A System for Preventing from Our Leaving Things Behind -- A Case in 2-Day USIT Training Seminar --

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ABSTRACT

USIT (Unified Structured Inventive Thinking) is a methodology and an overall procedure for creative problem solving, originally developed by Ed Sickafus and then further enhanced by the present author as a new generation of TRIZ. Usage and training of USIT are demonstrated in the present paper by example of an actual case of problem solving in a 2-Day USIT Training Seminar carried out with participants in a multi-company situation. The problem was to concept a practical system for preventing from our leaving things behind, such as a bag on a train's shelf, glasses on a restaurant table, an umbrella at an entrance, etc. The initially-vague problem was to be defined more clearly in terms of 'the timing of leaving a thing behind'. Then the situation is analyzed in the USIT scheme of Objects-Attributes-Functions and Space & Time, and ideal solutions are imagined by use of the USIT Particles method. On the basis of these analyses various solution ideas are generated and are composed into a conceptual solution. This example shows the USIT's capability of handling problems which are initially-vague , related to software, and oriented to process, etc.

1. INTRODUCTION

USIT (Unified Structured Inventive Thinking) is a methodology for creative problem solving developed originally by Ed Sickafus [1] at Ford Motor Co., under the influences of TRIZ (see, e.g., [2, 3]) and its much-simplified version, SIT (see, e.g., [4]). The present author has been introducing USIT in Japan since 1999 [5] and has extended it further in its system of operators for solution generation (i.e., USIT Operators) [6] and in its general scheme (i.e., USIT Six-Box Scheme) [7] expressed in the data-flow diagram. On the basis of these conceptual development and practical experiences of usage, the present author has been recommending USIT as an easy-to-learn and effective-to-apply methodology for creative problem solving, claiming it to be 'a new generation of TRIZ' [8] in the sense that it inherits the essence of TRIZ and it provides with a full procedure of creative problem solving.

Besides in many presentations and lectures, USIT has been trained in Japan by the present author in the form of 3-day or 2-day Training Seminars [5], held either within individual industries or in multi-industry open situations. A special feature of these USIT Training Seminars is the group practice of applying USIT to real unsolved problems brought in by the seminar participants. The actual use of USIT has been reported by several Japanese industries (including Fuji Photo Film, Fuji Xerox, Ricoh, NISSAN Motors, Matsushita Electric Industries, Matsushita Electric Works, Hitachi, etc.) and in a few universities (including Osaka Gakuin University and Kanto Gakuin University) [8]. All these presentations have been given in Japanese, however, except some in English by the present author.

The present paper intends to demonstrate the actual application of USIT to a practical problem, by using a case carried out in a recent 2-day USIT Training Seminar instructed by the present author. The case was solved in the open training seminar by a group of five participants coming from industries and a university. The present author proposed the problem, shown in the title of this paper, and guided the group as the Instructor of the seminar. The Instructor's specific guidance is minimal (or, to be honest, slightly more than the usual cases in the present author's Training), and the group carried out all the USIT procedure by following the general directions taught in the lectures during the training seminar.

The group practice generated 10 sheets of papers (of size 1 x 1.5 m, posted on the white board) as the records of all the ideas of analysis and solution generation. The 10 sheets are reproduced in the present paper faithfully (except the translation from Japanese into English, of course, and the redrawing of small figures for the sake of clarity). The present paper is based on the 'Training Seminar Documents' which was written by the present author in two days after the Seminar and was delivered to the participants. The Document was written with the 'Template of USIT Training Seminar Case Study', where the case is described along the actual process of group practice and particularly distinguishing five categories of descriptions. They are: (a) Instruction of the USIT procedure, (b) Resulting record of the group practice, (c) Supplementary explanation of the actual group practice, (d) Comments and discussions during the Seminar, and (e) Further comments after the Seminar.

The problem handled here is familiar to everybody. We make mistakes from time to time to leave something behind carelessly. We would like to have some effective means to prevent from our leaving things behind. In the new era of ubiquitous information society, we may be able to propose some system to deal with this common problem. This problem has special challenging features concerning the fields of application of USIT (and TRIZ): It is not a problem solving of an existing system, but we rather need to propose a conceptually new system. It involves not only hardware but also software technologies, where TRIZ does not have much experiences. The problem is characterized by the time dependence, where ordinary functional analysis (of TRIZ) is not easy to apply. Thus, even though the present paper gives only a rough concept of solution to this problem, it should be useful for illustrating the usage of USIT, or a new generation of TRIZ.

2. Outline of the 2-Day USIT Training Seminar

The USIT Training Seminar was conducted in two days of September 28 and 29, 2005 at Yaesu Hall in Tokyo, under the instruction of Toru Nakagawa and the organization by IDEA, Co. The seminar was conducted under the open participation from multiple companies. The goal of the training was set for the participants to creatively solve real problems through group practices along the USIT procedure and thus to master USIT at the level to become capable of applying it for themselves individually.

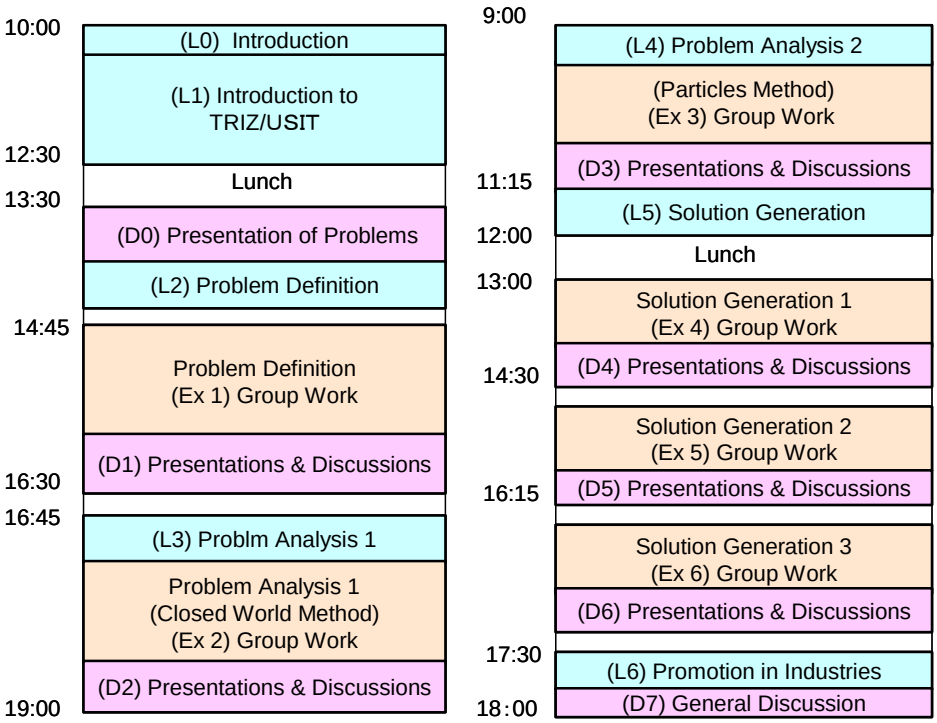
The Seminar called for participation for mastering the USIT methodology and for proposal of real problems to be solved with USIT. Eleven people, consisting of 9 engineers from manufacturing companies and 2 graduate students, joined the Training Seminar and worked to solve two problems in parallel (note: it is usual to solve three problems in parallel with 15-25 participants). The participants were assigned to the two practice groups by the seminar office with consideration of their backgrounds. Six engineers of Group A dealt with a mechanical problem of 'Neatly stacking the pieces of papers delivered by a conveyor', while five other people worked on the present case.

The present problem was proposed by the present author, because no other problem was submitted by the participants. The following five people of Group B worked on it: Mr. S. (Engineering manager in a big electric & IT company, a specialist in VE), Mr. T. (Engineer in another big electric & IT company, currently belonging to the IP division), Mr. N. (Engineer in a precision machinery company), Mr. Y. (1st-year graduate student at JAIST, having 11 years of experience as an engineer in a heavy industry company), and Mr. H. (1st-year graduate student at JAIST, a graduate in the IT field).

The Training Seminar was conducted with the agenda shown in Fig. 1. In the morning of the first day, an introductory lecture was given on TRIZ and then on USIT, because most of the participants were relatively new to both of them. The rest of the 2 days were devoted for the group practice of solving the two problems in parallel, along the USIT procedure divided into 6 Sessions. Each Session was typically composed of three Sub-sessions:

- Sub-session A: Lecture on some details of the procedure to be performed in the current Session.
- Sub-session B: Group practice for solving the problem; the groups work in parallel.
- Sub-session C: Sequential presentations by the groups to all the participants, comments by the Instructor, and discussions by all the participants.

Fig. 1. Agenda of the 2-Day USIT Training Seminar



In this scheme, each problem was solved in the group practice for about 7.5 hours in total together with the presentation and discussion for about 2 hours in total.

3. The Problem Proposal

The Problem was submitted to the Seminar with a simple document shown in Fig. 2.

Fig. 2. Proposal of the Problem to Be Solved with USIT

A Proposal of Problem to be Solved with USIT

Sept. 28, 2005 Toru Nakagawa (OGU)

Theme: A System for preventing from and alarming on the spot of our leaving things behind

Background: There can be various cases when we go out and leave our things behind.
E.g., an umbrella, a small bag, a suvenior, etc. etc.
We would like to have some effective means or system feasible in the coming ubiquitous information society.

Clarifying the focal point:
Not meant of our dropping and losing things carelessly.
-- What is the difference?
Not the system for searching for our things sometime later after realizing that we left them somewhere.
-- Important to alarm at the earliest timing on the spot

The present author explained the intention and background of this problem proposal as follows:

- This theme is not relevant to improving any existing system, thus not in the field of problem solving in its narrow sense.
- In my university seminar class, the present author and five 3rd-year undergraduate students worked for a while on problems such as 'a system for looking for a lost child in an amusement park', and 'a system for detecting and searching for things we have dropped'. At that time the problem presented here was also discussed just briefly.
- This theme seems suitable for handling with USIT in the sense that it is important (or very beneficial if successfully solved) and unsolved yet, but seems in danger to become unsuitable because of its lack of clarity, spreading too widely and openly. Thus we need to be careful to handle this problem with a clear definition.
- The theme is related to IT systems and software, where TRIZ does not have much experiences so far while USIT has some. Since the theme is quite familiar to everybody, I suppose that you can handle it even without any prior preparation.
- The other group (A) handles a problem in the mechanical field. Application of USIT to the two quite different problems may be of much interest to you. You should learn how to adapt USIT to real problems.

4. Problem Definition Stage (Session 1)

(a) Instruction of the USIT Procedure in This Stage

The group should discuss on the problem to find/decide the followings:

- Unwanted effect: Itemize one most unwanted effect, fact, difficulty, etc.
- Problem statement: Define the problem concisely with a statement in one or two lines.
- Sketch: Draw a simple sketch of the problem situation to focus on the mechanisms.
- Plausible Root Causes: State most possible root causes on the basis of prior experiments and reasoning/speculation.
- Minimal set of objects: After listing up objects relevant to the problem, minimize the list to the objects really containing the problem.

(b) Resulting Records of the Group Practice

Three sheets of papers were obtained as shown in Figs. 3, 4, and 5.

Fig. 3. Record B-1. Problem Definition Stage (1) Problem Statement

A System for preventing from and alarming on the spot of our leaving things behind B-1

[Session 1. Probelm Definition Stage]

Things likely to be left behind:
An umbrella
A mobile phone
A suite, a coat
Glasses (elderly people)
A sub-bag

Where?
In a train (on the shelf)
Cafe (on the table)
Entrance umbrella box
Rest room
Back of a chair

Similar but different cases:
- Forgot to take things,
- Could not remember something,
- Failed to receive the change,
- Dropped a thing without knowing

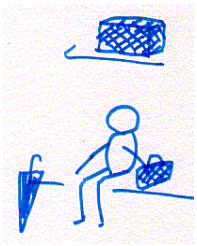
Why do you worry about it?
Leaving things behind
- causes the things to be lost (i.e. we cannot get it back.),
- forces us to go back and look for them.

Problem Statement:
A system for preventing from and alarming on the spot of our leaving things behind.
for decreasing the probability
for noticing us just before our leaving things behind
for alarming us when we left our things behind
-- this can be too late

==> A system for avoiding and preventing from our leaving things behind.

Fig. 4. Record B-2. Problem Definition Stage (2) Sketches and Scenarios of the problem situation

[Problem Definition Stage] B-2



Scenario 1.
Getting on the train.

Putting a bag up on the shelf. <-- Make a notice to remember.

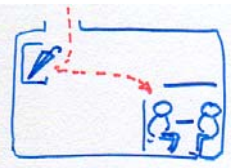
For some time (for a long time) <-- Keep (us) to remember all the time --?

Getting off the train, leaving the bag behind. <-- **Make a warning at this moment!**
<-- The failure has happened.

Noticing the missing of the bag at home.

Trying to remember/find out when and where I left it. <-- This is a different task.

Scenario 2.
Putting an umbrella in the box at the entrance. <-- Put it intendedly.
Not dropped it, not left it behind.
-- Maybe possible to have some means



Entering the room/office and spending time or performing a job. -- Often unconscious of the umbrella.

Going out through the entrance leaving the umbrella behind. (when it stopped raining.) -- the chance of getting close again
<-- Necessary to recall of the umbrella.

Going home.

Fig. 5. Record B-3. Problem Definition Stage (3) Root Causes and Objects

[Problem Definition Stage] B-3

Root causes: Candidates suggested:

- Becoming distant from the person.
- Taking something not usually taken.
- Being out of consiousness. -- 2 votes
- Being out of sight.
- Not able to recall it at the timing necessary to do -- 5 votes
- Not thinking it important.
- Not necessary at the moment. -- 3 votes

(d) Plausible Root Cuases

- Not able to recall it at the timing necessary to do.

(e) Objects in the problem system:

- The person.
- The thing which is left behind.
- The place where the thing is left behind
  (e.g., shelf in the train, table in the cafe, etc.)

(c) Supplementary Explanation of the Actual Group Practice

The initial part of the group discussion was led by the Instructor. He posed questions to the group members, and wrote their answers on the sheet.

- Firstly, for clarifying the problem situation he asked 'what kind of things are likely to be left behind?' and 'where?'.
- Then similar but different cases were listed up to distinguish the present problem situation from them.
- In the discussion to set up the Problem Statement, various possibilities of wording were proposed and recorded. Mr. T. proposed the words of 'avoiding' (suggesting some means to be applied beforehand) and 'preventing' (suggesting other means to be performed at the right time). This fixed the Problem Statement as shown in Fig. 3.

Then a typical problem situation was sketched as shown in Fig. 4. A scenario of the situation of leaving a bag in the train was written down and it stimulated some discussions on what kind of actions we would like to have with our new solution system; such discussions were recorded in Fig. 4 in green characters. From now on, Mr. S. played the role of the group leader in place of the present author. Then the group sketched a second case of leaving an umbrella at the entrance, and wrote its scenario. It became clear that the second case of leaving an umbrella at the entrance is more difficult to handle than the first case of leaving a thing on the shelf in the train.

For clarifying the Plausible Root Causes, possible alternatives were listed up first at the right part of the

sheet as shown in Fig. 5. Then the opinions of every member were asked and voted (with two votes per member) as shown in the numbers in Fig. 5 (the voting was done in order to have all the members committed in the decision, because younger members were still rather shy in the group practice). Thus the Plausible Root Causes was set as 'Not able to recall it at the timing necessary to do'. (This wording was proposed by the Instructor.)

(d) Comments and Discussions during the Seminar

The Instructor made the following comments during the Discussion Sub-session.

- In the present stage, the group had worked to clarify the problem situations and the range of problems we were going to deal with. The Problem Statement should be the conclusion of such a discussion.
- In the sub-step of drawing sketches, the problem situations were described further in the form of scenarios, which are capable of relating the situation change in time.
- The scenario writing (as recorded in Fig. 4) may be regarded as a form of analyzing the problem in time. Such a problem analysis was performed here (in advance of the standard USIT procedure), because such consideration in time was certainly necessary for clarifying the problem situations.

5. Problem Analysis Stage (1) Analysis of the Current System (Session 2)

(a) Instruction of the USIT Procedure in This Stage

The first part of this stage in USIT is to analyze the current system in problem by using the basic concepts of Objects-Attributes-Functions:

- Functional Analysis: The functional relationships among the Objects should be drawn schematically.
- Attribute Analysis: All the Attributes of Objects relevant to the unwanted effect should be identified and classified into the categories of increasing or decreasing relationships.

Then the characteristics of the problem should be analyzed with respect to Space and Time:

- Space Analysis: The characteristics of the problem situation with space should be represented in some form of graph or diagram.
- Time Analysis: The time characteristics should be represented in some form of graph or diagram.

(b) Resulting Records of the Group Practice

The group discussion produced the two sheets of documents as shown in Figs. 6 and 7.

Fig. 5. Record B-4. Problem Analysis Stage (1) Functional Analysis (Session 2)

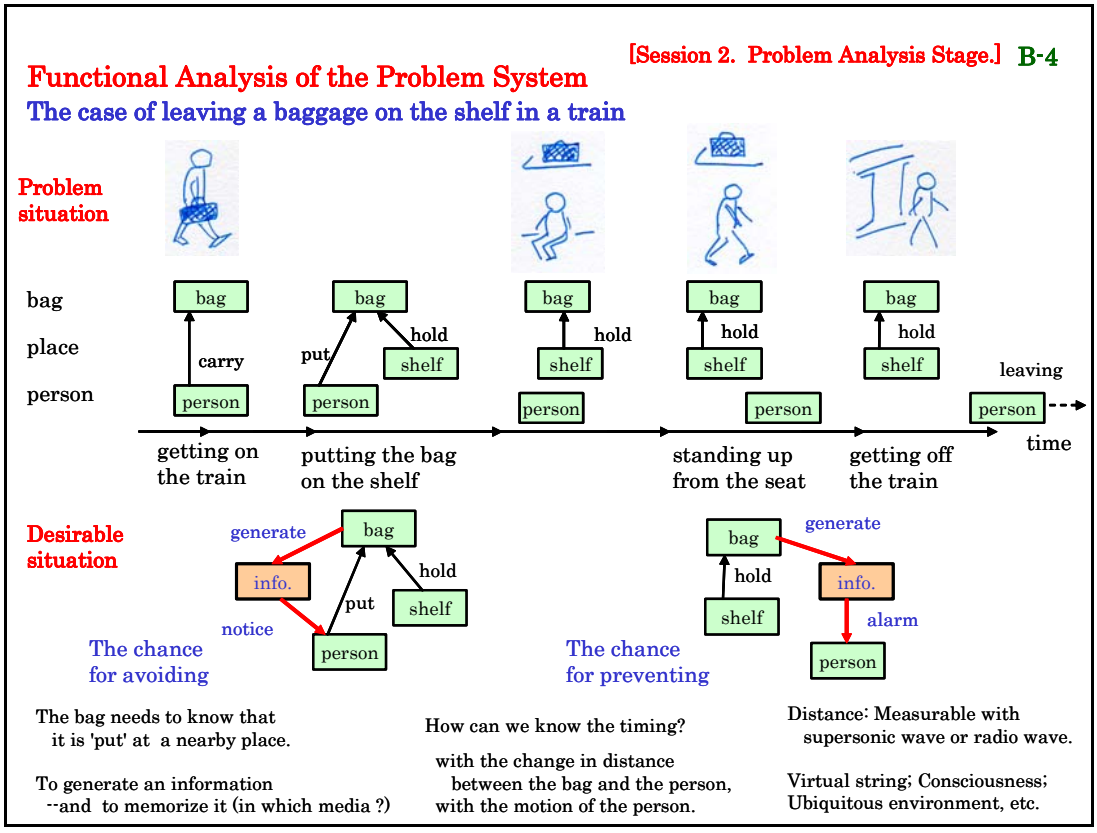
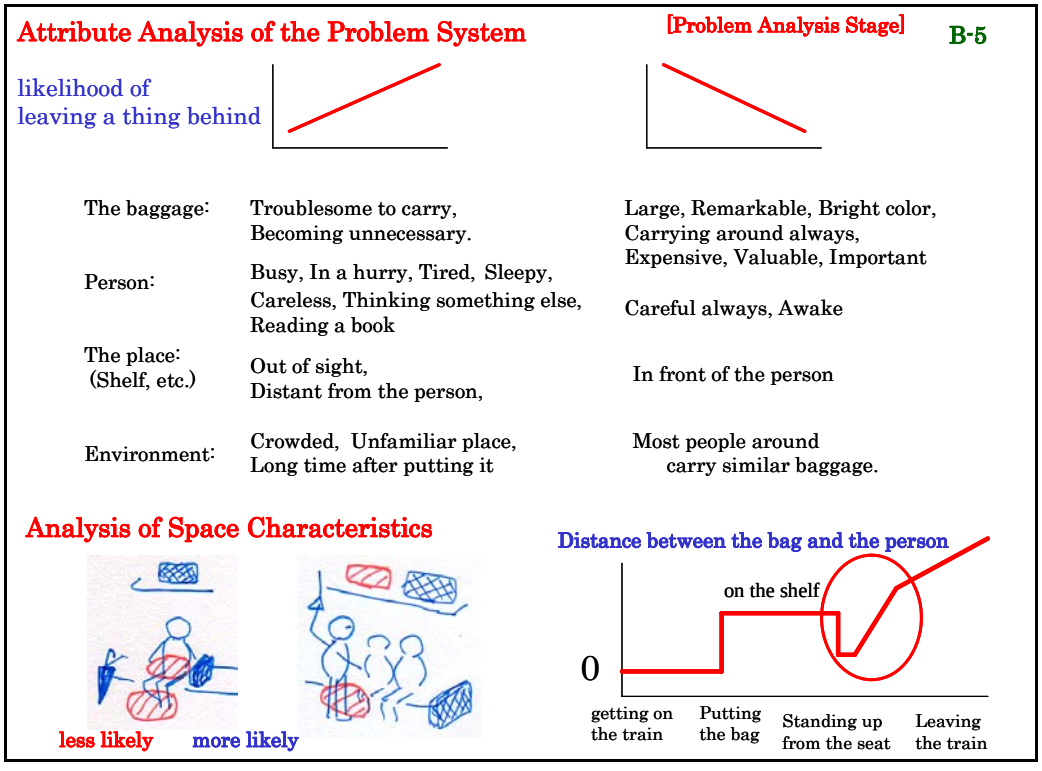


Fig. 6. Record B-5. Problem Analysis Stage (2) Attribute Analysis (Session 2)



(c) Supplementary Explanation of the Actual Group Practice

In the practice the group primarily used the simpler case shown in the first scenario. Since it became clear that the time dependence was in the core of the problem, the Functional Analysis was also carried out by showing several diagrams along the time axis. The USIT-style diagrams of Functional relationships among the Objects were drawn by the Instructor, while explaining the intentions of the diagrams. This was done in order to avoid unnecessary confusing discussions how to draw the Functional Analysis diagrams. The resultant diagrams were simple and straight forward and were approved smoothly by all the members.

The functional diagrams of the problem situation stimulated the discussion on what functions are missing and what are desirable. Thus the missing functions were drawn in the diagrams of 'desirable situations'. It became obvious that, ideally speaking, the bag itself should give a notice or an alarm to the person. The timing of critical importance also became clear. These discussions stimulated the group members to mention various ideas related to some fragments of solutions, as recorded at the bottom of Fig. 5. It became clear to the group that the distance between the bag and the person should be the key to the solution concept.

The Attribute Analysis shown in Fig. 6 were carried out with the standard USIT procedure, where the two figures of increasing and decreasing relationships are used to list up all the Attributes of Objects relevant to the unwanted effect, i.e. the likelihood of leaving a thing behind. In addition to the three basic Objects in the Problem System, the Environment was added in the figure.

The characteristics in Space was analyzed by drawing sketches of two cases, where the person was either seated or standing in the train. Places more likely and less likely to leave things behind were marked in the sketches. The group was standing still for a while at this point; then the Instructor drew the graph at the bottom-right in Fig. 6. This graph represented the change in distance between the bag and the person along the process (or the time axis); this is the most compact representation of the present problem by the joint use of Space and Time characteristics. The graph had suggested the group clearly that the critical timing when the person stands up from the seat for getting off the train can be detectable by analyzing the distance in real time.

(d) Comments and Discussions during the Seminar

The Instructor made the following comments during the Discussion Sub-session:

- Since the change in situations with Time is of critical importance in this problem, the Functional relationships may be represented not easily with one diagram but, instead, smoothly with multiple diagrams corresponding to characteristic stages of timing. This is a typical way for handling 'process-oriented' problems.

- In the Functional Analysis in USIT, Sickafus advises to draw the relationships of useful functions as originally intended by the system designer, even though we notice that the present system has some harmful or weak points.
- After drawing such Functional diagrams, it becomes clearer for us what are the harmful and insufficient functions, then we may go ahead to draw separate diagrams containing such harmful functions or containing new desirable functions.
- Drawing diagrams containing new desirable functions may be an activity to be carried out in the next step in Problem Analysis Stage; nevertheless, USIT may be applied much flexibly as shown in this case.
- Analysis of Space Characteristics does not request you to draw any particular type of graphs or diagrams; you should draw a sketch/graph/diagram in any style most natural for the characteristics at first.
- Such analysis steps may guide us to draw an abstract graph, as shown at the bottom-right of Fig. 6. Any idea vaguely emerging in our brain may become clearer by drawing them down. It is essential to realize that we are not drawing what we knew beforehand but rather are learning more clearly by drawing our vague or fragmental ideas on the board.

6. Problem Analysis Stage (2) Analysis of the Ideal System (Session 3)

(a) Instruction of the USIT Procedure in This Stage

The Particles Method developed by Sickafus is applied in the following sequence:

- Sketch the current problem situation, so as to clarify the current problem mechanism.
- Sketch the Ideal situation, so as to clarify the image of the ideal result, but you must not try to draw the means for achieving it (because we do not know such means yet).
- Put the x marks at the places where the two sketches are different, and call them 'Particles'. Imagine that the Particles are magical substance/"Field" which can have any desirable properties and can perform any desirable actions.
- Describe the actions which you want the Particles to perform; break down such actions in a tree diagram with AND/OR annotations.
- List up possible properties which the Particles should have desirably.

(b) Resulting Records of the Group Practice

The results of the group practice are recorded in Figs. 7 and 8.

Fig. 7. Record B-6. Problem Analysis Stage (3) Analysis of Ideal Situations (Session 3)

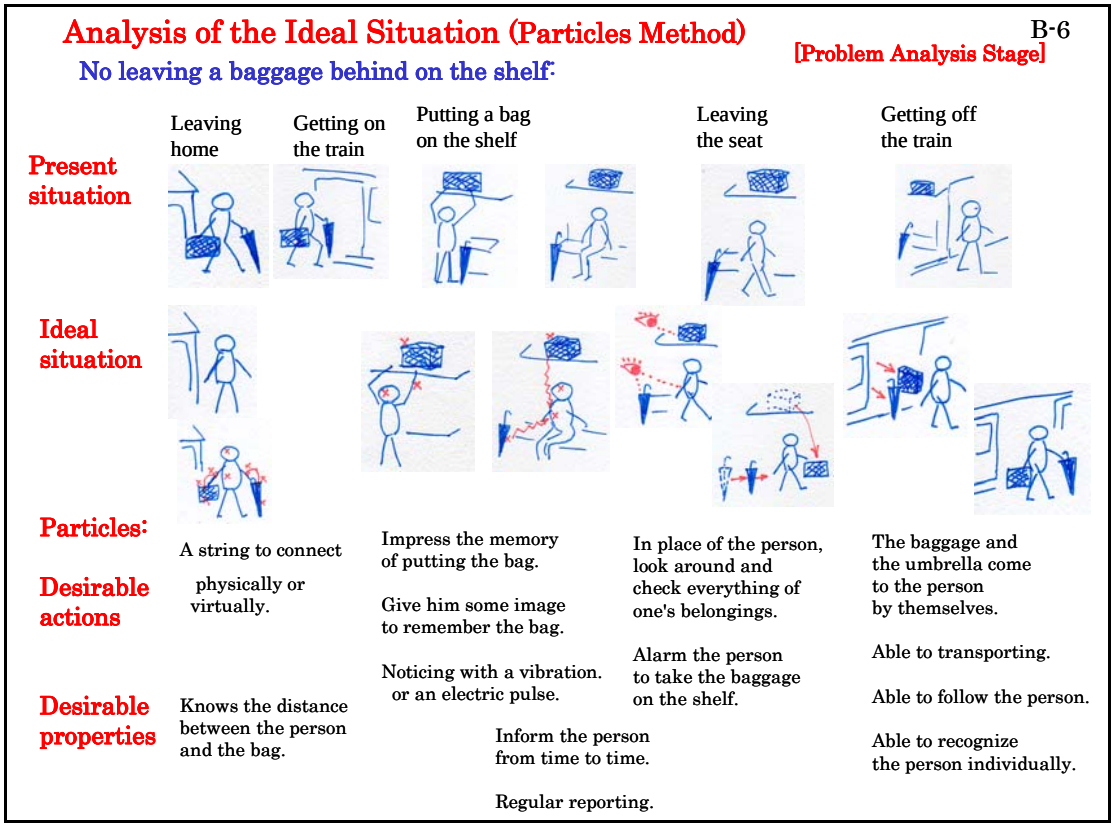
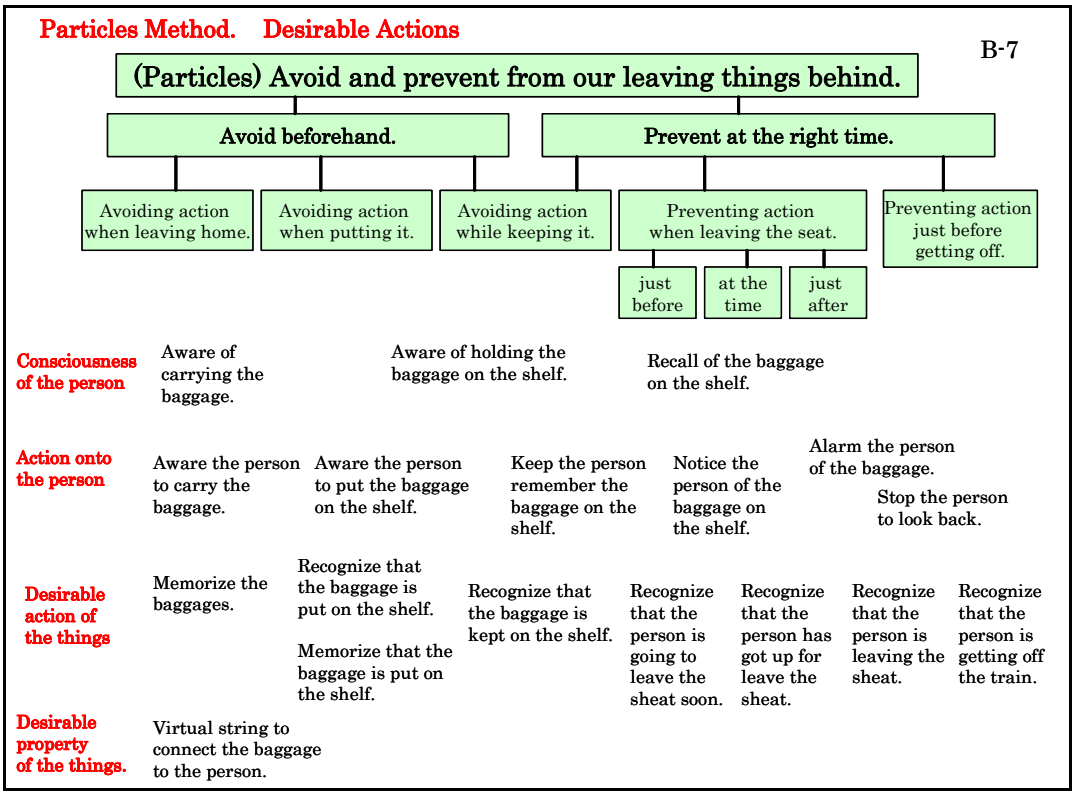


Fig. 8. Record B-7. Problem Analysis Stage (4) Desirable Actions and Properties (Session 3)



(c) Supplementary Explanation of the Actual Group Practice

The case of leaving a bag behind on the shelf is mainly treated here as before. Reflecting the time-dependence, the present and ideal situations were drawn at the characteristic timings of the process. Drawing of these images of ideal situations were assigned to all the members by turn so as to stimulate them to involve more actively in the group practice.

- The stage of 'leaving home' was introduced as the initial step of the process.
- An image of a string connecting the bag to the arm was drawn by Mr. H. The Instructor advised to consider it as a virtual string in addition to any real one.
- Then the members were urged to draw the x marks in the images of the ideal situations.
- At the stage of standing up from the seat, Mr. H drew a few 'eyes' which watch the bag and the person. They represent some kind of sensors, such as the cameras installed in the train, he said.
- At the bottom half of Fig. 7 were drawn various fragments of ideas of desirable actions by the Particles and possible solutions. After drawing them, the Group was wondering for a while what to do next.

The Instructor came to the Group and after reading the records in Fig. 7 he started to draw the main structure of the 'Desirable Actions to be performed by the Particles' as shown in Fig. 8.

- The top level of the Desirable Actions was set to be 'Avoiding and Preventing from Our Leaving Things Behind', corresponding to the Problem Statement. Then the avoiding and preventing actions were separated and their necessary timings were written explicitly to some detail.
- For writing the Desirable Actions in detail, the Instructor made a matrix-type frame work with the categories of 'Consciousness of the person', 'Action onto the person', and 'Action of the things', as shown in the left column. (We want the Particles to act on the consciousness of the person as well.)
- Using this framework, the previous ideas of Desirable Actions (shown in Fig. 7) were classified and many more ideas were generated smoothly by the members.
- The desirable actions were basically classified into three categories: 'what the person being aware of', 'the actions of the things to make the person aware of', and 'the actions of the things for recognizing the situations of the thing and the person'. It became clear that various actions of these categories were needed in different timings.

(d) Comments and Discussions during the Seminar

- The eye marks drawn in Fig. 7 can have roles similar to the Particles (in USIT), Smart Little People (in SLP), and the X-components (in ARIZ), with some emphasis of watching/sensing action.
- The top level of the Desirable Actions, which we want the Particles to Perform, were chosen to be the same as the Problem Statement. Since the latter states 'what we want to solve', this coincidence is quite natural.

- At the bottom part of Fig. 8, Desirable Properties of the Particles were not listed up enough due to the lack in time. Descriptions of such properties would stimulate various solution ideas in the next stage.
- In Fig. 8, we organized the Desirable Actions by using a matrix-type framework of 'categories vs the timing'. Such a choice should be taken case by case flexibly. Making a manual of such choices would not be fruitful. We should master such flexible choices through various experiences, not only in USIT.

7. Solution Generation Stage (1) Free Generation of Ideas (Session 4)

(a) Instruction of the USIT Procedure in This Stage

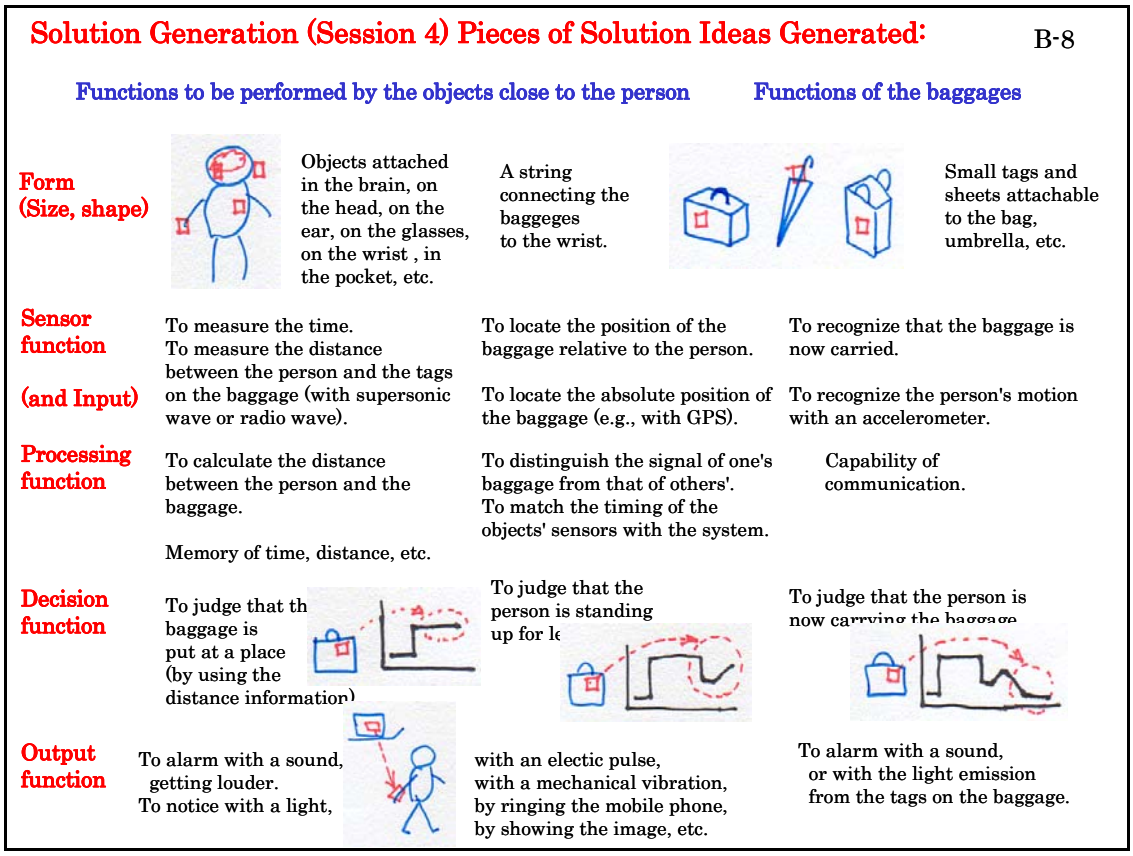
The Stage of Solution Generation was carried out on the second-day afternoon in three relatively short sessions. Even though the three sessions cannot be divided clearly in the USIT methodology, the Instructor gave the Group the following guidance for this Session:

- First, write down all the ideas you have obtained so far during the Problem Analysis Stage, do it individually and use the Post-It Notes.
- Then, in about 30 minutes, post all those ideas onto the big sheet of paper and share the ideas by all the members.
- With the stimulation of the results, especially, of the Particles Method and the Space and Time Characteristics Analyses, you will be able to generate a number of ideas smoothly.
- In this step you should better try to generate ideas freely without much thinking of the USIT Operators for solution generation.

(b) Resulting Records of the Group Practice

The ideas generated by the group members were recorded in Fig. 9 after some classification.

Fig. 9. Record B-8. Solution Generation Stage (1) Free Generation of Ideas (Session 4)



(c) Supplementary Explanation of the Actual Group Practice

For stimulating the idea generation, the Instructor drew a sketch of a person with small red rectangles at the positions of the brain (representing the consciousness), ear, eye, breast, and wrist, etc. These rectangles stand for some devices performing 'Functions to be performed by the device(s) near-by the body'. Then another sketch of things, e.g. a bag, an umbrella, and a shopping bag, were drawn; where the things also have a small red rectangle for performing some 'Function of the baggage'.

The group members wrote down their ideas they had obtained so far in Post-It Notes on the bases of these sketches and the results of Problem Analyses. After a while, they posted their ideas on the big sheet and explained them by turn.

Then it was found necessary to classify them in some manner. Thus the framework of four categories of functions was introduced as shown in the left column in Fig. 9. They are: Sensor function (including input to the system), Processing function, Decision function, and Output function. While classifying the ideas in the framework, a number of new ideas were further generated.

(d) Comments and Discussions during the Seminar

In about one hour of group practice, this group as well as the other group seemed to have written down

almost all the ideas at hand; thus the Instructor stopped the group practice and started the Presentation & Discussion sub-session.

8. Solution Generation Stage (2) Structuring the Ideas (Session 5)

(a) Instruction of the USIT Procedure in This Stage

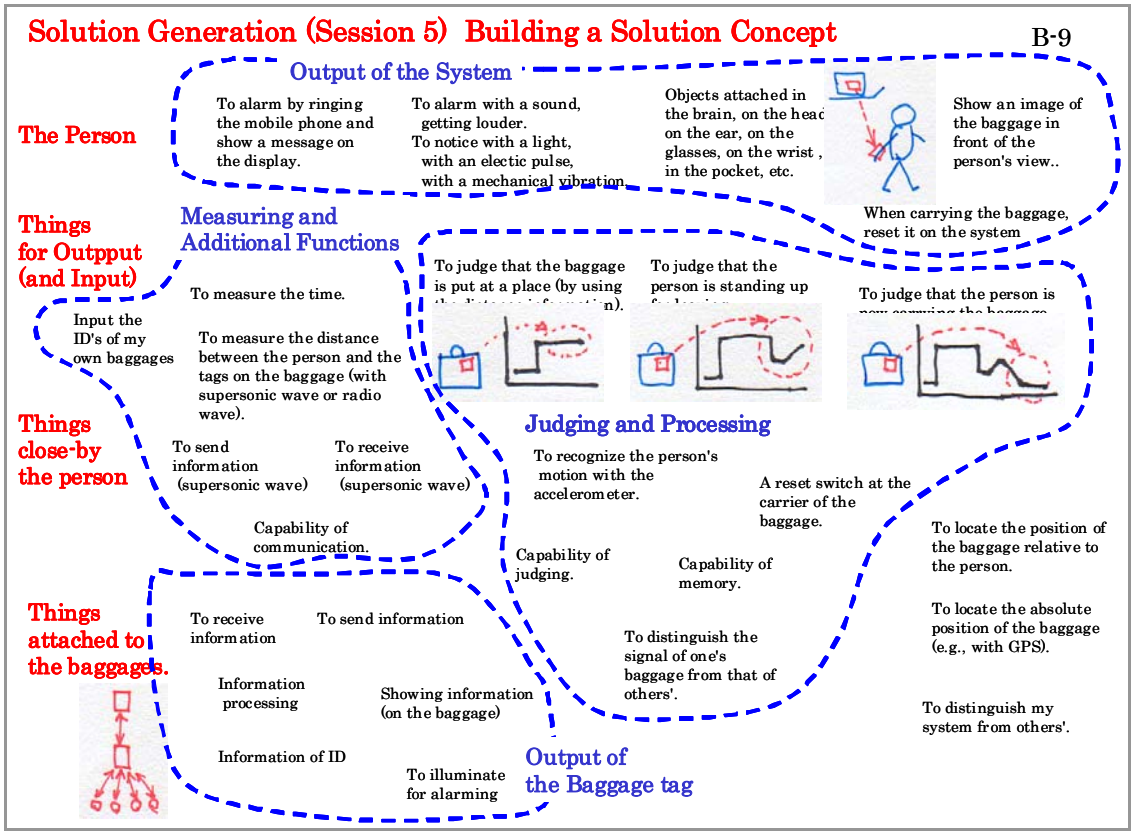
The Instructor gave the guidance to this Session in the following way:

- Theoretically speaking, USIT advises to apply the USIT Solution Generation Methods (or USIT Operators) to possible Operands (i.e., Objects, Attributes, Functions, Solution pairs, and Solutions) by turn to generate more and more solution ideas. But it is not so easy to apply USIT Operators immediately just after reading their guidelines in this 2-day Training Seminar.
- It is advised to generate various ideas without paying so much attention to the method of generation, and to think afterward of which USIT Operator can derive the solution, and thus to learn the nature of the USIT Operators. This way of reflection corresponds to the Solution Generalization Method in USIT.
- Various solutions should be reorganized into some hierarchical system of solutions; this is the way of Solution Generalization Method as well.
- Fragments of ideas, however large in number, often contain secondary problems and can not stand against criticisms/examinations in the real world. Hence, we should select some hopeful ideas among them and enhance the selected ones so as to make them at the level of conceptual solutions.
- For selecting hopeful ideas, we can use three criteria of 'Effectiveness (i.e., having a good effect)', 'Feasibility (i.e., possibility of realization)', and 'Novelty/Patentability', with the emphasis in this order. However, selection of ideas in these criteria can readily take one or two hours in ordinary sense. Thus we should apply the selection criteria only briefly to pick up several hopeful ideas.
- In the present case, we should try to build up one conceptual solution of a whole system covering as wide aspects as possible.

(b) Resulting Records of the Group Practice

The record of the result of the Group Practice in this Session is shown in Fig. 10.

Fig. 10. Record B-9. Solution Generation Stage (2) Building a Solution Concept (Session 5)



(c) Supplementary Explanation of the Actual Group Practice

- The Post-It Notes written in the previous Session were rearranged on a new big sheet of paper in order to build up a system of conceptual solution. The usage of Post-It Notes were convenient for this purpose.
- As shown in the left column, we set the four main components of the system. They were: 'The person (and interactions to the person)', 'Things for output to the person (and input from the person)', 'Things close-by the person (and their functions)', and 'Things attached to the baggage (and their functions)'.
- We also intended to write various items from left to right along the processes of leaving things behind.
- First the Group focused their attention to the function of measuring the distance between the person and the baggage. The device (named as 'Main System') close-by the person sends supersonic wave (or radio wave). The small device (called as 'Child System' or 'IC tag' etc.) attached on the baggage receives the supersonic wave and sends back the wave containing the information of its own ID. The Main System receives the reply and evaluate the distance to the Child System by use of the time delay in the response.
- For the bases to judge and process, the Main System needs to have the functions of memory and of distinguishing the signal from its own Child Systems (from the signal from other's Child Systems).

- The Main System need to have functions, including 'Function to judge that the baggage is put at a place', 'Function to judge that the person is standing up for leaving', and 'Function to judge that the person is now carrying the baggage'. All these judgment should be carried out by using the distance between the person and the baggage and the change in the distance.
- For ensuring the judgment, the use of auxiliary devices should be helpful, such as an accelerometer attached on the person for detecting the person's motion and a pressure sensor attached on the baggage handle for detecting that the baggage is now carried.
- The functions to derive the absolute position of the baggage and to locate the relative position of the baggage from the person were listed up in the previous step but excluded in the present step because of their low cost-performance.
- Finally the Group considered the Main System's functions to notice the information to the person. There are several alternative ideas for these functions.
- After listing up all these functions, the Group members found that almost all the basic functions seemed to be feasible and started to think that their solution should be realizable.

(d) Comments and Discussions during the Seminar

- In case of this problem, since no system was present yet, fragments of ideas were not enough as the solution. We needed to build up a conceptual solution and show convincingly that the whole system should work. For this purpose, we worked to compose the elements of ideas obtained in the previous step and to build a conceptual solution as a whole.
- During this work, we selectively used the individual ideas by use of the criteria of 'Effectiveness', 'Feasibility', and 'Cost effectiveness'. The selection of ideas was done intuitively mostly by Mr. S and Mr. T on the basis of their technical background knowledge.
- It was the principal goal for the Group to make a reasonable prospect of the feasibility of a system having our wanted function, i.e. avoiding/preventing from our leaving things behind. When we find it feasible, we go ahead to reduce the cost as much as possible.

9. Solution Generation Stage (3) Enhancing the Conceptual Solution (Session 6)

(a) Instruction of the USIT Procedure in This Stage

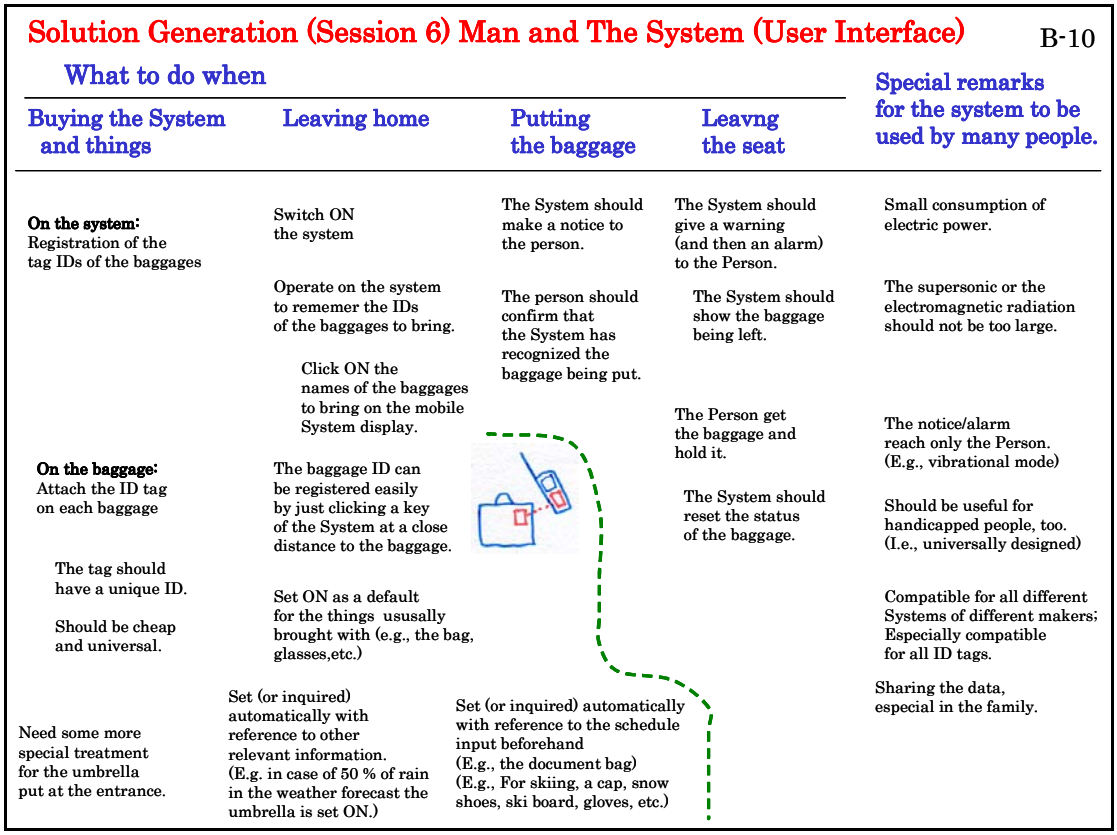
The Instructor explained the aim of this session as follows:

- In the 2-Day Training of USIT, we usually carry out two sessions for the Solution Generation Stage. Since we had only two problems to solve in this seminar, we were able to carry out the third session within the time schedule.
- In the previous Session we obtained a set of ideas to form a rough solution concept; for about 45 more minutes we should try to enhance them to build a solution concept which may be convincing for engineering people to think it most probably feasible.

(b) Resulting Records of the Group Practice

The Group produced the document as shown in Fig. 11.

Fig. 11. Record B-10. Solution Generation Stage (3) Enhancing the Solution Concept (Session 6)



(c) Supplementary Explanation of the Actual Group Practice

The Group discussed first what sort of things they should work out in this session. They found two choices: One was to examine the second scenario of 'Leaving an umbrella behind at the entrance', which was briefly discussed in the Problem Definition Stage as shown in Fig. 3. The other was to consider 'What system should we build concerning to the human-system interaction and other super-systems, in order to make the present solution really useful?' The Group decided shortly to discuss the latter topic.

- For considering the usage of the System, the steps in time sequence were chosen as: What to do 'when buying this System (i.e., the Main System and Child Devices)', 'when leaving home', 'when putting the baggage on the shelf', and 'when standing up the seat to leave'.
- When people buy the System (and various things as the baggage), it is desirable that the Child Devices are minimal in cost and universally compatible with different Main Systems (of different makers). Hence the Child Devices should be made with some IC tag (or other similar device), and when it receives a signal (in supersonic wave or radio wave, for example) from the Main System it should simply send back a signal which contains its unique ID number. The Child Device need not to have a clock. The Main System should have all the intelligence to perform the desired function of supporting to avoid and prevent from our leaving things behind. It may be an enhanced version of the current mobile phone.

- When leaving home, the user has to register all the baggage to the Main System. Several ideas emerged for making this registration process easier. The small figure at the bottom-left of Fig. 10 is related to this registration process; it shows that the baggage can be registered in a hierarchical way. For example, a suitcase or a bag can have an 'Intermediate System' which serves as a Child Device to the Main System and also as a manager to take care of several Child Devices attached to the items inside the suitcase (or the bag) and to send some signals to the Main System whenever it finds it necessary.
- When putting the bag on the shelf (or at some other place), the System (i.e. the Main System) should recognize the situation by itself. It is also desirable that the System displays its recognition of the situation so as the user can check it.
- When leaving the seat, the user should be noticed or alarmed by the System, and should be able to examine the display of which baggage is in the risk of being left behind. And when the user carries the baggage in hand, the System should reset the situation of being placed on the shelf and stop the alarm concerning to the baggage (note that there may be some other baggage in the danger of being left behind). We already examined in the previous session how the System should work to perform all these functions.
- Besides the considerations along the process of usage of the System, the Group discussed what should be considered to make the System widely used by many people, i.e., everybody in the train and in town. The basic requirements of small consumption of electric power, not too large radiation, alarming to the owner user alone, etc. were stated. It is an important remark that the System should be universally designed to be usable by handicapped people. The Systems and especially the ID tags to be attached to various things should be widely (i.e., globally) compatible among those of different makers. Sharing the data in the family may be a natural direction in the ubiquitous information society.

(d) Comments and Discussions during the Seminar

In this session the Group discussed on the relationships between the System and the humans and further on the relationships of the System with the super-systems (i.e., the ubiquitous society). It was nice indeed that the Group reached the far goals through the group practice during this 2-Day Training Seminar.

- The Group's decision of setting aside the 'Problem of an umbrella left behind at the entrance' was reasonable considering the time limitation. The Umbrella Problem may be solved by extending the graphical consideration of the distance with respect to time, and by making the Main System more intelligent.
- At the end of the usage process, we should add another step of 'when arriving at home'. The Person may need to reset and turn off several controls.
- The suggestion of 'making the System useful for handicapped people' was an important remark for making the present system valuable in wide use. Considering and designing the System further in this direction would be great in building a useful social system in the ubiquitous society.

10. Discussion and Remarks

This part of paper corresponds to the item (e) 'Further comments after the Seminar' in the USIT Case Study Template and was written in 2 days after the Training Seminar as a case study report being sent to the participants.

10.1 Choice of This Problem in the USIT Training

As mentioned in Sections 2 and 3, the present problem was submitted by the present author as the Instructor, because of lack in real-problem submission by the participants. It is a kind of 'everyday-life problems' and 'technical problems in society', and may be regarded at first as a 'toy problem for exercise'. The problem was initially submitted as making 'A System for preventing from and alarming on the spot of our leaving things behind', and was analyzed and solved to generate a consistent set of conceptual ideas all through the Group Practices along the USIT Training Seminar. Such consistency in the goal setting of the problem solving was the basis for the success in this practice case; this was prepared beforehand in the preliminary discussions in the present author's seminar at Osaka Gakuin University.

The present case was to take some common needs of almost everybody as the keys and to try to make an image and a conceptual plan of a new technical system (or a new product). When USIT was introduced as a Creative Problem Solving Method, some people regarded the 'problem solving' in a narrow meaning as 'solving problems (or defects) of existing systems'. The present case has clearly shown that the problem solving in USIT may be considered in a much wider sense including the planning of new type of products.

The present case of Group practice have produced active discussions and achieved the results at the level much higher than the Instructor expected beforehand. The group of five members were not so high level in their technical background among the groups of people the Instructor met in his in-house and open USIT Training Seminars. Nevertheless, the group produced the documents as shown in Figs. 2 through 11, by the joint efforts of all the five members in only two days of training.

10.2 On the Methods of Training of USIT

The present author had the experiences of conducting 22 times of USIT 2-Day (or 3-Day) Training Seminars as the Instructor. The agenda of the Training Seminar was established almost at the steady level. Some remarks on the present case follow:

- The present case was somewhat unusual because the present author made roles of both the Instructor and the Problem Proposer. Hence the Instructor led the Group Practice of the present problem directly at first. Even in such occasions, however, after briefly explaining the direction to go he posed questions to the members and wrote the members' answers on the board. The scripts in Fig. 2 and in the upper half of Fig. 3 reflect such a procedure.

- The Instructor drew the Functional Analysis diagrams in Fig. 5, without waiting for the members' action. The USIT-style diagrams of Functional Analysis are, if appropriately drawn, so simple and easy to understand that sometimes the participants ask 'Can they be so simple like that?'. But there were many cases where trainees' groups stack in arguments to draw the diagrams in more complicated ways. Furthermore in this case, several diagrams needed to be drawn at different stages of the problem process; but such a direction was not described in the Training Text. These were the reasons for the Instructor himself to have drawn them.
- The top part of Fig. 8 was also drawn by the Instructor. Just before drawing it, the Group was wondering for some time what to do next while the Instructor was involved in the other Group. Thus the Instructor drew the top part of the Desirable Actions in the Particles Method, in order to re-direct the Group.
- Besides the above two parts of drawings, the Instructor led the Group mostly by showing the framework of what to write. E.g., in the top part of Fig. 7, the framework of drawing the present and ideal situations along the steps of the scenario; in the lower part of Fig. 8, the framework of writing the desirable actions with the categories of 'consciousness of the person', 'action onto the person', and 'action of the things' and also horizontally along the steps of the scenario; and in Fig. 10, the framework for listing up the component functions of the System.
- The present author played the role of the Instructor, mostly, instead of the Problem Proposer. The Instructor's guidance or involvement was done slightly more, or rather slightly earlier, than usual, because there was some risk of wandering around due to the nature of the problem being a common-sense and wide-covering problem.
- Post-It Notes and big sheets of papers were used for recording the analyses and ideas. These means were found useful, especially when the ideas need to be rearranged for the purpose of classification and re-organization. This is advantageous over the electrically recordable whiteboards, even though there is the demerits of taking time in taking the photos and making copies of the prints.

10.3 On the Methods of Applying USIT

(a) Applying USIT to the problems to plan or design a new non-existing system/product was not the first but relatively new experience. The key points for such USIT applications were clarified as follows:

- At the Problem Definition Stage, one should be careful not to make the goal too broad and vague.
- At the Analysis of Present System, consider the current way of doing things and find what are missing; this leads us to think what kind of new system/product is wanted.
- The Space and Time Characteristic Analyses are found very useful, especially in this sort of new and relatively vague problem.
- The Analysis of the Ideal System (i.e., Particles Method) is most valuable; think over the aim of the new system/product in a free yet systematic and comprehensive way of thinking.
- At the Solution Generation Stage, apply the following steps: first write down all the ideas obtained so far at the analysis stage, then build them up into a (or multiple) set of conceptual solutions, and

further try to solve subsidiary problems in the conceptual solution and consider the relationships with its super-systems.

Thus all the steps of USIT were found useful and effective for solving this type of problem. Particularly, the consideration in the step of Analysis of Ideal System was found the crucial key to make the new plan novel and unordinary.

(b) The present case is also remarkable in the point that it requires the consideration of time dependence, or processes. Applying USIT to such a type of problems was also relatively new, thus the following points should be remarked:

- Since the time dependence is recognized at the early stage of Problem Definition, scenarios of typical cases are written down
- In the Functional Analysis of the Present System, multiple Functional Diagrams are drawn along the key steps of the scenarios.
- The Time Characteristics Analysis is crucial, and hence it should set the general framework in the whole problem solving procedure with USIT.
- Ideal Systems should also be considered along the whole process; particularly, not only at the stage of the trouble and at its immediate-prior stage but also at much earlier stages of the problem.
- Ideas for solutions should be generated for every step of the scenarios.
- For composing the ideas into a conceptual solution, the solution system should be designed to perform properly at different time steps.

In this manner, USIT has been proved applicable and effective to the problems with time dependence.

(c) This theme was also noticeable in its feature related to software as well as hardware technologies and to a distributed system of collaborative components in ubiquitous information society. Since the application of TRIZ/USIT has not been reported much so far in this field, the present case study should also be of value.

- Even though the system is related to software in some components, it has not caused any especial difficulty in applying USIT. Only the difference is that some of the functions in the system are supposed to be implemented with some digital information processing in IC chips, MPU, personal information terminals, etc., instead with hardware mechanisms in mechanics, electronics, etc. It is necessary to judge whether such a function is feasible or not with the background knowledge of software and IT technologies. Such a requirement of specialty in software and IT is essentially the same as the requirement of specialty in mechanics, semiconductors, chemistry, etc. for the TRIZ/USIT application in hardware technology fields.

The results obtained for the present case have been evaluated to have shown that USIT is useful and effective for creatively solving problems of planning and constructing a new system related to IT technologies and software.

(d) How to teach and train the Solution Generation Methods in USIT has been an important issue in the

present author's USIT Training Seminars. Many trainees in previous training seminars said that even though they produced many nice solution ideas in the group practices for themselves they were not clear enough how to use USIT Solution Generation Methods. Some remarks on this issue follow:

- From the theoretical view of the Six-Box Scheme of USIT, the solution generation is achieved in two steps, i.e. first to obtain pieces of ideas of solution by applying various USIT Operators and then to construct solution concepts (or solutions at the conceptual level) by applying mostly the technical background.
- In fact, the USIT Operators contain 32 sub-methods (in 5 main categories) in total and there are usually a large number of possible operands (i.e., Objects, Attributes, Functions of the system, and intermediate solution pairs, and solutions); thus 'applying the USIT Operators onto possible operands of the system and intermediate solutions' means a huge number of operations (or rather unlimited number of operations) to apply. Thus a theoretical suggestion of exhaustive search operations is not practical.
- Especially in the Training Seminar, the participants are not yet familiar enough with individual USIT Operators. Thus in the training seminar of only 2 days it is not practical to lead them to 'Apply USIT Operators explicitly'.
- Hence in the present seminar, the participants were first guided to write down all the ideas which they thought of during/after the problem analysis. They usually write 5 to 8 ideas each in 30 or 45 minutes, and some of them are at high level in quality. This reflects the effectiveness of the analysis methods in USIT.
- On the basis of such solution ideas, solution concepts can be constructed and further improved with additional ideas, as shown in the present case. Thus most of the participants of the USIT Training Seminars have evaluated the USIT solution generation itself productive and creative.
- In some previous training seminars, some participants had a feeling of 'still not clear yet how to apply USIT Operators'. Thus the Instructor advised the participants in the present seminar to take several ideas and to consider what USIT Operators can lead such ideas. This way of thinking is an application of USIT Solution Generalization Method and is good for understanding the essence of USIT Operators. More details of USIT Operators can be learned by the guidelines and examples coming from TRIZ/USIT.

This issue of how to teach USIT Solution Generation Methods needs further discussions and experiments.

10.4 Evaluation of the Resultant Solution Concepts

The results of the problem solving in the present case in the Training Seminar are the handwritten documents which are faithfully shown in Figs. 2 through 11 after translating from Japanese into English. Some remarks concerning the evaluation of them are as follows:

- The documents contain a nice set of conceptual solutions, even though they need to be rewritten and brushed up into a more formal technical proposal. The proposed solution here is at the level

of concepts, just as intended in the USIT methodology. The present author evaluates the solution in this case highly, especially in its overall consideration within the limited time of group practice.

- As modeled in the USIT Six-Box Scheme, a conceptual solution (i.e., in the 5th Box) need to be implemented into a user's concrete solution (i.e., in the 6th Box) before realizing the idea as a real product/process/service, etc. The implementation stage must be carried out not in the thinking world of USIT but in the real world of technologies, businesses, and society.
- The conceptual solution in the present case can provide a good proposal toward a useful system in the coming ubiquitous information society, which should be worthy of further examination and refinement for using in the real situations and of designing and prototyping for the implementation.
- Various components of the present solution concept need to be examined closely against their feasibility, effectiveness, cost, technologies, etc. There may appear various alternatives and refinements during such process of examination and implementation.
- Novelty and patentability of the concepts, if any, have not been checked. In real cases, this kind of checking and further search of relevant technologies must be done before/inbetween/after the USIT procedure.

11. Concluding Remarks

The present study has demonstrated a real case of group practice with USIT in its 2-Day Training Seminar. A real problem of avoiding and preventing from our leaving things behind was solved by a 5-member group by using the USIT procedure. Actual application of USIT has been shown with the produced documents and supplementary explanation. USIT has been applied to the problem of planning/constructing a new system related to IT and software field, and of time-dependant nature. USIT procedure has been applied smoothly by the trainees, after introductory lectures and with little guidance during the group practice. The present paper has demonstrated that the whole procedure of USIT can be learned easily and applied effectively to real problems.

Acknowledgement: The present author express sincere thanks to the five members who performed the group practice, although their names may not be cited here. The present case was disclosed publicly on February 1, 2006 in Japanese after the Problem Proposer (T. N.) (and the two group member's companies) had decided not to pursue patent filing, if any possibility, in accordance with the Agreement signed by all the participants of the Seminar.

REFERENCES [1)]

[1] Ed. N. Sickafus: "Unified Structured Inventive Thinking: How to Invent", NTELLECK, Grosse Ile, MI, USA (1997).

[2] Genrich Altshuller: "Creativity as an Exact Science", Gordon &Breach, 1984 (E).

[3] Darrell Mann: "Hands-On Systematic Innovation", CREAX Press, Ieper, Belgium, 2002 (E); Japanese edition, translated by Toru Nakagawa et al., SKI, Tokyo, 2004 (J).

[4] Roni Horowitz: 'From TRIZ to ASIT in 4 Steps', TRIZ Journal, Aug. 2001 (E); TRIZ HP Japan, Sept.

2001 (J). URL: http://www.start2think.com/ (E).

[5] Toru Nakagawa: 'Experiences of Teaching and Applying the Essence of TRIZ with Easier USIT Procedure', TRIZCON2002: Fourth Annual Altshuller Institute for TRIZ Studies International Conference, Apr. 30- May 2, 2002, St. Louis, MO, USA; TRIZ HP Japan, Jan. 2002 (J); May 2002 (E).

[6] Toru Nakagawa, Hideaki Kosha, and Yuji Mihara: 'Reorganizing TRIZ Solution Generation Methods into Simple Five in USIT', ETRIA World Conference "TRIZ Future 2002" held at Strasbourg, France, on Nov. 6-8, 2002; TRIZ HP Japan, Sept. 2002 (J); Nov. 2002 (E).

[7] Toru Nakagawa: 'USIT Operators for Solution Generation in TRIZ: Clearer Guide to Solution Paths', presented at ETRIA TRIZ Future 2004 Conference, held at Florence, Italy, on Nov. 3-5, 2004 (E); TRIZ HP Japan, Oct. 2004 (J), Nov. 2004 (R); TRIZ Journal, Mar. 2005 (E).

[8] Toru Nakagawa: 'Overall Dataflow Structures for Creative Problem Solving in TRIZ/USIT', TRIZCON2005: The 7th Annual Altshuller Institute for TRIZ Studies International Conference, Apr. 17-19, 2005, Detroit; TRIZ HP Japan, Mar. 2005 (J); Jun. 2005 (E).

Note: "TRIZ HP Japan" represents: "TRIZ Home Page in Japan", Editor: Toru Nakagawa.
http://www. osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/ (in English),
http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/ (in Japanese).

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

About the author:

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