11th TRIZ Symposium in Japan 2015
September 3 - 4, 2015
National Olympics Memorial Youth Center (NYC), Tokyo

USIT Case Studies in the Six-Box Scheme:

– Understanding Various Examples of Creative Problem Solving in the New Paradigm –

September 3, 2015

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CrePS Institute)

Introduction: Outline of the Talk

A. Recent Development of Methodologies of Creative Problem Solving

(1) Current conventional stage:
Science & Technology + Various 'Creativity Methods'
- Constructing theories and models in specific disciplines (in 'Four-Box Scheme')

(2) Contributions of TRIZ - Building and utilizing knowledge bases of S&T across the fields

(3) Contributions of USIT
- A concise whole process; integration of various TRIZ methods, 'Six-Box Scheme'

(4) CrePS ('General Methodology of Creative Problem Solving and Task Achieving')
- Unifying various methods (TRIZ and others) in the paradigm of 'Six-Box Scheme';
USIT is a concise whole process of CrePS

B. Publicizing USIT Manual and A Collection of USIT Case Studies

(5) USIT Manual

(6) A Collection of USIT Case Studies:
Ex. Case Study 10: A Large Variety of Writing Instruments

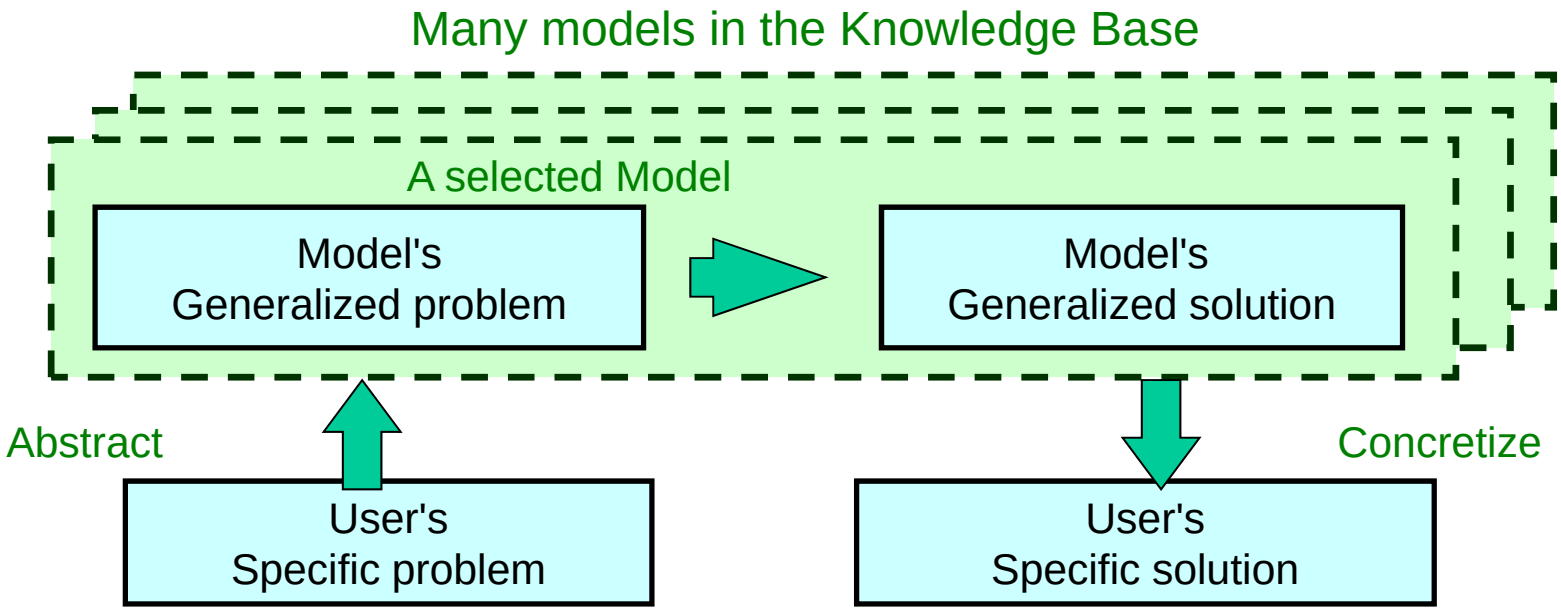
Concluding Remarks

A. Recent Development of Methodologies of Creative Problem Solving

(1) Current conventional stage:
Science & Technology + Various 'Creativity Methods'

Conventional Paradigm = Four-Box Scheme of abstraction

Many models in different specific fields



Contents of the Boxes depend on the models/fields; hence no general way to explain them.

Fit the problem to the model patterns, and use the outputs as hints for solutions.

==> (Enforced) analogical thinking

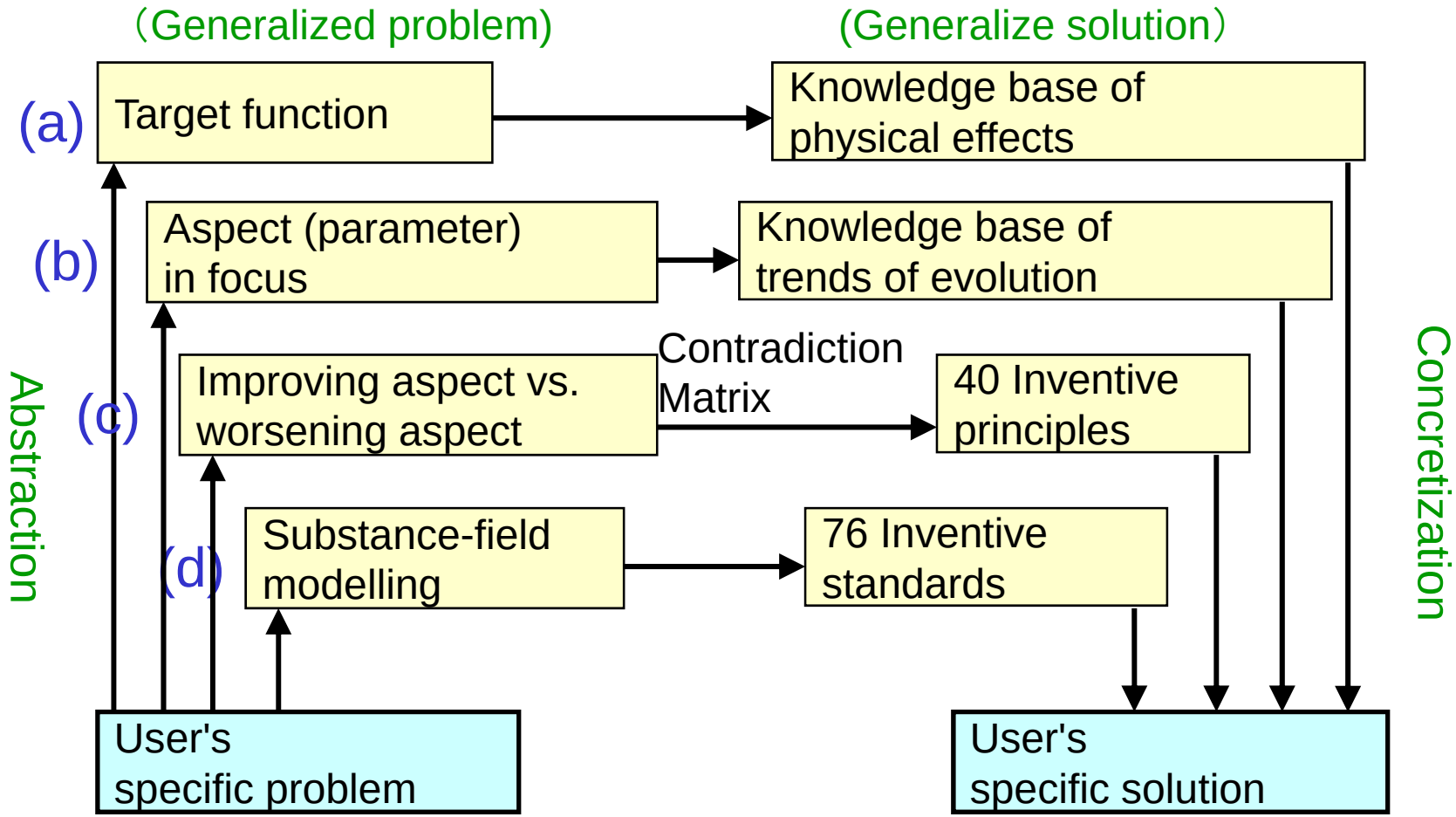
Various methods for creative problem solving & task achieving

Skip

Approaches	Examples in conventional methods	Examples in TRIZ/USIT
Basics in Science & Technology	Principles, theories & models in each discipline; knowledge bases	Knowledge bases of physical effects
Learning from cases	Analogical thinking, Collections of hints, Equivalent transformation thinking	Active use of patent databases
Analyzing problems/ tasks	Mind mapping, KJ method (Affinity method), Quality function deployment (QFD), QC tools, Root cause analysis, Value engineering (VE), Functional analysis	Problem definition, Root cause analysis, Function & attribute analysis, Formulating contradictions, Substance-field modeling
Supporting idea generation	Brain storming, Brain writing, SCAMPER	40 Inventive Principles, 76 Inventive standards, Contradiction matrix, USIT operators
Taking care of environment and mental aspects	Brain storming, Facilitation methods, Cynectics, NM method, 'The 3rd alternatives'	Size-Time-Cost (STC) operators, Smart little people (SLP) modeling, Particles method
Realizing the ideas	Design methods in each discipline, Pugh's method, CAD/CAE, Taguchi method	Technical knowledge bases
Foreseeing the future	Using various statistics, Delphi method, Scenario writing	9 Windows method, Trends of technical evolution, S-curve analysis, DE (Directed evolution)
Towards a general methodology	Four -box scheme of abstraction, analogical thinking, ET thinking	Four-box scheme, ARIZ, Six-box scheme of USIT

(2) Contributions of TRIZ

- Building and utilizing knowledge bases of S&T across the fields



Parallel structure of multiple tools based on the Four-Box Scheme

==> Partialness in each method + Complexity in the overall process (e.g., ARIZ)

(3) Contributions of USIT

A concise whole process for creative problem solving

Developed by Ed Sickafus (1985)

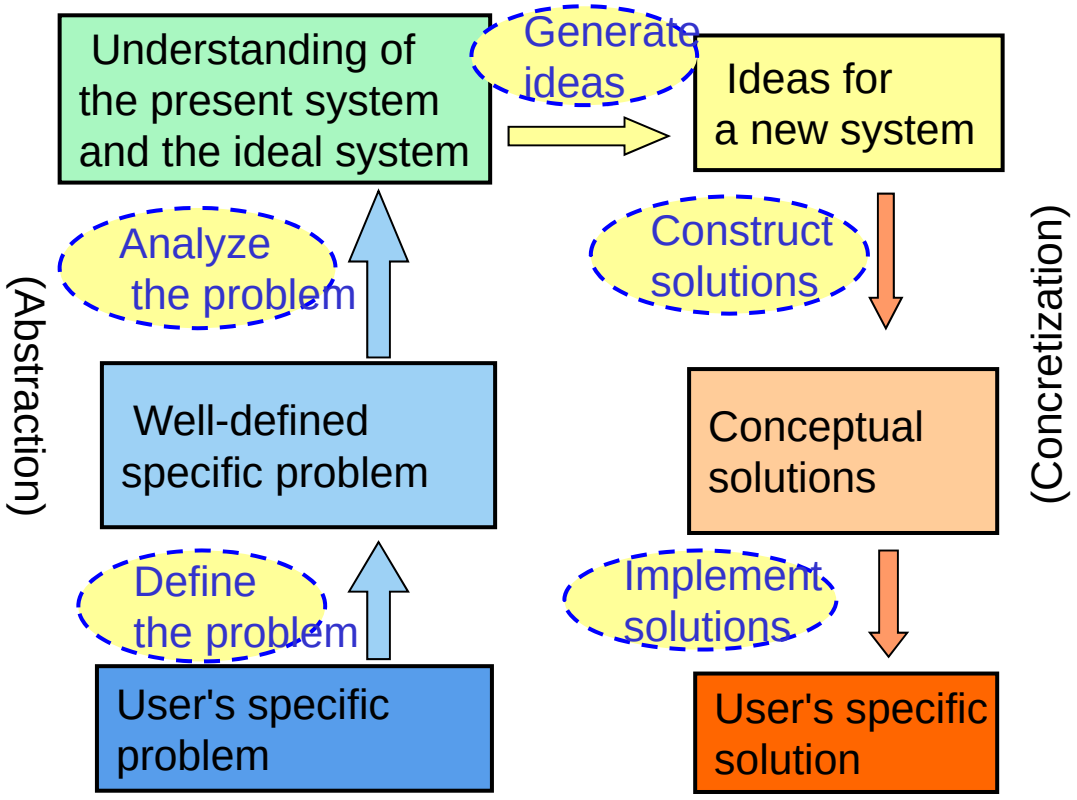
A clear thinking process
of creative problem solving

Note: Our previous understanding 'USIT started in 1995' is a mistake due to the typo in Sickafus' USIT Textbook and his original paper .
(Communication by Sickafus on Jul. 21, 2015)

Further improved in Japan
(Toru Nakagawa et al., 1999 -)

Integrated TRIZ solution generation methods into 'USIT Operators'

Established the 'Six-Box Scheme' as a new paradigm of creative problem solving

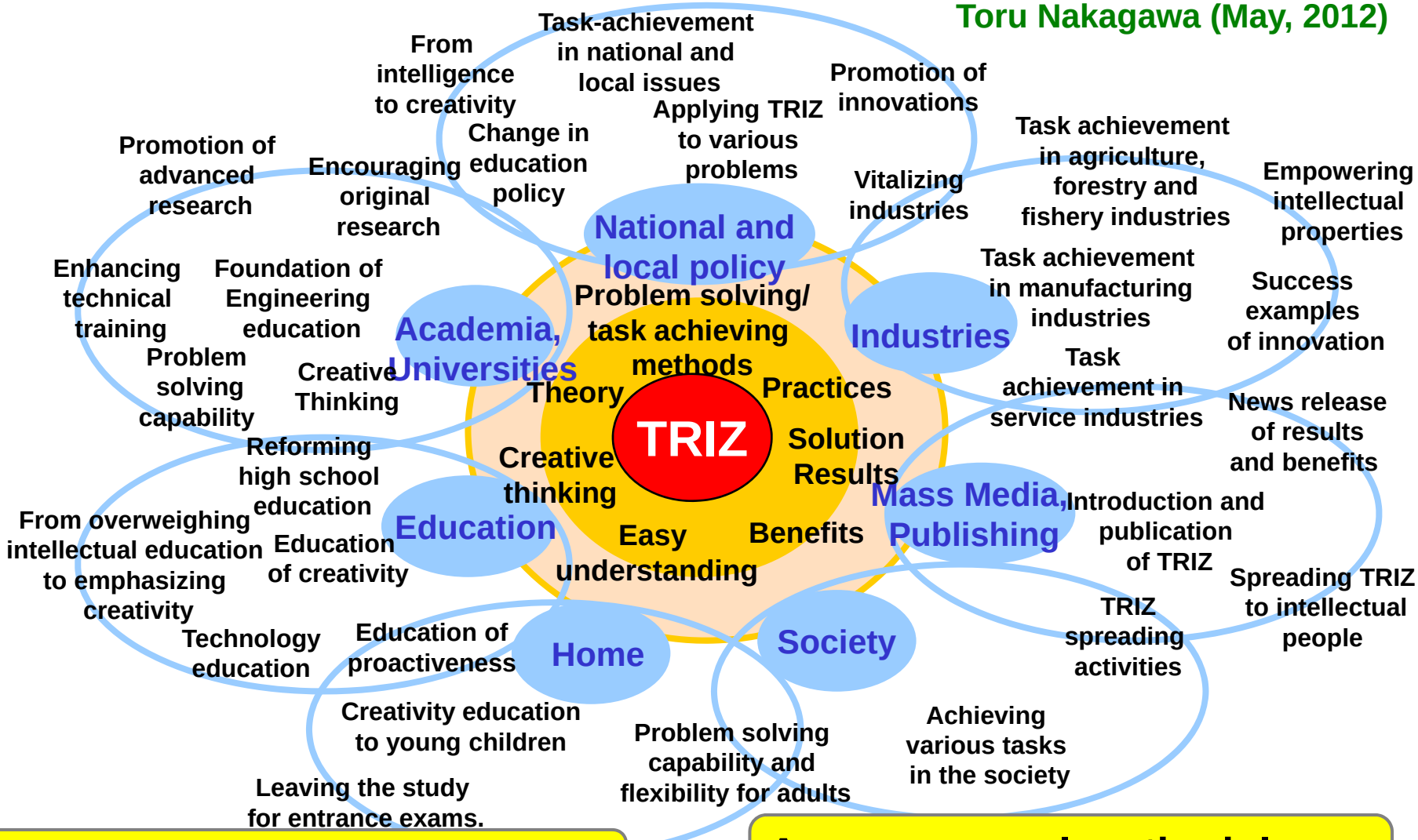


(4) CrePS (General Methodology of Creative Problem Solving)

Skip

Areas where Creative Problem Solving Methods are demanded

Toru Nakagawa (May, 2012)



We put TRIZ in the center first.

A more general methodology is demanded !

Reflection of the present situations on TRIZ has guided us

to a new target at a higher level Beyond TRIZ

(May 2012, Toru Nakagawa)

a new target at a higher level.

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).

The methodology is named as 'CrePS' (April 2013, Toru Nakagawa)

For Establishing CrePS: The present work has revealed so far:

(1) CrePS can be built on the basic paradigm of the Six-Box Scheme.

The Six-Box Scheme shows the basic structure/paradigm of the process. It is also the guiding principle of the methodology.

(2) Various methods including TRIZ can be integrated into CrePS by representing them in the Six-Box Scheme.

(3) USIT is a concise whole process practicing the Six-Box Scheme.

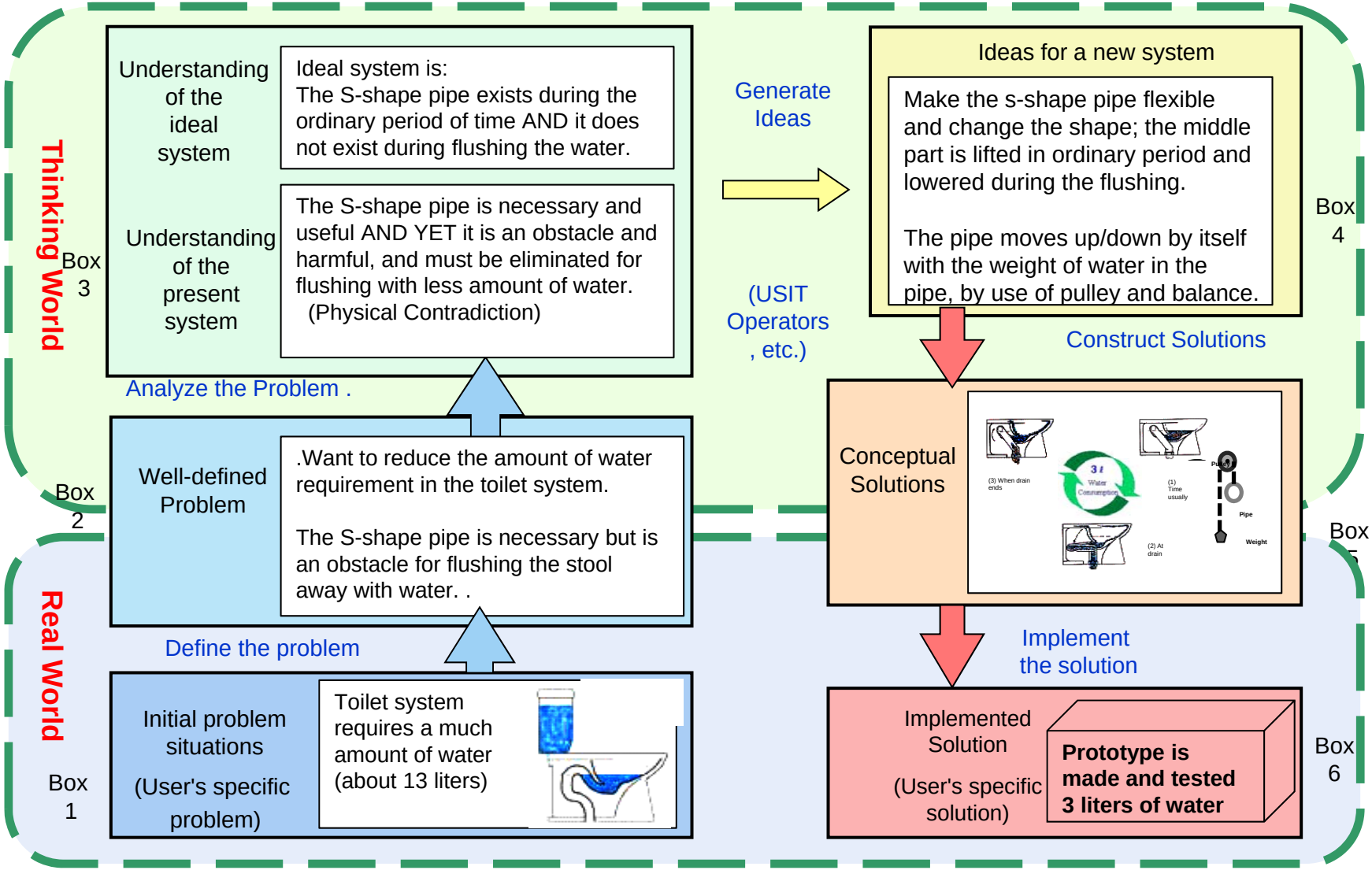
(4) USIT Manual and A Collection of USIT Case Studies have been publicized recently.

(5) Further Tasks: Various activities in the Real World and various methods for handling them need to be understood and incorporated in the CrePS methodology.

USIT Case Study 3 [Toilet] (overview). Saving Water for a Toilet System

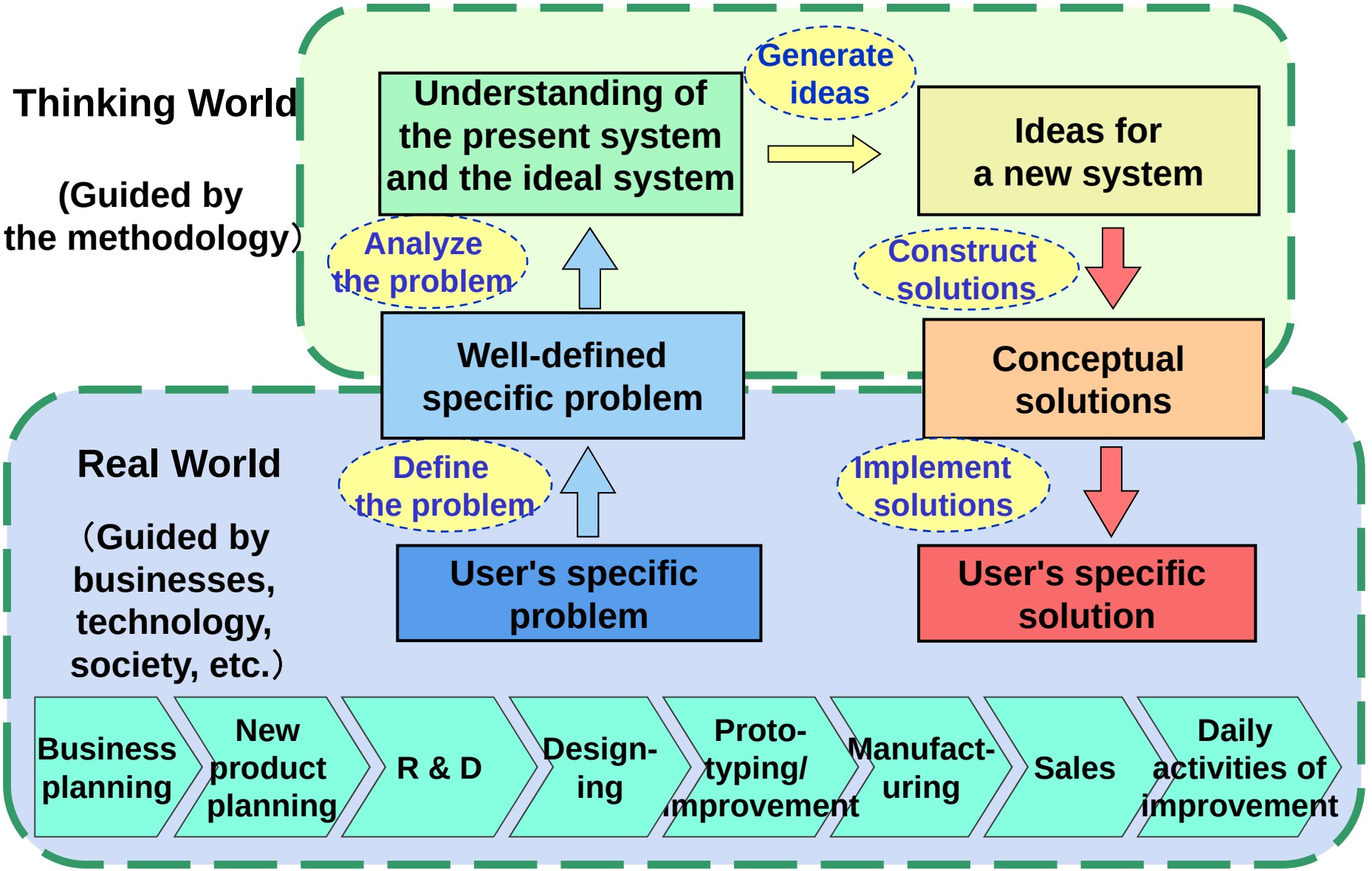
A familiar, important problem was solved nicely with the concept of Physical Contradiction in TRIZ.

H.S.Lee and K.W. Lee (Korea) (2003)



(5) To relate CrePS to various activities in the 'Real world'.

Position of CrePS and its Six-Box Scheme



B. Publicizing USIT Manual and A Collection of USIT Case Studies

(5) USIT Manual

(6) A Collection of USIT Case Studies:

Ex. Case Study 10:

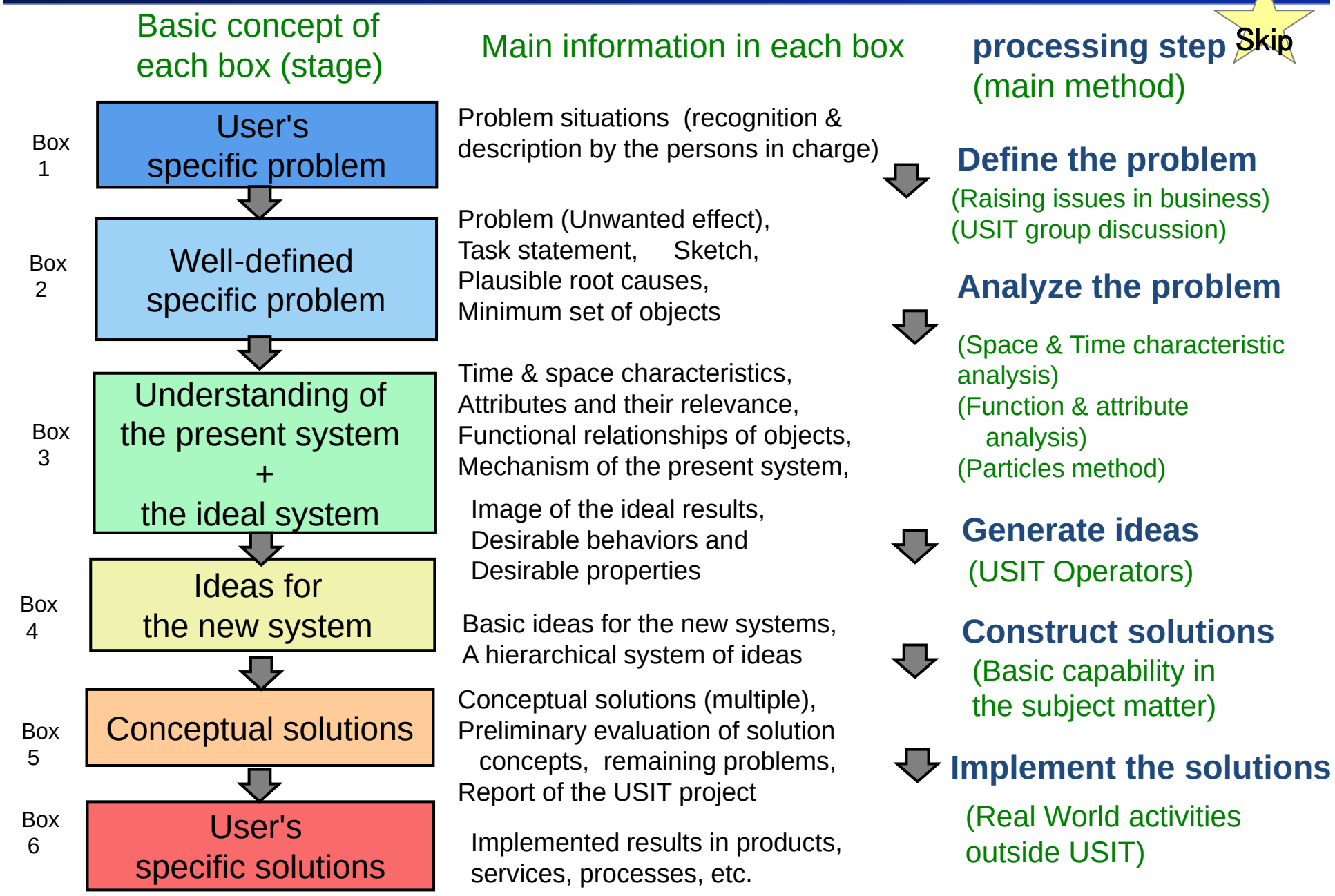
A Large Variety of Writing Instruments:

Studying the Evolution of Technologies

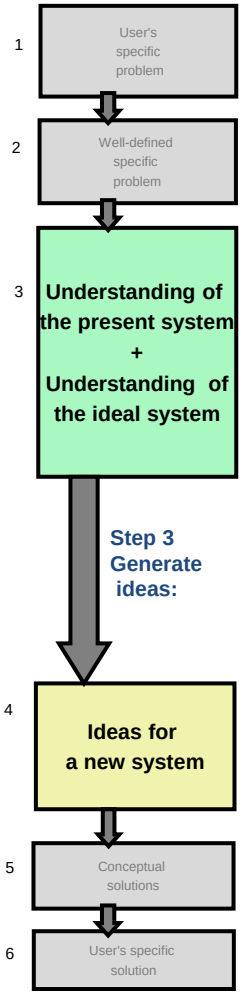
USIT Manual: Table of Contents

- **Preface:** Purposes, Targets, and Means
- **Introduction:** Purposes to learn and apply USIT; What is USIT?; Characteristic features of USIT; How to use USIT
- **Overall View of the USIT Process:** 'Six-Box Scheme'; Description of the 'Six-Box Scheme'
- **Execution steps of the USIT process:**
  - **Step 1: Define the Problem:** (1) Preparation: Forming the USIT project; (2) Clarify the problem situations and focus the scope
  - **Step 2: Analyze the Problem**
    - (A) Understand the present system: (1) Understand the space characteristics; (2) Understand the time characteristics; (3) Understand the attributes; (4) Understand the functional relationships
    - (B) Make an image of the ideal system : (1) Particles method (part 1 and part 2)
  - **Step 3: Generate ideas:** (1) Write down the ideas stimulated by the analyses; (2) Extend ideas with USIT operators
  - **Step 4: Construct solutions:** (1) Evaluate and select ideas; (2) Construct the conceptual solutions; (3) Report the results of the USIT project
  - **Step 5: Implement the solutions:** (Real activities in the 'Real World') ; Summary of the case study
- **USIT Case Studies:** About the Collection of USIT Case
- **Appendix 1. The System of USIT Operators**
- **Appendix 2. A Collection of USIT Case Studies**

Overall View of USIT process (in 'Six-Box Scheme')



Step 3: Generate ideas: (1) Write down the ideas stimulated by the analyses



Generate ideas by the stimulation from various analyses, and write them down and build them into a hierarchical diagram.

The problem analysis from various aspects have stimulated us to generate many, different ideas (e.g., items to be examined further, improvement ideas, drastic change ideas, etc.).
Write them down on cards one by one, and extend them further in group discussion, and arrange them into a hierarchical system of ideas.

- (Root) Causes => Eliminate the causes.
- Time characteristics => Solution ideas during the critical time zones
- Space characteristics => Solution ideas to be applied to the places/parts in trouble.
- Functional analysis => Solutions to handle the objects having harmful/insufficient functions
- Attribute analysis => Suppress the problem-increasing attributes, and enhance the problem-decreasing attributes
- Images of Ideal results => Directions of solutions
- Differences in requirements in respect to time/space/conditions => 'Physical contradiction'
  => Combine partial solutions.
- Particles method: Desirable behaviors and properties
  => many ideas and a hierarchical system of ideas
- System of desirable behaviors
  => A hierarchical system of solution ideas

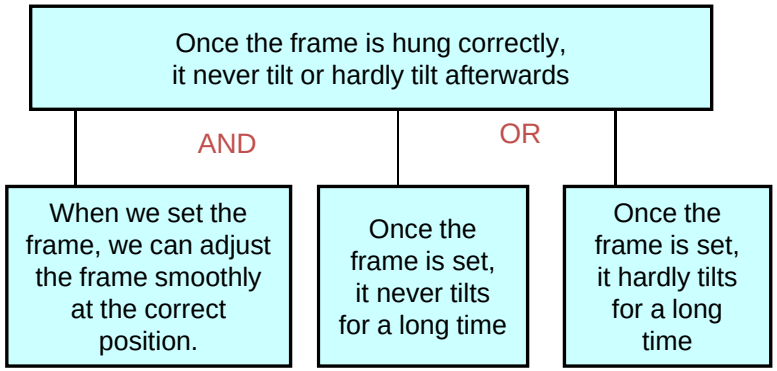
Generate various ideas as much as possible:

A lot of individual ideas: For instance,

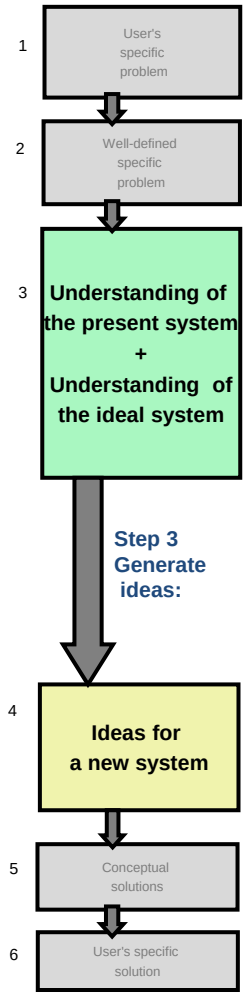
- Increase the friction between the nail and the string.
  (Make the nail surface rough; apply an adhesive; ..)
- Use two nails.
- When the adjustment is finished, apply some treatment for fixing or making hard to slip the string on the nail.
  (e.g., clip, press with a screw, apply an adhesive, etc.)
- Make the frame bottom edge not slip on the wall.
  (e.g., apply a cushion, fix with a double-faced adhesive tape)

Build them into a hierarchical system

The ideas are arranged in a hierarchical system as shown in the skeleton below:



Step 3: Generate ideas: (2) Extend ideas with USIT operators



Apply various USIT Operators intently to generate more ideas and extend/improve them further

The USIT Operators are the integrated and reorganized system of all the solution generation methods developed in TRIZ and USIT.

USIT Operators applicable to system elements:

- **'Multiplication'** of objects
- **'Dimensional change'** of attributes
- **'Re-distribution'** of functions

USIT Operators applicable to solution ideas:

- **'Combination'** of a pair of solution ideas
- **'Generalization'** of solutions

Please refer the System of USIT Operators (5 main- and 32 sub-operators) in a separate document.

You can understand them better when you re-consider which USIT Operators are used in individual solution ideas.

Apply a USIT Operator to any possible target (see above) somehow literally, and then think of an idea of making good use of it.

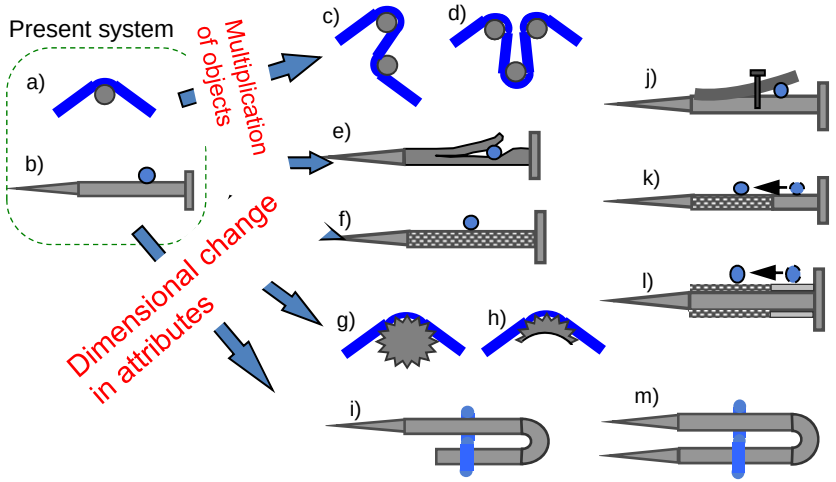
There can be various ways of good use.

You should think in a flexible manner.

There are a huge number of combinations of USIT sub operators and their possible targets; so you should not and need not try to exhaust the combinations.

USIT Operators are implicitly used everywhere in this Manual and in the USIT case studies.

Ideas obtained with various USIT Operators (Examples)



One idea can be derived with different USIT operators:

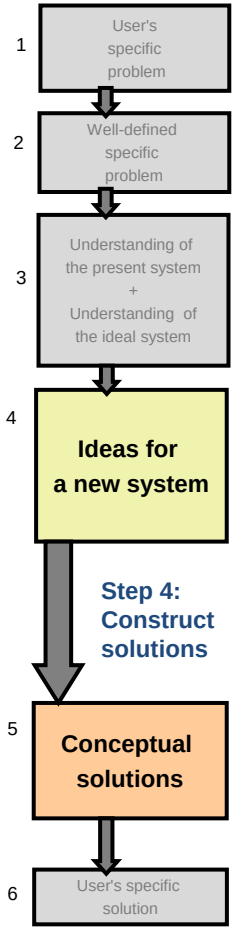
Adjust

Maintain

- Divide the nail into two parts, differ the surface properties and combine them again.
- Smoothness attribute of the nail was changed by places.
- The adjustment and maintenance functions of the nail are alocated to different parts of the nail.
- Solution of a smooth nail and solution of a rough nail are combined by the places
- The two solutions are combined in time..

If you are already familiar with the original TRIZ (or other) idea generation methods (e.g., 40 Inventive principles, Trends of evolution, Inventive standards, separation principles, etc.), you can use any of them here.

Step 4: Construct solutions: (2) Construct the conceptual solutions



On the basis of the capability in the subject matter, construct the conceptual (or preliminary) solutions

On the basis of the ideas selected in the preceding sub-step, construct conceptual solutions by use of both creative thinking and the capability related to the subject matter.

Among many ideas obtained in Step 3, try to build up good conceptual solutions on the basis of selected ideas. (Selection of ideas in the preceding sub-section helps us to concentrate our efforts.)

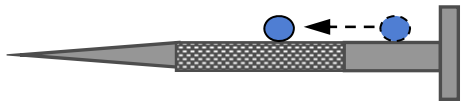
Consider from various viewpoints to construct good and convincing conceptual solutions.

- Describe the essence of ideas in the new solutions, its significance, effectiveness, novelty, etc.
- Describe further about unknown aspects, expected difficulties, aspects necessary to examine/ experiment, unsolved secondary problems, etc.
- Consider also on patentability, on possibility of infringing other's patents, etc.

If necessary, restart the steps of USIT process for solving the secondary problems.

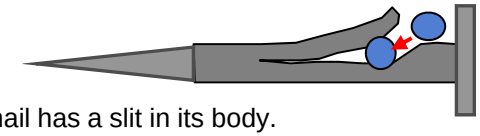
The solutions to be constructed in the present step are conceptual, i.e., in the Thinking World. To the best of the project team, these solutions are supposed to work well and solve the original problem.

Ex. A conceptual solution making the frame hardly tilt:



Make the surface of the nail rough at the front half of the nail while smooth at the hind half
Adjust the string on the smooth part of the nail, and after finishing adjustment push the string onto the rough part of the nail for holding string without moving for a long time.
This type of nail can be manufactured easily.
While holding, the frame hardly tilt, but it might tilt.

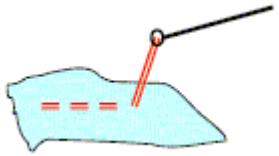
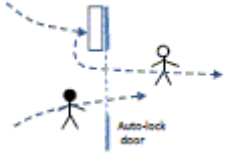
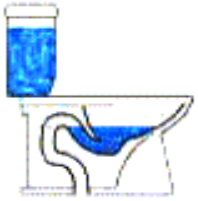
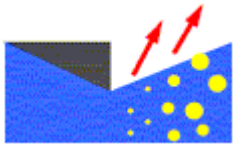
Ex. A conceptual solution making the frame never tilt.



The nail has a slit in its body.
Adjust the string at the ordinary axis part, and after finishing the adjustment push the string forward to set tightly in the slit.
Manufacturing the nail costs some. Simple and cheap.
After the adjustment, the string is essentially fixed, and it may be released by hand easily whenever necessary.

In this step , the capability in the subject matter is more important than the USIT methodology as a guide for the creative thinking.

USIT Case Studies （In accordance with the USIT Manual）

1	How to fix a string shorter than the needle		6	A Mom’s Bicycle for Safely Carrying Two Children	
2	How to prevent a staple from being crashed		7	How to Prevent Unauthorized Persons from Entering the Auto-locking Door of Apartment Building	
3	Saving Water for a Toilet System		8	A System for Preventing from Our Leaving Things Behind	
4	Picture Hanging Kit Problem		9	How to Prevent Cords and Cables from Getting Entangled	
5	Increase the Foam Ratio of Porous Polymer Sheet		10	A Large Variety of Writing Instruments: Studying the Evolution of Technologies	

[Case 10. Writing Tools] Step 1. Define the Problem (2) Clarify & focus the problem

Show the theme of the Seminar Class clearly

(1) List up different kinds of Writing Instruments, as much as you can think of !

1st Session of the Class

- Show your own favorite writing instruments of everyday use, and explain their good points!

2nd Session of the Class

- **With the keyword of 'writing instruments', list up as many examples as you can think of !**
- Describe each item on a Post-It-Note, one after another !
- Instead of a commercial product name, use more general name of the product !

Using general names is important

- Put every item card on a big sheet of paper, and try to classify them !

- **Homework:** Visit stationary stores, convenience stores, home-centers, stores of drawing materials, etc., and survey various kinds of writing instruments !

Watch the products closely, take photos, and take notes of them !
Also study in libraries, on the Internet, in catalogues, etc.!

[Case 10. Writing Tools] Step 2: Analyze the Problem (A) Understand the present system

Collect many examples, and understand their mechanisms and features

(4) Descriptions of Various Writing Instruments

(A part of Joint Report by the Class members)

All the Class members prepared for a joint Report,

to describe many examples

☐ Drawing/Writing Instruments, where ink is applied with a soft porous end

● **Felt Pen**

○ 油性フェルトペン（インクが油性であるもの。）

○ 水性フェルトペン（インクが水溶性であるもの）
（耐水性の水性サインペン）

◇ 蛍光ペン

● **'Paman'**

トラディオ・プラマン
（インキがなくなる最後までみずみずしく書けます。）
画像参照： http://www.pentel.co.jp/product/

● **'Line Marker'**

e-line2
（線を引くための筆記具。文字などの上にかぶせるように線を引くと、その下の部分が透けて見えるような、さまざまな色のフェルトペン。）
画像参照：http://www.pentel.co.jp/product/

● **'Bush-Pen'**（筆先が尖っていて、筆先全体が柔軟な多孔質材料でできている）
◇ふたやく筆ペン（PILOT）
（墨とうす墨の二色の筆ペン）

画像参照：PILOTホームページ
（http://www.pilot.co.jp/products/pen/sign_marker/fude_pen/futayaku_keityou/index.html）

● **'Color brush'** **[calligraphy-brush]**

カラーブラッシュ〈カリグラフィーブラッシュ〉
（みずみずしく色鮮やかな発色のカラーインキと毛筆が一つになって柔らかな線の表現や水彩表現ができ、広い面もスムースに塗れるカラー筆ペンです。）
画像参照：http://www.pentel.co.jp/product/

● **Roller** **(Drawing/Writing Instruments, where a cylindrical roller is turned while ink (or pai**
applied with its soft porous side material.)

☐ Drawing/Writing Instruments, where ink/paint is applied wit brush made of many thin hairs

● **Paint brush** （先端全体が細く尖ることはない）

● **Brush** （先端の毛が横幅広く植えられていて、太く、広く、描く／書く）

Think of Various Usages of Writing Instruments and Classify the Usages

(7) Classify Various Usages of Writing Instruments !

6th Session of the Class

- **What:** **Pictures, Drawings, Characters**

  (In the human history: Pictures --> Drawings --> Characters)

  (We say: Draw/paint a picture. <----> Write a character.
  Draw/write/make a drawing.)

- **On Which:** **Ground, Wall, Board, Clothes, Paper, Stone, Ceramics, Glass, Metal, Plastics,**

  These are arranged roughly in the historical order

Clarifying Usages reveals the Requirements and the Ideals

- **How: How about the results:**

  Multi-colored, clear, in the same thickness, ・・・

7th Session of the Class

How about the writing process:

Without getting tired, easy and convenient,
without getting dirty, ・・・

[Case 10. Writing Tools] Step 3: Generate ideas (1) Organize the ideas

Organize Various Writing Instruments with Their Usages

7th Session of he Class

Set up the tabular frame by Group work

(8) Table 2. Variety of Writing Instruments classified with the Usage (Summary)

On Which / What	Ground	Wall	Board	Clothes	Paper	Stone	Ceramics	Glass	Metal	Plastics
Pictures	Wood stick, stone	Spray, Brush, Roller	Painting brush, Brush, Spray, Roller	Painting brush, Pattern printing, Dying	Painting brush, Crayon, Crayon pastel			Spray		
Drawings		Carving knife, Stone	Carving knife		Painting brush					
Characters	Wood stick	Brush	Chalk	Felt pen	Pencil, Mechanical pencil, Fountain pen, Felt pen, Ball-point pen			Spray	'Solid marker'	

Describing Mechanisms corresponding to the usage

The view-points moved to the Solution Ideas (Step 3)

Evaluate Various Writing Instruments with Respect to Their Usage

12th Session of the Class: Made by Group work

(9) Table 3. Evaluation of Various Methods of Writing Instruments for Different Usages (On Which materials)

On Which / Methods	Ground	Wall	Board	Clothes	Paper	Stone	Ceramics	Glass	Steel	Plastics
Gives a damage	▲	▲	●	-	-	●	▲	▲	▲	▲
Leaves a part of itself as a trace	-	▲	●	▲	●	▲	▲	-	▲	▲
Adds a solid/powder	▲	▲	▲	▲	▲	-	▲	▲	▲	▲
Adds a fluid	-	●	●	▲	▲	▲	●	▲	●	●
Adds a liquid (ink, etc.)	-	●	●	●	■	▲	▲	-	▲	▲
Injects a material (powder/fluid/ liquid/gas)	-	●	●	▲	●	▲	▲	▲	▲	▲
Puts a material inside the medium	-	▲	-	▲	-	-	▲	▲	-	▲

Evaluation levels : ■ ● ▲ –

Initially marked with: ◎ ○ △ ×

Papers are developed especially highly among the media on which to write/draw.

Review the Project (Seminar Class) and summarize the results

(13) What Students Learned through This Class:

Summary by the Students

- **Our images about Writing Instruments have changed/extended.**

  Formerly: Writing Instruments = Tools to write on papers.

- **Things around us have hidden records of evolution of technologies.**

  Ex. An extension of pens was the invention of fountain pens.
  The drawbacks of frequent shortage of ink triggered the invention.

- **Clarifying needs and purposes inspires further development.**

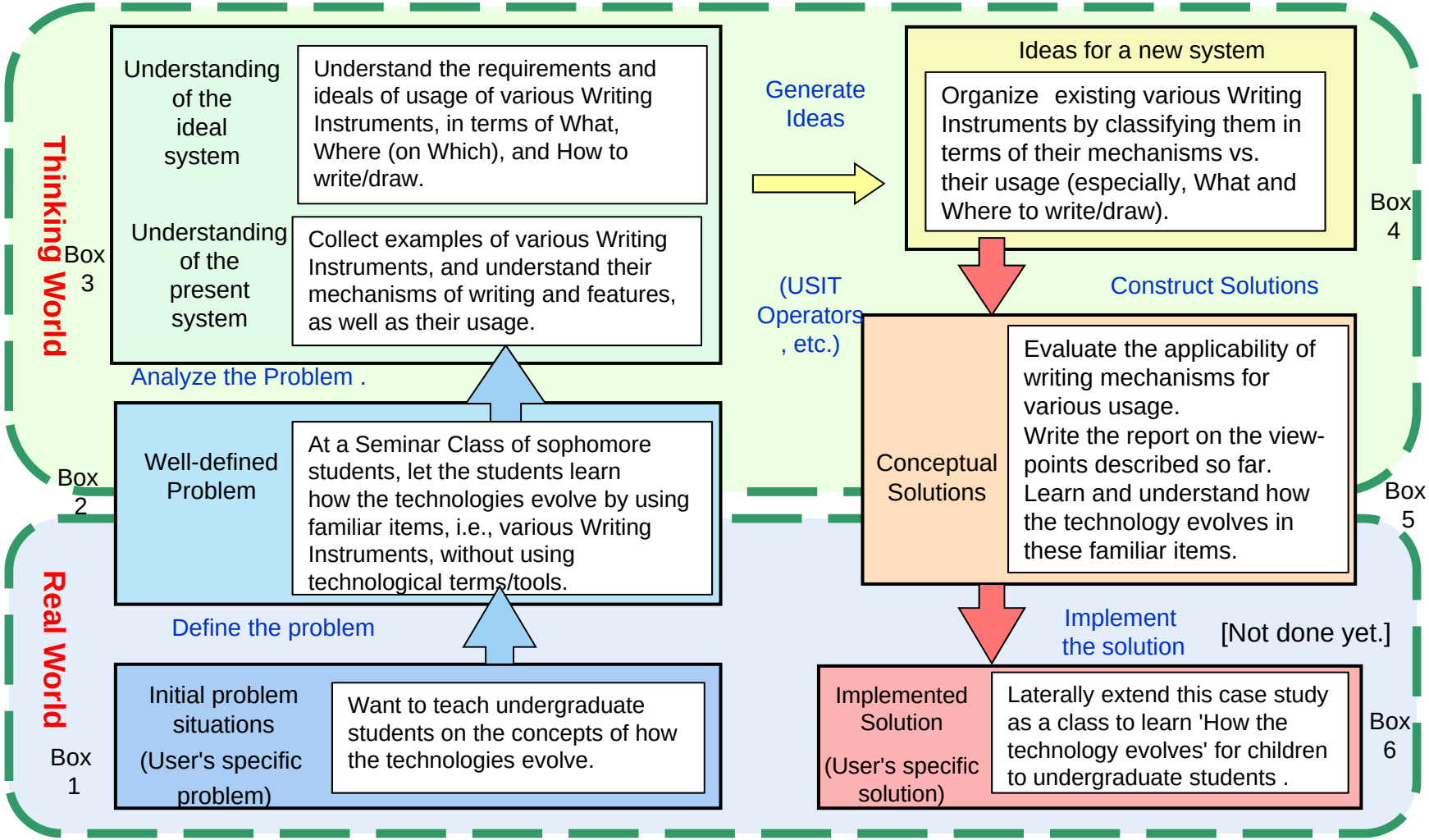
- **Lessons learned with the cases of Writing Instruments will be useful in the study of IT and Informatics, and many other.**

  Various machines must have similar mechanisms of evolution of technology.
  Various methods which we learned and used in this class will be useful in our further study in IT and Informatics.

USIT Case Study 10 [Writing Tools] (Overview). A Large Variety of Writing Instruments

A Class to learn important concept of evolution of technologies by using familiar items and no technological terms/tools

Toru Nakagawa and Kurumi Nakatani (2010)



Concluding Remarks:

The present study proposes the following new target:

To establish a general methodology of creative problem-solving / task-achieving (CrePS) , 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).

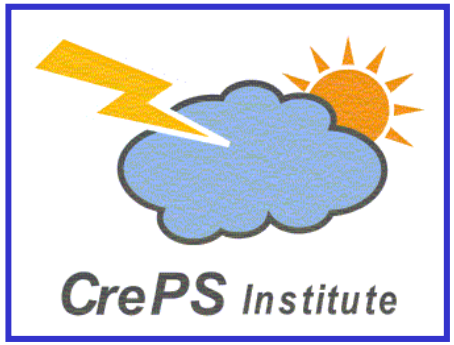
The present study has already revealed:

CrePS is feasible to be built on the paradigm of the Six-Box Scheme.
Various methods including TRIZ can be integrated into CrePS.
USIT is a concise whole process practicing the Six-Box Scheme.
USIT Manual, USIT Case Studies, and other documents on USIT have been publicized.

Further research and development tasks:

To understand different methods (besides TRIZ) and o position them in CrePS.
To relate CrePS to various activities in the 'Real world'.
To categorize various purposes of CrePS application and to recommend concise CrePS processes for each category.

Let us share the vision and collaborate together !!



Thank you
for your attention

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