

For Establishing A General Methodology of Creative Problem-Solving / Task-Achieving

Toru Nakagawa
Osaka Gakuin University, Japan,
nakagawa@ogu.ac.jp



Introduction:

Part I. Why a new target?

How TRIZ can be learned and mastered widely?

To whom and where TRIZ wants to go?

Do people want TRIZ? or what?

General methodology for creative problem solving !

Part II. How can we evolve from TRIZ to the new target?

TRIZ -- reconsider the Four-Box Scheme

USIT -- Unified concepts and Six-Box Scheme

General methodology for creative problem solving

Part I: Why a new target?

- General methodology for creative problem solving

Motivation: Why the creative problem solving method, TRIZ, does not penetrate more smoothly among people?

I built up a number of models to consider this problem.

Model of a person to learn TRIZ

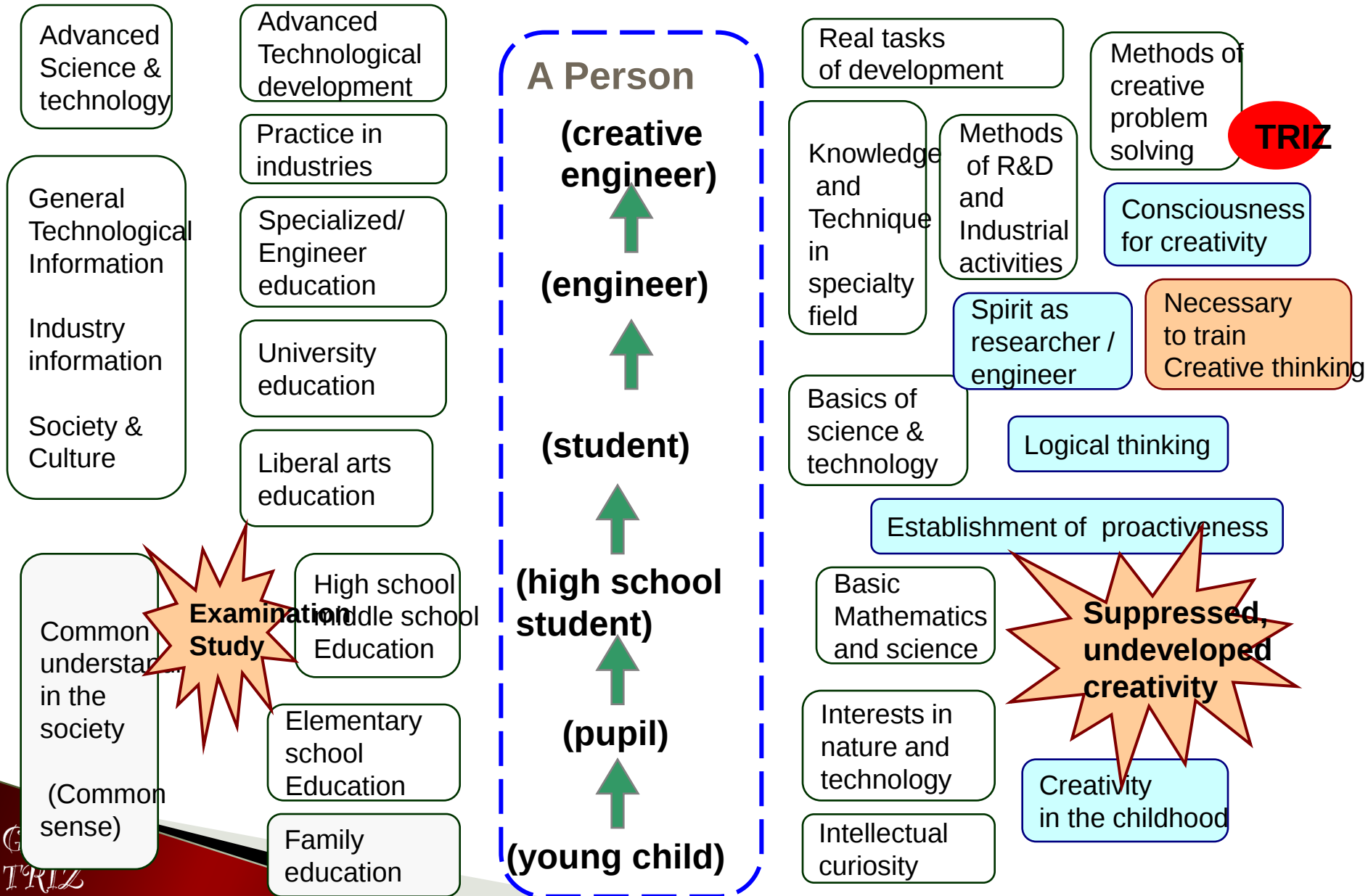
Model of an engineer and an industry to learn and accept TRIZ

Model of activities of TRIZ promoters (in Japan)

Model of areas where the application of TRIZ is desired

==> People in the wide range of application areas of TRIZ want not TRIZ itself but more general methodology effective for creative problem solving

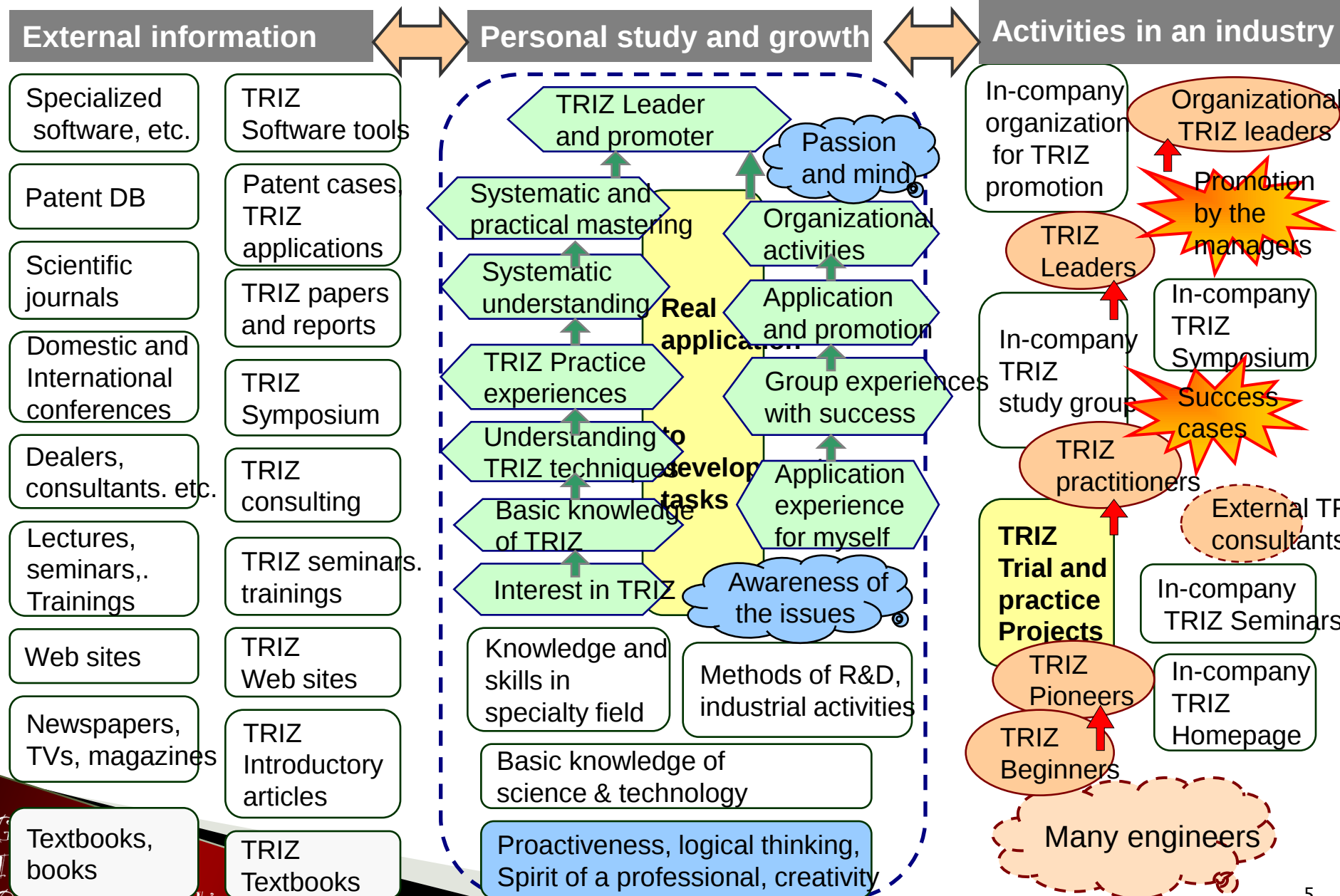
Model (a) of a person to learn and master a technique like TRIZ



Model (b) of activities for an engineer and a company

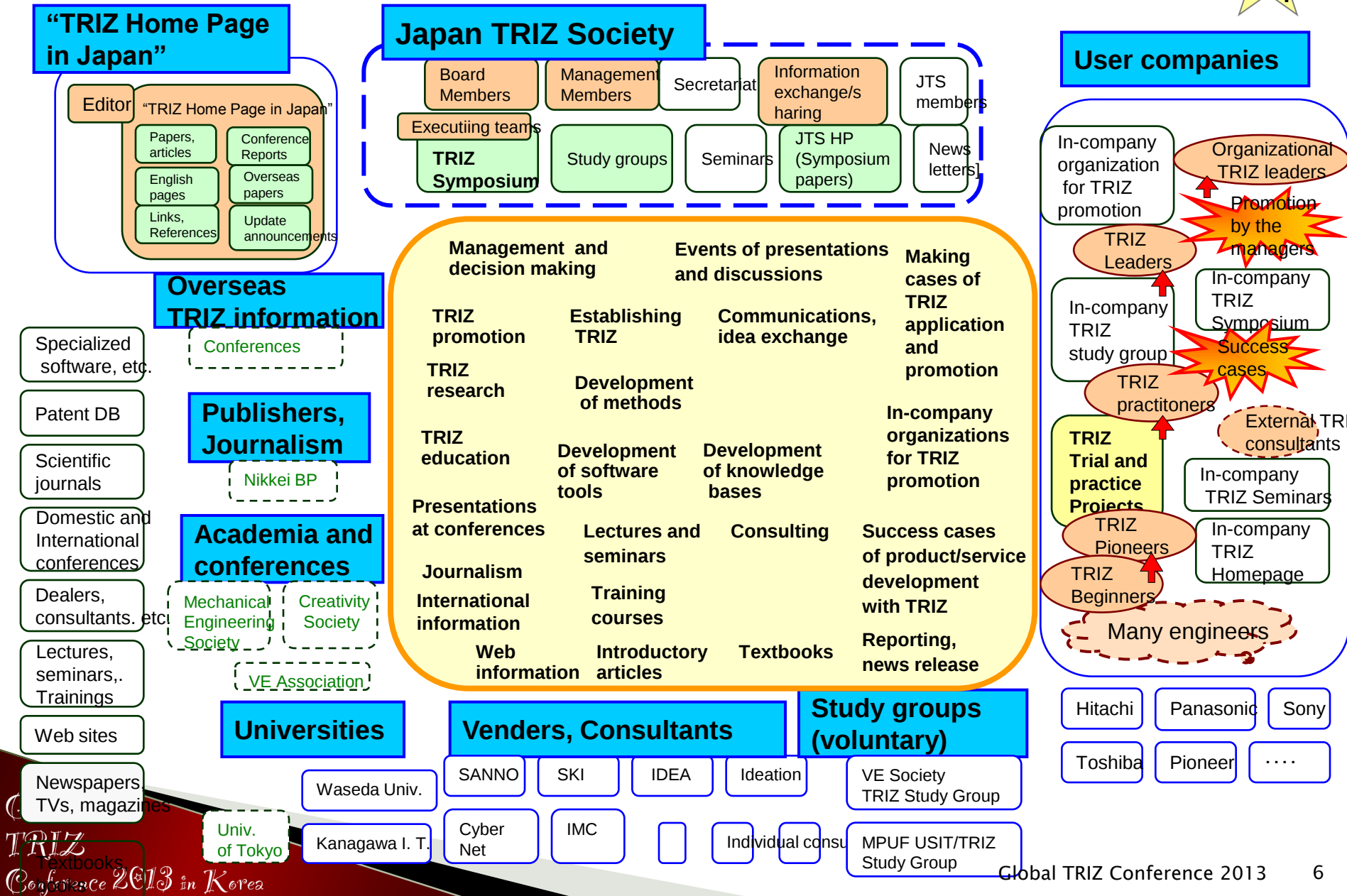
Paper-code

to learn and master TRIZ

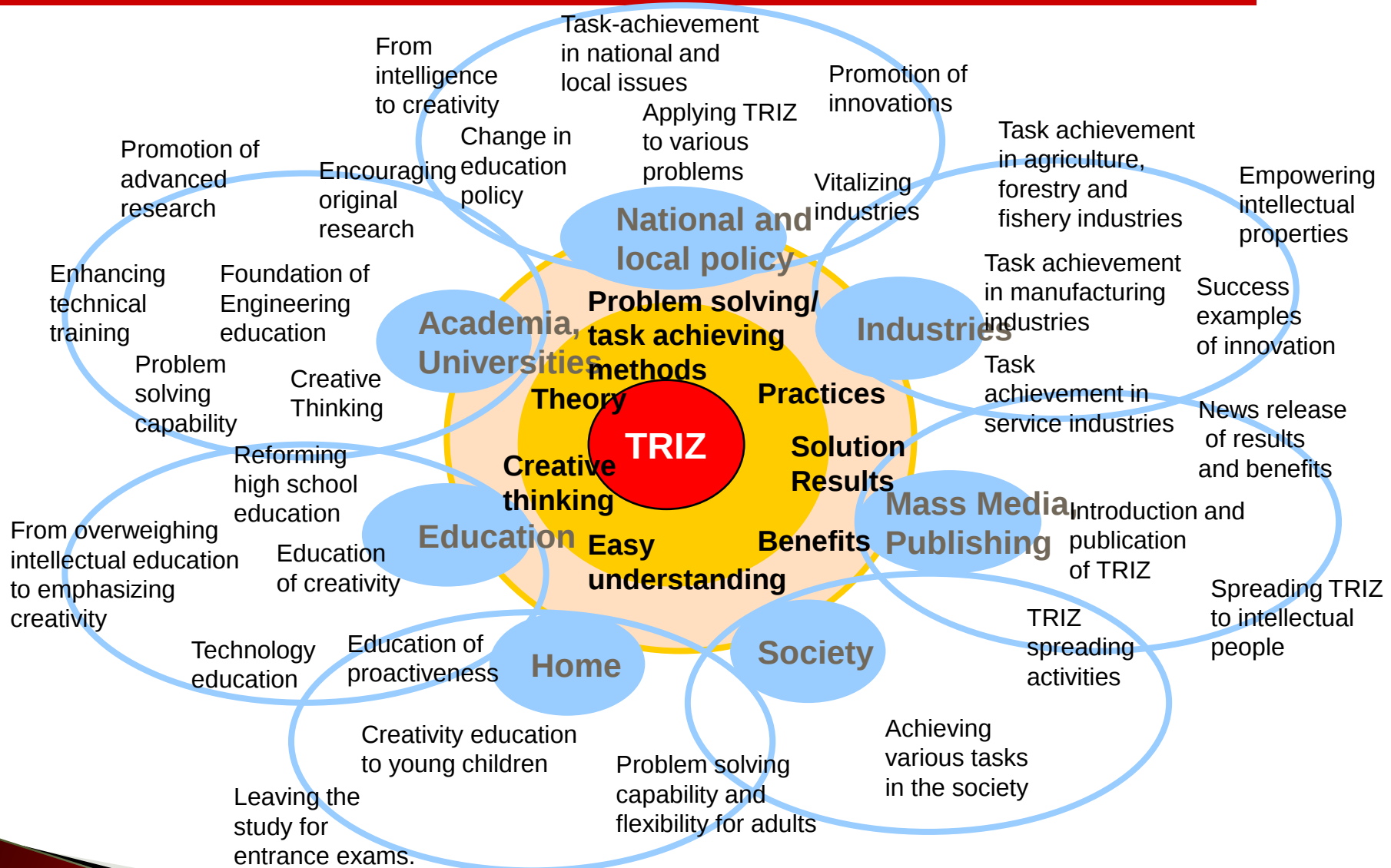




Model (c) of overall activities of TRIZ promoters in Japan (Merged)



Model (d) of areas for TRIZ application → Our new general target



We put TRIZ in the center. But we need a more general method !

The models have guided us to a new target at a higher level.

General Target :

**To establish a general methodology of
creative problem-solving / task-achieving,
to spread it widely, and
to apply it
to problem-solving and task-achieving jobs
in various domains
in the whole country (and the world)".**

Part II. How can we evolve from TRIZ to the new target?

Various approaches to creative problem solving

Basic paradigm in science and technology:
Four-Box Scheme of abstraction



TRIZ -- Knowledge bases and techniques across
the fields



USIT (Unified Structured Inventive Thinking)
-- Unified concepts and Six-Box Scheme



General methodology for creative problem solving

Various conventional approaches/methods for Creative Problem Solving & Task Achieving:

- (a) **Basic approach in science & technology:** Principles, theories, application & design methods in each discipline.
- (b) **Approaches learning from cases:** Building and using case bases and knowledge bases
- (c) **Approaches to analyze the problems and tasks:** Cause-effect, system, mechanism,
- (d) **Approaches to support idea generation:** generating as widely and as freely as possible,
- (e) **Approaches to arrange environment and take care of mental aspects:** relaxed feeling, free atmosphere, thinking the ideals, etc.
- (f) **Approaches for realizing the idea:** Selecting good ideas, designing & development, implementation, etc.: technologies in the discipline.
- (g) **Approaches for thinking the future and suggesting the directions:**
- (h) Approaches towards general methodologies for problem solving:**

Integrating all the approaches above to build a methodology useful and practical.
A system of methods suitable for each type/field of problems and tasks, and also
a system of methods universally applicable to a wide range of types and fields.

TRIZ Methodology for Problem Solving



Toru Nakagawa
Nov. 1997



"TRIZ Home Page
in Japan"
Since Nov. 1998
Editor: T. Nakagawa

**World of
Information
in Science &
Technology**

Science & Technology DB

Patents DB

Set ups → Effects

Problem → Solution

**World
Extracted
by TRIZ**

Inverse retrieval
of technology

solving contradictions

Trends of
Systems

Target → Method,
Method, ...

Contra- Principles of
diction → Invention

Principles &
Examples
of Invention

Support of
Problem Definition

**World of
Your Own
Problem**

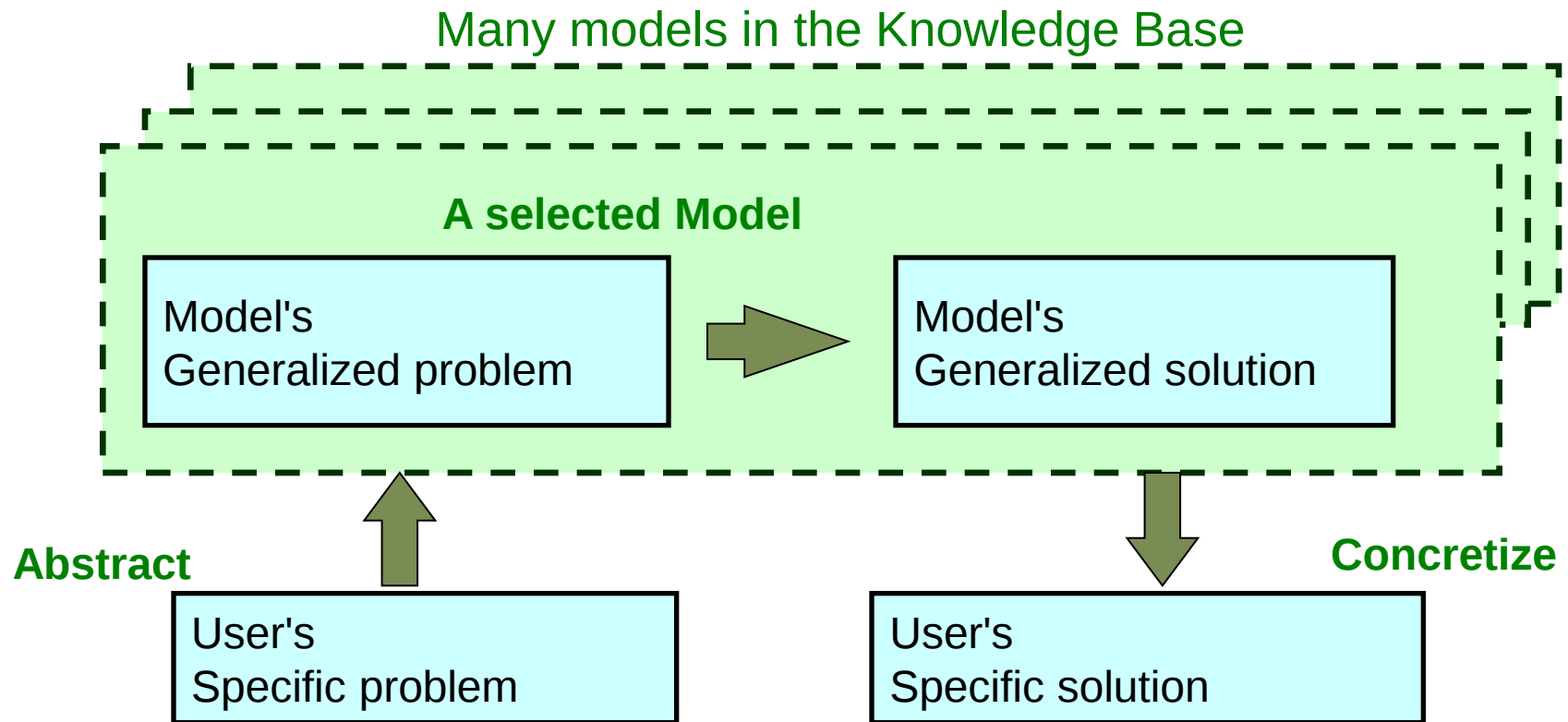
Description of
Your Own Problem

Solution for
Your Own Problem

Basic scheme for Problem Solving (Conventional: "Four-Box Scheme")

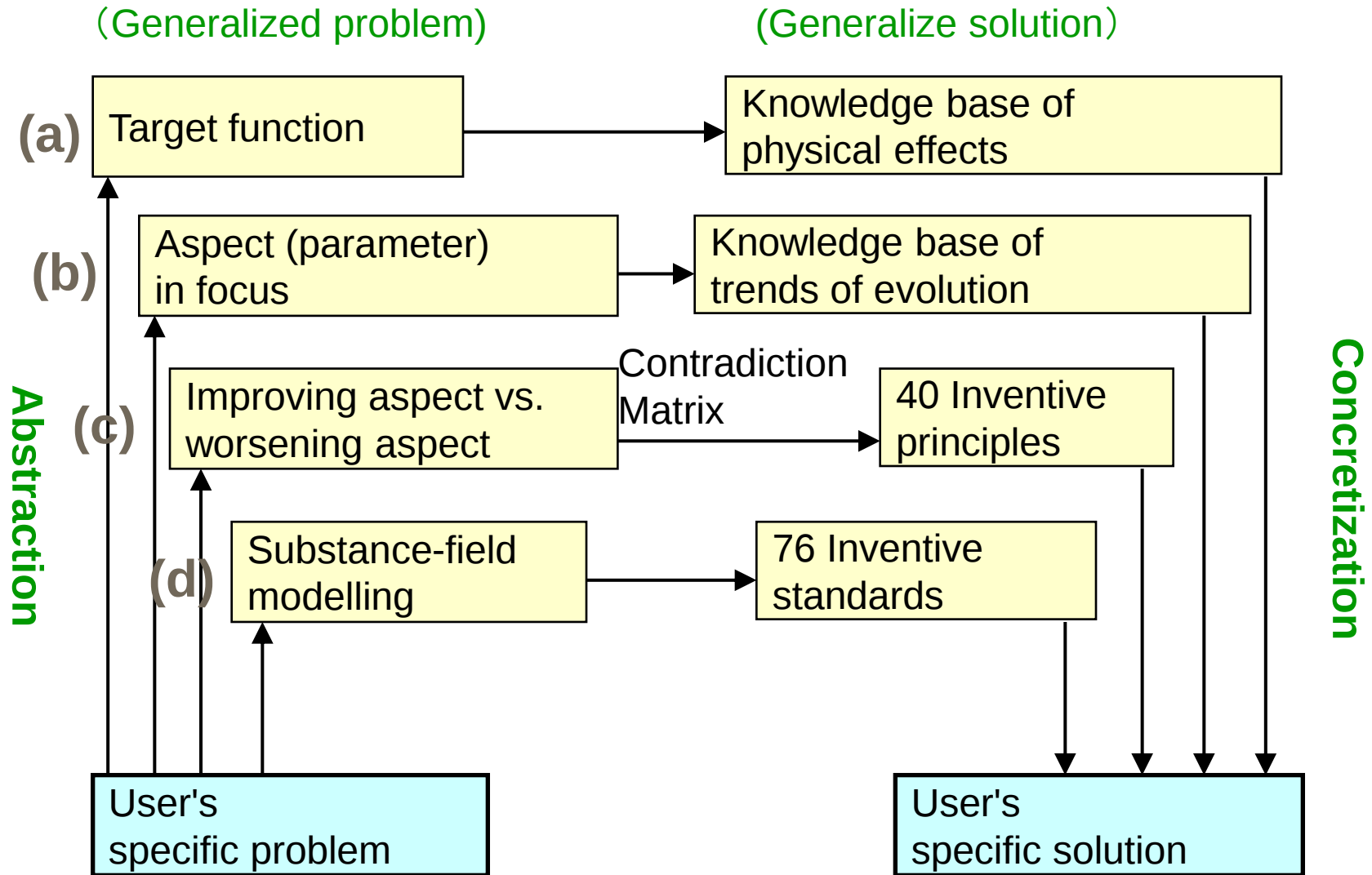
Science & Technologies (Many models, specialized in areas)

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



Problem is analyzed in an aspect and mapped onto a model.
 → Partial and insufficient analysis.

Tools of TRIZ (Based on the Four-Box Scheme)



Essence: Many tools and huge knowledge bases are applicable across technical fields.
But parallel structure of multiple tools = partialness in each method

Essence of TRIZ in 50 Words

Toru Nakagawa

TRIZCON2001, Mar. 25-27, 2001



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.



TRIZ is huge and complex, people often say, but
its essence is easy to learn and understand.

USIT (Unified Structured Inventive Thinking):

Developed by Ed Sickafus (USA) in 1995 under the influence of TRIZ.

It has a straightforward process with unified concepts and methods.

Problem Definition

Define the Problem
(in a Well-defined Form)

Problem Analysis

Analysis of the Present System
(Function and Attribute Analysis)
(Space and Time Characteristics Analysis)

Make Images of Ideal System
(Particles Method)
(Desirable Actions and Properties)

Solution Generation

Generate Ideas for solutions
(5 solution methods)

Build Up Conceptual Solutions

(After USIT)

(Implement into Real Solutions)

"USIT Operators": A system of solution generation methods

-- Obtained by re-organizing all the solution methods in TRIZ

T. Nakagawa, H. Kosha, and Y. Mihara (ETRIA 2002)

TRIZ methods for
Solution Generation

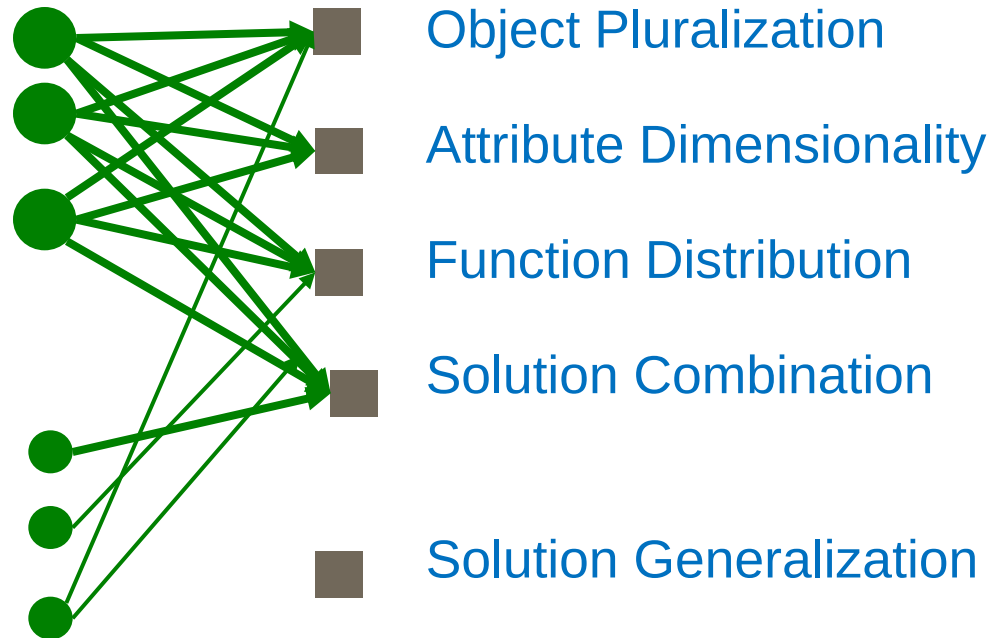
40 Inventive Principles
76 Inventive Standards
35 Trends of
System Evolution

Separation Principle
Self-X Principle
Trimming



USIT Operators

(5 Main-, 32 sub-methods)



USIT Operators are further classified in a hierarchical way.

An example of USIT Operator sub-method

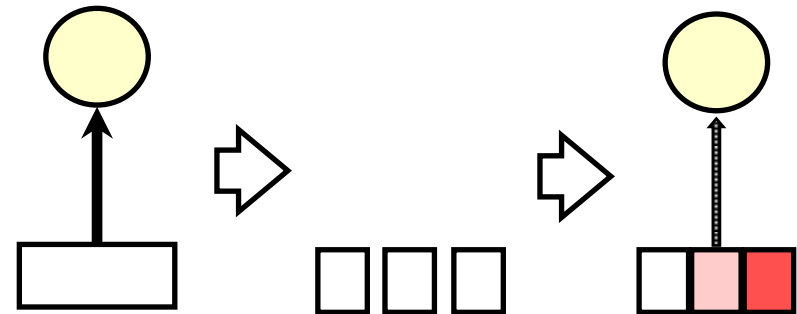
(1) Object Pluralization Method

(1c) Divide the Object (into $1/2$, $1/3$, ..., $1/\square$).

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

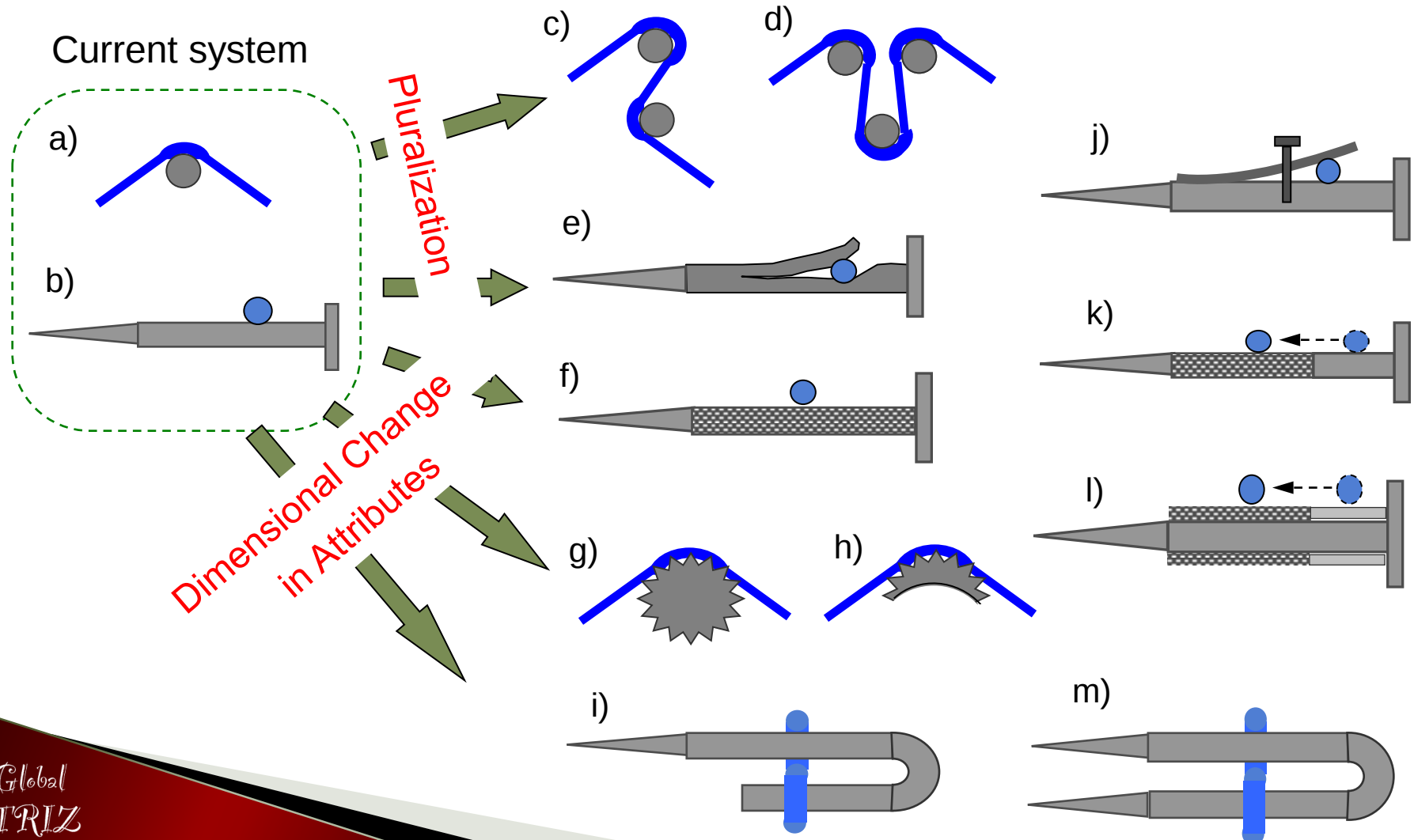
TRIZ Inventive Principles
which brought this sub-method:

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



Examples of Application of USIT Operators: (Part)

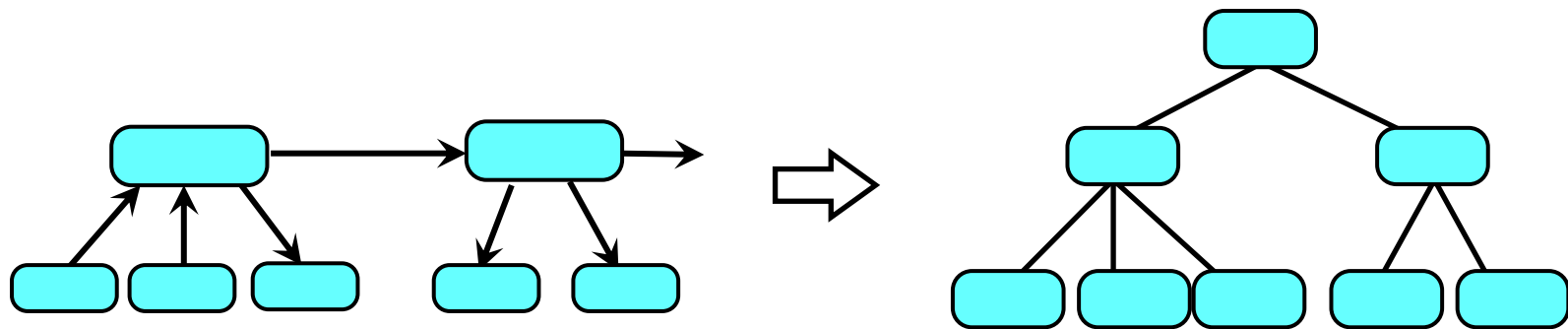
Picture Hanging Kit Problem. USIT Operators are applied to the nail.



(5) Solution Generalization Method in USIT

Represent a solution in a more general way,
form a solution template, and
obtain concepts of solutions
in the associative manner.

Also generate a hierarchical system of solutions.



USIT (i.e., a simple and unified TRIZ)
analyzes any problem in a standard process and
generates solutions systematically and comprehensively.

USIT Example: Solving Familiar Problems:

T. Shimoda and T. Nakagawa (2006)

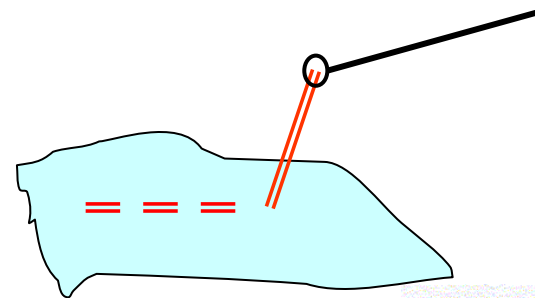


How to fix a string shorter than the needle at the end of sewing

Problem Definition:

- (a) **Undesirable effect:** The string is shorter than the needle and prohibit applying the standard way of making a knot.
- (b) **Task statement:** Devise methods for fixing the string left shorter than the needle.

(c) Sketch:

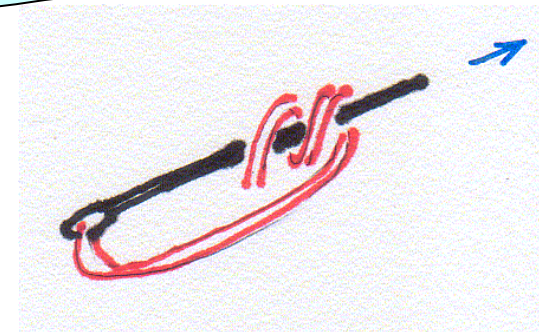


(d) Plausible root causes:

The standard way of making a knot is applicable only when the string left is longer than the needle.

(e) Minimum set of relevant objects:

Cloths, string (already sewn), string (left), the needle



Problem Analysis (1): Understanding the present system



(1) Functional analysis: What is the function of the Needle?

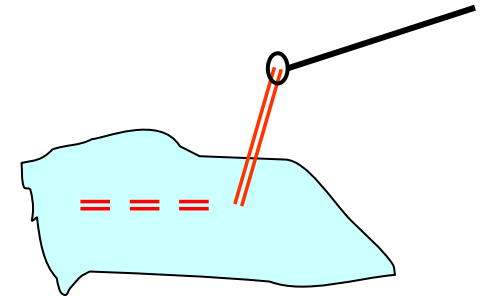
A base for making a loop of the string;

A guide for passing the end of the string through the loop

(2) Attribute analysis: Properties taken for granted form the Constraints:

The string does not expand = Its length does not change.

The needle is hard = No change in shape and length.



When any of these constraints is lifted,
there appears a novel solution.

(3) Analysis of time characteristics: Processes of sewing:

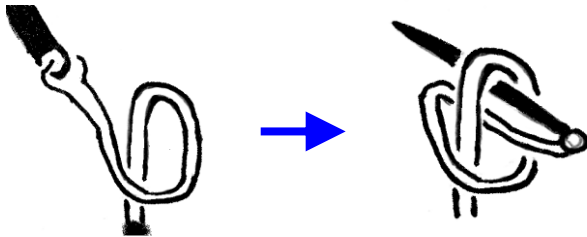
Solutions at the final stage and solutions at any earlier stage.

(4) Analysis of space characteristics: A knot makes the string thick at the end.

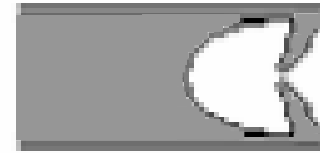
Watch out about the topology in making a knot and in the 'hole and string'.



Several known solutions:



A well-known technique.
Difficult to make the loop
of string in the space;
need some practices



The hole of the needle has a slit,
thus the string can be passed and
removed without cutting the loop of
the string. (a commercial product)

Problem Analysis (2) : Understanding the Ideal system

Ideal arrangement of a sting in space
for making a knot

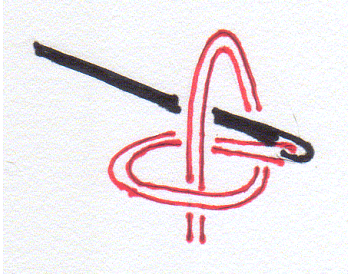


It should be nice if we could hold
the string in this arrangement
in the space.

Solution Generation: Generate Ideas and Construct Solutions



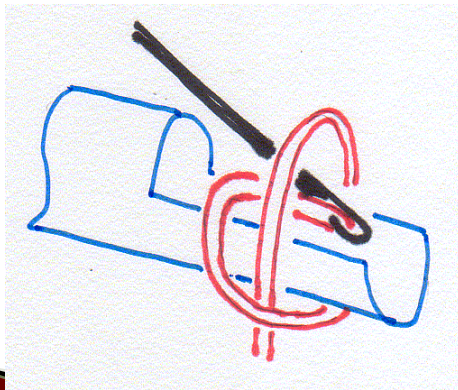
A ridiculous idea : 'Break the needle!!'



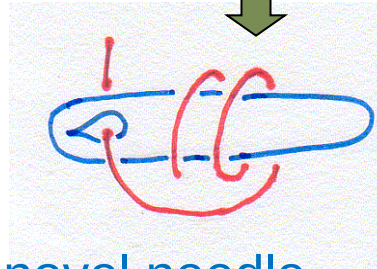
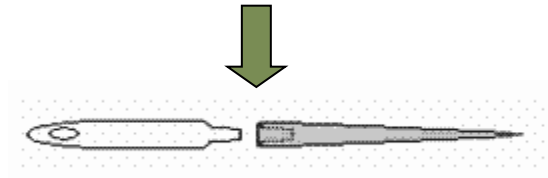
Known technique



Image of
Ideal situation

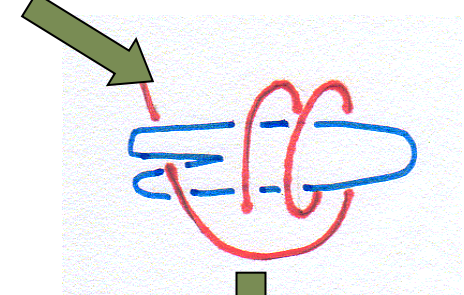


A novel tool
made of a straw

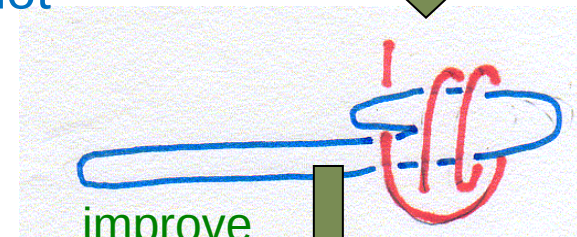


A novel needle
specialized for
making a knot

improve



improve



improve



USIT Training: In-company and open trainings



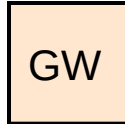
- USIT is much easier to learn than (conventional) TRIZ.
- USIT fits well for group work.
- USIT is applicable to real problems for conceptual solutions.
- Use TRIZ knowledge base tools in a complementary way.

2-Day USIT Training Seminar

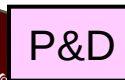
3 real, brought-in problems
are solved in parallel
in the group work



Lecture



Group work



Presentation
& Discussion

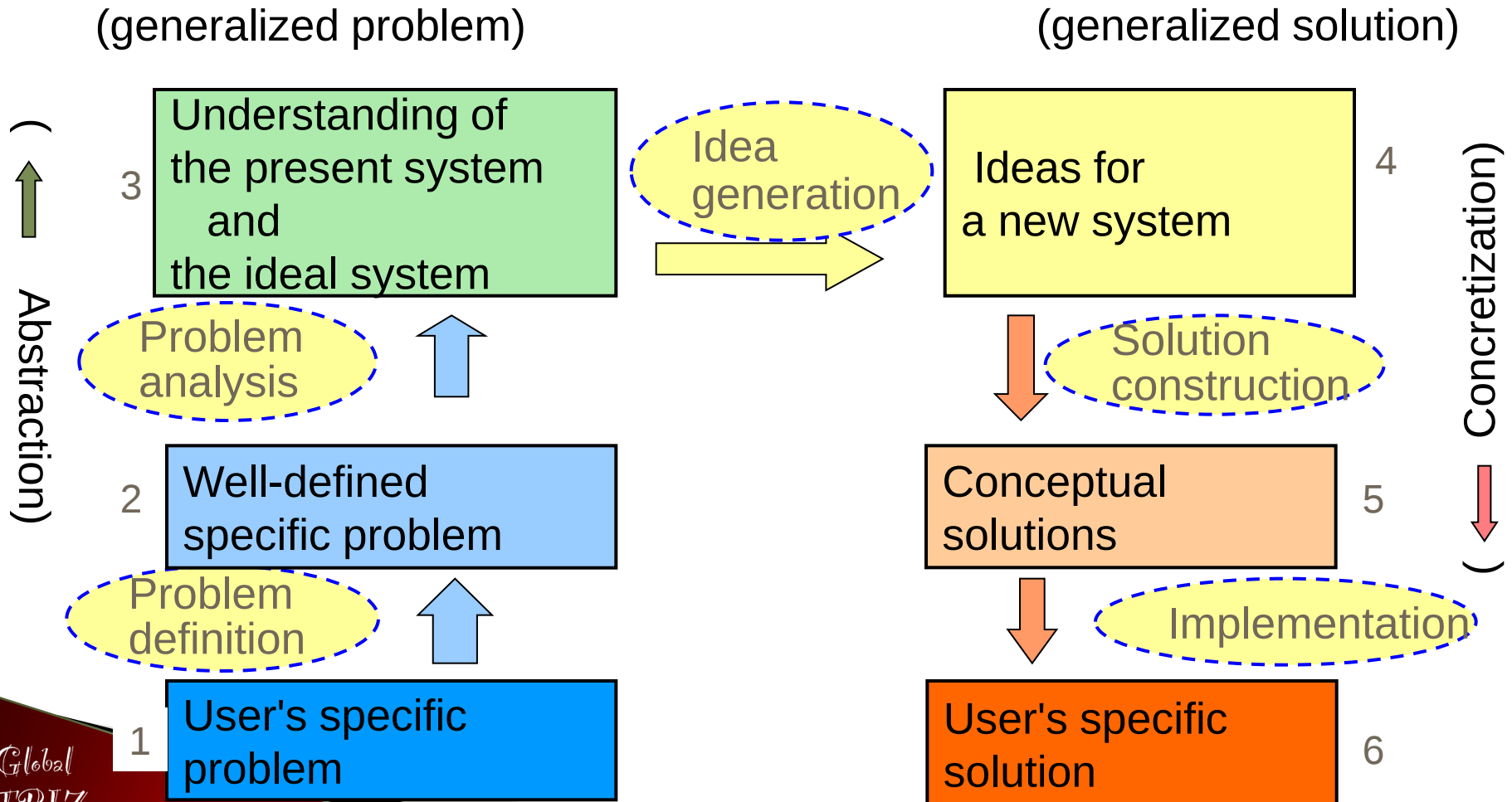
Introduction to TRIZ/USIT	L
Problem Definition	P&D
	L
	GW
	P&D
Analysis of Present System	L
	GW
	P&D

Analysis of Ideal System	L
	GW
	P&D
Solution Generation	L
	GW
	P&D
	GW
	P&D
Promotion in Industries	L
	D

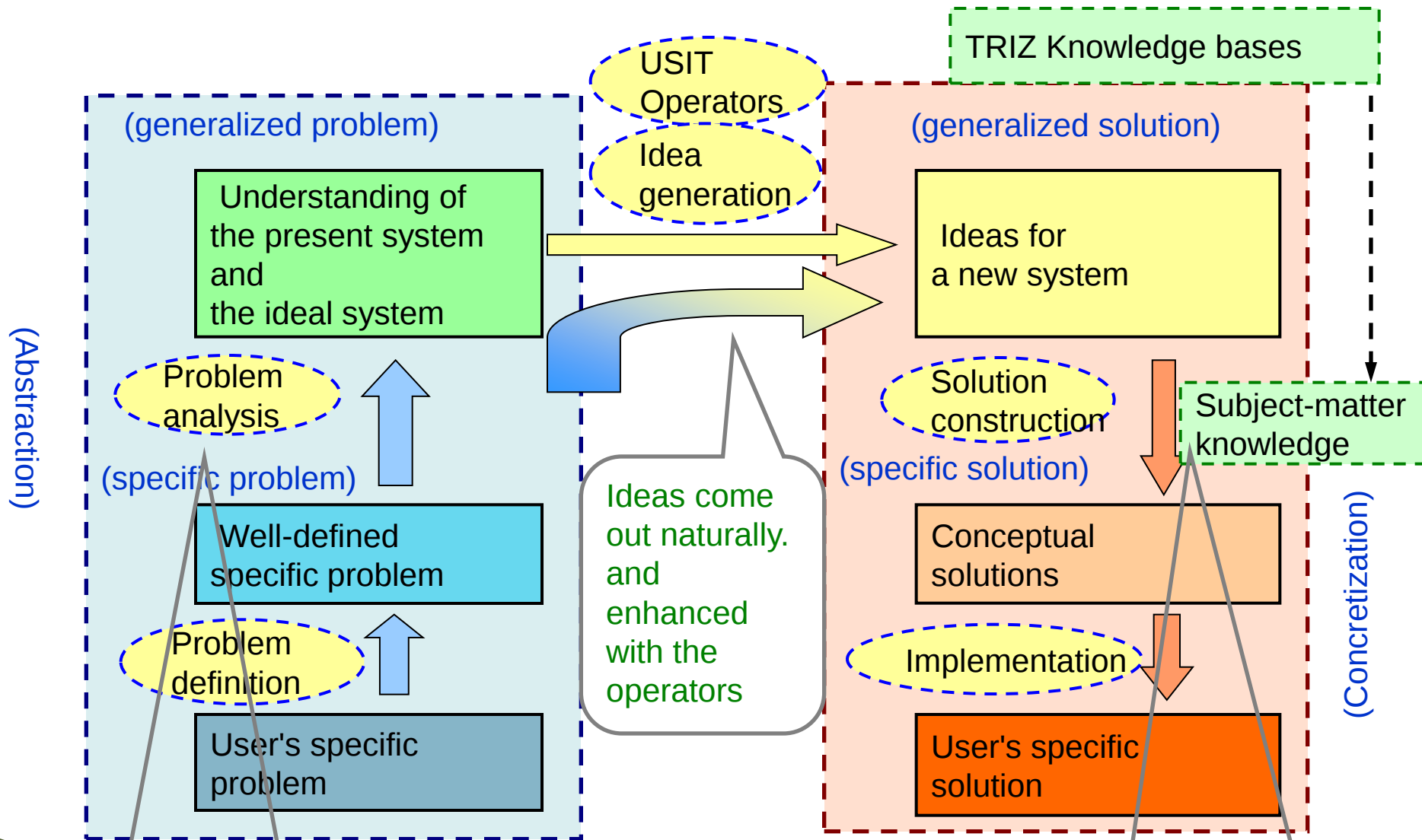
Six-Box Scheme of USIT: Toru Nakagawa (2005)

New Paradigm for Creative Problem Solving

A unified method across the fields



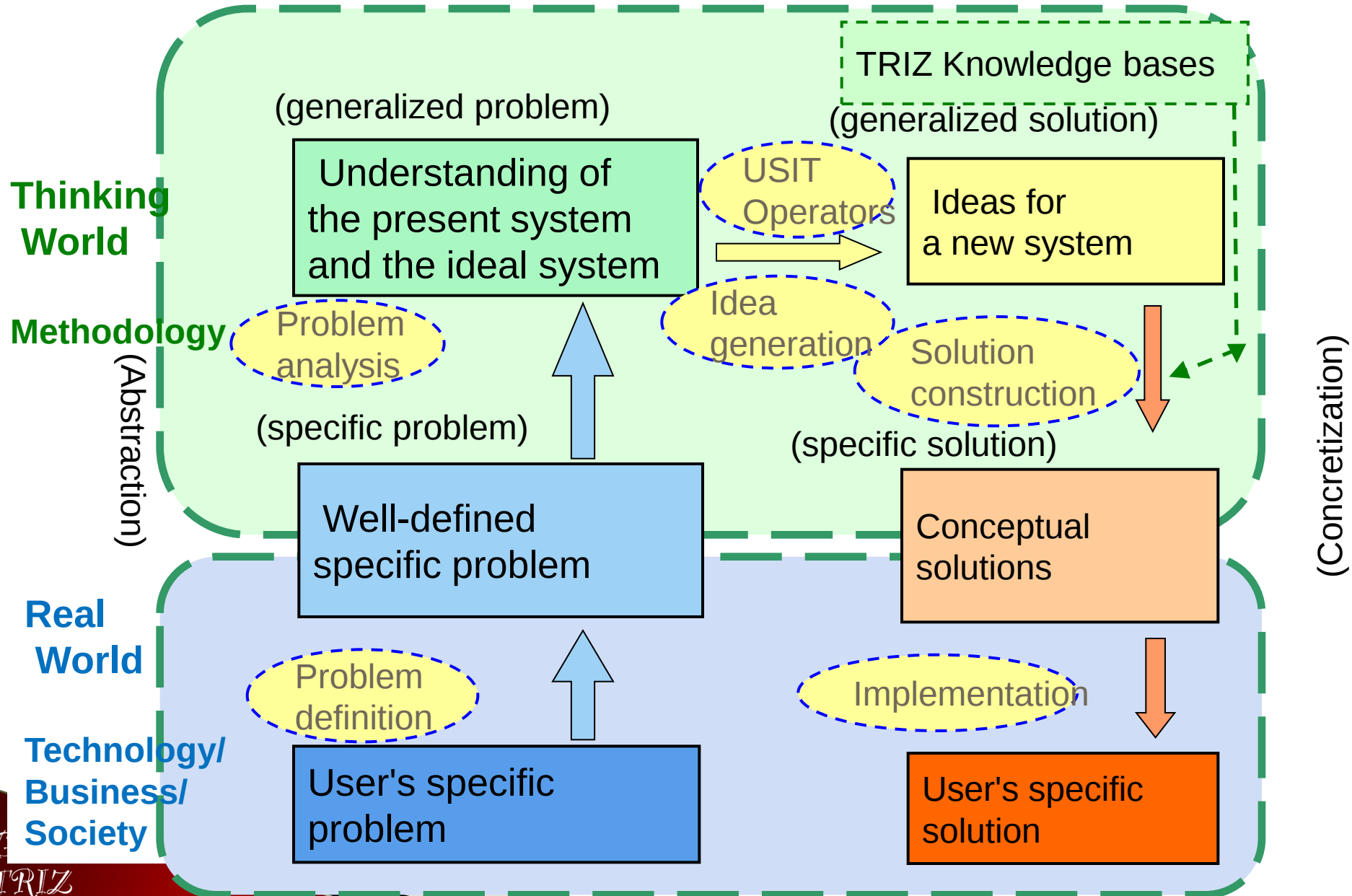
6-Box Scheme of Creative Problem Solving (USIT)



Use standard analysis tools in USIT, for a wide variety of problems

Use technological background and specialty. TRIZ Knowledge bases are also useful.

6-Box Scheme of Creative Problem Solving (USIT)



General Methodology of Creative Problem-Solving (Outline)

For technological problems

- (0) Whole procedure
- (1) Finding the problem
- (2) Understanding the present system
- (3) Imaging the ideals
- (4) Generating ideas
- (5) Constructing solutions

For non-technological problems

- (0) Whole procedure
- (1) Finding the problem
- (2) Understanding the present system
- (3) Imaging the ideals & visions
- (4) Generating ideas
- (5) Constructing solutions

Further extension of TRIZ

guided by the new paradigm of the 6-Box Scheme (of USIT)

General method for creative problem-solving/task-achieving (for technology)

Whole procedure

Consistent whole procedure

Simple/specialized processes

Finding the problem

Understanding the problem systematically

Consider the goals and tasks

Consider from broad perspectives

Focusing the problem

Understanding the present system

understanding difficulties and root causes

Understanding the mechanism of the present system

Functions & attributes

space & time characteristics

Clarifying contradictions

Examine various present solutions

Learn similar tasks in different fields

Imaging the ideals

Thinking the images of the ideals

Desirable behaviors & properties

Consider the direction of evolution

Generating ideas

Techniques of idea generation

Collection of possible hints

Resolve contradictions

Generate ideas as widely as possible

Identifying excellent ideas

Constructing solutions

Extending the ideas

Improving solutions with the ideas

Designing new solutions

Introducing good ideas used in different fields

Solving secondary problems

Identifying and evaluating excellent solutions

General method for creative problem-solving/task-achieving (for technology)

Requirements at the preceding stage

Applicable widely to science & technology

Mechanical,
electrical/electronic,
chemical, etc.

biological,
medical, etc.

Using effectively the whole information in science & technology

Implementing the S & T information in the method.

Effectively using patent information

Possible to use concepts, theories, and methods in the subject-matter fields.

Use the method of system analysis in the subject-matter field.

Clear relationships with methods for technology development

Able to find and understand the problem in the real world

Able to focus down the problem and clarify the task.

Able to refer to S & T information whenever necessary

Whole procedure

Finding the problem

Understanding the present system

Imaging the ideals

Generating ideas

Constructing solutions

Introductory articles & materials

Textbooks of the methods

Application examples

Software tools & knowledge bases

Easy-to-understand methods.

Practical application methods

Chances to learn

Chances of training

Requirements at the succeeding stage

Able to construct solutions

Able to use designing techniques in the subject-matter field

Able to implement the solutions

Coordinated with methods for implementing solutions (CAD/CAE/CAM, Taguchi method, etc...)

Able to evaluate the solutions in the real world

Coordinated with industrial and company infrastructure, e.g., designing, manufacturing, and sales

General method for creative problem-solving/task-achieving (for non-technology fields) (e.g., humans, society, business)

Whole procedure

Consistent whole procedure

Simple/specialized processes

Finding the problem

Understanding the problem systematically

Consider the goals, tasks, **and visions**

From **multiple** perspectives

Focus the problem

Consider in steps

Understanding the present system

understanding difficulties and root causes

Understanding the mechanism of the present system

Functions & properties **of organizations & persons**

space & time characteristics

Clarifying contradictions

Examine **preceding cases**

Learn similar tasks in different **countries, companies,** and fields

Imaging ideals & visions

Thinking the images of ideals

Stating the vision

Consider the directions **& steps** of evolution

Generating ideas

Techniques of idea generation

Collection of possible hints

Resolve **conflicts & contradictions**

List up the ideas as widely as possible

Identifying excellent ideas

Constructing solutions

Extending the ideas

Improving solutions with the ideas

Designing new solutions

Introducing good ideas in different **countries and** fields

Solving secondary problems

Identifying and evaluating excellent solutions

Areas where our 'Creative Problem Solving Methods' are wanted.



Stage 3 in our general target: To apply widely

Emphasis
area



Development
area

**Creative
PS / TA
methods**

Problem solving,
task achieving
methods

Theory

Creative
thinking

Easy,
understanding

Practices

Solution
Results

Benefits

(various areas of problems/tasks to apply)

Academia,
Universities

Creative
Thinking

Problem
solving
capability

Foundation of
Engineering
education

Enhancing
technical
training

Encouraging
original
research

Promotion of
advanced
research

Education

Education
of creativity

Technology
education

Reforming
high school
education

From overweighing
intellectual education
to emphasizing creativity

Home

Education of
proactiveness

Creativity education
to young children

Leaving the study for
entrance exams.

Society

Problem solving
capability and
flexibility for adults

**Achieving
various tasks
in the society**

Mass media,
Publishing

Introduction
& publication
of CrePS

**CrePS
spreading
activities**

Spreading CrePS
to intellectual
people

News release
of results
and benefits

Industries

Task achievement
in manufacturing
industries

Empowering
intellectual
properties

**in agriculture,
forestry and
fishery industries**

**in service
industries**

Success
examples
of innovation

National &
local policy

Change in
education
policy

From
intelligence
to creativity

**Applying CrePS
to various
problems**

Task
achievement
in national and
local issues

Vitalizing
industries

Promotion of
innovations

Note: Actually, we should find and get specific opportunities to try and apply the Creative PS/TA methods. Development of the method and extension of application area should be carried out in parallel. .

Concluding Remarks

- (1) For understanding the difficulty in penetrating TRIZ widely, the situations have been investigated by building **multiple models**.
- (2) Recognizing '**TRIZ is just one of many items** for a person to study', the contents of TRIZ should be either
well customized for the (narrow range of) target persons
or **well generalized** for the (wider range of) target persons.
- (3) Individual persons can learn TRIZ from outside information and promotion, but **mainly from his/her personal learning and experiences**.
- (4) For an industry to accept TRIZ, personal growth of TRIZ practitioners/ leaders, application of TRIZ to real projects, and promotion by the management need to go together.
- (5) TRIZ is applicable in the technological as well as non-technological areas. Thus TRIZ has a very wide range of application areas.
However, **not TRIZ itself but a more general methodology is wanted**.
Thus we have been guided to a new target at a higher level.

- (6) **'General methodology of creative problem solving'** is expected to be a further extension of TRIZ, especially guided by the Six-Box Scheme (of USIT).
- (7) In the technology fields,
it is under construction with TRIZ/USIT in its framework and components.
Various methods and processes need to be associated and integrated.

Significance of the vision need to be understood widely.
Effective in technological innovation and creative research & education.

- (8) In the non-technology fields,
it is similar to the one in technology in its framework and basic tools.

However, problems are often bigger, more complex, and delicate.
Mental aspects of stakeholders have bigger weight than tools.
Various methods **need to be developed more clearly.**

- (9) Realizing the higher level target, we will be able **to choose correct directions** in our application, development, and promotion activities.



Thank you for your attention

Toru Nakagawa
(Osaka Gakuin University, Japan)
nakagawa@ogu.ac.jp

"TRIZ Home Page in Japan"
<http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/> (English)