TRIZ Forum: Conference Report (22-B)

TRIZ シンポジウム 2009
The Fifth TRIZ Symposium in Japan

Personal Report of The Fifth TRIZ Symposium in Japan, 2009

Held by the Japan TRIZ Society, NPO, on Sept. 10-12, 2009, at National Women's Eduction Center (NWEC), Saitama, Japan

Part B. Methodologies in TRIZ

Reviewed by Toru Nakagawa (Osaka Gakuin Univ., Japan), Nov. 22, 2009

[Posted on Nov. 23, 2009]

TRIZ Home Page in Japan Jap.

For going back to Japanese pages, press Jap. buttons. Japanese translation of this page is not scheduled.

Editor's Note (Toru Nakagawa, Nov. 22, 2009)

This page is Part B of my Personal Report of Japan TRIZ Symposium 2009. Please see the Parent page Engl for the overall description of the Symposium and the general introduction of the Personal Report. I am thankful to the Authors for their permitting me to cite their slides here for introduction.

Note: (TN, Mar. 11, 2010) Click here for the PDF file of this page of Personal Report.

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4. Methodologies in TRIZ

The topic of Technology Forecasting is closely related to the two Keynote Lectures by Boris Zlotin and by Darrell Mann. Fortunately in the present Symposium we have had two more Oral presentations contributed by the Italian group, Gaetano Cascini, Davide Russo, et al., who are working actively to build a 'repeatable and objective' method for technology forecasting. Italian group's basic method is called 'Networks of scenarios' or 'Network of Evolutionary Trends (NET)'. It is an intensive and nice method, on which the Authors (Cascini and Russo together) presented a full detailed paper at ETRIA TFC2008. I wrote its review in my Personal Report and posted it in this Web site Engl..

Davide Russo, Caterina Rizzi, Tiziano Montecchi (Univ. of Bergamo, Italy) [E07 O-18] gave an Oral Presentation on **"Interconnectivity and White-Space Opportunity: Bringing Together Forecasting and Scenario Planning to find Innovative Opportunities".** Here is the Authors' Abstract:

> Nowadays an even more hard market competition pushes companies to continue innovation in the process and product development. Therefore, the role of emerging technologies forecasts can play as an information source in the decision-making of the private and public companies. Dozens of forecasting methods, dealing with social, economic, financial, environmental and technical aspects have been proposed so far in order to support decision makers, but limitations in accuracy on middle and long-term forecast, the poor repeatability and adaptability have limited their applications and diffusion.
>
> In this paper a methodology aimed to provide a visual synthesis of a system in all its evolution steps, design variants and future potential configurations, is presented. Such a method integrates new criteria for patent searching/clustering and knowledge organization. The Knowledge Mapping framework shows in a very concise way what has already been explored by competitors and highlights what can still be done. The outcome permits to identify key variants at the structure level both for a rapid and for a following deeper forecasting activity. A software implementation (called KOM- Knowledge Organizing Module) is under development to make the information extraction process more automatic.
> A case study of the method, already widely tested in different engineering domains, is here proposed.

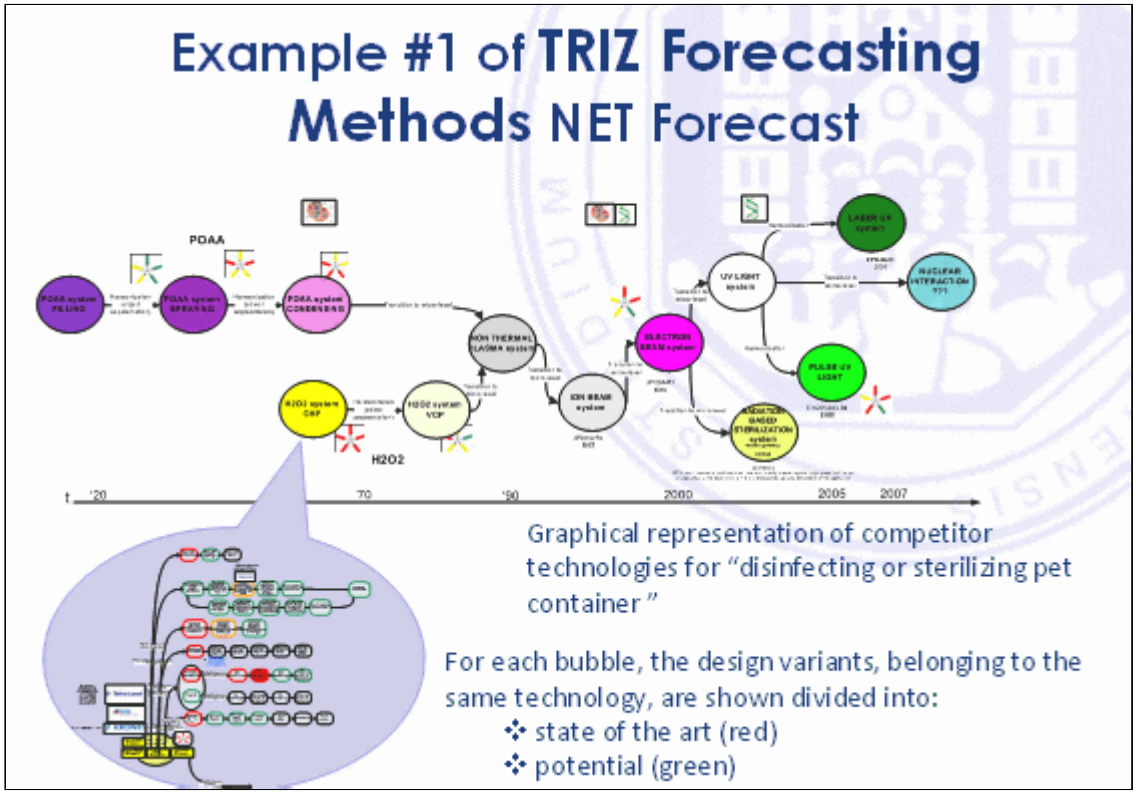
At the initial part of presentation the Authors critically review the currently present technologies; they include:

- NET (Network of Evolutionary Trends) Forecast: by Cascini and Russo (Italy)
- DE (Directed Evolution): by Zlotin and Zusman (USA)
- Evolution Trees: by Nikolay Shpakovsky (Russia)
- Generic scheme of technology evolution: by Petrov (Israel)
- Generic scheme of technology evolution: by Yuri Salamatov (Russia)

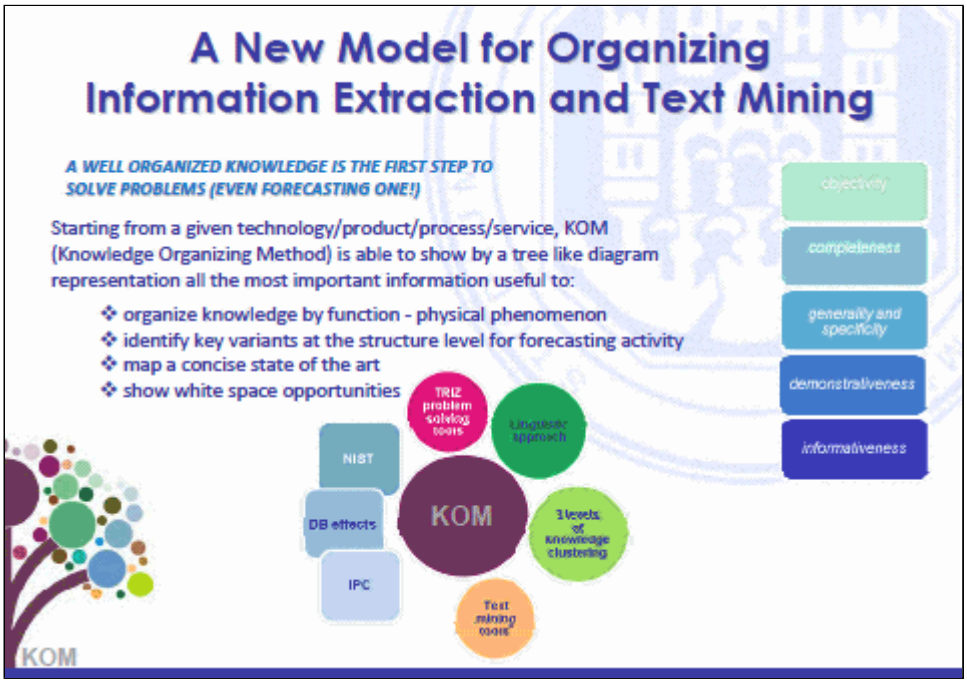
An example of the NET diagram by Cascini and Russo is show here (right). Various stages of evolution of the product are shown by the bubbles in the upper diagram. In

each bubble, the technology at the stage is further described by showing design variants.

For the sake of clarity and saving space, I would like to skip these review parts and jump into their new original part.

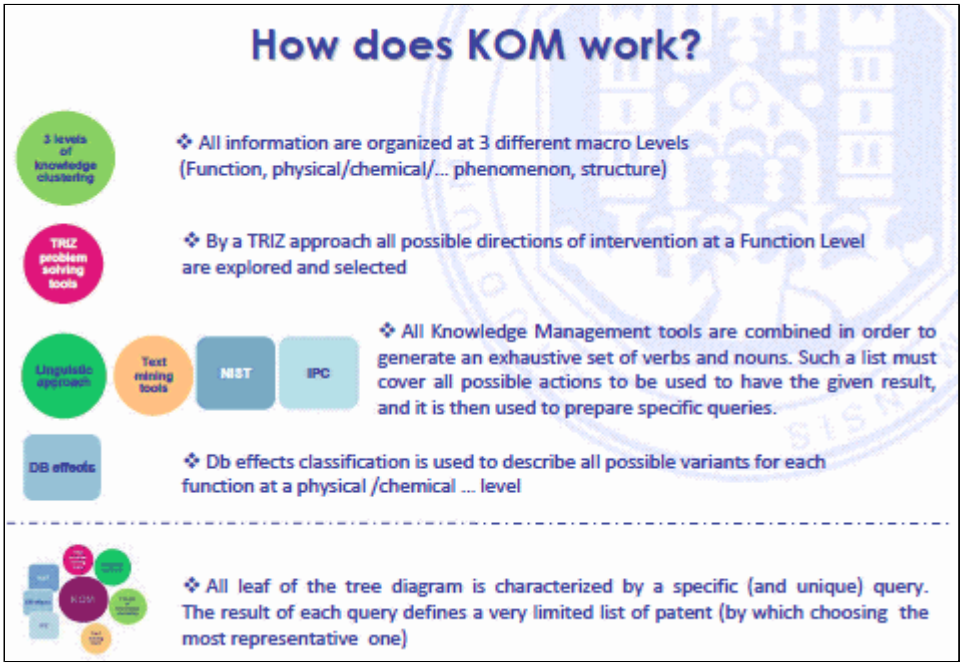


The new model by Davide Russo et al. is called the KOM (Knowledge Organization Method). This is a model for organizing information extraction and text mining. By using several components of methods and tools, this method builds up a tree-like diagram of all the information related to the evolution/variation of the product.

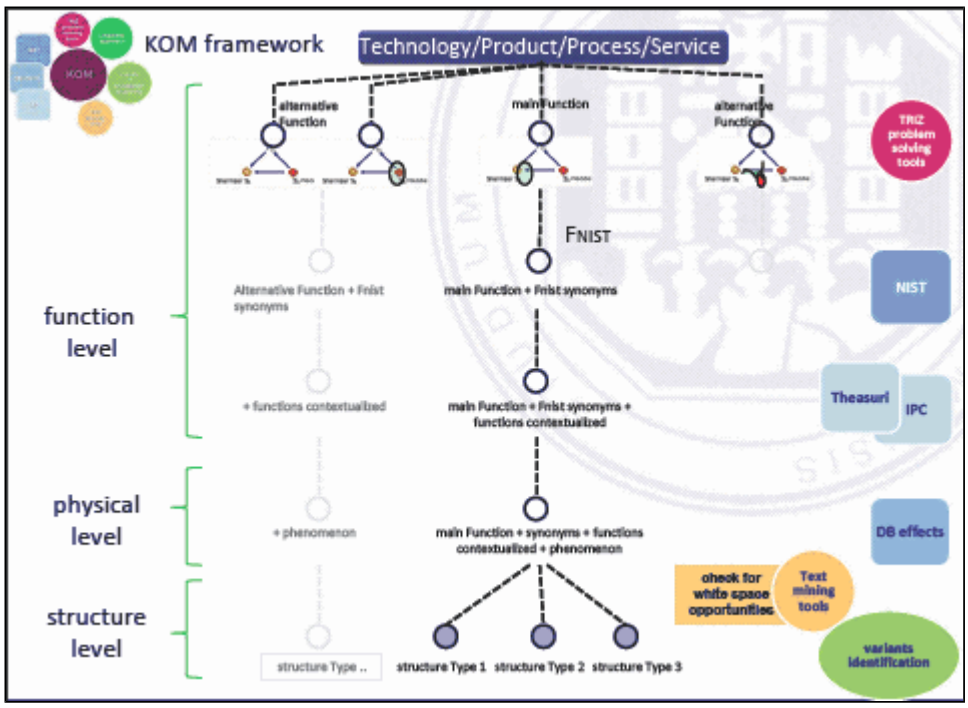


This slide (right) shows the overall structure of the method. It has 3 macro levels. (1) In the Function level, a TRIZ approach is used to explore all possible directions of intervention. Then several Knowledge Management tools are used in combination to generate an exhaustive set of verbs and nouns for representing the functions. (2) Further, the Effects Databases are

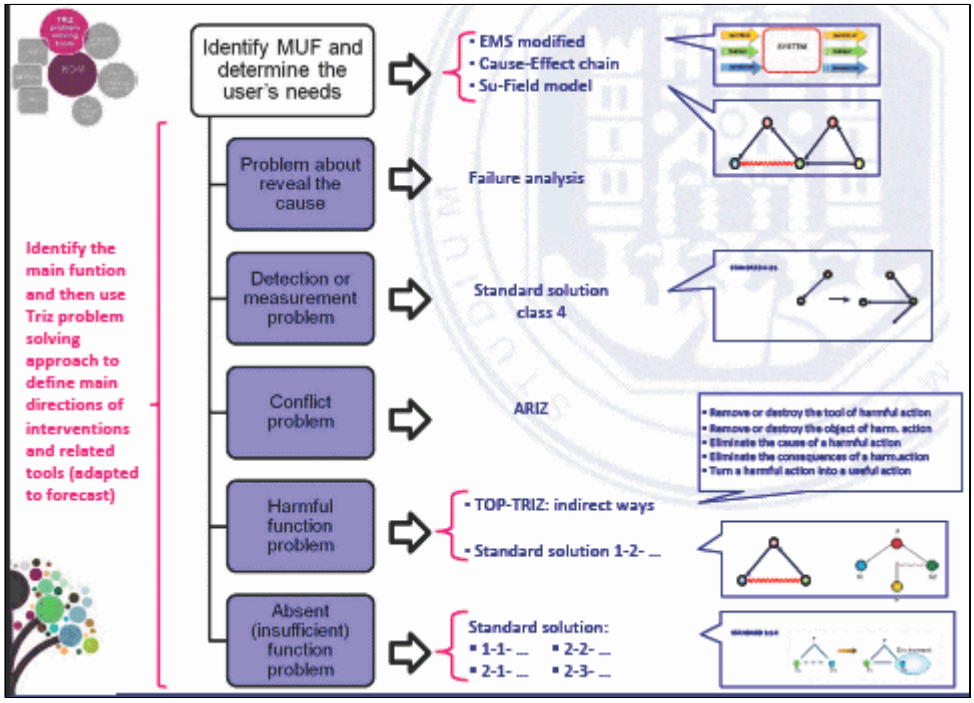
used to describe all possible variants. By following these steps a tree diagram is built with the leaves characterized by a specific query. (3) Such a query can find a very limited number of patents (in the structure level), the Authors say.



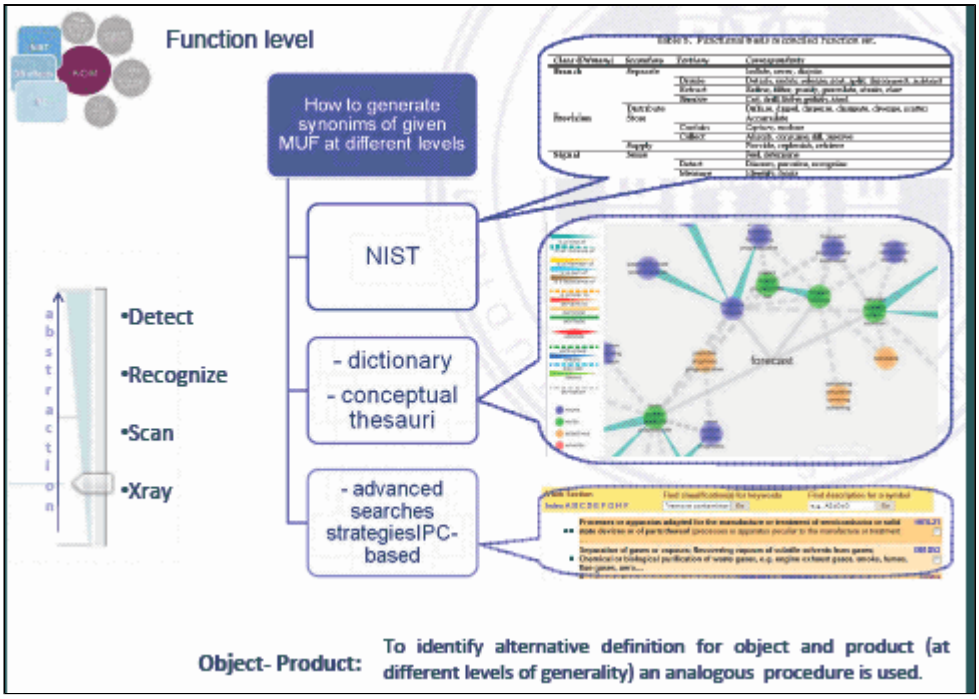
This slide explains the tree structure to be built (downward). At the top level, the TRIZ problem solving tools (i.e. Inventive Standards) are used to classify the solution directions schematically. Then the NIST classification of functions, and the exploration of synonymous functions through thesaurus and IPC are carried out to develop the branches of the tree. At the physical level, the Effects Databases are used. Finally at the structure level, patent databases are searched with queries with the support of text mining tools, resulting examples having different structure types.



The first step is shown here. First to identify MUF (Most Useful Function) and determine the user's needs. The needs are classified as (a) problem about revealing the cause, (b) detection or measurement problem, (c) conflict problem, (d) harmful function problem, and (e) absent (insufficient) function problem. According to these classifications, Standard solutions in TRIZ are suggested for the schematic, functional solutions.

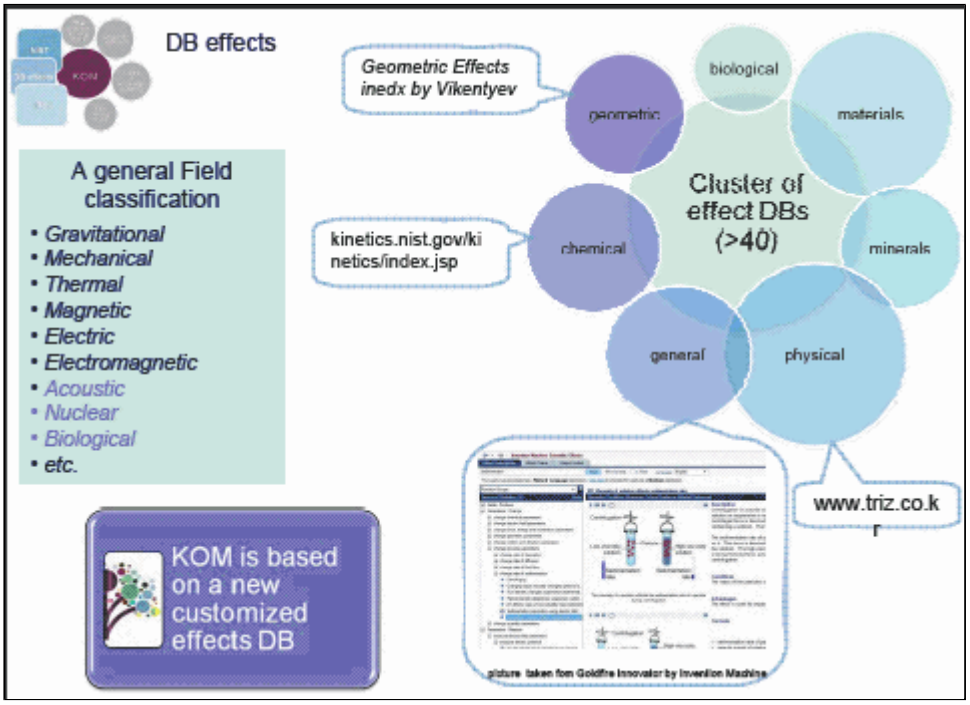


This slide (right) shows how to generate synonyms of the given MUF at different abstraction levels. NIST's functional bases are first used, and then dictionary, conceptual thesauri, and advanced searches of strategies on the basis of IPC are used in turn. At the left in this slide an example of abstraction of function is shown (i.e. Xray is abstracted to Scan --> Recognize --> Detect.)

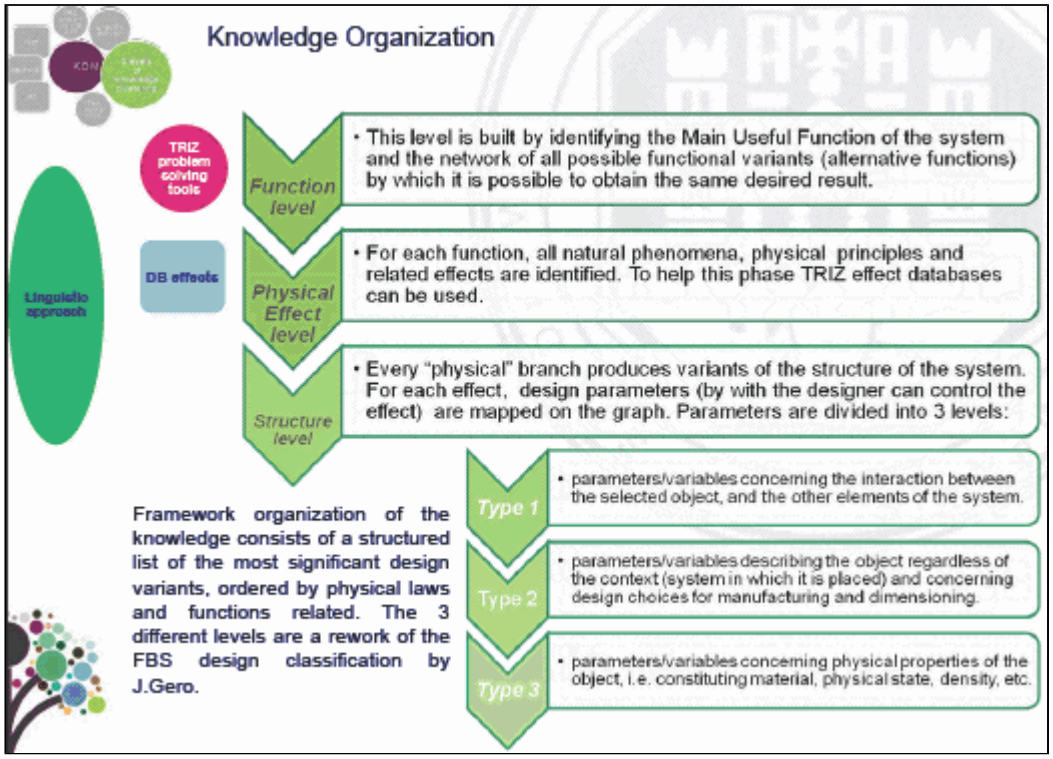


In the Physical level, various Effects Databases are used. As shown here, more than 40 Effects Databases are collected to use.

*** These collections of databases seem to be effective.

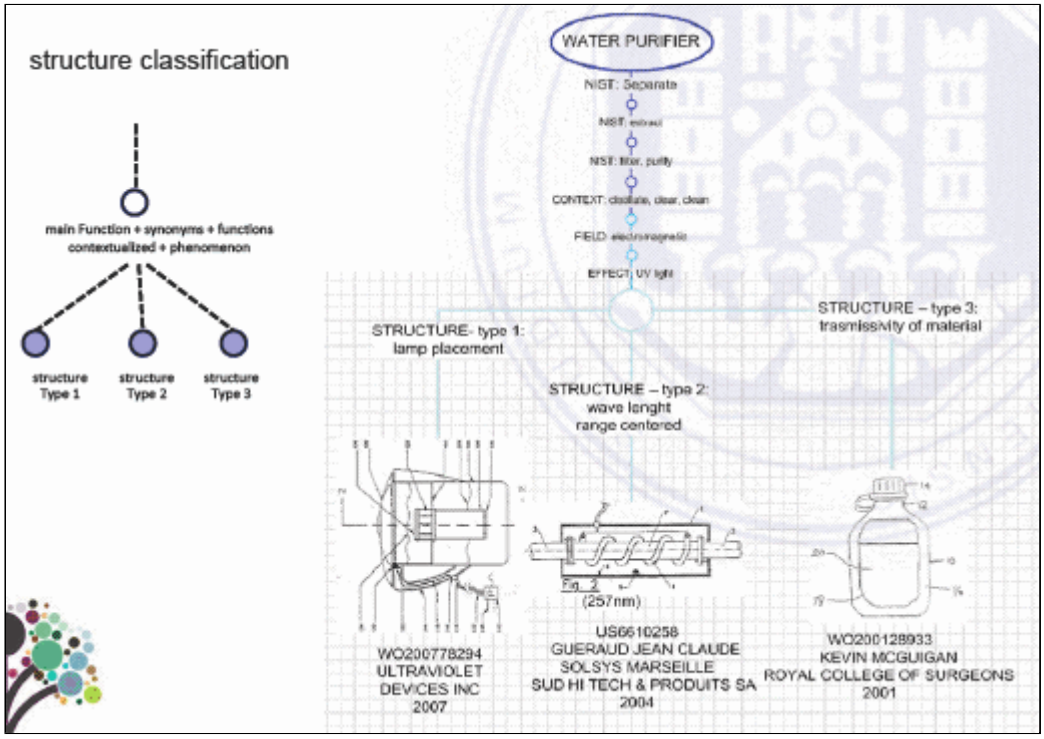


Then in the Structure level, for each branch of physical effects design parameters are mapped on the graph. Such parameters are divided into 3 levels (types 1, 2, 3).

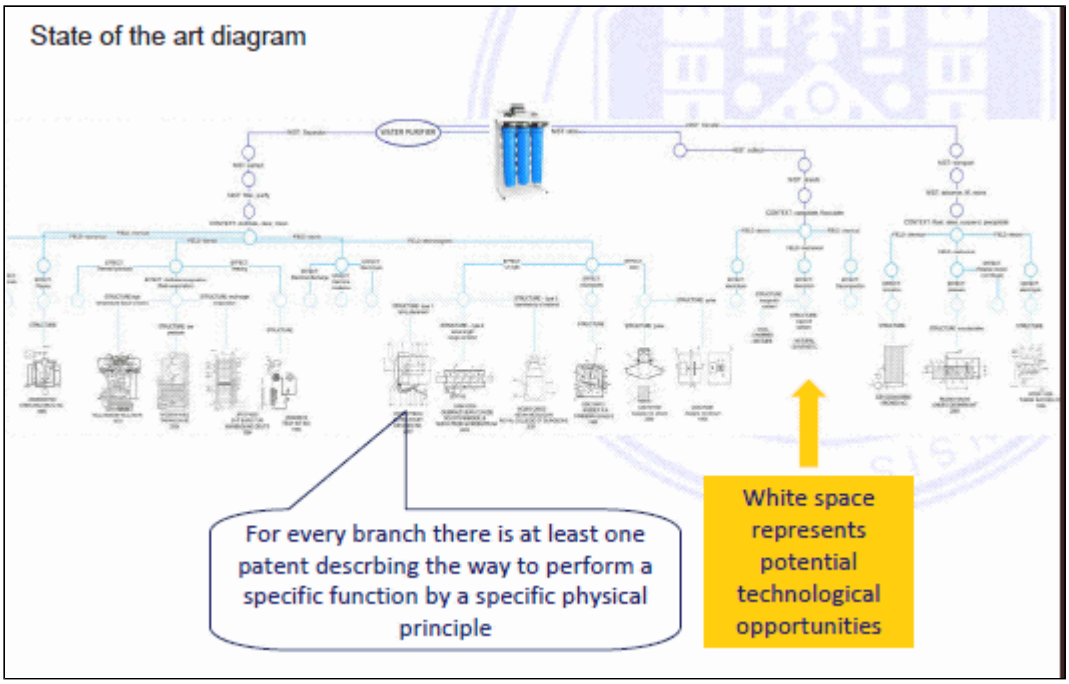


The slide (right) shows the leaf structure of the tree diagram. A case study was shown for the 'Water purifier'. One of the branch comes down like: Water purifier --> separate --> extract --> filter, purify --> distillate, clear, clean --> electromagnetic --> UV light. Now at the structure level, the design parameters are chosen, e.g. (type 1)

lamp placement, (type 2) wave length range centered, (type 3) transmissibility of material. Example of patents searched are illustrated in the figure.



In the manner described so far, the tree diagram is built step by step to explore the existing/possible solution space. By filling the results of the patent search, the state of the art of the Water Purifier is demonstrated in this slide. As shown in this example, there are cases where some of the leaves do not have known patents. Such cases represent potential technological opportunities.



*** This method utilizes various public modules/databases effectively and seems to be useful to explore existing and possible solution space systematically.

Gaetano Cascini, Niccolo Becatini (Politecnico di Milano, Italy), Federico Rotini (Universita degli Studi di Firenze, Italy) [E12 O-14] gave a nice Oral presentation with the title of "Network of Evolutionary Trends and Maturity Assessment through Contradictions Analysis". Here I will quote the Authors' Abstract first:

> TRIZ literature presents several papers and even books claiming the efficiency of Altshuller's Laws of Engineering System Evolution as a means for producing technology forecasts. Nevertheless, all the instruments and the procedures proposed so far suffer from poor repeatability, while the increasing adoption of innovation as the key factor for being competitive requires reliable and repeatable methods and tools for the analysis of emerging technologies and their potential impact.

Moreover, a paradoxical dichotomy characterizes most of TRIZ publications: most of them focused on problem solving, take into account the concept of contradictions, but practically neglect any relationship with the LESE. Vice versa, evolutionary analyses and "technology forecasting" applications are just based on the directions inspired by the LESE and/or by a few trends (e.g. the Inventive Standards of Class 2 and 3), but the notion of contradiction is missing.

The present paper introduces a contribution in this context through a study about the correlations existing between the evolution of contradictions and the Law of Ideality increase. A maturity index based on such correlation is defined. The full paper details the proposed algorithm for contradiction classification and an extended case study in the field of production of tablets in the pharmaceutical manufacturing sector.

Reflecting the Abstract, the Goal and outline of the presentation are shown in the slide (right). The fist half of the presentation concerns with the building of a network of scenarios (or a Network of Evolutionary Trends). This part is nice, but I will rather skip it because the Authors presented a more detailed paper at ETRIA TFC2008. I wrote its review in my Personal Report and posted it in this Web site Engl.

Goal and outline

- **Step-by-step algorithm** for analyzing a Technical System (TS) and the way its Main useful Function (MUF) is delivered at different detail levels
  - The working principle is then compared with previous generations of the system in order to build a structured classification of the information for evolutionary comparisons
  - These comparisons allow to build a network of scenarios with different involvement of resources, which constitutes a map of the TS evolution, where already commercialized products are visualized together with emerging patented inventions and free spaces for investments
  - Correlate the maturity of a technology with the evolution of the contradictions underlying its application in a certain field
  - The choice of the favorite strategical direction is still assigned to the beneficiaries of the forecast according to their attitude to the world, their mission and values, as already suggested by Altshuller

Thus the new part of the present paper is the latter half, i.e. to correlate the Contradictions and Evolutionary Stages.

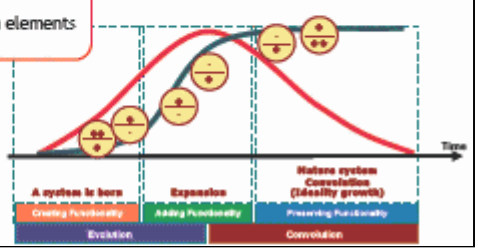
- Outline
  - Related Art
  - Reference models for system analysis
  - Functional modeling for TRIZ-based evolutionary analyses
  - Building a Network of Trends (NET)
  - Correlation between Contradictions and Evolutionary Stages
  - Exemplary application
    - Production of tablets in the pharmaceutical manufacturing sector
  - Conclusions and future works

For correlating the Contradictions with Evolutionary Stages, the Authors use the wave model by Yuri Salamatov. The growth of the degree of ideality can be compared with the consumption of resources. Characteristic patterns of changes in the Useful functions (UF), Costs (or Resource consumption) (C), and Harmful functions (HF) are shown in the graph of the evolutionary change of ideality of a system. Various parameters of UF, C, and HF are listed in the slide (right). The Authors discuss (though being skipped in this review) how to evaluate these parameters.

Correlation between Contradictions and Evolutionary Stages

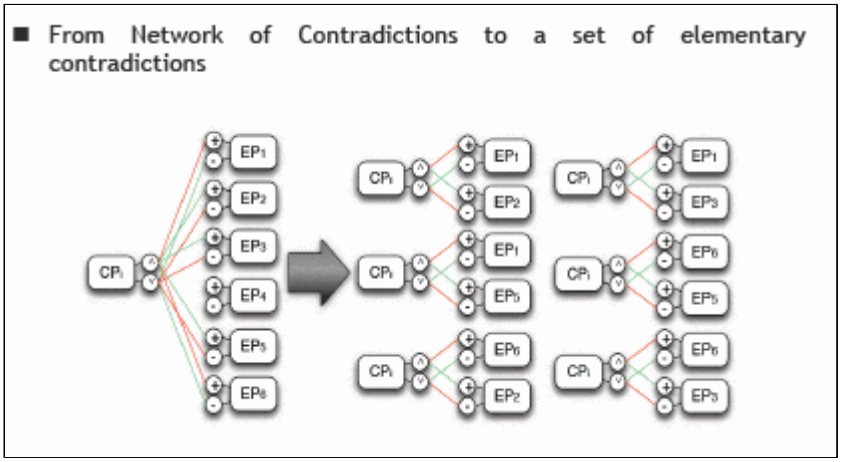
- Evaluation Parameters related to Ideality:
  - Main Useful Function (MUF) Performance
    - Threshold achievements
    - Versatility
    - Robustness
    - Controllability
  - Harmful Functions/Effects:
    - Acting on the MUF object:
    - Acting on system and subsystem elements
    - Acting on the environment
  - Resources Consumption:
    - Space
    - Time
    - Information
    - Material
    - Energy

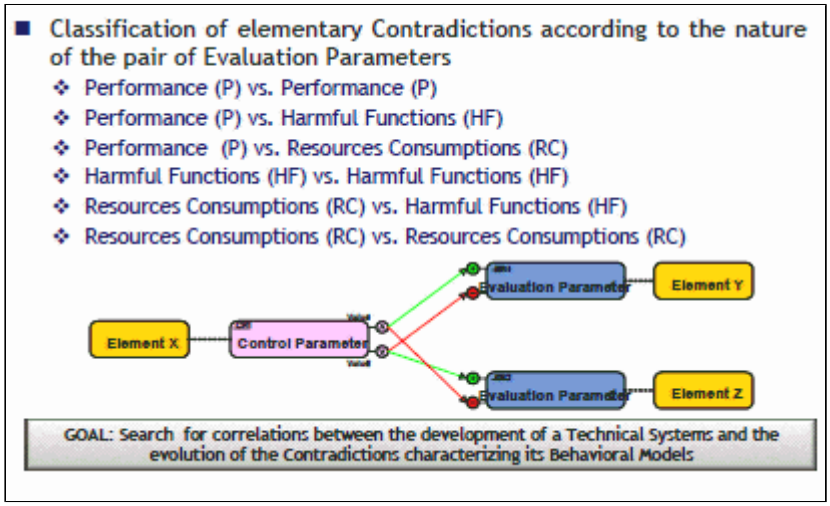
$$I = \frac{\sum UF}{\sum C + \sum HF}$$



Then the Authors show how to identify various contradictions which form a complex network of contradictions. The Contradictions are advised to separate into a set of elementary contradictions (slide right).

The elementary contradictions can be classified according to the nature of the pair of Evaluation Parameters (slide below left). The abundance of the elementary contradictions according to these patterns are empirically found to have the tendency as shown in the slide (below-right). I.e., Contradictions of performance vs performance are predominant in the emerging stage of evolution and fade out in the later stages, whereas contradictions of resource vs resource increase from the emerging stage to the



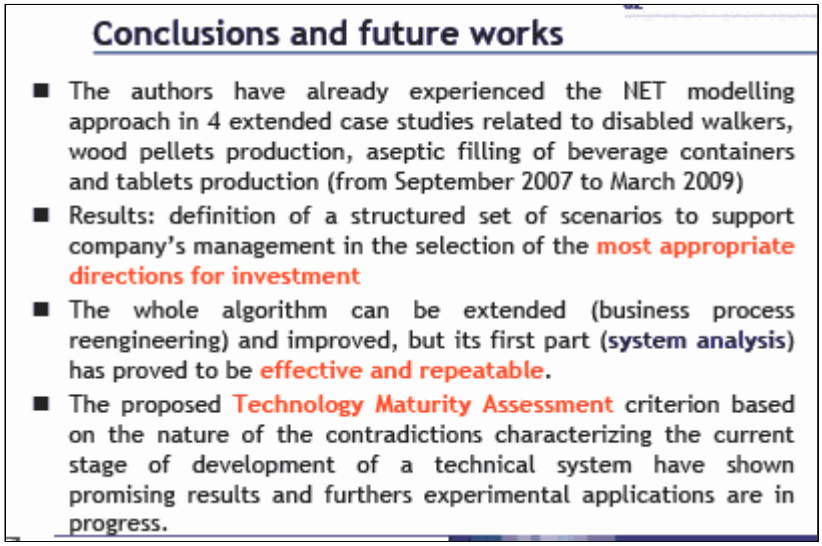


Technology profile	Performance vs. Performance	Harmful functions vs. Harmful functions	Resources vs. Resources
Emerging	41,6%	17,9%	40,5%
Growing	14,8%	16,7%	68,5%
Declining	8,4%	17,6%	74,0%

Average percentage of contradictions for BMs associated to the same stage of evolution

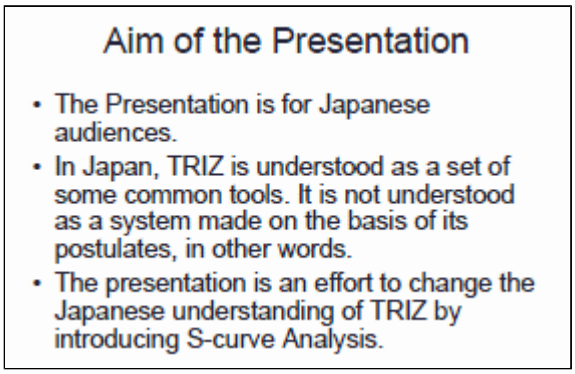
The slide (right) shows the conclusions and future works. The Authors have already applied the present approach of building the Network of Evolutionary Trends (NET) to 4 case studies, and have found it effective to support company's management in selecting the most appropriate directions for investment. Repeatability or objectiveness of the approach is the main merit of the present method, the Authors claim. The Technology Maturity Assessment based on the nature of contradictions need further experiments, they suppose.

*** The Authors seem to have made steady progress in the research of building a 'repeatable' method for predicting the future of technical systems.



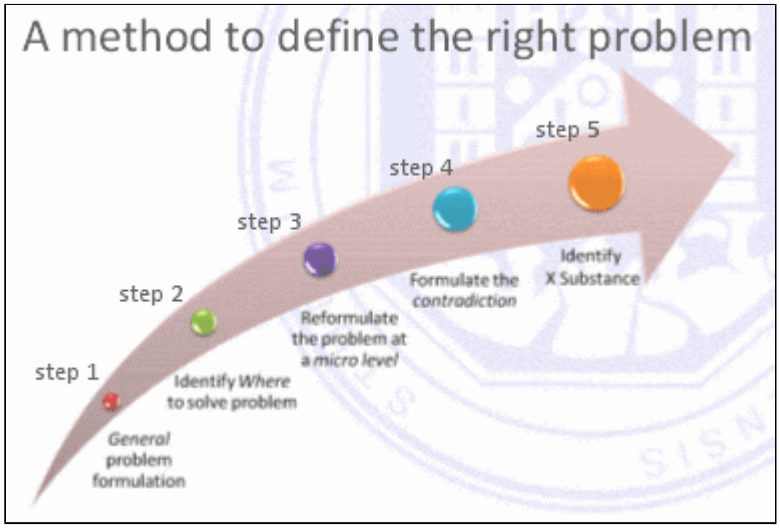
Shinsuke Kurosawa (The SANNO Institute of Management) [J04 P-A2] gave a Poster presentation on **"Using "Stages of Evolution of a Technological System": The Basic Tool for Problem Solving".**

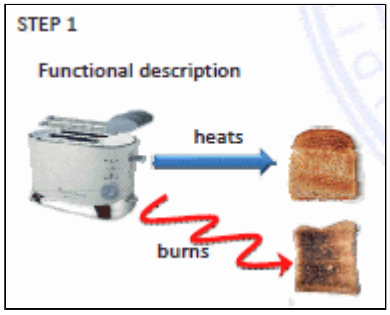
The Author writes the aim of the presentation as shown in the slide (right). Unfortunately, this is the only slide available in English (except the title slide), besides the 18 slides in Japanese. Since the Author is fluent in English and in Russian, we would like to look forward to his writing the article in English.



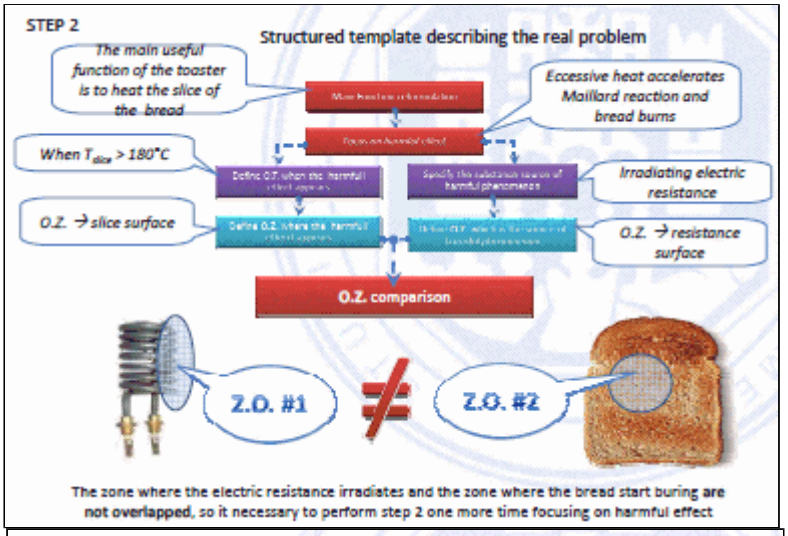
Davide Russo, Daniele Regazzoni, Valentino Birolini (University of Bergamo, Italy) [E05 P-B7] gave a Poster presentation with the title of **"How to define the right problem in a problem solving activity".**

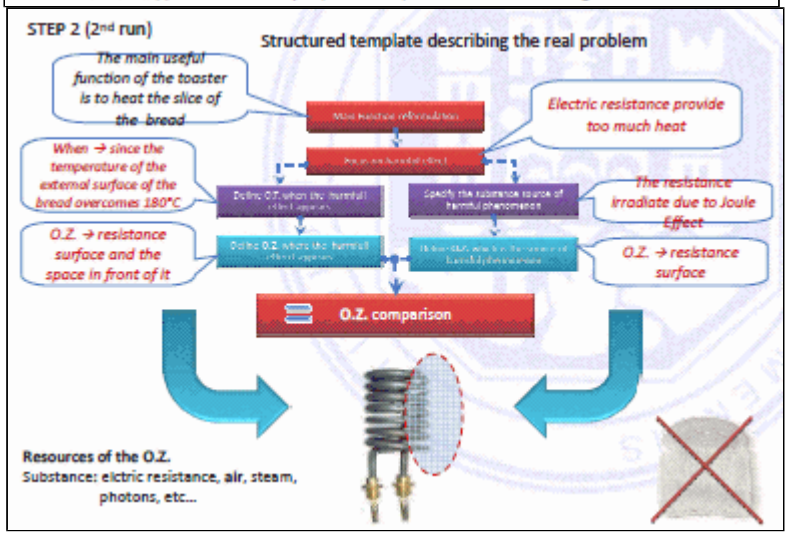
The Authors explain their 5 -step procedure in general terms, and then demonstrate case study of a bread toaster. Sometimes the toaster heats the bread too much and burns it.





Their Step 2 is shown in the following two slides (below). Here the task is to identify 'where to solve the problem' (i.e. Operational Zone). In the slide (below-left) the problem is understood as 'Excessive heat burns bread', and the Operational Zone 1 (where the harmful effect appears) is found to be the slice surface whereas the Operational Zone 2 (where the source of harmful phenomenon locates) the heater surface. Since the two zones do not match, the Authors suggest to redefine the problem to be 'The heater provides too much heat', as in the next slide (below-right). In this second problem setting, the two Operational Zones (i.e. where the harmful effect appears and where the source of harmful phenomenon locates) match. So the Authors go on to the subsequent steps to Step 5.





*** I feel the procedure shown in this example is quite artificial and has failed in guiding the user in a more straight forward and effective way to problem solving. I think that most of the procedures shown here in Steps 1 to 5 are actually analyzing the problem. 'Preventing the toaster from burning bread (too much)' is certainly be a problem among many others related to the toaster. I would like to have criteria to find whether this problem is the 'right problem', that is most important to tackle with among others and most fruitful in future if it is solved.

Takao Adachi (The SANNO Institute of Management) [J03 O-15] gave an Oral presentation on "A Design

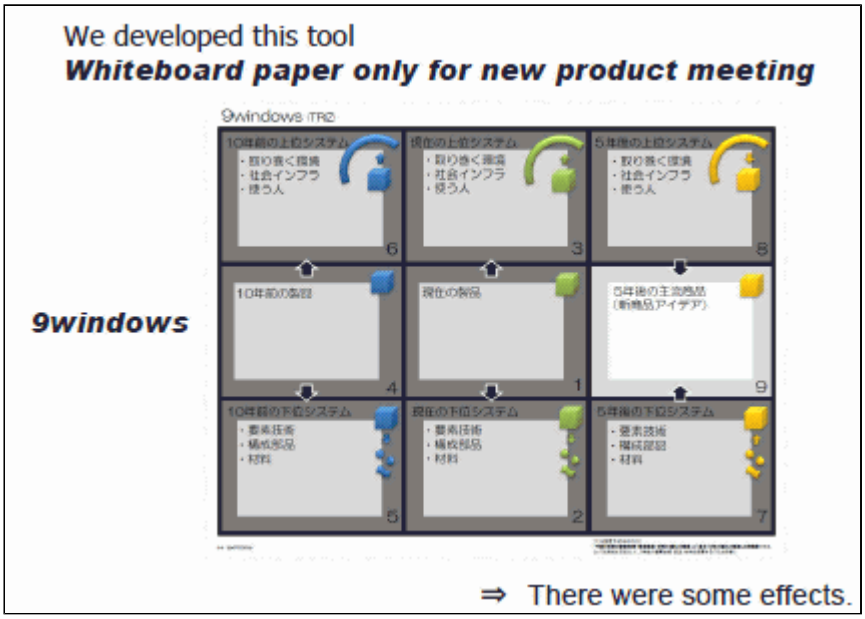
Method with TRIZ for Pursuing Ideality". This presentation was given with Japanese slides alone. So I will quote the Author's Abstract written in English. Sorry but I cannot find time to explain the contents.

> The present paper introduces a method for designing a new system, by using the Problem Formulator (developed by Ideation International Inc., USA) for avoiding contradictions and for making the ultimate use of minimal resources. Trying to improve preceding systems is the typical method we use for solving difficult technical problems. The design method, introduced here, however, intends to design a new system on the basis of a substantially different mechanism from the existing ones and to solve the same problem.
>
> In the improvement approach we try to use existing resources in and around the system more effectively than before, but in the present new approach we try to introduce new resources selectively from outside. Designing is an activity that selects a minimum set of necessary resources, we believe. On the basis of this selection we can solve contradictions in the course of designing, make ultimate use of minimum resources, and hence realize the design pursuing the ideality.

Rikie Ishii ([Miyagi TRIZ Study Group (Mi-TRIZ)] IDEAPLANT) [J20 P-B3] gave a Poster presentation with the title of **"Development of a Tool That Supports TRIZ Leaders during Idea Generation Meetings: 9-Windows Board".** Here is the Author's Abstract:

> Mi-TRIZ [Miyagi TRIZ Study Group] conducted a TRIZ study meeting open to the public. The participants having attended this meeting tried to use TRIZ at the meetings in their own companies, but they had a hard time in common. Mi-TRIZ wanted to overcome this situation and worked on the development of a tool that would make it easy to use TRIZ when running a meeting. Finally, Mi-TRIZ developed a whiteboard tool that designed the “9windows” which was in the highest demand. This presentation will introduce the real tool and report the results of the questionnaire survey on it.

The tool developed in the present work is shown in the slide (right). This is a large size (about 1 m in width) laminated paper with the design of the format of 9 windows method. This paper is typically spread on the table (or on the wall) for the discussion meeting for developing a new product. Guided with the 9 window framework and brief items for suggestions, the members of the meeting are facilitated to fill in the blank parts while the discussion. Users found it easy to fill in the windows and effective in discussion, especially to think of productive ideas and to form consensus of the members.



*** The Authors, who are based in Sendai City, Miyagi Prefecture, have made appoaches always attractive for SMEs.

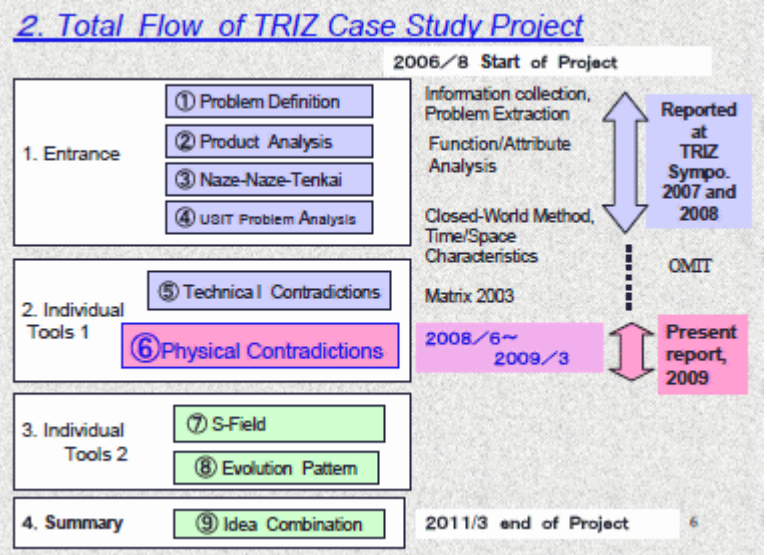
Makoto Unno, Hideaki Saegusa (Kawasaki Heavy Industries), Nobuhide Matsuda (Panasonic Co.), Kazuyasu Ikeda (Sekisui Engineering Co.) [J25 O-9] gave an Oral presentation with the title of **"Study on Development-Phase-TRIZ (part 3): Case Study on Contradiction Solving Process".** I will quote the Authors' Abstract first:

> In the Society of Japanese Value Engineering, Kansai Chapter (one of regional activities), many

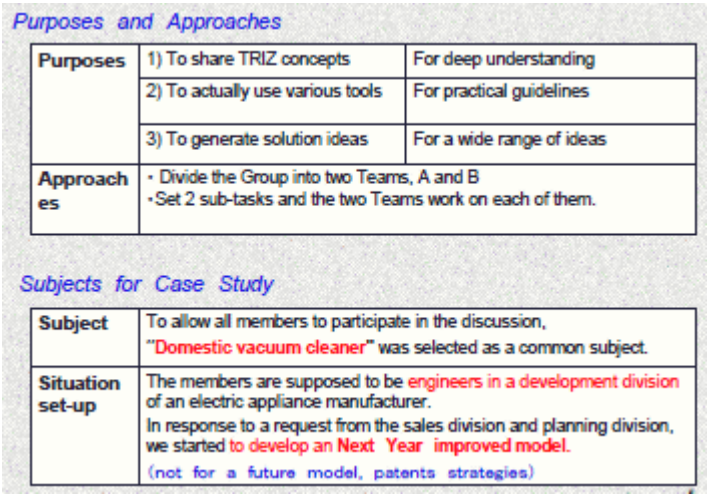
people are attracted to TRIZ, as the new knowledge, which shall be utilized in the creative thinking, and various problem solving processes in Value Engineering activities. Therefore, "Working Group for Effective Utilizing of TRIZ" has been established in 2003. The future target for the Working Group is the logical fusion-utilizing of VE and TRIZ.

Our Working Group expects that TRIZ tools could be utilized effectively in the new product concept planning-phase and technical development-phase, in the enterprise business process, and so various relevant tools have to be examined for finding more effective problem solving processes. Since 2006, the case-study has been started for the precise understanding of various TRIZ tool's features and effective process, and is planned to be ended in 2011. In this 3rd study results of the Working Group, practically useful knowledge are revealed, regarding "the contradiction solving process."

As written in the Abstract, the Group has been working since 2003, with 24 members coming from 16 different companies (with no consultants), and monthly meeting for a full working day in their sites by turn. It is amazing that this group has been making deep discussions together on the processes of TRIZ problem solving. The 5 year plan of their case study project is shown in the slide (right). The present report concerns to the Physical Contradictions. Since all the group members are TRIZ promoters in their companies, they know all these methods/tools. Thus it is not necessary for them to scan these methods/tools quickly (because they have already done it individually).



The purposes and approaches of their group and of their case study project are described in the slide (right). They try to understand each step/tool deeply by reading different textbooks and articles, by explaining their own ways of usage, by making practices together under the facilitation by the member by turn, by applying different ways of the tool, etc. Their main intention is to discuss/reveal/understand/improve the Thinking Process of formulating and solving the Physical Contradictions.



They have chosen the subjects for their case study with the intention shown in the slide (right). Improvement of "Domestic vacuum cleaner" was chosen.

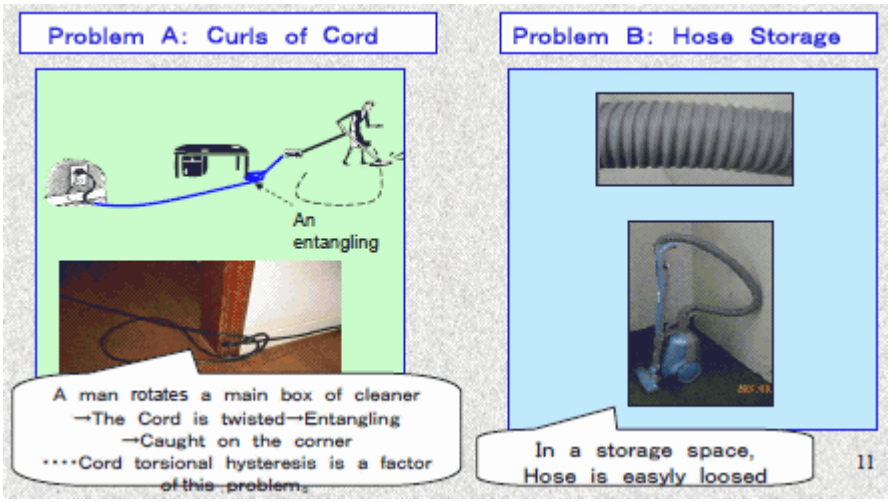
Under this general topic, they have chosen two problems as shown in the slide (right).

Problem A: Curls of cord. While using the vacuum cleaner, the user works around and rotates the cleaner body on the floor, causing the cord twisted and entangled.

Problem B: Hose Storage. In a storage space the hose is easily loosed and takes much space.

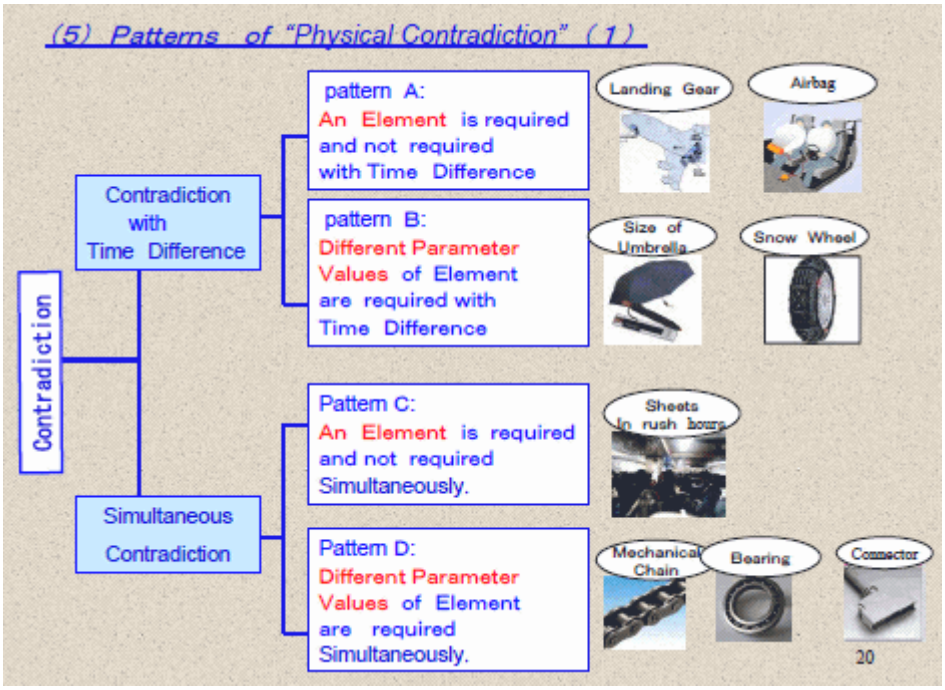
The present report discusses about

the treatment of Physical Contradictions in these problems.



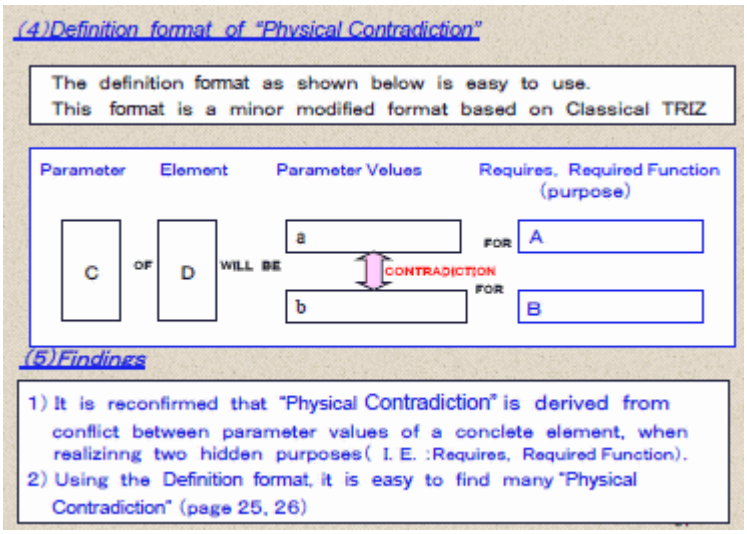
During the discussions, it is found useful to understand patterns of Physical Contradictions. The slide (right) shows one of such patterns (i.e. classifications). These 4 patterns are found easy to understand and useful to think of different ways of solving contradictions.

As also shown in the slide (right), various examples of Physical Contradictions (and examples of solutions to Physical Contradictions) have been collected. Such a collection is useful for the education purposes.



The formulation of Physical Contradictions has been discussed also. The Group has studied various textbooks on this topic, including "Classical TRIZ", Darrell Mann's "Systematic Innovation", Larry Ball's "Hierarchical TRIZ Algorithms", etc. They have found the definition format shown in the slide (right) useful. It is a minor modification of the format of Classical TRIZ.

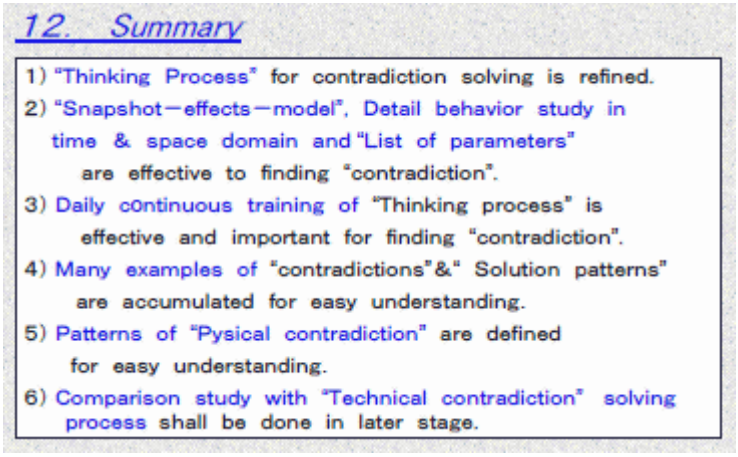
As shown in the Findings in the slide, they have found a lot of Physical Contradictions in their own problems and generated a large number of solutions to them (even though not shown in this review).



The conclusions by the Authors are shown in the slide (right). The "Thinking Process" mentioned here has some preliminary processes before formulating the Physical Contradiction. "Snapshot-effects-model" is a kind of functional model representing for each of critical timings of the problem. So they use rather standard functional analysis (considering the time dependence) and

attribute analysis, instead of ARIZ, as the preparation for the Physical Contradiction.

*** As I wrote in the beginning, the steady and intensive activities of this Working Group in Japan Value Engineering Society are indeed amazing. I recall the recent formation of similar group of industrial TRIZ people in the US, including Larry Ball (Honeywell) etc.



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