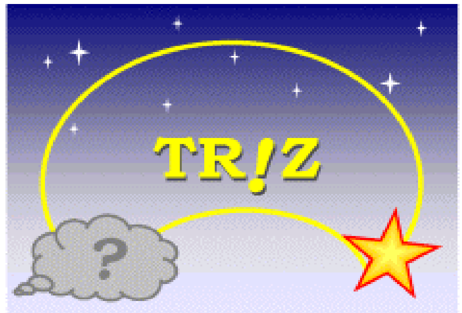
USIT (Unified Structured Inventive Thinking) in the Six-Box Scheme

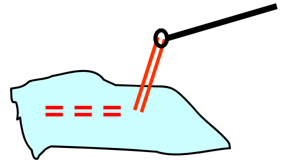
Toru Nakagawa, Osaka Gakuin University

July 15, 2015



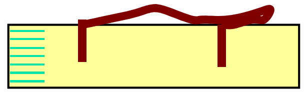
Outline

Brief Introduction to USIT



USIT Case Studies

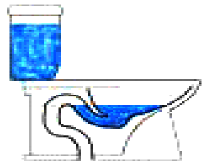
1. How to fix a string shorter than the needle



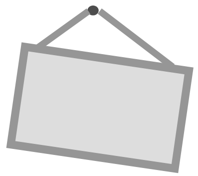
2. How to prevent a staple from being crashed

---------------- (break 10 minutes) -------

3. Saving Water for a Toilet System



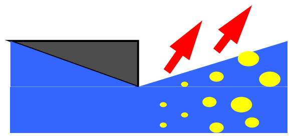
4. Picture Hanging Kit Problem



5. Increase the Foam Ratio of Porous Polymer Sheet

---------------- (break 10 minutes) -------

USIT Process



Concluding Remarks

Brief Introduction to USIT

USIT (Unified Structured Inventive Thinking)

In 1995 Ed Sickafus developed USIT at Ford.

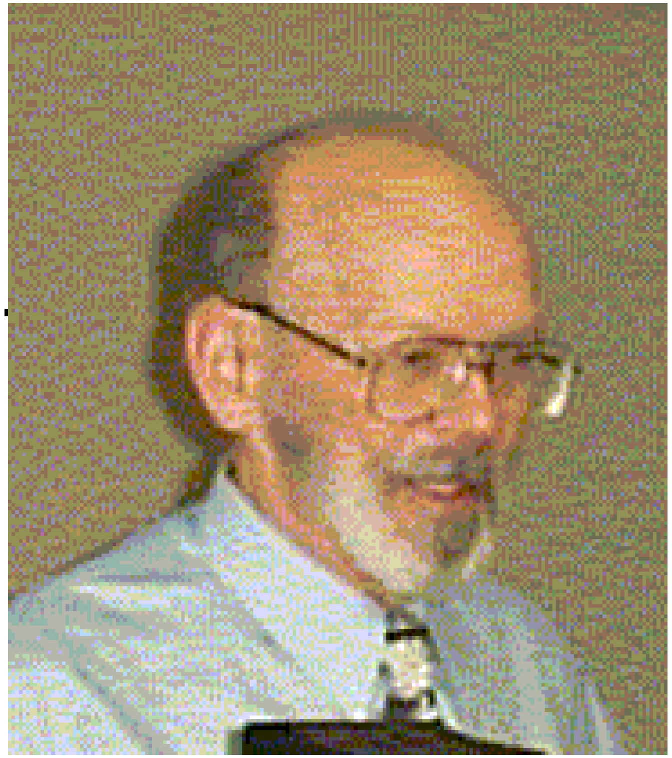
As its basis he introduced Israeli SIT,
i.e., a much simplified version of TRIZ.

On his basis as an experimental physicist,
he built up solid concepts and frameworks.

He created a well-defined thinking process
for problem solving.

He trained about 1000 engineers and
promoted its application projects in Ford.

Since 1999, Toru Nakagawa introduced USIT
into Japan, and extended it further as
a simplified, unified, new generation of TRIZ.



Ed Sickafus
(USA)

Extension of USIT in Japan ---> Significance of USIT

Extension of USIT in Japan	Significance of USIT
(1) Sickafus developed USIT, and we introduced USIT into Japan. (1999 Nakagawa)	Easy-to-learn TRIZ Slow-but-Steady Strategy for promoting TRIZ in Japan.
(2) We reorganized TRIZ solution generation methods and constructed USIT Operators. (2002, Nakagawa, Kosha, Mihara)	**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. (2004, Nakagawa)	**No need to depend on the analogical thinking.** **A New Paradigm of Creative Problem Solving.**
(4) We have established the vision of General Methodology of Creative Problem Solving (CrePS) based on the Six-Box Scheme, and established USIT as a simple process executing CrePS. (2012)	**General Methodology CrePS beyond TRIZ** **Simple USIT process for CrePS** **Easy-to-learn Case Studies** **Full training in 2 days**

Jun. 2015 TN

Nakagawa's Recommendations: (Positioning USIT and TRIZ)

We need concepts and methods for Creative Problem Solving.

● **From USIT, we learn how to think (or thinking process).**

USIT is a clear, practical process for creative problem solving.

Useful everywhere, every time.

-- We can learn it easily through case studies and actual usage.

● **From TRIZ, we learn philosophy and knowledge bases.**

TRIZ has deep philosophy and systematic way of structuring/ applying knowledge.

-- It may take a long time to learn, but useful as a background.

■ **You may learn either USIT => TRIZ or TRIZ => USIT;**

But problem solving with USIT is easy and effective.

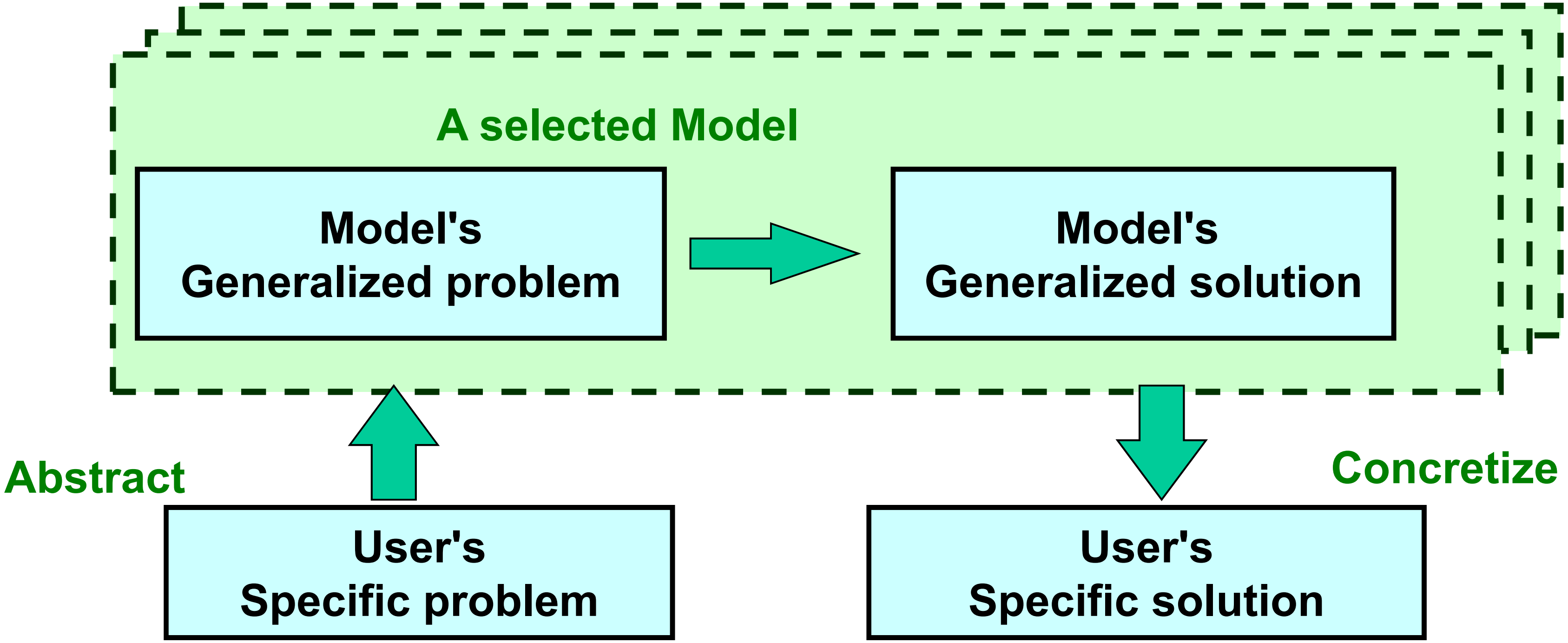
Apply USIT (TRIZ) to your real problems, and get your results!

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

Science & Technologies (Many models, specialized in areas)

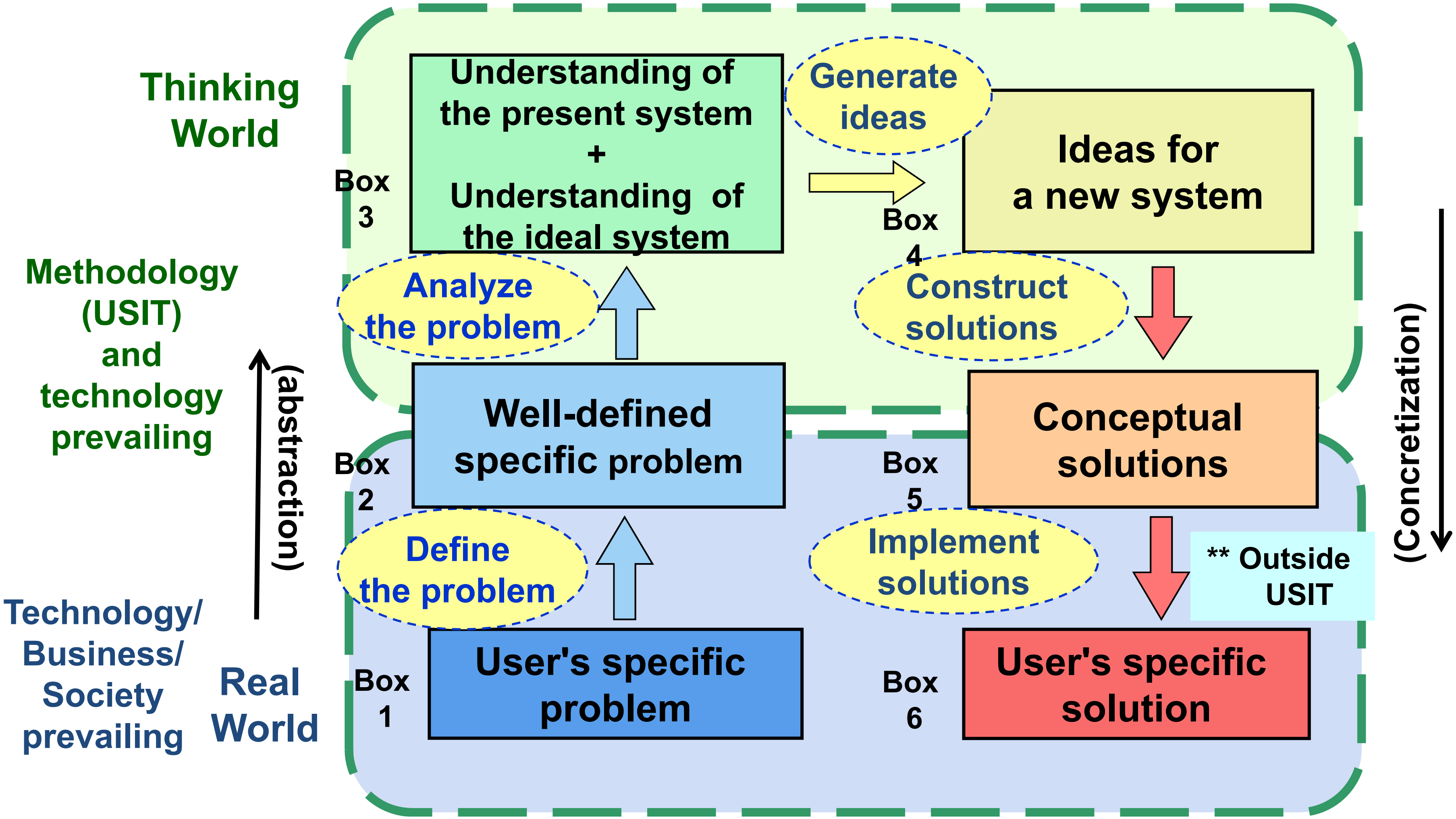
==> (Traditional) TRIZ (**Across areas**, but many separate tools)

Many models in the Knowledge Base



Contents of the boxes depend on areas, models, and problems; thus cannot be described in any further terms in a general way.

Overall View of the USIT Process ('Six-Box Scheme') (data flow representation)



Overall View of USIT process ("Six box method") (explanation)

Skip

	Basic concept of each box (stage)	Main information in each box
Box 1	User's specific problem	Problem situations (recognition & description by the persons in charge)
Box 2	Well-defined specific problem	Problem (Unwanted effect), Task statement, Sketch, Plausible root causes, Minimum set of objects
Box 3	Understanding of the present system + the ideal system	Time & space characteristics, Attributes and their relevance, Functional relationships of objects, Mechanism of the present system, Image of the ideal results, Desirable behaviors and Desirable properties
Box 4	Ideas for the new system	Basic ideas for the new systems, A hierarchical system of ideas
Box 5	Conceptual solutions	Conceptual solutions (multiple), Preliminary evaluation of solution concepts, remaining problems, Report of the USIT project
Box 6	User's specific solutions	Implemented results in products, services, processes, etc.

processing step (main method)

Define the problem
(Raising issues in business)
(USIT group discussion)

Analyze the problem
(Space & Time characteristic analysis)
(Function & attribute analysis)
(Particles method)

Generate ideas
(USIT Operators)

Construct solutions
(Basic capability in the subject matter)

Implement the solutions
(Real World activities outside USIT)

USIT Manual

Toru Nakagawa
(Osaka Gakuin University, Professor Emeritus)

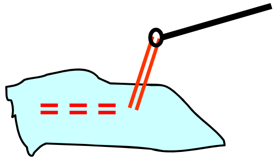
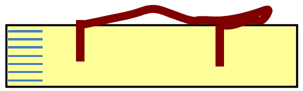
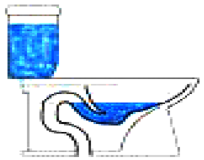
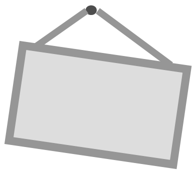
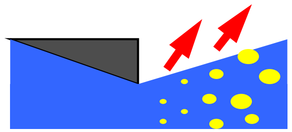
First edition: Feb. 9, 2014
2nd edition: Jun. 14, 2015

The latest edition is always posted in the public Web site "TRIZ Home Page in Japan":
Japanese edition:
http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/jCrePS/jCrePS-USIT/jCrePS-USIT-Manual.html
English edition:
http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/eCrePS/eCrePS-USIT/eCrePS-USIT-Manual.html

USIT Case Studies

A Collection of USIT Case Studies: (1) - (5)

Skip

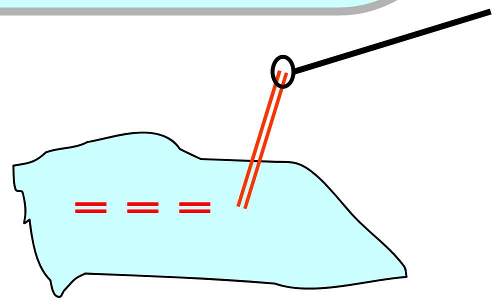
No.	Theme	Feature	
1 Sewing	How to fix a string shorter than the needle	Whole USIT Process is well illustrated for a familiar problem	
2 Stapler	How to prevent a staple from being crashed	A familiar problem was solved by finding the real root cause and by using the SLP method	
3 Toilet	Saving Water for a Toilet System	Example of catching big problem in daily life as physical contradiction, and solution	
4 Picture	Picture Hanging Kit Problem	A standard USIT Case Study on a familiar problem, easy to understand for everybody and yet deep in thoughts	
5 Porous	Increase the Foam Ratio of Porous Polymer Sheet	A real problem in the field of chemical engineering is solved with the Particles Method	

Overview of individual cases are shown below in the 'Six-Box Scheme'.

Table of Contents

USIT Case Study 1.

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



USIT Case Study 1. How to fix a string shorter than the needle

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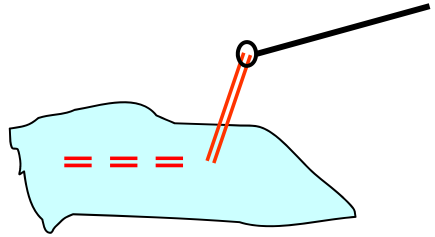
Case Study: How to fix a string shorter than the needle at the end of sewing



References:

[1] Source: "Creative Problem Solving Methods: How to fix a string shorter than the needle" , Tsubasa Shimoda, Thesis, Osaka Gakuin Univ. (Guided by Toru Nakagawa), Feb. 2006

[2] Introductory article: "Everyday-life Case Studies (1) How to Fix the String Found Shorter Than the Needle" in " TRIZ: Creative Problem Solving Methodology for Innovation (5)", Toru Nakagawa, "InterLab" Journal, May 2006;
"TRIZ Home Page in Japan", May 9, 2006 (in Japanese)

[3] Presentation: "A New Paradigm of Creative Problem Solving (3) Usage and Significance of the Six-Box Scheme in USIT", Presented at 2nd Japan TRIZ Symposium, Aug. 31-Sept. 2, 2006;
"TRIZ Home Page in Japan", Nov. 1, 2006 (in Japanese and in English)

[4] Description of this case study: "USIT Case Study (1)",
by Toru Nakagawa (OGU), Apr. 21, 2015 (in Japanese), Jun. 2, 2015 (in English)

[Case 1. Sewing] Step 1. Define the Problem (1) Preparation: Thesis work

In the Real World, raise an issue and prepare for the Project (Thesis Work)

Skip

(1) Preparation: Thesis Work for learning the Creative Problem Solving Methods

Situation: The capability of solving problems creatively is a basic and yet advanced and widely-applicable quality for students to master. In the thesis work, the students are expected to learn the methods and have the experiences of solving problems for themselves.

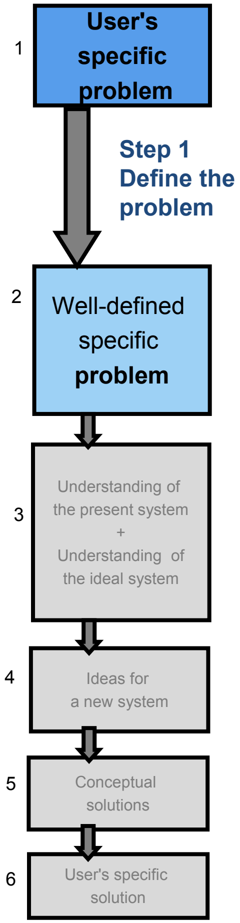
Target: To work to apply the TRIZ/USIT method to some familiar problem for solving the problem creatively and for mastering the methods and the thinking ways.

Project: Thesis work at Nakagawa's Seminar Class, Faculty of Informatics, Osaka Gakuin University. Students study in the Seminar Class during their 3rd and 4th years. The theme for the thesis is decided in June of the 4th year, and the thesis is submitted next February.
After the thesis work, Nakagawa brushed up the work and finished as a USIT Case Study.

Activities: The Seminar has a regular class of 90 minutes every week. 5 Students in the Class.
Nakagawa guided them both individually and collaboratively in the group work .

Team: 5 students in the Class. The students have their own individual themes and make practices and discussions together on all the themes.

Theme: This theme was proposed by Nakagawa, as a familiar problem.
Mr. Shimoda and all the students well understood the problem situations.



Please refer to the instructions in the USIT Manual

Define the Problem (using the standard template in the USIT Manual)

Step 1. Define the Problem

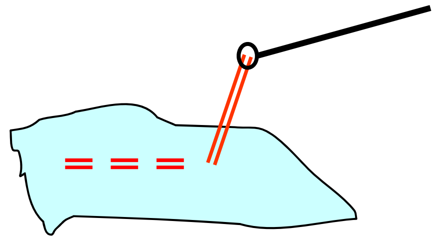
(a) An unwanted effect:

The string is shorter than the needle and prohibit applying the standard way of making a knot.

(b) Task statement:

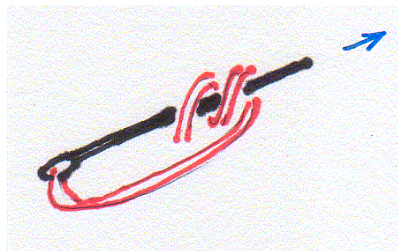
Devise methods for fixing the string left shorter than the needle.

(c) Simple sketch of the problem situation:



(d) Plausible root causes:

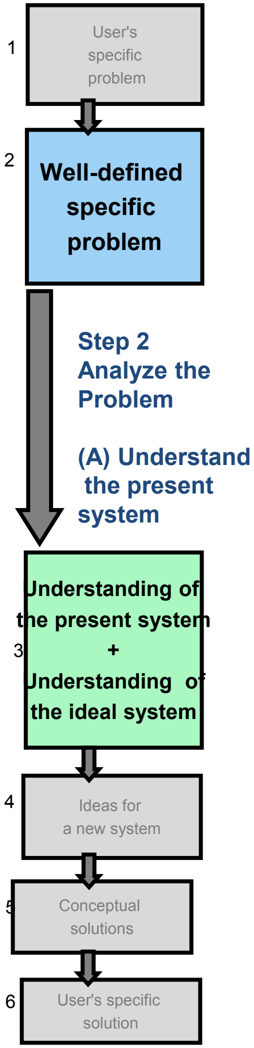
The standard way of making a knot is applicable only when the string left is longer than the needle



(e) A minimum set of relevant objects:

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

[Case 1. Sewing] Step 2: Analyze the Problem (A) Understand the present system



(A1) Understand the Space Characteristics

The purpose of making a knot is to make the string end 'suddenly thick' so that the string would be resistant to be pulled away.

Watch out the topological relations in 'a knot of string' and in the needle hole and the string, etc.

(There is a commercial needle with 'a slit at the hole', i.e. no genuine hole at all.)

(A2) Understand the Time Characteristics

Think about the process of sewing (in several steps)

The problem can be solved by going back to the preceding steps:
"No problem if we would have done .... in the previous step."
"We can go back the process now, and restart ... "

To solve the problem at the present final step of sewing
<== This is the approach we want to work in the present case study.

This is the problem setting in the present case study. We assume that the string can not be pulled to make it longer.

Basic Concepts in USIT: (by Ed Sickafus)

Object: A component of the system, and an entity existing by itself and occupy a space

Attribute: Category of characteristics of Object (Note: not a value)

Function: Action between Objects, which changes or controls an attribute of the target object.

Examples and anti-examples:

Examples of Objects: A nail, a picture frame, an airplane, an electron, light (a photon), air, 'information', ...

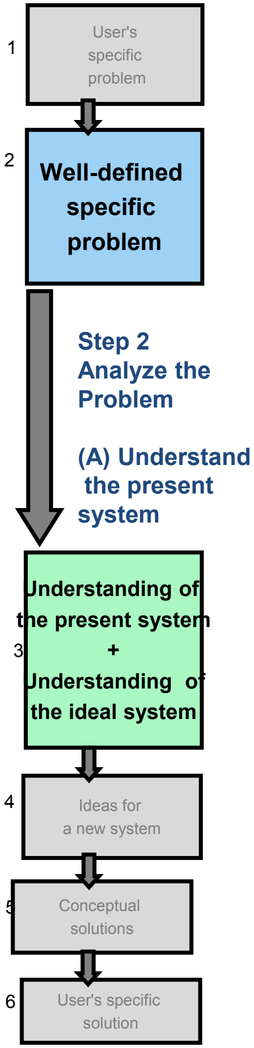
Anti-examples of Objects: A hole, a force, heat, electric current, ...
(These do not exist by themselves.)

Examples of Attributes: Color, weight, shape, positon, reflective index, ...
(These are expressed as categories.)

Anti-examples of Attibutes: Red, 10 kg, square, ...
(These are values of Attributes.)

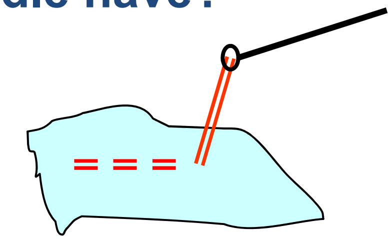
Examples of Functions: Accelerate, apply force, change color, contain, ...

[Case 1. Sewing] Step 2: Analyze the Problem (A) Understand the present system



(A3) Understand the Attributes (properties)

What kind of properties do the string and the needle have?



The string does not get longer.

= The length of the string (left) does not change.

The needle is hard.

= The shape and the length of the needle do not change.

The needle is thin. = The needle hole is small.

= It is difficult to release and pass the string through the hole again.

These properties are taken for granted.

==> These form the constraints, in our natural/common sense.

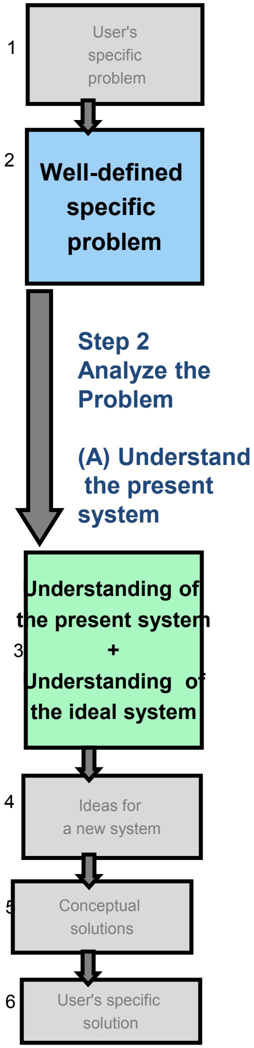
Do we need to follow these constraints?

Once we lift/break a constraint properly, we can have new solutions.

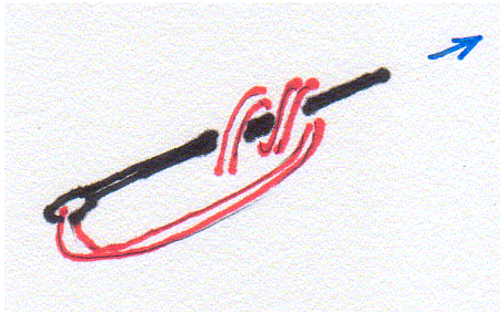
Constraints often come from our psychological inertia.

In the Thinking World, we can think freely without the constraints.

(A4) Understand the Functional Relationships



What is the function of the needle in the standard way of making a knot?



How the needle is working ?

How are you using the needle?

How do you want to arrange the string by use of the needle?

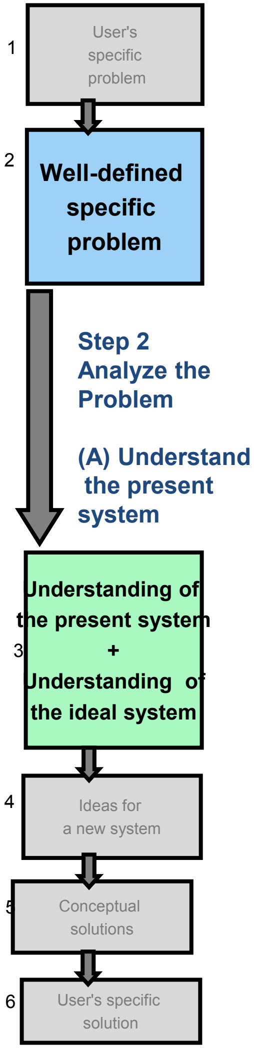
==> Express your answers in words

A student answered "Kuru-Kuru Suu" in Japanese.
It represents the motion of our hand.

==> The hand handles/moves the string.
"Kuru-Kuru" makes two loops of the string around the needle,
"Suu" passes the needle forwards, to pass the string through the loops.

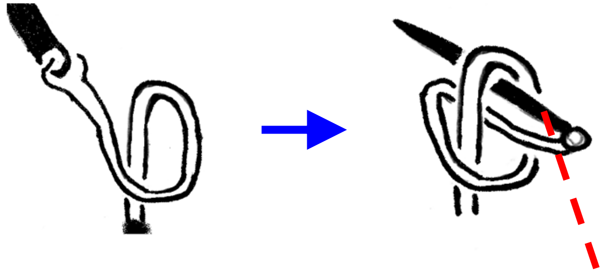
==> Then, how the needle is working? What is the function of the needle?

The needle works as: the base of making loops of the string and the guide of the string to pass through the loops.



(A5) Survey for known methods and techniques

Grandma's usually operate like this:



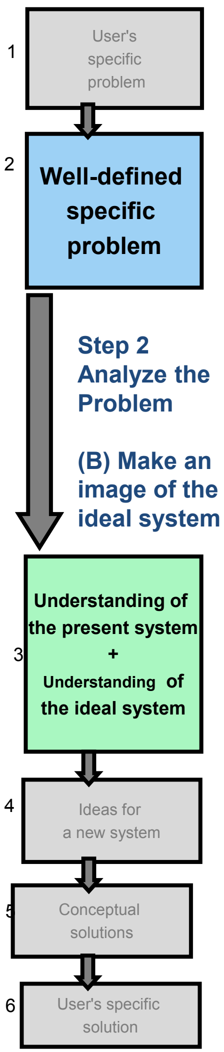
Hold the pointed end of the needle, and operate the string in the air so as to make a loop of the string, and pass the hole part of the needle into the loop. Then, cut the string near the needle hole, and pull the string to make a knot.

To make the string loop in the air is difficult and needs much practice.

A commercial needle;

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)

[Case 1. Sewing] Step 2: Analyze the Problem (B) Make an image of the ideal system

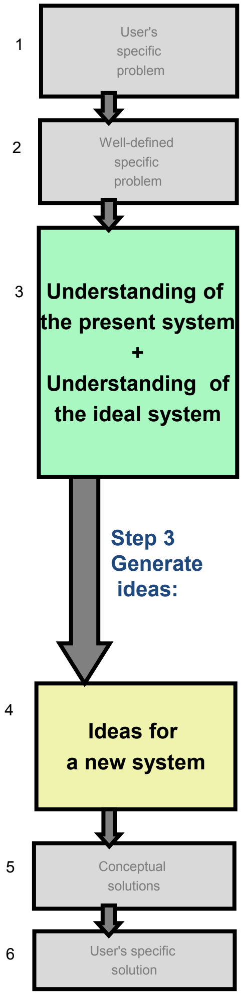


(B) Make an image of the ideal system

The image of the ideal arrangement
of the string for making a knot:

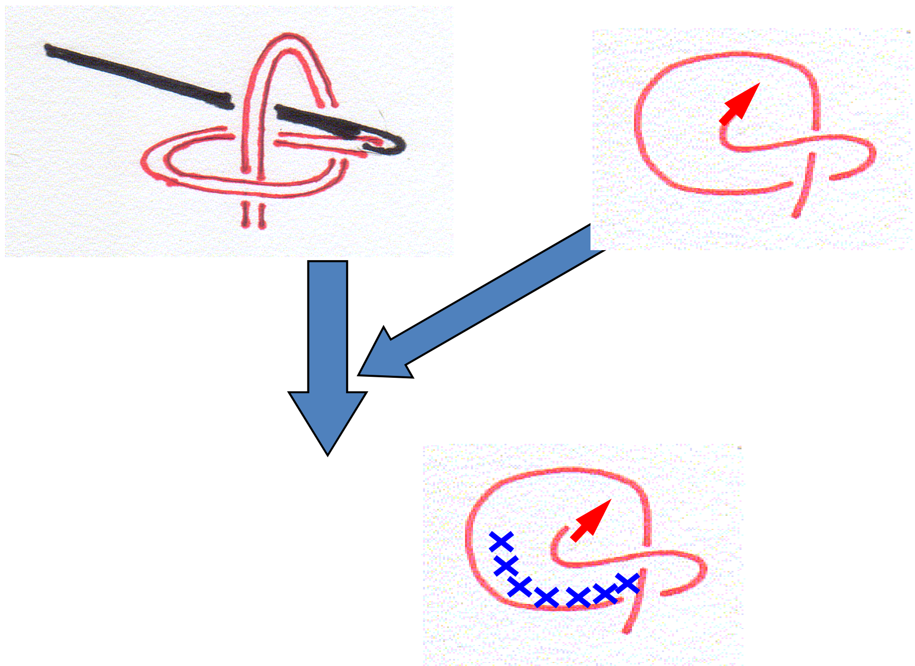
It is nice if we can hold the string in this arrangement in the air,
and if we can guide the string in this arrangement.

[Case 1. Sewing]   Step 3: Generate ideas



Step 3: Generate ideas

(1) By use of the similarity between the known method and the ideal way.

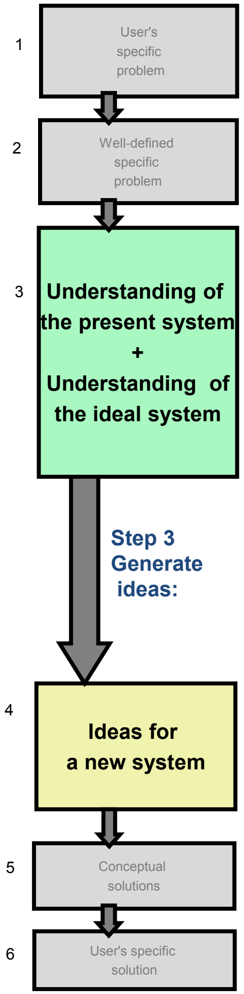


We should just hold the string in the air at the positions similar to the ideal ones.

A small experiment for trying this idea revealed a solution very quickly.

The solution is written in the slide of Step 4 of USIT.

[Case 1. Sewing] Step 3: Generate ideas



Step 3: Generate Ideas

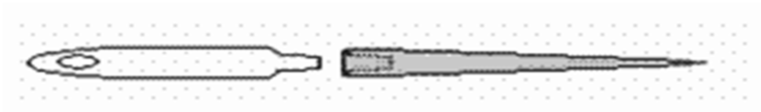
(2) Ideas with breaking the constraints (of properties)

Let's break the needle into two !

Ridiculous !
I thought first.

Since it is difficult to break,

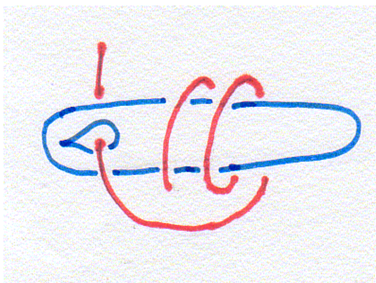
Screw type



What does this mean?

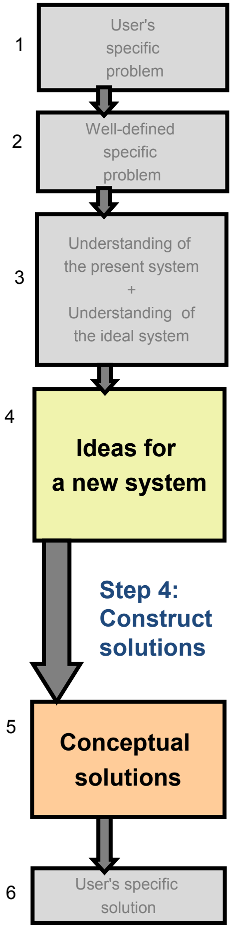
When I think over the implication, I found its significance..

Sewing is already done. So the needle point is not necessary .



A needle without the point and specialized for making a knot.

[Case 1. Sewing] Step 4: Construct solutions:



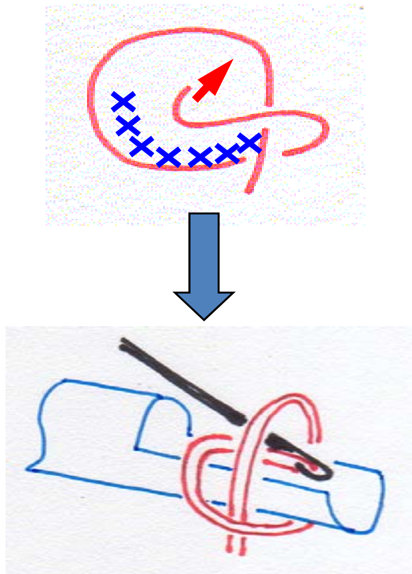
Step 4: Construct solutions:

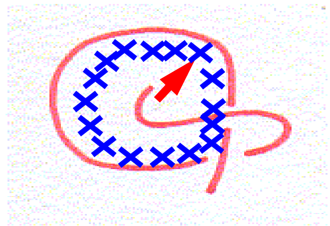
Idea of holding the string in the air

First I tried with a straw

==> failure

For passing the string through the string loop, not a circular pipe but a half pipe is suitable.





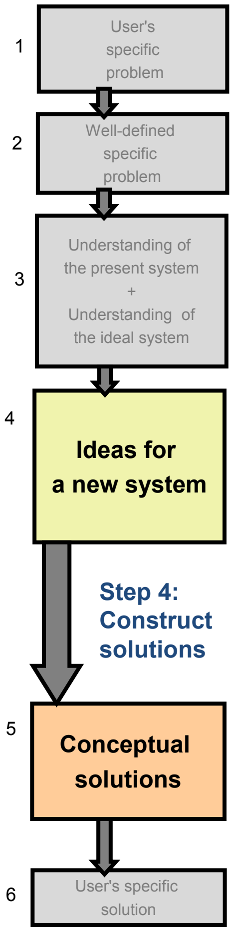
No good.

A tool made of a straw

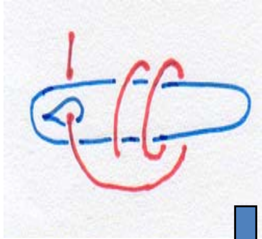
At home, you may cut the edge of a straw into a half pipe.

A tentative idea for a product:
  Made of a metal or a plastic, in the shape of a half pipe.
  diameter: 3 mm, length: 50 mm,
  Illustration of usage on the handle part.

[Case 1. Sewing] Step 4: Construct solutions:

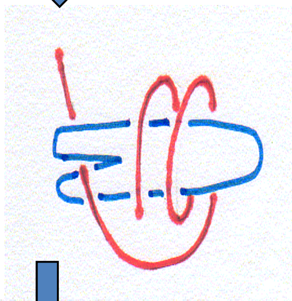


Idea of a pointless needle specialized for making a knot:



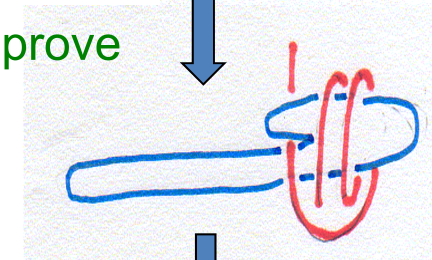
Improve the idea step by step for making it more useful:

Improve



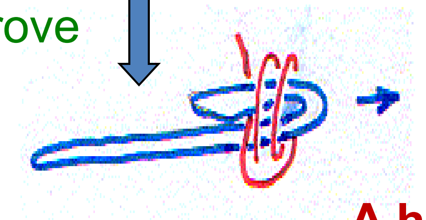
Not a hole but a slit:

Improve



Make an end longer for easy holding by hand.

Improve



A hairpin type for better holding of the string

Improve the idea step by step.

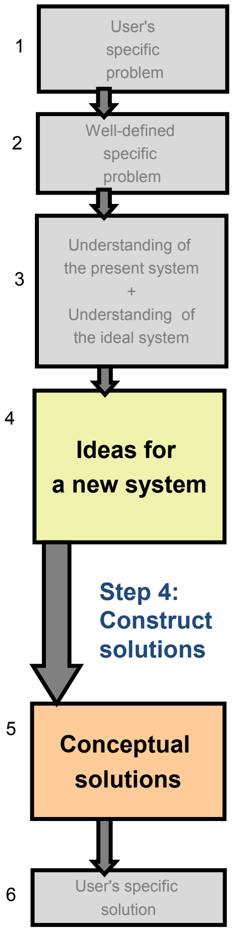
We can have better solutions.

A hairpin like tool for making a knot

[Case 1. Sewing] Step 4: Construct solutions (3) Report the results

Report as a Case Study.   Conclusion of the Case Study.

Skip



A new and fine Case Study of USIT Application was completed, for a simple and familiar problem "'How to fix a string shorter than the needle."

The standard way of applying USIT was found effective.

The concepts of functions and attributes are used effectively and are illustrated well.

The Case Study was described fully and presented at conferences and seminars; thus it became much refined than the original thesis work.

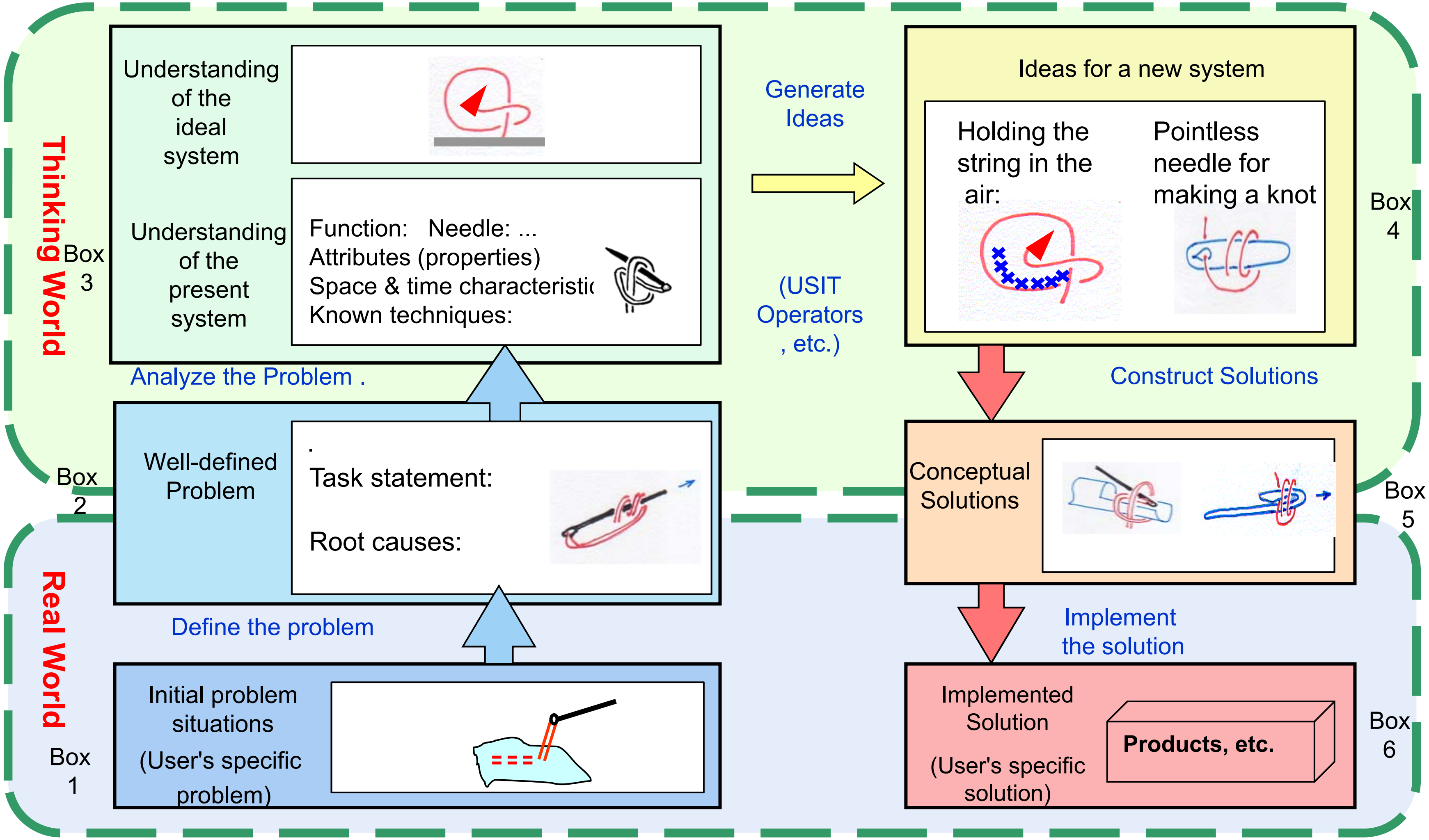
This Case Study is good for illustrating the USIT method and its usage.

The conceptual solutions of this Case Study have not been tried to make as real products. We may try it at some occasions in future.

USIT Case Study 1 [Sewing] (Overview): How to fix a string shorter than the needle

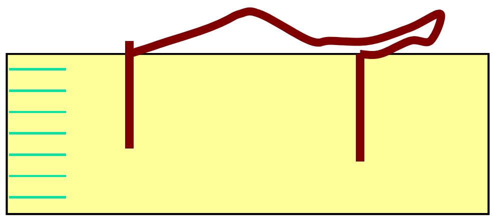
Whole USIT Process is well illustrated for a familiar problem

Toru Nakagawa and Tsubasa Shimoda (2006)



USIT Case Study 2.

How to prevent a staple from being crashed



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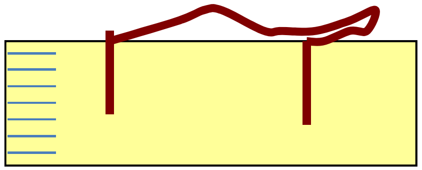
Case Study 2. How to prevent a staple from being crashed



References:

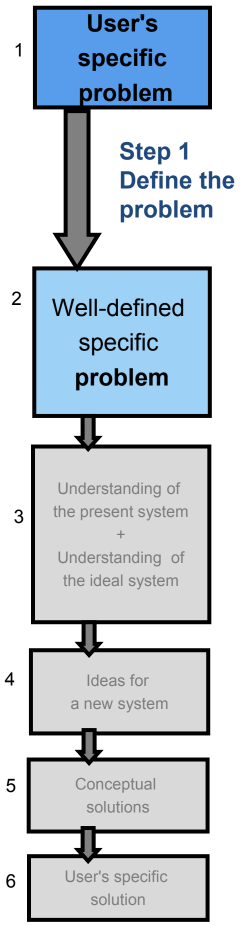
[1] Source: "Creative Problem Solving Methods: How to prevent a staple from being crashed " , Kazuaki Kamiya, Thesis, Osaka Gakuin Univ. (Guided by Toru Nakagawa), Feb. 2004

[2] Introductory article: "Everyday-life Case Studies (3) How to prevent a staple from being crashed " in " TRIZ: Creative Problem Solving Methodology for Innovation (13)", Toru Nakagawa, "InterLab" Journal, Jan. 2007;
"TRIZ Home Page in Japan", Jan. 7, 2007 (in Japanese)

[3] "A New Generation of TRIZ" , Toru Nakagawa, 1st TRIZ symposium in Japan, Sept. 1-3, 2005, at Shuzenji;
"TRIZ Home Page in Japan", Sept. 20, 2005 (in Japanese and in English)

[4] Description of this case study: "USIT Case Study (2)",
by Toru Nakagawa (OGU), May 12, 2015 (in Japanese), Jun. 3, 2015 (in English)

[Case 2. Stapler] Step 1. Define the Problem (2) Clarify the problem situations



Define the Problem (using the standard template in the USIT Manual)

Toru Nakagawa and Kazuaki Kamiya (2004)

Step 1. Define the Problem

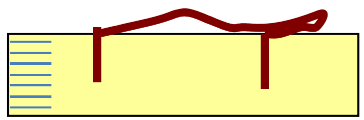
(a) An unwanted effect:

A stapler of the ordinary size (e.g. MAX10) can bind the papers up to 30 sheets. For more sheets of paper, the staple is crashed and fails in binding.

(b) Task statement:

With the stapler of the ordinary size, improve its capability of binding more sheets (e.g. 40-50) of papers.

(c) Simple sketch of the problem situation:



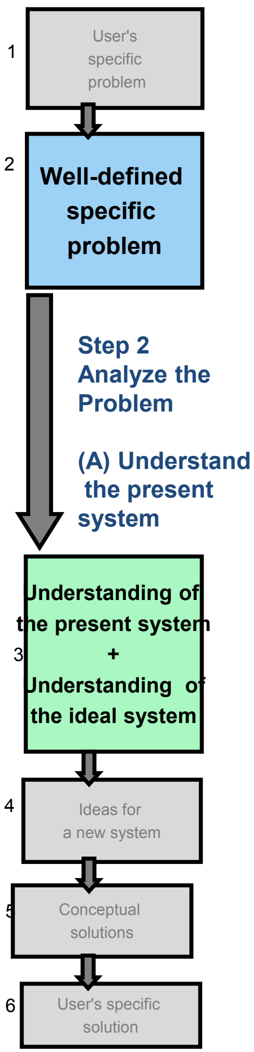
(d) Plausible root causes:

Since the staple is crashed always sideways, the looseness around the axle of the stapler is supposed to be the root cause.

(e) A minimum set of relevant objects:

Thick sheets of paper, the staple of the stapler, the stapler (magazine of the staples, driver, base plate, axle, etc.), human hand

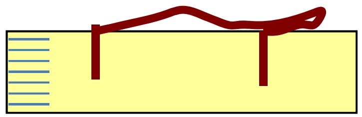
[Case 2. Stapler] Step 2: Analyze the Problem (A) Understand the present system



(A1) Understand the Space Characteristics

Repeating trials to bind the thick sheets of papers, we have found that about 30 sheets are the maximum thickness of successful binding.

The staple is crashed sideways all the time.



(A2) Understand the Time Characteristics

No temporal dependence.

This point was reviewed later.

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

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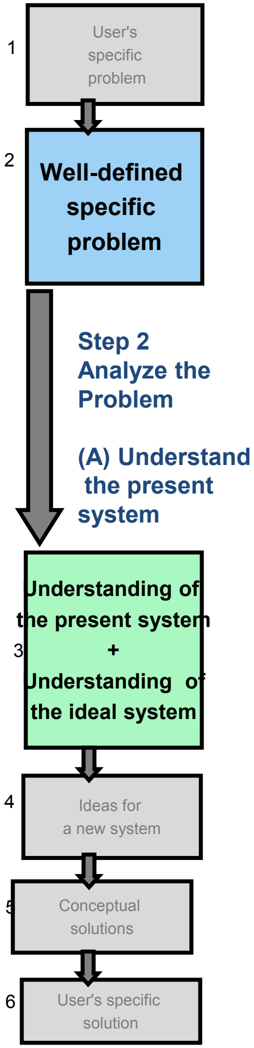
(A3) Understand the Attributes (properties)



Object	Attributes enhancing the easiness of being crashed	Attributes suppressing the easiness of being crashed
sheets of paper	Number of sheets, thickness of each paper, quality of paper	
staple	Thickness, length, friction with the paper	Strength of the material, sharpness of the point
magazine part	Space with the staple, looseness inside the stapler	
axle	looseness (in allowing the horizontal motion)	Thickness of the axle

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

(A4) Understand the Functional Relationships

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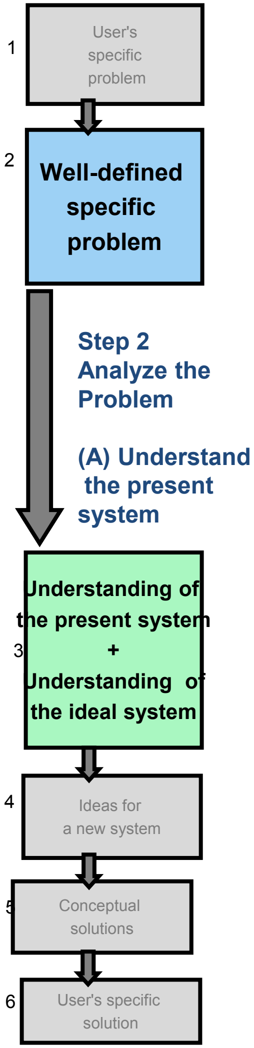
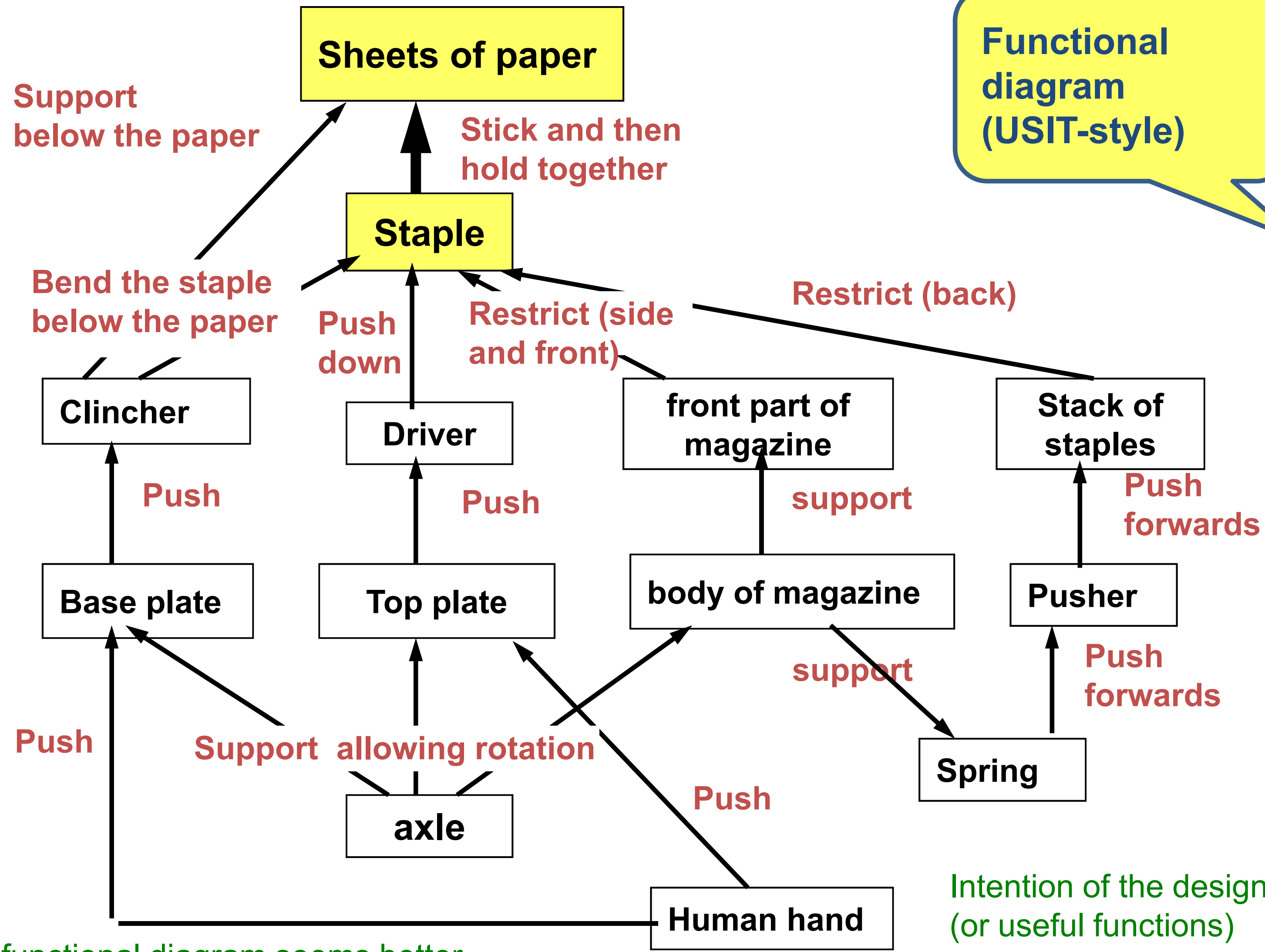


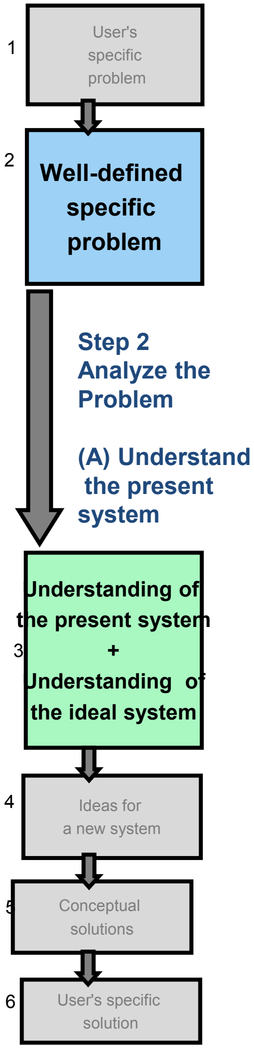


Functional diagram (USIT-style)

Intention of the designer (or useful functions) are drawn.

The USIT way of functional diagram seems better than the one in Darrell Mann's textbook.

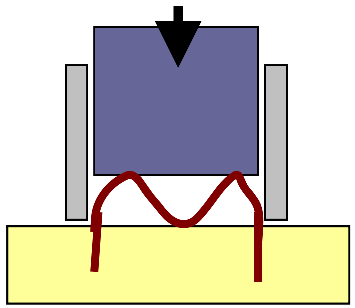
[Case 2. Stapler] Step 2: Analyze the Problem (A) Understand the present system



(A5) Unexpected finding in experiments

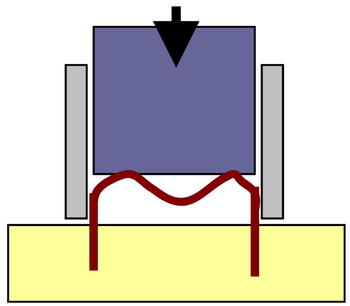
We were repeating the experiments, thinking that "the axle of the stapler should be made stronger and tighter".

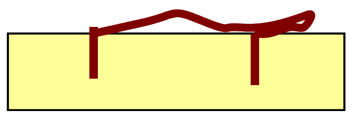
The staple was suddenly caught in the stapler and did not move. The staple was in the form ===>



So we made new experiments of releasing the power 'just before the staple is crashed'.

Then we have found that the staple bends into an M-shape just before being crashed.



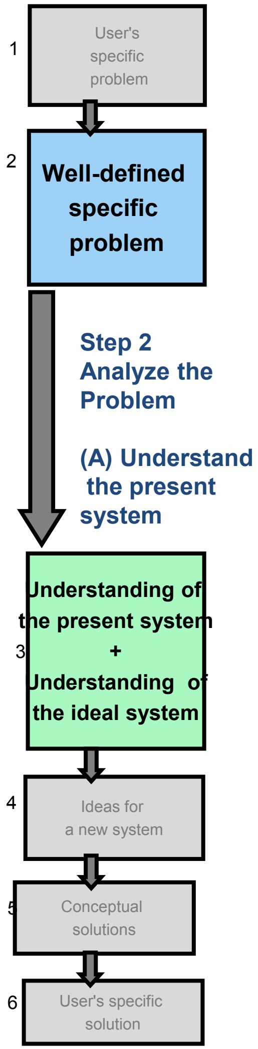


Why does it bends like this?
Why the middle of the top part of the staple bends down?
We do not push that part...

Observation and noticing like this is important.

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

(A5) Unexpected finding in experiments (continued)



When the staple is pressed tightly, it wants to release the energy by bending (rather than by becoming thicker or shorter), because it is the easiest way.
The staple bends in an M-shape because it is the simplest form of deformation.

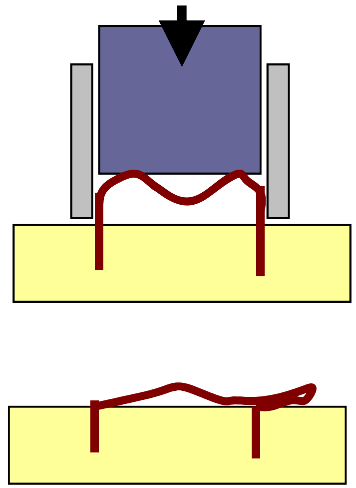
The staple is not supported on the inner side.

Once the staple starts to bend, it will be bent very easily.
(just like to hit a bent nail with a hammer.)

This is the real root cause of this problem !

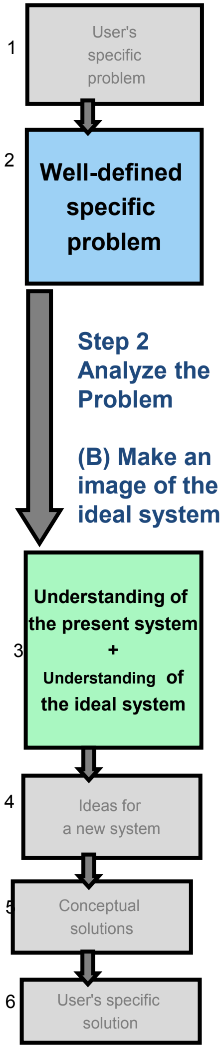
We also realized the importance of the consideration/observation of various phenomena in a close up view in time.

==> Understand the time characteristics.



A real root cause is now found.

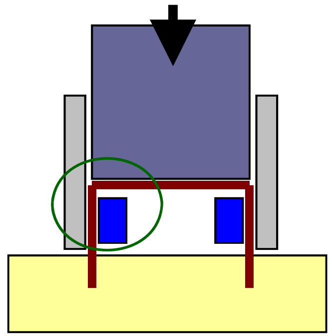
[Case 2. Stapler] Step 2: Analyze the Problem (B) Make an image of the ideal system



(B) Make an image of the ideal system

The observation in the previous sub-step (A5) showed us an ideal image:

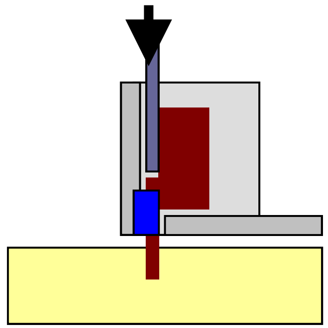
Yes! we should just support the staple on the inner side, as shown in the right.



But Wait! Something is not quite right!

Such a support becomes the obstacle of the staple to stick through the sheets of paper.

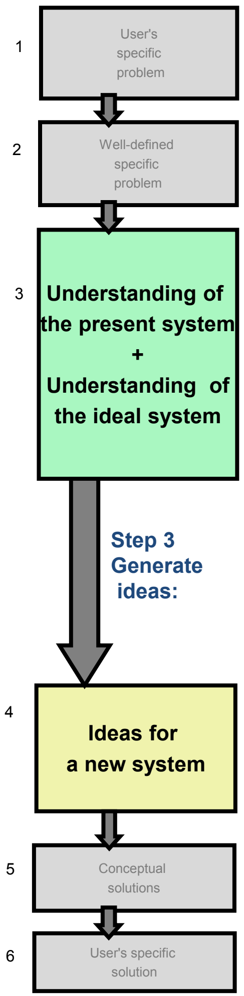
The Ideal system is:
the staple is supported by something on the inner sides, AND the staple can stick and hold the sheets of paper smoothly without being blocked by the support.



The ideal image may have apparently contradictory requirements.

Such contradictions should/can be solved in the next step of idea generation.

[Case 2. Stapler] Step 3: Generate ideas (1) under the guide of the ideal image



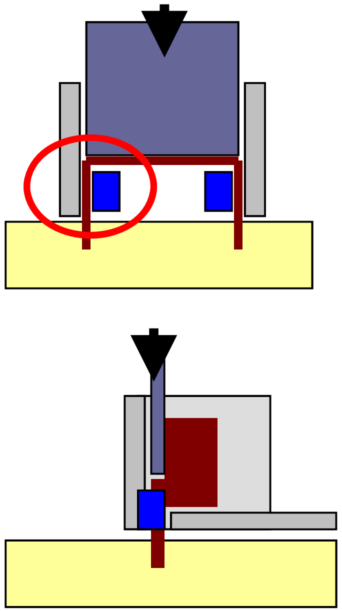
Generate ideas under the guide of the ideal image

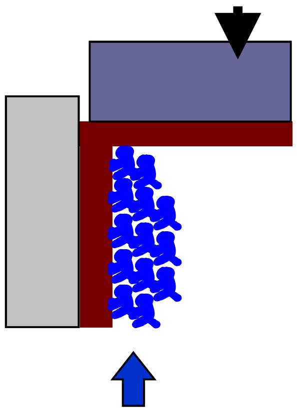
Altshuller's SLP (Smart Little People) method was used:

SLP is essentially same as the Particles Method of USIT

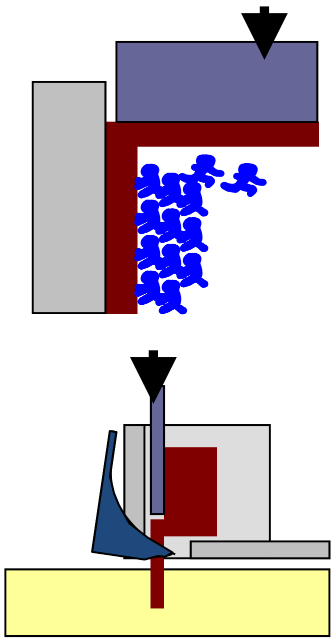
Suppose that the component are formed by a group of Smart Little People.

Imagine how the Smart Little People behave in this problematic situations:





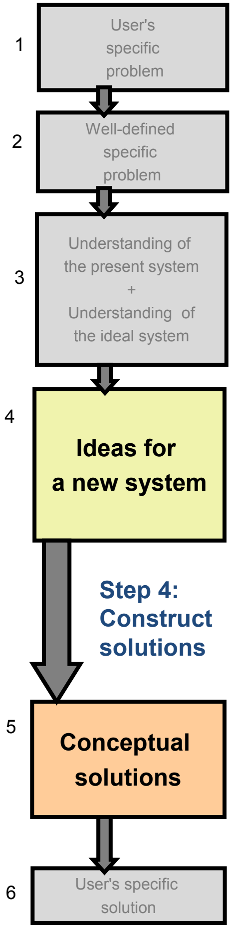
Smart Little People



The SLP who are pressed much want to escape one by one.

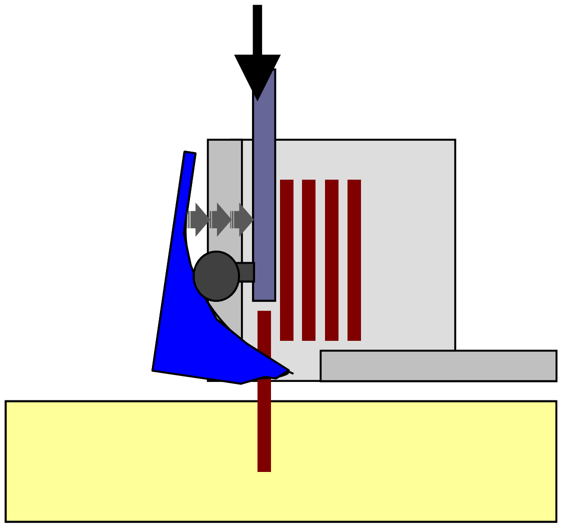
The SLP find the way to escape in the front direction of the stapler.

[Case 2. Stapler] Step 4: Construct solutions:(2) Construct the conceptual solutions



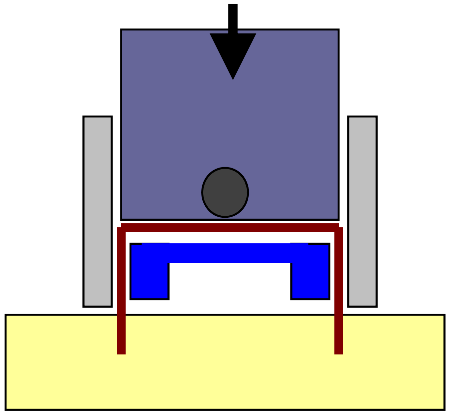
(2) Construct the conceptual solutions;

Consider the idea obtained in the previous step more concretely.



'Little People escape one by one to the front of the stapler' can be realized by 'a triangular supporting part (shown in blue) is pushed forward with the pressing down of the staple.

A ball is attached to the driver (a metal plate). As the staple is pushed down with the driver, the ball pushes the (curved) triangular part forwards.

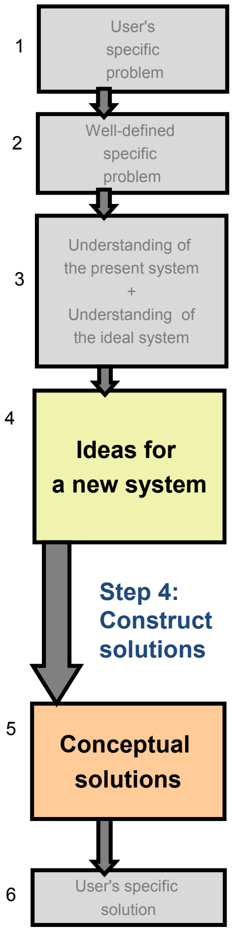


The metal triangular part is pulled back by a spring.
When the staple is pressed down completely, the driver goes up and the supporting part is pulled back for supporting the next staple.

[Case 2. Stapler] Step 4: Construct solutions (3) Report the results

Report as a Case Study. Conclusion of the Case Study.

Skip



A familiar problem of a stapler: 'How to prevent the staple from being crashed for binding thicker sheets of paper` is solve effectively by use of the USIT process.

The standard USIT process was useful,
but particularly in this case it was important that
while repeating the experiments with real material,
we met a accidental trouble and observed an unexpected phenomenon,
and realized a real root cause different from the initially supposed one.

The idea of the root cause guided us an image of the ideal situation,
and then the contradictory requirements in the ideal are solved
by use of the Smart Little People (SLP) method.

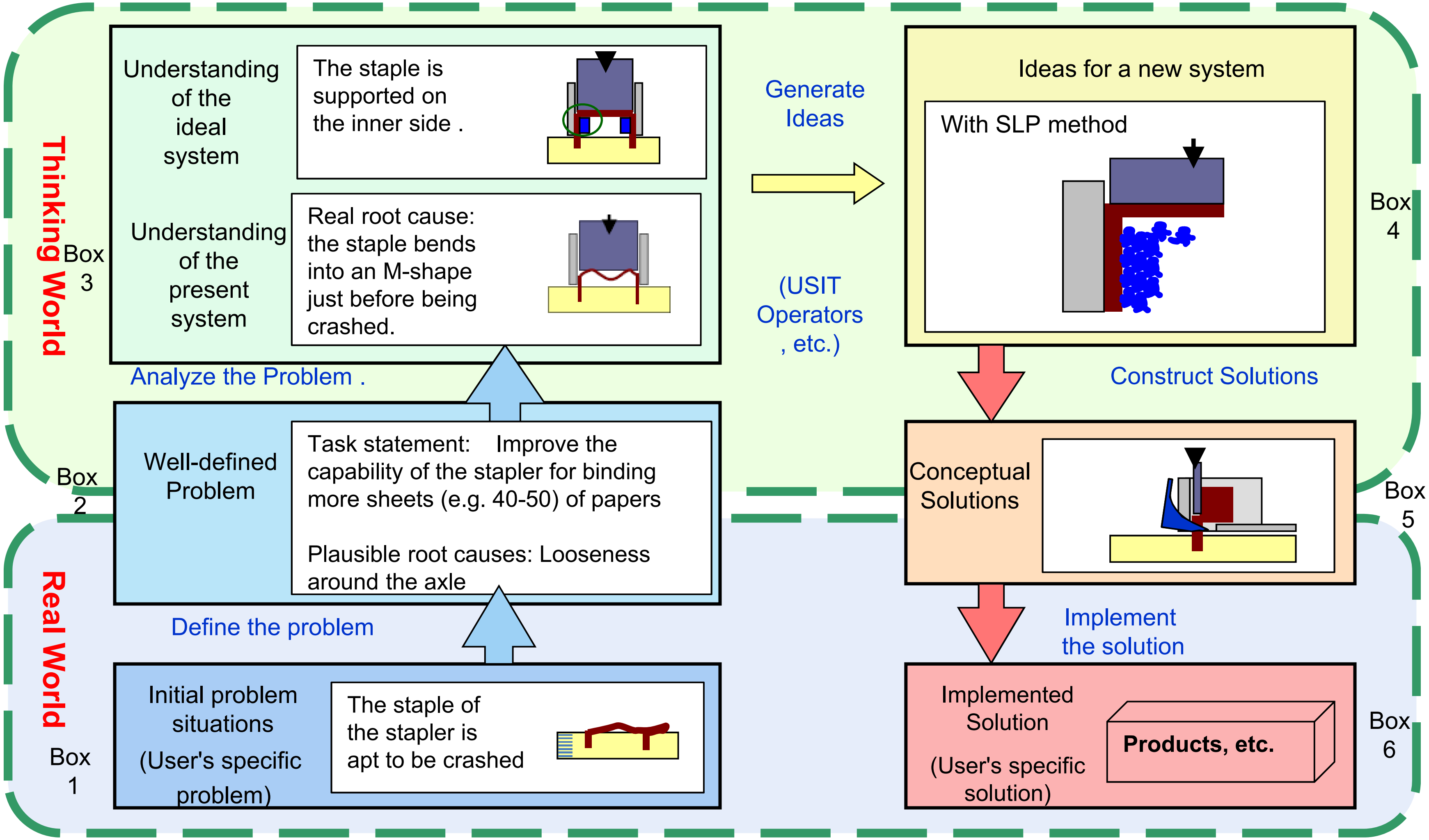
This is a nice case study, which may be understood by children and high school students.

On the basis of a thesis work, the case study was further brushed up and were presented in a journal, conferences, seminars, and Web sites.

USIT Case Study 2 [Stapler] (Overview): How to prevent a staple from being crashed

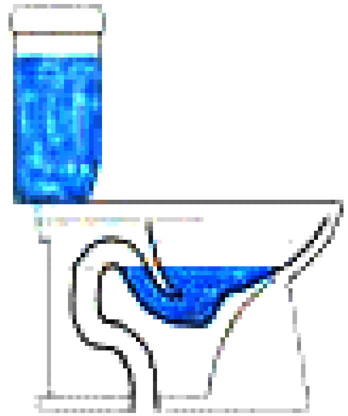
A familiar problem was solved by finding the real root cause and by using the SLP method

Toru Nakagawa and Kazuaki Kamiya (2004)



USIT Case Study 3.

Saving Water for a Toilet System



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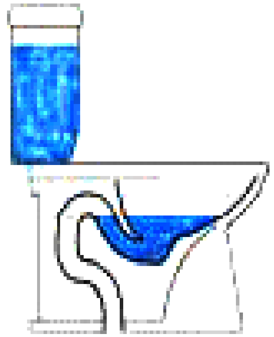
USIT Case Study 3. Saving Water for a Toilet System



References:

[1] Source: 'Practical Case Study of Resolving the Physical Contradiction in TRIZ; Super Water-Saving Toilet System Using Flexible Tube', Hong Suk Lee and Kyeong-Won Lee (Korea Polytechnic Univ., Korea), TRIZ Journal, Nov. 2003

[2] Japanese translation: "'Practical Case Study of Resolving the Physical Contradiction in TRIZ; Super Water-Saving Toilet System Using Flexible Tube', Japanese translation by Eiji Fukuzawa and Toru Nakagawa, "TRIZ Home Page in Japan", posted on Jan. 8, 2004

[3] Introduction: "A New Generation of TRIZ" , Toru Nakagawa, 1st TRIZ symposium in Japan, Sept. 1-3, 2005, at Shuzenji; "TRIZ Home Page in Japan", Sept. 20, 2005 (in Japanese and in English)

[4] Description of this case study: "USIT Case Study (3)", by Toru Nakagawa (OGU), May 13, 2015 (in Japanese), Jun. 4, 2015 (in English)

[Case 3. Toilet] Step 1. Define the Problem (1) Preparation: Development Project

In the Real World, raise an issue and prepare for a Project of problem solving

Skip

(1) Preparation: Start a Project for Developing the Water-Saving technology of Toilet

On the basis of the original paper and the talk with Prof. Lee,
this page was described by Nakagawa.

Situation: The large amount of water necessary for flushing lavatory is a serious social problem in the world. So we wish to develop a technology for solving the problem and to make a business by licensing patents. .

Target: To develop a technology of water-saving toilet system by use of TRIZ we already mastered. To make a patent of the technology and license it to some manufacturers and get the profit.

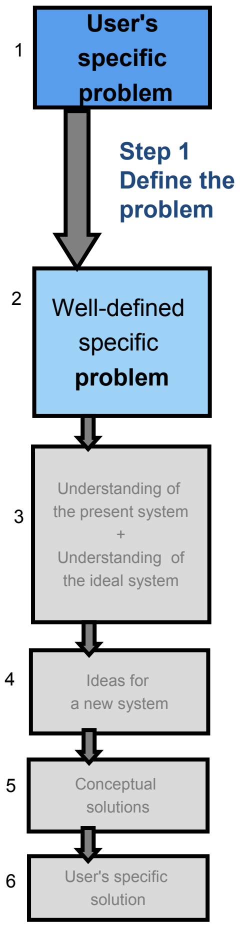
Project: A development project in a start-up company (Korea Item Development, Inc.) which was recently founded by Prof. K.W.. Lee.

Activities: Not disclosed. A technology development project with a very few member.

Team: Not disclosed. Supposedly: Main engineer: Hong Suk Lee, Manager: Prof. Kyeong Won Lee

Theme: Sanitary equipment necessary for everyday life

[Case 3. Toilet] Step 1. Define the Problem (2) Clarify the problem situations



Define the Problem (using the standard template in the USIT Manual)

Hong Suk Lee & Kyeong-Won Lee (Korea) TRIZ Journal (Nov., 2003)
'TRIZ Home Page in Japan' (Jan., 2004)

Step 1. Define the Problem

USIT Standard format is used here.

(a) An unwanted effect:

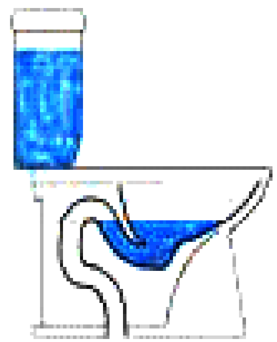
Flushing lavatory is clean and comfortable, but it wastes much water when it flushes water for sending away stool. About 6 to 13 liters at a time. This is a serious problem for the countries and seasons of shortage of water.

(b) Task statement:

Drastically reduce the amount of water necessary for flushing stool at a flushing lavatory.

(c) Simple sketch of the problem situation:

For flushing the stool, water is flushed suddenly in a much amount.



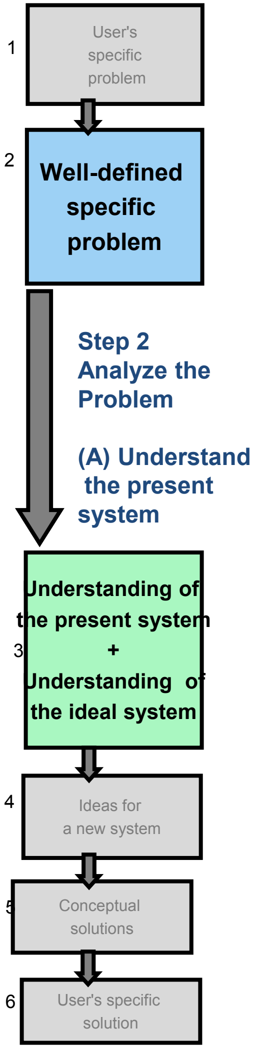
(d) Plausible root causes:

Behind the basin, the pipe is lifted in an S-shape. A large amount of water is necessary for overcoming this barrier for flushing.

(e) A minimum set of relevant objects:

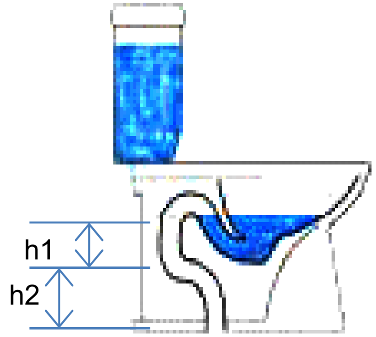
Basin, Stool, Water (water in the basin, additional flushing water) , S-shape pipe, sewerage, water tank

[Case 3. Toilet] Step 2: Analyze the Problem (A) Understand the present system



(A1) Understand the Space Characteristics

The pipe behind the basin is made in the form of S-shape:
For keeping water in the basin at ordinary period, especially during the usage of toilet, we need the height h1 about 15 cm.
For using the siphon effect at the time of flushing away the stool, the lowest part of the pipe should locate below the basin bottom by h2, about 15-20 cm.



(A2) Understand the Time Characteristics

The temporal cycles of usage are as follows:

Ordinary (non-usage) period: Keep the water in the basin, for the purpose of preventing bad smell from coming out through the pipe, and keeping the basin wall wet and clean.

During usage: The stool is kept in the water of the basin, without sticking to the basin wall.

At the end of usage: The user turns a knob (or a switch) to put additional water in the basin. The water goes beyond the top part of the S-shape pipe and the stool and water flow down through the pipe.
By the siphon effect, all the water in the basin flows down till the basin becomes empty.
Some more water is put in the basin, and return to the ordinary state.

[Case 3. Toilet] Step 2: Analyze the Problem (A) Understand the present syst

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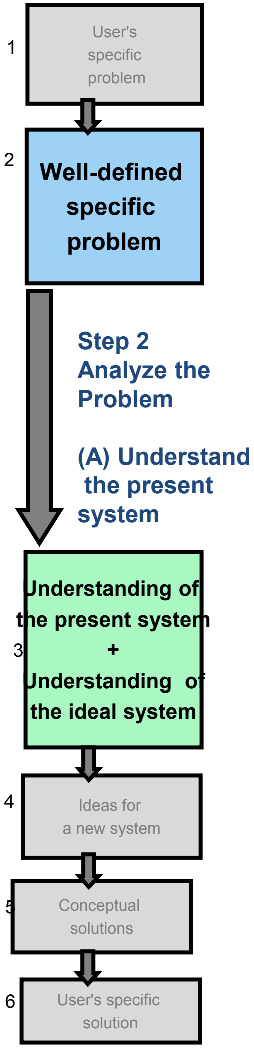
This page is inserted by Nakagawa



(A3) Understand the Attributes (properties)

Object	Attributes which increase the water requirement	Attributes which decrease the water requirement	Attributes irrelevant to the water requirement
Stool	Hardness, amount		
Water	Volume of additional water		Quality of water
Basin	Capacity of the lower part (= volume of water kept at the ordinary period)	Smoothness of wall, design of good water flow in the basin	Shape and height of the upper part, material, color
S-shape pipe	Height (h1) of the top position, diameter	Position (h2) of the bottom part	Material, color

(A4) Understand the Functional Relationships

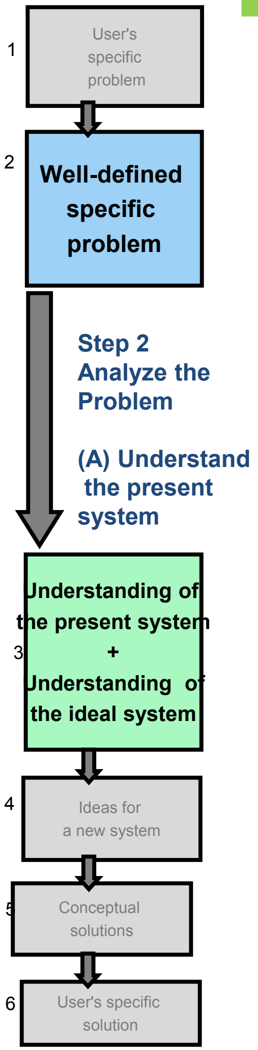
The purposes (or function) of having the S-shape pipe behind the basin are:

During the ordinary (non-use) period and the usage period, keep the water in the basin,
(in order to avoid the bad smell from coming out,
and to keep the stool in the water soft and without sticking to the wall),

At the time of flushing the stool with water, all the water goes down until the basin becomes empty .

However, the S-shape pipe is harmful because it request a large amount of water for flushing.

[Case 3. Toilet] Step 2: Analyze the Problem (A) Understand the present system



(A5) Understand the essence of the problem in terms of Contradiction

What is the essence of this problem (essence of the difficulty) ?

==> The S-shape pipe is useful, but it is harmful because it forms the barrier of flushing.

State about it more clearly.

==> The S-shape pipe is necessary AND YET better not have it (<= an obstacle)

Recognize the situation as a contradiction:

==> Request the existence of the S-shape pipe AND request Non-existence of it.

==> This is a case of Physical Contradiction in TRIZ

requesting the Existence / Non-existence of the S-shape pipe.

Can we separate the opposing requirements in terms of Space, Time, Conditions, etc.?

==> They are separable in terms of time (and condition)

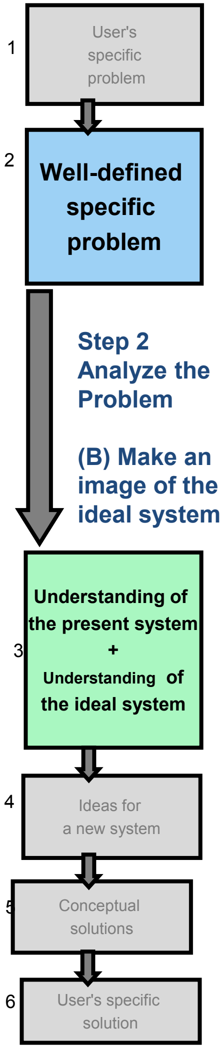
Ordinary period: Request the existence of the S-shape pipe.

During flushing: Request 'No existence of the S-shape pipe .

This page is the essence of the problem-solving method of TRIZ.

In USIT, the time characteristics analysis will reveal this contradiction.

[Case 3. Toilet] Step 2: Analyze the Problem (B) Make an image of the ideal system



(B1) Consider with Separation Principle (Altshuller's method)

Separate the requirements in time (or in condition) and generate the ideas to fulfill each requirement fully:

==> ordinary period: Existence of the S-shape pipe (the same as the present state)
flushing period: No existence of the S-shape pipe.
(The pipe can be straight down behind the basin.)

The ideal situation (which eliminates the contradiction) is the solution satisfying the two solutions at the same time:

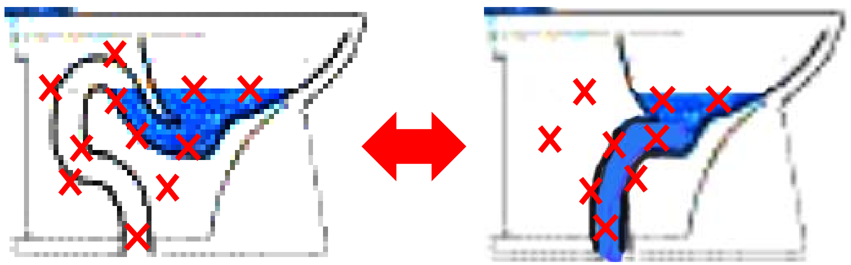
==> S-shape pipe EXISTS during the ordinary period AND
DOES NOT EXIST at the time of flushing.

To achieve the ideal situation, we go ahead to Step 3; Generate ideas.

(B2) Consider with Particles method (Sickafus' method)

Sketch of the Ideal system:

This sketch is based on the understanding of the ideal situation, obtained in the above (B1)



[Case 3. Toilet] Step 2: Analyze the Problem (B) Make an image of the ideal system

(B2) Consider with Particles method (continued)

This page is inserted by Nakagawa

1 User's specific problem
2 Well-defined specific problem
Step 2 Analyze the Problem
(B) Make an image of the ideal system
3 Understanding of the present system + Understanding of the ideal system
4 Ideas for a new system
5 Conceptual solutions
6 User's specific solution

(d) Desirable behaviors (to be performed by the magical Particles)

Skip

To reduce the amount of water necessary for flushing at the toilet

The S-shape pipe exists during the ordinary period and does not exist while flushing

The piping in the back changes its shape, and while flushing no S-shape (no lifting in the middle)

The change occurs in parallel to the flushing operation

Piping in the back is made flexible (in structure or material, partly or entirely)

A part of piping in the back is movable up & down

The flushing moves the pipe up & down by itself

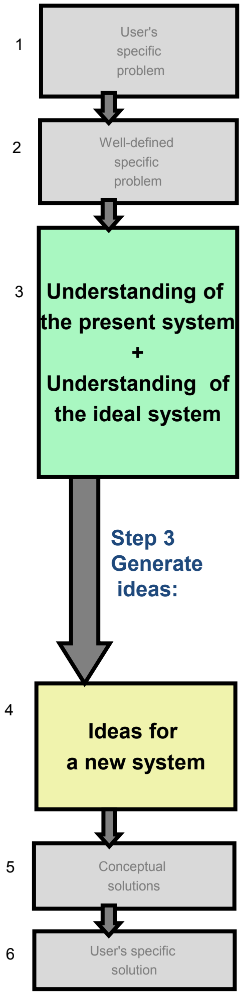
(e) Desirable properties

Made of flexible plastic, entirely.
Made of flexible plastic, partly
Bellows structure
Extend/shrink
Passible to bend
Switching between two different piping systems

Pull it up
Support with a bar
Slam it down
Using a chain

Mechanical synchronization
Connect with a chain
Electrical synchronization
Turn on a motor
Operate with pulley and chain
The weight of water in the pipe

[Case 3. Toilet] Step 3: Generate Ideas



(1) Generate ideas with the Separation Principle of Physical Contradiction

Requirement: S-shape pipe EXISTS during the ordinary period AND DOES NOT EXIST at the time of flushing

==> The S-shape pipe does not necessarily mean the **present metal pipe**;
it is called because of its shape, where the middle of the pipe is lifted.

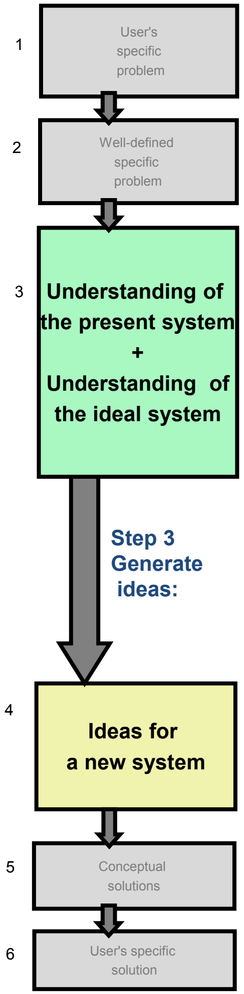
==> The pipe behind the basin is of **S-shaped (lifted at the middle)** in the ordinary period,
while it is not of S-shaped (not lifted in the middle) during flushing.

==> The pipe should **change its shape** in such a manner depending on the time.

==> For such a purpose, the pipe may be **made of some flexible tube** of plastics.

It is important to be able **to change the viewpoints** as written above.
By learning various examples, we may have such a capability.
This way of thinking may be more widely applicable and effective than simply trying to search for some suitable inventive principles.

[Case 3. Toilet] Step 3: Generate Ideas



(2) Basic ideas integrating various ideas stimulated by the problem analysis

Skip

- The pipe behind the basin is lifted in the middle (in an S-shape) during ordinary period, while is not lifted during the time of flushing.

- For this purpose, the pipe is **made of flexible tube**, either entirely or in two end places.

- The pipe (in the middle) is lifted and lowered smoothly by use of the flexible bending at some proper parts.

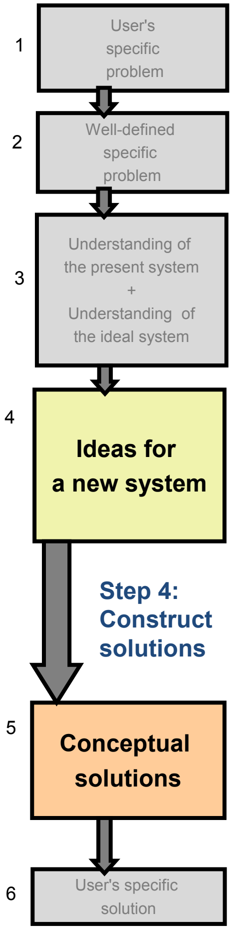
- When lowered, the **pipe may be slammed down**.

- The motion of up and down should be synchronized with the flushing operation. Mechanical links and electrical switching/motors may be used.

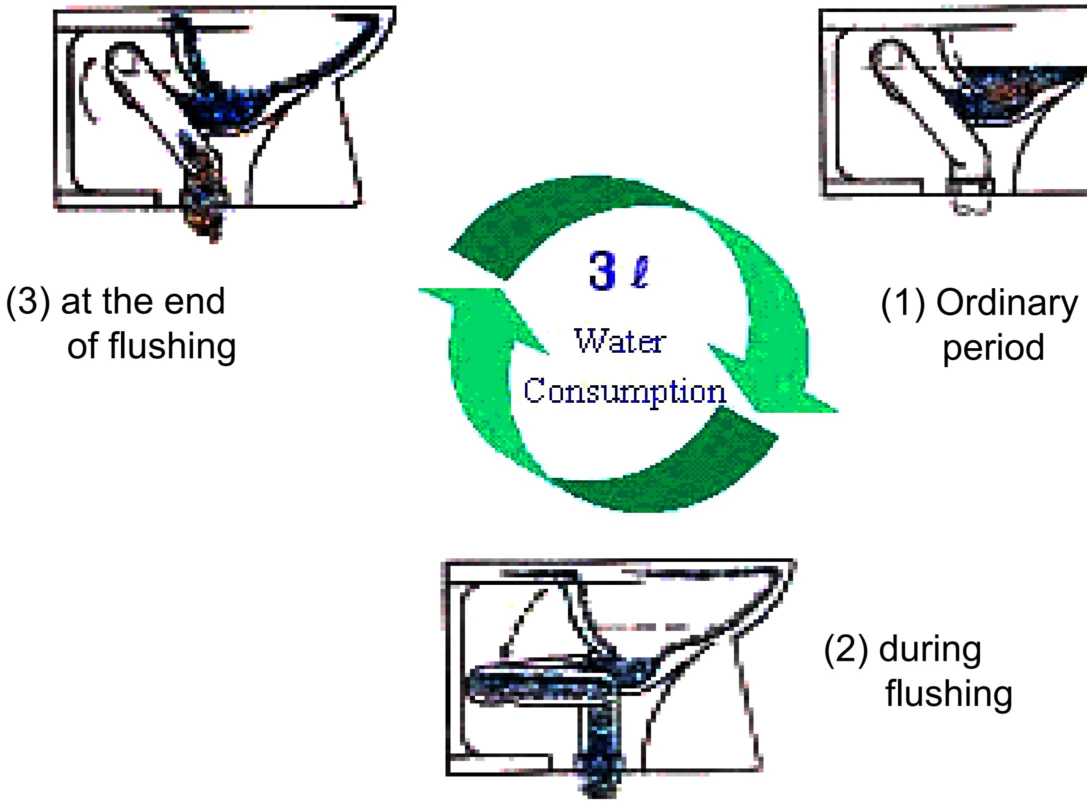
.

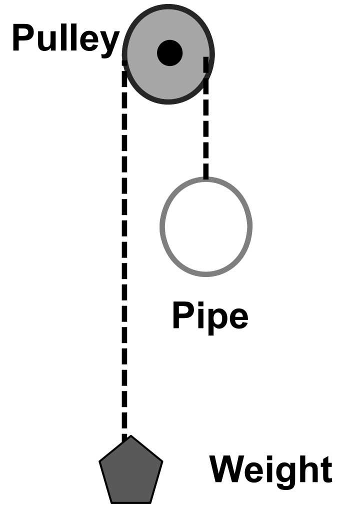
- It is a good idea of moving the pipe **up and down by itself** with the weight of water in the pipe by use of a pulley and a balance weight mechanism

[Case 3. Toilet] Step 4: Construct Solutions (2) Construct the conceptual solutions



On the basis of the basic ideas in the previous step, the conceptual solution is constructed:





When the water is flushed for removing the stool, the pipe filled with water becomes heavier than the balance weight and slam down to the floor. At the end of flushing, the pipe becomes empty and comes up **by itself**. .

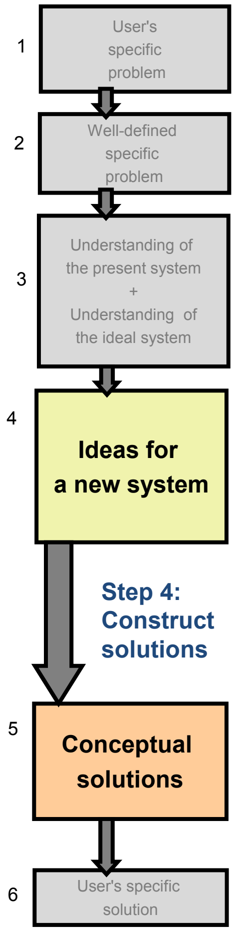
'By itself' is a form of an ideal in the sense of TRIZ.

[Case 3. Toilet] Step 4: Construct Solutions (3) Report the results

Skip

This page is inserted by Nakagawa

(3) Report the results as a development project



Because this project was carried out in a small start-up company, the usual process for a problem solving team to report the results to its parent project in the company seems to be skipped.

The results were evaluated highly and the next process of 'Implement the Solution' was started quickly.

The results of the problem solving (USIT) project may be summarized as follows:

(1) A good conceptual solution was obtained for reducing much the required amount of water for flushing at a toilet. It can be an important technology which can contribute to solve the problem of shortage in water supply.

(2) The familiar problem that the S-shape pipe of the toilet is an obstacle for flushing and causing much water has been recognized as a case of the Physical Contradiction in TRIZ and has been solved completely by the introduction of a flexible tube in place of the metallic S-shape pipe.

(3) The amount of required water has been reduced from conventional 13 liters (or 6 liters for some cases) to only 3 liters.

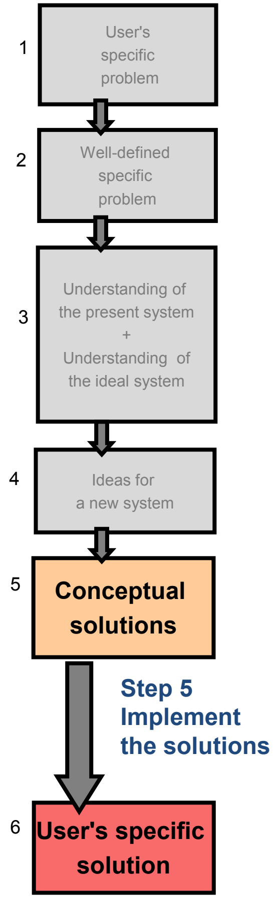
(4) We should now go ahead to make a prototype of the solution, examine the effectiveness, clear the possible secondary problems of the clogging of the sewerage lines, file the patent, license the patent, and make it commercialize.

(5) We should also report the project as a TRIZ case study in a journal.

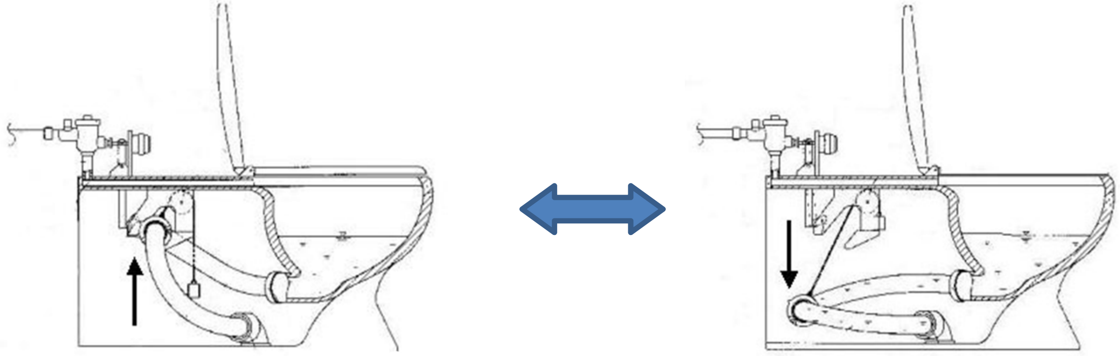
[Case 3. Toilet] Step 5: Implement the Solutions : (Real activities in the 'Real World')

Make a prototype of the solution

Skip



A rough design of a prototype:



a design for commercial facilities: a flushing valve is used, no water tank

A design for home: with a water tank of 3 liters

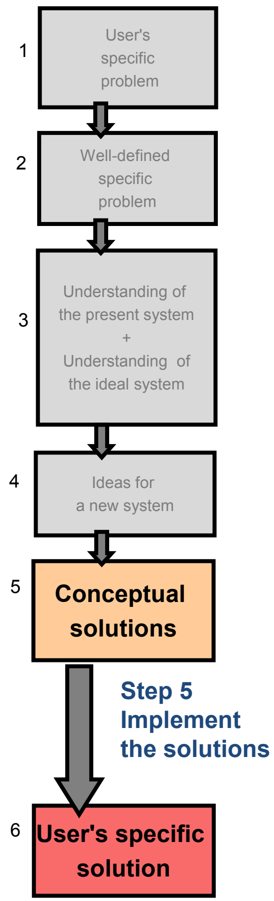
The pipe behind the basin is made of a flexible plastic tube, which is strong for warm /cold, persistent against acids, and of antibacterial property.

The flushvalve (self-closing faucet) was taken from the ordinary one for flushing urine.

[Case 3. Toilet] Step 5: Implement the Solutions : (Real activities in the 'Real World')

Performance test and reliability test

This is a summary of the description of original paper.



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(1) Following the criteria defined by the Korean Standards L1551, the performance test of cleaning the basin was carried out by use of rumpled paper and aniline dye. Required amount of water has been evaluated as 3 (±0.5) liters.

(2) Using a test equipment for pushing the flushing valve 4 times per minute, the persistence of the prototype was tested with success for 165,000 times of flushing (equivalent to 20 years of usage).

(3) The resistance test against chloric acid and bleaching agents is also OK.

(4) The sewerage pipe below the basin is usually made of polyvinyl chloride or iron, having 100 mm in diameter, and is set with the slope of 1/50.
The test of usage of the present water saving toilet was successful without clogging the pipe.
A prototype of the present solution was actually installed in a public restroom in a metro station, and the inner wall of the sewerage pipe at 30 m down-stream was examined with an industrial inner scope and found no problem.

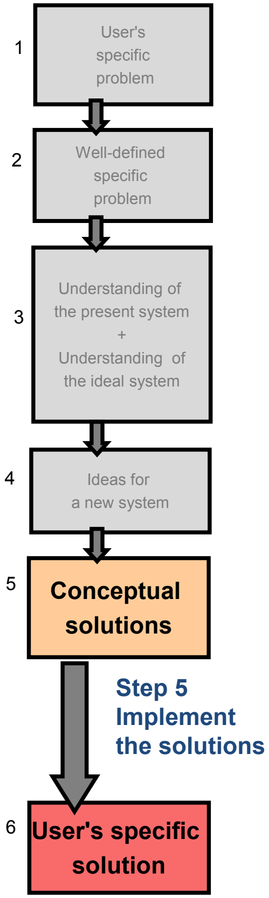
(5) The noise of flushing water of toilet sometimes causes troubles in apartment buildings at night.
By the actual measurement of the noise, the present prototype resulted 60 db in contrast to 70 db for ordinary ones; thus reducing the noise by 10db.

In conclusion, a prototype of water-saving toilet system with only 3 liters of water requirement is now developed successfully with assured reliability.

[Case 3. Toilet] Step 5: Implement the Solutions : (Real activities in the 'Real World')

This page is a summary of the description of original paper. plus comments

Filing a patent and trials of commercialization



(1) The original authors published their paper in the TRIZ Journal in Nov. 2003.

Skip

(2) The authors filed their patent in Korea, Singapore, and USA. And at the time of th
paper publication, a patent in USA was already granted, they say.

(3) Eiji Fukuzawa (TOTO Ltd.) and Toru Nakagawa translated the original paper into Japanese and posted it in 'TRIZ Home Page in Japan' on Jan. 8, 2004.

(4) Fukuzawa wrote a Postscript Note (dated Nov. 11, 2003) to discuss on this solution as follows:

(a) TOTO developed a water-saving toilet system with a fixed S-trap and sell it in USA. Because of the necessity to flush the stool down to the sewage main pipe, the toilet uses 6 liters of water.

(b) About 20 years ago, TOTO introduced to sell a US technology which uses pressurized air to transport the stool to the sewage main pipe with 2 liters of water; But Japanese municipal sewage offices in cities did not give permission of the system, probably in the risk of clogging of the sewage pipe.

(c) A toilet system using vacuum for flushing was permitted by the government and in the market.

(d) In Japan Matsushita Electric Works sells a 'turn-trap' toilet system (where the S-shape pipe changes its shape).

(5) At the time of 2004, neither TOTO nor Matsushita claimed against the patent of the present work and show any interest in the license of the present patent

I do not know the current situations about the patents, licenses, commercial products, markets, etc. in relation to the present case study.

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)

Thinking World

Box 3

Understanding of the ideal system

Ideal system is:
The S-shape pipe exists during the ordinary period of time AND it does not exist during flushing the water.

Understanding of the present system

The S-shape pipe is necessary and useful AND YET it is an obstacle and harmful, and must be eliminated for flushing with less amount of water.
(Physical Contradiction)

Analyze the Problem .

Generate Ideas

(USIT Operators, etc.)

Box 4

Ideas for a new system

Make the s-shape pipe flexible and change the shape; the middle part is lifted in ordinary period and lowered during the flushing.

The pipe moves up/down by itself with the weight of water in the pipe, by use of pulley and balance.

Construct Solutions

Box 2

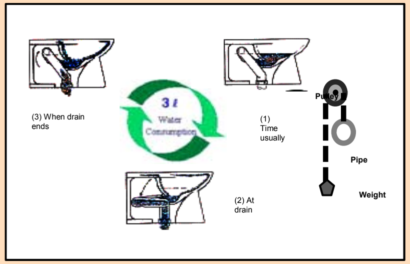
Well-defined Problem

.Want to reduce the amount of water requirement in the toilet system.

The S-shape pipe is necessary but is an obstacle for flushing the stool away with water. .

Box 5

Conceptual Solutions



Implement the solution

Real World

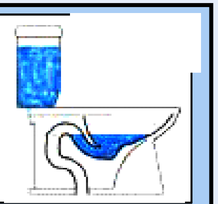
Define the problem

Box 1

Initial problem situations

(User's specific problem)

Toilet system requires a much amount of water (about 13 liters)



Box 6

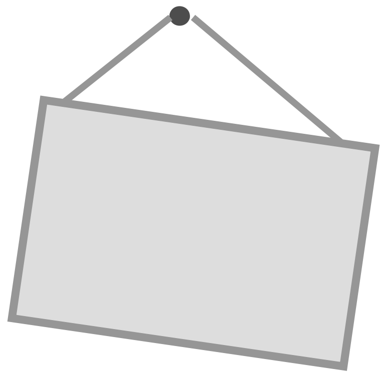
Implemented Solution

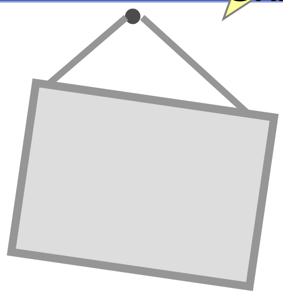
(User's specific solution)

Prototype is made and tested 3 liters of water

USIT Case Study 4.

Picture Hanging Kit Problem





USIT Case Study 4. Picture Hanging Kit Problem

References:

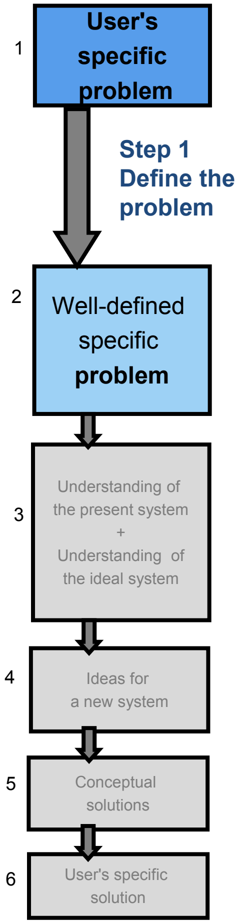
[1] Source: Ed Sickafus (Ford Research Lab. & Ntelleck): "Unified Structured Inventive Thinking: How to Invent", Ntelleck, 1997, pp. 439-442;
"Picture Hanging Kit Problem", Japanese translation: Toru Nakagawa, "TRIZ Home Page in Japan", Mar. 23, 2001

[2] Introduction: "Commentary on "The Picture Hanging Kit Problem"", Toru Nakagawa, (Discussion by Ed Sickafus), "TRIZ Home Page in Japan", Jul. 31, 2001 (in Japanese); Aug. 23, 2001 (in English)

[3] Introduction: "A New Generation of TRIZ" , Toru Nakagawa, 1st TRIZ symposium in Japan, Sept. 1-3, 2005, at Shuzenji;
"TRIZ Home Page in Japan", Sept. 20, 2005 (in Japanese and in English)

[4] Description of this case study:
"USIT Manual", Toru Nakagawa, May, 2015 (in Japanese), Jun. 2015 (in English);.
"USIT Case Study (4) Picture Hanging Kit Problem", Toru Nakagawa (OGU), May 15, 2015 (in Japanese), Jun. 8, 2015 (in English)

[Case 4. Picture] Step 1. Define the Problem (2) Clarify the problem situations



Through the group discussion, the problem is made clear.

Step1: Define the Problem (in the USIT standard template)

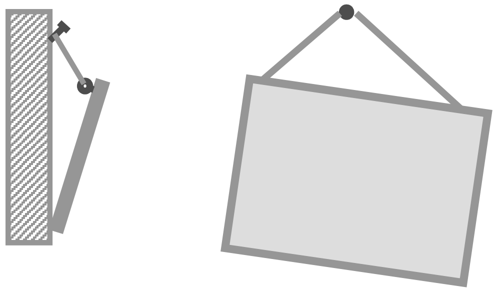
(a) An unwanted effect:

A picture is hung on a wall in a typical way by using a nail , a string, and two hooks, but it is apt to be tilted afterwards without knowing.

(b) Task statement:

Improve the ordinary picture hanging kit (with a nail, a string, and two hooks), so as the picture not likely to be tilted

(c) Simple sketch of the problem situation:



Drawing the sketch is important to understand the mechanism of the system/problem.

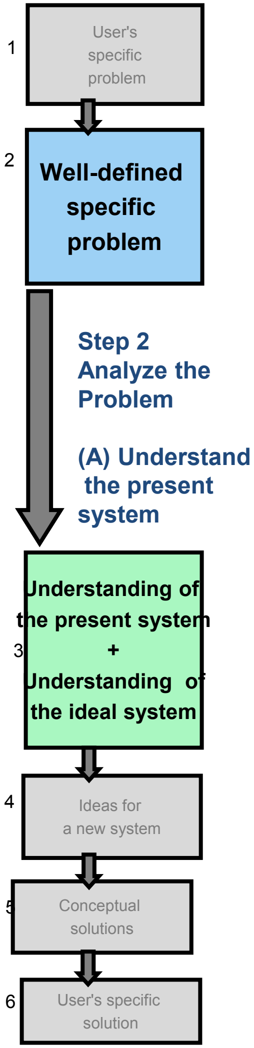
(d) Plausible root causes:

In case of vibration from the wall,
the string slips on the nail and the picture frame is tilted .

(e) A minimum set of relevant objects:

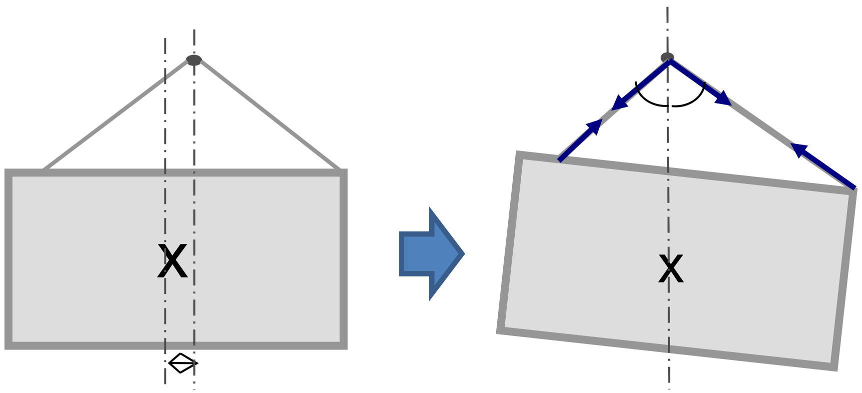
A picture frame (including the picture, frame, glass, etc.), a nail, a string, two hooks, and wall

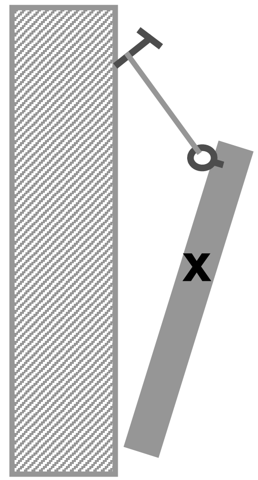
[Case 4. Picture] Step 2: Analyze the Problem (A) Understand the present system



(A1) Understand the Space Characteristics

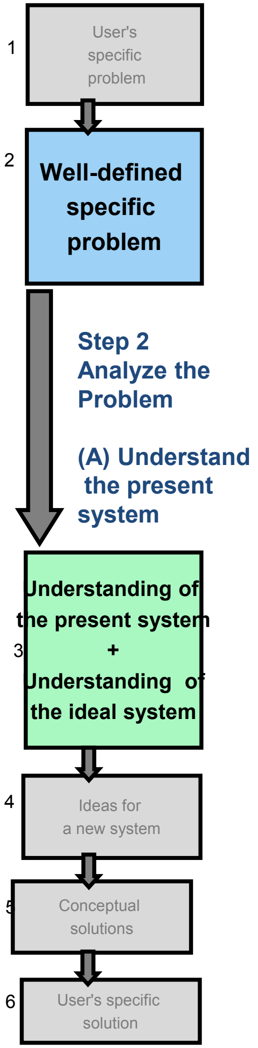
In this problem, the spatial arrangement (e.g., tilting) is the results of the balance of forces and torques. Thus it is essential to examine and understand the mechanical relationships correctly.



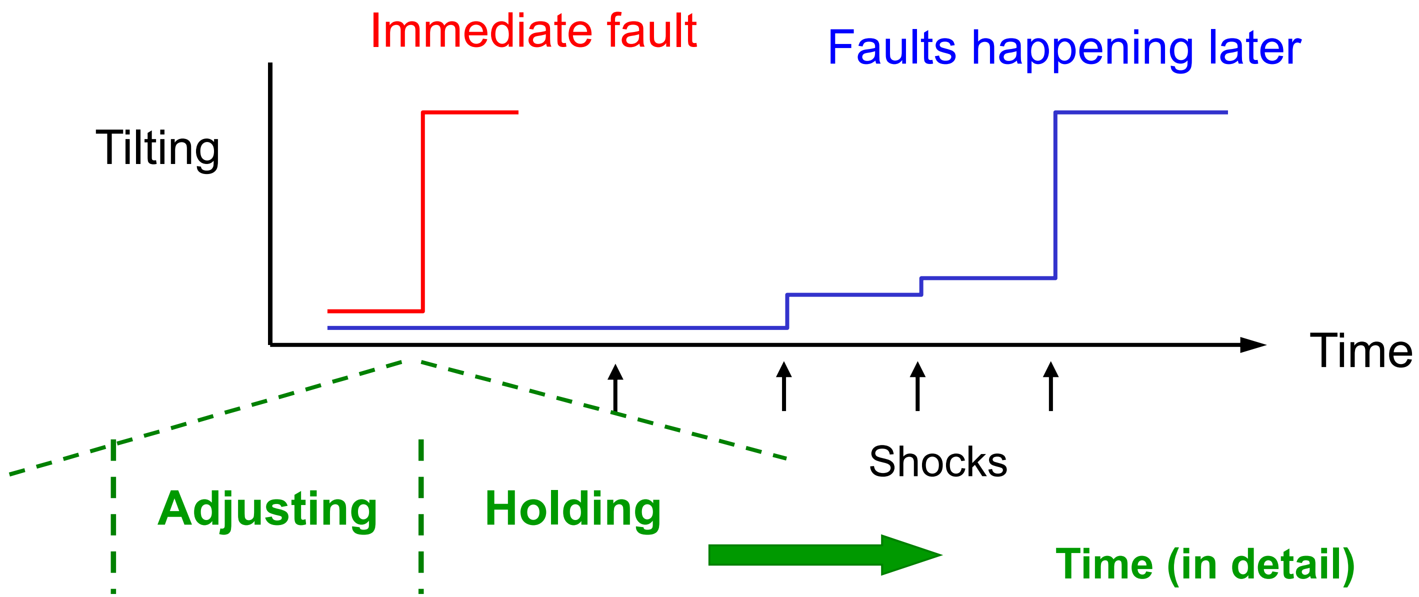


When we adjust the frame in the horizontal position, the center of mass of the frame must be located just below the nail. Otherwise, due to a torque the string slips at the nail and the frame will be tilted.

[Case 4. Picture] Step 2: Analyze the Problem (A) Understand the present system



(A2) Understand the Time Characteristics

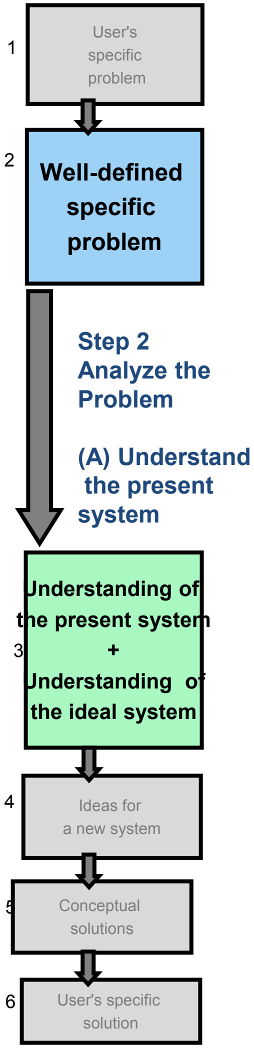


The string on the nail | should move smoothly | must not move | ==> 'Physical contradiction'

"Requirements while adjusting and requirements while holding the frame are different."
-- This is a very simple observation everyone knows, AND YET it is found to be the essence of the present problem.

The recognition of this contradiction will give an important effect on the solution process and on the evaluation of the solution concepts.

[Case 4. Picture] Step 2: Analyze the Problem (A) Understand the present system



(A3) Understand the Attributes (properties)

The table here is easier to understand than Sickafus's QC graphs

Attribute = Category of properties

List up the relevant attributes as much as possible and understand the mechanism

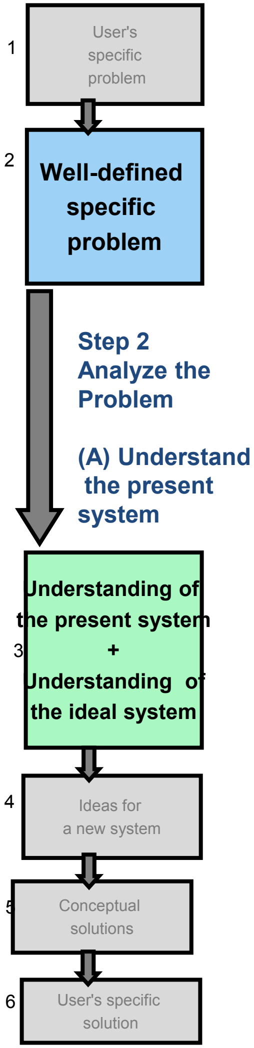
==> Enhance the understanding of the plausible root causes and prepare for the idea generation

Unwanted effect of this problem = Frame's easiness to tilt

Object	Attributes which increase easiness of picture frame tilting	Attributes which decrease easiness of picture frame tilting	Attributes irrelevant to the easiness of picture frame tilting
Picture frame	Offset of the center of mass from just below the nail., Asymmetry of shape & weight		color, width, length, thickness, weight
Hooks	Offset from the symmetric positions	adjustment of positions	
String	Slipperiness	Friction of string with the nail	Thickness, length, color
Nail	Slipperiness on the surface	Friction with the string, angle	Material, length, thickness
Wall	Vibration of wall	Friction with the frame bottom	Color, oldness

[Case 4. Picture] Step 2: Analyze the Problem (A) Understand the present system

(A4) Understand the Functional Relationships

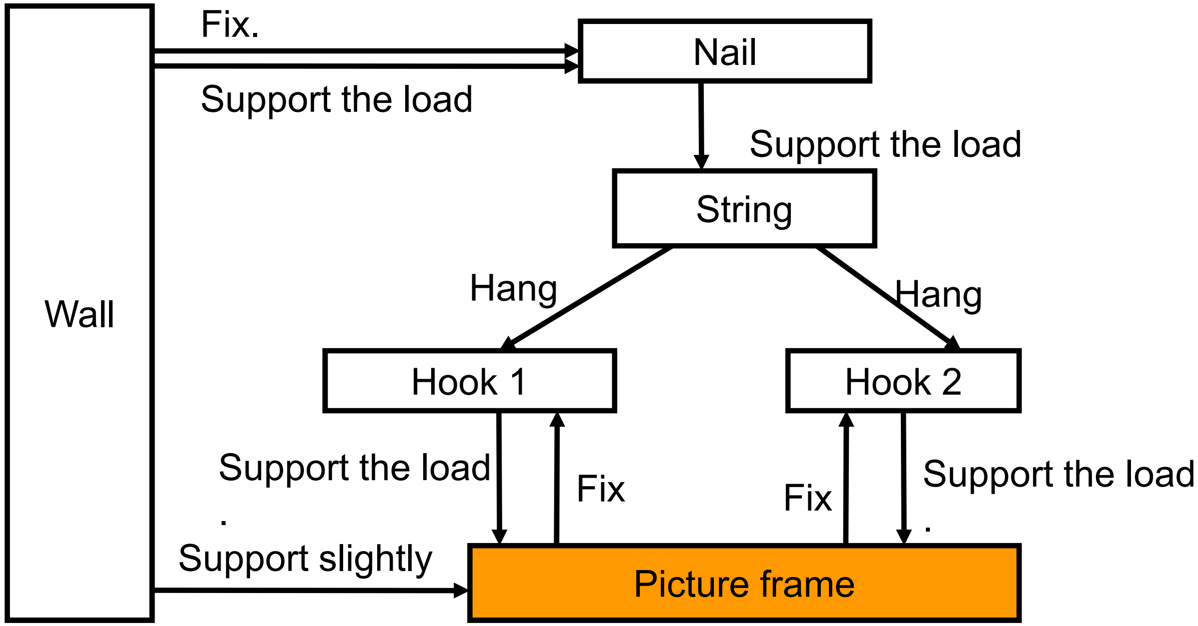


Terms related to the Interactions between objects:

- **Action** (or Function in a wider sense) **:** The interaction is viewed as a work from one object to the other.
- **Function (in a narrow sense):** Action regarded useful
- **Harm:** Action causing bad results (for people)

Depending on the problem, a same system can be viewed in different aspects and hence with different functional relationships.

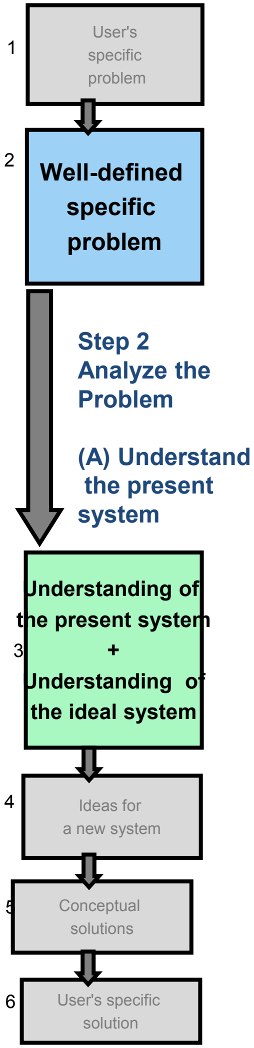
Thus, **the functional diagram below is NOT suitable for the present problem.**



On the arrangement/tilt of the picture frame (and its adjustment and holding), no information is available in this diagram.

[Case 4. Picture] Step 2: Analyze the Problem (A) Understand the present system

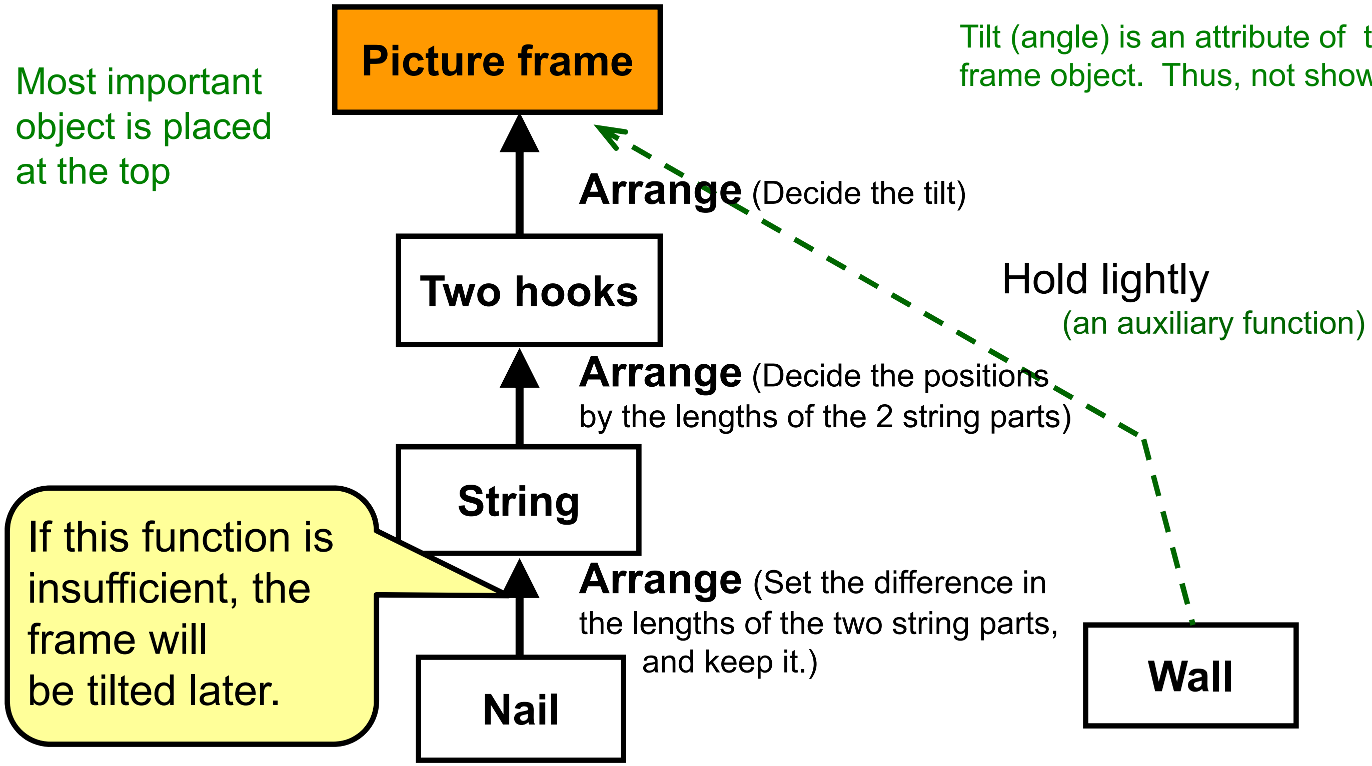
(A4) Understand the Functional Relationships (continued)



Clarify the mechanism and designer's intention of the present system for holding the frame without tilting.

The USIT way of Functional diagram

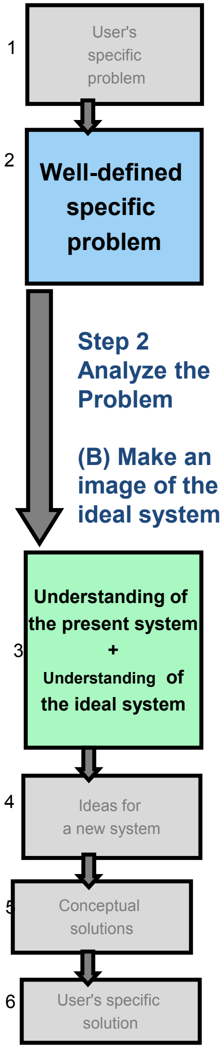
Tilt (angle) is an attribute of the picture frame object. Thus, not shown here.



Auxiliary functions are drawn in broken lines.

Harmful or insufficient functions may be commented explicitly, if significant.

[Case 4. Picture] Step 2: Analyze the Problem (B) Make an image of the ideal system



(B1) Consider the Ideal system with Separation Principle (Altshuller's method)

Formulate the problem in terms of the Physical Contradiction:

==> While adjusting the picture frame,
the string **must move smoothly** on the nail;
While holding the picture frame after finishing the adjustment,
the string **must NOT move** on the nail.

==> This is a case of Physical Contradiction, separable in time

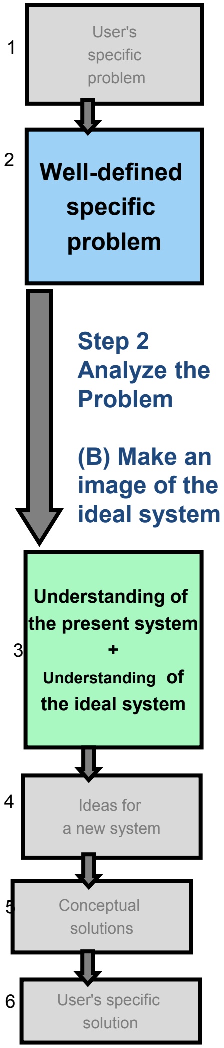
State the Ideal solution overcoming the Physical Contradiction
by use of the Separation Principle (in case of separable in time):

==> The string **moves smoothly** on the nail
while adjusting the picture frame, AND
the string **DO NOT move** on the nail
while holding the picture frame after finishing the adjustment,

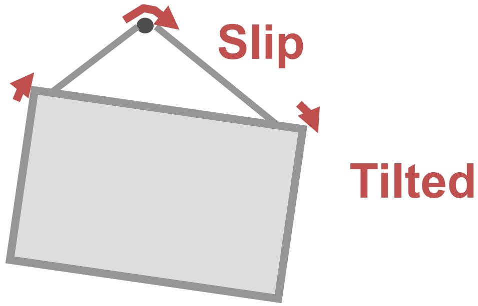
.

[Case 4. Picture] Step 2: Analyze the Problem (B) Make an image of the ideal system

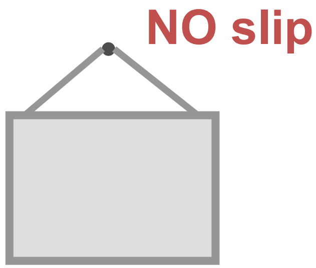
(B2) Consider the Ideal system with the Particles Method (Sickafus's method)



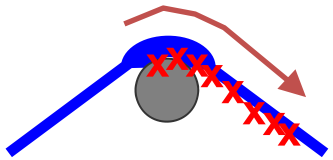
(a) Sketch the present system



(b) Sketch the ideal system
(as the result of achievement)



(c) Draw x marks at the places of any difference between (a) and (b):
Call x marks 'Particles'.



The Particles are supposed to be magical things/fields which can have any property and can make any behavior.

[Case 4. Picture] Step 2: Analyze the Problem (B) Make an image of the ideal system

Skip

(B2) Consider the Ideal system with the Particles Method (Sickafus's method) (Continued)

1 User's specific problem

2 **Well-defined specific problem**

Step 2 Analyze the Problem

(B) Make an image of the ideal system

3 **Understanding of the present system + Understanding of the ideal system**

4 Ideas for a new system

5 Conceptual solutions

6 User's specific solution

***

(d Desirable behaviors

Not Ideal but practical goals

Once the frame is hung correctly, it never tilt or hardly tilt afterwards

AND / OR

- When we set the frame, we can adjust the frame smoothly at the correct position
  - AND / AND
  - correctly with no tilting
  - Sense of no tilting
  - Easy to adjust the tilting
- Once the frame is set, it never tilts for a long time
  - OR
  - Hold the frame at no tilt position tightly
  - Tilting returns at the no-tilt position
- Once the frame is set, it hardly tilts for a long time
  - Hold the frame at no tilt position

(e) Desirable Properties

Lengths of string in two parts

Balance of the center of mass

Hook adjustment

Wall support

Auto-adjusting

Horizontal degree of the frame

Vertical degree of the frame

Smoothness of nail

Smoothness of string

Degree of freedom of adjustment

Fixing the string at the nail position

Strength of the fixing

Clinging

Fixing to the wall

Resilience

Elasticity

Automatic adjustment

Electro-magnet

Friction

Roughness of nail surface

Pressure

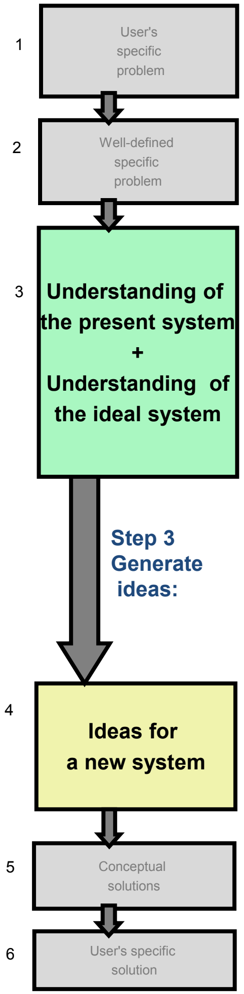
Strength of holding

Vibration suppression

[Case 4. Picture] Step 3: Generate Ideas (1) Write down the ideas stimulated by the analyses

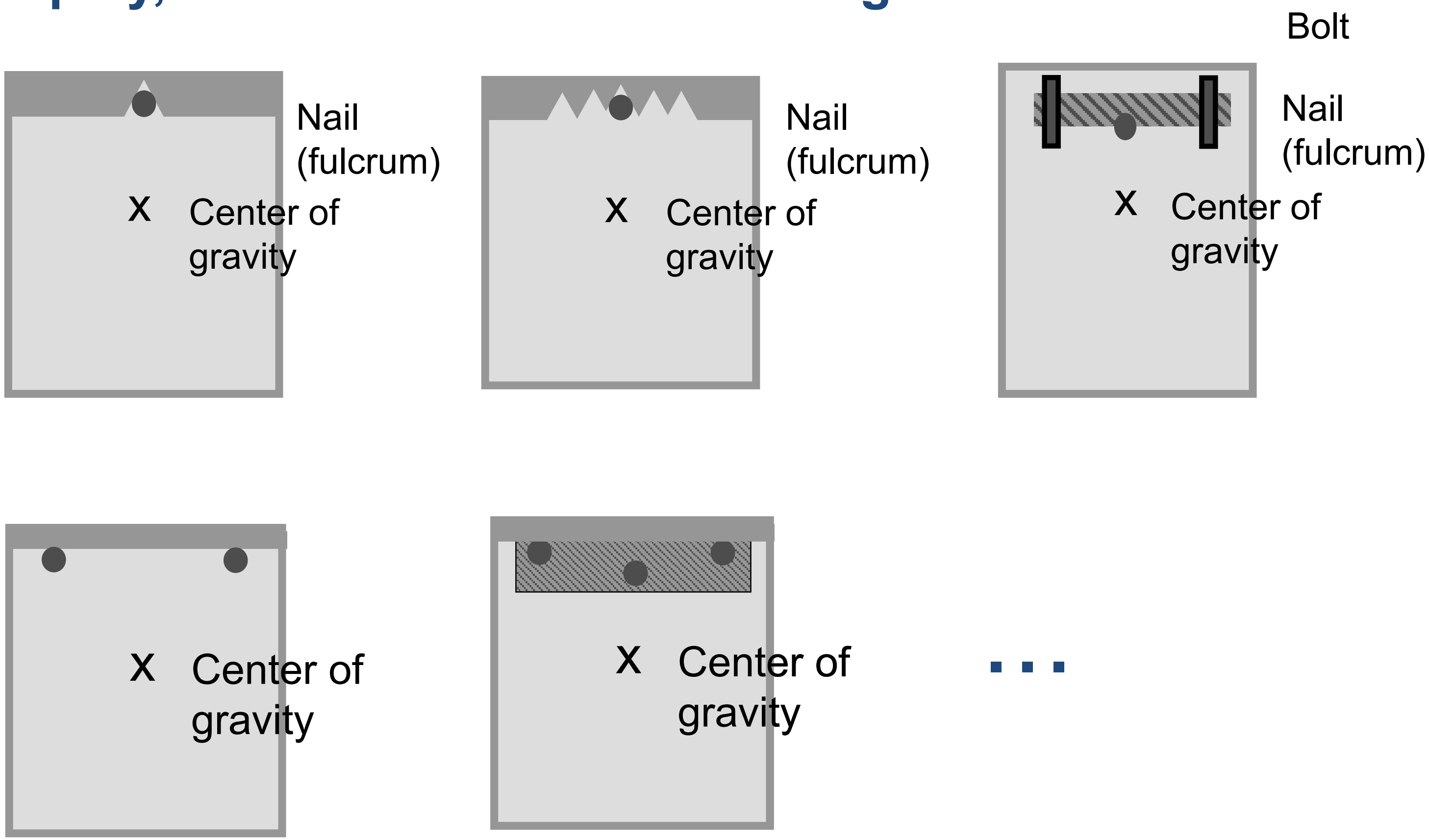
Skip

(1) Write down the ideas freely with the stimulation of the analyses

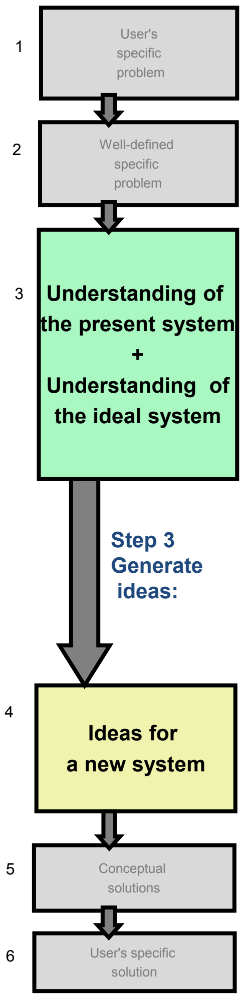


Description by Sickafus in his USIT Textbook [1], as shown in Nakagawa's introductory article [2]

Simplify, and use associative thinking.



[Case 4. Picture] Step 3: Generate Ideas (1) Write down the ideas stimulated by the analyses

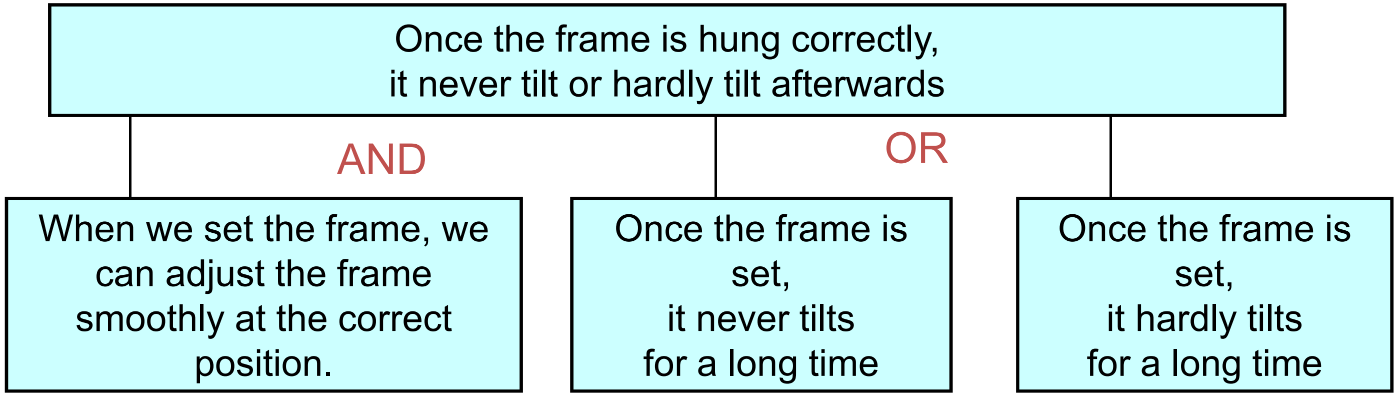


Generate various ideas as much as possible:

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 for the string to slip 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)
- ...

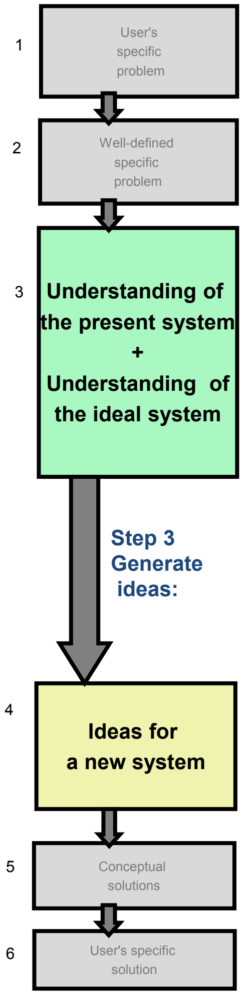
Build them into a hierarchical system

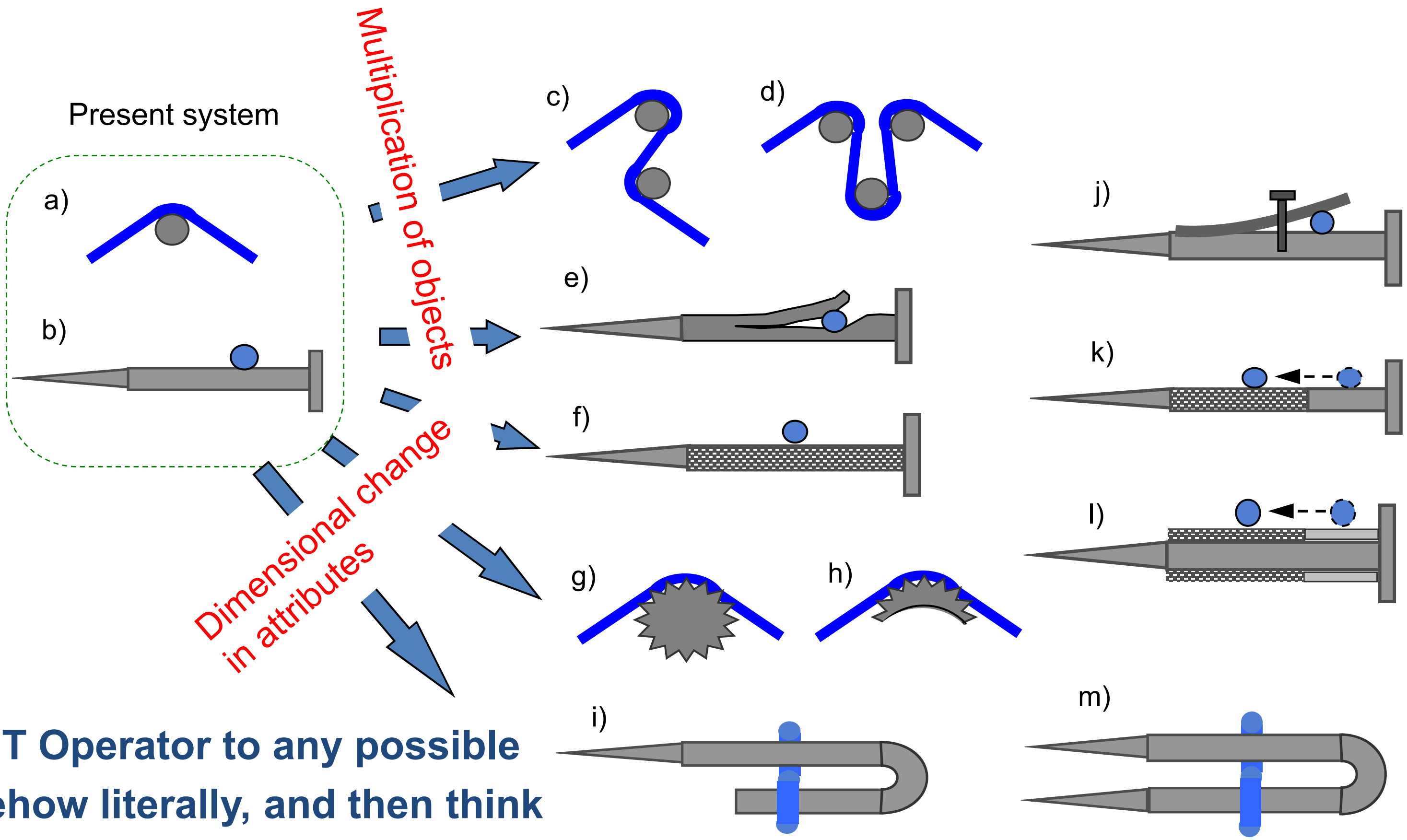


[Case 4. Picture] Step 3: Generate Ideas (2) Apply various USIT Operators intently

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

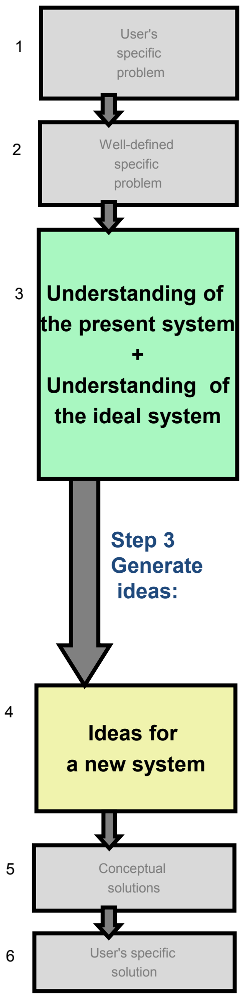
The USIT Operators are the integrated and reorganized system of all the solution generation methods developed in TRIZ and USIT. (5 main-, 32 sub-Operators)





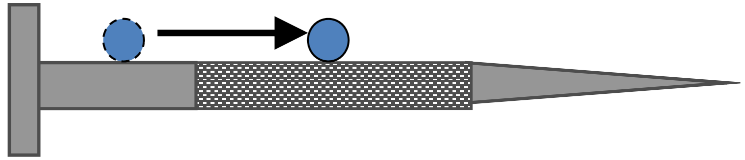
Apply a USIT Operator to any possible target somehow literally, and then think of an idea of making good use of it.

[Case 4. Picture] Step 3: Generate Ideas (2) Apply various USIT Operators intently



An idea can be interpreted in multiple ways of applying USIT Operators:

(Example) Sickafus' Nail



(a) Object Multiplication Method:

Divide the nail into two parts, differ the surface properties and combine them again.

(b) Attribute Dimensional Change Method:

Smoothness attribute of the nail was changed by places.

(c) Function Redistribution Method:

The adjustment and maintenance functions of the nail are allocated to different parts of the nail.

(d) Solution Combination Method:

(d1) Solution Combination in Space:

Solution of a smooth nail and solution of a rough nail are combined by the places.

(d2) Solution Combination in Time:

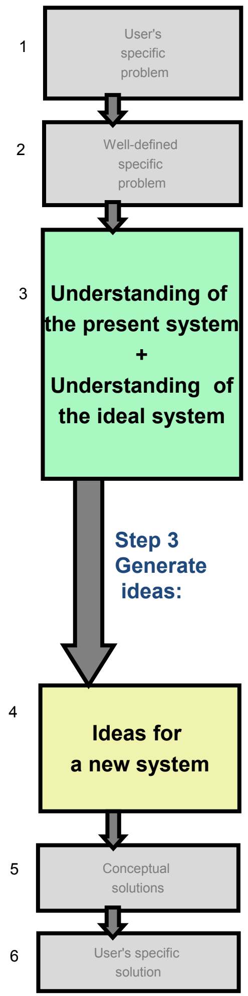
Solution of a smooth nail and solution of a rough nail are combined in time..

An idea can be interpreted in multiple ways of applying USIT Operators

==> Several USIT Operators can derive a solution.

The interpretation (d2) 'Solution Combination in Time' is most meaningful in this case, because it corresponds to **solving the Physical Contradiction by Separation in Time**.

[Case 4. Picture] Step 3: Generate Ideas (3) Resolving the Physical Contradiction



(3) Ideas generated by the recognition of the Physical Contradiction

Recognition of the Physical Contradiction has guided us the Ideal solution:

"The string moves smoothly on the nail while adjusting the picture frame, AND the string DO NOT move on the nail while holding the picture frame after finishing the adjustment,"

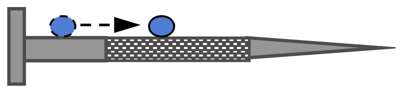
This guide us to a solution idea, straightforwardly:

" Just after finishing the adjustment, we should do some operation for making the string do not move (i.e. fixed) on the nail."

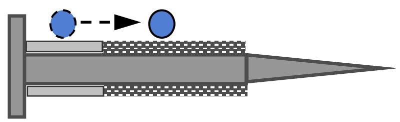
Fixing can be done by clipping, pressing, adhesion, pasting, binding, etc.

Some examples of solutions along this guideline:

k)

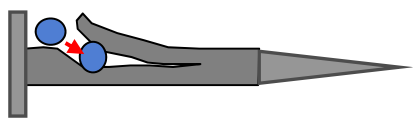


l)

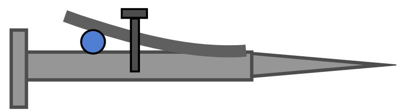


Solutions to make the string hard to move.

e)

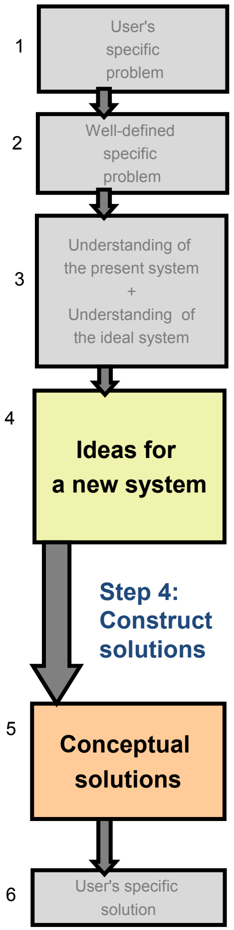


j)



Solutions to make the string impossible to move.

[Case 4. Picture] Step 4: Construct Solutions: (1) Evaluate and select ideas (2) Construct the conceptual solutions



(1) Evaluate and select ideas

In the present case, **"Overcoming the Physical Contradiction, or not"** is the clear and good criterion for the solution evaluation

The string is fixed (or made not to move) while the holding period
==> Made never tilt. ==> Good solution

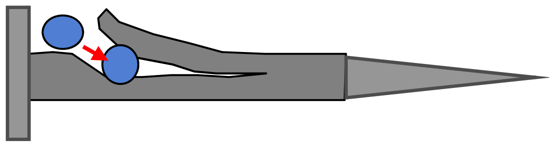
The string has larger friction with the nail while the holding period .
==> Made hardly tilt ==> Fair (not quite good) solution

(2) Construct the conceptual solutions

Solution where the picture frame never tilt.

Example:

e)

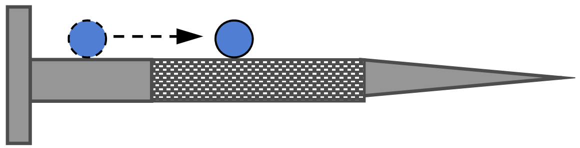


·

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.
Whenever necessary, after the exhibition, etc., the string may be released by hand easily

Solution where the picture frame hardly tilt.

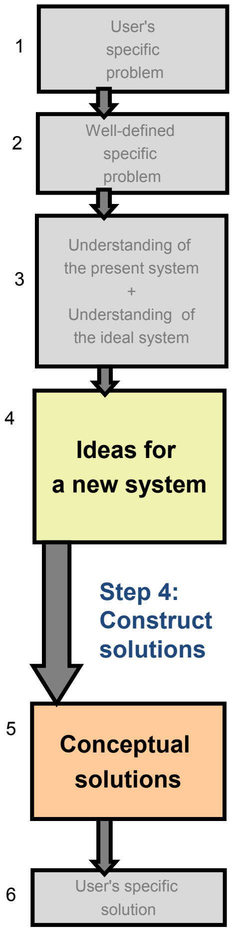
k)



[Case 4. Picture] Step 4: Construct Solutions: (3) Report the results

Skip

Finalize as a Case Study and Report it. Conclusion as the Case Study.



USIT was applied to a familiar problem "Improve the picture hanging kit so as to make the picture never/hardly tilt" and its process is shown.

This is a standard USIT Case Study, where the USIT process and its representation have been improved many times so far.

The methods for understanding the present system have been improved in all the aspects of space, time, attributes, and functions.

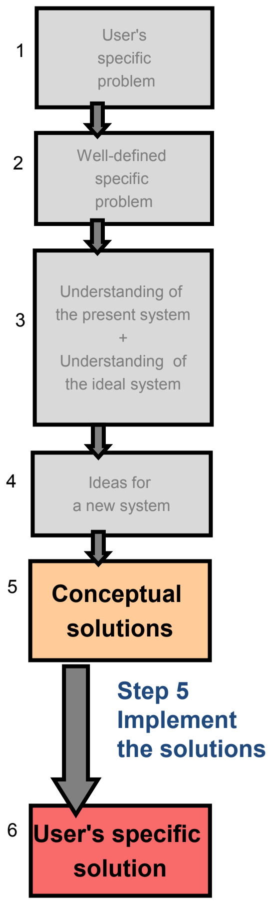
The methods of idea generation are integrated into the USIT Operators and are demonstrated with the examples in this case study.

These experiences and improvements have been described and reported at conferences and seminars, and posted in "TRIZ Home Page in Japan".

A standard USIT Case Study on a familiar problem, easy to understand for everybody and yet deep in thoughts.

[Case 4. Picture] Step 5: Implement the Solutions : (Real activities in the 'Real World')

Skip



In the present case, we have not yet tried any of designing, prototyping, manufacturing, marketing, etc.

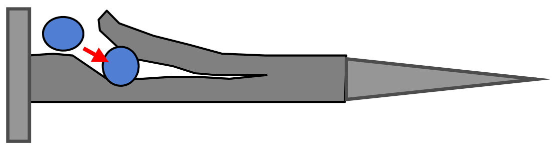
For such a trial, we should select some good solution concepts among the ones obtained in the preceding step.

Especially, an improved nail which has overcome the Physical Contradiction.

Namely, The adjustment of the picture frame can be carried out smoothly,
the string is fixed on the nail after the adjustment,
and the string may be released easily by hand when necessary.

A conceptual solution:

e)



Some items to be examined in the process of implementing the solution:

- Materials (iron, brass, SUS, steel, etc.) and manufacturing methods
- Design and appearance (whole length, shape, shape of the head, color, etc.)
- Shape of the slit part and manufacturing process of the slit part
- Method of installing in the wall (nail of driving type, rectangular nail, wood screw, a bolt, etc.)
- Sales (art supply stores, hardware stores, DIY shops, etc.)

USIT Case Study 4 [Picture] (Overview). Picture Hanging Kit Problem

**A standard USIT Case Study on a familiar problem,
easy to understand for everybody and yet deep in thoughts**

Ed Sickafus and Toru Nakagawa (1997-2005)

Thinking World

Box 3

Understanding of the ideal system: While adjusting, the string moves smoothly on the nail and after the adjustment the string does not move on the nail. (Ideal overcoming the Physical Contradiction)

Understanding of the present system: The lengths of the two parts of the string decide the tilt of the picture.

When the string slips on the nail, the picture is tilted.

Analyze the Problem .

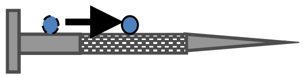
Generate Ideas

(USIT Operators , etc.)

Box 4

Ideas for a new system

Various ideas, stimulated by the analyses and driven by the application of USIT Operators: An example:



Adjust Hold

Construct Solutions

Box 5

Conceptual Solutions: A solution overcoming the Physical Contradiction

Adjust Hold

Box 2

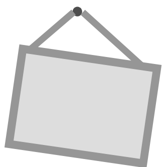
Well-defined Problem: Improve the ordinary picture hanging kit so as the picture won't tilt afterwards.
In case of a shock from the wall, the string slips at the nail, resulting in the tilting of the picture.

Define the problem

Real World

Box 1

Initial problem situations (User's specific problem): A picture hung on the wall is apt to be tilted without knowing



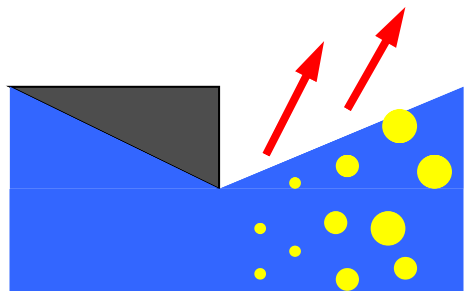
Implement the solution

Box 6

Implemented Solution (User's specific solution): **Products, etc.**

USIT Case Study 5.

Increase the Foam Ratio of Porous Polymer Sheet



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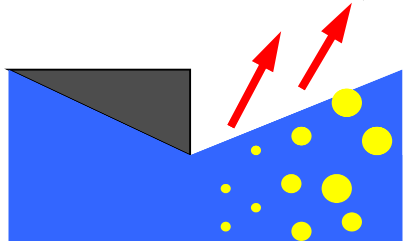
USIT Case Study 5. Increase the Foam Ratio of Porous Polymer Sheet



References:

[1] Source: Case Study made by Toru Nakagawa, at USIT 3-day Training Seminar (Instructor, Ed Sickafus), on March 10-12, 1999, in Detroit

[2] Original report: "USIT Case Study (2) Increase the Foam Ratio in Forming a Porous Sheet from Gas-Solved Molten Polymer", Toru Nakagawa (Osaka Gakuin Univ.), "TRIZ Home Page in Japan", Jul. 2, 1999 (in Japanese); Aug. 26, 1999 (in English)

[3] Conference presentation: "Approaches to Application of TRIZ in Japan", Toru Nakagawa, TRIZCON2000, Apr. 30 - May 2, 2000, Nashua, NH, USA, pp. 21-35; posted in "TRIZ Home Page in Japan", May 8, 2000 (in English); Feb. 28, 2001 (in Japanese)

[4] Description of this case study: "USIT Case Study 5. Increase the Foam Ratio of Porous Polymer Sheet", Toru Nakagawa (OGU), May 15, 2015 (in Japanese), Jun. 10, 2015 (in English)

[Case 5. Porous] Step 1. Define the Problem (1) Preparation: R&D Project

Skip

In the Real World, raise an issue and prepare for a Project of problem solving

(1) Preparation: R&D Project in the Real World

This case study has Two stages of Real World:
(1) R&D project in a Manufacturer and
(2) USIT Training Project

Situation: As a leading manufacturing company in the area of polymers, R&D of technologies and products are crucial activities.

Target: For empowering R&D capability in engineering divisions and laboratories, it is decided to introduce the new problem solving method TRIZ/USIT and try to apply it to ongoing real problems.

Project One of real, regular projects in engineering research laboratories.
At an initial stage of a theme of technology development. .

Activities: An R&D project carried out by a small research team.

Team: Several researchers/engineers.
One of the members is a beginner in TRIZ/USIT.

Theme: A topic in the field of chemical engineering. Technology for producing porous polymer sheets.

[Case 5. Porous] Step 1. Define the Problem (1) Preparation: USIT Training

In the Real World, raise an issue and prepare for a Project of problem solving

(1) Preparation: USIT Training by use of real problems

This case study has Two stages of Real World:
(1) R&D project in a Manufacturer and
(2) USIT Training Project

Situation: In Nov. 1998 Nakagawa was impressed with the USIT presentation by Dr. Ed Sickafus at the First TRIZ International Conference. Reading his USIT Textbook, I asked him to open a USIT training Seminar. Sickafus conducted the 3-day USIT Training Seminar in Mar. 1999.

Target: To understand and master USIT and to apply USIT to a real problem for myself.

Project The 3 -day Training Seminar was openly held with 10 participants.
1st day: General introduction and small exercises;
2nd day: Group practices with 4 real problems (with mostly Function-Attribute analysis);
3rd day: Group practices with different 4 real problems (with mostly Particles Method). .

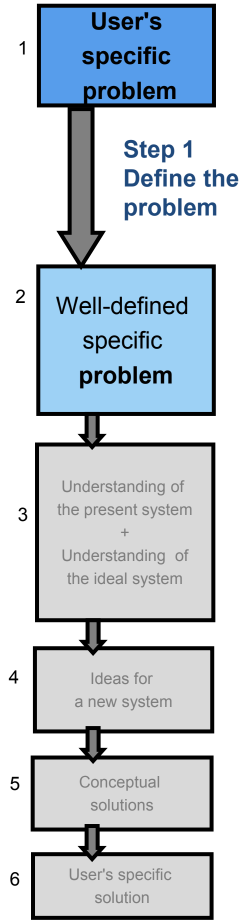
Activities: The 10 participants made 4 groups, and practiced to solve different problems in parallel.
3 cycles of lecture/group-practices/discussions were carried out in a day.

Team: Toru Nakagawa and Ravi Chona (Texas A&M Univ.). Problem owner: Toru Nakagawa.

Theme: A topic in the field of chemical engineering. Technology for producing porous polymer sheets.

[Case 5. Porous] Step 1. Define the Problem (2) Clarify the problem situations

Define the Problem: Clarify the problem situations and focus the scope



Step1: Define the Problem (in the USIT standard template)

Toru Nakagawa (Mar. 1999, USIT Training Seminar)

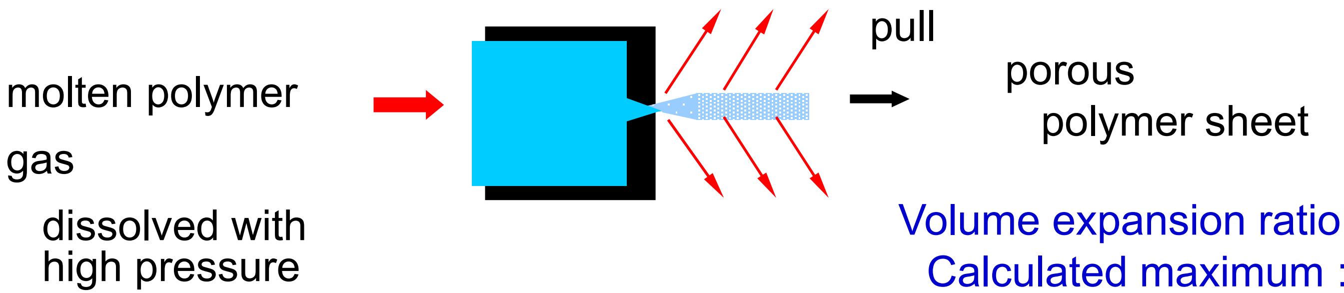
(a) An unwanted effect:

For producing porous polymer sheets, a high-temperature molten polymer, in which gas is dissolved with a high pressure, is pushed out through a slit-shaped nozzle and pulled for extension. The foam ratio, as measured by the volume expansion, however, is as low as 2 to 3 times in comparison with the theoretical value of 10.

(b) Task statement:

Improve the volume expansion ratio in forming porous polymer sheets from gas-dissolved molten polymer, up to as close as the theoretical value.

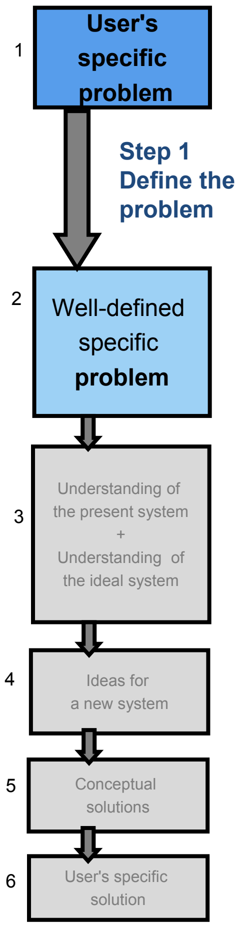
(c) Simple sketch of the problem situation:



Volume expansion ratio
Calculated maximum : x 10
Current experimental : x 2-3

Note: In this slide, technical details (e.g., names of polymer and gas, pressure, mechanism of pushing, etc.) are omitted intently. USIT considers and solve the problem at a conceptual level as shown here.

[Case 5. Porous] Step 1. Define the Problem (2) Clarify the problem situations



(d) Plausible root causes:

Escape of the gas through the surface,

Not many bubbles, not large bubbles

Note: **A discussion** was made during the seminar:

Are these really "Root causes' or aren't they just "Results" caused by some more deeper facts?

Certainly, there are various underlying facts such as:

- Temperature and pressure distributions inside the polymer just after getting out of the nozzle which can determine the conditions of bubble formation,
- Molecular structure and thermo-dynamic properties of the polymer, etc.

When we go down to the causes deeper and deeper, the real situations and relationships become more and more complex and can not be revealed before examinations.

The present statements of root causes show the causes **at a phenomenological level**, and it is clear that if we can improve these aspects, we can certainly solve the problem.

(e) Minimal set of relevant objects:

Porous polymer sheet, Molten polymer, Gas, Nozzle, Air

Note: **Air** in the environment is apt to be overlooked, but is actually involved in cooling the polymer on the surface and in the flow of gas.

[Case 5. Porous] Step 2: Analyze the Problem (A) Understand the present system

(A1) Understand the Space Characteristics

Draw the figures and consider the mechanism

1 User's specific problem

2 **Well-defined specific problem**

Step 2 Analyze the Problem

(A) Understand the present system

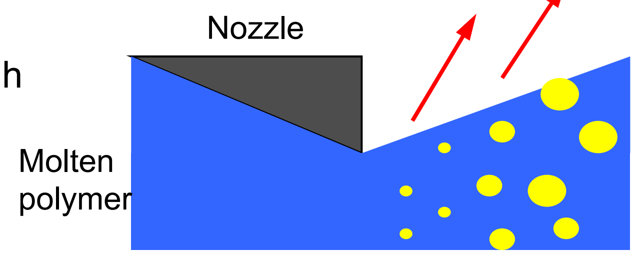
3 **Understanding of the present system + Understanding of the ideal system**

4 Ideas for a new system

5 Conceptual solutions

6 User's specific solution

Enlarged sketch of the part where the molten polymer is pushed out through the nozzle (an image).



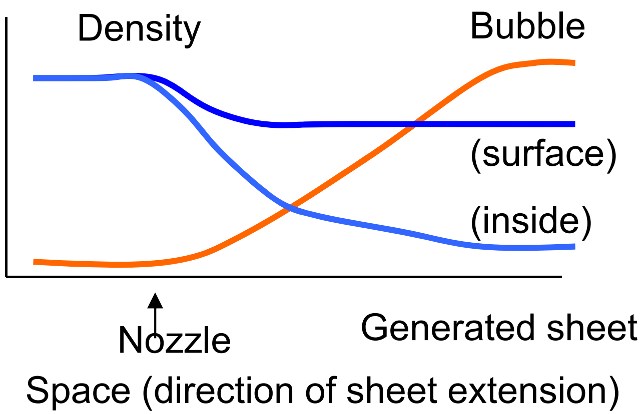
The gas is going out of the polymer surface.

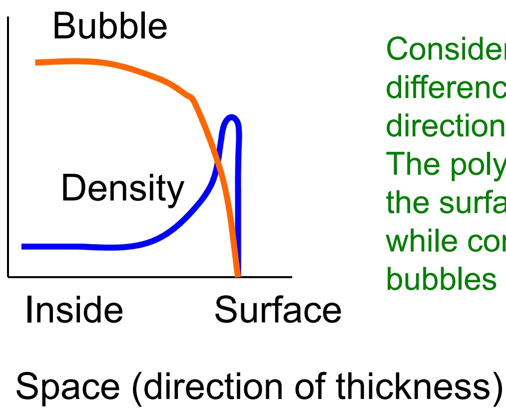
Not many bubbles are generated.

Bubbles do not grow large..

At high temperature and under high pressure the gas is dissolved in the molten polymer → Out of the nozzle, the pressure is released → Many small bubbles come out and grow. → The polymer gets cooled, and gradually becomes a porous sheet containing the bubbles inside.

Characteristics

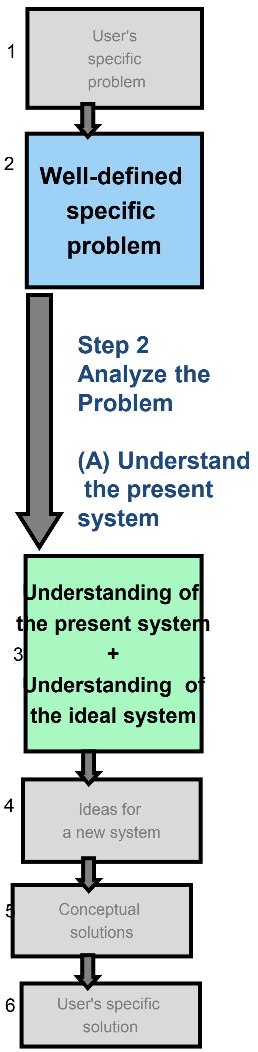




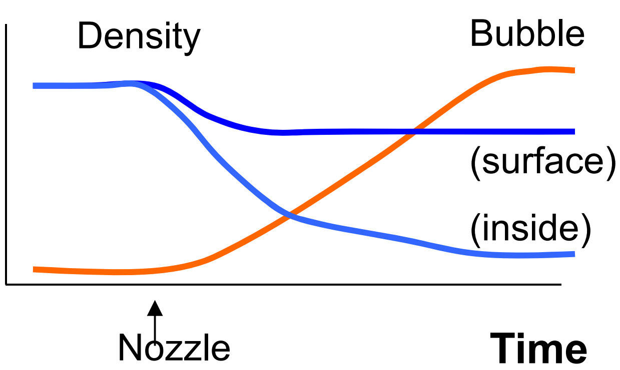
Consideration of the spatial difference in the thickness direction is useful.
The polymer is cooled from the surface and gets solid while containing the gas bubbles inside.

[Case 5. Porous] Step 2: Analyze the Problem (A) Understand the present system

(A2) Understand the Time Characteristics



Suppose a small volume of molten polymer.
It is pushed out of the nozzle, and is extended and gradually cooled to form the porous polymer sheet.
In this graph the time is taken as the abscissa.



In this case, the time characteristics is qualitatively same as the space characteristics inthe sheet extension direction.

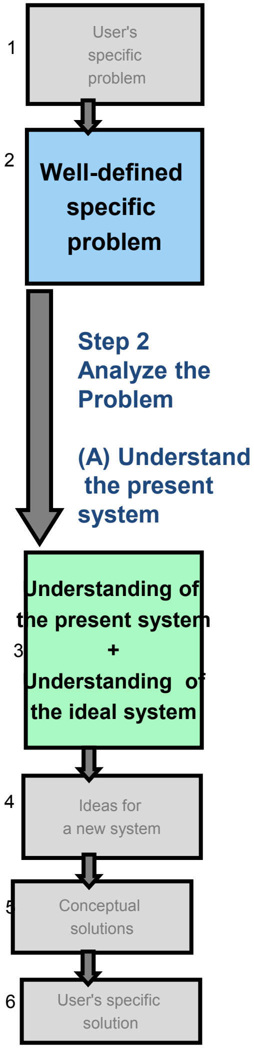
At high temperature and under high pressure the gas is dissolved in the molten polymer	Out of the nozzle, the pressure is released	Many small bubbles come out and grow.	The polymer gets cooled, and gradually becomes a porous sheet containing the bubbles inside.

It is desirable for a specialist to be able to estimate qualitatively various characteristics such as:
- External pressure and pressure distribution in the polymer,
- Temperature distribution in the polymer (inside and near surface),
- Viscosity distribution in the polymer (inside and near surface),
- Size and number of bubbles, and pressure of gas in the bubbles

Specialists in (or around) the project may be able to obtain these information through simulation.

(A3) Understand the Attributes (properties)

This step was skipped in the Seminar, and inserted here newly.



It is not easy to describe this part, because we need subject matter knowledge. The table below is tentative.

When the molten polymer is released through the nozzle, the gas dissolved in the polymer forms bubbles and esca partly through the surface. Cooling occurs by the air on the surface and by the bubble formation and escaping of th gas. This makes complex and dynamic situations of spatial distribution of temperature, pressure, viscosity, etc. in the polymer and the bubbles are formed and grow. Such situations change rapidly in time. All these situations can be understood properly only through detailed simulations.

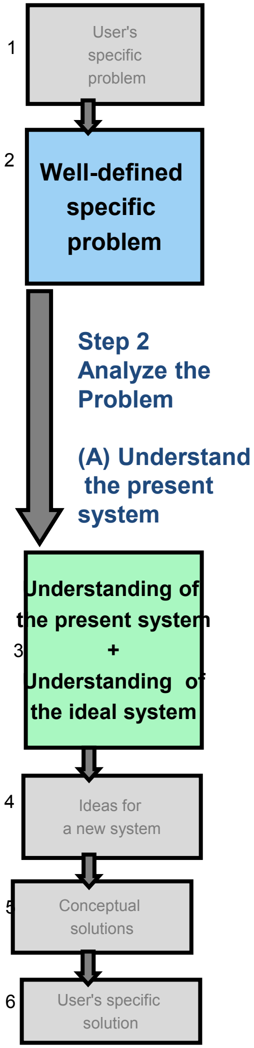
Skip

Object	Attributes enhancing the bubble formation and growth	Attributes preventing the bubble formation and growth	Attribute enhancing the gas to escape	Attributes preventing the gas from scaping	Other attributes
Polymer (in molten sate)	Solubility of gas				
Polymer (going out of nozzle)	Internal (bulk) temperature	Viscosity	Temperature near the surface	Viscosity near the surface	
Polymer (in the solid state)				Thickness of the sheet	
Gas	Solubility of gas, pressure				
Nozzle, and wall					
Air (environ-ment)			Surrounding temperature	Air flow for cooling	
Others	Time duration for the bubbles to be generated, Number of places of bubble formation		Speed of extension of the polymer sheet		

[Case 5. Porous] Step 2: Analyze the Problem (A) Understand the present system

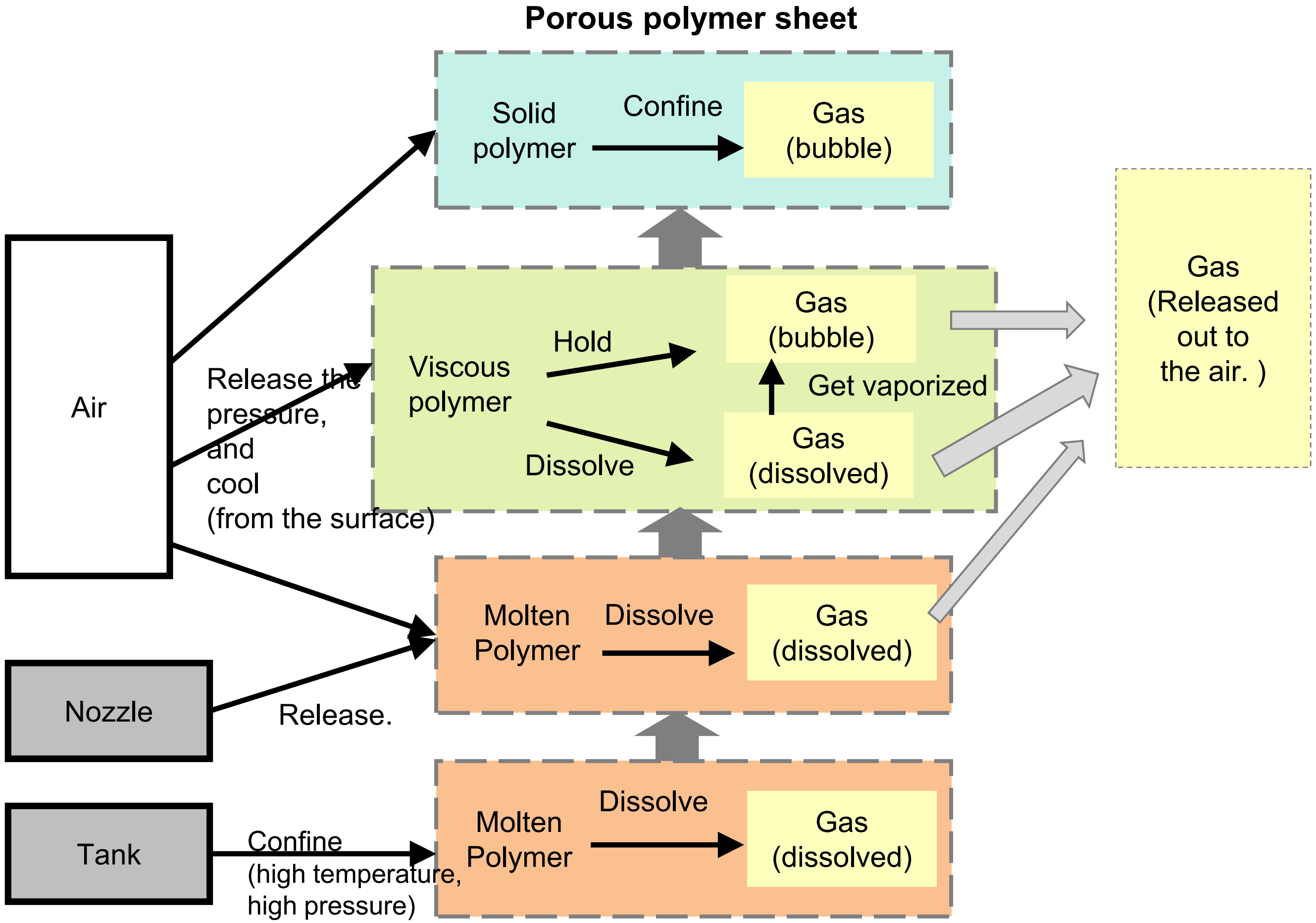
(A4) Understand the Functional Relationships

This step was skipped in the Seminar, and inserted here newly.

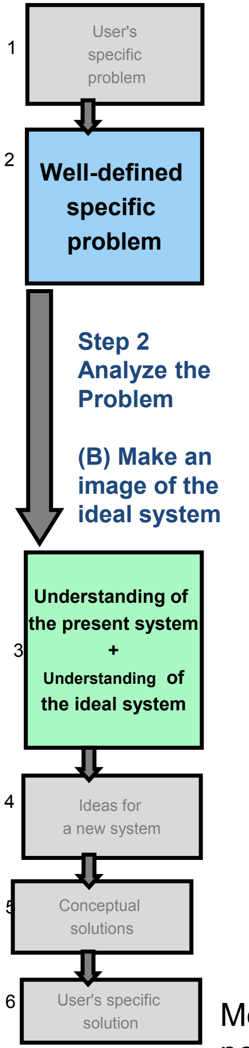


It is not easy to describe this part also, because we need to show a process. The following is a trial.

Selecting four typical stages of the process, functional relationships of relevant objects in each stage are described, and the time dependent changes are also drawn in a consistent manner.



[Case 5. Porous] Step 2: Analyze the Problem (B) Make an image of the ideal system



(B2) Consider the Ideal system with the Particles Method (Sickafus' method)

The Particles Method was applied vividly and effectively in this case study.

Particles Method is the core of this case study.

A good example.

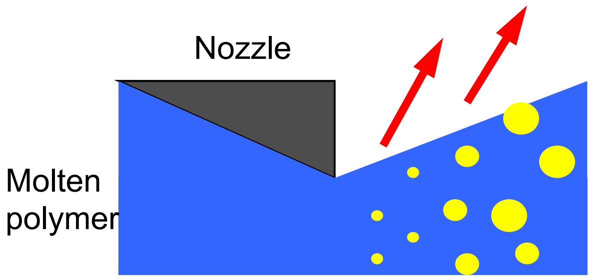
(a) Sketch the present system

Draw the sketch so as to illustrate the mechanism of the problem (unwanted effect).

(b) Sketch the ideal system (as the result of achievement)

Never try to draw "how to achieve the ideal results",
because such means and mechanisms are not known at the present stage
(before any idea generation and any solution construction).

(a) sketch of the present system:



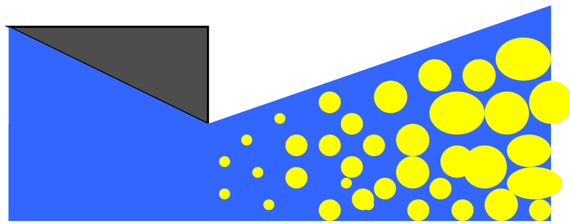
The gas is escaping

Not many bubbles

Not large bubbles

This close-up construction was suggested by Dr. Sickafus.

(b) Sketch of the ideal system:

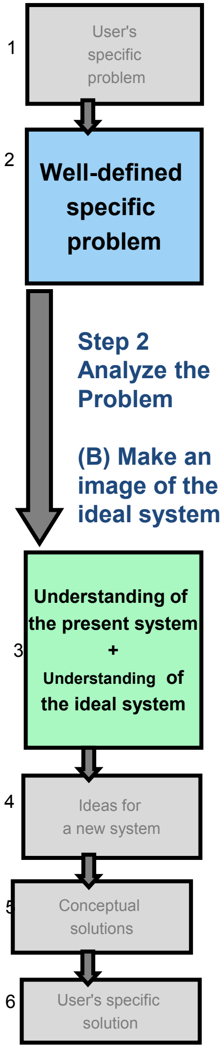


The gas is NOT escaping

More bubbles

Larger bubbles

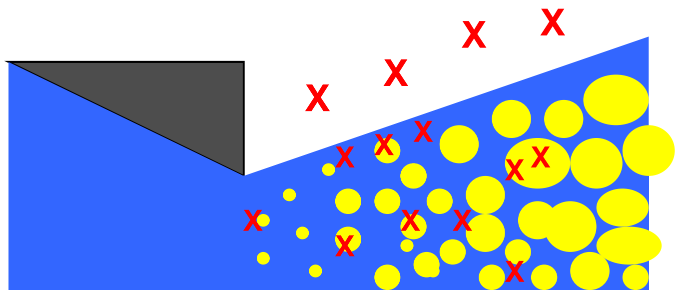
[Case 5. Porous] Step 2: Analyze the Problem (B) Make an image of the ideal system



(B2) Consider the Ideal system with the Particles Method (continued)

(c) Draw x marks (i.e., Particles) at the places of differences between (a) and (b).

xxx "Particles": Magical substances/ Fields" having any desirable properties, and able to do any desirable actions



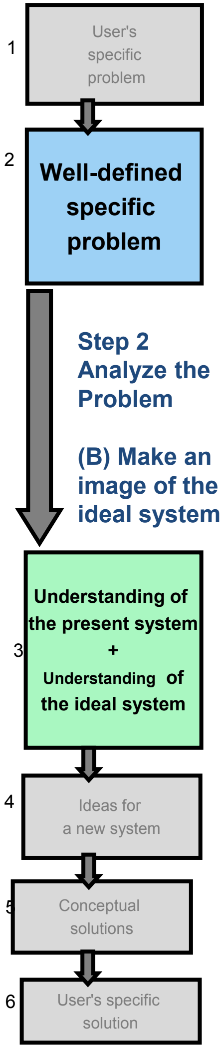
Particles **XXX** are placed outside the polymer surface and inside the polymer, in and around the bubbles.

"Particles" are magical things which can do anything desirable.

Suppose we have such magical things, and let's think what we would like to ask them. We should imagine freely.

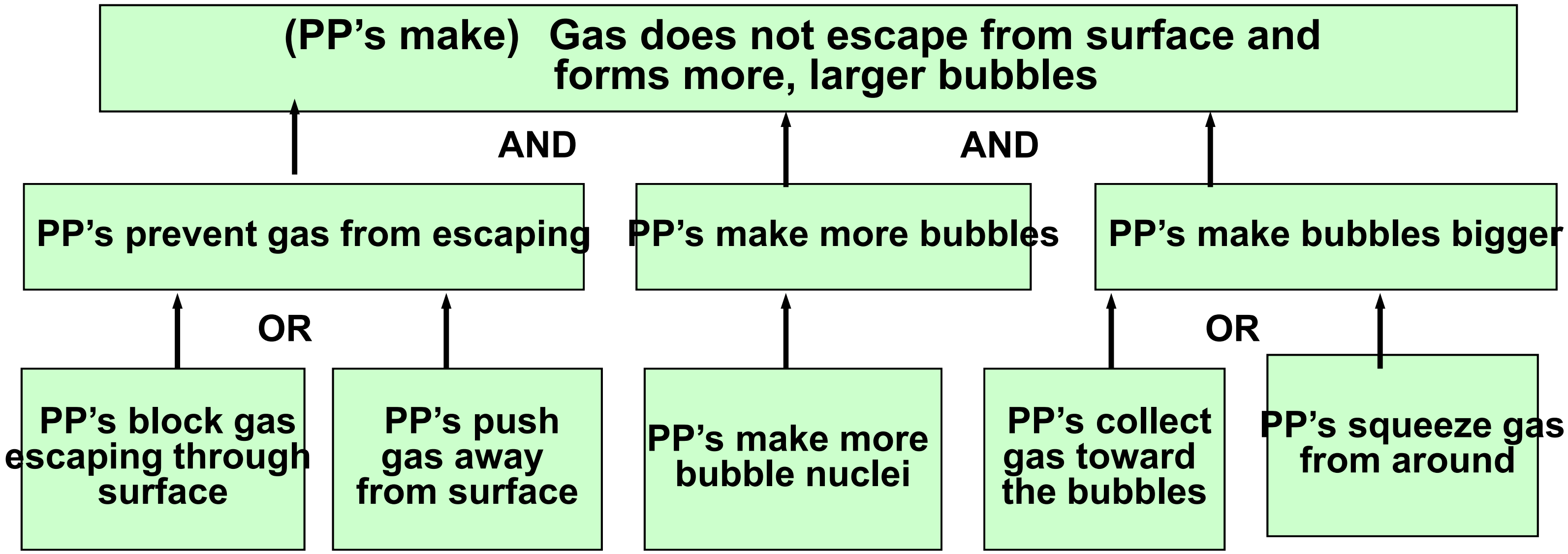
(At the later steps we will generate ideas which can realize such imaginary thoughts in accordance to sciences.)

[Case 5. Porous] Step 2: Analyze the Problem (B) Make an image of the ideal system



(B2) Consider the Ideal system with the Particles Method (continued)

(d) Think about Desirable Behaviors



At the top, write the target to do in a sentence. (You may take it from the Task statement (of Step 1(b)) or the keywords expressing your ideal system (Step 2B(2)).

Ask the Particles (PP's) to do any action you want; or rather imagine how such smart magical particles are behaving to achieve the targets for you.

Express such behaviors in a hierarchical tree diagram. Top-down thinking is recommended, even though random/bottom-up idea generation are also OK.

Use plain words, in place of technical terms for avoiding Psychological Inertia of technical terms.

[Case 5. Porous] Step 2: Analyze the Problem (B) Make an image of the ideal system

1 User's specific problem

2 **Well-defined specific problem**

Step 2 Analyze the Problem

(B) Make an image of the ideal system

3 **Understanding of the present system + Understanding of the ideal system**

4 Ideas for a new system

5 Conceptual solutions

6 User's specific solution

(B2) Consider the Ideal system with the Particles Method (continued)

(e) List up Desirable Properties for the Particles may have

For each desirable behavior at the bottom of the preceding tree diagram, list up desirable properties the Particles may have. Think them widely and freely.
Do not try to criticize any feasibility or effectiveness of them.

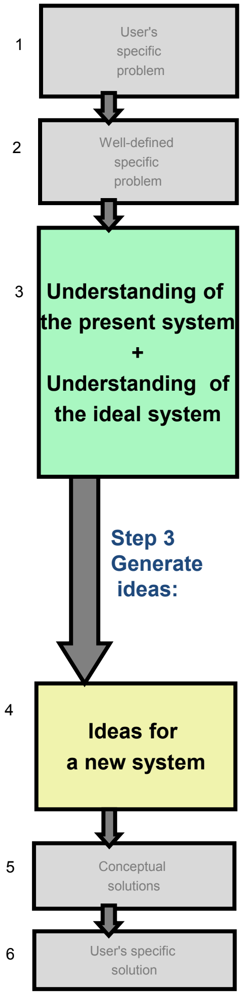
PP's block gas escaping through surface	PP's push gas away from surface	PP's make more bubble nuclei	PP's collect gas toward the bubbles	PP's squeeze gas from around
- container	- temperature difference	- seeds for bubble nuclei	- absorption	- temperature difference
- pressure	- pressure difference	- container surface	- inter molecular force	- pressure difference
- electric field	- distribution of the bubble nuclei	- additional interface	- electrical field	- polymer's crystal formation
- magnetic field	- composition difference,	- reaction for forming bubble nuclei	- magnetic field	- solubility
....		- taking time	- taking time	- ....
			-	

When we write down such a property, we may naturally make images of applying/realizing it.
They form good bases for generating ideas in the next step.
Remember or write it down separately in a card (e.g., Post-It-Note).
Group discussion of them will be done later at the Step 3(1).

[Case 5. Porous] Step 3: Generate ideas:

Skip

(1) Write down the ideas freely with the stimulation of the analyses



At the Training Seminar, we ended up with the previous step 2(B)(5).
Since various ideas were already in my mind, I wrote them down a few days later.

- First, in order to generate more bubbles:

Since the bubbles are generated in the homogeneous molten polymer, we need some form of **inhomogeneity**.

==> To put **seeds** for starting the bubble formation.

We should have **longer time period** having suitable condition for bubble generation.

- For the generated bubbles to stay inside the polymer:

We should arrange so that the bubbles would not escape from the polymer surface.

==> We should make a wall of the instrument.

E.g., **Attach some parts in front of the nozzle** and constrain the expansion of the polymer.

==> **Cool the surface first** and make the surface part of polymer solid,

so that the gas has no pass to escape through the surface.

Cool the bulk of the polymer slowly, and keep the condition of bubble formation longer,

so that many bubbles are generated and kept enclosed in the polymer.

- We should control the temperature and pressure distribution inside the polymer

while cooling down in a desirable way.

At present, we are simply pushing out the molten polymer and extend it forwards.

By controlling the pressure and temperature distribution, we can arrange the viscosity distribution of the polymer, bubble formation speed of the gas, and time dependence of various conditions .

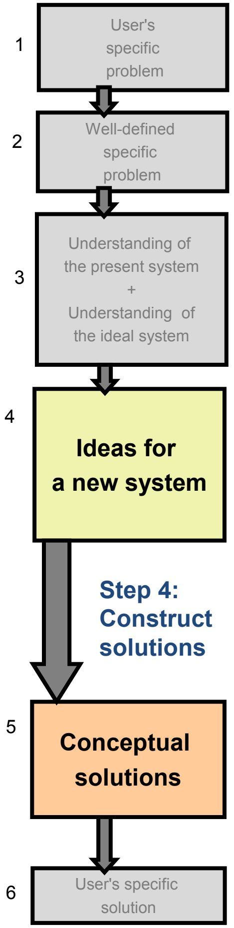
Thus, we will be able to control the number and sizes of the bubbles and the escape of the gas out of the polymer, etc.

- We need to analyze how to control these factors by use of theoretical simulation.

[Case 5. Porous] Step 4: Construct Solutions (2) Construct the conceptual solutions

Construct the conceptual solutions

These solution concepts were written down a few days after the Training Seminar.



(1) To put seeds for accelerating the bubble nuclei formation.

Nonhomogeneous elements are necessary in the homogeneous solution.
Solid powder; porous, surface active, gas absorbing, etc.
To take time for forming bubble nuclei around the seeds.

(2) To put an attachment in front of the nozzle and to control the pressure/temperature distribution

Do not release the pressure at once. To let the attachment be a container/holder.
To generate the conditions suitable for the formation and growth of the bubbles, and to keep the conditions for some time along the polymer pass.

(3) Not to form bubbles on/near the surface and to prevent gas from escaping

To cool the surface of the sheet and to form dense polymer layer on the surface.
To generate temperature difference between surface and inside, and control the conditions for bubble generation.
To keep the attachment surface inactive/preventive for the bubble formation.

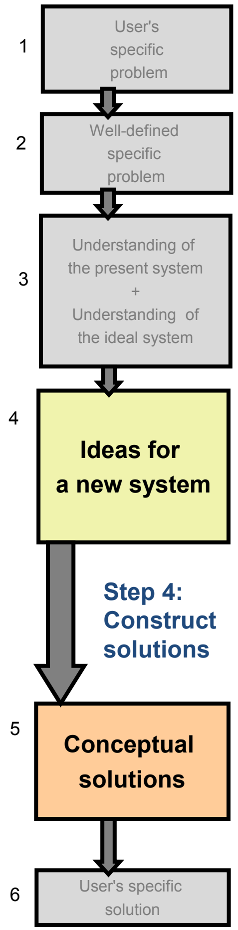
(4) To let all the gas contribute to the bubbles inside the sheet.

To form suitable temperature/pressure conditions along the polymer pass (i.e. along the time of sheet formation)

These concepts are executable at the same time. It seems to be technically feasible.
A technical simulation and the design are necessary.

[Case 5. Porous] Step 4: Construct Solutions (3) Report the results

Finalize as a Case Study and Report it.   Conclusion as the Case Study.



USIT was applied to a real technological R&D problem,
i.e., "To increase the foam ratio of porous polymer sheet", and
we obtained a set of conceptual solutions.

This was my first experience to learn USIT in a 3-day USIT Training Seminar.
This case study was carried out on the third day. Even in such a short time,
I understood well how to apply USIT for analyzing the problem and for generating ideas,
through the practices of case studies.

This Seminar (conducted by Dr. Sickafus) was very helpful for me to learn
how to apply USIT and also how to conduct USIT training seminars.

The present case study is excellent especially for using **the Particles Method.**

On the basis of the records written in cards and big paper sheets in English at the Seminar,
I made slides and documents of this case study both in Japanese and in English in a week
and reported them to the people involved in the real project.

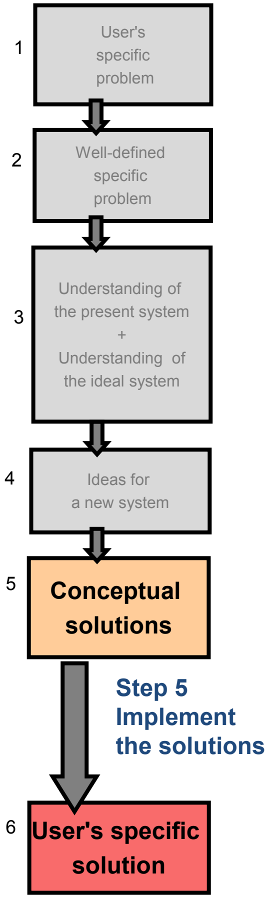
The slides and the detailed documents of this case study and the USIT Training Seminar
were publicly posted in "TRIZ Home Page in Japan" in Jul. 1999.

I also gave presentations and seminars on this case study many times
in conferences, lectures, and training seminars.

[Case 5. Porous] Step 5: Implement the Solutions : (Real activities in the 'Real World')

Skip

Examine and evaluate the results in the parent project.



I reported about the whole result of USIT case study to the manager of the R&D project.
(The problem solving process with USIT, contents of the intermediate thinking process, and the final results of the conceptual solutions, etc.).

The manager responded to say:
"**These solution concepts are ideas already known individually, and look quite orthodox**."

For a problem at an early stage of technology R&D for several months,
a non-specialist have analyzed and solved by use of USIT to have generated
a set of conceptual solutions which are evaluated 'orthodox' by the project manager
-- this must be a very positive result, I believe.

We should note here that
the creative problem solving must not always seek for astonishing/strange/inventive solutions.

Dr. Ed Sickafus wrote about the aims of USIT as:
"In industries, rather than seeking for inventions, we should better generate
multiple concepts which solve real industrial problems as rapidly and creatively."

In the industry of this problem, after checking the present conceptual solutions,
they carried out some experiments and technology developments further;
but I do not know any detail.

USIT Case Study 5 [Porous] (Overview). Increase the Foam Ratio of Porous Polymer Sheet

A real problem in the field of chemical engineering is solved with the Particles Method

Toru Nakagawa (1999)

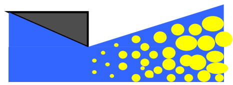
Thinking World

Box 3

Understanding of the ideal system

Ideal situation is:

No gas escape, More and larger bubbles



Understanding of the present system

On pushing the molten polymer out of the nozzle, the pressure and temperature distributions are not controlled well to form bubbles.

Analyze the Problem .

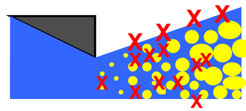
Generate Ideas

(USIT Operators , etc.)

Box 4

Ideas for a new system

Cool the surface first, and keep suitable conditions for bubble generation inside the polymer for longer time.

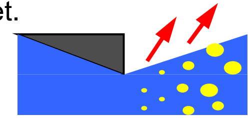


Construct Solutions

Box 2

Well-defined Problem

Want to increase the foam ratio in manufacturing a porous polymer sheet.



Gas escapes, Not many, Not large bubbles

Define the problem

Box 5

Conceptual Solutions

(1) To put seeds for making more bubbles and
(2) to put attachment in front of the nozzle to control the pressure /temperature distribution

Implement the solution

Real World

Box 1

Initial problem situations

(User's specific problem)

In the manufacturing process of porous polymer sheets, the foam ratios is low in comparison to the theoretical value

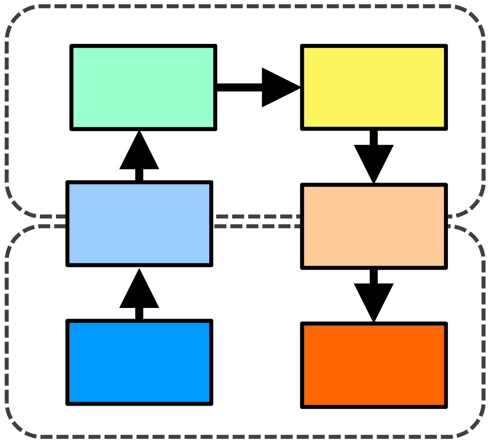
Box 6

Implemented Solution

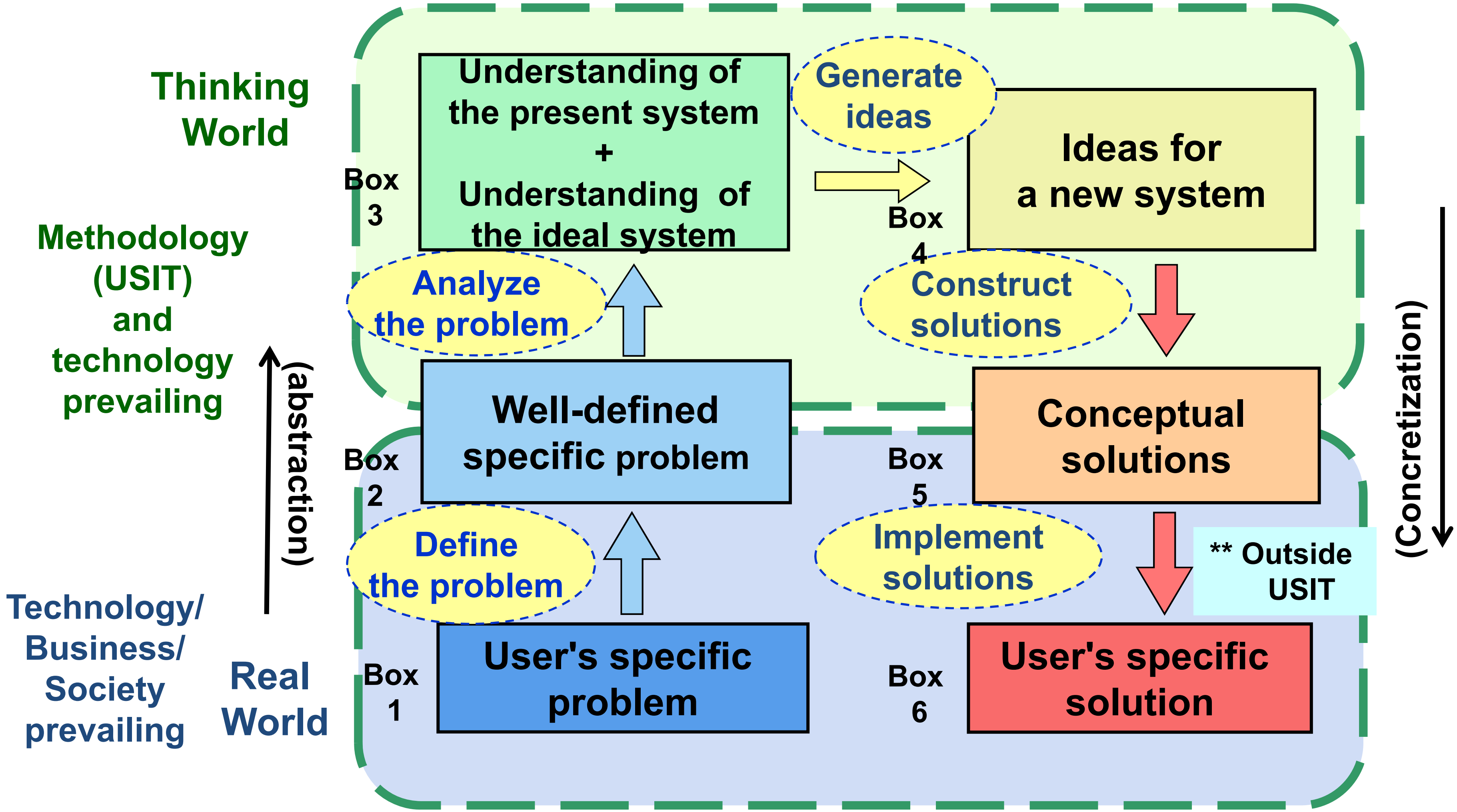
(User's specific solution)

Products, etc.

USIT Process

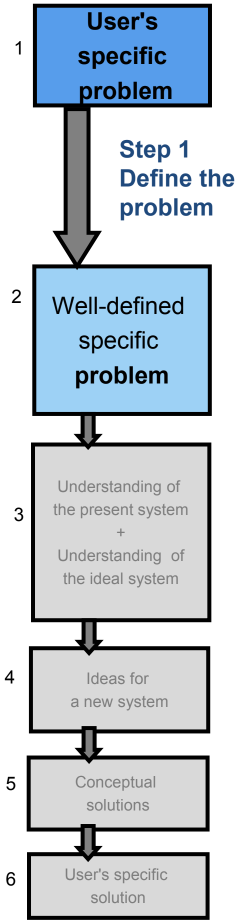


Overall View of the USIT Process ('Six-Box Scheme') (data flow representation)



Step 1: Define the Problem: (1) Preparation: Form the USIT project

In the Real World, raise an issue and prepare for a problem-solving project .



We want to solve some real problems or to achieve some new tasks in the Real World, so we start to work for 'Creative Problem Solving'.
We want to think and work hard for solving a problem unsolved so far and for achieving a task unachievable so far.
We need to prepare well for the project.

· Think and survey the present situations of the problem/task

· Clarify what we want to do and set the target.

- Think if the USIT project for creative problem solving is appropriate, and decide to start it.

· Decide the size, duration, style, etc. of the USIT project.

· Decide the Organizer, Trainer, and members of the USIT project and organize the team.

· State these decisions clearly, communicate with the team, and start the USIT project.

The description above is relevant mainly to a real project for a real problem. You may have other projects for introducing the USIT method and for training people in USIT. The example in the right part is for USIT training.

Step1: Define the Problem.

(1) Preparation: To set up the USIT Training project.

Situations: Though we have various problems in the real jobs, we have few people who have mastered methods for solving them effectively.

Target: To introduce the method for creative problem solving (USIT) into our company and to apply it to our technology development in the near future.

Project: To execute an In-house USIT training project

Structure: Training for 2 days, 8 to 15 participants,
Lecture + real practices (on 2 problems in parallel)

Team: (For a general problem) Organizer: Head of training section, Trainer: USIT expert, Members: voluntary engineers from different sections.

(For a real problem) Organizer: Manager of the engineering section, Trainer: USIT expert, Members: people assigned in relevant sections

Execution: Execute the training for 2 days, and make the teams to report the results in a week after.

In the USIT training, general themes (e.g., textbook examples) should be explained by the lecturer, while real and familiar themes relevant to the teams should be used in the real practice.

Step 1: Define the Problem: (2) Clarify the problem situations and focus the scope

Clarify the problem situations and focus the scope

1 **User's specific problem**

↓ Step 1 Define the problem

2 Well-defined specific **problem**

3 Understanding of the present system + Understanding of the ideal system

4 Ideas for a new system

5 Conceptual solutions

6 User's specific solution

The person in charge reports the problem situations, and the team discuss to clarify the five items (a) - (e) on the fact basis for sharing the understanding of the problem situations.

· Focus on one unwanted effect : easier to solve one by one than to handle multiple problems at a time.

·State the task to be achieved in 1-2 lines.

· Conciseness helps to clarify the focus point.

·Draw a sketch (or a schematic graph) so as to clarify the mechanism of the system.

·Figures of an overall view, enlarged micro views, and time-dependent views, etc. may be useful.

Consider possible causes of the unwanted effect.

·Sort out the problem situations (with IS/ISNOT analysis of the KT method) .

· Consider the (physical) mechanism of the problem system. -- This is most important.

·If you find difficulty in finding the causes, you may think to make the system in failure on purpose.

· Express the essence of the difficulty of the problem in terms of the contradiction

·Limit the scope of the problem, and express the objects in general terms.

Example: Picture Hanging Kit Problem

Step1: Define the Problem

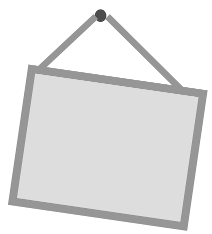
(a) An unwanted effect:

A picture is hung on a wall in a typical way by using a nail , a string, and two hooks, but it is apt to be tilted afterwards without knowing.

(b) Task statement:

Improve the ordinary picture hanging kit (with a nail, a string, and two hooks), so as the picture not likely to be tilted

(c) Simple sketch of the problem situation:



(d) Plausible root causes:

In case of vibration from the wall, the string slips on the nail and the picture frame is tilted .

(e) A minimum set of relevant objects:

A picture frame (including the picture, frame, glass, etc.), a nail, a string, two hooks, and wall

This case study was described first by Ed Sickafus in his USIT text book, and was later extended by Toru Nakagawa for use in the USIT training.

Step 2: Analyze the Problem (A) Understand the present system
(A1, A2) Understand the space and time characteristics

Understand the Space and Time Characteristics of the present system

1 User's specific problem

2 **Well-defined specific problem**

Step 2 Analyze the Problem

(A) Understand the present system

3 **Understanding of the present system + Understanding of the ideal system**

4 Ideas for a new system

5 Conceptual solutions

6 User's specific solution

The present system is analyzed in the four aspects, i.e., space, time, attributes, and functions. The order of the 4 aspects may be chosen differently depending on the problem. The order described here may be appropriate in most cases.

Analyze the system's behavior and characteristics **depending on the space**:

- Draw the structure of the system and understand the mechanism and the problems.
  - ・Differences/distributions on parts or places.
  - ・Macro views (the whole system & environments) and micro views (milli, micro, and nano)

Analyze the system's behavior and characteristics **depending on the time**

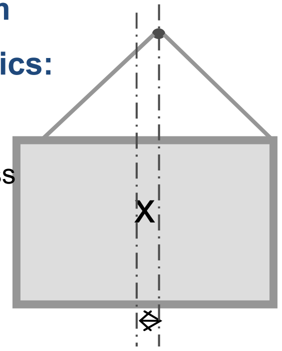
- Temporal change of phenomena and problem.
  - ・In cases of processes like manufacturing, reveal the stages of process and their characteristics.
  - ・Draw a graph of temporal change in some specific characteristics (e.g. unwanted effect, root cause property, etc.)
  - ・Macro view (long term change, pre and post phenomena) and micro view (detailed process of instantaneous change).
  - ・Analyze the conditional changes as a part of the time characteristics. 'In the case of ...' = 'When ...'

Step2: Analyze the Problem

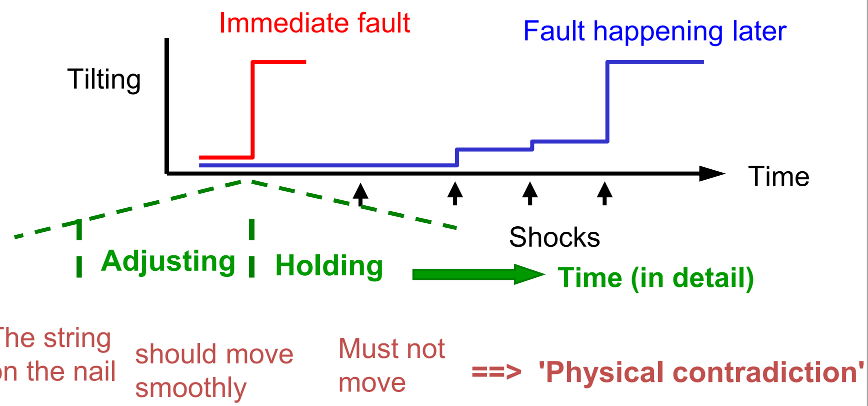
A. Understand the present system

(1) Analysis of space characteristics:

When we adjust the frame in the horizontal position, the center of mass of the frame must be located just below the nail. Otherwise, due to a torque the string slips at the nail and the frame will be tilted.



(2) Analysis of time characteristics:

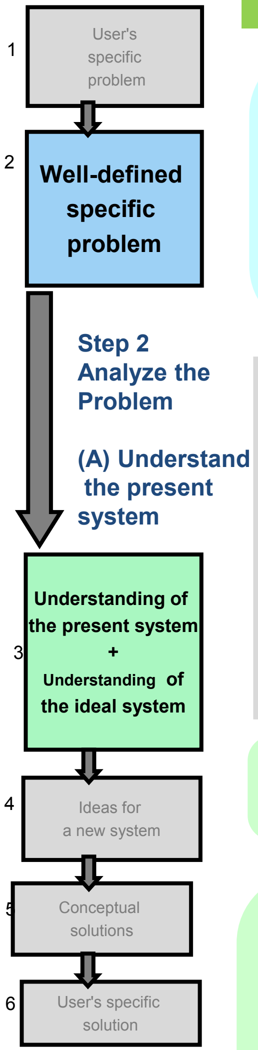


Analyze the present system, and clarify the requirements for the desirable situations (and also ideals)

- Find the differences in requirements depending on places and on time regions ==> Clarify them as the essence of the difficulty and (physical) contradictions.

Step 2: Analyze the Problem (A3) Understand the attributes

Understand various attributes of the objects in the present system: Attributes increasing/decreasing (or irrelevant to) the unwanted effect



Objects: Components of the system, entities existing by itself, occupying space; ('information' is especially included)
(Ex. an airplane, a picture frame, a nail, an electron, air, light (photons), signals)
Attributes: Categories of the properties of objects.
(Ex. color, weight, shape, position, reflectivity)
Note: red,, 10 kg, etc. are values of attributes.

Consider various attributes of all the relevant objects and list them up under classification:
If the attribute value is increased/strengthened,
the unwanted effect increases --> enhancing
ibid decreases --> suppressing
ibid behaves specifically --> specific
ibid does not change --> irrelevant

Also consider explicit/common-sense/implicit **constraints** in various attributes.

This step examines again the **plausible root causes** (see Step 1(d)) more deeply and fully.

Unexpected (inventive) solutions are generated when the attributes relevant to the problem are **changed qualitatively** (or drastically): e.g., an attribute causing the unwanted effect is discarded, made irrelevant, or turned into useful.

Such solutions can be generated by **lifting/breaking the constraints in attributes.**

(3) Analysis of attributes:

Unwanted effect of the present problem = Easiness in tilting

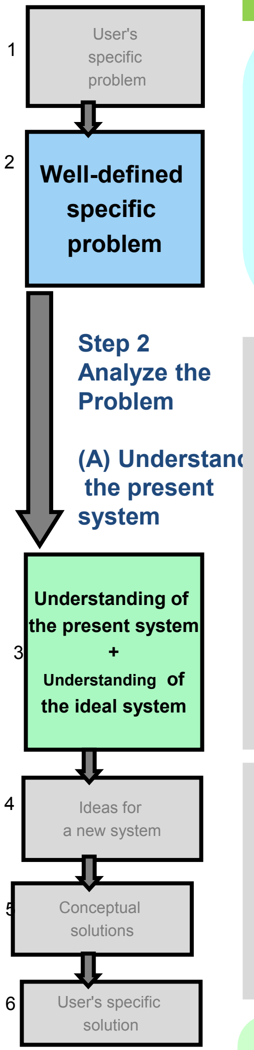
Object	Attributes which increase easiness of picture frame tilting	Attributes which decrease easiness of picture frame tilting	Attributes irrelevant to the easiness of picture frame tilting
Picture frame	Offset of the center of mass from just below the nail., Asymmetry of shape & weight		color, width, length, thickness, weight
Hooks	Offset from the symmetric positions	adjustment of positions	
String	Slipperiness	Friction of string with the nail	Thickness, length, color
Nail	Slipperiness on the surface	Friction with the string, angle	Material, length, thickness
Wall	Vibration of wall	Friction with the frame bottom	Color, oldness

Note: Though the QC diagrams were introduced by Sickafus, this tabular format may be more familiar for beginners.

USIT considers the problem 'qualitatively' (i.e., in their essence), and hence does not handle the values of the attributes directly.

Step 2: Analyze the Problem (A4) Understand the functional relationships

Draw the functional relationships among the objects, and understand the designers' intentions and the problems of the present system



Terms related to the Interactions between objects:
- **Action:** The interaction is viewed as a work from one object to the other.
- **Effect/influence:** Results of the action
- **Cause:** The source (starting point) of the action
- **Function:** Action regarded useful
- **Harm:** Action causing bad results (for people)

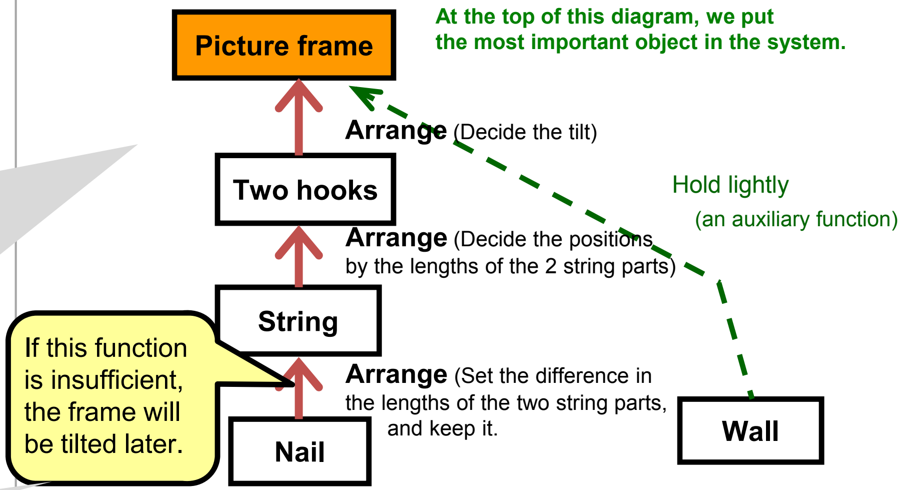
Functional Analysis:
First, draw the functional relationships (or designer's intention) among the objects in the minimal relevant set.
- **At the top**, draw the object most important for the system's purpose.
- Draw the objects which are serving for the object above **in a functionally-desirable relationship** ** one by one below the upper objects.
- Draw an arrow from the lower to the upper object and write the function between them.

Notes on additional drawing:
- You may additionally draw some objects not intended by the designer, if necessary.
- You may draw, if necessary, the functions with insufficient, excessive, unstable, and harmful effects.

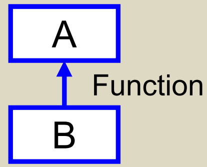
Functional analysis is useful for understanding the mechanism of the system and also their relationships with the unwanted effect.

(4) Analysis of the functional relationships

The mechanism and designer's intention of holding the frame without tilting in the present system .



**** A functionally-desirable relationship between the objects:**
- B is in contact with A, and causes an effect.
- A is more important than B, and B serves for A.
- If A is discarded, B loses its significance of existence, and becomes unnecessary.



Note: This diagram is called as 'Close world diagram' by Sickafus, but is called more commonly as 'Functional diagram'.

Step 2: Analyze the Problem (B) Make an image of the ideal system

Make an image of the ideal situations and clarify the directions of solutions

1 User's specific problem

2 **Well-defined specific problem**

Step 2 Analyze the Problem

(B) Make an image of the ideal system

3 **Understanding of the present system + Understanding of the ideal system**

4 Ideas for a new system

5 Conceptual solutions

6 User's specific solution

Clarifying the ideal system and the directions for the ideal is crucial both for solving problems in the present system and for developing new products. **USIT advises to execute this step always.**

For solving contradictions, TRIZ advises to set the **ideal state where the contradicting requirements are both fulfilled.**

Particles method by Sickafus:

(a) Draw the sketch of the present system to clarify the mechanism.

(b) Draw the image of the ideal result:
You must not try to draw the means and mechanisms for achieving the ideal, because they are not known yet.

(c) Put x marks (Particles) at the places where you find any difference between (a) and (b):
The Particles are magical things/fields which can have any property and can make any behavior.

Altshuller developed the **'Smart Little People method (SLP)'** in TRIZ and used symbols of dwarfs; while Sickafus uses more abstract x marks. You may use whichever you like.

(B) Make an image of the ideal system

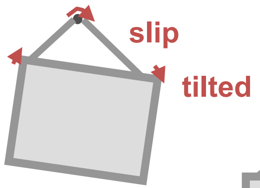
(1) Set the ideal which overcomes 'Physical contradiction':

State the ideal by use of the 'Physical Contradiction':

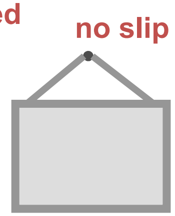
The string moves smoothly on the nail while adjusting, AND the string stays without moving on the nail after the adjustment for a long time while holding the frame.

(2) Consider the ideal system with the Particles method:

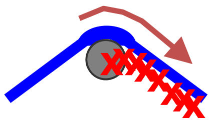
(a) Sketch of the present system



(b) Sketch of the ideal system (as the result of achievement)



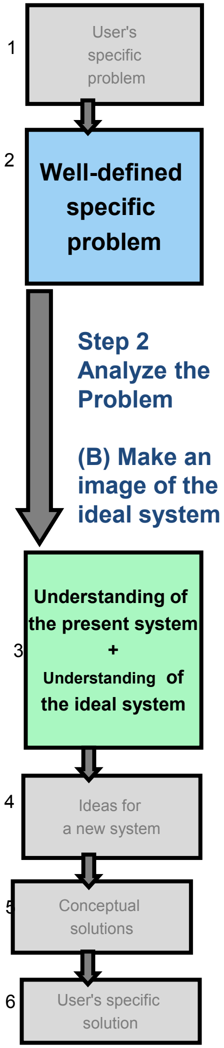
(c) Draw x marks at the places of any difference between (a) and (b): Call x marks 'Particles'.



TRIZ assumes "**Technical systems evolve toward the direction of the increase in Ideality**, where
Ideality = system's main useful function /(cost + harm)"

TRIZ also has the concept of **'Ideal Final Result (IFR)**', where the main useful function is achieved with no cost and no harm. A function which is performed **'by itself'** is a form of IFR.

Step 2: Analyze the Problem (B) Make an image of the ideal system (Particles method 2/2)

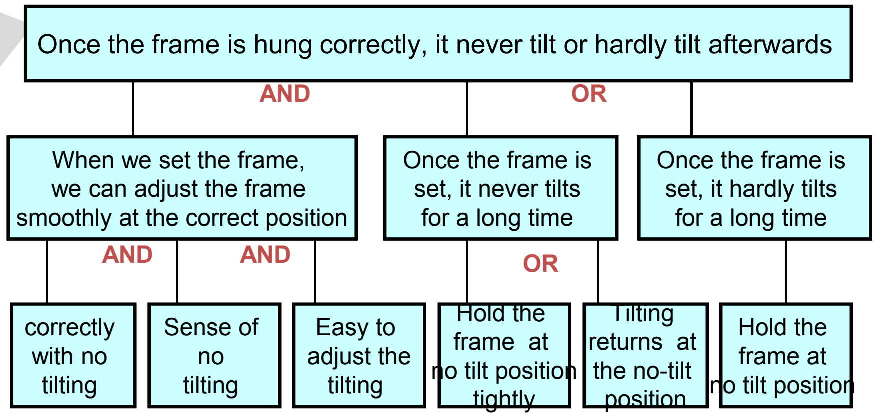


Consider desirable behaviors and desirable properties systematically, with the help of magical Particles

(d) Think of what you want the Particles to do, and draw them in a tree structure

·State what you want them to achieve finally in a sentence and write it at the top of the tree diagram.
· Divide compound requirements into simpler ones and think of any behavior that the Particles would do and draw them in the diagram while breaking them down.
- Since Particles are magical/imaginary, you may make images of their actions in a relaxed view: "Particles would behave like this, ..."
· Use familiar plain words, instead of technical terms. This would avoid from being trapped in the psychological inertia of the technical terms.

(d Desirable behaviors



(e) Think of desirable properties that the Particles would have for performing such behaviors.

· Think of any desirable properties that the Particles would better have for performing the behaviors and list them up below the tree diagram.
· Do not try to check the feasibility of such properties and think freely at this step.
· When we write down such a property, we may naturally make images of applying/realizing it. Remember or write it down separately in a card (e.g., Post-It-Note). (Group discussion of them will be done later at the Step 3(1).

(e) Desirable Properties

Lengths of string in two parts
Balance of the center of mass
Hook adjustment
Wall support
Auto-adjusting

Horizontal degree of the frame
Vertical degree of the frame

Smoothness of nail
Smoothness of string
Degree of freedom of adjustment

Fixing the string at the nail position
Strength of the fixing
Clinging
Fixing to the wall

Resilience
Elasticity
Automatic adjustment
Electro-magnet

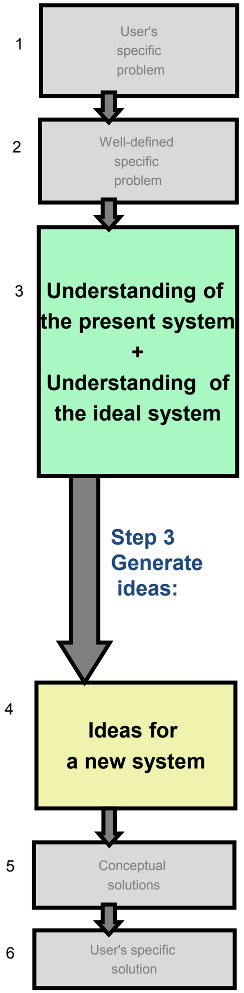
Friction
Roughness of nail surface
Pressure
Strength of holding
Vibration suppression

Sickafus calls this diagram as 'AND-OR Tree', suggesting to write the AND/OR logic of the behaviors. But in this Manual, the emphasis is on the hierarchical and systematic representation of ideas without difficult terms.

Thinking about ideal systems clarifies the directions of solutions. In this step , the image of the ideal system is thought of in a free and relaxed manner by using familiar plain words and sketches.
The tree diagram (d) is built (finally) in a top-down structure, and the images of possible ideal systems are guided to be systematic and hierarchical.

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.

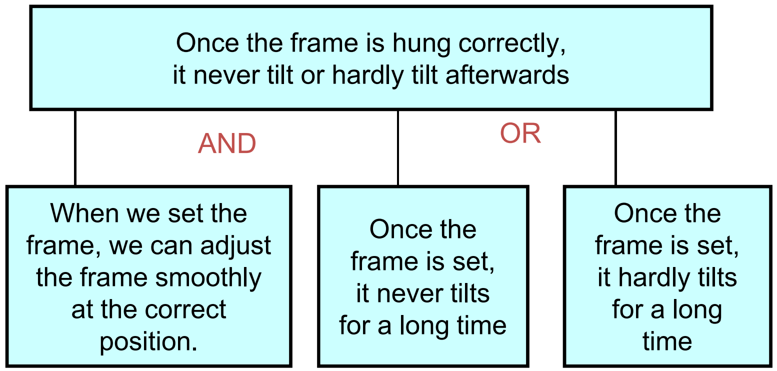
- (Root) Causes => Eliminate the causes.
- Time characteristics => Solution ideas during the critical time zones
- Space characteristics => Solution ideas to be applied to the places/parts in trouble.
- Functional analysis => Solutions to handle the objects having harmful/insufficient functions
- Attribute 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:



"USIT Oprators": A system of solution generaton methods

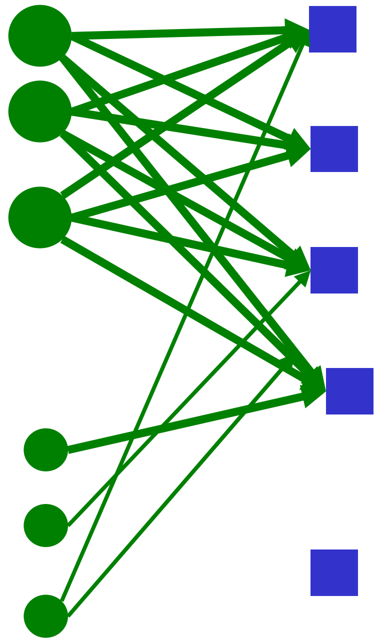
-- Obtained by re-organizing all the solution methods in TRIZ

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

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

40 Inventive Principles
76 Inventive Standards
35 Trends of
System Evolution

Separation Principle
Self-X Principle
Trimming



Object Pluralization
Attribute Dimensionality
Function Distribution
Solution Combination

Solution Generalization

USIT Operators are further classified in a hierarchical way.

USIT Operators

Nakagawa, Kosha, Mihara (2002)

Skip

(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

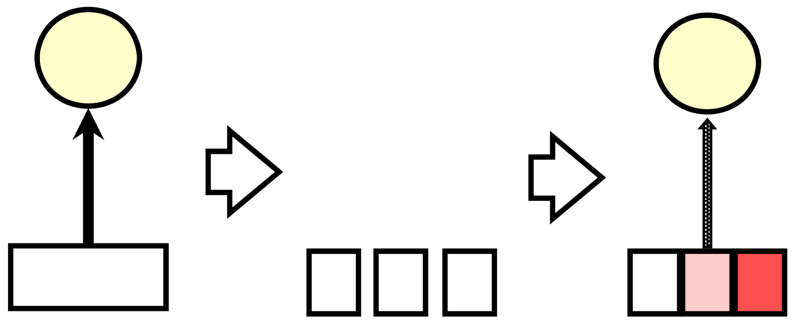
(1) Object Pluralization Method

(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



'Separation Principle for Solving Contradictions' in TRIZ

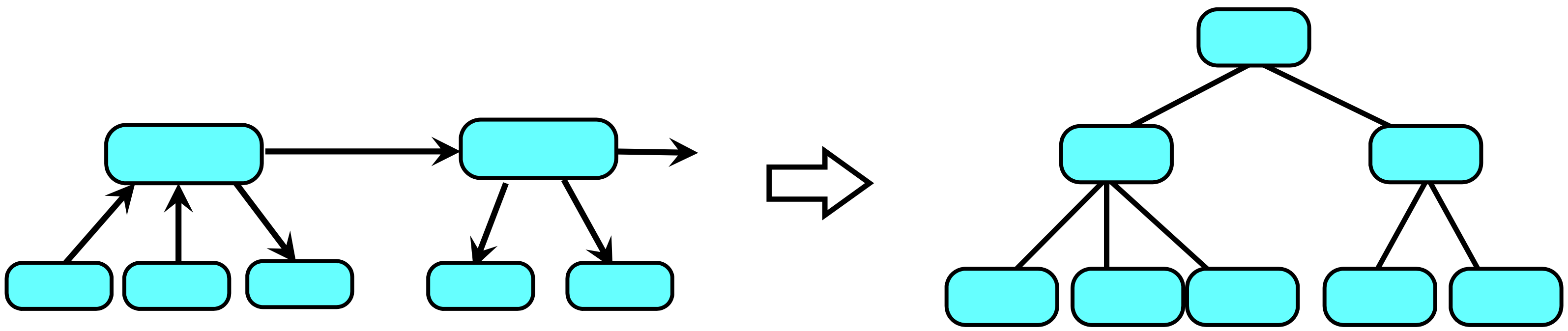
==> 'Solution Combination Method' in USIT

(4) Solution Combination Method

Combine multiple solutions (or multiple elements of solutions)
in various ways
(such as functionally, spatially, temporally,
structurally, at the principle level, etc.)
so as to form a new solution
which enhances the strong points,
complements the drawbacks, and
overcomes the contradictions.
Also solve the problem
by transferring to the super-system level.

(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.

How to learn/apply USIT Solution Generation Methods

Skip

-- It takes time to master them.
They contain the essence of all the methods in TRIZ.

(A) Understand the meaning of each sub-Operator.

- Read/learn texts of solution generation merhods (in USIT and in TRIZ).
- Learn various examples of application.
- Interpret for yourself any solution in terms of USIT operators. -- This is effective!

(B) Realize which (sub-)Operators are effective in various situations

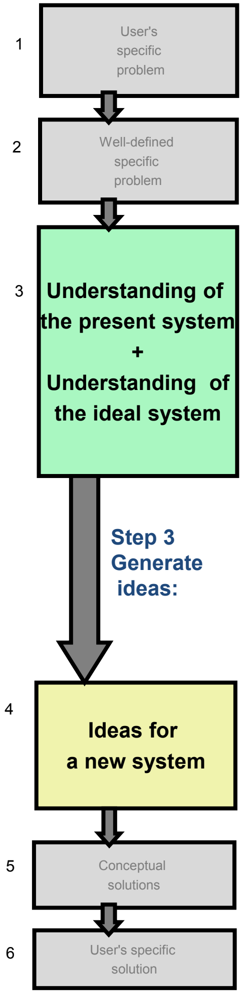
- Basically any sub-Operator is useful. Do not bother too much in selection.
- Analysis of the problem often guides you naturally to some sub-Operators.
- There are several frequently-used sub-Operators. You can learn them soon.

(C) Master the secrets of applying each sub-Operator to real problems.

- Apply the sub-Operator onto the target anyway, and then think of its good usage.
- Apply it not in conventional ways but in its essential, principle-based ways.
- Application methods may never be unique. Think differently and flexibly.

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.

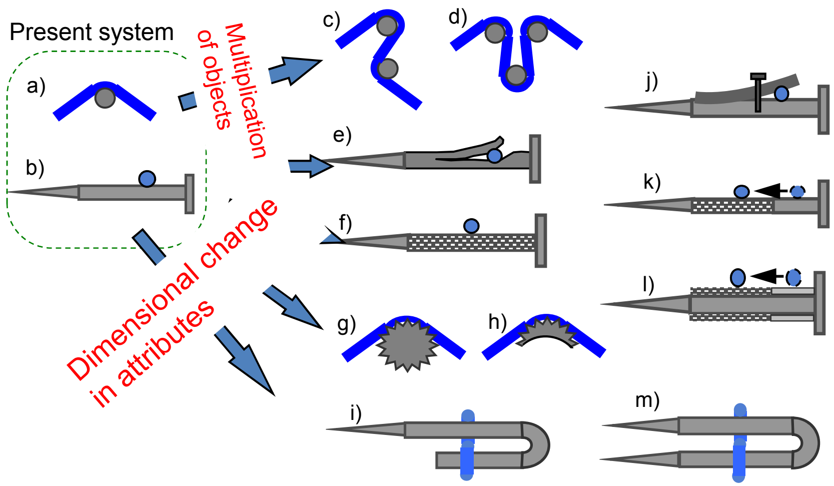
There can be various ways of good use.

You should think in a flexible manner.

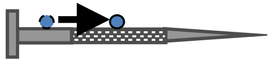
There are a huge number of combinations of USIT sub operators and their possible targets; so you should not and need not try to exhaust the combinations.

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

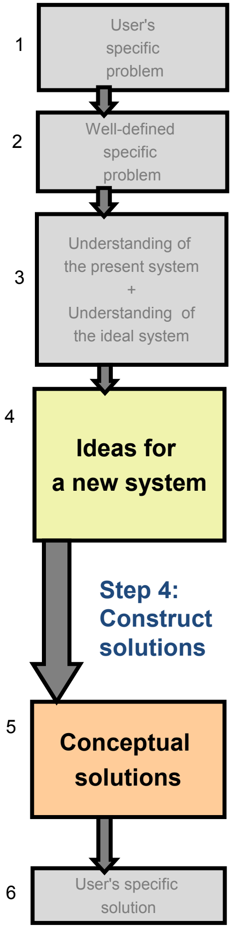
Maintain

- 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: (1) Evaluate and select ideas

Evaluate a lot of ideas generated so far and select significant ones to be examined and extended further



Evaluate a lot of ideas obtained so far and select significant ideas to be examined and extended further.
Rather than detailed individual ideas, we should consider the directions and intentions of solution groups and decide at slightly higher level in the system of solution ideas.

Generally speaking, the followings are the three main criteria:

A. Effectiveness (estimated effectiveness)
B. Feasibility (from the aspects of technology, cost, timing of delivery, business, etc.)
C. Novelty/originality/patentability

TRIZ Viewpoint:
Is the 'Contradiction' overcome?
Qualities of solutions can be evaluated.

The criteria of evaluation should be adjusted to match the purpose of the problem solving project, i.e., the intention of the parent project.

What are requested for this USIT project?

- Finding directions towards future, ideals
- Innovative ideas, even if containing some risks
- New solution concepts feasible in 2-3 years
- Realistic solutions implementable within a year
- Solutions implementable immediately

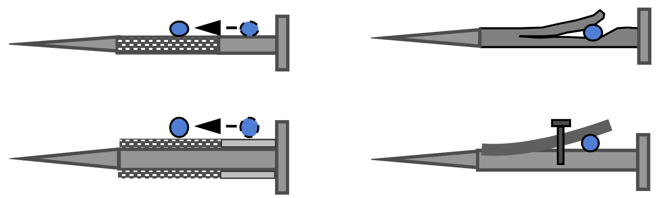
See Step 1 (1)

Example of idea evaluation:

We have found **the essence of this problem is the Physical Contradiction in TRIZ**; thus our solution overcoming it is:
"During adjusting the frame, the string should move smoothly on the nail, while later during holding the frame for a long time, the string should never move on the nail. "

Thus any solution that does not distinguish these two contradictory time zones has not overcome the contradiction.
(Ex. 'Make the surface of the nail rough for more friction.')

Solutions where **the string 'never' move** on the nail during holding should be evaluated highly than those where **the string 'hardly' move**. It is also desirable that the treatment for making the string 'never' move is simple, without disturbing the adjustment, and also can be released when we want.

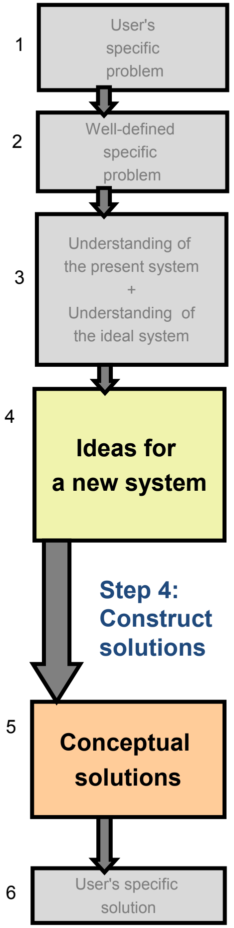


The string 'hardly' move on the nail.   The string 'never' move.

Evaluation in this step needs thorough understanding of the parent project and of the subject matter (in the Real World).

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.)

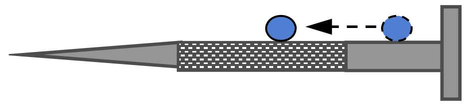
Consider from various viewpoints to construct good and convincing conceptual solutions.

- 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.

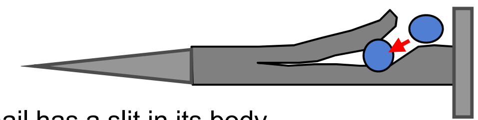
The solutions to be constructed in the present step are conceptual, i.e., in the Thinking World. To the best of the project team, these solutions are supposed to work well and solve the original problem.

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.

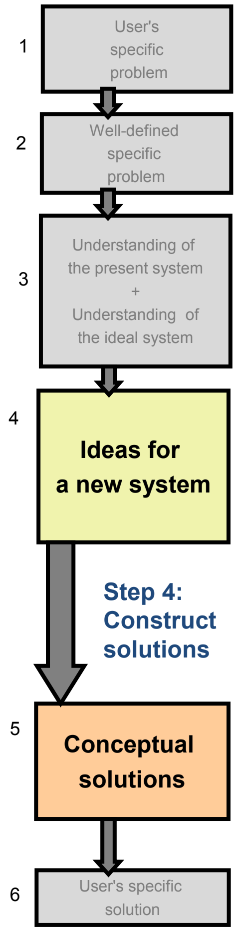


The nail has a slit in its body.
Adjust the string at the ordinary axis part, and after finishing the adjustment push the string forward to set tightly in the slit.
Manufacturing the nail costs some. Simple and cheap.
After the adjustment, the string is essentially fixed, and it may be released by hand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

Step 4: Construct solutions: (3) Report the results of the USIT project

Prepare reports of the results of the USIT project, and state proposals.

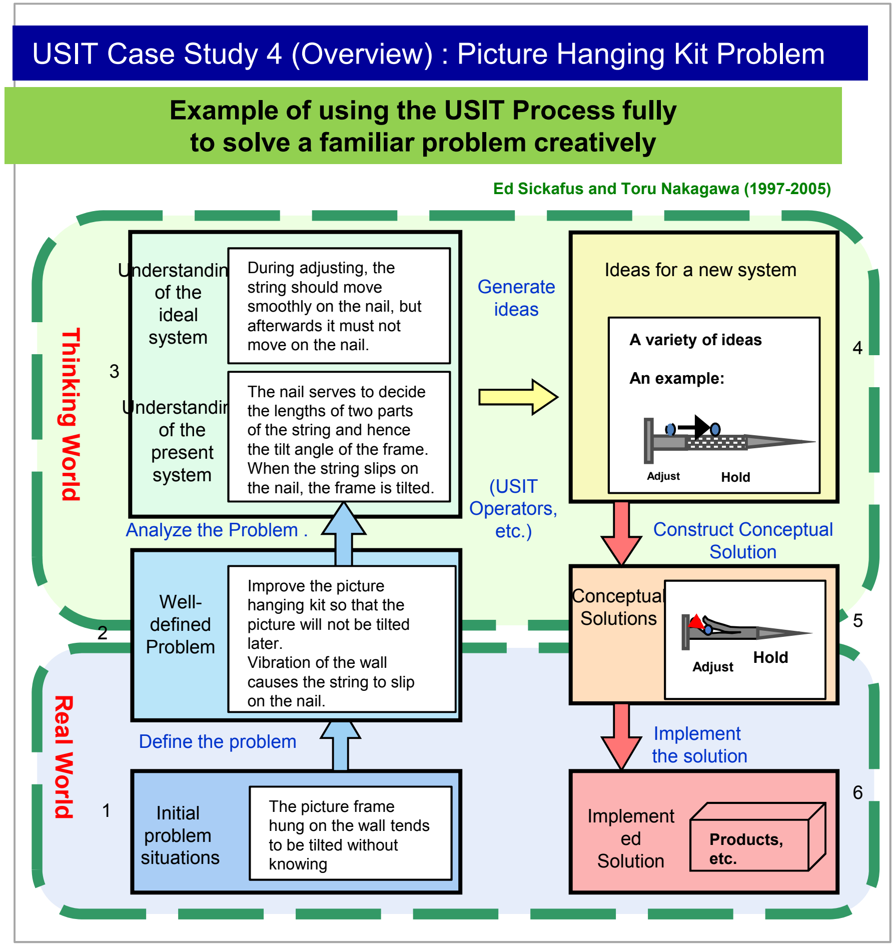


Summarize the whole process by writing reports at the end of the USIT problem solving process. Conclude with the proposals of final conceptual solutions and describe the whole thinking process for supporting the conclusion.

The conceptual solutions (in Box 5) are the most important results of the problem solving project.

For supporting the conclusion, describe the full process of the USIT problem solving process and **explain why and how the team reached the proposals.**
Since this USIT Manual guides the whole problem solving process in a logical way, documents of statements, diagrams, etc. made along the steps are useful as the base materials of the reports.
As a brief summary of the whole logic, the overall view shown in the Six-Box Scheme may be useful.

Several examples of case studies are shown in the style of Six-Box Scheme, and attached at the Appendix of this Manual. They are summaries of cases documented in the **Collection of USIT Case Studies.**



For real projects, only the reports and proposals are the results of the USIT problem solving projects.
For USIT training/trial projects, writing reports of the experiences and contents is essential for mastering the USIT process.

Step 5: Implement the solutions: (Real activities in the 'Real World')

Utilize the results of the problem solving project, and implement the new solutions through the activities in the 'Real World'

1 User's specific problem

2 Well-defined specific problem

3 Understanding of the present system + Understanding of the ideal system

4 Ideas for a new system

5 **Conceptual solutions**

Step 5 Implement the solutions

6 **User's specific solution**

This step is out of the USIT process (in the 'Thinking World') and to be carried out as the real activities of technology/business/ society etc. (in the 'Real World').
Use the 'Real World' criteria in decisions and activities.

After having obtained the conceptual solutions, we need company-wide activities for implementing them as real products, services, processes, etc. :

- Evaluate and examine the conceptual solutions in the parent project and decide the directions to do in the Real World
- Solve secondary problems, and develop necessary technology, etc.
- Experiments, simulations, etc.
  Use Taguchi Method, prototyping, testing, etc.
- Designing
- Manufacturing
- Marketing, sales,
- Obtaining/clearing intellectual properties

Box 5 Conceptual Solutions

Implement the solution

Box 6 **Implemented Solutions**

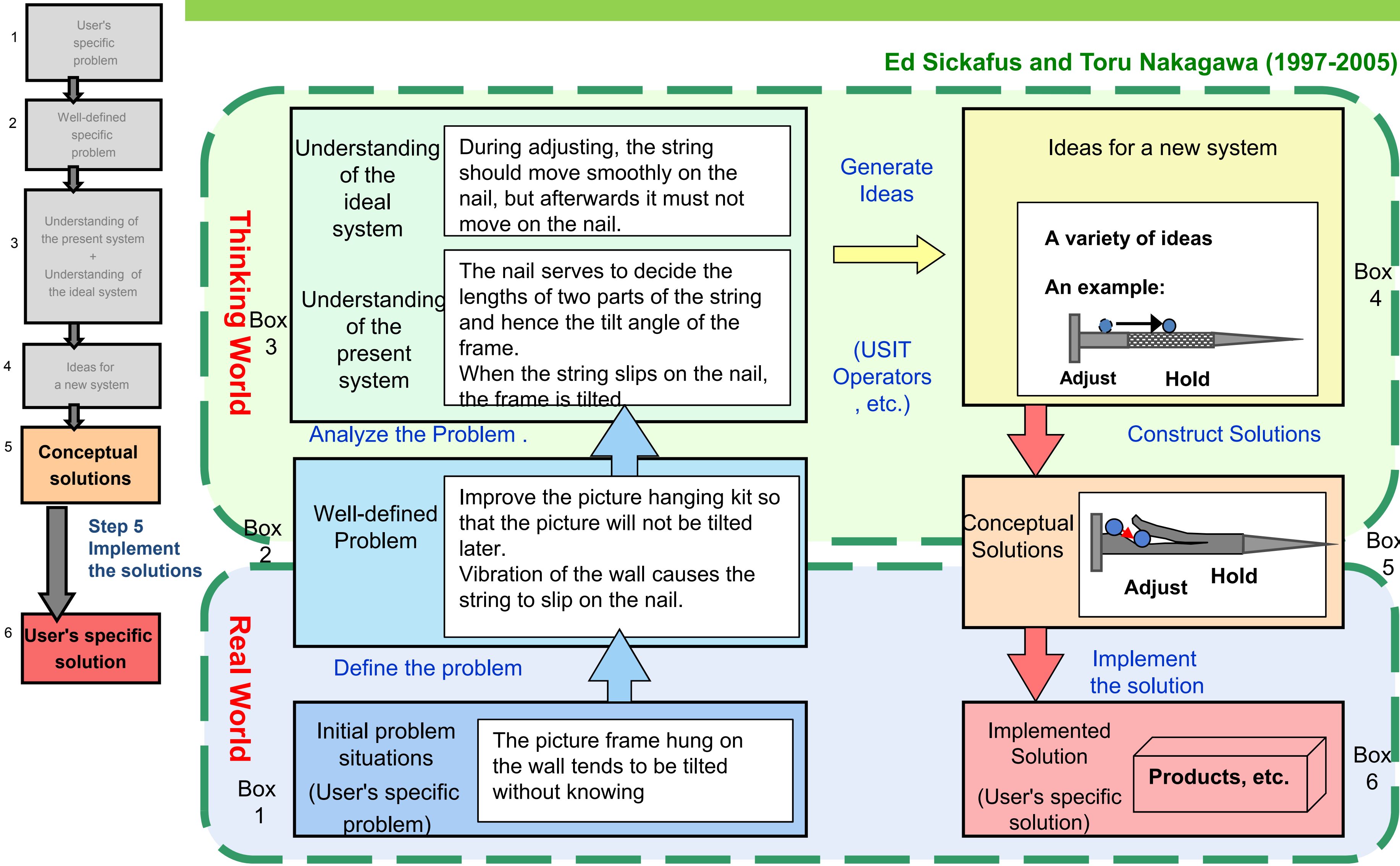
(products, services, processes, etc.)

Without carrying out this step of implementation, 'Creative problem solving' does not make any fruit. Make results of the 'real problem solving' in the 'Real World'.

USIT Case Study 4 (Overview) : Picture Hanging Kit Problem

Example of using the USIT Process fully to solve a familiar problem creatively

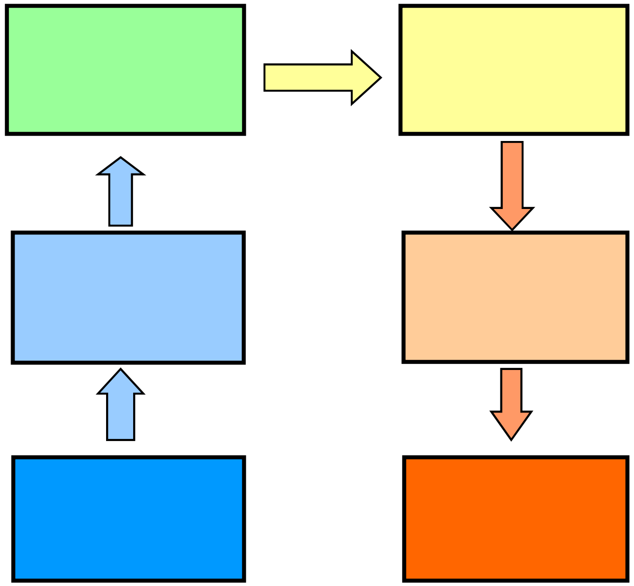
Ed Sickafus and Toru Nakagawa (1997-2005)



Concluding Remarks

Conclusion

'Six-Box Scheme' is
A New Paradigm of
Creative Problem Solving.



The Scheme clarifies
what types of information are required
for every stage of problem solving.

This solves a fundamental problem
in TRIZ (i.e. the lack of clear overall structure).

USIT is a practical procedure
for performing the Six-Box Scheme.

2-Day USIT Training Seminar (Nakagawa)

Practice USIT in solving real, brought-in problems in groups.

Time	Day 1
10:00	(L0) Introduction
	(L1) Introduction to TRIZ/USIT
12:30	Lunch
13:30	Presentation of Problems
	(L2) Problem Definition
14:45	Group Work (1)
	Presentation & Discussions
16:30	
16:45	(L3) Analysis of Present System
	Group Work (2)
	P & D
19:00	

Time	Day 2
9:00	(L4) Analysis of Ideal System
	Group Work (3)
	P & D
11:15	(L5) Solution Generation
12:00	Lunch
13:00	Group Work (4)
	P & D
14:30	Group Work (5)
	P & D
16:15	Group Work (6)
	P & D
17:30	(L6) Promotion in Industries
	General Discussion
18:00	

How to Apply and Pracice USIT in Industries

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

⇨ Bring up (a few) USIT experts as the leaders in a company,
and train many engineers in in-house training program to understand USIT.

(2) USIT fits well for group work.

⇨ Make joint teams of 1-2 USIT experts and 4-6 engineers for problem solving.
USIT expert facilitates the team, or asks suitable questions to the engineers.

(3) USIT is applicable to real problems for conceptual solutions.

⇨ Apply to imporant real industrial problems and get results.
Can be implemented smoothly in the R&D framework in industries.
Selecting problems and implementing solutions need to be done in the criteria of the real business/technological world.

(4) Use TRIZ knowledge base tools in a complementary way.

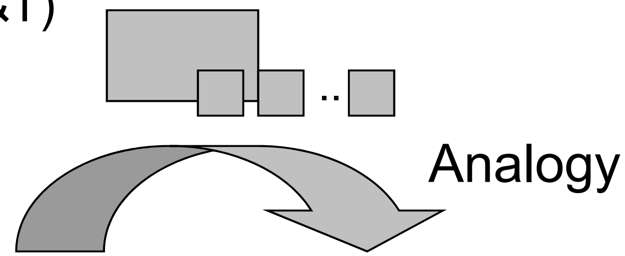
⇨ Use USIT in a group for guiding human thinking process, and
Use TRIZ software tools as the knowledge bases, mostly individually at separate time zones.

Implications of the New Scheme (2) Idea generation

Traditional paradigm: (TRIZ and generally S&T)

Presenting a few (Inventive) Principles
together with application examples

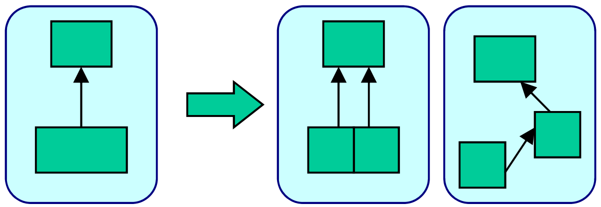
==> (Enforce) analogical thinking



New Paradigm with USIT:

(In theory)

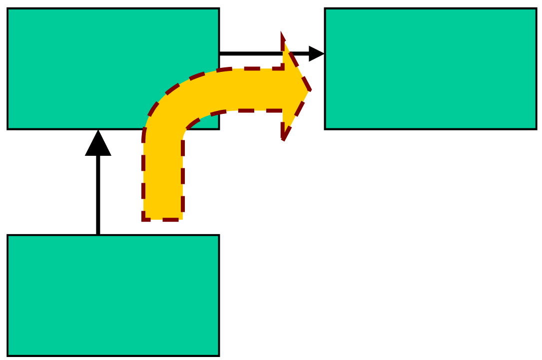
Apply USIT Operators
one after another in the abstract level



(In practice)

Already generated in the brain during the analysis stage

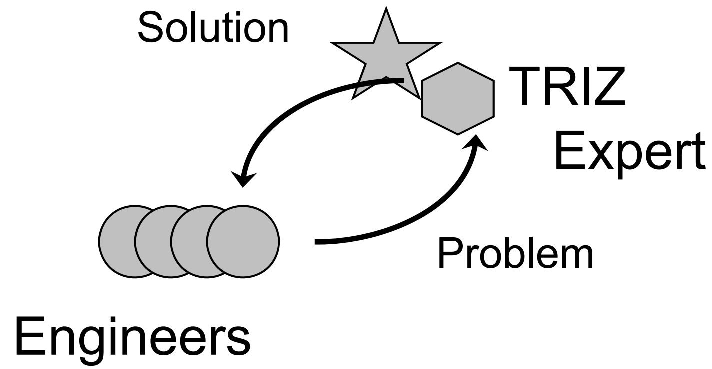
List them up and
build into a tree structure.
(Can be done smoothly)



Implications of the New Scheme (3) Ideal expert

TRIZ Traditional:

an almighty inventor
an almighty contract researcher
in any technology field

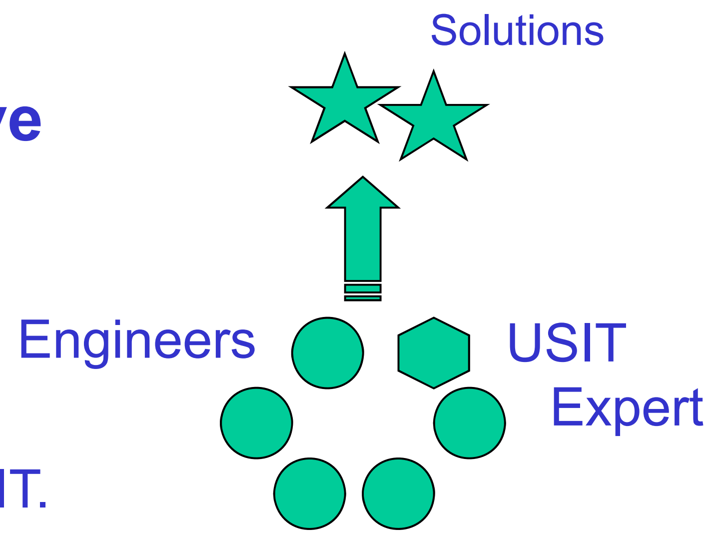


New Paradigm with USIT:

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

Thank you for your attention

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