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USIT: A Concise Process for Creative Problem Solving Based on the Paradigm of 'Six-Box Scheme' -- USIT Manual and USIT Case Studies --

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Abstract

USIT (Unified Structured Inventive Thinking) was originally developed by Ed Sickafus in 1985 as a concise whole process of creative problem solving and has been developed further since 1999 in Japan. In 2002 we reorganized all the solution generation methods of TRIZ into a System of USIT Operators. In 2004, I represented the whole USIT process in a data-flow diagram and realized it as a new paradigm for creative problem solving and named it the 'Six-Box Scheme'. In 2012, I realized that what are really wanted by society are not individual methods but a more general way of thinking for creative problem solving. So I am proposing to integrate different methods of problem solving into a unified general methodology CrePS on the basis of the 'Six-Box Scheme'. Hence, USIT is now regarded as a simple process for executing the CrePS methodology.

In the present paper, the USIT Manual was prepared and more than10 published cases of creative problem solving have been documented along the 'Six-Box Scheme'. The present paper discusses about (1) the Six-Box Scheme in comparison with the conventional schemes, (2) possibility of integrating diverse methods of creativity and innovation into CrePS, (3) overall process of USIT, especially how to support the idea generation step, (4) documenting various case studies executed with other methods in the USIT Six-Box Scheme, (5) further issues and tasks for pursuing the new vision/target of establishing CrePS. .

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Keywords: USIT; Creative problem solving; Six-Box Scheme; CrePS; Case studies

1. Introduction

USIT (Unified Structured Inventive Thinking) was originally developed by Ed Sickafus in 1985* as a concise, consistent process of creative problem solving [1, 2] and has been developed further in Japan by the present author. USIT history in Japan can be characterized by the following four stages:

Nomenclature	
TRIZ	Theory of Inventive Problem Solving
USIT	Unified Structured Inventive Thinking
CrePS	General Methodology of Creative Problem Solving /Task Achieving

* The year of USIT development (at that time called SIT) was written as 1995 in Sickafus (1999) [2]. But Sickafus writes in a recent communication: “the 1999 paper is a typo. I began studying the Israeli SIT in 1985 and later that year began teaching a modified version of it in Ford Research Laboratory. That program continued until my retirement in 2000.”

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(1) The present author introduced TRIZ into Japan since 1997 and also USIT since 1999, and tried to improve them further. Initially, we regarded USIT as a 'Simplified TRIZ' and used it as the key method of the 'Slow but Steady Strategy of Introducing TRIZ into Japan' [3] in contrast to the 'Rapid and Drastic Strategy' which was prevailing at that time in the world.

(2) In 2002 we reorganized all the solution generation methods of TRIZ and USIT. All TRIZ tools (e.g., 40 Inventive Principles, 76 Inventive Standards, Trends of Evolution of Technical Systems, etc.) were once decomposed into individual suggestions and then rebuilt into a System of USIT Operators, which are composed of 5 main Operators having 32 sub-operators [4]. Then we regarded USIT as 'A simplified, unified, next-generation TRIZ'.

(3) In 2004, the author represented the whole USIT process in a data-flow diagram (in place of a flow-chart) having 6 boxes, and realized it as a new paradigm for creative problem solving and named it the 'Six-Box Scheme' [5, 6]. This finding gave a solid basis for applying USIT in various areas.

(4) In 2012, while considering about the future directions for us to proliferate TRIZ widely and deeply, the author realized that what are really wanted by society are not individual methods like TRIZ, USIT, etc. but a more general way of thinking for creative problem solving and the methods supporting it. And he called it CrePS ('General Methodology of Creative Problem-Solving and Task-Achieving'). He also found that the 'Six-Box Scheme' can form the common basic paradigm of the general methodology CrePS and can integrate and unify different methods of problem solving, including TRIZ, USIT, and many others, in a systematic way [7]. And hence, USIT is now regarded as a simple process for performing the CrePS methodology.

In the present paper, the USIT Manual [8] was prepared to illustrate the typical ways of performing the USIT process. And more than 10 published cases of applying creative problem solving have been documented along the 'Six-Box Scheme' in detail, and they form 'A Collection of USIT Case Studies' [9]. The case studies show the common nature of the main steps of the whole process and the effectiveness of the 'Six-Box Scheme' as the basic paradigm.

The present paper first describes the basic concepts of the Six-Box Scheme (of CrePS and USIT) in comparison with the conventional 'Four-Box Scheme' used in standard science and technologies and in TRIZ and other creativity methods. The necessity of a certain framework is shown for integrating/unifying a large variety of approaches in creative problem solving and innovation and the possibility of such integration/unification is demonstrated on the basis of the Six-Box Scheme.

Then the present paper illustrates the USIT process by using some of the case studies as summarized in the overview of the Six-Box Scheme. The process of idea generation for obtaining a variety of ideas for the new system (Box 4) on the bases of information of understanding the present system and the ideal system (Box3) is especially illustrated by using the USIT Manual.

Finally, future tasks for establishing the CrePS methodology and the USIT process are discussed in the conclusion.

2. The Six-Box Scheme as a new paradigm of creative problem solving

2.1. What is the Six-Box Scheme

The Six-Box Scheme [6, 7] is a framework representation of the general process of solving problems and achieving tasks creatively. It is defined by the dataflow representation, shown in Fig. 1.

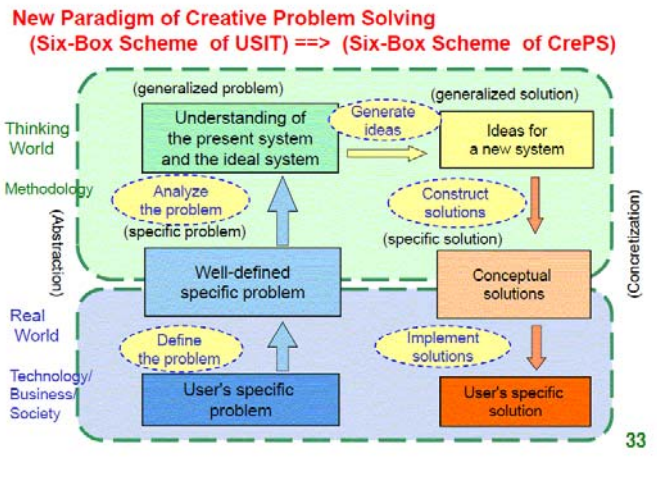

Fig. 1 Six-Box Scheme as the new paradigm of creative problem solving (CrePS/USIT) [6]

It is fundamentally characterized by the six boxes, which represent the information to be obtained at the specified stages of the procedure. The arrows stand for the process for obtaining the information requested for the next box, on the basis of mainly the information of the previous boxes and also of various other background knowledge relevant or even seemingly-irrelevant to the subject matter. The arrows show the main stream; it is natural in practice to have side streams for shortcuts, multiple paths, going back, loops, spiral motion, etc.

Distinguishing the Thinking World (i.e., four boxes in the upper half) from the Real World (i.e., four boxes in the bottom half) is an important concept introduced in this scheme. Problems start with the recognition in the Real World and should finish as concrete solutions implemented in the Real World, where the decision criteria need to reflect the value concepts and the actual situations of society, business, technology, etc.

On the other hand, the process of analyzing the problem and generating good and effective solutions should better be carried out in the Thinking World, where free, wide-scope, and creative way of thinking is encouraged and guided with some methodology. This is a general consensus in practice and in theory of pursuing creative problem solving. At the interface of the two Worlds, Box 2 and Box 5 show the information to be handed-on between the two World.

In the Real World, where problem solving starts, there are a large variety of activities, jobs, stakeholders, products, etc. are running in parallel. Specific problems are recognized first in the Real World and then need to be defined well (i.e., sorted out, examined, selected, focused, stated, etc.) to be solved, and is handed-on to problem solving projects.

In the Thinking World, the specific problem should first be confirmed in the problem/task statement, problem situations, and the request from the parent project in the Real World. Then the problem should be analyzed to understand the present system and to understand the ideal system. Such understanding should be done in various aspects including time and space characteristics, objects - attributes - functions, root causes, mechanisms, etc. The analysis can be guided by some problem solving method, but the information source must be the knowledge of the real problem and real situations. Getting images of the ideal system is also crucial at this stage for generating good solutions later.

Then in Box 4 various ideas for a new system are to be obtained . They are, exceeding simple hints in other systems for suggestion, some basic ideas, e.g., to change or introduce a core component/function for a new system. For generating these ideas various methods, such as check lists, hints, guidelines, principles, operators, etc. may be used. However, during the previous process of obtaining thorough understanding of the present and ideal systems, our brain usually work actively to think of various ideas smoothly. Thus a large number of ideas are to be listed and organized in a hierarchical system.

Around some core ideas, conceptual solutions (Box 5) should be constructed . In this stage, capability and knowledge in the subject matter are necessary even more than the methodological capability, in order to build up effective and creative conceptual solutions.

Conceptual solutions (Box 5) are the final results of the problem solving in the Thinking World , and yet just the start to implement into real products/services/processes in the Real World. For the implementation, various processes such as prototyping, secondary problem solving, experiments, CAE, designing, manufacturing, marketing, etc. are necessary and should be carried out with the full power of the industry, etc.

2.2. Conventional Four-Box Scheme

Science and technology in general conventionally use the Four-Box Scheme (Fig. 2) as their basic paradigm.

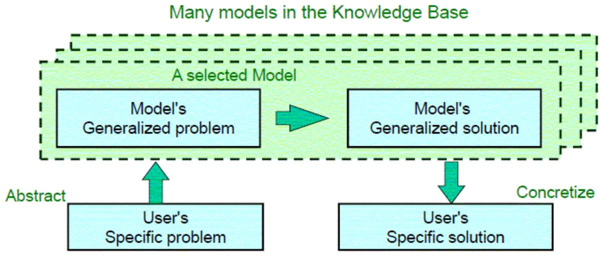

Fig. 2. Four-Box Scheme of conventional science and technology

This is the typical scheme we learn especially in mathematics since our school days. Various theories and models have been built and used in every discipline of science and technology. They work effectively for typical problems in each discipline.

However, in the cases of problems requiring new, creative solutions, it is often not clear which models are effective to use and actually missing. This situation occurs because how to abstract the specific problem into generalized problem differs much depending on the individual models. In other words, there exists no way to explain generally, or independently of the models, how to abstract your problem to find generalized problem.

2.3. Contributions of TRIZ and their limitation

TRIZ [10, 11] originally developed by Genrikh S. Altshuller and his followers has contributed much in this situation. It established several important models which are widely applicable across various fields in technology (and some more) by using huge and well-organized knowledge bases compiled with world patents and other scientific and technological documents. Principal TRIZ methods/tools are based on the Four-Box Scheme as illustrated in Fig. 3 [7].

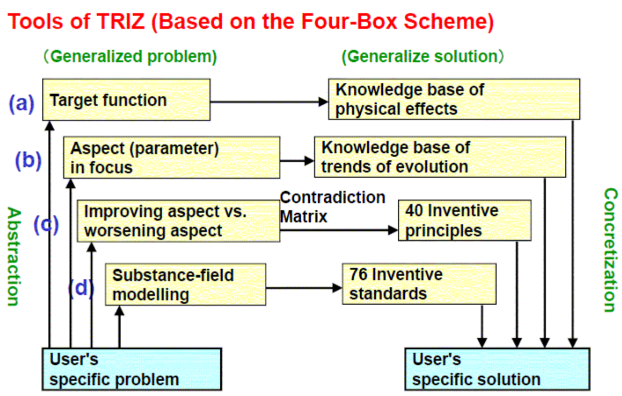

Fig. 3. Principal TRIZ tools, each based on the Four-Box Scheme with big knowledge bases

These TRIZ tools have a common structure where user's problem is to be abstracted in a tool-specific viewpoint, as shown in the upper-left boxes, and then by consulting the knowledge bases a few pre-installed 'generalized solutions' are shown to the user. This means that the problem solvers need to be assisted by a handbook, a software tool, or an expert having the (big) knowledge base, and that the 'generalized solutions' are selected among the pre-installed ones and are suggested to the user just as possible hints. Thus in the concretization process in Fig. 3, the user should find some ideas for a new system from the hints and has to further construct conceptual solutions.

Multiple tools having big knowledge bases exist in parallel in TRIZ. This is the strength of TRIZ, of course. However, the viewpoint in the abstract stage of each tool is partial and limited in the scope. Therefore multiple tools become necessary to use for solving (difficult) problems thoroughly. Thus the overall procedures of solving problems in TRIZ are heavy and complicated (like in ARIZ [11]), and are actually proposed and practiced in different ways by different TRIZ experts.

Some more limitations of TRIZ methodology (Fig. 3) can be understood clearly in the eyes of the new paradigm 'Six-Box Scheme' (Fig. 1).

- TRIZ does not distinguish Thinking World and Real World, causing unclear start of the problem solving and weakness in constructing effective conceptual solutions and in implementing them in the real world.
- Understanding/analysis of the problem in TRIZ is fragmental in each tool and not well integrated among the tools.
- 'Generalized solutions' are suggested by TRIZ tools just as hints, and the process of concretization is not guided.
- No main stream of overall process and no clear explanation of the information required at every stage of the process.

3. Possibility of integrating diverse methods of creativity and innovation

3.1. Requirements of proliferation by the society

For us, those who have encountered TRIZ and realized its tremendous possibility, it has been an eager hope of establishing TRIZ further as an effective methodology for solving various problems creatively and proliferating it widely. The actual progress of proliferation of TRIZ, however, has been much slower and limited than our expectations. In 2012, I was drawing the expected fields and themes of TRIZ applications, e.g., in industries, in government and public sectors, in academia and universities, in education, at home , in society, in mass media, etc. Then I realized that the people in all these areas of application do not want individual methods like TRIZ; they really demand some general methodology for creative problem applicable and effective in various areas. It should be a general methodology to be established newly at a level or two higher in the hierarchy of methodologies. I named the target methodology as CrePS (General methodology of creative problem solving/task achieving) [7].

The new target/vision is stated as [7]:

"To establish a general methodology of creative problem-solving / task-achieving, to spread it widely, and to apply it to problem-solving and task-achieving jobs in various domains in the whole country (and the world)"

3.2. Diversity of methods for creativity and innovation

Darrell Mann is the pioneer who recognized the necessity of integrating a diversity of methods and promoting a more general methodology, in the name of 'Systematic Innovation' [12]. He and his group have been surveying a wide range of methods, which are listed in one of his slides shown in Fig. 4. [13]

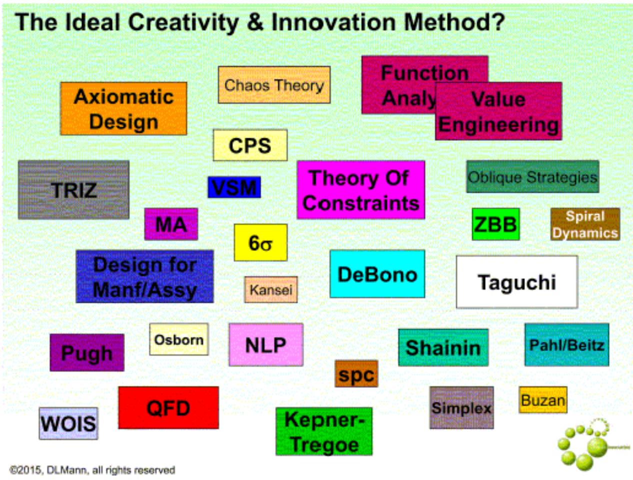

Fig. 4. A diversity of Creativity and Innovation methods (Darrell Mann [13])

He has a vision of using these various methods effectively at their strong places in response to the demands of individual problems. This approach is the same when he says "there are many TRIZ tools (e.g., 22 chapters in his textbook [12]) and you should just learn and use them one by one when you find it necessary". Such a selective use of many big tools, without simplification/unification, is obviously too much for engineers, scientists, business persons, etc. who are facing with real problems.

3.3. Classifying various approaches of component methods

As a preparation for integrating such diverse and big methods, we should better decompose them into their component methods and classify them according to their types of approaches and intentions. A preliminary table of such component methods is shown in the following [7].

It is noticed that big methods are composed of various sub-methods and those sub-methods are largely overlapped with one another having some differences in detail and that many methods have their emphases in some aspects in this table and often intend to make shortcuts in the problem solving process. The current situations of the methodologies for creative problem solving (including creativity and innovation methodologies) are apparently unorganized and unnecessarily competing with one another, thus failing in contributing well to the society.

Table 1. Various methods for creative problem solving, decomposed and classified in their approaches [7]

Various methods for creative problem solving & task achieving

Approaches	Examples in conventional methods	Examples in TRIZ/USIT
Basics in Science & Technology	Principles, theories & models in each discipline; knowledge bases	Knowledge bases of physical effects
Learning from cases	Analogical thinking, Collections of hints, Equivalent transformation thinking	Active use of patent databases
Analyzing problems/ tasks	Mind mapping, KJ method (Affinity method), Quality function deployment (QFD), QC tools, Root cause analysis, Value engineering (VE), Functional analysis	Problem definition, Root cause analysis, Function & attribute analysis, Formulating contradictions, Substance-field modeling
Supporting idea generation	Brain storming, Brain writing, SCAMPER	40 Inventive Principles, 76 Inventive standards, Contradiction matrix, USIT operators
Taking care of environment and mental aspects	Brain storming, Facilitation methods, Cynectics, NM method, 'The 3rd alternatives'	Size-Time-Cost (STC) operators, Smart little people (SLP) modeling, Particles method
Realizing the ideas	Design methods in each discipline, Pugh's method, CAD/CAE, Taguchi method	Technical knowledge bases
Foreseeing the future	Using various statistics, Delphi method, Scenario writing	9 Windows method, Trends of technical evolution, S-curve analysis, DE (Directed evolution)
Towards a general methodology	Four -box scheme of abstraction, analogical thinking, ET thinking	Four-box scheme, ARIZ, Six-box scheme of USIT

The main reason for the divergence of methods, as shown in Fig. 4, and for the unorganized competing situations of the sub-methods, as shown in Table 1, is the defect/weakness of the conventional paradigm, the Four-Box Scheme, I believe. Introduction of the Six-Box Scheme as the new paradigm of creative problem solving (CrePS) will certainly serve for re-organizing these diverse methodologies and their numerous sub-methods [7].

3.4. Positioning the Six-Box Scheme in the Real World

The Six-Box Scheme shown in Fig. 1 says that the process of actual problem solving should start and finish in the Real World which contains the problem. We meet various problems and we want to solve them in the real situations, which differ widely in case by case. It is not theoretically sound if we assume such real situations belong to individually-specific Real Worlds. We should rather think of a number of different types of Real World corresponding to the areas where we want to apply. For example, in the case of industrial applications, we should consider a Real World where typical industrial activities are taking place, as shown in Fig. 5 [14].

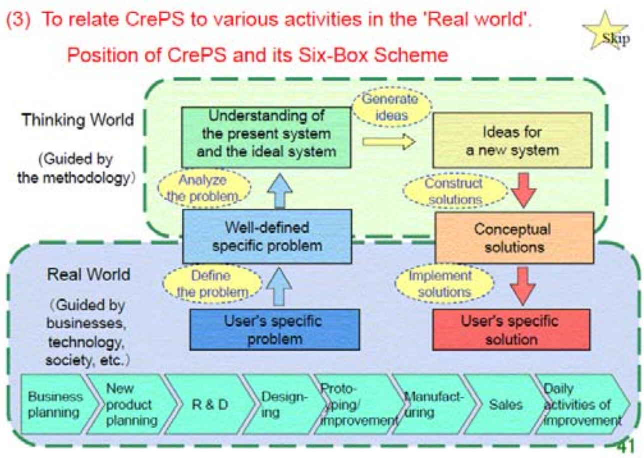

Fig. 5. The Six-Box Scheme placed in the Real World, e.g., an industrial world. [14]

It is important that the problem solving process (Box 2 through Box 5) in the Thinking World is more universal and less dependent on the problem types in the Real World. The USIT process, as illustrated in detail in the next section, is a concise process for such a general purpose problem solving in the Thinking World.

The step of solution implementation (from Box 5 to Box 6) should be carried out again in the Real World (of industrial application in the present case), and need to be adjusted well to different types of problems and solutions.

4. The USIT process -- its overview

4.1. Overall view of the USIT process

The overall process of USIT is illustrated in Fig. 6 [7, 8].

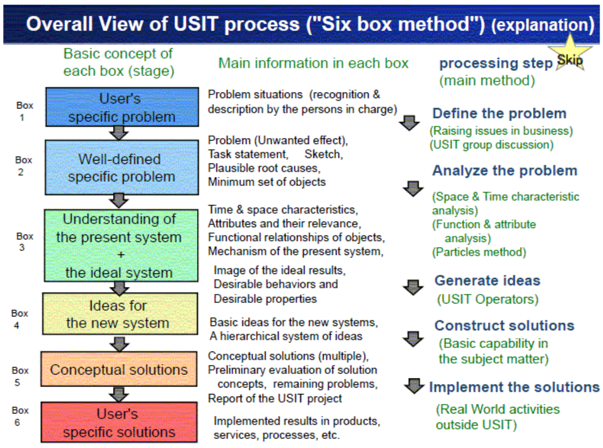

Fig. 6. Overall process of USIT. Basic concepts of the six boxes, main information in each box, and processing steps. [7]

The left column in Fig. 6 shows the six boxes along the main stream of the Six-Box Scheme, while the middle column describes the main information to be obtained in each box in the USIT process. The right column lists the processing steps and their main methods used in USIT. It should be noted that the information in the boxes and the methods in steps are typically used in their standard USIT ways for various types of problems, while allowing minor adjustment depending on the problems [8].

4.2. Problem definition step

The problem definition (from Box 1 to Box 2) in the Six-Box Scheme should be carried out in the Real World; but in practice of USIT the team in the Thinking World should actually trace the problem definition step and confirm the well-defined specific problem. In Box 2, USIT simply requests the following information: an unwanted effect (a statement of 1 or 2 lines), a task statement, a simple sketch of the problem, plausible root causes, and a minimum set of objects relevant to the problem. Group discussion in the team is the usual way of deriving these information.

4.3. Problem analysis step (A) Understanding the present system

USIT uses the basic concepts of Objects (i.e., components of the system), Attributes (i.e., category of properties of Objects), and Functions (i.e., action of one object onto another), besides time and space, for analyzing the system [1, 8]. Analysis of the system in time and space characteristics is always carried out in this step, and it sometimes reveals the (physical) contradictions in the requirements of the system. Attribute analysis is to list up relevant attributes of all the objects and examine them whether they enhance or suppress the unwanted effect with the increase of the attribute values. Functional analysis requests to draw the functional relationships among the objects, primarily to reveal the intention of the original design and then the mechanism of the problem. These analysis reveal the mechanism of the present system and root causes of the problem.

4.4. Problem analysis step (B) Understanding the ideal system

Getting the image of ideal system at this step is mandatory in USIT. When a physical contradiction is found in the previous sub-step, the ideal system is set as the combination of partial solutions satisfying the contradictory requirements separately [10]. In other cases, the user is requested to imagine and draw a sketch of the ideal results without mentioning any means to achieve them. USIT uses Sickafus' Particles Method [1], a revised version of Altshuller' SLP.

4.5. Idea generation step and USIT Operators

By virtue of the full understanding of both the present system and the ideal system, a large variety of ideas usually come to mind smoothly in USIT. In addition, USIT has a system of USIT Operators which can help users generate many ideas systematically. The USIT Operators were obtained by reorganizing all the TRIZ solution generation methods in the scheme as shown in Fig. 7 [4]. The full descriptions of the USIT Operator system are posted in the Web site "TRIZ Home Page in Japan", containing 3 versions of detail level (i.e., simple, standard, and extended versions) and bi-directional cross references between TRIZ tools and the USIT Operators. [15] The five main USIT Operators are applicable respectively onto objects, attributes, functions, pairs of solutions, and solutions. Examples of their applications will be illustrated later in the description of USIT Manual (see Section 6.). It should be noted that the ideas generated are generalized individually and organized in a hierarchical system of ideas in this step; it is an example of systematic approach in USIT by use of its solution generalization Operator (shown at the bottom-right in Fig. 7).

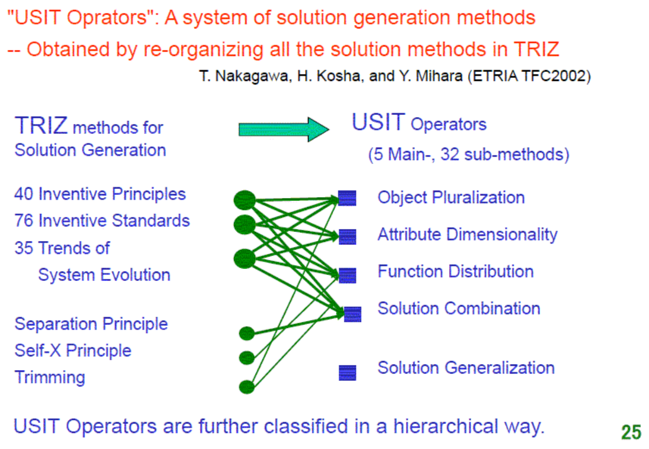

Fig. 7. Reorganizing TRIZ solution generation methods into a system of USIT Operators [4]

4.6. Constructing conceptual solutions

Selecting some ideas among the ones generated, the team goes ahead to construct conceptual solutions, which are supposed to work effectively solving the original problems. In this step the capability of the team in the subject matter is needed and can be enhanced by the support of knowledge bases and experts outside the team. The reports of problem solving and the proposals of the conceptual solutions are the final results of the USIT team who worked in the Thinking World.

4.7. Implementing into real specific solutions

Then the activities of the problem solving return to the Real World. The conceptual solutions are to be examined, tested, prototyped, designed, manufactured, marketed, etc. before they are actually realized as commercial products, services, processes, etc. The implementation step must be directed under the value criteria in the Real World and carried out with all the powers and efforts of the industry, etc., including the use of various methods appropriate for this step. Even though the implementation step is outside the thinking process of USIT, it is most crucial for the success in the actual problem solving.

4.8. Documents of CrePS/USIT and its applications

The concepts and applications of the Six-Box Scheme (in the forms of TRIZ-extended, USIT, CrePS, etc.) have been publicly presented at conferences and posted in Web sites, especially in "TRIZ Home Page in Japan" [16]. Recently, the present author posted a full set of documents of CrePS/USIT in [15], including CrePS/USIT references, USIT manual, USIT case studies, USIT operators, etc. The USIT process is now described in detail in the USIT Manual [8] with the illustration of one case study consistently, and its usage is shown in more than 10 case studies documented in the consistent manner with the USIT Manual. In the next two sections the manual and the case studies are described.

5. USIT Case Studies described in the Six-Box Scheme

5.1. General intention of USIT Case Studies

As is described so far, we are now making efforts for integrating/unifying various creativity & innovation methods into a general methodology of creative problem solving (named CrePS) based on the Six-Box Scheme and for developing some easy and effective processes (e.g., the USIT process for a general purpose) of practicing the methodology. And we want to show its actual usage as the case studies.

We have already published a number of examples of applying the USIT process originally. So we have revised them as USIT case studies in accordance with the process and style of the USIT Manual.

In the world, there are many more excellent case studies of solving problems creatively by use of TRIZ and other methods and published in various places. They are good resources for showing case studies of the general methodology CrePS and its process USIT, I believe, if we review and restructure them in the paradigm of the Six-Box Scheme. So I started to select some case studies which are published by other authors applying different methods, and to review and rewrite them in the form of the USIT Case Studies. This work of rewriting case studies of different methods into the USIT Case Study in the Six Box Scheme is found productive for understanding various methods and for integrating/unifying such methods.

5.2. A Collection of USIT Case Studies

Fig. 8 lists the ten USIT Case Studies described so far both in Japanese and in English [10]. Each case study describes, in about 20 slides, the full procedure of USIT in accordance with the USIT Manual. You can read these case studies in its full length in the Web site, “TRIZ Home Page in Japan”.

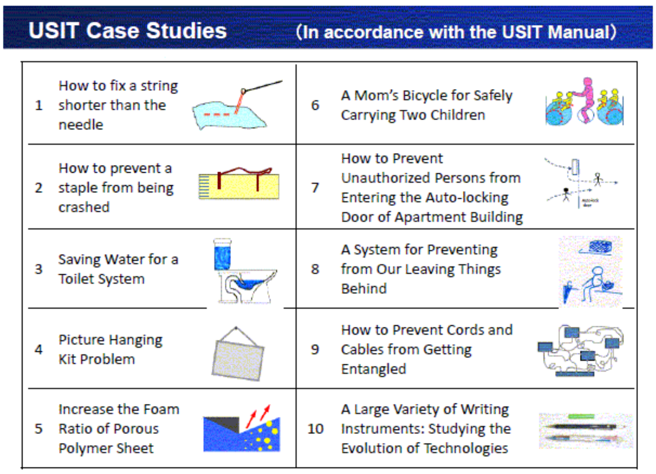

Fig. 8. 10 USIT Case Studies described in accordance to the USIT Manual

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

This case study is based on a thesis work by Tsubasa Shimoda at Osaka Gakuin University applying the USIT standard procedure to a familiar problem. For saving the space of the present paper, only the overview summary slide is shown in Fig. 9. The information obtained in each box is briefly shown with some illustrative sketches.

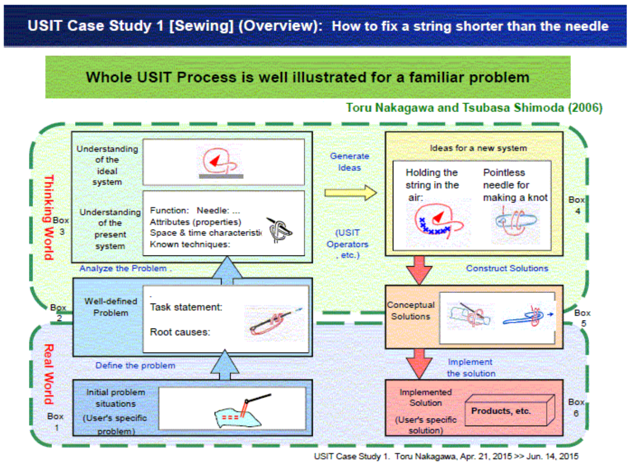

Fig. 9. USIT Case Study 1. Overview summary.

5.4. USIT Case Study 3. Saving Water for a Toilet System

The case study shown in Fig. 10 is a re-written version by the present author on the basis of problem solving with TRIZ by H.S. Lee and K.W. Lee [17]. Conventional toilet system demands much water for flushing. The Korean authors found the S-shape pipe behind the basin is the root cause of the problem, and they formulated the problem as a case of Physical Contradiction and solved it with the Altshuller’s method of Separation in time.

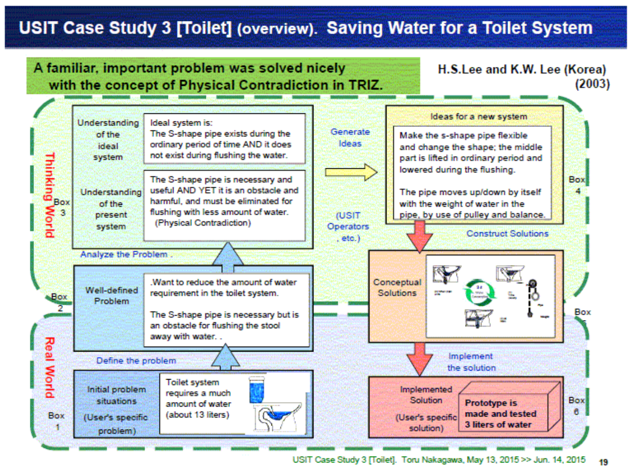

Fig. 10. USIT Case Study 3. A Physical Contradiction was solved with TRIZ by H.S. Lee and K.W. Lee [ ]

In USIT, the problem is recognized as two conflicting demands on the existence/non-existence of the S-shape pipe in the time-characteristic analysis. Then the ideal system is understood that the S-shape pipe exists in the ordinary time AND it does not exist at the time of flushing. Ideas in Box 4 are obtained naturally with the change in the shape of the pipe depending on time (or on usage condition). Then the conceptual solution has been constructed in Box 5.

In this manner, in USIT, the Physical contradiction is recognized smoothly at the early stage in understanding the present system (without any lengthy process, such as ARIZ), and the consideration of the ideal system and the idea generation can smoothly reflect the Altshuller's method of Separation Principle.

5.5. USIT Case Study 4. Picture Hanging Kit Problem

Fig. 11 shows the overview of the standard USIT case study, which was originally described by Ed Sickafus in his USIT textbook [1] and revised many times by the present author. Focus of this case study was how to represent the attribute and functional analysis of the present system and how to generate various effective ideas. Especially the latter issue led us to the research which resulted in the system of USIT Operators [4].

Our rather recent study put more stress on the understanding of this problem as a case of Physical Contradiction as well. The string should move smoothly on the nail while adjusting, but it must not move on the nail once the adjustment has finished. This recognition has guided us to revise the criteria in selecting the conceptual solutions. These points will be shown later in a sample figure of the USIT Manual (Fig. 15).

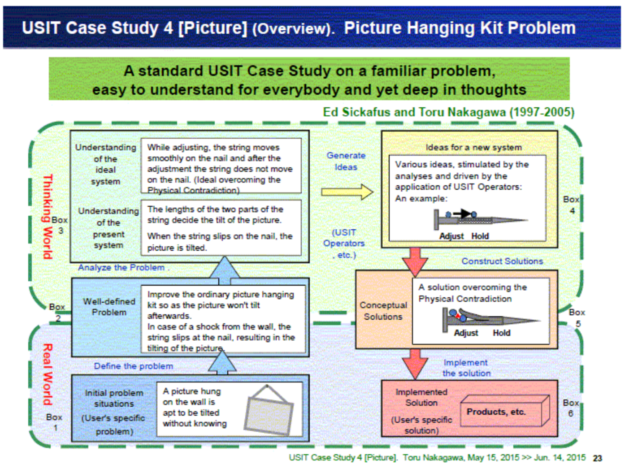

Fig. 11. USIT Case Study 4. Picture Hanging Kit Problem

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

Case Study 5, shown in Fig. 12, handles a real technical problem in chemical engineering. There was a research project of developing the technology for manufacturing porous sheets of polymer, where improving the foam ratio is the focus issue at that time. I addressed this problem at a 3 day USIT training seminar conducted by Ed Sickafus in 1999, and solved it in one day with the use of Particles Method in USIT [18]. Thus this Case Study 5 is a good reference for Particles Method (a revision and extension of Altshuller's SLP (Smart Little People's modeling) and for handling a time-dependent process.

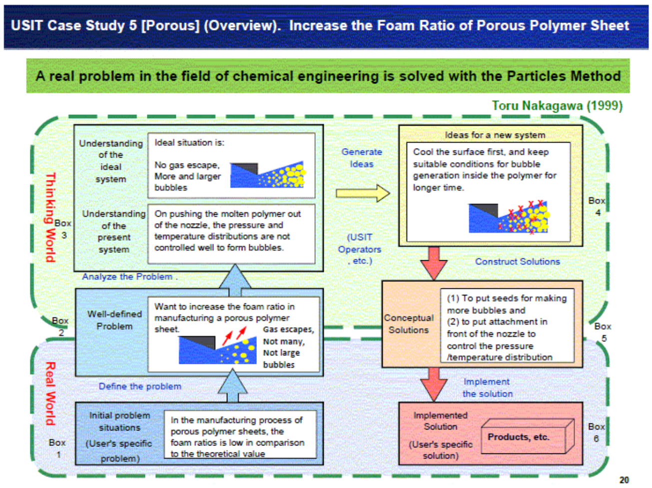

Fig. 12. USIT Case Study 5. Increase the Foam Ratio of Porous Polymer Sheet

6. USIT Manual describing the USIT process in detail

6.1. Instructions to the USIT Process

Instructions to the whole USIT process are described in the USIT Manual [8]. They may be overviewed in the table of contents as shown in Fig. 13. Please note various subsidiary steps which are not mentioned well elsewhere because of the shortage of space.

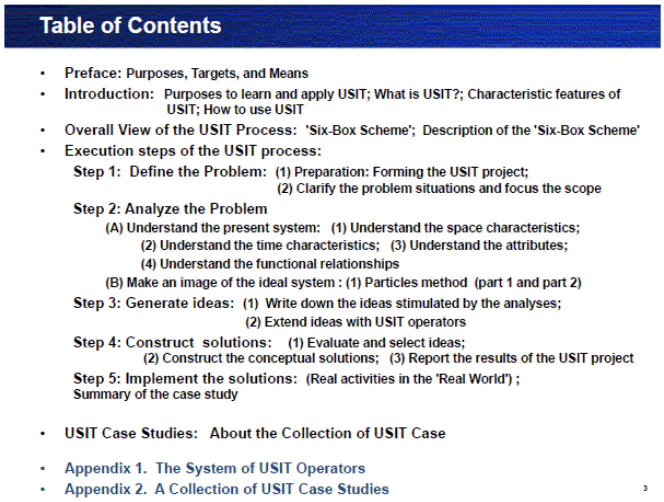

Fig. 13. Table of contents of the USIT Manual

6.2. Instructions for the idea generation step (1)

When I explain about the Six-Box Scheme (Fig. 1) and the USIT process (Fig. 6), people often ask questions about how the idea generation step (i.e., from Box 3 to Box 4 in Fig. 1) is supported in USIT.

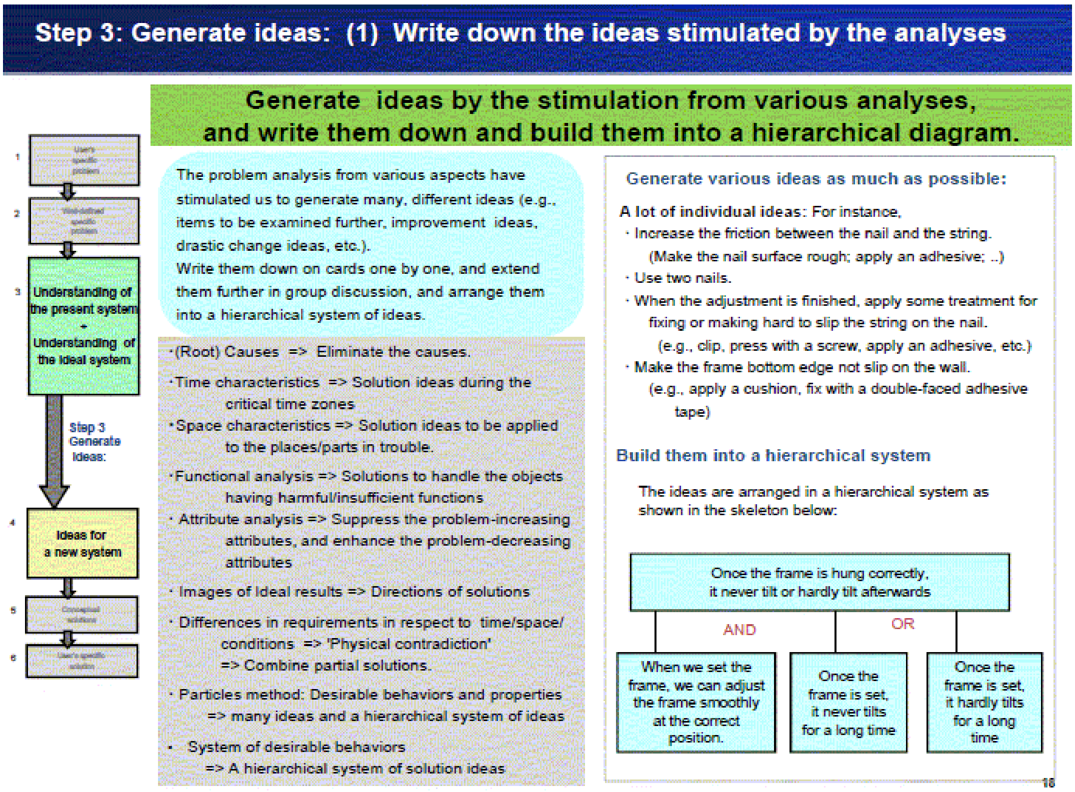

Fig. 14. Instructions for the Idea generation stage (1) Spontaneous idea generat ion based on the understanding of the problem

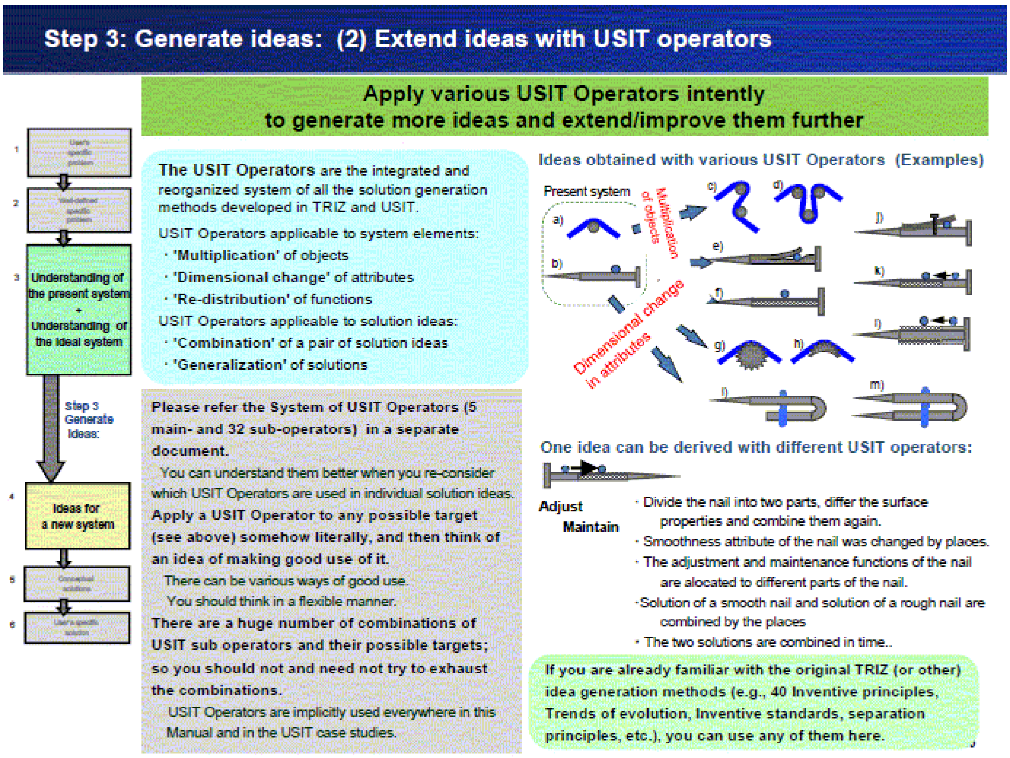

Fig 15. Instructions for the Idea generation stage (2) Extended idea generation by use of USIT Operators

I answer that while we obtain thorough understanding of the present system and of the ideal system (Box 3), our brains are actively working and various ideas usually come up with spontaneously. Fig. 14 shows the instructions at this sub-step, with the illustrations of the standard case study (i.e., USIT Case Study 4: Picture Hanging Kit Problem). You can see that your problem will be fully analyzed from various aspects at the stage of Box 3 and you can rely on your capability as a problem solver you have obtained through your education and training for many years.

6.3. Instructions for idea generation step (2) USIT Operators

For the purpose of generating more ideas systematically, the USIT process has the system of USIT Operators, which were developed by the reorganization/unification of all the TRIZ solution methods (see Fig. 7). For details of the operator system and its usage please refer our paper [4] and documents [15]. Fig. 15 shows the instructions about the USIT Operators and their usage with illustrations.

USIT Operators are more systematized and easier to apply than 40 Inventive Principles, 76 Standard Solutions, etc. in TRIZ. However, if you are well familiar already with such TRIZ principles and solutions, you can of course use them at this sub-step in place of the USIT Operators..

7. Concluding Remarks

7.1. Summary of what are made clear

The present author believes that the following points have been made clear already:

- In the fields of creative problem solving (or creativity & innovation methods), a general methodology (or a super-system methodology) are demanded by society which can integrate and unify a variety of individual methods such as those shown in Fig. 4 (including TRIZ). We call the general methodology as CrePS.
- Science & technology in general and various creativity & innovation methods (including TRIZ) are not effective enough nor systematized well, because the conventional paradigm of the Four-Box Scheme (Fig. 2) does not work well enough for the creative problem solving. A new paradigm is necessary.
- The Six-Box Scheme (Fig. 1) can serve as the new paradigm for creative problem solving. It defines the Thinking World distinguished from the Real World, and guides the whole process of creative problem solving. The main stream of the process is a sequence of steps, i.e., defining the problem, understanding the present and ideal systems, generating ideas for a new system, constructing conceptual solutions, and implementing the specific solutions.
- USIT (Fig. 6) is a concise and consistent process for creative problem solving executing the Six-Box Scheme. It is shown effective and practical for various problems.

7.2. Further issues and tasks in the near future

There exist many more issues to be considered and tasks to be achieved in the near future. They include:

- The vision of CrePS and the new paradigm of Six-Box Scheme should be made clearer and shared widely.
- Case studies of applying various methods of creativity & innovation to different types of real problems should be collected, examined, and documented systematically to form the basis of developing CrePS and its processes.
- Activities in various types of Real World (such as shown in Fig. 5) should be examined and categorized in the aspect of creative problem solving, and requirements on the processes of creative problem solving need to be clarified.
- The processes in the Thinking World for executing the Six-Box Scheme (Fig. 1) should be made rich, effective, and yet handy by studying and unifying various methods for creativity & innovation.
- Corresponding to different types of Real World and different categories of their activities, some suitable versions and adjustments need to be made in the processes (e.g., USIT) in the Thinking World. Possible to consider different types of processes (besides USIT) executing in accordance to the Six-Box Scheme.
- The concepts, methods, tools, documents, etc. need to be made publicly and widely known. Proliferation of theme into industries, academia, education, publication and mass media, etc. should be tried actively.
- Collaboration by researchers and promoters of different methods of creativity & innovation should be realized.

Our new target/vision [7] is stated here again:

- "To establish a general methodology of creative problem-solving / task-achieving,
- to spread it widely, and
- to apply it to problem-solving and task-achieving jobs in various domains in the whole country (and the world)"

Thank you very much in advance for your understanding and collaboration.

References

[1] Sickafus, Ed N.. "Unified Structured Inventive Thinking : How to Invent". Ntelleck, Grosse Isle, Michigan, USA, 1997, pp. 488.
[2] Sickafus, Ed N. A Rationale for Adopting SIT into a Corporate Training Program. TRIZCON99: First Symposium on TRIZ Methodology and Application, held on March 7-9, 1999 at Novi, Michigan, USA.
[3] Nakagawa, Toru. 'Approaches to Application of TRIZ in Japan'. TRIZCON2000: The Second Annual AI TRIZ Conference, Sheraton Tara, Nashua, NH, USA, Apr. 30 - May 2, 2000, pp. 21-35; THPJ, May 8, 2000 (E)
[4] Nakagawa, Toru, Hideaki Kosha, Yuji Mihara. 'Reorganizing TRIZ Solution Generation Methods into Simple Five in USIT'. ETRIA World Conference: TRIZ Future 2002, Strasbourg, France, Nov. 6-8, 2002, pp. 333-345; THPJ, Nov. 19, 2002 (E).

[5] Nakagawa, Toru. ‘Overall Dataflow Structure for Creative Problem Solving in TRIZ/USIT’. TRIZCON2005, Detroit, USA, Apr. 17-19, 2005; THPJ, Jun. 16, 2005 (E)
[6] Nakagawa, Toru. ‘A New Paradigm for Creative Problem Solving: Six-Box Scheme in USIT’, ETRIA TFC2006, Kortrijk, Belgium, Oct. 6 - 8, 2006; THPJ, Nov. 29, 2006 (E)
[7] Nakagawa, Toru. ‘General methodology for creative problem solving and task achieving (CrePS): Its vision’. ETRIA TRIZ Future Conference (TFC2013), Oct. 29-31, 2013, Paris, France; THPJ, Oct. 25, 2013 (E)
[8] Nakagawa, Toru. ‘USIT Manual: USIT (Unified Structured Inventive Thinking): A Concise Process of Creative Problem Solving in the 'Six-Box Scheme'’, “TRIZ Home Page in Japan”, URL: http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/eCrePS-USIT/eCrePS-USIT-Manual.html, May 23, 2015 (J), Jun. 26, 2015 (E)
[9] Nakagawa, Toru. ‘A Collection of USIT Case Studies: USIT (Unified Structured Inventive Thinking): A Concise Process of Creative Problem Solving in the 'Six-Box Scheme'’, “TRIZ Home Page in Japan”, URL: http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/eCrePS/eCrePS-USIT/eCrePS-USIT-CaseStudies.html, May 23, 2015 (J), Jun. 26, 2015 (E)
[10] Altdshuller, Genrikh. S. “Creativity as an Exact Science: The Theory of the Solution of Inventive Problems”, Gordon and Breach, New York, 1984.
[11] Litvin, S., V.Petrov, M.Rubin. ‘TRIZ Body of Knowledge’, URL: http://triz-summit.ru/en/203941/, April 2, 2007
[12] Mann, Darrell. “Hands-On Systematic Innovation”, CREAX Press, Iyeper, Belgium, 2002, pp.464.
[13] Mann, Darrell. ‘Systematic Innovation: Past, Present and Future’, Keynote, ICSI 2015 (6th International Conference on Systematic Innovation), Hong Kong, Jul. 15-17, 2015.
[14] Nakagawa, Toru. ‘General Methodology of Creative Problem Solving & Task Achieving (CrePS): Reorganizing Various Application Cases and Their Methods in the ‘Six-Box Scheme’’. ETRIA TFC 2014, Lausanne, Switzerland, Oct. 29-31, 2014; THPJ, Nov. 7, 2014 (E).
[15] Nakagawa, Toru. ‘USIT Process Documents (Index): USIT (Unified Structured Inventive Thinking): A Concise Process of Creative Problem Solving in the 'Six-Box Scheme': USIT Manual, USIT Operator System, USIT Case Studies, USIT References’, “TRIZ Home Page in Japan”, URL: http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/eCrePS/eCrePS-USIT/eCrePS-USIT-Doc.html, Jun. 26, 2015 (E)
[16] Nakagawa, Toru, Editor. “TRIZ Home Page in Japan” (abbreviated as THPJ), URL:
http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/ (in English)
http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/ (in Japanese)
[17] Lee, Hong Suk, and Kyeong-Won Lee. 'Practical Case Study of Resolving the Physical Contradiction in TRIZ; Super Water-Saving Toilet System Using Flexible Tube'. TRIZ Journal, Nov. 2003; (Japanese translation) THPJ, Jan. 8, 2004 (J).
[18] Nakagawa, Toru. ‘USIT Case Study (2) Increase the Foam Ratio in Forming a Porous Sheet from Gas-Solved Molten Polymer’. THPJ, July 2, 1999 (J), Aug. 26, 1999 (E)