Extension of USIT in Japan: A New Paradigm for Creative Problem Solving

Toru Nakagawa (Osaka Gakuin University, Japan)

Abstract

One of particular features in the TRIZ community in Japan in comparison to the World is its emphasis on easier and more unified way of studying and applying TRIZ. USIT (Unified Structured Inventive Thinking), originally developed by Ed Sickafus under the influence of SIT (in Israel) and TRIZ, has been introduced in Japan since 1999 and has been further improved and penetrated in Japan, as you see several USIT papers presented in Japan TRIZ Symposium last year and this year. USIT has been improved in Japan in the two principal aspects. First, all the TRIZ tools for solution generation, including 40 Inventive Principles, 76 Inventive Standards, Trends of Technical Evolution, etc., are reorganized into a system of USIT Operators, having 5 main methods containing 32 sub-methods. Second, the dataflow representation of USIT has revealed a new paradigm of creative problem solving, which is named the 'Six-Box Scheme' in contrast to the conventional, widely-known 'Four-Box Scheme'. These improvements have provided a new solid basis of understanding, applying, and promoting TRIZ in an easier and unified way.

1. Introduction

One of particular features in the TRIZ community in Japan in comparison to the World is its emphasis on easier and more unified way of studying and applying TRIZ. This may be considered as a trial of adopting and digesting the newly introduced methodology and make it more suited to and effective in our own culture.

TRIZ has been developed by Genrich Altshuller [1] and a large number of his followers in the former USSR and then in the World, and it now forms a huge system containing deep technological philosophy, a variety of thinking methods, huge knowledge bases, software tools, training practices, etc.

Such a big system was not easy for us to understand in our initial stage of introducing TRIZ in Japan around 1997. TRIZ was first introduced as a system of technical knowledge bases and software tools for accessing them. Few references were available because of the language barriers. This situation made it delayed and difficult for us to understand the ways of thinking and to master the problem solving methods in TRIZ.

In the First International Conference on TRIZ held in USA in November 1998, I met Ed Sickafus and his USIT method. As you may know, USIT (Unified Structured Inventive Thinking) [2] was developed by Sickafus under the influence of TRIZ and SIT (Systematic Inventive Thinking, a much simplified version of TRIZ). Reading his textbook and attending at his USIT 3-Day Training seminar in 1999, I started to introduce USIT in Japan as an easy and unified process for creative problem solving.

Applying TRIZ to real problems were tried by a number of big industries in Japan. Such applications were guided mostly by software tools in some cases and mostly by consultancy in some other cases. Applying Altshuller's Contradiction Matrix was the most popular approach at that time in Japan.

It took several years for us to establish reliable TRIZ textbooks in Japanese. We understood the Classical TRIZ and some more advancements in Russia by publishing the Japanese translation of Yuri Salamatov's Textbook in 2000 [3]. And then we understood the full scope of TRIZ in a much modernized form by publishing the Japanese Edition of Darrell Mann's textbook "Hands-On Systematic Innovation" in 2004 [4]. International conferences in TRIZ and various Web publications were good sources for us to understand TRIZ more in the global advancement.

In parallel to these studies of TRIZ, our experiences in USIT became deeper to the point of expanding USIT in our own ways. One of the achievements was the reorganization of all the principal methods of solution generation in TRIZ into a new framework of USIT, thus forming the system of USIT Operators in 2002 [5].

Second achievement of USIT in Japan was obtained in 2004 when I considered the whole USIT procedure in the sense of a 'data flow diagram'. The new diagram was formed in the six boxes from user's specific problem to user's specific solutions. This diagram was named 'Six-Box Scheme' in contrast to the well known 'Four-Box Scheme' of abstraction in TRIZ as well as in the orthodox science and technology. The implication of the Six-Box Scheme was explored to find it as a 'New Paradigm of Creative Problem Solving' [6].

Together with these methodological expansion, USIT has been taught to university students and also to industrial engineers in various training seminars both in-house and open multi-company situations. A number of case studies of applying USIT have been published so far and have given a basis of gradual penetration into Japanese industries. The current situation of USIT in Japan can be seen in several presentations every year in the TRIZ Symposium in Japan.

The expansion of USIT in Japan outlined above will be described and discussed in the following sections.

2. Initial Introduction of USIT in Japan

My initial interests[1] and understanding of USIT was posted in my Web site ("TRIZ Home Page in Japan" [7]) as a report of attending at Sickafus' 3-day USIT Training Seminar held in March 1999 [8]. The report described the whole USIT procedure in detail and was accompanied by the two case studies which I made in the Seminar. These were the (world) first reports on USIT in a comprehensive yet compact form other than Sickafus' voluminous textbook [2].

2.1 USIT as developed by Ed Sickafus

The principal characteristics of USIT, in its original form developed by Sickafus [2, 8], may be summarized as follows:

(a) USIT provides the whole process of problem solving in a streamlined and structured manner. The three main stages are problem definition, problem analysis, and solution generation. This is in contrast to TRIZ, which has multiple of big methods in parallel. Thus the overall procedure of problem solving in TRIZ has been in a controversy among many TRIZ specialists even though individual component methods are commonly understood.

(b) The stage of analysis of present system in the problem is clear in USIT and is based consistently on the concepts of Objects - Attributes - Functions. The problem is considered in its essential space and time and in the functional relationships among relevant objects. For each function, relevance of attributes of the acting object and of the acted object are considered explicitly. These concepts are similar to TRIZ concepts of Operational Zone and Operational Time and to Israeli SIT's Closed World Approach.

(c) For making an image of an ideal system, USIT has developed the Particles Method, where the Particles are imaginary almighty agency as in Altshuller's Smart Little Peoples' Modelling Method. The method applies the Particles in a step-by-step process and then it uses a tree diagram for showing desirable actions and desirable properties (of the Particles). This diagram becomes the basis of constructing a system of solutions in the next solution-generation stage.

(d) In the solution generation stage, USIT [2] has four basic methods, reflecting the simplifying idea of Israeli SIT. They are called Dimensionality (to be applied on attributes), Pluralization (of objects), Distribution (of functions), and Transduction (for linking two functions). In addition to these four basic methods, Sickafus regards that the Uniqueness (in space and in time) play roles of analysis and solution generation and that Generify (the solutions) is also a basic method to be applied for improving solution ideas.

(e) USIT intends to be applied to real industrial problems quickly to generate multiple new ideas, which should be examined later for real implementation. Sickafus put less emphasis on inventions than on multiple practically-useful solutions.

(f) USIT is designed to be a method of guiding the process of problem solving and enhancing engineers' ability of problem analysis and idea generation. USIT, in contrast to TRIZ, does not depend on handbook-type knowledge bases and software tools. USIT assumes that engineers are already trained to have a lot of speciality knowledge but need to be enhanced in their flexibility in thinking.

(g) Sickafus' 3-day USIT training seminar was intensive and effective. On the first day he gave an overview lecture and made small textbook practices. On the second day the 10 participants coming from various organizations made group practices to solve four brought-in real problems in parallel. On the third day they solved other four problems by using the Particles Method.

2.2 Activities for Introducing USIT into Japan

Since 1999 I introduced USIT in Japan by giving lectures and by making group practices in 3-day Training Seminars, first in in-house situations and later in open multi-company situations as well. In the 3-day training, a lecture was given in the morning of the first day, and then group practices were made for 2 days and half to solve three (or four) brought-in real problems in parallel. Handling multiple problems is tough in a sense but good to learn effectiveness and natural variation in applying USIT to different problems.

Most participants of these initial training seminars were pioneering engineers who studied TRIZ already and were participating at the Users Study Group organized by

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[1] My interests in USIT was first triggered by a case study paper by Ford Motor Co. published in the TRIZ Journal, Dec. 1997. Then I listened Ed Sickafus' presentation on his USIT practices at First International Conference in TRIZ in Nov. 1998. I read his USIT textbook and then met him again at the First TRIZCON in Mar. 1999. Just after TRIZCON99, I attended at Sickafus' 3-day USIT Training Seminar held for the first time outside Ford.

Mitsubishi Research Institute. Some of them started their USIT activities in their companies: they include Yuji Mihara and Hideaki Kosha in Fuji Photo Film Co., Shigeru Kasuya in Fuji Xerox Co., etc.

The most important findings for us in this stage is that we should not try to promote TRIZ hastily without understanding its essence well enough. The predominant strategy for introducing TRIZ in late 90s in the World was, so to speak, the combination of 'Orthodox TRIZ already established in Russia', 'Convenient software tools implemented in USA', and 'Total Quality Control movement proved successful in Japan'. We realized the danger in following these slogans.

We needed to understand TRIZ more deeply to the level to make it easier to learn and apply, we needed to have the capability of solving problems by using our own brains instead of software tools, and we should better promote TRIZ steadily on the grass-root basis. With these understandings, I proposed the 'Slow-but-steady Strategy' of promoting TRIZ in Japan, in October 1999. The understanding of USIT formed a solid basis of this strategy.

The experiences in Japan under the 'Slow-but-Steady Strategy' was reported in my papers [9, 10]. This strategy formed one of the pillars of the TRIZ promotion in Japan and became the origin of the Japan's unique features of TRIZ acceptance.

3. Reorganizing TRIZ Solution Generation Methods into the System of USIT Operators

One of the difficulties experienced by many USIT users, including myself, in the initial period was how to use the solution generation methods. Even though Sickafus showed various examples in his textbooks, his description is logical in some places but mostly intuitive in many other places. Because of the nature of idea generation in general, this was unavoidable but yet to be improved some more.

So we wanted to understand Sickafus' methods of solution generation better by linking them with various methods in TRIZ. Hideaki Kosha first made a look up table between the 40 Principles and USIT's methods. Then Toru Nakagawa worked to decompose all the sub-methods in TRIZ knowledge bases (including 40 Principles, 76 Inventive Standards, and Trends of Evolutions, etc.) and to find the relationship with USIT methods. Thus the USIT methods became very rich containing all the elements of TRIZ solution generation techniques. Then the USIT methods were classified into a hierarchical system [5]. (See Fig. 1.)

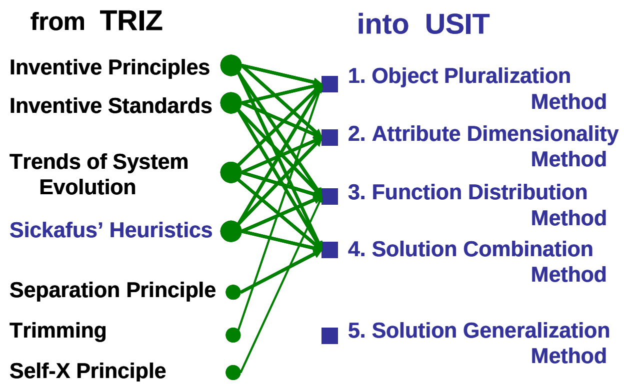

Fig. 1. Reorganizing TRIZ solution generation methods into USIT Operators

The new system, named 'System of USIT Operators', has five principal methods and 32 sub-methods [5]. The five principal USIT Operators are revisions of Sickafus' methods in the following way:

The first three USIT Operators are performed on the Objects, Attributes, and Functions of the present system, respectively; thus they are named Object Pluralization, Attribute Dimensionality, and Function Distribution. The Transduce method was mostly classified into the Function Distribution.

The fourth Operator, Solution Combination, is to be performed on a pair of preliminary solutions. This is a new category and found its significance in the close relationship with TRIZ Separation Principle. The steps of solving Physical Contradictions are explained in TRIZ as (1) separation of contradictory requirements, (2) making two solutions separately to satisfy the two requirements, and then (3) combine the two solutions. We all know that the real breakthrough need to be achieved in the third step. Thus our fourth USIT Operator addresses this step, Solution Combination.

The fifth Operator, Solution Generalization is an extension of Sickafus' Generify. The concept of building a hierarchical system of solutions is explicitly introduced here.

Under these five principal USIT Operators, all the elements of solution generation methods coming from TRIZ and from Sickafus' Heuristics in USIT [2] are classified into 32 sub-operators.

By example, one of the most frequently used USIT sub-operators is (1c) "Divide the Object (into 1/2, 1/3, ..., 1/∞)".   You may recall TRIZ Principle 1: Segmentation. The guideline of this USIT sub-operator is given as "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." This guideline was derived by unifying the essence of four TRIZ Principles: 1. Segmentation, 2. Taking away, 3. Local quality, and 15. Dynamicity.

The usage of the USIT Operators was demonstrated in various case studies, like 'Picture Hanging-Kit Problem'. Fig. 2 [11] shows one of Sickafus' solution, where the string is adjusted at the smooth part of the nail and then set to hold at the rough part of the nail. This solution can be interpreted in five different ways of applying USIT Operators, as shown in the figure. Such redundancy is typical in the usage of USIT Operators and is useful for generating many good ideas.

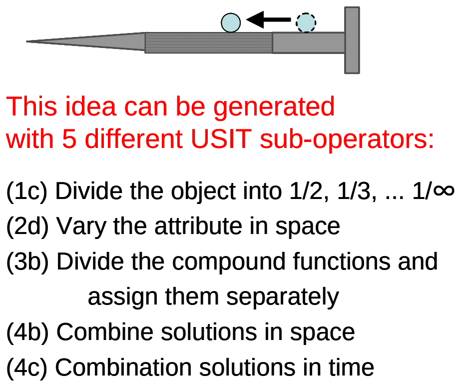

Fig. 2. Sickafus' nail for a picture hanging kit

The whole procedure of USIT is shown in a Flowchart in Fig. 3 [6].

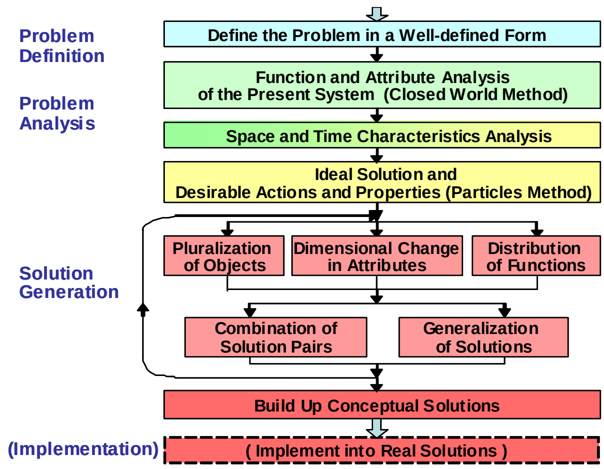

Fig. 3. Flowchart of the USIT procedure

As mentioned in Section 1, in the mean while, we have learned TRIZ step by step especially by translating textbooks written by Salamatov [3] and by Mann [4] into Japanese, and also by applying TRIZ/USIT to various problems for ourselves On such a basis, since January 2003, I changed the 'Slow-but-Steady Strategy' into 'Steady Strategy' of promoting TRIZ. At this stage we felt confidence in our understanding of TRIZ and in our general capability of applying TRIZ/USIT to industrial problems successfully [12].

4. Six-Box Scheme of the USIT Procedure

Another, even more important extension of USIT was achieved when I tried to draw the whole USIT procedure in the style of Data Flow Diagram (DFD). DFD is a well known concept in computer science. Any (information) process may be drawn in DFD, by specifying the boxes representing the information used/obtained in the input and output and at every intermediate step; whereas the processing itself is just shown by the arrows (with names) connecting the boxes. DFD specifies the required/used/obtained information without describing how they are actually transformed. The well known 'Four-Box Scheme' of problem solving with abstraction is also an example of DFD representation.

4.1 The Six-Box Scheme

I obtained the six-box DFD representation of the whole USIT procedure in 2004 [11, 6], as shown in Fig. 4.

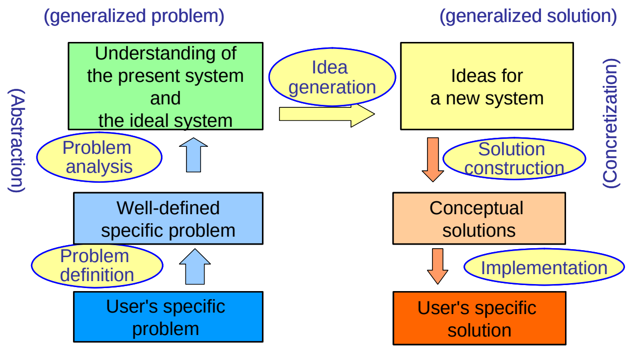

Fig. 4. Six-Box Scheme of Creative Problem Solving

The first box is the starting situation of the problem, while the second box declares the 'User's Well-formed Problem' as defined by Sickafus [2]. At the lower right, the fifth box is the 'Conceptual Solution' as the final result of USIT procedure according to Sickafus, and then the Sixth box represents the final result implemented in the industrial products/processes etc. Thus, the four boxes at the bottom half of Fig. 4 reflect the basic idea of USIT by Sickafus; whereas the upper four boxes, i.e. Boxes 2 to 4, are new in this scheme.

In the top-left, Third box, I put the wording of 'Understanding of the Present System and the Ideal System'. In USIT, the present system is understood in terms of the basic concepts of Objects-Attributes-Functions as well as Space and Time. We may say we are trying to understand the mechanism, or cause-effect relationships, of the present system/problem on the basis of these five key concepts.

Putting 'Understanding of the Ideal System' also in this top-left box together is a seemingly minor but significant point in this scheme. This claims that understanding the

Ideal System, or target of the problem solving, need to be obtained in this position of procedure. The flowchart in Fig. 3 instructs to analyze the present system and then the ideal system in sequence. One should remind that in the early days USIT was taught to analyze either or both of the present and ideal systems (i.e., not always both of them).

In the top-right, Fourth box, I selected the wording of 'Ideas of a New System'. An idea in this sense may be a small, fragmental idea to change a part of the present system. This is NOT a 'hint' in the conventional analogical thinking, but may be the essence of a hint whose effective use is already found. The idea at this stage is not a solution yet but a core idea around which the user tries to derive a conceptual solution. For building up conceptual solutions from a core idea, one needs the capability of the relevant field of engineering more than the ability of applying the USIT methodology.

4.2 Performing with the Six-Box Scheme

Now let us check again how we can convert (or process) the information from one box to another in this Six-Box Scheme.

From Box 1 to Box 2 is the Problem definition. Discussion in the project team is usually performed for this purpose, where general capability and decision criteria in business and engineering are required.

From Box 2 to Box 3 is the Problem analysis stage, for which USIT can give detailed instructions as already thoroughly discussed in the previous sections.

From Box 3 to Box 4 is the stage of Idea generation. The USIT Operators [5] described in the preceding section can be operated repeatedly on various components in the system (i.e., objects, attributes, functions, solution pairs, and solutions).

Describing the process more closely, one applies USIT sub-operator (for instance, Sub-operator (1c) mentioned above) onto a component (for instance a nail in the Picture Hanging Kit) and follow the guideline to derive an idea (e.g., to divide the nail into two parts and change the smoothness of the surface) and try to find an effective way of using the idea (e.g., to adjust the string at the smooth part and then to hold the string at the rough part). Such operations can generate a large number of ideas, and hence the essence of this stage is to find the effective ways of using such ideas generated.

The above description of applying USIT Operators is somewhat formal and theoretical. In practice and in reality, users can obtain a lot of ideas during the process of Problem Analysis, especially through the Particles Method, and during the discussion of idea generation. Students of USIT training seminars often complain that they have obtained a large number of ideas without explicitly using USIT Operators. This situation may reflect the factors that mastering USIT Operators takes time, that the Analysis methods in USIT are effective in stimulating ideas, and that our brains are always active in producing ideas.

From Box 4 to Box 5 is the stage of constructing conceptual solutions around the core idea, where engineering capability plays larger role than the USIT methodological capability. Knowledge bases of scientific/technical principles and cases of patents are most useful in this stage, instead of the idea generation stage (i.e., from Box 3 to Box 4).

From Box 5 to Box 6 is the stage of implementation in engineering and business; USIT has finished its role when it has derived the information in Box 5. In this stage engineering people already know much about Taguchi Methods, CAD/CAE/CAM, designing methods, etc.

5. New Paradigm of Creative Problem Solving

Let us examine the implications of the Six-Box Scheme [6, 13], in comparison with the conventional Four-Box Scheme.

The Four-Box Scheme, shown in Fig. 5, has been regarded as a sophisticated standard way in problem solving [4]. It is advised to think in an abstract model, instead of trying to solve in the concrete problem field. User's specific problem is abstracted into a generalized problem, mostly by mapping onto a chosen model. Then once the generalized problem is solved into generalized solution, it can be used as a hint.

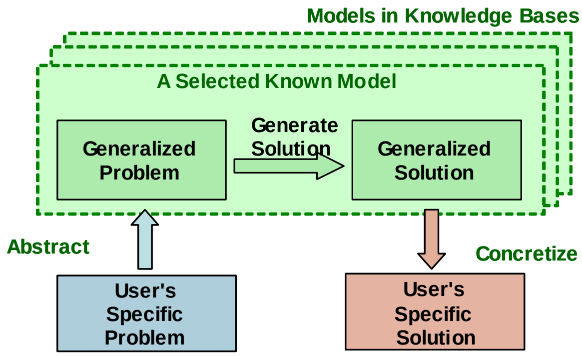

Fig. 5. Fig. 1. The Four-Box Scheme of Problem Solving Supported by Knowledge Bases

On the basis of this scheme, a wide variety of theories and models have been developed in different fields of science and technology. They work well for the problems in each proper specific field of the model. However, in the situations we address in the creative problem solving, the problems are not clear yet to be formulated easily in any field or by any model. Thus, typically in enforced analogical thinking, various models and examples are searched for and tried as the hints for idea generation.

In this context, TRIZ has contributed to establish several big models applicable across different fields of technology. The Contradiction Matrix method with the technical contradiction formulation, the Separation Principle method using the Physical Contradiction formulation, the Su-Field modeling which leads to the Inventive Standards, etc. are such big models. However, each of these big models handles (or abstracts) a limited, different aspect of the problem. Thus, for exploring full aspects of the problem and for finding different new solutions, we need to perform the processes of these big models one after another.

The Six-Box Scheme in USIT, on the other hand, deals with the full aspects of a problem across different fields of technology. The Scheme provides with a standard set of methodological tools for problem definition, problem analysis, and idea generation. And the Scheme also advises how to introduce relevant technological methods in this Scheme.

The essential point in the New Scheme is that the information in Box 3 is obtainable with the standard set of analysis tools and provides the understanding of the present and ideal systems in terms of the standard concepts of Objects-Attributes-Functions, Space-Time, and Desirable behaviours and Desirable properties. Such information does not come from any model outside the problem but comes from the problem itself. Ideas for a new system also arise by applying USIT Operators to the information of Box 3, or even more naturally during the process of deriving the information in Box 3.

With this understanding, Nakagawa has recognized that the Six-Box Scheme in USIT is a 'New Paradigm for Creative Problem Solving' [6, 13]. It has much clearer definition of the Boxes, in comparison to the orthodox Four-Box Scheme, and has a concrete way of performing the scheme, i.e. the USIT procedure.

6. Practices of Applying USIT

USIT (together with TRIZ) has been taught to undergraduate students in Osaka Gakuin University. Several case studies of everyday-life problems were obtained by these students. Such case studies are easy to understand and nice for explaining how to think in TRIZ/USIT [14].

Training Seminars of USIT for engineers have been established with the 2-day agenda as shown in Fig. 6 [14]. The same agenda is applicable to both in-house and open multi-company situations. Three real, brought-in problems are solved in parallel by group practices. Groups of 4 to 7 members, having different technological backgrounds, are desirable. In case of a larger number of participants, two or three subgroups of such a size may work on a same problem in parallel.

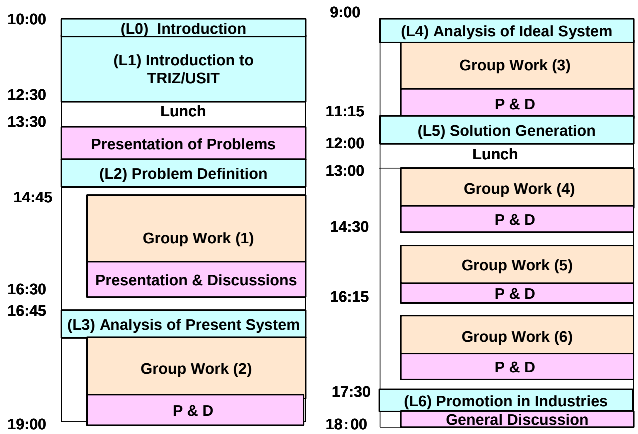

Fig. 6. Agenda of 2-Day UST Training Seminar

This Training Seminar is often done in a situation where most of the participants are engineers relatively new in TRIZ and have no experience of USIT whereas a few have some knowledge of USIT. Overview of TRIZ/USIT is taught first, and the processes of USIT are explained step by step in the short lecture of each stage.

For almost all participants including the Instructor, the real problems handled in the seminar are new. It is apparent that the Instructor can not involve so much in the group practices and did not have new solutions beforehand. Hence the participants know that the results of the seminar are obtained mostly by their own group work guided through by the methodology. They have the feeling that they have actually solved the problem by themselves.

For these 9 years Nakagawa conducted 35 USIT Training Seminars (for 3 days initially and for 2 days later) so far, including 14 open multi-company seminars and 21 in-house seminars (in 8 different companies). Besides these seminars, I wrote various articles and papers on USIT and gave presentations at conferences and lectures in various opportunities. All of these open activities and their presentation documents are posted in my Web site in Japanese and/or in English [7].

TRIZ users in Japan (other than myself) have posted 24 USIT-specialized articles in my Web site so far [7]. Most of them were originally presented either at the Japan IM Users Group Meeting (2001-2003) or at the TRIZ Symposium in Japan (2005-2007). Fuji Film, Fuji Xerox, Ricoh, Nissan Motor Co., Matsushita Electric Works, Konica-Minolta, and Sekisui Chemical Industries, are the companies which actively worked/are working with USIT.

It is interesting that in these companies the leaders who introduce USIT are trying to make their own training documents with their in-house case studies. Typical way of their USIT promotion is to arrange problem solving meetings/workshops for the engineering group and USIT promotion core members together. This style of activity matches with the USIT philosophy that the USIT expert should not be considered as a contract-based almighty inventor but rather as a methodical supporter of engineers in their problem solving thinking process [13]. Almost all the companies mentioned above have the experiences of introducing a few different styles of TRIZ and then the weight of USIT has gradually increased among them. They are mostly working in the grass-root style with some support by their organizations.

As shown in the 2-day training seminars (see Fig. 6), USIT is much easier and quicker in learning and mastering in comparison with TRIZ. The whole procedure of USIT can be taught in somewhat logical way and also by using various case studies.

A network-based study group, named USIT/TRIZ Study Group, has been organized by MPUF (Microsoft Project Users Form) a year ago and has made active voluntary off-line meetings in Tokyo [7]. This group seems growing to be a forum of new and experienced people interested in USIT.

7. Conclusion

USIT has been introduced into Japan since 1999 and has been well accepted as an easy and unified process for problem solving in industries. USIT has been extended further in Japan. All the solution generation methods in TRIZ have been reorganized into the system of USIT Operators. The data flow diagram representation of USIT has revealed the Six-Box Scheme, which is recognized as a New Paradigm for Creative Problem Solving, overcoming the shortage of the well known Four-Box Scheme. Based on these methodological refinement, USIT has been used in various industries in Japan and has been extending steadily to form one principal practice in applying TRIZ. USIT is an easy and unified process of problem solving as a next generation of TRIZ, and also gives us a new paradigm for creative problem solving.

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