

Classes of 'Creative Problem Solving Thinking' -- Experiences at Osaka Gakuin University --

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

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Altshuller Institute 9th International TRIZ Conference
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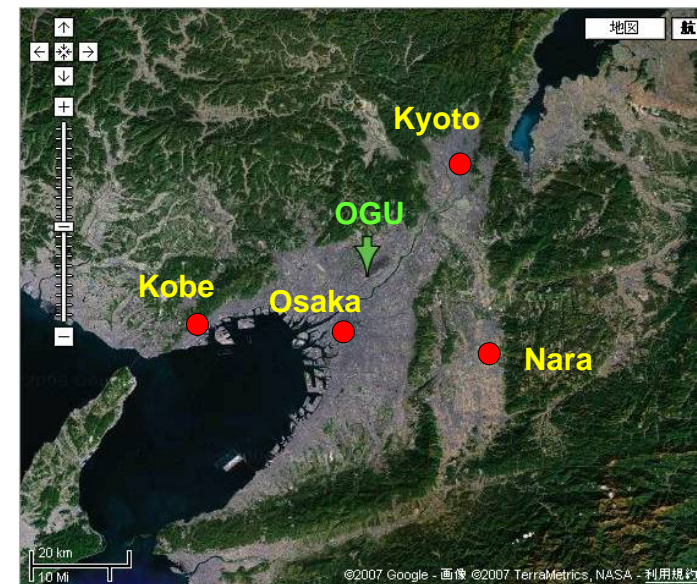
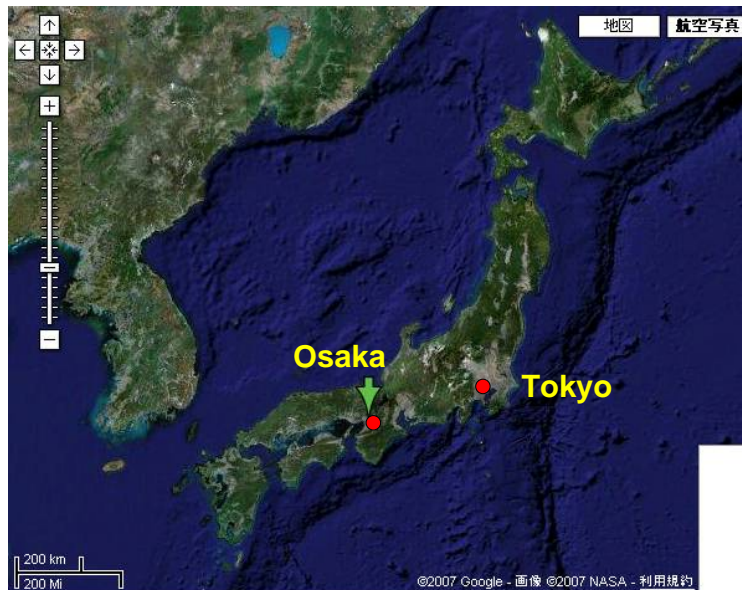
Outline of Talk

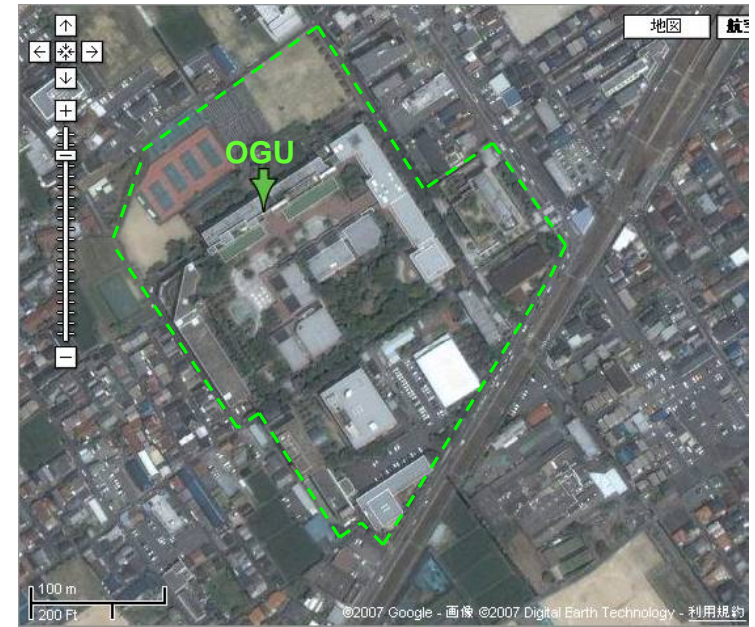
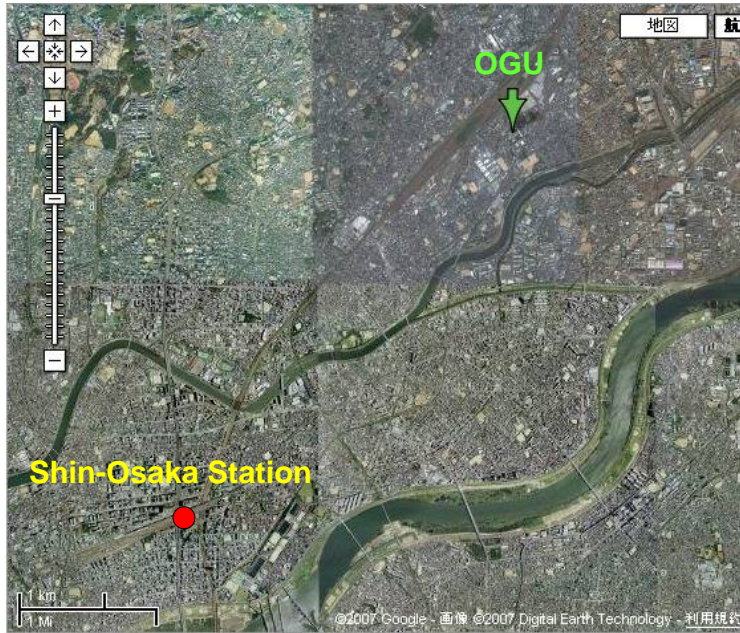
A Report of experiences of teaching TRIZ in my university classes:
Lecture class on 'Methodologies of creative problem solving'
for 2nd (and over) yr students
Seminar class for 3rd yr students
Thesis work class for 4th yr students

Contents and Results of the classes:

Lectures base on TRIZ/USIT
"TRIZ Home Page by Students for Students"
Case studies obtained by students
Students' findings what they learned

Concluding remarks





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OSAKA GAKUIN UNIVERSITY

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Campus Map

Click on a number for information on the corresponding facility.

**A private university,
 Established in 1963.
 8 Faculties, e.g., Economics, Law,
 Foreign Language, etc.
 About 10000 students,
 250 faculty members**

Faculty of Informatics
 (Computer science course,
 Human science course)



Informatics Building



Informatics Entrance





Computer Class Room



Lecture Class Room



Class Room
for Group Exercises
(My class on Software
Engineering)

My Background: Toru Nakagawa

(A) researcher in physical chemistry in a university

Experiments and computer analysis

(B) researcher in software engineering in an industry lab

Research and promotion of software QC
Managing staff of R&D

(C) professor in informatics in Osaka Gakuin Univ.

Research and education in TRIZ/USIT
Editor of "TRIZ Home Page in Japan"
Promotion of TRIZ/USIT in industries & academia

3 Classes I am teaching on TRIZ

	Lecture class	Seminar Class	Thesis Class
Semester	2nd yr (or over) Fall	3rd yr Spring and Fall	4th yr Spring and Fall
Hours	1.5 hr × 13-15	1.5 hr × 26-28	1.5 hr × 26-28
Students	40 - 60 (Selective)	1 - 5 (Mandatory) →	1 - 5 (Mandatory)
Theme	Methodologies of creative problem solving	Creative problem solving thinking	
Teaching style	Lecture	Group training	Group training and individual thesis work
Task	a report	reports	preliminary reports and a thesis

Lecture Class: 'Methodologies of Creative Problem Solving'

Lecture (1) An easy introduction

- Need to think and solve problems creatively
- Simple case studies:
 - Archimedes' crown
 - Squeak and buzz problem of windshield molding (Ford),
 - Saving water in the toilet system (Lee, Korea), etc.

Lecture (2) Three principal approaches with science & technology

- (a) Observations -- (induction) --> hypothesis --> verified hypothesis
 - (b) Principles -- (reasoning) --> theories --> applications
 - (c) Problems -- (analysis and solution) --> solutions --> applications
- This Class teaches the third approach: Problem Solving.

Lecture (3) Finding the problem and its focus

Finding/noticing the problem is necessary first of all.

- Needs high motivation to notice a problem.
- Think over the problem in a wider perspective
- Find the core of the problem and focus on it.
- Collect information relevant to the problem.

Lecture (4) How come up with ideas?

- Good ideas often come up suddenly like an enlightenment.
- After a long period of thinking/struggling, it happens on some relaxed timing,
- No guarantee whether and when it happens.
- Ways of struggling: brainstorming, trial-and-error experiments, searching for hints, 'know-hows for inventions', etc.

This lecture will show you some more systematic ways to obtain such ideas.

Lecture (5) What are 'Systems'

- 'A group of related parts which work together forming a whole'.
- Hierarchy of systems
- Blackbox model of a system. Function of a system.
- Law of completeness of a technical system (TRIZ).

-- Problem Analysis --

Lecture (6) Finding root causes of the problem

- Find the real problem of the situation: harmful/unwanted effect
- Clarify the mechanism and find the causes of the problem.
- Identify (plausible) root causes.

Lecture (7) Analyzing functions and attributes of the system

- Use general theory of systems in addition to subject-matter knowledge.
- Concepts of Objects, Attributes, and Functions.
- Functional Analysis of the system. (TRIZ ways and USIT way)
- Attribute Analysis (USIT)

Lecture (8) Extra: How to construct and write a report.

Basic training for academic/business purposes

Lecture (9) Analyzing space/time characteristics and ideal solution

- Clarify the system's characteristics with respect to space
- And also with respect to time (changes with time; process analysis, etc.)
- Think what are the Ideal Situations (TRIZ IFR)
- Consider desirable behaviors and desirable properties of the ideal system (Particles Method in USIT)

-- Solution Generation --

Lecture (10) Fully utilizing knowledge bases

- Consult much wider and deeper knowledge of science and technology
- Knowledge bases of science & technologies, and patent data bases
- Use TRIZ knowledge bases (and software tools):
 - Trends of evolution of technical systems,
 - Technical means retrievable from target functions,
 - '40 Inventive principles' in TRIZ
 - 'Altshuller's contradiction matrix' in TRIZ, and its new version Matrix 2003.

Lecture (11) How to break through the barriers

- Concept of contradictions: Technical Contradictions and Physical Contradictions
- TRIZ Separation Principle for solving Physical Contradictions
- Case study: Water saving in a toilet system (K. W. Lee et al.)
- Two necessary conditions for a solution to be inventive (ASIT)
- ASIT approach (a simplified TRIZ) for finding inventive solutions

Lecture (12) A system of solution generation operators (USIT)

- USIT approach for generating solutions effectively.
- Reorganizing all the methods in TRIZ into the USIT Operator system (T. Nakagawa).
- Usage of USIT Operators: Examples: Picture hanging kit problem.

-- Summing Up of the Class --

Lecture (13) Case studies of everyday-life problem solving

- 'How to fix the string shorter than the needle' (OGU)
- 'How to prevent the staple from being crashed' (OGU)

Lecture (14) Creative problem solving with USIT

- Overview of USIT in the data-flow diagram (Six-Box Scheme of USIT) (Nakagawa)
- Overview of USIT in the flowchart.
- Problem definition and Problem analysis (Function/attribute analysis, Space/time characteristic, Particles method)
- Solution generation (USIT operators).
- A new paradigm of creative problem solving with USIT

Lecture (15) Creative problem solving with TRIZ

- TRIZ philosophy: Essence of TRIZ in 50 words (Nakagawa)
- TRIZ knowledge bases and TRIZ software tools.
- TRIZ methods for analyzing problems
- TRIZ methods for generating solutions (esp. for solving contradictions).
- TRIZ, its history and current situations of penetration in the world.

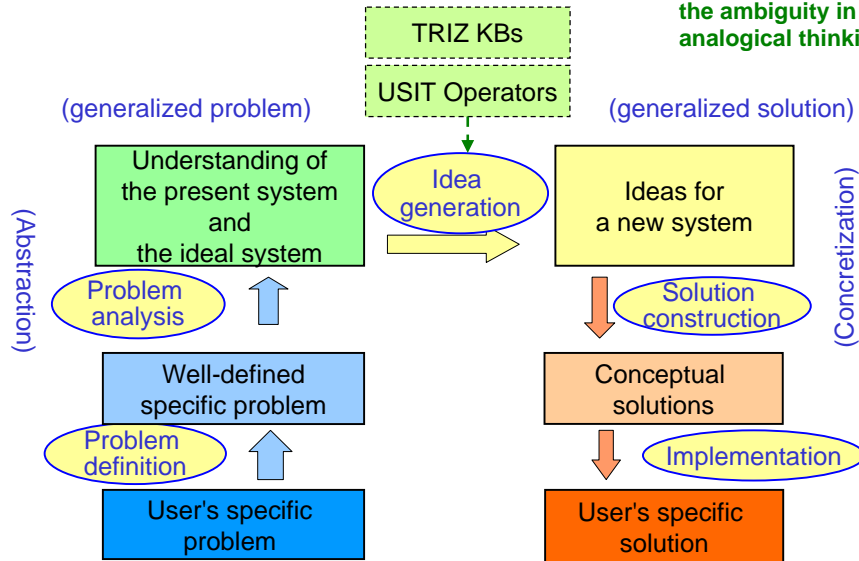
-- Conclusion of the Class--

- We have obtained reliable systematic methodologies for creative problem solving.
- They are applicable in a wide range, especially for innovations in technologies.
- Mastering such a methodology will become a valuable skill for yourself.

A New Paradigm for Creative Problem Solving

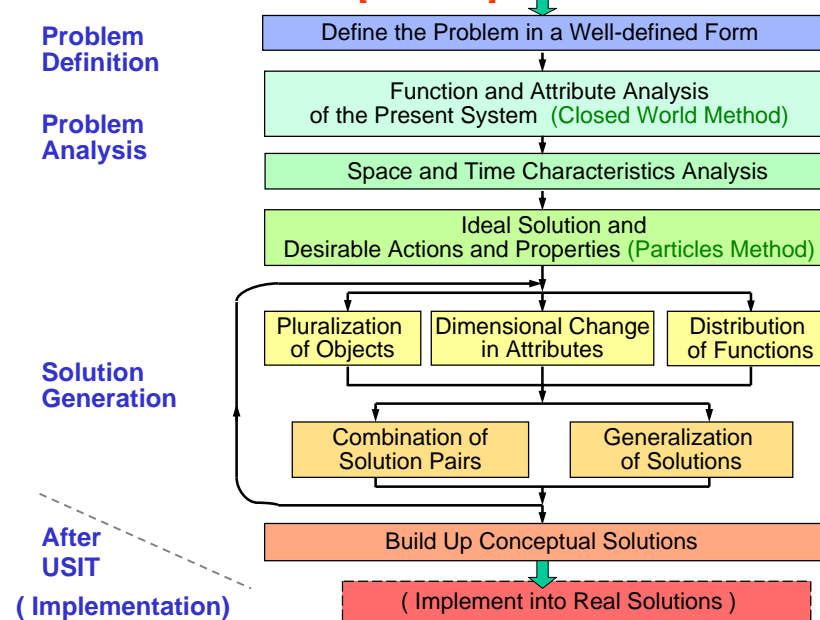
Six-Box Scheme in USIT

We have overcome the ambiguity in analogical thinking.



USIT Procedure [Flowchart]

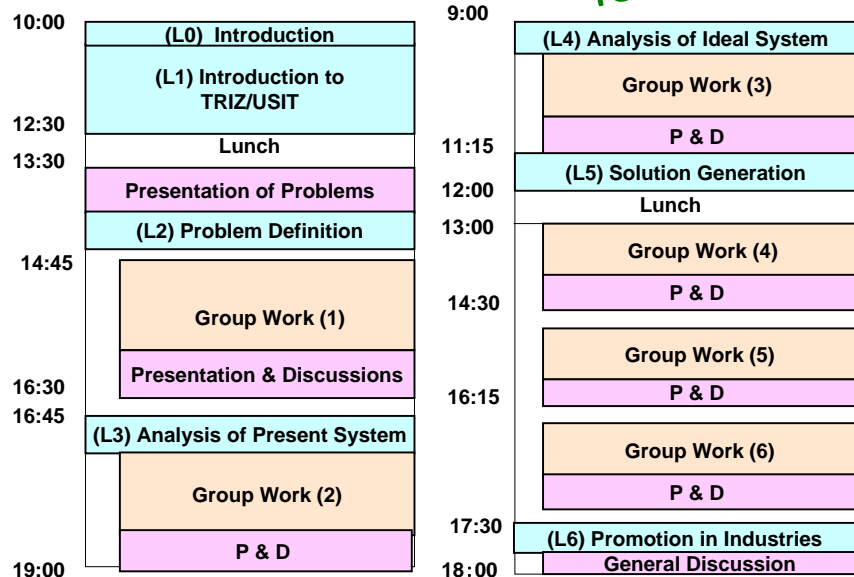
[T. Nakagawa, Mar. 2005]



Practices of Training/Applying USIT

2-Day USIT Training Seminar (Nakagawa)

for Engineers



Practices of Training/Applying TRIZ/USIT Seminar and Thesis Classes (Nakagawa)

for Students

Seminar Class (A small group of 3rd yr students)

- Most Textbooks on TRIZ for engineers are not suitable for students study.
- Studying case studies and working on them again are useful.
- Case studies published in Japanese or developed in OGU are used.
- Group practices of solving various everyday-life problems -- with explanation of the problem solving methods TRIZ/USIT.

Thesis Class (the same students who are now 4th yr)

- Continuation of group practices on various everyday-life problems
- Finding a problem for individual thesis work
- Student's presentation and group discussion on each student's thesis problem
- Writing a thesis (Abstract in two pages is mandatory.)
- Presentation/defence of the thesis work in a joint-Lab meeting
- Building a Students' Web site and posting the thesis works publicly.

Results posted in "TRIZ Home Page for Students by Students"

"TRIZ Home Page for Students by Students"

<http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/TRIZ-st/index.htm>



Mizuo Omori

Naoya Hayashi

Tsubasa Shimoda

Toru Nakagawa

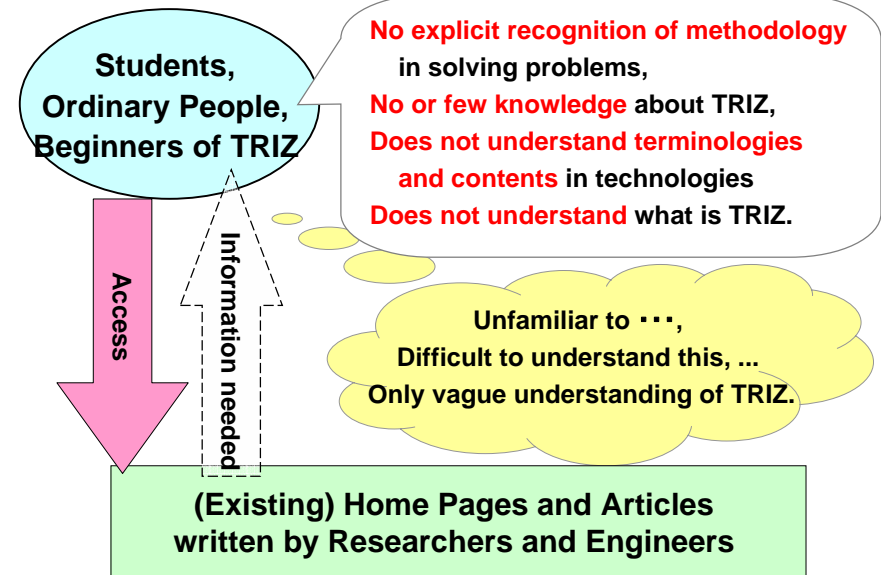
Masayuki Hida

Faculty of Informatics, Osaka Gakuin University

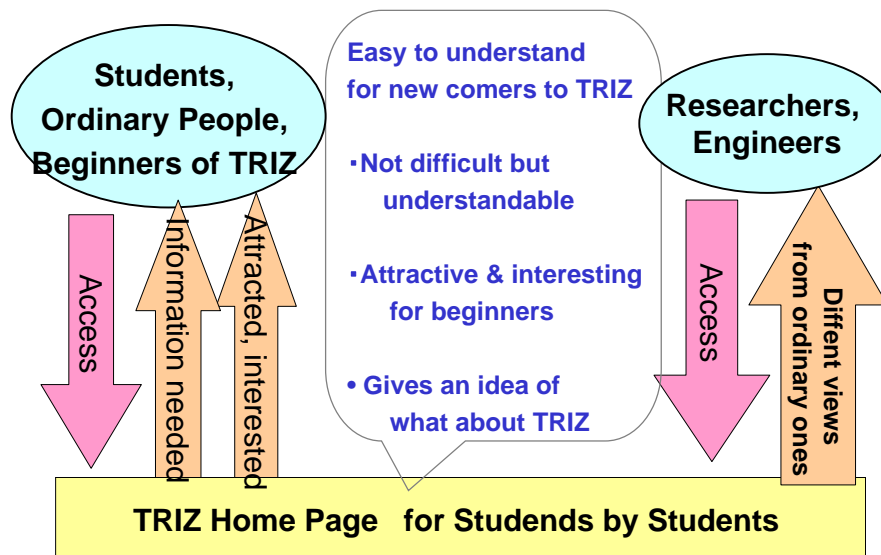
Nakagawa's Seminar Class for the Thesis Work

Graduated in March, 2006 (Photo taken on the day of Graduation Ceremony)

Needs for a TRIZ Home Page for Students



Aims of a TRIZ Home Page for Students



TRIZ Home Page for Students by Students

(Established in Mar. 2006)

• About TRIZ:

Introduction to the History and Methods in TRIZ

• What we think we obtained by studying TRIZ/USIT

- A record of the discussion on Feb. 1, 2006 just before the graduation -

• Case Studies of our Applying TRIZ/USIT to Everyday-life Problem Solving

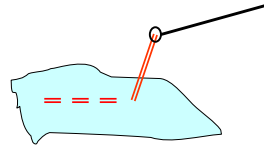


Everyday-life Case Study: How to fix a string shorter than the needle at the end of sewing

Define the Problem:

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

(c) Sketch:



(d) Plausible root causes:

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



(e) Minimum set of relevant objects:

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

Problem Analysis (1): Understanding the present system

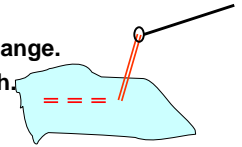
(1) Functional analysis: What is the function of the Needle?

- A base for making a loop of the string;
- A guide for passing the end of the string through the loop



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

- The string does not expand = Its length does not change.
- The needle is hard = No change in shape and length.
- The needle is thin = The hole is small = Difficult to pass the string through the hole.



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

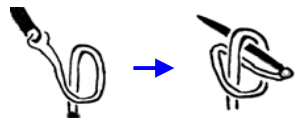
(3) Analysis of time characteristics: Processes of sewing:

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

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

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

Several known solutions:



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



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

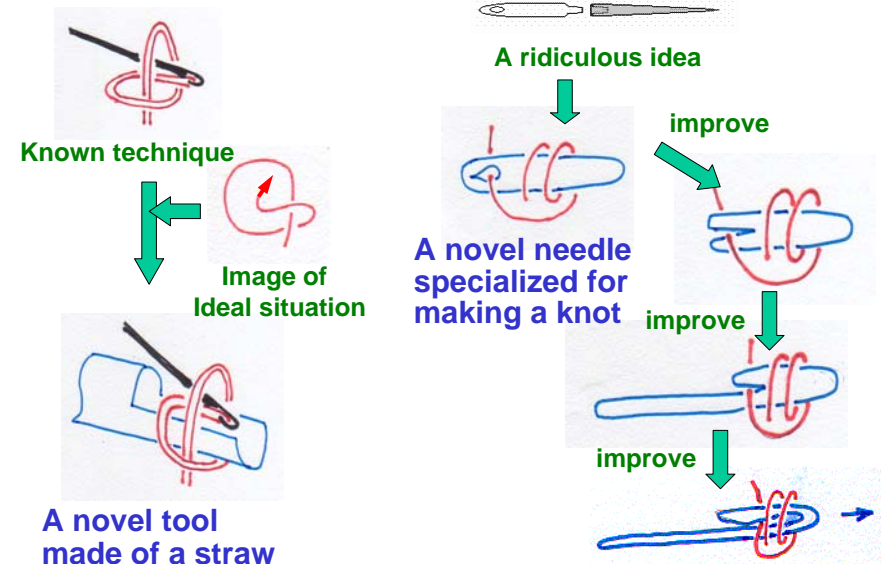
Problem Analysis (2) : Understanding the Ideal system

Ideal arrangement of a sting in space for making a knot



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

Solution Generation: Generate Ideas and Construct Solutions



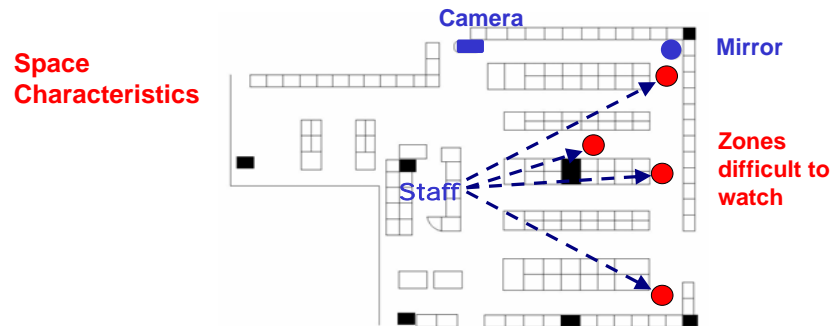
(by Naoya Hayashi (2006))

Applying TRIZ/USIT to Everyday-Life Problems

(2) How to Prevent from Shoplifting in a Bookstore

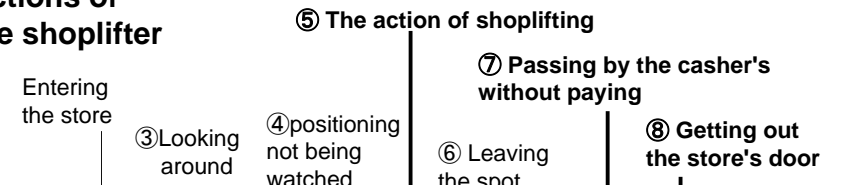
Problem situation:

At a small bookstore for which the author was working part-time, the profit of sales is completely lost due to shoplifting.



Time Characteristics (scenario of the problem situation)

Actions of the shoplifter



Actions of the store staff

Required Actions for capturing the shoplifter

See the shoplifting action on the spot

Warning at the cashier's counter

Capturing the shoplifter at the moment of leaving

Difficulties at the Heart of the Problem (Root Contradictions):

- (1) The store staff must see the **Three Moments (5)(7)(8)** of criminal actions and capture the criminal at the moment of his leaving away.
- (2) **The timings and places** of the Three Moments can be chosen by the shoplifter's will and decision.
- (3) Before capturing the Three Moments on the spots, the store staff **must handle any person as their 'Guests'**.

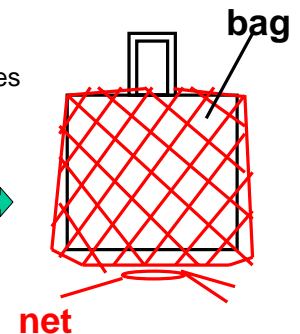
A Direction for Solving the Problem:

Make the 'Moment' into a longer period of time:
E.g. 1 second --> 10 minutes

Solution ideas:

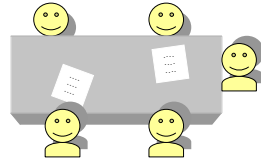
Preventing the guests' bags from being used for the shoplifting.

- (a) Put the guests' bags in the specified bags, with fasteners, with locks, etc.
- (b) Close the guest's bag opening with some sheet, with a device alarming when it is opened.
- (c) Close the guest's bag opening with some tapes or strings
- (d) Set a net over the guest's bag and close the net at the bottom of the bag.

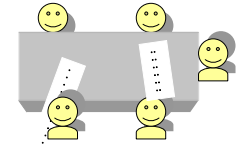


Record of Students' Discussion just before their graduation

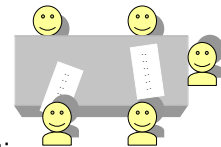
What we think we obtained by studying TRIZ/USIT



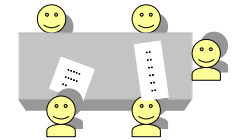
- **At first** we did not have much interests in it; we started to learn it without knowing what it is (except the information in the syllabus).
- **By the experiences of practices of solving problems,** we have been attracted with TRIZ little by little.
- **TRIZ thinking:** In my everyday life, when I meet some problem, I now find myself trying to analyze the problem and to figure out solutions.
- **My impression of TRIZ** was not so good at first, but it turned out to be much different and much better.



- **Confidence:** Though I was poor at making ideas, I now feel that I myself is able to think of something new.
- **Collaborative Thinking:** I have found that rather than thinking alone, thinking in collaboration with my Seminar group members brings us new findings and new ideas and hence much better solutions.
- **Thinking consciously:** I am interested in analyzing problems and finding solutions with explicitly applying the thinking methods which we were usually not aware of.
- **Novel method:** It is interesting that TRIZ has studied 'how to invent' and has systematized the ways of thinking.

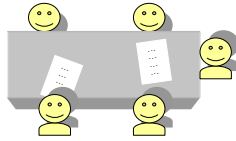


- **Analytical thinking:** When we analyze problems from various viewpoints, we come to see their solutions. Thinking in Space and in Time we did much vaguely before, and now learned to do it more logically. We have noticed that thorough analyses are essential for problem solving.
- **Ideas have come up to my mind more often** than before. The experiences of studying to solve a number of problems have led us to find solutions of different problems.
- **I feel envious** when I watch on TV that somebody invented a nice method to do something, because I could also have found that solution by using TRIZ. Finding a good problem is most important, I learned.



- **Selfconfidence:** While solving several everyday-life problems in the seminar, I really feel the improvement of my capability of problem solving.
 - **Golden Eggs:** Apparently ridiculous ideas and images of ideality are the eggs of gold, I realized, which we should warm and hatch for ourselves individually and in group.
- ➔ **By solving every-day life problems with TRIZ/USIT, we became familiar with TRIZ and received the influence of TRIZ on our own life style, feeling it pleasant and interesting.**

Advantages and Limitations of Studying TRIZ in the Universities



Advantages:

Having (enough) time to study,
Possible to master the basics of TRIZ
by encouraging interests and
by removing the initial impression of being difficult.

Limitations:

Even though possible to challenge a number of problems,
it is often impossible to really make prototypes and
examine the solutions
due to lack of technologies and practical environment.
(Especially in Faculty of Informatics
we do not have a machine shop.)

Concluding Remarks

for Students

- (1) Have established a lecture on 'Methodologies of Creative Problem Solving' on the basis of TRIZ/USIT.
- (2) The Six-Box Scheme and Process Flow of USIT are studied and applied successfully by students.
- (3) Studying and solving case studies, especially on familiar, everyday-life problems are useful.
- (4) Attitude of creative problem solving thinking seems to be learnt by the students with two year seminars.
- (5) Specialty, technical training need to be carried out in parallel to the generalized, system-oriented training with TRIZ/USIT.