Creative Problem-Solving Methodologies TRIZ/USIT: Overview of My 14 Years in Research, Education, and Promotion

Toru Nakagawa
Faculty of Informatics, Osaka Gakuin University
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Abstract:

The capability of solving problems creatively is most desirable and indispensable not only for individual persons, regardless a student or a working adult, but also for companies, organizations, communities, and even countries. Since I joined Osaka Gakuin University in 1998, I have been working principally on the theme of 'methodologies for creative problem solving' in research, education, and promotion of social penetration.   On retiring the University in March this year, it is my great pleasure to have a chance of publishing here an overview of my work for these 14 years.

The core of my working activities has been the research on TRIZ ('Theory of Inventive Problem Solving') and USIT ('Unified Structured Inventive Thinking'). I have attended and presented at international conferences on TRIZ every year, and extended USIT (i.e. a unified and simplified TRIZ) further to find a new paradigm called 'Six-box Scheme' for creative problem solving. In the field of education, besides several other classes on ordinary information science, I have been teaching on this theme in a lecture class and also in 3rd and 4th year seminars, where my students and I have made several successful case studies of solving familiar problems.

On the basis of these research and education. I have been working for the promotion of penetration of TRIZ and USIT. I established a public Web site "TRIZ Home Page in Japan" and have been operating it for these 13 years.   Founding and joining the Japan TRIZ Society, we have held 'TRIZ Symposium in Japan' annually. With further development and wider penetration, the methodologies of creative problem solving will support the movement of technological innovation and will cultivate human resources having the capability of creative thinking, I hope.

1.   Introduction: A Historical Summary of My Activities in Research, Education, and Promotion

I was a physical chemist in my original career. For 17 years as a graduate student and then a research associate in universities, I did research on precise determination of molecular structures by using physical experiments and computer analysis in the field of molecular spectroscopy. Then after moving to a basic research institute of a computer manufacturer, I did research in quality control of software development and worked for supporting various research activities in the aspects of international relations, patent promotion, etc. for 18 years.

At the end of May 1997, i.e., a year before I joined Osaka Gakuin University, I happened to attend at a seminar conducted by MIT for its sponsor companies in Japan, where a young MIT researcher talked for 2 hours about a thinking method for invention. It was my fateful encounter to TRIZ (pronounced like 'trees' in English). The method was developed by Genrich S. Altshuller in the former USSR and became known in the Western World after the end of the Cold War. It has a collection of knowledge bases in science and technology which have been accumulated through the analysis of a huge number of patents in the world and has unique techniques, or thinking methods, useful for breaking through technical barriers, he said. I was much impressed with the method. It was just the time when the introduction of TRIZ into Japan started with the initiatives of TRIZ tool vendors in USA. I studied the method, realized its significance and importance, and worked to introduce it in my company.

When I joined Osaka Gakuin University as a professor in 1998, I already made up my mind to work on TRIZ for the coming decade in my life. In a month I wrote an introductory paper 'TRIZ: Theory of Inventive Problem Solving -- Understanding and Introducing It --' [1] and published it in the present Bulletin. As a result of my study of TRIZ for one year, I wrote my understanding of TRIZ principally in the aspects of knowledge base and software tool, reflecting the common understanding of TRIZ in Japan at that stage.

On Nov. 1, 1998 I established my Web site "TRIZ Home Page in Japan" [2]. In the initial year at my university, I was teaching a class of Information Processing Exercise, where I taught effective use of personal computers and set the task of building own home pages to the students. So I made my own home page, too. On Nov. 17-19, 1998, the First International Conference on TRIZ was held near Los Angeles, as the really first international academic conference in the Western World. So I made English pages of my Web site quickly and presented them in a poster session at the conference. "TRIZ Home Page in Japan" is located inside the official, open Web site of Osaka Gakuin University. I have been serving as the Editor, and also as the Web master, for over 13 years. The site has been posting many articles written not only myself but also many different people in Japan and overseas, in Japanese and in English mostly in parallel. It is now the site representing Japan in the field of TRIZ and well known as a unique public site among the international TRIZ community.

In March 1999, an international conference TRIZCON99 was held in USA by the Altshuller Institute for TRIZ Studies. On my way of attending at it, I took part in a 3-day Training Seminar of USIT ('Unified Structured Inventive Thinking') conducted by Ed Sickafus [3]. At the conference in the previous year I got acquainted with Sickafus, and read his textbook of USIT, which he described a simplified and unified version of TRIZ. When I wrote my wish of visiting his laboratory at Ford Motor Company, Sickafus kindly arranged the open seminar outside Ford for the first time. Since then my research in the field of TRIZ has been focused on further extension of USIT.

In August 1999, I made a trip to Russia and Belarus for 2 weeks in order to interview about 20 TRIZ experts including the late Mr. Altshuller's family. Economic situations in Russia was worst at that time, but I wanted to learn the real history/situations of TRIZ, which was still in the mist for us Japanese learners. I wrote a report of this trip in English [4] and posted it in "TRIZ Home Page in Japan". Information in the report, such as the creativity education based on TRIZ to school children, may be still useful.

Near the end of '90s, industries in Japan, especially big manufacturing companies, paid much attention to the software tools and techniques of TRIZ. Users' study group in TRIZ was organizes by a tool vendor. About 100 engineers coming from different companies attended at monthly seminars and worked together in group exercises. I was a regular member in the study group. In such a circumstance, I could publish Japanese editions of some TRIZ textbooks by a joint work of over a dozen people and conduct USIT training seminars.

Principal information source in TRIZ was initially a Web site "The TRIZ Journal" edited by Ellen Domb in USA. The site posted several papers and case studies every month. In 2001 the European TRIZ Association

(ETRIA) was organized and it held an international conference TFC (i.e., 'TRIZ Future Conference') in November.   Thus, every year in spring in USA and in autumn in Europe, I attended and presented papers at international conferences in TRIZ.

However, the penetration of TRIZ was not easy.   Even we say 'TRIZ is a wonderful method for inventive thinking', people say (or think) 'It's doubtful.   There can not be any method of easy invention'.   Since software tools of knowledge bases were very expensive, only a limited number of people in big industries can buy and use them.   Thinking method, on the other hand, can not be well understood through written texts alone and need to be mastered through personal training for a certain long period of time.   Thus when the initial boom of TRIZ faded out, only the people who had understood the real strength and wanted to master the way of thinking stayed in TRIZ.   Years from 2002 to 2004 were such a period in Japan.   I overcame those years by publishing many articles in my Web site "TRIZ Home Page in Japan".

Motivation of working together in collaboration among TRIZ promoters and users was gradually built up in Japan.   Thus we established the Japan TRIZ CB (i.e. 'Collaborative Board of TRIZ Promoters and Users in Japan') in 2005 and extended it into the Japan TRIZ Society, NPO, at the end of 2007.   We held the 'First TRIZ Symposium in Japan' in September 2005.   We openly called for papers in Japan and in the world.   The first Symposium was attended by 104 people (including 4 from overseas).   We have been holding the TRIZ Symposium every year holding the goal to be 'Primarily Japanese National AND Partially (but as much as possible) International'.   I have been serving as the Program Chairperson of the Symposium all through its history.   The Symposium has been evaluated highly as an active and useful (partially international) TRIZ conference along with conferences in USA, Europe, and Russia.

For me, research of TRIZ and education in university are mutually supporting activities.   When my Faculty of Informatics started in Osaka Gakuin University in 2000, I set a lecture class of 'Scientific Information Methodology' in the new curriculum.   The class name means the methodology of how to handle scientific information, including general scientific/technological information and specific information relevant to the current topic/problem, appropriately in science and technology.   In the class I gave a series of lectures on the theme of 'methodologies for creative problem solving', including TRIZ/USIT and some other relevant methods on the basis of my research.   In the Seminar Classes for the 3rd and 4th year students, I also set the subject of 'creative thinking for problem solving' as the main theme and conducted group exercises to solve familiar problems in a creative way.   Students and I have solved several familiar problems and published the results.   Case studies of such familiar problems are easy to understand for students and engineers and useful for illustrating actual successful thinking processes.   I reported the overview of my education activities in the present Bulletin in 2007 [5].

Under the historical background described so far, I would like to describe the contents of my research, education, and promotion activities in the following sections.

2.   Research Activities: Research (Study) of TRIZ and Research (Original Extension) of USIT

2.1   Research of TRIZ: Learning, Application, Translation, and Presentation

Our TRIZ study in Japan started with the learning/understanding of the huge accumulation of knowledge developed in the former USSR.   The materials we learned were books written by Genrich Altshuller and papers, lectures, and software tools delivered by a large number of his students and followers; we used English materials in place of (mostly original) Russian sources.

A software tool, called TechOptimizer, was very useful for me in the initial stage. It was built by a group of Altshuller's former students who emigrated from Russia to USA. For 3 months from autumn 1997 to winter 1998, I used TechOptimizer to master its knowledge basis. I wrote my original instruction manual of the software, "Software Tools for TRIZ -- Mechanism, Usage, and Methodology Learning --" [6]. My understanding of TRIZ at this stage was represented well in Fig. 1 [1]. On the basis of this figure, I designed the symbol mark of "TRIZ Home Page in Japan", as illustrated at the top-right part of Fig. 1.
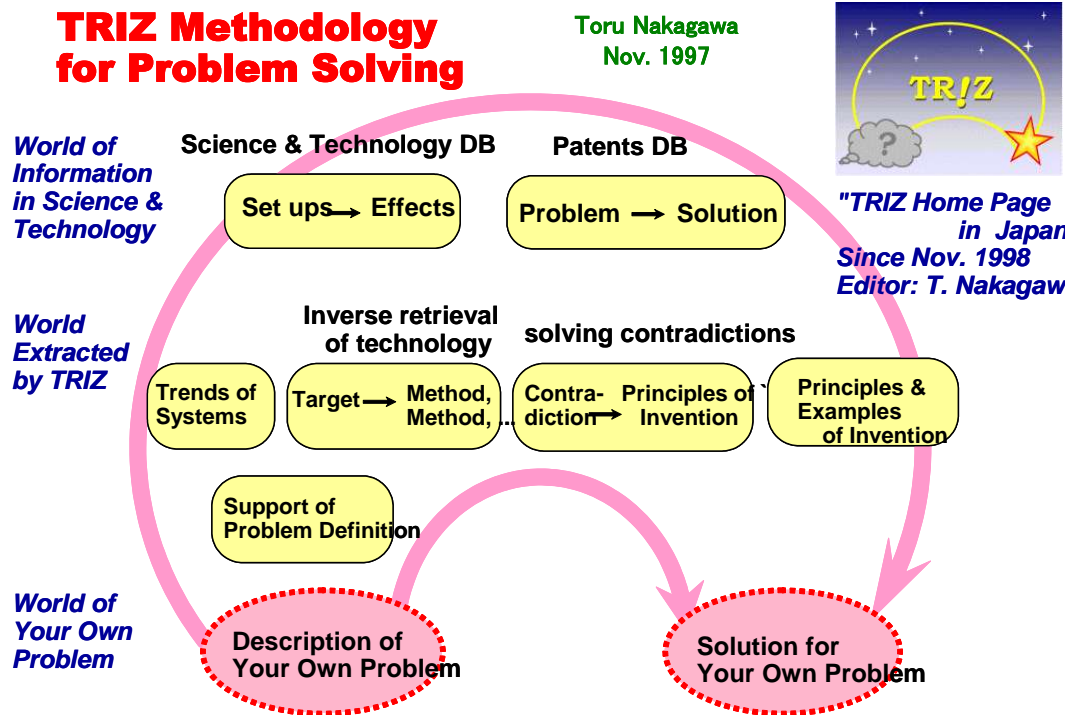

Fig. 1. Conceptual overview of the problem solving process with TRIZ focused on its knowledge bases [1] and the symbol mark of "TRIZ Home Page in Japan" [2] (top-right)

The original part of TRIZ, i.e. the part developed by Altshuller and his students/followers under the direct supervision by Altshuller till 1985, is usually called Classical TRIZ. For learning Classical TRIZ and some further extension in Russia, the textbook "TRIZ: The Right Solution at the Right Time" written by Yuri Salamatov and translated into English by Valeri Souchkov was useful. With the collaboration of about 15 people, we translated it into Japanese and published it from Nikkei BP in 2000 [7]. Through this textbook I learned the TRIZ philosophy on the evolution of technical systems and TRIZ way of problem solving. Under the situations people commonly say 'TRIZ is huge and complex', I wanted to summarize the essence of TRIZ in one slide. The slide was first shown in my talk at TRIZCON2001 in USA and later presented as a part of my full length paper at ETRIA TFC 2001 [8]. The 'Essence of TRIZ in 50 Words (in English)' is shown in Fig. 2 both in English and in Japanese.

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Essence of TRIZ:

Recognition that
  technical systems evolve
    towards the increase of ideality
    by overcoming contradictions
    mostly with minimal introduction of resources.
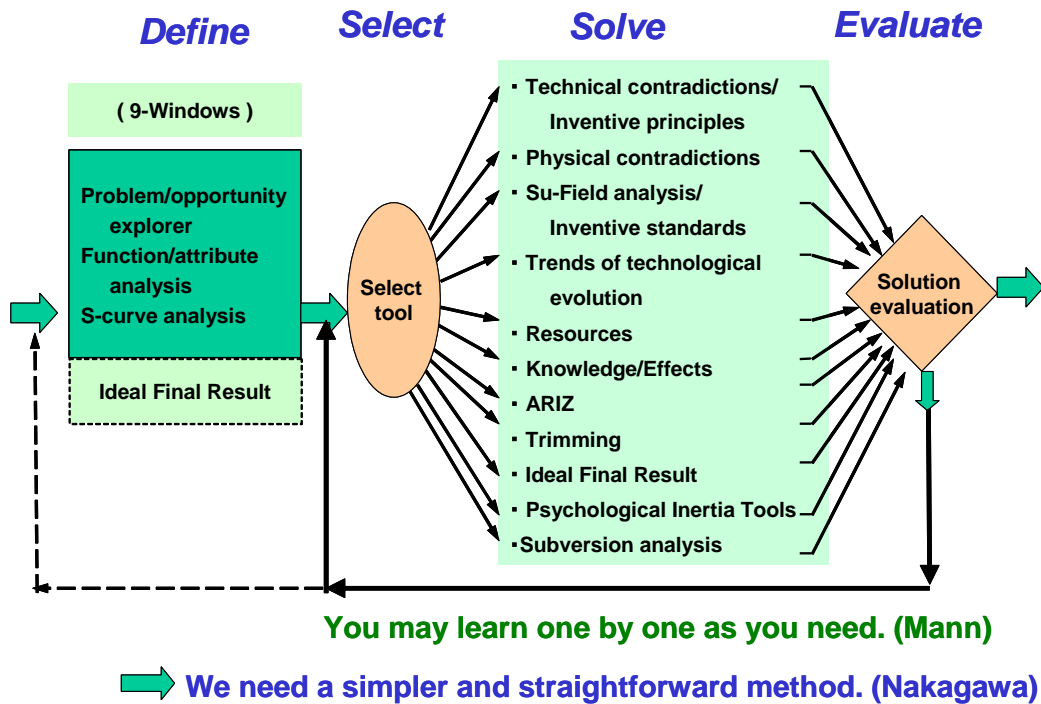
Thus, for creative problem solving,
  TRIZ provides with a dialectic way of thinking,
    i.e.,
    to understand the problem as a system,
    to make an image of the ideal solution first, and
    to solve contradictions.

</div>

Fig. 2. Essence of TRIZ -- in 50 Words (in English) [8]

In the mean time, researchers in the West started to publish new TRIZ textbooks by fully mastering TRIZ with the background of the western culture. Such an excellent example was "Hands-on Systematic Innovation" by Darrell Mann, UK. It was originally published in July 2002. On reading the book, I immediately made up my mind to publish its Japanese Edition. A team of 17 voluntary members of Mitsubishi Research Institute's Study Group worked together and published the Japanese Edition from Sozo Kaihatsu Initiative (SKI) in June 2004 [9]. This book has been regarded as the standard and most comprehensive textbook of (modernized) TRIZ, in the world and in Japan.

For understanding the whole process of problem solving described in Mann's textbook, I drew it in a flowchart, as shown in Fig. 3. The keywords of methods in the diagram are taken from the chapter titles of Mann's textbook, which contains 22 chapters. Mann explains various methods well in a manner easy to understand, but keeps the multi-track structure of TRIZ itself. (Originally, Altshuller developed many of these individual methods and constructed them into a much more complex system of processes, with the name of ARIZ (i.e., 'Algorithms of Inventive Problem Solving').) I was strongly motivated in the direction that we need a whole process of creative problem solving having a much simpler structure of effective methods.

Fig. 3. The whole process of creative problem solving explained in Mann's textbook [9]. Flowchart representation by Nakagawa [9].

It was disclosed in March 2003 that Darrell Mann authored the textbook as the result of a big research project he conducted in CREAX.   They analyzed all the USA patents granted since 1985 and updated/modernized the whole information basis of TRIZ, which was originally accumulated by Altshuller mostly in 1970s.   Many lists of examples in his textbook, such as application examples of TRIZ 40 Inventive Principles, were taken from the data of the analyzed patents.

Darrell Mann et al. also modernized Altshuller's Contradiction Matrix.   This method recognizes a technical problem as a case of the conflict where a trial of improving a property of the system by some known method would worsen another property of the system to an unallowable degree.   (Altshuller called this type of conflict as 'Technical Contradiction'.)   Altshuller considered 39 different properties (or parameters) and represented the whole problem space by the matrix of 39 improving parameters $\times$ 39 worsened parameters.   Then, each patent was analyzed to classify the problem in this framework of matrix and its solution in terms of the 40 Inventive Principles in TRIZ.   By analyzing about 140 thousands patents (or actually 'Author Certificates' of the former USSR), Altshuller built the Contradiction Matrix which described up-to-4 most frequently used Inventive Principles in each cell of 39×39.   Darrell Mann et al. analyzed all the USA patents granted from 1985 to 2002 and built a revised matrix of 48×48 parameters.   They published their results in the book of "Matrix 2003" and in a software tool.   I published its Japanese Edition [10].   (Mann published a further new version "Matrix 2010", and I have just made its Japanese Edition ready for publication.)   The following figure illustrates how to use the Contradiction Matrix.

Worsened Parameter / Improving Parameter	···	45. Complexity of the System	46. Complexity of control	···
···				
28. Loss of information		6, 25, 13, 24	10, 6, 25, 2, 3	
···				
32. Adaptability/ versatility		6, 28, 29, 31	28, 25, 37, 19	
···				

Suggested Inventive Principles：
6: Versatility，25: Self-service, 28: Mechanism substitution, etc.

Fig. 4.   Illustration of how to use the TRIZ Contradiction Matrix

Among various new books and papers published by Western authors, I was much attracted with a course material authored by Larry Ball (USA).   He built up the document by using a large number of (small) case studies with interesting illustrations and in a unique framework of problem solving process.   Toshio Takahara and I translated the material into Japanese, and posted it in "TRIZ Home Page in Japan", and later published in a CD-R edition [11].   This book is nice in demonstrating the thinking way of solving 'Physical Contradictions', i.e., the type of conflict where two opposite requests are demanded on a parameter of the system.   Solving a Physical Contradiction is the unique and powerful means developed in TRIZ.

In May 2006, I read a part of English manuscripts of "TRIZ Principles for Information Technology" written by Umakant Mishra (India) and was impressed with it.   When Altshuller originally developed TRIZ, the main fields of application target were mechanical, electrical & electronic, and chemical engineering.   Thus, when TRIZ was initially introduced into Japan, many people in the IT/software industries said 'TRIZ would not be applicable to our IT/software problems'.   It became gradually clear that TRIZ is also effective in the field of IT/software.   Mishra, in relation with the CREAX patent research project, has analyzed a large number of IT/software patents and classified the essence of patent ideas in terms of the TRIZ 40 Principles.   Overcoming various difficulties, we have translated the book into Japanese and are now almost ready to publish it with the title of "A Collection of Ideas for Solving Problems in IT/Software" [12].   Being involved in the software field, I am happy to have this book in Japanese as an answer to the 15-year old question by my colleagues.

Besides these mentioned above, I have been impressed by many people and papers presented at conferences in USA, Europe, and Japan.   Due to the limited space, I have to omit them to record here.

2.2   Research of USIT (Unified Structured Inventive Thinking): Learning, Application, Extension, Theory Building, and Practices

History of USIT started in early 1980s when a group of Altshuller's students immigrated into Israel and realized the necessity of simplifying TRIZ for penetrating it.   They set up only 4 solution generation methods and constructed the SIT (Systematic Inventive Thinking) method.   In 1993 Ed Sickafus (USA) learned SIT, and after studying TRIZ as well he built up a consistent process of inventive thinking, in the name of USIT.   He

trained and penetrated it inside Ford Motor Company and published its textbook in 1997.   It has a streamlined process using a consistent set of basic concepts.   So I was much interested in it. .

I started my research of USIT by learning and introducing it.   I read Sickafus' textbook and participated at the 3-day USIT Training Seminar conducted by Sickafus.   The seminar, with 10 participants who were asked to bring in their own problems, was carried out in combination of lectures and group exercises by 2-3 members each.   I reported about this seminar with the descriptions of the USIT method, the way of the Seminar, and two actual case studies I made in the Seminar [3].   This was the first introduction of USIT in Japan.

Encouraged by Sickafus I started the USIT Training Seminar as early as in July 1999 in a company with the group exercises of handling real problems.   Later soon I started open-participation USIT Training Seminars together with engineers coming from different companies.   Training Seminars were important means for us to penetrate USIT and also to master and refine various techniques in USIT.   Utilizing the advantage of open training seminars, we published/posted the case studies of problem solving in detail.

On the basis of these research/practice activities, I found that the problem solving process with USIT is much easier to learn and apply than with the conventional TRIZ.   Thus I became sure that we should promote TRIZ by using USIT as the principal tool in it.   In contrast to the prevailing strategy of promoting TRIZ in a drastic/quick manner, I advocated the Slow-but-Steady Strategy of TRIZ promotion, as summarized in Fig. 5 [13].   My strategy became a useful guideline in the penetration of TRIZ in Japan in early 2000s.

Hurry and Forcing	Slow but Steady (Nakagawa)
In a complete form of the whole TRIZ,	Starting with the understandable parts of TRIZ,
Using the full ARIZ algorithm,	Using USIT process (I.e. a simplified TRIZ),

Teaching system analysis,
    from the beginning,
	Using TRIZ data base and USIT,
	    at the beginning,

With top-down leadership organization,	With bottom-up grass-root organization,
Ordering to all/many employees,	By groups of volunteer employees,
Changing current R&D style drastically,	Introducing into the current R&D activities,
Believing in its effectiveness,	Proving its effectiveness by ourselves,
Rapidly, extensively, and widely	Without hurrying; steadily, and deeply

Fig. 5.   Contrast of two Strategies for TRIZ Promotion: Drastic Promotion Strategy vs Nakagawa's Slow-but-Steady Promotion Strategy
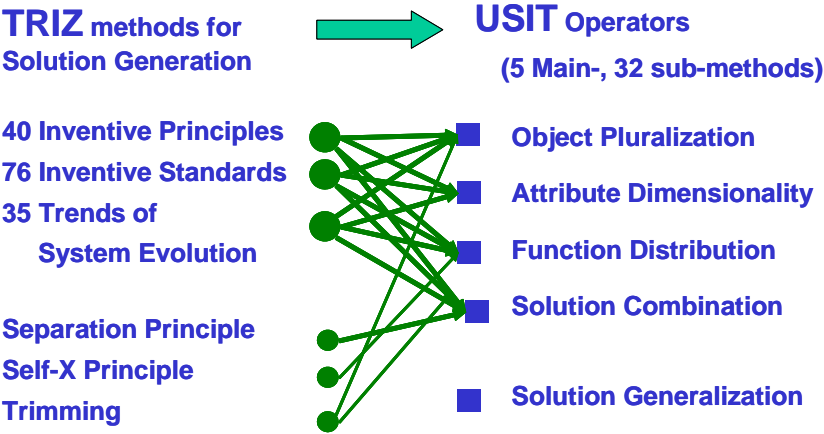
One significant difficulty realized from the beginning in learning and applying USIT was related to the idea generation methods.   Even though Sickafus' explanations in the analysis stage were clear, those in the solution generation stage were somewhat intuitive and not well systematized.   Thus many people requested us to make the USIT five solution generation methods clearer.   In early 2002, Hideaki Kosha started the work of relating the TRIZ 40 Inventive Principles to the 5 solution-generation methods in USIT, and I joined the work.   As shown in Fig. 6, we re-classified all the individual sub-methods of various TRIZ solution generation methods into the five main methods of USIT.   Then using those individual/fragmental sub-methods coming from TRIZ we built up a hierarchical system of USIT Operators for solution generation, which is composed of 5 main

operators and 32 sub-operators [14]. (In the USIT terms, 'Object' means a component of the system (e.g., a part of a product), and 'Attribute' means the category of a property of an Object (e.g., Temperature is an Attribute and 25 ℃ is a value of the Attribute).

"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.

Fig. 6.   Reorganizing all the TRIZ solution generation methods into the USIT Operators

USIT solution generation methods are expressed in the form of 'to operate on something to do something'. Thus they are called 'USIT Operators' or 'USIT Sub-Operators'. As an example, one of the most frequently used Sub-Operators is illustrated in Fig. 7. It is the Sub-Operator 'Divide the Object'. A simple slide like this is the guideline of the Sub-Operator. At the bottom-left corner, the TRIZ solution generation methods which contributed to derive this USIT Sub-Operator are shown; they are four Inventive Principles in this particular case.
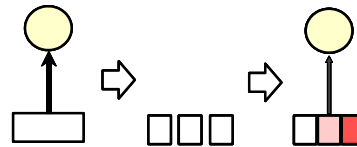
(1) Object Pluralization Method

(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

Fig. 7.　An example of USIT Sub-Operator: (1c) 'Divide the Object'

Fig. 8 demonstrates the application of various USIT Sub-Operators to the Picture Hanging Kit problem, which requests "to improve the ordinary picture hanging kit composed of a nail and a string so as to prevent the picture frame from being tilted".　Various USIT Sub-Operators are applied on the nail in various ways to get the solution ideas shown in Fig. 8.　In order to apply a USIT Sub-Operator (e.g., the Sub-Operator (1c) shown in Fig. 7), (a) choose an operand (e.g., the Object, Nail), (b) apply the Sub-Operator to the operand along the guideline of the Sub-Operator (e.g., to divide the Nail in the middle into two parts, make the surface of one part smooth while the surface of the other part rough, and finally combine the two parts in the original form), and (c) think of any method to effectively use the modified operand (e.g., to adjust the left-right balance of the String length at the part of Nail having a smooth surface and then push the Sting on the Nail so as to hold the String at the rough surface of the Nail).　In this manner, the guidelines of the USIT Sub-Operators are clear and easy to apply to the operands (i.e., Objects, Attributes, Functions, Pairs of partial solutions, and Solutions, respectively for the five USIT Main Operators) [15].

Examples of Application of USIT Operators: (Part)

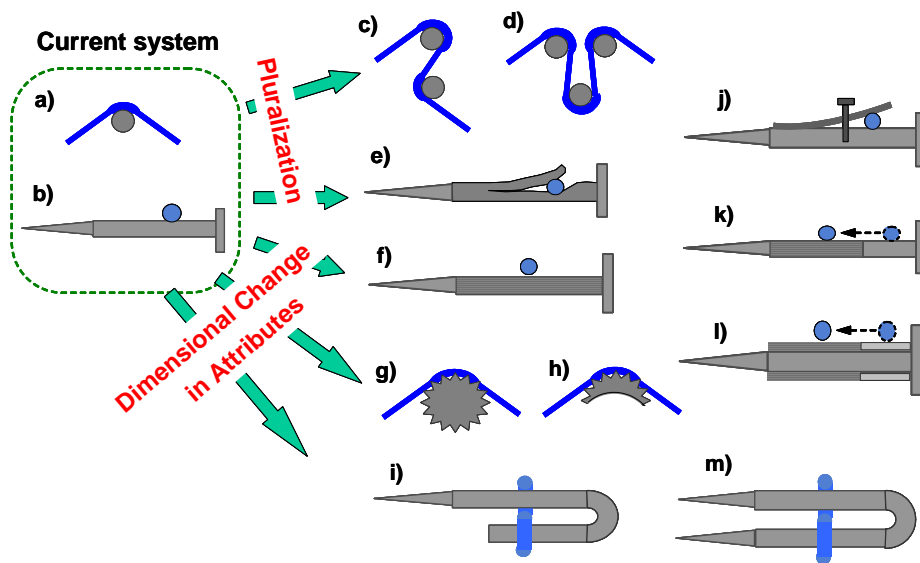**Picture Hanging Kit Problem. USIT Operators are applied to the nail.**

Fig. 8.   Examples of application of USIT Operators: Various USIT Sub-Operators were applied to the Picture Hanging-Kit Problem

The fifth USIT Operator, i.e., Solution Generalization, is illustrated in Fig. 9.   As shown in the bottom-left part of the slide, we can use this Operator intently in both directions of generalization (or abstraction) and specification (or concretization) to enhance the associative idea generation.   This simple technique is much more productive than the ordinary brainstorming session.   As shown in the bottom-right part, making a hierarchical structure of the desirable/obtained solution ideas is also very useful for the purposes of extensive search of possible solution ideas, preventing the failure of missing ideas, and trying to find better solution ideas.

(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.
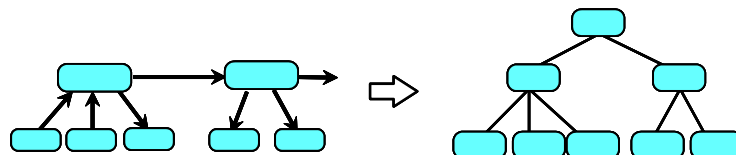Also generate a hierarchical system of solutions.

Fig. 9.   Guideline of the USIT Operator (5) Solution Generalization

The essence of the Picture Hanging-Kit Problem was found to be: "While we adjust the Picture frame the String must move smoothly on the Nail but while we keep the Picture frame stay alone after the adjustment the

String must be fixed/not move on the Nail".   This may be regarded as an instance of Physical Contradiction in terms of TRIZ.   Once we understand the problem in this manner, we can distinguish the solution ideas solving this essential problem from other non-essential ideas.

The whole process of USIT, whose example can be seen later in Section 3.3, has usually been expressed by a flowchart.   The flowchart shown in Sickafus' Seminar [12] was further improved.   In 2004, the whole process of USIT was represented by a flowchart in a revised way as shown in Fig. 10 [15].
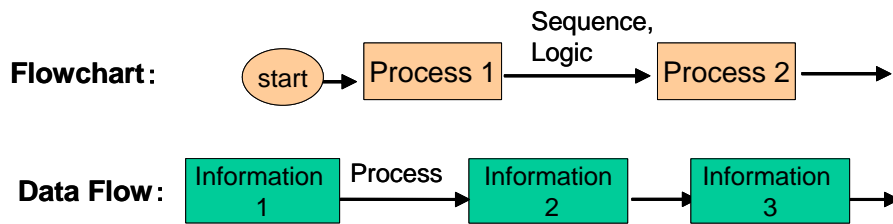
USIT Procedure [Flowchart] [T. Nakagawa, Mar. 2005]

Problem Definition

Define the Problem in a Well-defined Form

Problem Analysis

Function and Attribute Analysis of the Present System (Closed World Method)

Space and Time Characteristics Analysis

Ideal Solution and Desirable Actions and Properties (Particles Method)

Solution Generation

Pluralization of Objects

Dimensional Change in Attributes

Distribution of Functions

Combination of Solution Pairs

Generalization of Solutions

After USIT (Implementation)

Build Up Conceptual Solutions

(Implement into Real Solutions)

Fig. 10.   The whole process of problem solving with USIT (in the Flowchart Representation)

My understanding of the creative problem solving process has changed much when I represented the USIT whole process in the Data Flow Diagram, in place of the Flowchart.   I will explain about this point in the next Session.

2.3   Research of 'New Paradigm for Creative Problem Solving'; Concept and Significance

For representing a process of information processing, Flowchart is the method best known and most frequently used.   Data Flow Diagram is another basic representation method (See Fig. 11).   Flowcharts intend to describe the processing methods (or actually, names of the processing methods).   Data Flow Diagrams, on the other hand, intend to describe the information which is necessary and used in the initial stage (as input), in the intermediate stages, and in the final stage (as output).   Thus, Flowcharts represent the process with a chain of 'How', while Data Flow Diagrams with a chain of 'What'.   (For example, in case of a software development process, specifying the requirement specification, conceptual design, and detailed design documents, etc. is the chain of What, while specifying the ways of converting such information is the chain of How.)   In the field of

information science, it is well known that Data Flow representation is much more stable than the other, because a chain of What can be achieved in various ways, i.e. in different chains of How.
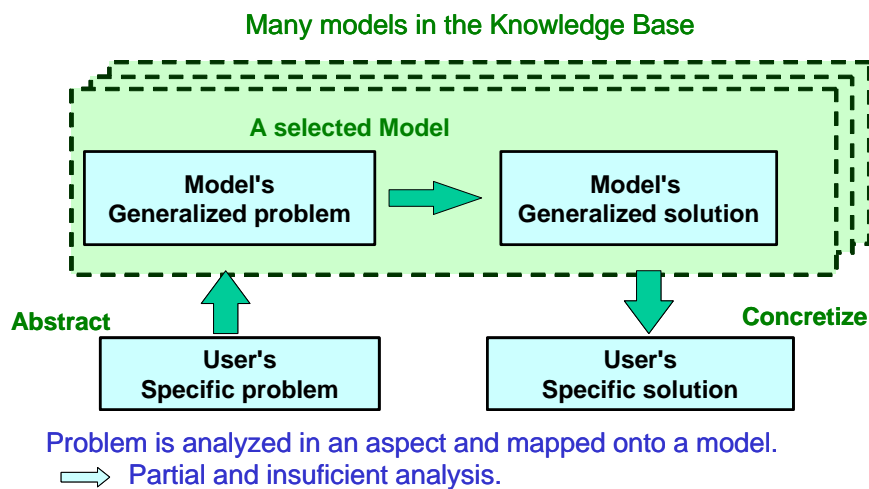

Fig. 11.   Flowchart vs Data Flow Diagram

Traditionally, thinking process of problem solving has been shown in an very abstract level by Data Flow Diagrams, i.e. the 'Four-Box Scheme' for abstract thinking (Fig. 12).   In place of trying to solve the specific problem in the specific, concrete level, the Four-Box Scheme advises to abstract the problem into a generalized Model well known in the knowledge base, to obtain the generalized solution of the Model, and to find a specific solution by concretizing it (or by using the generalized solution as a hint).   This is well known as the basic scheme in science and in technology.   Thus numerous Models have been accumulated in the forms of theories, templates, case examples, knowledge bases, etc. in every field and in every place.   The basic scheme in TRIZ is also the same; Fig. 1 illustrates such a scheme.   TRIZ has contributed much to this scheme by building up several powerful Models which are useful across the conventional fields in science and technology; for example, the Contradiction Matrix in Fig. 4 is such a Model.
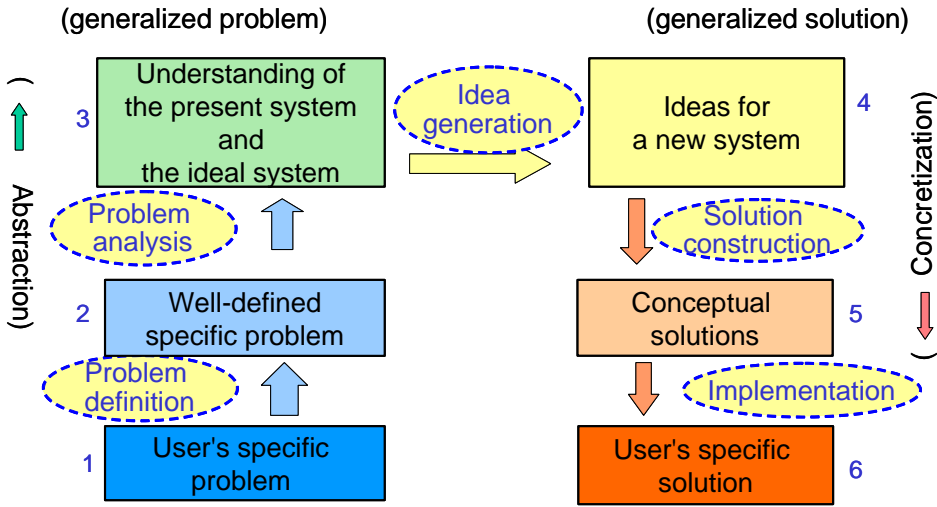

Fig. 12.   Conventional 'Four-Box Scheme' for creative problem solving, i.e. the basic scheme in science and technology as well as in TRIZ

As previously shown in Fig. 4, the whole process of problem solving with TRIZ has a multi-pass parallel structure.   This means that TRIZ has multiple Models, and that each Model is not sufficient.   Actually, the process of abstraction in a Model is often just 'mapping' to some existent Model (e.g., choosing two parameters among 39 (or 48) parameters of the Contradiction Matrix), and requires the consideration/analysis in a limited aspect of the problem.   In consequence, 'generalized solution obtained in the Model' is often just a hint/suggestion.   Understanding any possible concrete meaning of the hint (or obtaining a new specific idea) is not obvious, and hence the concretization of the generalized solution into specific solutions is not an easy pass.   Not only TRIZ but also many conventional techniques use the 'Four-Box Scheme' at the level of analogical thinking (i.e., thinking on the basis of a hint).   The contents of the 'Generalized Problem' and of the 'Generalized Solution' are quite different depending on the Models, thus there is no further general description of them.

In 2004, I expressed the whole USIT problem solving process in a Data Flow Diagram for the first time [15], and obtained the Six-Box Scheme representation, as shown in Fig. 13.   Then I realized its significance to be 'A New Paradigm for Creative Problem Solving' [16].

Fig. 13.   'Six-Box Scheme of USIT' =   'A New Paradigm for Creative Problem Solving'

Viewing the Scheme more closely, the upper half of the figure (i.e., the process from Box 2 to Box 5) belongs to the World of Thinking in USIT (or TRIZ or other) while the lower half belongs to the Real World. The initial process from Box 1 to Box 2 is the preliminary stage of USIT for determining what problem we should/want to handle (i.e., Problem Definition Stage).   The end process from Box 5 to Box 6 is the Solution Implementation Stage, where the Conceptual Solution of Box 5 need to be implemented into real product/service after detailed designing, testing, manufacturing, etc. and also need to be refined to match the market, etc.; thus the Solution Implementation Stage is actually regarded as the post-USIT process.   The initial and end processes at the lower half of the Six-Box Scheme should be carried out by using the criteria of Real World, including technical, business, and social considerations.   Thus in such processes, methods other than USIT (or TRIZ)

should play the roles. They include QFD (Quality Function Deployment), CAD/CAE/CAM, Taguchi Method, and others.

The essence of the 'Six-Box Scheme' exists in the contents/nature of Box 3 and Box 4. Box 3 contains 'understanding of the present (problematic) system and understanding of the ideal (problem-free) system'. For the understanding of the present system, by using the basic concepts of Objects-Attributes-Functions and Space & Time, the mechanisms of the system in work and the mechanisms (or causes) of the system in problem/difficulty are to be revealed. (For this purpose, the processes such as Function & Attribute Analysis and Space & Time Analysis are employed.) For understanding the ideal system, we need to understand the desirable behaviors and possible desirable properties of the (ideal) system. For reaching Box 3 from Box 2, or for obtaining the information of Box 3, the subject-matter knowledge need to be extracted and processed with the guidance of the analysis technique (e.g., USIT).

Box 4 contains 'Ideas for a new system'. Such an idea is NOT a hint but a clear suggestion of 'changing (specific) something in the present system in some (specific) manner'. It is an idea which should play a core role in building a new system, but it may not be clear yet how the idea is feasible in the new system and how effectively the new system will work and solve the problem. Such an idea may be small and fragmental in the first sight. But it is all right, because we remember that the core ideas of even great inventions in the history were small indeed.

Then, how can we obtain the ideas in Box 4? An answer from a theoretical standpoint is 'we can obtain such ideas by applying various USIT Operators (or Sub-Operators) onto various possible operands of the present system (i.e., the information in Box 3) in various different/exhaustive ways (as demonstrated in Fig. 8)'. However, the exhaustiveness in the application is not the essence in this process. (You may easily imagine that a computer software generates hundreds and thousands of candidate ideas automatically.) Essence is in the capability of finding, i.e. generating and selecting, the ideas which will certainly become a core of a new and better system. Another answer from a practical standpoint is 'meanwhile in the problem-analysis process of obtaining the information of Box 3, we understand the essence of the problem and the system and we naturally think of ideas what and how we should improve the system (because human brain naturally works in such a way). If one knows various technologies and masters the techniques like USIT Operators (or TRIZ 40 Inventive Principles), one may be able to obtain such ideas more smoothly, of course.

The 'Conceptual Solution (or Concept of Solution)' in Box 5 should be the solution idea that one believes to work well and solve the original problem. For building up such a Conceptual Solution (Box 5) from the Ideas (Box 4), capability of technology (or business, etc.) in the relevant fields is necessary more than any thinking method (like USIT). Thus it is natural that non-professional persons even with some good ideas (Box 4) can not achieve good inventions because of the difficulties in reaching the solutions at the stages of Box 5 and Box 6. Even so, the understanding of the present and ideal systems (Box 3) helps one build up the Conceptual Solution (Box 4). Also technologies/solutions known in other fields are often helpful, and hence knowledge bases (in TRIZ and others) are useful in this stage of building up the Conceptual Solutions.

There are various ways to understand the 'USIT Six-Box Scheme' of Fig. 13. One important implication is shown below in Fig. 14. The left part of the figure represent the process of analyzing and understanding the problem; the process is 'Abstraction' in its genuine sense, and not mapping/matching onto known Models. The right part of the figure, on the other hand, represents the process of 'Concretization' of the initial core ideas into the Conceptual Solutions and further into Implemented Solutions.
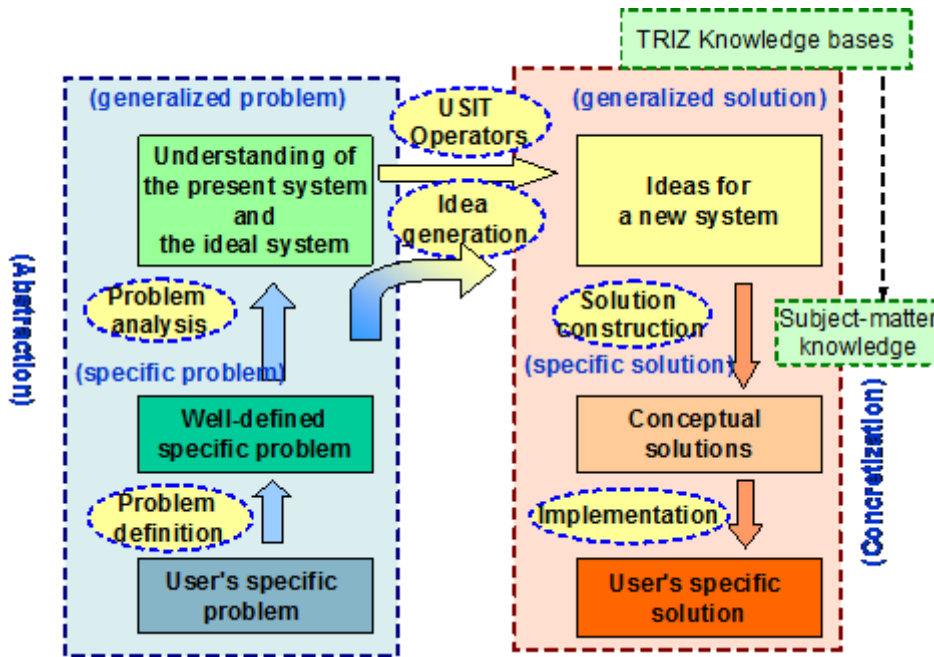
Fig. 14.   An implication of the New Paradigm for Creative Problem Solving

A significance of the Six-Box Scheme is its easiness to learn and its versatility to apply, because it uses the standard basic concepts and the standard versatile methods especially in the Problem Analysis stage, i.e. the left half of Fig. 14.   The scheme is new in the points that it is neither a method of matching with (or mapping onto) existing models, nor a method to think of a new idea by analogical thinking with the assistance of hints.   It gives a consistent whole process of problem solving in place of partial, fragmental methods.   On the basis of these facts, I have been claiming the 'Six-Box Scheme' of USIT as 'A New Paradigm for Creative Problem Solving' [16].

3.   Educational Activities: Education of 'Creative Problem Solving' and Education of 'Independence/Responsibility'

3.1   Lectures on 'Methodologies of Creative Problem Solving'

As described before, I wrote a paper on my educational practices and published it in the Bulletin of Osaka Gakuin University in March 2007 [6].   The main lecture course I gave was the class of 'Scientific Information Methodology', for the second-year students.   I posted the full set of my lecture materials of 13 lectures of 90 minutes given in year 2001 in the Web site "TRIZ Home Page in Japan".   I revised the lecture materials slightly year after year.   The 14 lectures given in 2010 were composed as shown below [17].

---

(1) An easy introduction with simple case studies

(2) Three principal approaches in science & technology: third approach: Problem Solving.

(3) Finding the problem and its focus

(4) How come up with ideas?   Enlightenment, Brainstorming.

(5) What are 'Systems'

```
-- Problem Analysis --
(6) Finding root causes of the problem
(7) Analyzing functions and attributes of the system
(8) Extra: How to construct and write a report.
(9) Analyzing space/time characteristics and ideal solution (Particles Method)
-- Solution Generation --
(10) Fully utilizing knowledge bases:   TRIZ Knowledge bases
(11) How to break through the barriers: Physical Contradictions and TRIZ Separation Principles
(12)   A system of solution generation operators: USIT Operators
-- Summing Up of the Class --
(13) Case studies of everyday-life problem solving
(14) Creative problem solving with USIT
(15) Creative problem solving with TRIZ
          -- Conclusion of the Class--
```

Fig. 15   Topics of the Lectures of 'Scientific Information Methodology' Course. (Main theme is 'Methodologies for Creative Problem Solving')

As you see in the topics of lectures shown above, I have given lectures about methodologies for creative problem solving, with focus on TRIZ/USIT and in a wider relevant areas.   I talked many case studies on familiar problems.   In the academic year of 2010, I had my lectures video-recorded (i.e., from Oct. 2010 to Jan. 2011), with the intention of making it open either inside the university or even publicly outside the university. It was a live-recording in a small comfortable auditorium.   However, since there are scenes where some students may be identified personally, the videos were decided not to be disclosed.   The lecture slides and other hands-out in the class have been posted in my Web site "TRIZ Home Page in Japan" [17].

3.2   Seminar on 'Creative Problem Solving Thinking': Case Studies of Solving Familiar Problems

The Seminars for the 3rd year and for the 4th year (i.e., for the thesis work) are taught by the same teacher. As I wrote in my report [5], I set the prerequisite of taking my lecture 'Scientific Information Methodology' in the 2nd year, but actually some students join my Seminar without filling this prerequisite.   This makes the Seminar operation sometimes difficult.   Students were requested to learn various cases of solving familiar problems, do the group exercises, and work on some individual themes of problem solving in their thesis work. My students made the following results, among others:

- 'Consideration of future evolution of mobile phones' by Takuo Kasahara (2004) -- Applying the TRIZ nine-window method.

- 'How to prevent the stapler needle from being crashed' by Kazuaki Kamiya (2004) -- Applying the method of Smart Little People.

- 'How to fix the string left shorter than the needle at the end of sewing' by Tsubasa Shimoda (2006) -- A case study of applying USIT in the whole process of problem solving.

- 'How to prevent shoplifting at a bookstore' by Naoya Hayashi (2006) -- Use of Time Analysis; A case where people are involved in the problem.

- 'How to prevent unauthorized persons from entering the auto-locking door of apartment building' by Arata Fujita (2007) -- Applying TRIZ/USIT to a social & technical problem

- 'How to prevent cords and cables from getting entangled' by Tomoyuki Itoh (2007) --   A study of systematic classification of various solutions.

- 'How to help recall passwords' by Yutaro Ueda (2009) -- A case of physical contradiction related to human thinking.

- 'On Methods and Tools for Weeding (or Removing Weeds)' by Takahisa Miyake (2011) -- Systematic understanding of the problem, purposes, methods, and tools.

My students also made and publicized a Web site "TRIZ Home Page for Students by Students" and posted their own case studies of problem solving [18].   Their intention is illustrated in Fig. 16.   Even though I posted a large number of articles, including some introductory ones, in my Web site "TRIZ Home Page in Japan" with the intention of penetrating TRIZ, my students found them not attractive at first and not easy to understand.   So they tried to post something more attractive and written in a way easy to understand in their own public Web site
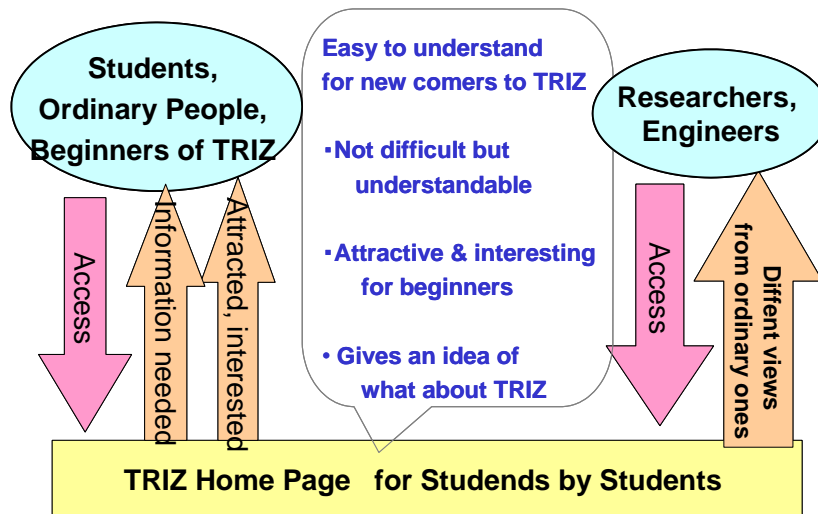

Fig. 16.   Intention of building "TRIZ Home Page for Students by Students" [16]

3.3   Solving Familiar Problems: 'How to fix the string left shorter than the needle at the end of sewing' -- A case study of problem solving with USIT

Here shows a case study of the whole process of using USIT (see Section 2.2) by using one of the thesis works by my students.   The work is based on Tsubasa Shimoda's thesis and presented after Nakagawa's revisions in many occasions of talks and papers including a series of lecture articles of TRIZ published in the "InterLab" magazine [19].   Frankly speaking, I initially had some feeling of a wrong deed in presenting student's thesis work not as it is but in a revised manner.   But later I became confident that after students submitted their thesis the teachers should revise and publish them in their final forms, and that it is a part of teachers' responsibility.   The results obtained by (undergraduate) students can not be complete as they are, but they can become good case studies by complementing some insufficient aspects and revise the expressions. Such case studies can become very useful for many students and even engineers and business people to learn the method.

The task of this problem is to think of methods/devices for fixing a string left shorter than the needle at the end of sewing.   Here are the four slides of the case study which I show in a recent talk (Fig. 17).   Since the

space is limited in the present article, I will not explain these slides.   Anyway, these four slides show the whole process of applying USIT in a natural manner following the steps of Problem definition, Problem analysis (1) and (2), and Idea generation.

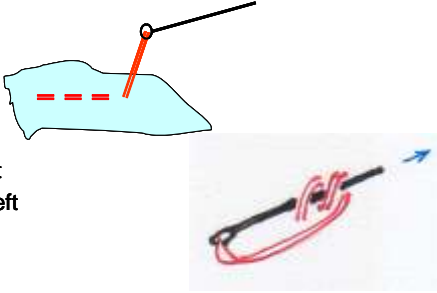## How to fix a string shorter than the needle at the end of sewing

Problem Definition:

(a) Undesirable effect: The string is shorter than the needle and
prohibit applying the standard way of making a knot.

(b) Task statement: Devise methods for fixing the string left shorter
than the needle.

(c) Sketch:

(d) Plausible root causes:
The standard way of making a knot
is applicable only when the string left
is longer than the needle.

(e) Minimum set of relevant objects:
Cloths, string (already sewn), string (left), the needle

Problem Analysis (1): Understanding the present system

(1) Functional analysis: What is the function of the Needle?
A base for making a loop of the string;
A guide for passing the end of the string through the loop

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

The string does not expand = Its length does not change.
The needle is hard = No change in shape and length.

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

(3) Analysis of time characteristics: Processes of sewing:
Solutions at the final stage and solutions at any earlier stage.

(4) Analysis of space characteristics: A knot makes the string thick at the end.
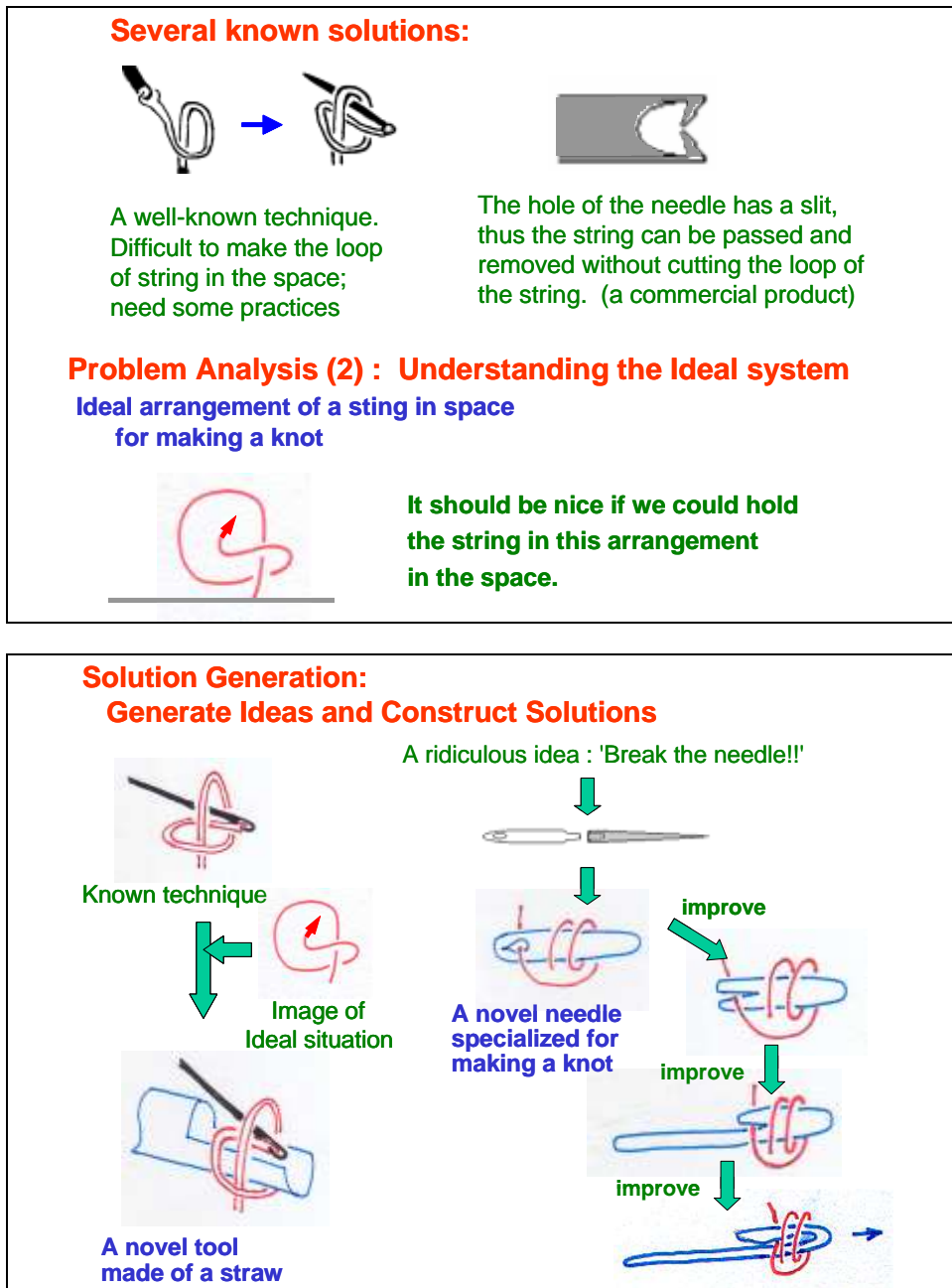Watch out about the topology in making a knot and in the 'hole and string' .

Several known solutions:

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

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

Problem Analysis (2) : Understanding the Ideal system

**Ideal arrangement of a sting in space
for making a knot**

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

**Solution Generation:
Generate Ideas and Construct Solutions**

A ridiculous idea : 'Break the needle!!'

Known technique

improve

Image of
Ideal situation

**A novel needle
specialized for
making a knot**

improve

**A novel tool
made of a straw**

improve

Fig. 17.   A student's case study of applying USIT: 'How to fix a string left shorter than the needle at the end
of sewing'.   (The whole process of USIT)

3.4   Seminar IB for the first year students: Learning with "7 Habits of Highly Effective Teens"

Another education practice I would like to report here is the Seminar IB class for the first-year students. The Seminar intended originally in the curriculum of Faculty of Informatics to be training of reading, writing, and presentation, but in 2008 it was slightly shifted in the unified curriculum of the University to be training of reading, writing, thinking, and presentation.   Choice of contents and materials is left to individual teachers.   In 2008 I changed my Seminar materials/contents into the book "7 Habits of Highly Effective Teens" written by Sean Covey [20].   The 'Habits' in this book mean our ways of thinking and behavior which a person usually do consciously or unconsciously.   The book advises to have/develop the following '7 Habits'.

Habit 1: Be Proactive.

Habit 2: Begin with the End in Mind
Habit 3: Put First Things First
Habit 4: Think Win-Win
Habit 5: Think First to Understand, Then to Be Understood
Habit 6: Synergize
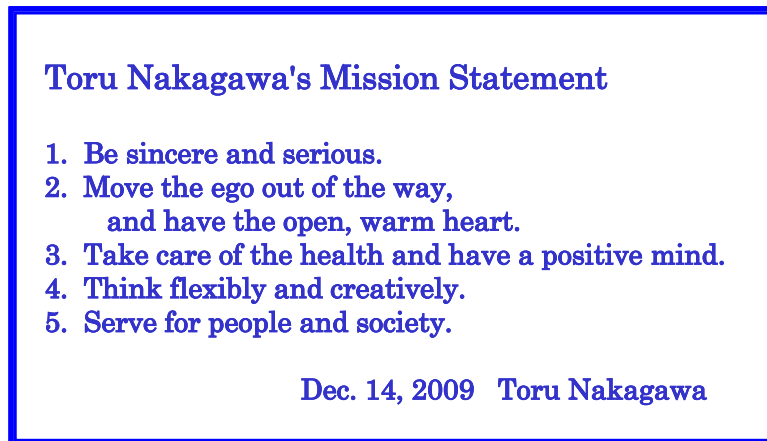Habit 7: Sharpen the Saw; Keep Hope Alive!

I have posted a full set of the practice reports of the Seminar (i.e., Intention and practice of the Seminar, Introduction to the book, (Excerpts of) Students' reports, and Nakagawa's comments to each student) in my Web site "TRIZ Home Page in Japan" [21].　During the class, I requested the students to read aloud a page or so of the book by turn, and asked 'how do you think about this part?' to students for discussion.　I requested the students to submit reports 3 times (or 4 times in later years)　The report title is specified as 'On What I learned and What I thought at the Seminar'; i.e., a writing/essay on 'How I felt' is not accepted.　(We cannot criticize student's feelings, but we can advise/teach/discuss on students writings of learning and thinking.)　On each report I revised their expressions (without changing what they wanted to tell) and added comments why I revised the expressions and also wrote advices and criticisms on the contents themselves.　A collection of students' reports and teacher's comments of all the classmates (10 to 16 per class) was fedback to all the students.　For each student, reading reports by and comments on all the classmates is interesting and useful to learn; thus the students agree to disclose their own reports to the class.　Reading teacher's comments on other student's reports are found effective to learn in different aspects on 'reading, writing, thinking, and presentation'.

While a student read aloud in the Seminar, I sometimes advised 'while reading, pause a moment at a period showing the end of a sentence'.　Reports by some of the students were poor and messy in their expressions in the initial round, but became significantly better in the third round or so as the result of training.

The book advises first to 'Be proactive'.　I.e., to behave with responsibility; instead of reacting emotionally on outer events to 'press a pause button' and think what to do before you do.　Near the end of the class on this topic, I posed a question to the students "Shouldn't we press a 'Start and Go Button' to be proactive?"　Young people in USA are taught and grown up to be aggressive, while those in Japan are grown up to see around and adjust oneself to match with the circumstances.　Thus I think we should put some different emphases depending on the (Japanese) culture.　The attitude/spirit of 'being proactive' is indeed the basis of a person to 'think creatively'.　The 7 Habits which are advised by this book (and originally by Stephen R. Covey) touch the basic core of our personality for students, for business people, and for myself.

3.5 "Toru Nakagawa's Mission Statement" -- A homework submitted by a teacher

The book used in Seminar IB advises the 2nd Habit: 'Begin with the End in Mind' and to write up our own 'Mission Statement'.　It should be a statement, in any form, on 'What I want to be' as a motto.　Even though I was much impressed in reading "7 Habits of Highly Effective People" and started the Seminar IB, I could not write my own Mission Statement for a year and half.　In the second year of my Seminar IB class, I thought that since I am requesting the students to write reports I should also write my own report.　Thus in December 2009, I wrote my own 'Mission Statement', as shown below [22].

Fig. 18. Toru Nakagawa's Mission Statement

I also wrote a report of ' "Toru Nakagawa's Mission Statement" and its description' and handed it to the students together with a collection of students reports and my comments on them.   The report was posted in my "TRIZ Home Page in Japan" [22].   As I wrote there, this is the statement of 'What I want to be' and not 'What I am'.   Especially, Item 1 and Item 2 are always struggling in my mind.

3.6 "How to Build & Write a Report (Paper)"

The Lecture (7) in the Class described in Fig. 14 in Section 3.1 is worthy of mentioning.   The lecture on 'How to Build & Write a Report (Paper)' is an extra topic, specially given in the class supplementary to my trip to ETRIA TFC Conference.   The lecture text was posted in my Web site "TRIZ Home Page in Japan" in February 2002.

8 years later, I received an unexpected mail from a reader who found this article by an Internet search.   On her request, I started a 2-day training seminar on this subject as a part of the Training Course for Certification of Nurse Managers, to 50 nurse manager candidates.   On the occasion I enhanced the course materials and later published them in the "Communications of Osaka Gakuin University" and in "TRIZ Home Page in Japan" [23]. The materials are composed of 3 parts: Part 1 describes, in a top-down manner, clarifying the purpose of the report, building up the contents to write, preparing for writing, framework/formats of report, structuring the body of the report, etc.   Part 2, on the other hand, explains in a bottom-up way about concrete guidelines in writing at the levels of words & phrases, a sentence, sentences in connection, paragraphs, sections & chapters, and the whole report.   Part 3 is a summary in one page in a style often recommended in businesses for remarks, as shown in Fig. 19.   These materials are a summary of my study and practices of writing reports.

Fig. 19. One-page summary of 'How to build & write reports [23]

4. Promotion Activities: Presentation in Conferences, Seminars, Trainings, Home Page, TRIZ Society, TRIZ Symposium, etc.

New techniques and thinking methods like TRIZ/USIT are most desirable to be recognized and used widely in society. Thus, together with the research and education activities described so far, I regarded the promotion/penetration activities important and pursued from the beginning. Considering the characters of TRIZ/USIT, the people of penetration targets should be: (1) businesses (engineers and managers), (2) academia and universities (professors/teachers and students), (3) society (leaders and intelligent people), and (4) middle and elementary education (teachers and children). It is also useful and effective to promote TRIZ/USIT not only in Japan in a closed manner but also in the world in a widely open manner. Even though we still have a long, long way to go, I will summarize my own activities done so far.

4.1 Presentations at conferences, lectures, writings, translations, conference reports, etc.

The first form of promotion activities is to present my own results of study and research in papers at conferences. In Japan the occasions of presentations were (in the initial era) Knowledge Creation Study Group

and IM User Symposium held by Mitsubishi Research Institute and (since 2005) Japan TRIZ Symposium; every year I presented papers in these occasions.   I presented papers in Japan Creativity Society a few times.   I also made much efforts for presenting papers in international conferences: at TRIZCONs in USA I presented 8 papers from 2000 to 2009, and at ETRIA TFCs in Europe I gave papers every year from 2001 to 2011.   Besides these, I was invited to PSST (Problem Solving Strategies and Techniques) Conference held in Tehran, Iran to give a keynote lecture (two times in 2006 and 2012).   In 2006, since I could not make a trip I sent a 15-minutes video lecture, while in February 2012 I visited Iran and gave a keynote lecture by person.

Whenever there were chances of being invited to give talks in conferences and seminars, I talked with thanks.   In these recent years, I talked at Ohkan-rengo 2nd Technical Symposium, Japan Mechanical Engineering Society 16th Conference of Engineering Design & Systems Division, Nikkei Monozukuri "7 Techniques for Innovation" Publishing Memorial Seminar (2006); Kitakyushu City University MOT Seminar, 38th VE Kansai Conference, Softpia Japan New Products Development Techniques Seminar, Miyagi Prefecture Industrial Technologies Center TRIZ/USIT Seminar (2007); Next-Generation University Education Conference (2008); Japan Creativity Society 5th Creativity Seminar (2010); Japan Mechanical Engineering Society Engineering Design & Systems Division Seminar, Kyoto Prefecture SME Technology Center Skill-Up Training, Nara Advanced Institute of Science and Technology FD Seminar (2011).

It is also important for me to write introductory articles.   I wrote 3 series of introductory articles in 3 different monthly magazines: 'Aha! the Methods: Modern TRIZ' (in "Nikkei Monozukuri" journal, 4 articles, 2005) [24], 'Creative Problem Solving Technique for Technical Innovation: TRIZ' (in "InterLab" journal, 22 articles, 2006-2007) [25], and 'Introduction to USIT: Easy Method for Creative Problem Solving' (in "Machine Design" journal, 5 articles, 2007) [26].   All these articles are posted in "TRIZ Home Page in Japan" just after publishing in the journal.

As already written in Section 2.1, I have translated excellent textbooks and materials written overseas and published in Japanese Editions [6, 8, 9, 10, 11].   I and two colleagues translated Ed Sickafus' USIT eBook and posted its Japanese Edition in "TRIZ Home Page in Japan" [27].

For the purpose of penetrating TRIZ, I have made much efforts in writing participation reports of international conferences on TRIZ.   Since I attended at First International TRIZ Conference held in USA in 1998, I wrote participation reports of international conferences for the purpose of reporting overseas TRIZ situations to Japanese TRIZ colleagues and posted them in "TRIZ Home Page in Japan".   On my report of TRIZCON 2001 in Japanese, I received a request from an overseas TRIZ expert to translate into English; hence I started to write my participation reports in English in detail, and in Japanese just briefly.   I wrote 'Personal Reports' of TRIZCONs in USA (8 reports), of ETRIA TFCs in Europe (7 reports), TRIZ Symposium in Japan (6 reports), and two other international conference/seminar (2 reports); thus 23 reports in total.   These are 'Personal Reports' where I reviewed and introduced the presentations with my own personal responsibility, in the words as I understood, and with my own evaluation; thus they are different from ordinary (sometimes official) reports where any criticism and personal evaluation are usually avoided.   As I made much efforts for understanding well and introducing appropriately each presentation, I fortunately received with high evaluation for these reports by many (Japanese and overseas) authors and readers (i.e., TRIZ experts).   Writing such Personal Reports, however, has become heavy burden more and more, and hence I quitted writing the reports of USA and European conferences and put efforts for reviewing and introducing in English all the papers presented in Japan TRIZ Symposium [28].

I also translated (by getting some collaboration of my colleagues) selected excellent papers published at the "TRIZ Journal" and at international conferences (TRIZCONs and ETRIA TFCs) into Japanese and posted in "TRIZ Home Page in Japan".

On summarizing these works, I noticed that I have not written any book on TRIZ/USIT yet. Since there are good textbooks on TRIZ already, I should write a textbook on USIT in the near future, I am now thinking.

4.2 Training: In-company and open USIT Trainings

I mastered USIT in March 1999 at Sickafus' 3-day Training Seminar, and in July 1999 I was invited by a manufacturing company to conduct the first USIT Training Seminar in Japan for 3 days. I gave lectures on TRIZ and USIT, and led the trial of solving real industrial problem with USIT. Since then till 2008, I conducted the USIT Training Seminars for 3 or 2 days 22 times in 8 different manufacturing companies. In 2003, I was requested by a company to shorten the Seminar from 3 days to 2 days, and I shortened the training seminar into 2 days. Four companies, out of the 8, held the USIT Training Seminar 3 times or more, and established the teams to promote TRIZ/USIT for themselves. Since I did not have real experiences of working in development and manufacturing divisions in industry, I made trainings but not consulting in industries.

Open USIT Training Seminars were more effective for promoting TRIZ/USIT. In the early stage (from 2000 to 2003), Mitsubishi Research Institute held sets of a half-day or one-day seminar for presenting TRIZ/USIT to wider audience and a subsequent 3-day USIT Training Seminar with 15 to 25 participants; we had 5 sets of seminars in this manner. Later from 2005 to 2008, IDEA held 6 times while MPUF held 2 times the 2-day Open USIT Training Seminars. The actual way of conducting the 2-day USIT Seminar was published in detail in my article in "TRIZ Home Page in Japan" [29]. The agenda is shown in Fig. 20.
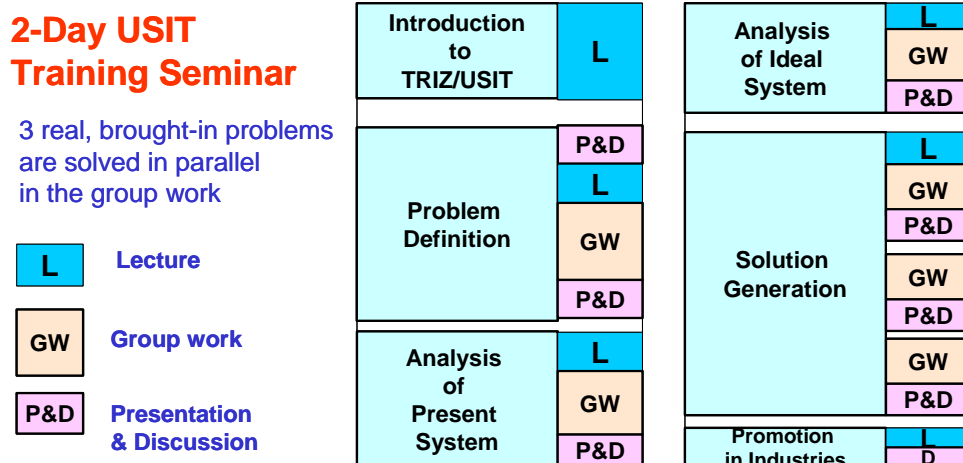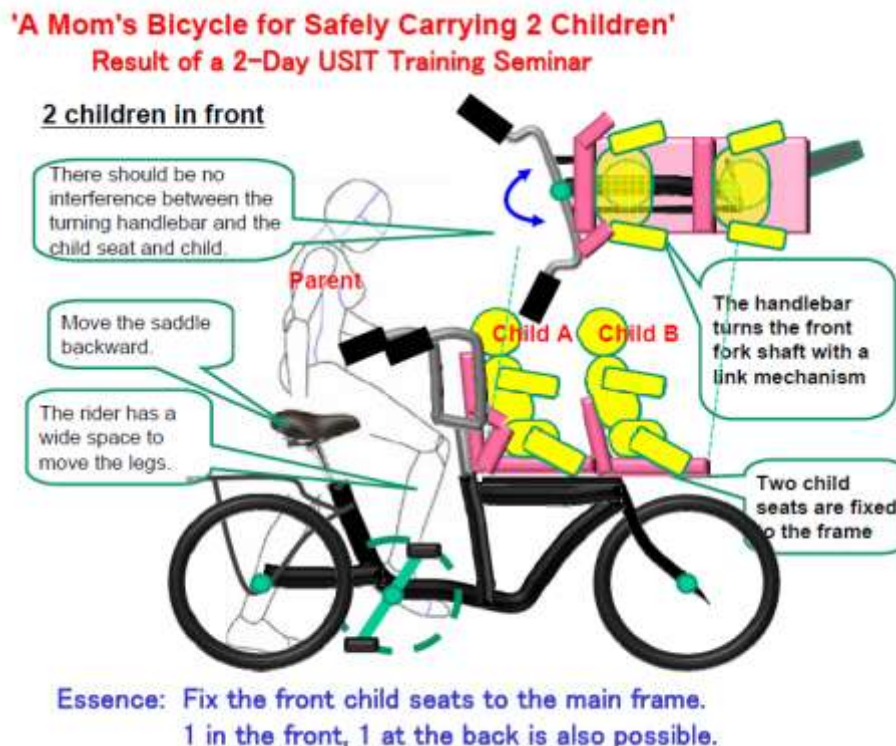

Fig. 20.   Agenda of 2-Day USIT Training Seminar

The merits of Open USIT Training Seminars are the chances of working together with engineers/promoters having high motivations and talents coming from different companies and of solving real industrial problems with USIT and also the high possibility of the participants to become practitioners and promoters of TRIZ/USIT in their own companies. One critical issue was that the companies do not allow the participants to bring in any real problem because of risks of disclosure of companies proprietary information. For clearing this issue we had all the participants signed the pledge written, in essence, as "The results of the Seminar belong to the person who proposed the problem; all the participants must not disclose the technical contents of the Seminar for 2 years; and after 2 years the contents may be publicized by any participant (including the Instructor)."

The results of the training seminar concerning to the problems I proposed for myself were allowed to publish just after the seminar. In such a manner, two case studies were published: 'A System for Preventing from Our

Leaving Things Behind' [30] and 'A Mom's Bicycle for Safely Carrying Two Children' [31].   In the latter case, we have obtained (by some additional work after the seminar) the idea as shown below.   (Unfortunately, no bicycle manufacturer has adopted our idea yet.)

Fig. 21.   A solution obtained in a USIT Training Seminar: A Mom's Bicycle for Safely Carrying Two Children

Besides these, I tried twice one-day Open USIT Exercise Seminars for a rather large number of attendees in a simplified manner.   But I have found the degrees of learning the USIT method and of understanding the problem was not satisfactory.   And hence, in case of half a day or one day, we should better have lectures together with a lot of case study demonstrations and Q&A, in place of actual exercises by the participants, I am now thinking.

So far the participants of USIT seminars and trainings were mostly industry engineers and relatively few university researchers.   In the near future, I would like to find the occasions of USIT seminars and trainings with the leaders/researchers in universities and national institutes, graduate students, and school teachers. Further ahead, I would like to try USIT with classes of adults, with classes or clubs of school kids/children in future.

4.3   Promotion with the Web site "TRIZ Home Page in Japan" and the vision of 'Global Network of Public Web Sites'

The central means of my TRIZ/USIT penetration activities has been my Web site "TRIZ Home Page in Japan" [2].   I have made very much efforts for editing and operating it.   I established it inside the official, open-to-public Web site of Osaka Gakuin University in November 1998, and has been editing and operating it actively for these 13 years.   It is a site edited and operated by myself on a voluntary basis and with full personal

responsibility. But it is not a private site. "TRIZ Home Page in Japan" has set the purpose of posting introductory articles, full detailed information, communications, etc. related to TRIZ on a not-for-profit and public-service basis. It publishes articles and papers contributed by many different authors in Japan and overseas besides my own ones.   In these senses it is a 'Public Web Site'.

I have posted many articles which I thought useful for penetrating TRIZ/USIT after my own selection. They include introductory articles, papers, application/promotion case studies, reviews, conference reports, news, publication announcements, links, communications, questions and answers, etc. on the topic of TRIZ/USIT and related areas.   In each article (i.e., page), I put Editor's Note describing the information source and the background and intention of obtaining/writing the article.   For every new article I wrote a brief introduction/summary together with the information source and accumulated in the page of New Information. The top page shows such New Information of articles newly posted for these 6 months.   I am also maintaining the General Index, where all the articles posted for these 13 years since the beginning are classified into categories (about 10 main categories and about 40 sub-categories) and arranged in a chronological order in each sub-category and have links which allow accesses to the article pages in one click.   I have been trying to post pages in Japanese and in English in parallel as much as possible.   In each article, the pages in Japanese and in English can be switched easily.   In each page, hyperlinks are attached to many reference pages and URLs in close relationship.

As the entrance page for novices, the page of 'Introduction to TRIZ' has brief description of TRIZ and shows several important introductory articles (selected in the current eyes) and buttons to the articles.   The important role of "TRIZ Home Page in Japan" is to post good papers presented at various conferences, etc.   I selected excellent papers presented at the TRIZ conferences held in USA, Europe, Japan, etc. and, after getting the permissions by the authors and conferences, I post the papers in their original language and possibly in Japanese or in English translation.   A large number of papers are accumulated already on the methodology of TRIZ/USIT and on case studies of applying and promoting TRIZ/USIT (about 100 application case studies). All my research, education, and promotion works mentioned in the present article are posted in "TRIZ Home Page in Japan".   My 'Personal Reports' of international TRIZ conferences, mentioned in Section 4.1, may be worthy of remarks.   .

A collection of links to important TRIZ-related Web sites in Japan and in the World is also made.   I spent much efforts for making/updating them every few years.   The current version of 'World TRIZ Links' was made by the survey work in March to May 2008 and contains 120 Web sites.   I traced various links and read (or sometimes watched) their principal pages, evaluated the contents, and wrote rather detailed annotations to the sites individually.   Due to the language barriers, this survey work was difficult and the Web sites in languages different from English were not evaluated properly.   Nevertheless, I evaluated the importance of each site as much as possible and annotated on it as I think appropriate; this can be done because I personally owe the responsibility as the author of the article and editor of the Public Web site (and not Official Web site).

I have been updating "TRIZ Home Page in Japan" irregularly with the interval of 2 to 4 weeks and has posted 1 to 5 articles every time.   On every update I have sent Update Announcement via email with slightly arranging the descriptions in the 'New Information' page.   The announcements are sent to about 730 people in Japan and about 400 people overseas.   As the consequence, the top pages of "TRIZ Home Page in Japan" received about 157 thousand visits in the Japanese page while 26 thousands in the English page during 6 years from Nov. 2005 till Oct. 2011.

On the basis of the experiences with "TRIZ Home Page in Japan", I have been proposing to the TRIZ leaders in the World to build up 'A Global Network of Public Web Sites on TRIZ' [32].   The 'Public Web Sites' in this proposal mean the Web sites which have not-for-profit and service-to-public purposes, openly accept articles

contributed by many different people, and after editing post them openly for public use. 'Public sites' are distinguished in their nature from 'Private sites' of personal interests, from 'Private/Proprietary sites' of companies for commercial profit purposes, and from 'Official sites' of academic or social organizations for expressing the organization's official standpoints. Sometimes the Web sites of persons, companies, academic or social organizations, etc. are operated (in a part) to post pages of information for not-for-profit and service-to-public purposes; in such a case the parts of the Web sites may be regarded to have the common nature with the 'Public Web sites'. In order to keep/improve quality and reliability of articles, it is important to be edited appropriately by the editors. Explicit description of the authors, dates of writing, and dates of posting is also necessary, I believe.

For the purpose of making a 'Global network', we have to overcome the language barriers. For overcoming this problem in a feasible manner, I am proposing to adopt the English language as the de facto common language in the world and to build Public Web sites having parallel pages written in English and in their own languages. Then, in order for the own people to see out the World, good English articles should be translated into their own language, while in order the people in the World to see inside the country good articles originally written in the country's own language are to be translated into English. (Translation of papers from the original language into English often needs much efforts but is useful for obtaining proper evaluation and understanding in the world.)

Fig. 22 illustrates the vision of my proposal. It is envisioned that 'Public Web Sites' are established in every country with various scopes and policies. Then the mutual network of them will naturally grow into a Global Network of Public Web sites without any specific (or central) organization for certification or authorization. Such a Global Network will bring up a united Global TRIZ Community and will help TRIZ penetrate into the world in a sound manner. This is a vision applicable not only to the field of TRIZ but also to any field and any topic.
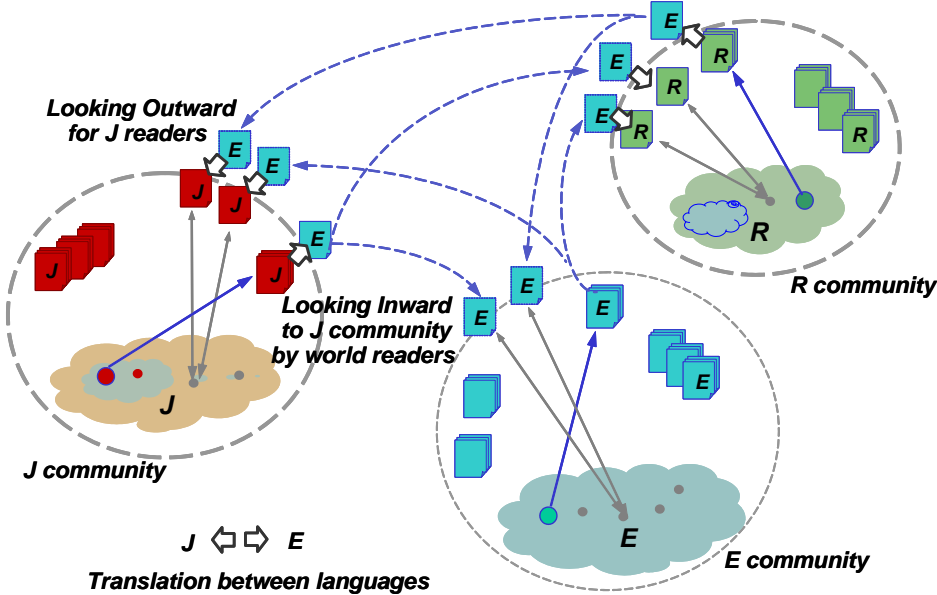

Fig. 22. The vision of Global Network of Public Web Sites

4.4 Organizing Japan TRIZ Society (NPO) and Holding TRIZ Symposium in Japan

The Japan TRIZ Society was organized by the promotion of voluntary members as the national center in Japan for promoting and penetrating TRIZ. It was approved as an NPO by Tokyo Metropolitan Office. It was

born by the predecessors, namely, TRIZ Konwakai (a voluntary communication circle) in 2004 and Japan TRIZ CB (i.e. 'Collaborative Board of TRIZ Promoters and Users in Japan') in 2005.   Previously in Japan there were two competing and somewhat conflicting groups of TRIZ promoters in reflecting a severer competing situations among TRIZ vendors in USA.   Industry and academic TRIZ users in Japan played the role of mediator to form a cooperative relationships among the competing vendors/consultants firms.   Such efforts for organizing a TRIZ community have proceeded well and now the Japan TRIZ Society (JTS) has about 120 regular members of voluntary individuals.   It is managed by about 20 Managing members, including 9 Board Members (I am one of the Founding, Board Members of JTS).

The principal activity of JTS is to hold the TRIZ Symposium in Japan annually in early September.   JTS does not have financial support from industries, is not well recognized in academia, and does not join any national/public research project yet.   Nevertheless, in the world of TRIZ, Japan TRIZ Society is regarded as one of the most stable and active organizations in the national level, especially in good cooperation among the leaders.

I have been serving as the Program Chairperson of Japan TRIZ Symposium every year since its start in 2005 (see the Official Report page of the 7th Japan TRIZ Symposium 2011 [33]).   The primary goal of the Symposium is, first of all, that the people involved in TRIZ (including promoters, users, and novices) all over in Japan gather together, present their activities and results, discuss and communicate with one another, and promote the understanding and penetration of TRIZ.   Since we know that the presentations and participations from overseas are useful for stimulating and advancing TRIZ in Japan, we have chosen to make the Symposium internationally open.   This choice, of course, urges us to solve the language barrier problem; otherwise the Symposium would become frustrating both for Japanese and for overseas participants.   We set our basic policy of the Symposium to be 'Primarily Japanese national AND partially (but as much as possible) international'.

Official language was chosen to be Japanese and English.   Call for Papers and Call for Participation were announced in Japanese and in English to obtain papers and participants from Japan and all over the world. During the presentation, we projected Japanese slides and English slides in parallel in most cases, even though Japanese slides alone in some sessions.   Sequential interpretation between English and Japanese was served only during Q&A in the sessions.   We have chosen these ways of 'prior translation' because the 'simultaneous interpretation' was impossible due to the lack of talented persons and budgets, and because the 'sequential interpretation' of the presentation would waste the time so much.   Proceedings were made in two editions, one for Japanese participants and the other for overseas.   We asked Japanese authors to make English slides for themselves as much as possible and the Program Committee supported them in English translation or brushing up.   Slides of overseas presenters were translated into Japanese by the Management members and some volunteer members of JTS.   These supporting work was quite hard for the organizers, but gradually most of Japanese authors became to submit their English slides for themselves.

For the preparation of holding the Symposium in early September, we have established the schedule: Call for Papers in February, Submission of extended abstract in mid May, Announcement of advance agenda and Call for Participation in early June, Submission of final manuscripts (slides: required, paper: optional) in late July, and Registration deadline in late August.   On accepting the extended abstracts the Program Committee do some screening, and on accepting the presentation slides we sometimes give comments and advices, but we do not make any refereeing.   Reasons for such a policy are to make the deadlines of submitting abstracts and final manuscripts as late as possible in order to allow the authors present their latest results, and to announce advance agenda in detail as early as possible in order to obtain as many participants as possible.   We think it impossible for the Symposium organizers to take responsibility of the contents of presentation even after refereeing. Authors should present what they believe correct and best under their own responsibility, and individual

participants should evaluate such presentations for themselves.   Many presentations by proactive authors are the keys to active and useful Symposium, we believe.

As a result of these preparations, Japan TRIZ Symposium has annually obtained about 40 presentations (including about 10 from overseas) and 100 to 200 participants (including 4 to 46 from overseas) for the 3 days (the number of participants changed much due to economic situations and the 3.11 disaster).   It is evaluated highly by Japanese and overseas participants that industrial users present their practices and the general atmosphere of the Symposium is active and cooperative.   We believe it very important for the penetration of TRIZ in Japan that the Symposium is active and useful for all the participants.   We have been trying to achieve such a goal for these 7 years and will keep going on further.

Recently Japan TRIZ Society has started the discussion on publishing an (electronic) journal for refereed papers.   We would like to make TRIZ recognized properly in academia.

5.　Concluding Remarks

I have described above my overview of my activities for these 14 years (from April 1998 to March 2012) working for Osaka Gakuin University in research, education, and social promotion.   I am very delighted and grateful to be able to work in many different aspects on the main theme of 'Methodologies for Creative Problem Solving: TRIZ/USIT'.   I sincerely wish my thanks to all the people who gave me kind supports, especially the faculty members, students, and staff of Osaka Gakuin University, people of Japan TRIZ Society and TRIZ leaders in the world, and also my wife Masako.

References

[Note: References without explicit description of the author are authored by Toru Nakagawa.   TRIZ HP is the abbreviation of "TRIZ Home Page in Japan" [2].   Most of the references have Japanese versions (J) and English versions (E).]

[1] 'TRIZ: Theory of Inventive Problem Solving -- Understanding and Introducing It --', Mitsubishi Research Institute Home Page, May 1998 (J); Bulletin of Cultural and Natural Sciences in Osaka Gakuin University, No. 37, Sept. 1998, pp. 1-12. (J); TRIZ HP, Nov. 1998 (J); TRIZ HP, Feb. 1999 (E).

[2] "TRIZ Home Page in Japan", Editor: Toru Nakagawa, Established in Nov. 1998.
URL: http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/ (J)
URL: http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/ (E)

[3] 'Seminar Participation Report: USIT Training Seminar Conducted by Dr. Ed Sickafus', TRIZ HP, Mar. 1999 (J & E).

[4] 'Report of A Personal Trip to TRIZ Mother Countries (Russia & Belarus, Aug. 1999)', TRIZ HP, Aug. 1999 (E), Sept. 1999 (J).

[5] 'Classes of 'Creative Problem Solving Thinking' -- Experiences at Osaka Gakuin University --', Bulletin of Cultural and Natural Sciences in Osaka Gakuin University, No. 54, Mar. 2007, pp. 1-19. (J); TRIZ HP, Jan. 2007 (J); TRIZCON2007, Apr. 23-25, 2007, Louisville, Kentucky (E); TRIZ HP, May 2007 (E).

[6] "Software Tools for TRIZ -- Mechanism, Usage, and Methodology Learning -- Invention Machine's TechOptimizer Pro Version 2.5", Internal manual, Fujitsu Laboratories, Jan.- Feb. 1998 (J); Mitsubishi Research Institute Home Page, Jul. 1998 (J); TRIZ HP, Nov. 1998 (J); TRIZ HP, Feb. 1999 (E).

[7] "TRIZ: The Right Solution at the Right Time", Yuri Salamatov, ed. Valeri Souchkov, Insytec, the Netherlands (1999) (E); Japanese Edition: translated by Toru Nakagawa and Mitsubishi Research Institute, Nikkei BP,

Tokyo (Nov. 2000); See also: 'Salamatov's TRIZ Textbook: Japanese Edition and Q&A's on the English Edition', TRIZ HP, Nov. 2000 (E).

[8] 'Essence of TRIZ in 50 Words', TRIZ HP, May 2001 (E); TRIZ HP, May 2001 (J). 'Learning and Applying the Essence of TRIZ with Easier USIT Procedure', ETRIA TFC 2001, Bath, UK, Nov. 7-9, 2001 (E); TRIZ HP, Aug. 2001 (J); TRIZ HP, Nov. 2001 (E).

[9] "Hands-On Systematic Innovation", Darrell Mann, CREAX Press, Jul. 2002 (E); Japanese Edition: "TRIZ Practices and Benefits. Vol. 1. Systematic Technological Innovation", supervising translator: Toru Nakagawa, SKI, Tokyo, Jun. 2004 (J); See also: 'Darrell Mann's "Hands-On Systematic Innovation" -- Publication Announcement of the Japanese Edition and Q&A Documents for the English Edition', TRIZ HP, Jun. 2004 (E); TRIZ HP, Jun. 2004 (J)..

[10] Japanese Edition of "Matrix 2003: Updating the TRIZ Contradiction Matrix" by Darrell Mann et al., CREAX Press (2003), translated: Toru Nakagawa, Sozo Kaihatsu Initiative (SKI) (J); Publication Announcement of the Japanese Edition and Q&A Documents for the English Edition, TRIZ HP, Apr. 2005 (J); TRIZ HP, Apr. 2005 (E).

[11] Japanese Edition of "Hierarchical TRIZ Algorithms" written by Larry Ball, translated by Toshio Takahara and Toru Nakagawa, Sozo Kaihatsu Initiative, Sept. 2007 (J); TRIZ HP, Feb. 2006 to Jul. 2007 (J).

[12] Japanese Edition of "TRIZ Principles for Information Technology" written by Umakant Mishra, Aug. 2008, supervising translator: Toru Nakagawa, Sozo Kaihatsu Initiative, CD-R Edition, Jan. 2012 (J); Announcement of Japanese Translation Project, TRIZ HP, Jan. 2012 (J); TRIZ HP, Jan. 2012 (E).

[13] 'Approaches to Application of TRIZ in Japan', TRIZCON2000, Nashua, NH, USA, Apr. 30 - May 2, 2000 (E); TRIZ HP, May 2000 (E); TRIZ HP, Feb. 2001 (J).

[14] 'Reorganizing TRIZ Solution Generation Methods into Simple Five in USIT', Toru Nakagawa, Hideaki Kosha and Yuji Mihara, ETRIA TFC 2002, Strasbourg, France, Nov. 6-8, 2002 (E); TRIZ HP, Nov. 2002 (E); TRIZ HP, Sept. 2002 (J).

[15] 'USIT Operators for Solution Generation in TRIZ: Clearer Guide to Solution Paths', ETRIA TFC 2004, Florence, Italy, Nov. 3-5, 2004 (E); TRIZ HP, Nov. 2004 (E); TRIZ HP, Oct. 2004 (J).

[16] 'A New Paradigm for Creative Problem Solving: Six-Box Scheme in USIT without Depending on Analogical Thinking', 27th Annual Conference of the Japan Creativity Society. Oct. 29-30, 2005, Tokyo (J); TRIZ HP, Nov. 2005 (J); TRIZ HP Apr. 2006 (E).

[17] 'Methodologies of Creative Problem Solving (A Series of 14 Lectures Given to the Class at Osaka Gakuin University)', Class of 'Scientific Information Methodologies', Faculty of Informatics, Osaka Gakuin University, Oct. 2010 to Jan, 2011 (J); TRIZ HP, Jan. 2012 (J).

[18] ' "TRIZ Home Page for Students by Students": Understanding TRIZ/USIT by use of solving familiar problems', Masayuki Hida, Mizuo Ohmori, Tsubasa Shimoda, Naoya Hayashi, and Toru Nakagawa, Japan TRIZ Symposium 2006, Sept. 2006 (J); TRIZ HP, Mar. 2006 (J).

[19] 'Series: TRIZ: Creative Problem Solving Methodology for Innovation (5) Everyday-life Case Studies (1) How to Fix the String Found Shorter Than the Needle', "InterLab" Journal, May 2006 (J); TRIZ HP, May 2006 (J).

[20] "7 Habits of Highly Effective Teens", Sean Covey, Franklin Covey Co., 1998. (E)

[21] 'Teaching Practices: Nakagawa's Seminar Class of 1st-year Students for Learning with "7 Habits of Highly Effective Teens" by Sean Covey', (Part 1) TRIZ HP, Jan. 2010 (J); TRIZ HP, Jan. 2010 (E); (Part 2) TRIZ HP, Mar. 2010 (J); (Part 3) TRIZ HP, Mar. 2011 (J); (Part 4) TRIZ HP, Mar. 2012 (J).

[22] ' "Toru Nakagawa's Mission Statement" and its description', TRIZ HP, Jan. 2010 (J); TRIZ HP, Jan. 2010 (E).

[23] 'How to Prepare and Write Reports: Preparation of the Contents, Building the Structure, and then Writing Sentences', "Communications of Osaka Gakuin University", Sept. 2010 (J); TRIZ HP, Oct. 2010 (J).

[24] 'Series: Aha! the Method: TRIZ Up-to-Date (Part 3 to 6)', "Nikkei Monozukuri" Journal, May to Aug. 2005 (J); TRIZ HP, Jul. to Oct.2005 (J).

[25] 'Series: TRIZ: Creative Problem Solving Methodology for Innovation (Part 1 to 22)', "InterLab" Journal, Jan. 2006 to Nov. 2007 (J); TRIZ HP, Jan. 2006 to Nov. 2007 (J).

[26] 'Series: Introduction to USIT: A Simple Method for Creative Problem Solving (Part 1 to 5)', "Machine

Design" Journal, Nikkan Kogyo Shinbun, Aug. to Dec. 2007 (J); TRIZ HP, Jul. to Dec. 2007 (J).

[27] "USIT: An Overview (eBook)", Ed Sickafus, 2001 (E); Japanese translation, Keiji Kawamo, Shigeomi Koshimizu, and Toru Nakagawa, TRIZ HP, Oct. 2004 (J).

[28] 'Personal Report of Sixth TRIZ Symposium in Japan 2010' (Detail in English, brief in Japanese), TRIZ HP, Oct. 2010 to Apr. 2011 (E); TRIZ HP, Oct. 2010 to Apr. 2011 (J).

[29] 'Practices and Principles of USIT 2-Day Training Seminar', TRIZ HP, Jul. 2005 (J).

[30] 'A System for Preventing from Our Leaving Things Behind -- A Case in 2-Day USIT Training Seminar --', TRIZ HP, Feb. 2006 (J); TRIZCON2006, Apr. 30 - May 2, 2006, Milwaukee (E); TRIZ HP, Jun. 2006 (E).

[31] 'USIT Case Study: A Mom's Bicycle for Safely Carrying Two Children', Hiroshi Sakata, Tetsuya Sudo, Keiichi Hasegawa, Katsura Hino, Akira Kato, and Toru Nakagawa, 4th Japan TRIZ Sympo., Sept. 2008 (J); TRIZ HP, Jan. 2009 (J); TRIZCON2009, Mar. 2009 (E); TRIZ HP, May 2009 (E).

[32] 'Global Network of Public Web Sites in TRIZ: A Proposal for Building A Global TRIZ Community (3)', TRIZ HP, Oct. 2010 (J); TRIZ HP, Oct. 2010 (E); ETRIA TFC 2010, Nov. 2010 (E).

[33] 'The Seventh TRIZ Symposium in Japan, 2011 Held by Japan TRIZ Society, NPO, on Sept. 8-10, 2011, in Yokohama: Results and Documents (JTS's Page)', TRIZ HP, Sept. 2011 (J); TRIZ HP, Sept. 2011 (E).