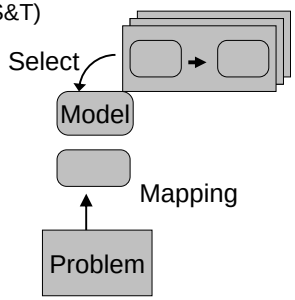


Implications of the New Scheme (1) Analysis/Modeling

Traditional paradigm: (TRIZ and generally S&T)

A known Model is selected
from Knowledge Bases
intuitively or with trial-and-error

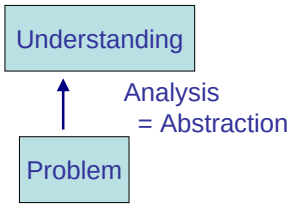
Real Problem is mapped onto the Model
on the basis of intuitive similarlity.



New paradigm with USIT:

A real Problem is well defined, and then
analyzed in the standard terms
by using standard way of analysis.

The way of Abstraction is standardized and
used consistently for any problem.

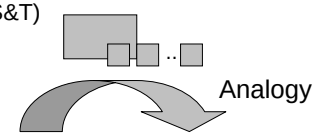


Implications of the New Scheme (2) Idea generation

Traditional paradigm: (TRIZ and generally S&T)

Presenting a few (Inventive) Principles
together with application examples

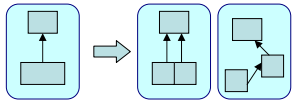
==> (Enforce) analogical thinking



New Paradigm with USIT:

(In theory)

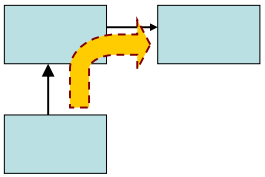
Apply USIT Operators
one after another in the abstract level



(In practice)

Already generated in the brain
during the analysis stage

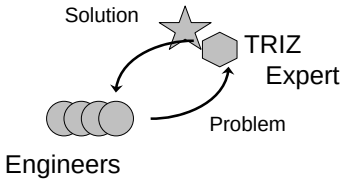
List them up and
build into a tree structure.
(Can be done smoothly)



Implications of the New Scheme (3) Ideal expert

TRIZ Traditional:

an almighty inventor
an almighty contract researcher
in any technology field

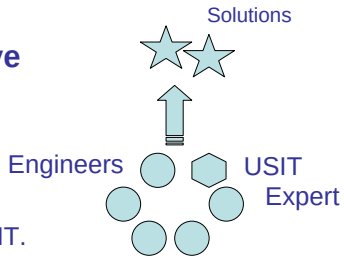


New Paradigm with USIT:

a guiding assistant of engineers
to help engineers think and solve

work together with engineers in any field

can achieve much more
than he/she can do alone
and than the engineers can do without USIT.



==> practical and suitable for wider penetration

(5) Current Status of Application and Penetration of USIT

USIT: Current status of penetration

USA: 1995-2000: In Ford, Sickafus developed USIT, trained engineers and applied USIT to industrial projects.

1997: Sickafus, USIT Textbook. 2001, USIT Overview eBook.
2000: Sickafus retired Ford. Web site and News Letters still continue.
USIT activities in Ford seem continuing but **no new publications.**

Japan:

Nakagawa: Education of TRIZ & USIT in a University

Several Case Studies of problem solving in USIT.
- How to fix a string shorter than the needle.
- How to prevent the staple from being crashed.
- How to prevent unauthorized persons from entering the auto-locking door of apartment buildings.

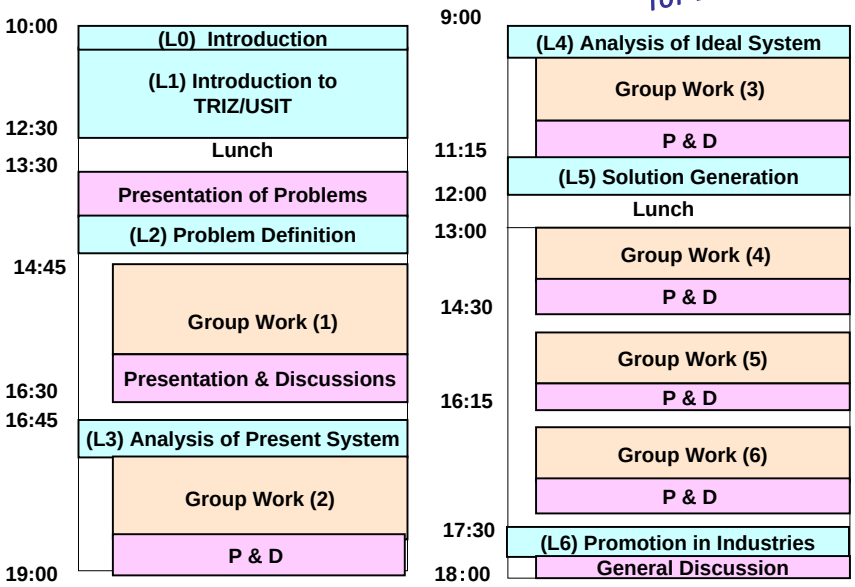
"TRIZ Home Page for Students by Students" (2006)

Training of USIT to engineers: USIT 2-day Training Seminars

In-house training and open, multi-company training

2-Day USIT Training Seminar (Nakagawa)

for Engineers



Japan: Public Presentations on USIT from Industries: TRIZ Symposium in Japan, 2005 - 2008

Fuji Film Co.: Improving the USIT method (2005, 2006)
Fuji Xerox Co.: Case studies (2005)
Matsushita Electric Works: Promotion and application (2005, 2006, 2007)
Nissan Motor Co.: Promotion and application (2005)
Konica-Minolta group: Promotion & practices (2006, 2007, **2008**), Method (**2008**)
Toshiba group: Case study (2007)
Sekisui Chemical Industries: Promotion and application (2007)
Ricoh group: Case study (**2008**)
Pioneer: Promotion and application (**2008**)
Sharp : Promotion and application (**2008**)
MPUF USIT/TRIZ Study Group: Case Study (**2008**) [**SONY**]
IDEA USIT Training Seminar: Case study (2008) [**Sekisui House**]

Observations:

Most industries have tried several ways of promoting/using TRIZ.
Among them USIT has been increasing its weight in real applications.
Mostly in the bottom-up promotion with some support in the organization.
Study groups of engineers from multiple companies will play important roles in the near future.

Summary: Extension of USIT in Japan

(1) Sickafus developed USIT, and we introduced USIT into Japan.

Easy-to-learn TRIZ

Slow-but-Steady Strategy of promoting TRIZ in Japan.

(2) We reorganized TRIZ solution generation methods and constructed USIT Operators.

USIT has unified the whole body of TRIZ.

USIT is a new generation of TRIZ.

(3) We represented the USIT procedure in the Six-Box Scheme and realized it as a new pradigm.

No need to depend on the analogical thinking.

A New Paradigm of Creative Problem Solving.

(4) We have established the methods for education in university , training industrial engineers, and practical application to industrial problems

Easy-to-learn Case Studies

Full traning in 2 days

Steady Strategy of promoting TRIZ