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

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ABSTRACT

Experiences of the classes of 'Creative Problem Solving Thinking' at Faculty of Informatics of Osaka Gakuin University are reported. A course of 15 lectures has been given to 2nd year (and over) students with the theme of 'Methodologies for Creative Problem Solving'. Since the students do not have much background knowledge of technologies yet, the course is taught by giving basics of doing research and thinking and basics of concepts of systems and functions. Processes of problem solving were explained step by step showing various examples and different methods mostly of TRIZ and USIT. In the Seminar Classes, small groups of students were trained on the theme of 'Creative Problem Solving Thinking' at about 27 classes for 3rd and for 4th year students. Training is mostly done with group practices by using published or new case studies. Students have solved various everyday-life problems as their thesis works. A new Web site "TRIZ Home Page for Students by Students" has been established in March 2006, posting their thesis woks and discussions on their findings with TRIZ/USIT. Some case studies of solving everyday-life problems are demonstrated.

1. INTRODUCTION

This is a report of my experiences of teaching students in my university classes especially on the topic of 'Creative Problem-Solving Thinking'. Since this topic is so general, materials to teach may be chosen differently depending on the background of a teacher, and the ways to teach and the reactions of students may be quite different depending on students and classes. Thus first I am going to introduce my background briefly and describe about my students.

1.1 My Background and My Students

I was a physical chemist doing experiments and computer analyses in molecular spectroscopy during my days as a graduate student and as a junior faculty member in the University of Tokyo. Then at the age of 39, I became a researcher in computer science in a basic research institute in Fujitsu Ltd. and worked on quality improvement in software development and then served as a research management staff. At the age of 57, I became a professor of Faculty of Informatics of Osaka Gakuin University. I happened to learn about TRIZ (Theory of Inventive Problem Solving, established by G. S. Altshuller) [1] a year before my moving to the university, and since then I have been deeply involved in the study of TRIZ. In parallel to teaching students in computer science classes, I have been doing research on the methodologies of creative problem solving especially based on TRIZ and have extended USIT (Unified Structured Inventive Thinking, developed by Ed Sickafus) [2] further. My main activities in TRIZ have been to promote TRIZ/USIT in Japanese industries especially by publicizing information in the Web site "TRIZ Home Page in Japan" [3] as the founding Editor on a voluntary basis. Thus it is quite natural for me to teach students on the topic of 'Creative Problem-Solving Thinking' by using TRIZ and USIT.

My university, Osaka Gakuin University (OGU), is one of many private universities in Japan. It was established in 1963 in the field of commerce and economy, and has grown into a large (but not huge) university having 8 Faculties and nearly 10000 students altogether. Faculty of Informatics was established in 2000, i.e. 2 years later of my joining, as a new faculty related in natural science and technology. It has the capacity of 100 students each year at the undergraduate level; roughly half of them are interested in the computer science course while the rest in the human science course of our Faculty of Informatics. OGU is not a prestigious but an ordinary university, and after the graduation most students want to find jobs in IT, manufacturing, and service industries. The average level of university students in Japan currently suffers from some degradation, unfortunately, in their basic academic training and in their motivation. Thus we cannot assume our students having so much background knowledge of technologies.

1.2 Classes I Am Teaching

In my university, as usual in Japan, the academic year starts in April. Classes are given from April to July in the first (spring) semester, and from October to January in the second (fall) semester. Each session of a class is given once a week and lasts 90 minutes. There are lecture classes, either mandatory or selective, and seminar classes which are mandatory and given to small groups of students. Thesis work in a seminar class is mandatory for graduation.

I am/was teaching a number of classes, as listed in Table 1. I recently wrote a report [4] in Japanese, on essentially the same but slightly wider topic than the present one, which covers the classes shown with * or ** marks. In the present report, I am going to describe more specifically on the classes with ** marks, for the purpose of being informative without much dependence on the students situations.

Table 1. Classes I am/was teaching

	Class name	content (style of teaching)	student year (number of sessions per year)	students (requirement)
(a) *	Seminar IB	Basic training of reading, writing, and presentation (group training)	1st year, fall (13-14)	a small group (mandatory)
(b) *	General Topics I	'What Are You Going to Do in Your College Life?' (lecture)	1st+ year, spring (3) in 2000 - 2003	from all the 8 faculties (optional)
(c)	Computer Science	Basics of computer and software (lecture and exam.)	1st+ year, fall (13-14)	a large class from all the 8 faculties (selective)
(d) **	Scientific Information Methodology	Methodologies of creative problem solving (lecture and report task)	2nd+ year, fall (13-15)	(selective)
(e) *	Numerical Computing	Numerical computing (lecture and programming in Full BASIC)	3rd+ year, spring (13-14)	(selective)
(f) *	Software Engineering	Methods of software development (lecture and group practice)	3rd+ year, spring (13-14)	(selective)
(g) **	Seminar II	Creative problem-solving thinking (group training)	3rd year, spring & fall (26-28)	a small group (mandatory)
(h) **	Thesis work	Creative problem-solving thinking (group training and individual thesis)	4th year, spring & fall (26-28)	a small group (mandatory)

Here are brief remarks on the classes with * marks: (a) Seminars for the 1st year students are given with the general theme common to all the seminar classes in the Faculty. (b) In the class of 'General Topics I', I gave three sessions of lectures with the title 'Way of Thinking for Creative Problem Solving: What Are You Going to Do in Your College Life?'. The subtitle is the example of problem which students were encouraged to think over in a creative way. This lecture was published in Japanese [5] in my Web site. (e) In the class of Numerical Computing, I teach programming in Full Basic also for implementing algorithms in numerical computing and simple graphics. Three BASIC programs on themes of student's free choice are the requirements of the class. (f) In the class of Software Engineering, 5-member groups of students are requested to plan some software of their own choice and do the specification requirement and basic design of the software by using the methodology of structured prototyping which is taught in the class. Group work exercises are unique experiences for the students.

In the following chapters, the three classes with ** marks in Table 1 are described one by one together with some results by students.

2. Lecture Class on 'Methodologies of Creative Problem Solving'

The Class (d), formally named 'Scientific Information Methodology', was created by my initiative when our Faculty of Informatics started. It meant to teach a general methodology of handling information scientifically and creatively to solve problems, in other words, 'Methodologies of Creative Problem Solving'. The 13 lectures given in this class for the first time in 2001 were published in Japanese in my Web site along with English translation of the top page alone [6]. Since then the lectures grew together with my understanding of the topic, especially TRIZ and USIT. Table 2 shows the outline of the 15 lectures given recently in the fall semester of 2006.

Table 2. Lectures on Methodologies of Creative Problem Solving

(1) An easy introduction: Flexible ways of thinking are necessary for innovation
(2) Three principal approaches of studying and applying science and technology: From observation, from principles, and from problems
(3) Finding the problem, focusing on it, and collecting information
(4) How come up with ideas? Trial and error, enlightenment, and creativity
(5) What are 'Systems': Components and their relationships, hierarchy of systems, and technical systems
(6) Analysis of problems (1) Finding root causes of the problem (or difficulty)
(7) Analysis of problems (2) Analyzing functions and attributes of a technical system
(8) Extra: Task of the report for this class; How to construct and write a report.
(9) Analysis of problems (3) Analyzing space and time characteristics; Making an image of the ideal solution
(10) Generating solutions (1) Fully utilizing knowledge bases
(11) Generating solutions (2) How to break through the barriers
(12) Generating solutions (3) A system of solution generation methods (USIT Operators)
(13) Case studies of everyday-life problem solving
(14) Summary of a methodology for creative problem solving (1) USIT
(15) Summary of a methodology for creative problem solving (2) TRIZ; Conclusion of the Class

Since this Class is designed originally by reflecting my current understanding of the methodologies of creative problem solving, I will explain the contents of the lectures in some more detail.

Lecture (1) An easy introduction

First I explain the aims of this Class: "In our era of severe competition, we need creative innovation. So in this Class I am going to explain methodologies for thinking in flexible and creative ways and for solving problems systematically." With presentation slides I show ways of creative thinking by using several examples: the historical story of Archimedes' crown, the problem of squeak and buzz of windshield molding (Ford Case Study), how to prevent the staple from being crashed, problem of increasing the foaming ratio in producing foam polymer sheets, the problem of saving water in the toilet system, etc. These examples are selected from published TRIZ/USIT case studies [3], whose essence of ideas are clear and easy to understand.

Lecture (2) Three principal approaches of studying and applying science and technology

For studying and applying science and technology, there are three principal approaches: The first is to start with observations, then to set up a hypothesis which explains the experiences, and finally to verify the hypothesis. Even though this may seem primitive, it is the basic Induction approach that has generated the whole science itself. The second is to start with principles, i.e. highly verified hypotheses, and then to apply them to various situations by using scientific reasoning; this is the Reduction approach. We need to be careful about the limitations and approximations in the principles and derivations. The third is to start with problems, then to analyze them, to find solutions, and finally to apply the solutions in reality. In school education the first and the second approaches have been taught mostly, but it is the third approach that is needed often in the real world. The present Class teaches the third approach.

Lecture (3) Finding the problem, focusing on it, and collecting information

For problem solving, finding or noticing the problem is necessary first of all; this can not be achieved without high motivation. The problems which must be solved, whose solution would give much benefits, and whose solution has much needs in society, are good candidates for making efforts for solving. It is important to think over the problem in a wider and higher perspective and then to find the core of the problem sharply to concentrate your efforts of problem solving. For collecting information related to the problem, you should not rely too much on the information retrieval on the Web, but should use book references and academic journals which contain much deeper and more reliable information.

Lecture (4) How come up with ideas?

Good ideas often come up suddenly like an enlightenment "Oh, yes! We can make it like this!". After a long period of thinking and struggling, the enlightenment happens to come unexpectedly on some relaxed timing, as known from a lot of case studies of scientists and inventors. But there are no guarantees whether and when it comes. Thus we have to do brainstorming, experiments on the basis of trial and error, searching for any hints, etc. The lectures of this Class will show you some more systematic ways to obtain such ideas earlier and with higher probability. We believe the ability of finding good ideas are given not only to geniuses but all of us.

Lecture (5) What are 'Systems'

A system means 'a group of related parts which work together forming a whole'. Such parts may be things, persons, organizations, etc. Systems form hierarchies like supersystem - system - subsystem. Systems may be understood first as black boxes performing some function, by using inputs and resulting outputs. In order to perform the system function properly, technical systems must have a full set of energy source, engine part, transmission part, working part, control part, and an object to be worked on (Law of completeness of a technical system) [1].

Lecture (6) Finding root causes of the problem

Now let us start analyzing the problem. First, even when we set up a topic of the problem, sometimes it is not known well what is really a problem, or a difficulty/wrong point. For instance, what is the problem in the situation that some students are sleeping during the class? For clarifying such a difficulty in the problem, you should consider harmful/unwanted effects caused by the present problem situation. Next, we need to clarify the causes of the problem. We should examine the mechanism in the present problematic system and follow the cause-effect chains back to plausible root causes. Identifying the root causes at the core of the problem is crucial for the problem solving.

Lecture (7) Analyzing functions and attributes of the technical system

In order to understand the mechanism of a technical system, specialty knowledge of the subject matter is usually used, but it is also beneficial to use the general theory of systems, especially with the concept of 'Objects-Attributes-Functions' [2]. 'Objects' are the substances forming the components of the system, while 'Attributes' are the categories (and not values) of various properties of the Objects. 'Functions' mean the actions/effects performed among the Objects, with particular attention at the change in some Attribute of the affected Object. To understand the mechanism of the technical system in the problem, Functional Analysis is useful and effective. It should be noted that the Objects and Functions we should consider in the system depend on the problem at hand. Examining various Attributes relevant to the problem (i.e. Attribute Analysis) is also useful and is effective to enhance the root-cause analysis.

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

This lecture intends to be a basic training of writing a report/paper for academic/business purposes and is given in an extra/supplementary session for compensating my leave for the ETRIA TRIZ conference.

Lecture (9) Analyzing space and time characteristics; Making an image of the ideal solution

For almost all the problems, clarifying the system's characteristics with respect to space and with respect to time (e.g., changes with time, processes, etc.) is crucial. You should draw such characteristics in graphs, in scenarios, etc. It is also important to clarify what are the Ideal Situations in contrast to the present problem situations. We should first make an image of the ideal result, and then consider desirable behaviors and desirable properties of the imaginary ideal system; we can use Particles Method in USIT [2] for this purpose.

Lecture (10) Fully utilizing knowledge bases

Now that we have analyzed our problem from several different aspects, we should go ahead to the methods for generating solution ideas. For finding solutions to our problems, we should not limit our thinking within our own experiences and expertise knowledge but consult much wider and deeper knowledge of science and technology including those in other disciplines and in other industries by fully using various knowledge bases. Knowledge bases of principles of science and technologies and patent data bases are useful. In addition to these, TRIZ [1, 7] has created several useful knowledge bases having original frameworks; they include: the knowledge bases of Trends of evolution of technical systems, Technical means retrievable from target functions, '40 Inventive principles' in TRIZ, and 'Altshuller's contradiction matrix' in TRIZ. We should learn the basic concepts underlying these knowledge bases.

Lecture (11) How to break through the barriers

The critical process in the problem solving is to overcome the barriers (i.e., difficulty or contradiction) and achieve a breakthrough. In TRIZ, the essential barriers are called contradictions and we try to clearly identify the contradictions in the problem [1]. The most concentrated form of contradiction is named Physical contradictions, where two opposite demands are requested with respect to one aspect of the system. TRIZ claims that such a form of intrinsic contradictions can certainly be solved by use of the Separation Principles; TRIZ has demonstrated a lot of such successful case studies. The case of a toilet system by K. W. Lee et al. is shown as an example. According to ASIT [8], i.e. a much simplified method for applying TRIZ, for a solution being inventive, the solution must satisfy the following two conditions: one is not to introduce different kind of objects into the system while the other is to bring a qualitative (drastic) change in the relationship between the problem characteristics and one of the relevant attribute. ASIT pursues inventive solutions with this finding as the guideline.

Lecture (12) A system of solution generation methods (USIT Operators)

USIT [2] is a methodology built with the intention of making TRIZ simpler and easier to apply to technical problems. By reorganizing all the different solution generation methods in TRIZ, USIT has built a system of solution generation methods (USIT Operators) having 5 main methods with 32 sub-methods in total [9]. The usage of USIT Operators is demonstrated with examples applied to the Picture hanging kit problem. Every nice solution can be obtained in several different ways of applying USIT Operators. This fact facilitates the generation of good solution ideas with USIT.

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

For the purpose of reviewing the full course of problem solving explained so far, two case studies of solving everyday-life problems are demonstrated in their full extent. One is the problem 'How to fix the string shorter than the needle' [10], and the other is the problem 'How to prevent the staple from being crashed' [11]. These studies were the results obtained by the students as the thesis work in my seminar class, and were explained at relevant stages of problem solving in the present class.

Lecture (14) Creative problem solving with USIT

As a summary of the present Class, the whole procedure of creative problem solving with USIT [2, 12, 13] is reviewed, in a systematic way by using the materials already explained in the lectures given so far. The overview of USIT is explained first, especially by using the data-flow diagram (i.e., Six-box scheme of USIT) [14, 15] and with the flowchart of the whole process. Then the methods of problem definition, problem analysis (Function and attribute analysis, Space and time characteristic analysis, and the Particles method for making an image of ideal situations), and solution generation (USIT operators). A new paradigm of creative problem solving [16] is explained by use of the USIT Six-box scheme. Practical ways of introducing USIT in industries and of USIT training are mentioned [13, 15].

Lecture (15) Creative problem solving with TRIZ, and Conclusion of the Class

TRIZ [1, 7] is underlying most of the lectures in the present Class, as is mentioned at various points. Since it is a much larger system of methodology for creative problem solving, I have chosen to summarize it after USIT. TRIZ has a philosophy covering the recognition of technologies and creative thinking. Its essence is shown in 50 words in English (and in Japanese translation) [12]. TRIZ has built a system of knowledge bases for the use of problem solving in a wide range of technologies and related fields, and has installed them in useful software tools. TRIZ has also developed a large number of methods for analyzing problems and for generating solutions, especially for solving contradictions. TRIZ, originally developed in the former USSR, has been penetrating into industries and academia gradually in the USA, Europe, Japan, Korea, etc.

-- Conclusion of the present Class: We have learned that we have obtained reliable systematic methodologies for creative problem solving. Such methodologies can be applied to a wide range of problems. They will serve to enhance and promote innovations in technologies and many other areas in human society. Mastering such a methodology will certainly become a valuable skill for yourself.

In the Class, an MS Word (or PowerPoint) document of about 8-12 pages is handed out every week in print and is shown on the projector. Several case studies are used throughout the course materials, and a number of examples are illustrated in each lecture. I asked questions to the students from time to time and request them to draw their ideas on the classroom board or on their notes.

For obtaining the credit of the Class, students are requested to write a report on a topic they choose individually. This requirement was shown on the first day of the class. A formal report, not an essay, with 5 or more pages is requested, on any topic related to this class (or to the area of Faculty of Informatics). I taught 'how to write a report' (Lecture (8)) [17] in November. Students have to submit an outline of the report in early December, and the final report at the end of January.

Students have written reports on various topics, for example case studies of problem solving, e.g. 'How to play a guitar for exercise without disturbing neighbors in flats', 'How to eat the whole thing of a cup noodle without drinking soup', 'What is wrong in sleeping during the class', etc. Topics related to the computer and society are also favorite for students. 40 to 50 students successfully took the credit of the Class every year.

3. Seminar and Thesis Classes on Creative Problem-Solving Thinking

3.1 Seminar II Class for the 3rd Year Students

In our Faculty of Informatics, every student is assigned at the start of the 3rd year to belong to a Seminar Class led by a faculty member and continues to do a Thesis work in the same Seminar Class. The students are assigned primarily in accordance to their preference but some of them to their lower preference due to the limits in the class capacities. The number of students in my Seminar varied in the range from 5 to 1 depending on the year. In the syllabus I recommend the students to take the Lecture Class described above prior to enter my Seminar Class, but some students actually came without taking it. Some of the students in my Seminar Class are technology oriented but some others non-technology oriented.

Under these situations, the start of the Seminar II Class needs to be adjusted to the students. In early days, I started the class with reviewing videos of "Project X, the Challengers", which were famous and excellent NHK TV programs (on air from 2000 to 2005) documenting projects of innovation for these 60 years in Japan. Later I tried to let students read and discuss a textbook on development methods in manufacturing industries; but it was too difficult for the students who do not have enough knowledge in technologies nor experiences in industries. I also tried to let them read and discuss an easy TRIZ textbook written by a group of Japanese authors; but this was frustrating for myself.

I have given the students several texts in TRIZ and USIT: e.g. three collections of my selected articles posted in the "TRIZ Home Page in Japan" [3] for these 8 years, presentation texts of my 2-day USIT training course [13], and the Japanese Edition of Darrell Mann's "Hands-On Systematic Innovation" [7]. They seem to be not so easy for the students as I expected.

After various trials we have found an effective way. That is to study the previous examples of TRIZ/USIT applications which are either published in Japanese in the "TRIZ Home Page in Japan" [3] or achieved by the former students in our Seminar Class. After reading such a case study, we tried to work on the problem again by use of TRIZ/USIT. While doing this work as a group practice and discussion, I have chances of explaining physical mechanism of the individual problem and of instructing and discussing practical ways of applying various methods in TRIZ/USIT.

Then we also go ahead to solve new problems of everyday life by group practice. For example in the 2004 fall semester the students worked together for solving a series of problems, 'A system which tells us on the spot that we have dropped or left something behind', 'A system to find a lost child in a big playing park', and 'An on-line system to know the popularity and crowdedness of different corners in an exhibition park', etc. The experiences of working on these problems became a foundation of the case study [18] achieved in a 2-day USIT training by a group of multi-company engineers.

3.2 Thesis Class for 4th Year Students

In our Faculty of Informatics, Thesis work is mandatory for graduation. Near the end of January every student must submit the Extended Abstract of Thesis in a standard format, 2 pages of A4 size. These Extended Abstracts of all the graduating students are copied into a CD-R and handed to them on the day of graduation ceremony. All other details of how to perform the thesis work are left to the decision by each faculty member. In my Thesis Class, it is the tradition that thesis is worked individually; thesis of about 20 to 30 pages must be submitted; the thesis must be defended in the presentation conference jointly held with Professor K's Class; and the results of thesis are posted in an open Web site.

I request the students to find and solve an everyday-life problem for the thesis work. Since it is important for each student to think and solve a problem for himself, I request them to do the thesis work individually on different topics. But since collaboration is important and fruitful, we attack each problem together during the Seminar Classes.

During the first half of the spring semester, 4th year students are busy to find jobs after graduation. I request them to propose a problem to solve before the end of June. When a student brings in a proposal, we discuss in the class how to approach the problem. In this manner, some of the students could set their thesis topics smoothly and used the summer vacation season for preparing for the thesis work. Some others, however, had some difficulty in finding appropriate topics until November.

Since we had 4 students last year and 5 this year in the Seminar, we do not have enough time to discuss with and guide all the members in each class. So we set a joint seminar class of 3rd and 4th year students and have all the students attended at the two consequent classes. We also set a rule that the student who has brought in some material done as a homework has a priority in discussing his topic in the class.

In January the students are struggling to finalize their thesis works. The trainings of writing a thesis and of giving a presentation on it are tried but not at a satisfactory level for me. We hold the defending conference in an auditorium of 64 sheets. Each student gives his thesis presentation for 20 to 30 minutes and has to defend from questions for 30 - 40 minutes. The questions by Professor K are often very severe, and the students could not reply well. Thus as a matter of fact, all the students had to give a second defending presentation in mid February.

4. Results of Students' Thesis Works

Several results of students' thesis works have been already reported in my articles and lectures, mostly in Japanese and some also in English translation. Here are some of them:

- 'Foreseeing the Evolution of Mobile Phones' (T. Kasahara, 2004) [19](J, E) -- Effective use of the 9-window method
- 'Improving the Performance of A Stapler' (K. Kamiya, 2004) [11,19] (J, E) -- Demonstration of Smart Little People's modeling
- 'How to Fix a String Shorter than the Needle' (T. Shimoda, 2006) [10, 20, 21] (J) -- Simple and nice example of whole USIT process
- 'How to Prevent from Shoplifting in a Bookstore' (N. Hayashi, 2006) [20-22] (J) -- Finding the core problem in the time analysis

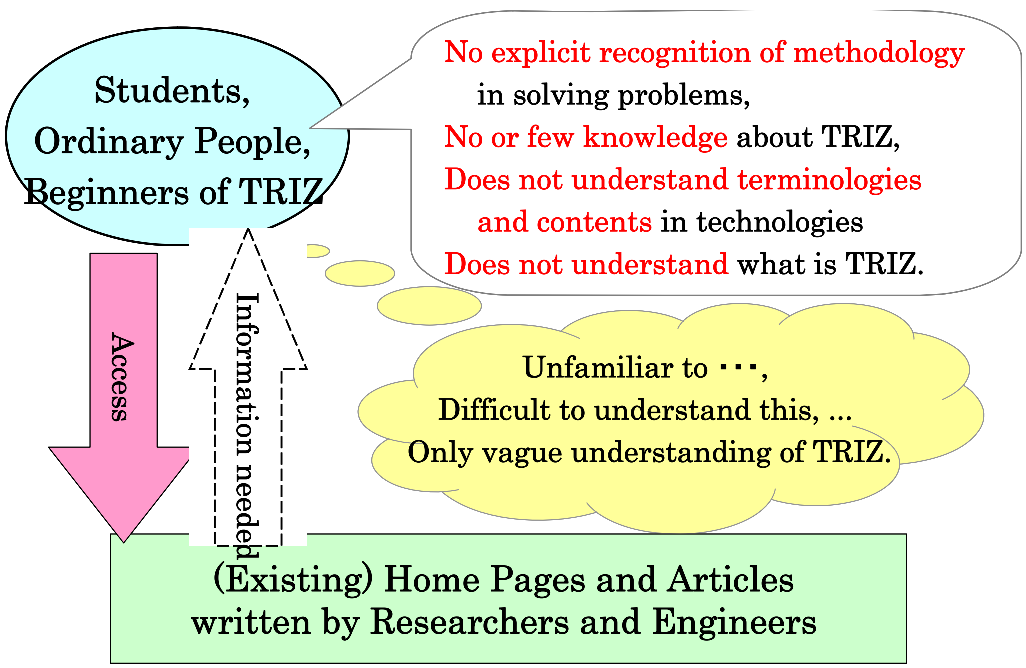
Appendices show the last two cases for demonstrating our typical (but not so formal) approaches of problem solving in TRIZ/USIT done by students.

I should also mention that my series of papers 'Software Engineering and TRIZ' [23, 24] reflects the discussions in the Thesis Class with my students, Shin Kunimi and Kohei Kasasa (graduated in March 2005).

The four students who graduated in March 2006 have built a new Web site, "TRIZ Home Page for Students by Students" [25], and publicized some introduction to TRIZ/USIT and their thesis works. Even though this site is located under the directory of "TRIZ Home Page in Japan" [3] for management reasons, it was created and edited solely by the students. Masayuki Hida et al. [21] made a Poster presentation on this at Second TRIZ Symposium in Japan.

The intention of the Students' TRIZ Home Page is clearly illustrated in the following Figure [19].

Fig. 1. Needs of for a TRIZ Home Page for Students (Hida et al. [21])



The students feel that even though they read the articles in the existing Web sites and textbooks they can not understand them fully and hence can not get enough information of their interests. Thus, they thought that writing articles by themselves would help other students and beginners in TRIZ to understand TRIZ more smoothly.

The project of building the Web site was not easy, especially in writing an interesting and attractive introduction to TRIZ/USIT. Masayuki Hida, the leader of this project, had not yet found a proper style/way of introducing TRIZ to students even after submitting the extended abstract of his thesis. On February 1, 2006 when I happened to enter our seminar room, he had just posed a question to the members, 'What did we learn from TRIZ/USIT?'. So the four students discussed, and I encouraged their discussion and recorded their talks on the white board in a mind-mapping style, as we often do in my seminar classes. The discussion lasted for only 30-40 minutes. Then Masayuki Hida realized that they should frankly write their thoughts which they just talked, and he made the discussion record in a readable form.

The article of this discussion is one of the main features of the students home page [25]. The principal messages by the students are summarized in Table 3, according to their poster presentation [21] in the TRIZ Symposium. At the poster presentation Hida talked about their experiences passionately and attracted many eager industry people who are trying to penetrate TRIZ in their companies.

Table 3. Students' Discussion: "What we think we obtained by studying TRIZ/USIT" [21, 25]

- 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.
- Confidence: Though I was poor at making ideas, I now feel that I myself is able to think of something new.
- My impression of TRIZ was not so good at first, but it turned out to be much different and much better.
- 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.

- Self-confidence: 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.
- Even though it is possible to challenge a number of problems in the university, it is often impossible to really make prototypes and examine the solutions due to lack of technologies and practical environment.

5. Conclusion

With the growth of my own understanding in TRIZ and USIT, the lectures in the class on 'Methodologies of Creative Problem Solving' become richer and yet more understandable for students. Training in seminar classes is found effective when everyday-life problems are used as known case studies and also as unsolved real problems. Students' application of TRIZ/USIT to real everyday-life problems is getting more successful and steady, in our university experiences. Such case studies done by students would be helpful for wider penetration of TRIZ. In our university environment, the experiences of implementing the ideas into real solutions with prototyping and experiments are still lacking and need to be obtained.

Acknowledgement

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Note: (E): written in English, and (J): written in Japanese.

About the author:

Toru NAKAGAWA: Professor of Informatics at Osaka Gakuin University. Since he was first exposed to TRIZ in May 1997, he endeavored to introduce it into Fujitsu Labs for which he was working. After moving to the University in April 1998, he has been working for introducing TRIZ into Japanese industries and academia. In November 1998 he founded the public WWW site "TRIZ Home Page in Japan" and serves as the Editor. He is currently working to present TRIZ in a simple, unified and yet powerful way for solving real industrial problems and for teaching students. -- He graduated the University of Tokyo in chemistry in 1963, studied at its doctoral course (receiving D. Sc. degree in 1969), became Assistant in Department of Chemistry, the University of Tokyo in 1967; he did research in physical chemistry, particularly experiments and analyses in the field of high-resolution molecular spectroscopy. He joined Fujitsu Limited in 1980 as a researcher in information science at IIAS-SIS and worked for quality improvement of software development. Later he served as a managing staff in IIAS-SIS and then in R&D Planning and Coordination Office in Fujitsu Labs. -- E-mail: nakagawa@utc.osaka-gu.ac.jp

Appendix 1.　How to Fix the String Shorter Than the Needle

Ref. Toru Nakagawa [20],　based on the Thesis by Tsubasa Shimoda

Fig. 2　Appendix 1. Problem Definition

T. Shimoda and T. Nakagawa (2006)

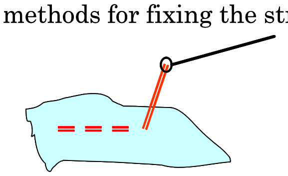
Everyday-life Case Study:
How to fix a string shorter than the needle at the end of sewing

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

Fig. 3.　Appendix 1.　Problem Analysis (1)

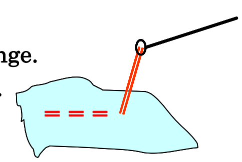
Problem Analysis (1): Understanding the present system

(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 granted form 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 novle 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' .

Fig. 4. Appendix 1. Known solutions and Ideal system

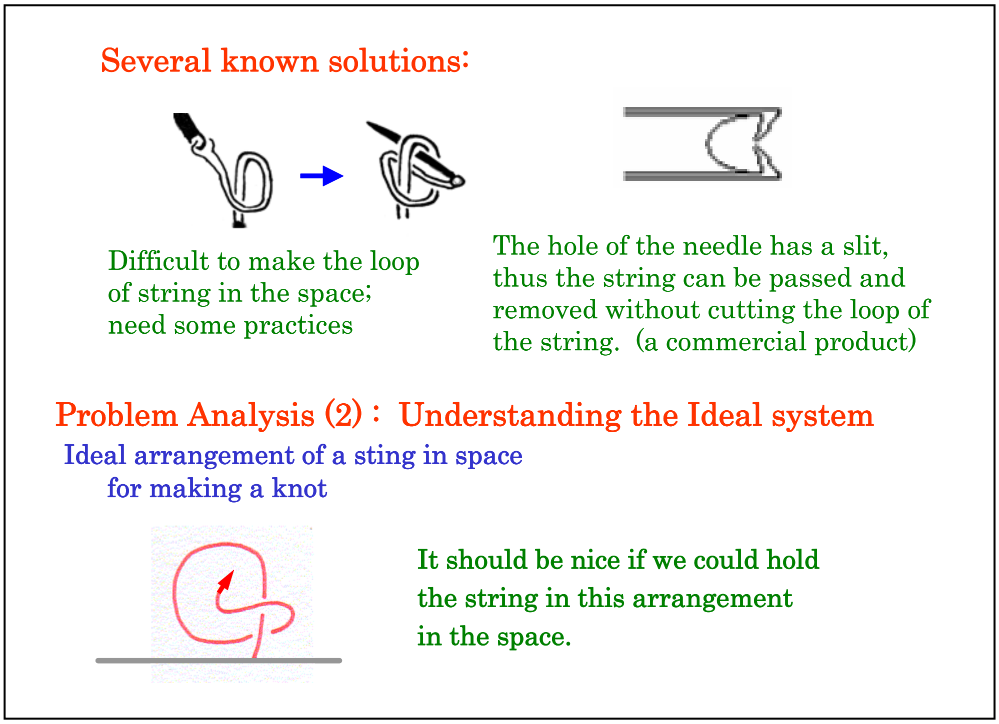
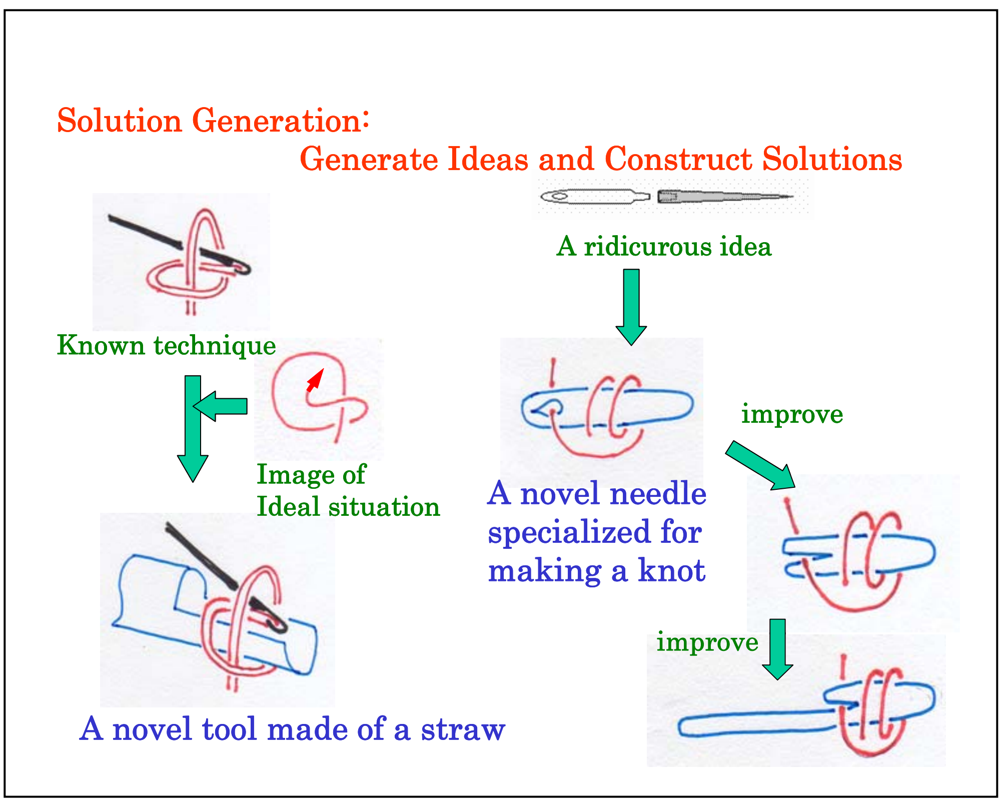


Fig. 5. Appendix 1. Solution Generation



Appendix 2. How to Prevent from Shoplifting in a Bookstore

Ref. Masayuki Hida et al. [21], based on the Thesis by Naoya Hayashi

Fig. 6. Appendix 2. Problem Analysis

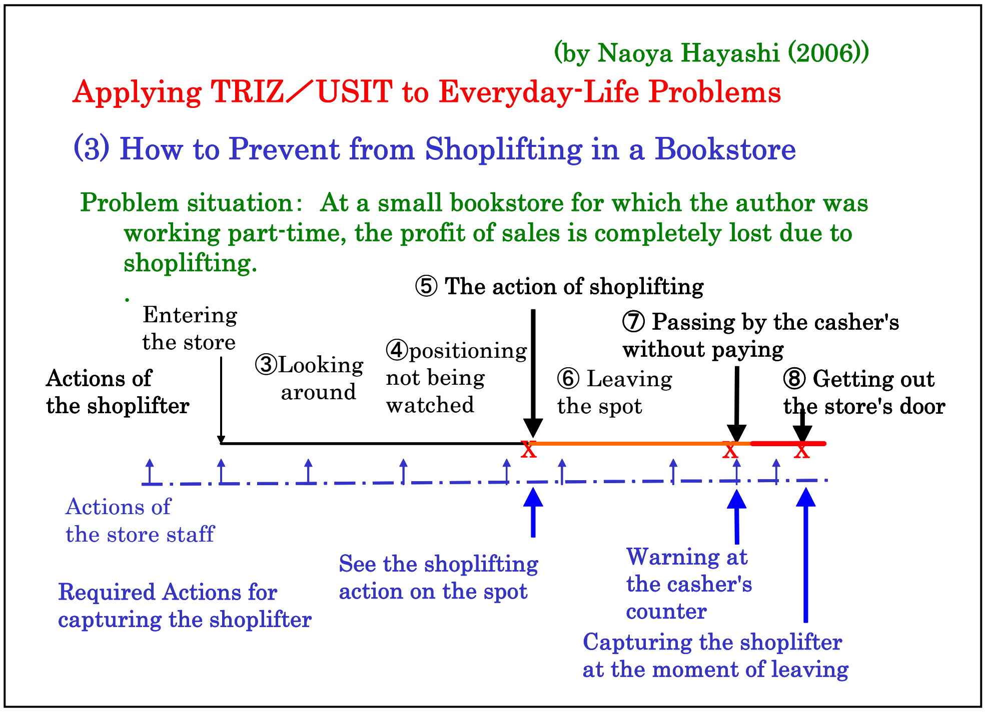


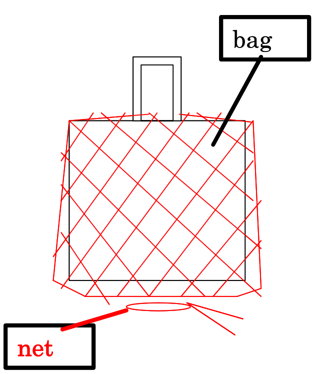
Fig. 7. Appendix 2. Root contradictions and Solutions

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

(1) The store staff must see the Three Moments ⑤⑦⑧ 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'.



Solution ideas: Preventing the guests' bags from being used for the shoplifting.

(a) Put the guests' bags in the specifed 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.