Editor's Note (Toru Nakagawa, Jan. 30, 2008)

This is a personal report of ETRIA "TRIZ Future 2007" Conference held on November 6 - 8, 2007 in Frankfurt am Main, Germany (See ETRIA Official Web site and TFC2007 Web site). As you might already know in ETRIA Web site or in this Web site, I have written this kind of 'Personal Report' for all the ETRIA TFCs, TRIZCONs, and Japan TRIZ Symposia since 1998. The intentions and purposes of writing such reports are to introduce the contents of these conferences to people who are interested in TRIZ but were not able to attend the conference. Reports written from personal views can have unique roles of conveying vivid information with some evaluation, which neither official 'fair' reports nor authors' 'original' papers can have. However, personal reports need to be written in a delicate balance of personal interests and evaluation vs. fairness, under the limitation of reporter's understanding of the papers and presentations (see some more description in my previous report).

Writing 'Personal Report' is getting more and more heavy load for me, I feel. Partly because I was so busy to write the report of Japan TRIZ Symposium until mid-November, partly because there are as many as 50 papers, partly because I could attend at less-than-half of the presentations due to double- or triple-track sessions, partly because I am not good at taking notes of speeches, etc., etc. I started writing this report on Nov. 25, wrote little by little in parallel to reading the papers, and have just finished writing reviews of individual papers today on Jan. 30, 2007. From now on I will need to write concluding remarks, to brush up the whole report, to make links, to get permissions from authors for citing their figures, to write the summary of this report in Japanese, and to prepare for posting, etc. I hope I will be able to post this around Feb. 8, 2008.

I wish to express my sincere thanks to all the people who organized this TFC 2007 Conference, especially Dr. Carsten Gundlach (IHK) and Professor Gaetano Cascini (ETRIA), and who contributed and participated to it for making it successful. I also wish to thank all the authors who gave me permission of citing their figures in this report. The paragraphs (or sentences) starting with "***" and the inserts enclosed in [ ] show my personal comments. If you (especially the authors of the conference papers) find any mistake or misunderstanding in this report, please notify me via email.

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7. Usage of TRIZ in Academia
8. Patent Studies
9. Quality and TRIZ
10. Miscellaneous and No-Presentation Papers
11. Concluding Remarks

List of Papers Published in the "Proceedings of the ETRIA TRIZ Future Conference 2007"
1. Outline of the Conference

Name of the conference: The ETRIA 'TRIZ Future 2007' Conference

Date: Nov. 6, 2007 (Tue.) 9:00 -- Nov. 8, 2007 (Thu.) 15:00 (3 days)

Location: IHK (Chamber of Commerce and Industry) Innovation Support Center, Frankfurt am Main, Germany

Held by: ETRIA (European TRIZ Association), European TRIZ Centrum for Creativity Problem Solving, CCI Innovation Support Center Hesse, and Technology Transfer Network Hesse

Participants: About 120

Presentations: 4 Keynote Speeches, 44 Oral Presentations (in single/double/triple tracks), 3 Tutorials


is the Seventh "TRIZ Future Conference" held by ETRIA. You can see my Personal Reports of the previous conferences in Bath, UK (2001), in Strasbourg, France (2002), in Aachen, Germany (2003), in Florence, Italy (2004), in Graz, Austria (2005), and in Kortrijk, Belgium (2006). This year it was held in Frankfurt am Main, Germany.

The Conference was organized by the collaboration of ETRIA (Professor Gaetano Cascini) and German organizations, including European TRIZ Centrum for Creativity Problem Solving (Mr. Horst Ried and Dr. Rolf Herb), CCI Innovation Support Centre Hesse (Dr. Carsten Gundluch), Technology Transfer Network Hesse, and Technical University of Munich (Professor Udo Lindemann). We thank all those who made this conference possible and fruitful.

The theme of the Conference was "Current Scientific and Industrial Reality". The Proceedings of the Conference contain 45 papers in 290 pages. It is divided into two parts, i.e. Scientific Articles and Industrial and Pratical Articles, reflecting to the two reviewing committees. Scientific Committee with 23 members and Industrial/Pratical Committee with 16 members made double or triple peer reviews for accepting and suggesting improvements of the papers.

2. Agenda of the Conference

Table of Contents of the Proceedings is attached here in the PDF format (4 pages, 18 KB), as provided by the Organizers.

Agenda of the Conference is outlined in the following tables. The titles and the authors are sometimes abbreviated; see the List of Papers for more detail. The * marks in these tables represent Nakagawa’s attendance at the presentation.

Agenda of ETRIA TRIZ Future Conference 2007

Nov. 6, 2007 (Tuesday)
### Nov. 7, 2007 (Wednesday)

#### Morning

<table>
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<th>Parallel Sessions</th>
<th>Scientific Contributions:</th>
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<td>Bionics in Patents · Semantic-based Analysis or the Exploitation of Bionic Principles in Patents Lothar Walter at al. [17]</td>
<td>ISQ vs PE &amp; FAA Mahmoud Karimi et al. [32]</td>
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<td></td>
<td>Relationships between TRIZ and Classical Design Methodology Markus Deimel [7]</td>
<td>Selecting Contradictions or Managing Problem Complexity Valeri Souchkov et al. [43]</td>
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**Key Note 3:** An Original Contribution to the Understanding of Laws of Technical Innovation: Gilbert Simondon's Tribute to "Mecanology" Vincent Bontems [48] *

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### Afternoon

#### Plenary

**Key Note:** Design Methodologies: Blessing or Curse? Lucienne Blessing [46] *

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### Evening

Get Together + Dinner *

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### Parallel Sessions

<table>
<thead>
<tr>
<th>Scientific Contributions:</th>
<th>TRIZ &amp; Company Experiences:</th>
</tr>
</thead>
</table>

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### Plenary

**Key Note 2:** Innovation Management within Alstom Transport Guillaume Vendroux [47] *

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**Tutorials**

- **Morning:** Present and Future Technology Dmitry Kucharavy *
- **Fundamentals** Nikolai Khomenko
- **Technology** Pavel Livotov

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**Afternoon:**

- **Plenary**
  - TRIZ Future Conference 2007 -- Opening and Welcome Sonke Bastlein; Rolf Herb; Gaetano Cascini *
  - Introduction to the Conference and TRIZ Udo Lindemann *
  - Keynote: Design Methodologies: Blessing or Curse? Lucienne Blessing [46] *

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**Parallel Sessions**

- **Scientific Contributions:**
  - Applying TRIZ for Systematic Manufacturing Process Innovation: The Single Point Incremental Forming Case Joost Duflou et al. [8]
  - TRIZ·Fractality of Mathematics Victor Berdonosov et al. [3]
  - Creating a Holistic Product Development Methodology by Merging Systems Theory and Dialectics Jorg Feldhusen et al. [9]

- **TRIZ & Company Experiences:**
  - Trends of Toyota Production System Evolution TPS-TESE Dmitri Wolfson et al. [44] *
  - Lessons Learned in the Introduction of TRIZ at Siemens A&D Robert Adunka [18] *

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**Plenary**

- **Key Note 2:** Innovation Management within Alstom Transport Guillaume Vendroux [47] *

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**Evening**

- Get Together + Dinner *

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**Scientific Contribution:**

- Systematic Design through the Integration of TRIZ and Optimization Tools Gaetano Cascini [8]
- TRIZ & Innovation:
  - TRIZ Tools to Evaluate Marketing Strategy and Product Innovation: A New Start-up Case Study of Silicone Technology Robert Nani et al. [40] *
- TRIZ Tools & Methodology:
  - Applying the TRIZ-CBR Model for Improving A System Guillermo Cortes Robles et al. [23]
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
<th>Topic</th>
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<tbody>
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<td></td>
<td>TRIZ Method Introduced to the Calculation Field</td>
<td>Simona-Mariana Cretu [6]</td>
<td>The Introduction and Application of TRIZ in Industrial Business in Germany · An Investigative Study Martin Jandt et al. [26] *</td>
</tr>
<tr>
<td></td>
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<td>TRIZ as a Catalyst or Project Management (PM) Excellence (and PM as Catalyst or Systematic Innovation, i.e. the Other Way Round)</td>
<td>Giacomo Bersano et al. [20]</td>
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<td></td>
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<td>From Problem Solving to Innovation: Providing and Efficient Framework for TRIZ</td>
<td>Dmitri Van Nuland et al. [41]</td>
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<td>TRIZ &amp; Innovation: Innovation Improvement of Consumer Products</td>
<td>Marina M. Ksenofontova et al. [34]</td>
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<td>Innovation and Quality Need to Go Together for Capturing Value</td>
<td>Atsuko Ishida [27]</td>
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<td>TRIZ Tools within IP Strategic Framework Development Sergei Ikovenko [26] *</td>
<td>Sergei Ikovenko [26]</td>
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<tr>
<td>Evening</td>
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<td>Dinner and Social Event *</td>
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<tr>
<td>Nov. 8, 2007 (Thursday)</td>
<td>Key Note 4: General Theory of Innovation and Its Applications</td>
<td>Greg Yezerski [45]</td>
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<td>Education and Training of Creative Problem Solving Thinking with TRIZ/USIT</td>
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<td>TRIZ Course Enhances Thinking and Problem Solving Skills of Engineering Students</td>
<td>Iouri Belski [2] *</td>
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<td></td>
<td>Parallel Sessions</td>
<td>Practioner Contribution OTSM-TRIZ as a Technology of Training of the Expert in Education</td>
<td>Anna Korzun [19]</td>
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<td></td>
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<td>In Search of Seventh Generation of Quality, A New Paradigm TRIZ</td>
<td>Edguardo Cordova Lopez et al. [22]</td>
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<td></td>
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<td>The Application of TRIZ Methodology in Iron &amp; Steel Making Industry</td>
<td>HeeChoon Lee et al. [36]</td>
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<td>Afternoon:</td>
<td>Parallel Sessions</td>
<td>Rhetorical Topics and TRIZ - Progressive Methods with Unnoticed Capacity?</td>
<td>Thomas Bayer et al. [1]</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Classical TRIZ and OSM as a Scientific Theoretical Background for Nontypical Problem Solving Instruments</td>
<td>Nikolai Khomenko et al. [11]</td>
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</table>
In the Agenda the presentations were arranged in the categories of topics. In the present Report, however, I am going to classify them in a slightly different way as follows:

3. Methodologies in TRIZ
4. Integration of TRIZ with Other Methodologies
5. Case Studies in Industry
6. Promotion of TRIZ in Industries
7. Usage of TRIZ in Academia
8. Patent Studies
9. TRIZ and Quality
10. Miscellaneous and No-Presentation Papers
11. Concluding Remarks

3. Methodologies in TRIZ

Ellen Domb (The PQR Group, USA) and Joe A. Miller (Quality Process Consulting, USA) [25] gave a presentation with the title of "The Complete Technical System Generates Problem Definitions". This paper is in a series of their trials of how to teach TRIZ effectively to beginners. I will cite their Abstract first:

Beginners frequently encounter one barrier to success with TRIZ: They must understand both the problem they are dealing with AND TRIZ in order to get a good start. But they frequently lack the patience to learn TRIZ in enough detail to do the analysis and formulation of the problem, or, their organization wants to see results from a "pilot project" before investing in the training that is necessary. In other word, introducing TRIZ into many corporate environments requires resolving the contradiction that they want comprehensive understanding and sophisticated problem solving without spending any time learning either of them.

Building on the method of using the beginners' version of the complete technical system that we introduced in the ETRIA TRIZ Future 2006 Conference, we will show how beginners can learn quickly and how to make use of some of the most powerful tools of TRIZ including

- The Ideal Final Result
- The System Operator
- Contradictions

Examples will be provided from the work of beginners in business and technical applications.

This work is not intended to dilute or diminish TRIZ. It is intended to help beginners get a fast start, so that the benefits of their early projects can pay for the time, training, and work needed to do more extensive TRIZ applications later.

The Authors also state: "We assume that while competency is necessary and desirable for both "career" knowledge and "methodology" knowledge, TRIZ will generally only be an adjunct to the person's job. Few beginners intend to make TRIZ a career. They have jobs to do and are just looking for a little help to do them better. We therefore structure instruction and exercises to illustrate the adaptability and flexibility of TRIZ to their own discipline, whatever it may be."

One example of the Authors' way of instruction may be illustrated with the following figure of expansion of the System Operator. This illustrates that even for one initial situation there can be multiple possible environments (i.e., super systems) and correspondingly multiple contributing elements to consider. This helps the students to think of different ways of defining their problems. [I am not sure why the Authors put the sub-systems at the top and the super-systems at the bottom.]
Anyway, this paper is worthy of reading for those who are in the position of guiding TRIZ beginners.

Valeri Souchkov (ICG Training & Consulting, The Netherlands) and Karel Bolckmans (Koppert BV, The Netherlands) [43] gave a presentation on “Selecting Contradictions for Managing Problem Complexity”. The Authors have introduced a diagram called RCA+ (Root Conflict Analysis) since 2004 (See ETRIA TFC 2006), and have applied it to 183 projects both in technology and business areas, they say. The diagram is useful to describe causal relationships and reveal contradictions. In many cases, they have found the problems are so complex that the diagram contain 15-20 different contradictions and hence it is necessary to decide which contradictions should be addressed first.

To illustrate the situation, I will cite the Authors' case study of the Windmill Electric Generator, first. The problem description and its RCA+ diagram are as follows:

"An offshore electric windmill is installed in a sea near the coastline and converts wind energy into mechanical energy produced by rotation of the blades, which is subsequently converted into electricity. However, due to strong winds, the velocity of the tips of the blade becomes very high. This causes the upper part of the blades (tip) to hit the dust particles and water droplets which are present in the air with high force. As a result, the tip’s surface gets deformed, which reduces the overall performance of the windmill. The blades should be periodically replaced which is a quite cost-ineffective procedure."
In the RCA+ diagram, ovals represent useful effects (+) while rectangles either harmful/negative (-) or contradictory (+-) effects; the arrows show the causal relationships among them. The most important feature of the diagram is its ability to show the contradiction in a clear manner, as a set of a pair of + and - effects forming technical contradiction' and 'an + - effect of source of physical contradiction'. The scheme of a contradiction is illustrated below (left) along with a simple example (right).

In the actual RCA+ diagrams, as illustrated above for the Windmill problem, there are various complex cases involving multiple contradictions. Hence the Authors' objectives in the present paper are:

- To demonstrate what different types of relationships can exist between contradictions in inventive problems. => > 5 types are found.
- To present a number of heuristic rules which help to select a contradiction which has to be solved in case of complex RCA+ diagrams. => > 3 types of selection methods are proposed.

In the followings, the 5 types of relationships between contradictions are demonstrated one by one, by showing the scheme and its example, while explaining appropriate selection method in each type:

(1) Independent ("OR"-related) contradiction causes:
Since the two contradictions independently affect on the common negative effect, the importance of the two should be evaluated separately and ranked for selection. (C1 is selected in the example.)

(2) Dependent ("AND"-related) contradictions:

Two (or more) causes together form a negative effect. Thus it is enough to eliminate just one contradiction, and the negative effect will be completely eliminated. For the selection of contradiction to address, 'Ideality-based criteria' should be used. The criteria are: (a) involving least number of (or no) supersystem elements and then least number of system elements; (b) involving elements we can change easily; and (c) alignment with the overall strategy of the problem owner. (C2 is selected in the example.)

(3) Causally-Related Contradictions:

In this type, the contradiction cause (C2) causes another contradiction cause (C1) which leads to a negative effect. Eliminating either of the two will break the chain to the negative effect. Thus the 'Ideality-based criteria' described in (2) may be used for selection. (C1 is addressed in the example.)

(4) Complexity related contradictions:
In certain cases, contradictions can be interrelated in several different ways. (In the above figure, C1 and C2 are linked with "AND", and C1 and C3 make a chain. Thus resolving any of C1, C2, and C3 can eliminate the negative effect in this case.) Ideality-based criteria are to be used for selection. (C1 is selected in this example.)

(5) A "root" contradiction:

The situation when two contradictions (C1 and C2) are independent of each other ("OR"), but they are both caused by the same contradiction (C3). Selecting the root contradiction (C3) is the first choice (i.e., 'Root contradiction selection rule'). If C3 is not allowed to eliminate, then use the 'Ideality-base criteria' to select the second choice. (C3 is addressed in the above example.)

After clarifying these 5 types of contradiction relations and the heuristic rules of selecting the contradiction to be addressed first, the Authors show their reasoning about the Windmill case study. For considering the Ideality-based criteria in this case, the Authors use a table and selected C5 in the following way:
As we can see, contradictions C2, C3, and C4 involve the entire blades and the wind, while C1 and C5 include the tips of the blades and droplets. By looking at the parameters responsible for the contradiction, it is logical to conclude that we can more easily manipulate the weight of the tips of the blades. Thus, we choose C5. 

This paper has revealed different types of complexity in the cases of multiple contradictions and has provided a nice heuristics for selecting a contradiction to be addressed first. RCA+ diagrams seem very useful for analyzing complex problems.

Nikolai Khomenko (European Institute for Energy Research, Germany) and Mansour Ashtiani (Delphi, USA) [11] gave a paper with the title of "Classical TRIZ and OTSM as a scientific theoretical background for nontypical problem solving instruments". I will quote the Authors' Abstract first:

This paper presents the structure of Classical TRIZ (the Theory of Inventive Problem Solving created by Genrich Altshuller) and OTSM (the Russian acronym for the General Theory of Powerful Thinking, proposed by Altshuller in several papers and letters to Russian TRIZ community between 1975 and 1986). In brief, the model comprises a key problem to be solved by the theory and the assumptions established to solve it. A set of fundamental models based on these assumptions was developed as the theory evolved. Practical instruments were then developed on the basis of these models. The System of Instruments was also used to evaluate the theory and develop it further. The model of an applied scientific theory was used to study TRIZ and develop OTSM.

As you see in the Abstract, this paper deals with a big issue of developing TRIZ itself further than the Classical TRIZ (as typically embodied in ARIZ-85C) in the direction proposed (but not fully developed) by Altshuller himself. Nikolai Khomenko started this research over 20 years ago with communication with Altshuller.

In the following slide the Authors show a brief summary of evolution of TRIZ towards OTSM.
In the paper the Authors discuss mostly about the fundamental structure of Classical TRIZ (from the eyes of OTSM) and then rather briefly about the structure of OTSM as a scientific theory. Thus it is not easy for me to understand OTSM itself, which of course has a system of theory bigger (or deeper) than Classical TRIZ. I will cite several of their presentation slides here.

I would like to take some more notes on OTSM Axioms. OTSM has only one main axiom, i.e. 'the Axiom of Descriptions'. The Authors write: We use subjective models of objects we are thinking about. These models have their limitations when produced in the mind of an individual problem solver. To solve a problem we need to change the way we view it; i.e. change the stereotypes we have in our minds when we approach it. In this way we manage to change our understanding of the problem. By replacing our initial description with a different model we are able to simplify the problem solving process by removing the stereotype which can in itself part of it, and can stand in the way of a solution.

Then the Authors lists up the first group of axioms that describe the model of the thinking process efficiently enough for problem solving. They are (1) Axiom of Impossibility; (2) Axiom of Root of Problems; (3) Axiom of Reflection; and (4) Axiom of Process. As an example, the Authors explain about (2) Axiom of Root of Problems: ‘The root of any problem is a contradiction between human desire in relation to a certain specific problem and the objective laws that drive that situation.’ (For example, we need to make a piece of metal float in water or fly it in the sky. According to the laws of Archimedes metal can neither float nor fly. But humans wanted to make it fly and float. Some inventors discover the other way around the law of Archimedes and solved the conflict between human desire and objective natural law so that now we have metal that can fly and float.) Thus, this Axiom leads to a general recommendation: ‘In order to solve a problem we need to find which objective natural law contradicts our desire and use it to develop another way around.’

The Authors list the second group of axioms (Axioms on World Vision) that describe the uses of a problem
solving model of the world where problems arise. They are: (1) Axiom of Unity; (2) Axiom of Disunity; (3) Axiom of Connectedness. [Unfortunately these axioms are not explained any further.]

The Key Models of OTSM are shown in the following slide. The ENV model is easy to understand. ENV stands for the triplet, 'Element - Name of feature - Value of the feature'. For example, instead of saying 'The tomato is red, round and eatable', ENV model advises to say 'The element TOMATO has a feature that is called Colour and a specific value of the feature is red but it could be green, yellow or black.' This helps clarifying various concepts in problem solving, the Authors say. The OTSM model of problem solving process is characterized as 'A non-linear fractal process of the transformation of an initial description of a problem into the description of a satisfactory conceptual solution. This means that we form some parts of the general image of a solution at the beginning and then step by step makes it more and more specific.'

The slide below-left shows the tools for problem solving, but the paper does not have enough space to explain them. The slide below-right summarizes the core of the problems in comparison with Classical TRIZ and OTSM.

*** This paper is much philosophical and sophisticated, and hence never easy to understand. However, I am much interested in reading further about OTSM Axioms, Models, Instruments, etc. The explanation on 'Axiom of Root of Problems' is nice as an example. I wish the Author, Nikolai Khomenko, to describe his findings in a more straightforward way (to show its conclusive essence without postponing to 'separate, coming later' papers) together with simple examples.

Simon Dewulf (CREAX, Belgium) [24] gave a presentation with the title of "Product DNA and the CREAX Property Matrix". I will quote the Author's Abstract first:

This paper provides a structured approach to researching outside your domain. Product DNA forms a common ground for technology transfer, be it in new product development,
problem solving or new market development. The paper shows the simplicity of the method, whilst its increased functionality in relation to other structured approaches.

This is a nice presentation. Since the Author gave a keynote speech in Japan TRIZ Symposium 2007 (Aug. 30 - Sept. 1, in Yokohama) on a similar topic, please refer to the presentation slides and Nakagawa's Personal Report in "TRIZ Home Page in Japan". So I will quote only a few slides here.

The main idea of this paper is that any product (or object) has certain properties in order to achieve some intended functions. Thus, the property-function relationships are extracted from patent databases (either for specific type of products or else in a completely general scope) and accumulated into a Property-Function matrix. An excerpt of such a PF matrix is shown in the following figure.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>glide</td>
<td>stabilize</td>
</tr>
<tr>
<td>transport</td>
<td>prevent blooming</td>
</tr>
<tr>
<td>glide</td>
<td>break</td>
</tr>
<tr>
<td>stack</td>
<td>shapes</td>
</tr>
<tr>
<td>contain</td>
<td>improve health</td>
</tr>
<tr>
<td>clear</td>
<td>improve melting</td>
</tr>
<tr>
<td>hold</td>
<td>glass</td>
</tr>
<tr>
<td>join</td>
<td>dominoic</td>
</tr>
<tr>
<td>assemble</td>
<td>cobalt</td>
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<tr>
<td>camouflage</td>
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<td>product</td>
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<td>appear</td>
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<tr>
<td>indicate</td>
<td></td>
</tr>
<tr>
<td>direct</td>
<td></td>
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<tr>
<td>function</td>
<td></td>
</tr>
</tbody>
</table>

A type of usage is to build a PF matrix from the patents of a specific type of products, for example chocolates; then the matrix can show a wide variation of ideas accumulated from the patent for the products, as shown in the following figure.

Another usage is the form of software tool, named DIVA, which contains a huge accumulation of the PF relationships extracted from patent databases. In the process of searching for innovative ideas, one may
select a property as a first keyword and a function as a second, then the software tool will generate an advice as demonstrated in the following figure. The advice is based on the concepts of evolution of technical systems (in the aspect of properties) and on the concepts of property-function relationships (in the aspect of functions).

The following slide is the conclusion by the Author:

**Evolution, Prediction,**

**Dmitry Kucharavy and Roland De Guio (LGECO - Design Engineering Laboratory, France) [12]** presented a paper with the title of "Application of S-Shaped Curves". (Note that Kucharavy also gave a Tutorial on a slightly larger topic "TRIZ Instruments for Forecasting: Past, Present and Future"). The paper is a result of a project supported by European Institute for Energy Research (EIFER) and forms an intensive review of references related to S-curve analysis methods and their applications. The Abstract is:

This paper deals with the application of S-shaped curves in the contexts of inventive problem solving, innovation and technology forecasts. After explaining the origin of the logistic S-curve its application, as seen in publications from different domains, is reviewed. Despite much criticism and the failure to apply the logistic function or long-term forecasting, it continues to be a popular model for describing the evolution of systems (technological, economical, social and others) over time. This paper can help researchers and practitioners to understand the scope of application of S-shaped patterns, their limitations, and peculiarities

As written in the Abstract, this topic is delicate and likely to be misled. The Authors discuss how the data can be collected and how the 'Ideality' or 'Main indices of the System' can be (or can not be) evaluated quantitatively. The following table seems to be most informative to understand the scope of
this paper. In the three different contexts (or purposes), the merits (written in blue) and demerits (in red) are listed for the qualitative approaches and quantitative approaches.

<table>
<thead>
<tr>
<th>Context</th>
<th>Qualitative</th>
<th>Quantitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventive problem solving</td>
<td>Quick and easy to perform. No necessity to collect and refine data.</td>
<td>Clear definition of features and values to improve. How to measure a new quality?</td>
</tr>
<tr>
<td></td>
<td>Ambiguity of definition (e.g. large, small). Partial &amp; biased.</td>
<td></td>
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<tr>
<td></td>
<td>How to position the Innovations in time, in space, and in competitive environment?</td>
<td>It takes a lot of time for data gathering and refining.</td>
</tr>
<tr>
<td>Technological forecast</td>
<td>Compatible with long-term forecast.</td>
<td>Results are measurable and precise. Repeatable, adaptable, and cost effective.</td>
</tr>
<tr>
<td></td>
<td>Inaccuracy of forecasting in time (when?) and in space (where?). Higher-biased. How to deal with competitive technologies?</td>
<td>Based on past data and trends. Indirect biases through computation models, assumptions and data.</td>
</tr>
</tbody>
</table>

One important application of S-curve may be the forecasting emerging technologies. They pose a question: "How to forecast the future of emerging technologies using an S-curve and the law of natural growth before system pass the 'infant mortality' threshold?" The Authors' working hypothesis is shown in the following figure. They consider three phases for a technology to proceed, i.e., exploration, experimentation, and exploitation. Each phase has its learning curve of knowledge growth as shown in the figure. Thus, if one can evaluate the current status of knowledge acquisition of an emerging technology in its exploration phase, the future of its transition to its experimentation phase may be forecast with some certainty. However, there remain some more questions, they say: 'How to measure knowledge acquired?' and 'How can one calculate the time necessary for decisions about the transition to the next phase, i.e. experimentation?'
Manabu Sawaguchi (The Sanno Institute of Management, Japan) [15] gave a presentation on "Innovation Activities Based On S-curve Analysis and Patterns of Technical Evolution—"From the standpoint of engineers, what is innovation"?" The first half of his paper is the result of analysis of the answers by 45 engineers in Japan on the question of "What is Innovation?". The answers written freely were analyzed with the Affinity Diagramming Method (or the KJ Method) to reveal a general structure of the engineers understanding on innovation. To make the structure more clearly, the Author figured out 'Four Patterns of Innovation'. The 2x2 patterns are derived from two aspects. First is the aspect of technology used: whether new or existing technology. Second is the aspect of business influence: whether disruptive or sustaining. In the following figure, the four patterns are shown by four windows.

In the figure the Author included, in each pattern, his thought of the relations between the conventional S-curve and the innovation S-curve, on the basis of Clayton Christensen's model. The black S-curves represent conventional products/services and the black arrows their "Merchantable Quality". The red S-curves, on the other hand, represent the innovative products/services.

In the figure below, the Author further added the information of "Level of Customer Requirements" for each pattern. This shows the situations more clearly in the sense of Christensen's model.
The following figure shows the predictive path about evolution of innovation. The Author also mention another path starting at Pattern 4 and going to Pattern 2 and back.

*** This is nice for understanding different types of innovations.
Technological System Tool as a basis of TRIZ’. This paper uses production methods of cast flat glass as a case study, but is more theoretical/methodological in nature. I will quote the Authors' Abstract first:

System Operator can be used to describe Technological System development. The present-to-future transition is much harder to describe. However it is possible to investigate not only Complete Technological System in windows of the System Operator but also its parts (tool, transmission, engine, etc.). For investigation of the present-to-future transition in the System Operator the patterns of evolution can be used. Development of a tool activates the quality changes of the whole Technological System. The analysis of the possible line of the tool development, which is integrated in a System Operator, is then possible to be used as a base of TRIZ prediction. Examples of progress will be demonstrated on theoretical and practical cases.

The problem to be discussed in the present paper is how to predict the future generation of a technical system. System Operator, i.e. 9-windows method, can be used in such a discussion. A real case of manufacturing flat glass is illustrated in the following slide. The present well known technology is the "Float Process", which was a major breakthrough started in 1959 on the basis of the patent of Pilkington Brothers. Replacing the roller and grinding process, the Float process cast the molten glass on a molten metal (tin) bath, using the advantage of flatness of the (molten) liquid surface.

![Example: Prediction of a tool development for production of cast flat glass](slide1)

What will be the major breakthrough in the future? and how can we predict it? Can we generalize the method of prediction? To these questions the Authors answer in the following way on the basis of historical analyses of development of technical systems. As shown in the following slide, the Authors state that one has to focus on the development of 'Working Tool'. (In this case, the object is glass, the main function is flattening, and the working tool is now the molten metal bath.)

![Development of a Working Tool (WT) in TS](slide2)

Then the Authors argue that three strategic ways are known for developing the Working Tool and consequently originating a novel Technical System. The below-left slide states the three ways while the
In the case of the flat cast glass manufacturing, the Authors pay a special attention to the patent by Gen Kojima (JP 9295819, 1997-11-18, Asahi Glass Co.). One of the main demerit (or contradiction) of the molten metal bath is the contamination of glass due to the molten tin metal itself. The new method, shown in the following slides, is called "Aqua Float Method" (or more properly "Steam Float Method" in the current TRIZ sense). As shown in the right, from the water-containing hydrophilic multiporous substrates the steam of water is generated due to the heat of hot glass and supports the weight of hot glass.

The Authors interpreted this method in terms of the Trends of Engineering System Evolution (TESE) in TRIZ as shown in the following slide. The Working Tool is understood as the steam (i.e., a gas) delivered by the water-containing porous substitute (i.e., a system with active capillaries providing water). The fit with these TESE predictions is the most important point of view from TRIZ, the Authors believe.
Thus the Authors finally show the following figure as the System Operator view of "Float process" in glass manufacturing. Furthermore, the Authors believe that the 'Aqua float process' also opens one more stage of manufacturing glasses of curved surfaces, as shown in the right-most column of the System Operator window.

Now I will quote the slide of Conclusion by the Authors:

- The System Operator of the TRIZ methodology supports system thinking which is base for creative thinking
- The most important Subsystem inside of TS is Working Tool
- Correct development prediction of Working Tool have to correspond with Trends of Engineering System Evolution (TESE)
- Correct development prediction of Working Tool is condition of correct TS prediction

*** Since the Author, Pavel Jirman, is an expert in glass manufacturing industry and in TRIZ, the case study shown here is persuasive. During the discussion of the presentation, he answered that the Aqua-
float process is not yet the industry standard simply because the glass industry has a large momentum. This paper is a nice combination of theory and practice.

**Market and Innovation**

Greg Yezerski (Institute of Professional Innovators, USA) [46] gave a Keynote Speech with the title of "General Theory of Innovation and Its Applications". He observes many cases of good technical inventions having failed in the markets. Thus he proposes a scope of Innovation as shown in the following slide. He defines Innovation as the process of value-offer formation.

Then the Author proposes "General Theory of Innovation (GTI)", for which he describes its foundation as shown in the next slide:

According to the Author, the findings of GTI and its major finding are summarized in the following two slides:
The application areas and the tools of GTI are summarized in the following table. As a case study, the Author shows the case of movie rental vs. movie on-demand companies. I would like to skip it, because I am not familiar in the US consumer markets.

<table>
<thead>
<tr>
<th>Applications</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reactive Innovation (Defensive)</strong> Value is known</td>
<td></td>
</tr>
<tr>
<td>1. A performance-based challenge</td>
<td>1. RelEvent Diagram</td>
</tr>
<tr>
<td>2. Cost reduction</td>
<td>2. Problem Formats</td>
</tr>
<tr>
<td>3. Quality / Reliability improvement</td>
<td>3. Problem Solution Templates</td>
</tr>
<tr>
<td>5. Failure prevention</td>
<td>5. Algorithm (ACE)</td>
</tr>
<tr>
<td>6. Patent circumvention/protection</td>
<td></td>
</tr>
<tr>
<td><strong>Pro-active Innovation (Offensive)</strong> Value is unknown</td>
<td></td>
</tr>
<tr>
<td>1. System evolution forecasting</td>
<td>1. Evolutionary Templates</td>
</tr>
<tr>
<td>2. Strategic Innovation Portfolio</td>
<td>2. Growth Strategies</td>
</tr>
<tr>
<td>3. Business applications such as</td>
<td>3. Value Growth Templates</td>
</tr>
<tr>
<td>- Growth (HYLR), incl. turnaround</td>
<td>4. Value Matrix</td>
</tr>
<tr>
<td>- Business strategy / model</td>
<td></td>
</tr>
<tr>
<td>- Increasing ROIC (incl. R&amp;D)</td>
<td></td>
</tr>
<tr>
<td>- Investment opportunities (M&amp;A)</td>
<td></td>
</tr>
<tr>
<td><strong>On-Demand Innovation Capability</strong></td>
<td></td>
</tr>
<tr>
<td>1. Entity's capability to create successful innovations on-demand (deployment)</td>
<td>1. Education and coaching</td>
</tr>
<tr>
<td>2. Invincible Enterprise</td>
<td>2. Facilitation</td>
</tr>
<tr>
<td></td>
<td>3. Certification</td>
</tr>
</tbody>
</table>

Dimitri Van Nuland and Cristobal Péran Estépa (De Valck Consultants, Belgium) [41] gave a presentation on "From problem solving to innovation: Providing an efficient framework for TRIZ". They are working as TRIZ/Systematic Innovation experts for a huge consulting company. On the motivation of this presentation the Authors write: 'Having gone through over 70 projects over the last 4 years it became clear that, apart from the generation of good solutions to a problem, other aspects had to be taken into account in order for a project to be successful and implemented within a company.' And they write: 'Through the years, a lot has been experienced and learned, resulting slowly into the different elements that now form the backbone of our approach, and which are united into neo (= Latin for new).’ The
All these interactions and research made it clear that in order to make sure an innovation or problem solving project goes well, 6 elements need to be looked after at all times:

- Psychological Inertia
- Creative Thinking
- Knowledge
- Process
- Direction
- Emotion & Climate

They together form the framework of our approach "neo".

Guenter Schuh, Christoph Haag, and Jennifer Kreysa (Fraunhofer Institute for Production Technology, Germany) [16] gave a presentation with the title of "TRIZ-based Technology Know-how Protection - How to find protective mechanisms against product piracy with TRIZ". This paper deals with a new type of problem 'How to protect a product against product piracy'. The following slide shows categories of imitation of products:

In order to select optimal protection mechanisms, the vulnerability of a product/company must be analysed

<table>
<thead>
<tr>
<th>Imitations</th>
<th>Partial or total reproduction of certain product characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counterfeits</td>
<td>fabricating in imitation of something else with intent to deceive</td>
</tr>
<tr>
<td>Plagiarisms</td>
<td>claiming of original authorship of someone else’s written or creative work</td>
</tr>
<tr>
<td>Brand piracy</td>
<td></td>
</tr>
<tr>
<td>Illegal overproduction</td>
<td></td>
</tr>
<tr>
<td>Functional replica</td>
<td></td>
</tr>
<tr>
<td>Smugish imitation</td>
<td></td>
</tr>
</tbody>
</table>

Now I will quote the Authors' Abstract (after skipping its first 4 lines):

Fraunhofer IPT now enters a new field for TRIZ applications: technological know-how protection, i.e. the avoidance of product piracy in technology intensive markets by integrating new, technology-based protection mechanisms into products and processes. Within a research projects, Fraunhofer IPT conducts TRIZ workshops with consortium partners from different branches to identify innovative protection concepts for specific products of the companies involved. Function analysis is conducted in a first step, while in a subsequent step, the application of suitable TRIZ tools such as "sabotage" or "ideality thinking" help to generate innovative protection concepts. Following the workshops, Fraunhofer IPT supports the respective companies in elaborating the identified concepts.

This paper gives insight into the project "Technology Know-how Protection". After illustrating the design and implementation of the TRIZ workshops, and evaluation of different TRIZ tools is presented concerning their applicability in the field of technology.
know-how protection as an innovation process.

I would like to focus on the Authors’ findings on the applicability evaluation of 6 TRIZ tools in the idea generation for the product piracy protection. Their concluding recommendations are summarized in the following slide:

Details of their application and evaluation are shown below for the four tools, i.e. Ideal design, Analogy approach, Effects database, and Resource concept, by skipping 40 Inventive principles (simply for saving space here) and ‘Sabotage’ (i.e. Subversion analysis) (because of its low evaluation):
This paper makes a further extension of TRIZ application fields, especially of a new type of problem. Fraunhofer IPT, along with other several European universities, seems to have good cooperative relationships with industries. This is a strong point of the European TRIZ community, in comparison with US and Japan TRIZ communities.
4. Integration of TRIZ with Other Methodologies

Design Methodologies

Lucienne Blessing (University Luxembourg) [46] gave a Keynote Lecture with the title of “Design methodologies: blessing or curse?” The Author talked with various quotations of references, but their points were not clear to me to my regret. I will just show her last slide of conclusion here:

Markus Deimel (Polysius AG, Germany) [7] gave a presentation with the title of "Relationships between TRIZ and classical design methodology". This is an intensive paper having some theoretical aspects and a detailed case study. The Author's Abstract is cited here first:

The paper shows that more similarities than differences exist between TRIZ methods and classical design methods. The solution principles of abstraction and concretion are discussed in detail and are formalized mathematically. As an example, the methodical analogies of the conflict modelling and the preparation of similarity rations for dimensioning are pointed out TRIZ methods are integrated in a typical model of a systematical design process. For selected working steps of the design processes, the author describes alternative suitable design methods. Further, the article includes the experiences of the author concerning conflict and contradiction modeling and resents a simple manageable software tool to support the conflict modelling. A complex case study from automotive industry shows the harmonized use of TRIZ and classical design methods.

Theoretical parts of the presentation contain interesting materials and valuable references to the classical design methodologies. I will quote in the following figure the systematical design process developed by the Author by integrating TRIZ methods into the classical design methodology (‘Braunschweige’ Model). TRIZ methods are assigned some in the 'clarification of the task’ phase and mostly in the 'Principle' phase, whereas no in the evaluation process, the Author noticed. In the two ovals in the slide the Author recommended 'search matrix' and 'function matrix' (see below) as individual tools alternative to TRIZ tools. The application of this methodology is shown in the following case study.
The case study was carried out in the framework of collaborative R&D project 'GINA', supported by German Federal Ministry for Education and Research (BMBF). The problem here is to design a front end module for a low-consumption vehicle, especially to integrate headlamps in the module. The problem is stated in the slide below-left, and the methods applied are listed in the slide below-right.

At the starting point, the conventional headlamp packaging was chosen. And then a Contradiction (i.e. Physical Contradiction) was derived concerning to the fixation, i.e. must be rigid AND must be flexible. By using four types of separation principle, the Author derived the ideas as shown in the slide below-right.
Then the Author goes ahead to apply the Conflict Modelling (i.e. deriving Technical Contradictions and applying TRIZ Contradiction Matrix), as shown in the following two slides. Using the parameters 'Stability' vs 'Adaptability', the Author got several Inventive Principles, and then derived the solution ideas shown in the slide.

Next the Author used the 'Function Matrix' tool. Function Matrix is an index of functions (or effects) arranged in a matrix form of 'input quantity' vs 'output quantity'. (This kind of Matrix seems to be constructed since 1970s.) In the following slide the Author uses the matrix cell of the functions converting distance into force. With the hints of these functions (or physical effects), the Author has derived the two ideas shown here.
Then the Author established the 'Design Catalog' with the information from the literature and patent research together with the generated solution ideas. Design Catalog (or Solution Catalog) is a hierarchical presentation of relevant solutions to a specific design task, in this case 'Improving the gap design'. The following figure shows a small excerpt of the catalog. Once this sort of catalog is established, suitable solutions may be selected depending on (future) specific requirements.

Then the project made a detailed and close evaluation of ideas. The idea developed with Inventive Principle 30 ('Flexible hulls and films') was chosen as the best because of self-actuating and simple adjustment and of insensitivity to thermal change. The detailed embodiment of the idea was supported by CAD and was achieved as shown in the following slide.
*** This paper shows a solid base of design strategy well incorporating TRIZ tools. Deriving various ideas with TRIZ tools and constructing them into Solution Catalogs with the support of literature/patent search seem to be constructive for engineering in each specific area.

*** In the theoretical part, the Author mentioned that the TRIZ separation principles do not derive so many ideas in comparison to the TRIZ Contradiction Matrix method. However, separation principles can guide you to most of the Inventive Principles (as shown in Darrell Mann's textbook, "Hands-On Systematic Innovation", for example), and hence even more than the Contradiction Matrix can usually do.

Gaetano Cascini, Paolo Rissone, and Federico Rotini (University of Florence, Italy) [4] gave a presentation with the title of "From Design Optimization Systems to Geometrical Contradictions". This paper has analyzed the contradictions emerging during the design embodiment phase. In this phase, since the functional architecture of the product is already fixed, design conflicts arise due to contradictory geometrical requirements; the Author uses the term 'Geometrical Contradiction' for representing such contradictory geometrical requirements. The latter half of the Authors' Abstract writes:

The present paper first describes how Design Optimization can be adopted as a means to link CAI [Computer-Aided Innovation] and PLM/EKM systems: then a detailed analysis of geometrical contradictions is reported together with the criteria proposed for their categorization. Finally, the discussion is focused on the adoption of the proposed classification of geometrical contradictions as a pointer to the most suitable inventive principles and geometrical effects to overcome the design conflicts.

One method to reveal such a Geometrical Contradiction is to get optimized solutions (with a design optimization software) for individual cases of requirement. For example, a connecting rod for combustion engines alternatively supports traction and compression loads. Optimization of the geometry of the connecting rod for each load situation separately gives the results as shown in the following figure. Optimized topology of the connecting rod is different for the compression (above) and traction (below) loads.
The Authors collected a hundred inventive solutions based on a geometrical evolution of the system, from their experiences and much more patent searches. Then they analyzed the solutions to reveal the Geometrical Contradictions involved, and then tried to classify the Geometrical Contradictions. Some types of classifications are:

(a) Time/Condition based classification
- operation vs operation: e.g. compression vs traction (in the above figure)
- manufacturing vs operation: e.g. manufacturing a plastic wheel vs its usage
- operation vs end of life: e.g. a plastic bottle for drinking water and its disposal with crashing

(b) Geometrical difference based classification
- size contradictions: e.g. short vs long (see the figure below)
- shape contradictions: e.g. sharp vs rounded
- topological contradictions: e.g. monolithic vs segmented (see the figure below)

(c) Functional based classification

Depending on these categories of Geometrical Contradictions, the Authors suggest some separation principles and Inventive principles to use. Since the Authors’ description is rather complex, let me leave you to read the original paper.

*** Anyway, this paper should be useful for constructing some general guideline for handling and solving contradictory requirements in the embodiment phase.

Manufacturing process

Joerg Feldhusen (Chair and Institute for Engineering Design IKT, Germany) and Ingo Schulz (Cassalla GmbH i. G., Germany) [9] gave a paper with the title of “Creating a Holistic Product Development Methodology by Merging Systems Theory and Dialectics”. I will quote their Abstract first:

The situation of product development today is characterized by numerous methodologies that are supposed to facilitate a fast, cost-efficient procedure. Frequently these methodologies compete with each other instead of complementing one another. Therefore, at IKT a generic frame model was developed which allows creating a metamethodology of product development on basis of philosophies describing technique. In this way the integration of different, up to now rival design methodologies is achieved for the first time so that for every problem situation in product development the most suitable methodology can be selected.

In the Authors' scope, SED (Systematic Engineering Design, developed in Germany, e.g. G. Pahl & W. Belts) and TRIZ are principal methodologies besides QFD, AD, and VA. For integrating these methodologies, the Authors took the approach of starting with the philosophy setting and going down to methodologies and practices as shown in the following slide.
At the Philosophy level, the Authors clearly adopted Systems Theory and Dialectics. The Authors’ discussion about the introduction of Dialectics, or the concept of Contradictions, is interesting for me. They discuss:

This unsatisfactory situation [between SED and TRIZ] can be explained by a basic misunderstanding about the concept "contradiction". SED denies the contradiction; for example negative functions are mostly not intended. TRIZ on the other hand uses especially the contradiction as a source for innovations. However, both methodologies talk about two different interpretations of the contradiction. While SED is meaning the logical contradiction, TRIZ considers the dialectic one. ...

TRIZ puts strong importance on the fact that it is necessary to look at the problem from different points of view. In contrast SED only knows the "real" logical contradiction, which is not solvable even from another point of view. Therefore SED limits itself needlessly. It is interesting that systems theory in general seems to have a blind spot on contradictions.

As the framework to merge Systems Theoretical and Dialectical methodologies, the Authors use a generic model of representing technical systems as shown in the following figure. In terms of 'Entanglement', the Authors introduce the causal relationships among the systems.

On the basis of the above-mentioned generic model, each system can be described with a general product model as shown in the following figure. A (technical) system is described by three partial models, i.e., "process", "product data", and "organization".
The process model (shown above) is the central component of the product model, which shows the product development process in the form of a metamethodology, the Authors write. The Process Model is shown more closely in the following slide. The procedure of the product development is mapped into a five-stage process of the process model. The procedure was derived from the analysis of different development methodologies, especially SED and TRIZ as well as QFD, AD, and VA. [The description of further detailed models is at an abstract level and not clear to me. So I will quit the review here. The Authors are developing software for supporting the product development in the models described here.]

Claudia Hentschel (Fachhochschule für Technik und Wirtschaft Berlin, Germany) [10] gave a presentation on "Tracing Unorthodox Use - A TRIZ-related Ideation Method in Systematic Product Innovation". I will quote the Author's Abstract first:

Lots of companies deliver products and services that serve the customer a determined purpose or function, but they often go wrong about how the products is finally used. Such diversions show the seeds of creativity to generate ideas for new product outcomes and problem solutions. However, this potential is only scarcely exploited so far. Based on a survey on consumers' and developers' opinions on unorthodox use, a new method is introduced to transfer product functions to unexpected application fields, which helps galvanizing the ideation process. It shows many similarities to the systematic way of thinking, to the contradiction logic and to selected knowledge- and analogy-based mental block breaking tools in TRIZ.

The paper introduces the topic in an attractive way by using a number of anecdotes, survey results, and references. The Author originally uses the German word 'zweckentfremdung' and looked for an appropriate English expression, and finally using the term 'Unorthodox use'.

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The Author proposes a systematic method for tracing unorthodox use potential, as shown in the following slide:

An example of using this process is shown for the case of cellular phones: (1) Capture: One can realize in certain circumstances some people display sort of an even affectionate attitude (hugging, caressing, shaking, etc.) towards the cellular phone device itself - probably depending on the person who has called. (2) Concede: The mobile phone has long become a personal belonging like pieces of jewelry or purses; a little more step towards becoming a personalized product. (3) Co-opt: Here the Author has chosen the field of personal basic commodity and clothing for investigating further. (4) Conceive: Sending moods and feelings along with speech and pictures may be a new feature here. E.g., a tactile-sensitive mobile could send emotions by MMS (Multimedia Messaging Service), resulting in a slight squeeze of the receiver's arm. (5) Chart: Clothes which can receive emotions via mobile, e.g. a pressure sensitive arm sling. (6) Choose: This step should give an answer of how much sense it makes for a mobile communication company to enter the textile industry and vice versa. The Author writes: "Denying this question is not an option. When the new application, say a pressure sensitive arm sling, is selected, the company has to go into the subject more deeply, also by addressing questions like context awareness of such personalized wearable phones - or who wants to be remotely embraced in the middle of an inconvenient situation? Here, one can hope, that such systems remain to be switched off by the consumer".

*** This approach seems rather difficult to be convincing. I would like to suggest readers to refer to the "Reverse Market Approach" by Miecznik and Glaser [39].

Giacomo Bersano (Active Innovation Management, France) and Valerio Bregonzio (SAIPEM Spa, R&D Department, Italy) [20] gave a presentation with the title of "TRIZ as a Catalyst for Project Management (PM) Excellence (and PM as Catalyst for Systematic Innovation, i.e. the Other Way Round)". I will quote the Authors' Abstract first:

The techniques of project management (PM) have been created at end of the '50s in the United States and are considered amongst the most effective procedures to improve efficiency in launching new products and services on the market. This paper focuses on:
- to show some effective way to adopt TRIZ techniques in order to improve weaker areas inside project management processes and,
- the other way around, to show in which way project management best practice could be beneficial to increase penetration and success of TRIZ tools.

Authors' basic understanding of the weaker phases in the PM is illustrated in the following figure. The figure shows (in the middle row) the phases of project lifecycle and that the first two phases are the weaker ones in PM and that Systematic innovation techniques (e.g. TRIZ) can contribute much in these phases (as shown by thicker arrows).
The Authors also discuss on the directions of further possible development of PM method by using TRIZ nine-windows method. The Authors' views are demonstrated in the following slide. "Future" part (written in blue fonts) has been derived by the Authors by using the Trends of Evolution suggested by Altshuller (shown in blue arrows) and by Darrell Mann (shown in green arrows).

The Authors further discuss on possible improvement of the PM method especially in the aspect of Risk Management (among the nine aspects of management including: integration, scope, time, procurement, communication, risk, human resources, quality, and cost). One of the sub-processes in Risk Management Process is Risk Identification. The Authors suggest to draw the subprocess as shown in the following slide. In this figure, broken rectangles (representing input information) and green ovals (representing positive RM actions) are taken from RM Relevant diagram (by Greg Yezersky), and the red rectangles are introduced by the Authors to describe negative effects. This kind of diagrammatic representation has been stimulated by TRIZ literatures.
At the end of the paper, the Authors refer to Simon Litvin's paper (ETRIZ TFC 2005) on the weaknesses in TRIZ and suggest to introduce PM best practices to compensate them.

**Integrated Tools**

Guillermo Cortes Robles, Maricela Gallardo Córdova (Instituto Tecnológico de Orizaba, Mexico), Stéphane Negny and Jean Marc Le Lann (Institut National Polytechnique de Toulouse, France) [23] gave a presentation on "Applying the TRIZ-CBR model for improving a system". These Authors have been reporting for a few years on this approach. They are building a software tool which combines the CBR (Case Based Reasoning) method and TRIZ problem solving process. In the present paper the Authors have shown two case studies, i.e., the water container and the homokinetic joint (CV joint). I would like to explain here the former because the problem is simpler and good enough for illustrating the Authors' approach.

The problem is to improve the purified water container (see left figure) so as to maximize the available space in vehicles for distribution. The container is inconvenient because (1) they cannot be piled up, (2) if piled up, not easy to pick it up, (3) too heavy (20 kg), etc. The diagram shown below-right represents a schematic design tree that exemplifies the dynamic relation between the knowledge available in the TRIZ-CBR system and the solution space. The green arrows show the support provided by the system knowledge to the solution concepts while red arrows the storing of new concepts to modify/update the knowledge.
The software system seems to help the user by guiding the problem solving process and showing, e.g., the contradiction matrix. However, the assistance is not automatic, of course. The user has to choose the parameters to look up the Contradiction Matrix. Thus the diagram shown above seems to be a schematic for illustrating the user's thinking results. Some of the branches, e.g. the branch of Physical Contradiction, are just omitted to make the diagram fit the space, the paper says.

*** As is discussed by the Authors, the essential problem left with this CBR-TRIZ approach is how to accumulate the CBR knowledge and how useful the knowledge is. In the above example, except for the TRIZ knowledge in the Contradiction Matrix, the CBR knowledge seems not used actually.

Ahto Kalja, Toomas Matsalu (Institute of Cybernetics at Tallinn University of Technology, Estonia) and Tiit Tiidemann (Tallin College of Engineering, Estonia) [31] gave a presentation on "TRIZ and a New Artificial Intelligent PRIZ Type Software". In this title, 'PRIZ' is a Russian acronym meaning 'Programs for Solving Engineering Tasks'. The Authors used a new PRIZ tool, 'CoCoViLa software' (i.e. Compiler for Visual Programming Language) running under the Java Runtime Environment, and introduced TRIZ knowledge, especially the Contradiction Matrix and 40 Inventive Principles, into the environment. The Authors demonstrated a student's case study of Conveyor garage, parking tower. The tower can be drawn as in the following figure by use of the ordinary CAD capabilities of the software. Then a problem was noticed, that the conveyor chain distance between the cars must be short in the vertical positions, p, but longer at the bottom and the top corners. To solve this problem, Contradiction Matrix was used and a few Inventive Principles were derived. One of the solution ideas is to hold the chain in zigzag at the vertical position (see the figure in the right).
Mahmoud Karimi (Iranian Institute of Innovation & Technological Studies, Iran) and Meysam Maleki Anvar (Imam Hosein University, Iran) [32] gave a paper with the title of “ISQ vs PE & FAA in One Case Study”. I did not attend at this presentation, and I now feel it very difficult to understand real points and to evaluate this paper. The case study was carried out in one of the most famous car manufacturing factories in Iran, and the initial problem situation was described in the paper as follows:

Our problem took place in one of the manufacturing lines of a car manufacturing factory. In this line, most of the equipments are resistant welding guns or some welding oriented equipments. The [our] company is maintenance representative in one of its construction lines. According to the contract between our company and the factory, up to 10 minutes halt is allowed in each working shift but for any more halt time we would have to pay the appropriate penalty cost. Notice that this line was set up three months ago and from that time on we are its maintenance representative. By some reason there was no pre-study before starting the project and there is no technical document available right now.

*** This situation of the factory and of the contract between the factory and the maintenance company is quite unusual, and various other background situations described in the paper are difficult for me to understand well.

According to the paper, the Authors' team applied ISQ (Innovation Situation Questionnaire, developed by Ideation International) first and tried to correct the contract itself and other situations. Then later they used PE (Problem Explorer) and FAA (Function and Attribute Analysis), both developed by CREAX and Systematic Innovation to analyze the problem further. The Authors' summary says that PE and FAA are found easier or quicker than ISQ to get understanding of the problem in this particular case.

*** The Authors may be right, but we should be careful about this kind of comparison because any one (with a second method) can go quicker once we have found a way or the goal direction (with the first method). In this sense, I will not reproduce the paper here any more detail.

Marina M. Ksenofontova and Oleg N. Feygenson (Technology Research Center Algorithm, Russia) [34] gave a presentation on "Innovative improvement of consumer products". The Authors write: 'The authors of this paper have participated in the [GEN3 Partners] projects concerning the development of novel cosmetic moisturizing and lightening products as well as food products. This publication summarizes the experiences accumulated in these projects and illustrates methodological approaches to solve arising problems.' The Authors' approach is schematically shown in the following slide:
For improving or developing consumer products, the first main task is to find ‘Main Parameters of Value (MPV)’. Usually consumer evaluates attractiveness of the product by the basic parameters including performance, convenience, indulgence (i.e. pleasure for consumer when using the product), safety, and cost. However, not all these parameter are really important for the consumer: he/she makes the purchasing decision by only few parameters, which are called MPV. Consumer MPVs can vary depending on the market segments or different stakeholders. So it is very important to identify actual MPVs for every group of the consumer, the Authors say. The paper has shown, though not explained here any detail, that product MPVs can be identified through a joint of approaches, including market unmet needs, market trends, product using occasions, and functional analysis at the supersystem level.

The next main task is to convert these consumer parameters of value (MPVs) into physical measurable parameters, i.e. in the technical language. For this purpose, Cause-Effect Chain Analysis (CECA) is to be applied. For each MPV, ask the question “what physical (or technical) parameter it is defined by?” and repeat asking the same question to the identified parameter in chain until reaching the level where the physical parameters are common for the products with any action principle. The procedure of correlating MPVs with physical parameters are illustrated in the following slide on the example of skin lightening product. Skin lightening products existing on the market are characterized by two main action principles: one is biochemical (i.e., influence on the biochemical processes of skin pigmentation) and the other is optical (i.e., skin masking by applying optical particles on it). ‘Generalized physical parameters’ are to be measurable and independent of the action principles. In the slide, ‘level of incident light scattering’ is one of them.
Then the goal is now reformulated: "how can we improve each Generalized Physical (or Technical) Parameters?". For example, "how can we improve the level of incident light scattering to the desired level?" Thus the physical (or technical) parameters shown at the bottom level in the above slide are derived. These are the measurable parameters which can be set as goals for solutions.

Then the paper further describes how to use TRIZ tools for figuring out possible solutions to improve/develop consumer products in the direction of the goals set above. In this latter part, the paper discusses mostly on the peculiarities in treating chemical problems associated in the cosmetic and food-related consumer products. Thus I will skip the latter part.

*** The approach of this paper seems to be useful and should be worthy of learning more.

**Dmitri Wolfson (Galgano & Associates, Italy) and Sergei Ikovenko (MATRIZ, USA) [44]** gave a presentation with the title of "Trends Of Toyota Production System Evolution TPS-TESE". (The subtitle in their presentations slides says "a quick look at early TPS tools through a TESE lens.") I will quote the Authors' Abstract first:

*Toyota Production System (TPS) is the most coordinated manufacturing system ever existed. While many companies are trying hard to reproduce this "perfect" process, no one yet has come near "natural" excellence of the Japanese giant. How does Toyota achieved it? In order to understand the real "secret" of Toyota's own product development system it is useful to experience application of some of the early TPS tools. Visualizing this process through a Trends of Engineering System Evolution (TESE) lens helps a practitioner to see deeper into the past and answer why the particular set and sequence of tools needs to be applied. On the other hand it allows to foresee when and how to integrate manufacturing and R&D efforts through feedback loops and self-learning mechanisms.*

This paper is a nice and concise introduction to Toyota's TPS for the audience who are familiar with TRIZ. The presentation file contains 85 slides, including 45 slides describing the methodology and 40 more describing a case study in an (Italian (?) factory. Since I missed to attend at the presentation and the paper does not describe the case study, I cannot follow some details of the case; thus I will just introduce you the methodological part of the paper.

The Toyota Production System (TPS) is schematically shown in a form of a house as follows:

![Toyota Production System Diagram](image)

The Authors have tried to understand the essence of all the components of TPS through the TRIZ concepts, especially the Trends of Engineering Systems Evolution (TESE). The general structure of TESE is shown in the paper in the following way (ref. GEN3 Partners training materials):
First, the Authors explain TPS’ main concept of ‘Value’ as follows, and compare it with TRIZ’ main concept of Value and Increasing Ideality.

**Value in Toyota Production System**

**Definition**

When TPS is implemented a value for a customer \( Value = VA/Cost \) increases because:

- the value added \( (VA) \) functionality of the system increases or remains the same and/or
- the total cost of building and operating \( (VA+NVA) \) the system decreases and
- cost of waste (muda) is removed.

Then, the Authors explain the TPS mechanism to be ‘Lead-time reduction through waste elimination’ and compare it with the ‘Increase in degree of trimming’ in TRIZ Trends. For reducing the lead-time, TPS uses the tool of Value Stream Mapping, which is shown in the following slide. The Authors compare the VSM with the functional analysis of processes.

**Material & Information Flow Mapping**

A Value Stream is the set of all actions (both value added and non value added) required to bring a specific product or service from raw material through to the customer.

Value Stream Mapping

- Follow a “product” or “service” from **beginning to end**, and draw a **visual representation** of every process in the material & information flow.
- Then, draw (using icons) a “**future state**” map of how value should flow **without waste**.
- Focus on “**the big picture**”.
- Pencil & paper tool

Then, as the foundation, TPS puts stress on standardization (of work) and uses both Kaizen (i.e., incremental improvement) and Kaikaku (i.e., revolutionary change) depending on the situations. Furthermore, as shown in the right column of the house of TPS, Jidohka is important in TPS, which the Authors interpret with the TRIZ Trends (TESE) of ‘Decreasing human involvement’ and ‘Increasing controllability’. The following slides explain the concept of Jidohka (i.e., Autonomation) and its levels to be achieved.
In the left column of the house of TPS, the concept of "Just-in-Time" is shown. This concept is explained by the Authors with three TESE concepts, i.e., 'Increase of the effectiveness of utilization of substances, energy and information flows', 'Increase of dynamism, flexibility, and adaptability of ES', and 'Increase of coordination of parts with each other and supersystem'. The concept of Kanban in TPS is explained in the following slide:
The Authors concluded that “TPS has developed a variety of excellent tools of designing manufacturability and flexibility into the product and the process together”

*** TPS has achieved a lot indeed. And many Japanese companies are trying to adopt its concepts. As far as I understand, the present paper is a good and correct introduction to TPS. For industry people, full understanding and integrated use of TPS and TRIZ are important issue to be learnt.

Hansjuergen Linde (University of Applied Sciences, WOIS Innovation School, Germany), Gunther Herr (WOIS Institute, Germany), and Andreas Rehklau (University of Applied Sciences, WOIS Innovation School, Germany) [37] gave a presentation with the title of "Inventing Business Innovations and traditional TRIZ – by WOIS: Contradiction Oriented Innovation Strategy". This presentation gives a holistic view of WOIS innovation methodology, by using beautiful and well designed slides. I will quote the Authors' Abstract first:

Creating and maintaining leadership is all about inventing innovations and inventing innovations is not only about technology.  
For inventing innovations it is necessary to build a clear picture of the company's situation and its likely future. This includes technological opportunities, but also refers to the market situation, the resource exploitation and the development of the competition situation. 
The innovation strategy WOIS combines in the Contradiction Oriented Innovation Strategy elements of known successful methodologies such as the German Design Theory, TRIZ, Synectics and others with new aspects for encouraging a challenging innovation culture and value creation strategies. Inventing and designing highly competitive value creation chains and realizing successful innovations for integrated product and process developments is the target of WOIS. 
This paper will discuss perspectives that could foster TRIZ to extend its power in Business Innovation.

Since we do not have enough space here to reproduce the Authors' logics of building up their elements for business innovation, I would like to show their methodology in a top-down manner by using their slides. The following slide shows the Authors' conclusion on the core elements necessary for innovation leadership as a business. The three elements are (a) innovation power (being strengthened by (WOIS) innovation knowledge), (b) prognosis reliability (being increased by (WOIS) direction finding models), and (c) short-time realization (being shortened by (WOIS) innovation technology).
As the basis of (a) innovation power, the Authors provide the following figure on innovation knowledge (or fundamental sciences for innovation strategies). Here they show four elements: First is the philosophy (of the company) on the structures of Thinking culture, Technologies, Society, and Nature (or Resources). Second is the Evolution theory on technologies and businesses. The third is Psychology of the (company's) people. And finally the fourth is Economy in the sense of benefit/effort for doing right things right.

As for the basis of (b) prognosis reliability, the Authors have been advocating the WOIS innovative shortcut method as illustrated in the following figure. The essence of this method is to step aside from a development marathon (i.e. competitions in the conventional directions) and to consider the core contradictions in the problem. By solving such a contradiction (with WOIS, or essentially with TRIZ, we
may say), one can make an innovative shortcut to come up to a leading position at a higher level of the product evolution.

The basis of (c) short-time realization of the invention into an innovation is given in the following slide showing the concept of WOIS innovation process. In this figure, the Authors advise to consider all the four areas, i.e., Thinking culture, Technologies, Society, and Nature (or Resources), just as mentioned in the Philosophy. The first phase of this innovation process is the Direction Searching: it consists of several detailed steps which finally summarize the information into innovative quotients. Then the second phase is the Direction Decision which is conducted with the use of Matrix of effectiveness to identify the key contradictions to be solved. The third phase is the Innovation Finding to solve the key contradictions and to develop the solutions into innovative ones. During these processes, one should consider the future directions of technologies (and society, nature, etc.) and use the strategic orientation tools (represented by (TRIZ) Trends, Laws of evolution, and Innovation principles).

[*** This slide seems newly revised to contain a lot of methodological theories and practices, in the background.]
A case study is shown in the paper (but omitted in the presentation, probably due to shortage of time). The following slide shows the development process for professional Hilti-Chisels carried out in 2000/2001. (See bottom-left of the figure first.) In the present situation (at that time), the company had difficulty in the business of selling their chisels because of its high cost of re-sharpening at the professional center. The conventional direction was to make the material harder to extend the duration time but it would make the re-sharpening cost even higher. Thus it was necessary to reduce the material effort and to increase the destruction power of the chisels at the same time. By the use of strategic orientation tools, 'self-sharpening' concept was identified as the key guiding value. Then the chisel cross-section was made in the geometry as shown top-right in the slide. This resulted: +30 % of demolition power, self-sharpening due to the strong core with light wings, no complex service processes at all and significantly reduced manufacturing effort, the Authors write.
The WOIS methodology seems to have established a systematic and general approach for innovation and have applied it in various industries. Their approach looks fairly standard and orthodox, probably because of their basis of German Design Theory, and at the same time powerful, probably because of TRIZ.

Vincent Bontemps (CEA, Commissariat à l’énergie Atomique, France) [48] gave a Keynote Speech with the title of "An original contribution to the understanding of laws of technical evolution: Gilbert Simondon’s tribute to "mecanology" ". This Keynote has introduced us that a French school represented by Gilbert Simondon established a concept of laws of technical evolution similar to the one in TRIZ, independently. Sorry but I could not understand this Keynote well. See the paper by Denis Cavallucci et al. [5]

### 5. Case Studies in Industry

HeeChoon Lee, Jin Su Kwak (POSCO, Korea), Isak Bukhman (TRIZ Solution Inc., USA), and Hong R Yoon (TRIZ Centre Inc., Korea) [36] gave a presentation on "The Application of TRIZ Methodology in Iron & Steel Making Industry". The Authors' Abstract describes the background of this case study:

This article describes a project that has recently been done in iron and steel making industry. The problem of deposits of Coal Oven Gas (COG), one of the chronic problems in iron and steel making industry, is introduced in this paper. Coal oven gas produced by coal carbonization process is widely used as an energy source in the iron and steel making industry. Approaches were divided into three parts: (1) How to prevent the formation of impurities during COG transporting, (2) How to measure the amount of deposits, (3) How to block the inflow of deposits at a certain area. It is said that coal oven gas and impurities such as surfer, ammonia and vapor create deposits inside pipe during the transporting. Deposits cause undesirable effects such as energy loss by the measurement error and defects of manufactured goods. To overcome these undesirable effects, 6-sigma methodology and TRIZ methodology were applied for this project. This paper focused on how to block the inflow of deposits at reheating furnace which uses coal oven gas as an energy source.

POSCO is a big iron and steel making industry in Korea. It has adopted TRIZ for these several years and has already established a company-wide system of TRIZ training as shown in their slide:
The present problem is summarized in the following slide. Deposits of COG clogs the pipe as shown in the upper-left photo, and causes errors in the temperature control at different zones in the furnace.

Tackling this problem the Authors have thought of two IFRs (Ideal Final Results). (1) Deposits themselves will be disappeared during the transporting. (2) Pipe can block the particles and allow gas to be transported. Then they searched the knowledge base for scientific effects and patent database for specific devices. They found the Andreae Standard Filter, which was used for paint industry, effective and easy for maintenance. (See the figure.)

The results of the implementation are demonstrated in the following photos: They show the inside of the valves and pipes after several months operation, before implementing (right column) vs. after implementing (left column) the ASF separator. The left figure shows the graphs of gas supply pressure. The graph in purple shows the frequent pressure fluctuation in the case of no separator, while the one in blue shows no fluctuation after installing the separator.
Problems and solutions of case studies often look rather simple, after having been solved well.

Wolfgang Sallaberger (Congelo, Austria) [49] gave a pleasant and wonderful pre-dinner talk on "TRIZ as Problem Solving or how to win time, quality and money with TRIZ". To our surprise, he is a chef (and inventor) who made the side-dish recipe served at the dinner. Even though convenience food is more and more accepted by people and is served even in top hotels, vegetable side dishes are not yet available in such a form. Vegetable side dishes are usually made "fresh", with the 10-13 steps of wash, peel, cut, cooking each vegetable separately, cool down, heat, flavor and spice, cool again, dress on plates, "reshine" with butter; (and for later use) cool and store, heat in the oven, and "reshine" again with butter before serving. All these processes take many cooks and a long time, the Author says. So he challenged this problem and derived a number of ideas by using TRIZ 40 Principles.

The main principles he used are prior counter action, prior action, and cushion in advance. The side dishes are finished before they are needed. The dressing of the side dishes is done before the main dish is dressed and takes only 1 step no matter how many kinds of vegetables are used. Leaving away/minimize the expensive cook's work for the side dish, using steam ovens which can be handled easily by each person (ovens are programmed). In this manner, he made the nice vegetable side dishes as shown in the following photos.

Joost R. Duflou and Joris D'hondt (Katholieke Universiteit Leuven, Belgium) [8] gave a presentation on "Applying TRIZ for Systematic Manufacturing Process Innovation: The Single Point Incremental Forming Case". This is a case study of improving an emergent sheet-metal forming technology, called Single Point Incremental Forming (SPIF). In the SPIF technique, a metal sheet supported in the frame is pressed at a single point at a time and is formed into a specified shape by moving the pressing point under the control of a CNC machine. It will fulfill the needs for producing prototypes and small batch production of sculptured sheet metal parts because it allows to form a wide variety of shapes in a short lead time and at low cost. The difficulty of the technique at moment is its geometrical inaccuracy of the product due to poor control of the deformation of the sheet without back-support nor shaping mould.

The Authors analyzed the problem with Axiomatic Design, TRIZ Su-Field Analysis, and TRIZ Contradiction Analysis, etc. The following slide shows most clearly the logic of revealing the difficulty and solving it. The Authors have found the difficulty as a Physical contradiction that the metal must be easily deformed at the tool contact area AND must not be deformed at other places. Then they solve the contradiction by use of TRIZ separation principle:
They have adopted a strategy to change the property of the metal sheet temporarily and locally at the tool contact area. Thus they introduced a laser for heating the metal sheet at the tool contact spot. The experimental set up is illustrated in the following slide. The metal sheet is clamped vertically and pushed with a hemispherical-tip tool which is operated with a 6-axis robot of the CNC machine. The NdYAG laser is applied from the back to heat the tool contact spot. For better performance, the metal sheet is intensively cooled with water for keeping the heated spot area small and the laser spot is controlled to go a bit ahead of the tool. The result of this dynamic heating can be seen in the photo of the products. Conventional SPIF technique was only successful to make the product shown left in the slide, while the present technique of dynamic heating SPIF made the product shown right, with better formability and accuracy and with less remaining stress.

*** In this paper, the logic of solving difficulty with TRIZ is clearly described. The Authors say that the technique embodied here has been filed for a patent.

6. Promotion of TRIZ in Industries

Peter Schweizer (MethoSys GmbH, Switzerland) [42] gave a presentation with the title of "No Need for Methods?". This presentation was interesting in its description of peoples' reactions to a method, e.g. TRIZ, and of our (promoters') choices of re-reactions. In fact, there were a lot of discussions just after this presentation. I will quote the Author's Abstract here first:

In the first part, the psychological mechanisms are explained, for example, why methods and tools are not appealing. This is especially the case in R&D. Really good ideas are often neither accepted nor realized. In the second part it is shown that you do not need to be a masochist to propose methods. Ways are shown, how methods and TRIZ could get a broader acceptance, or at least how hopeless situations can be recognized earlier, so we do not waste our time on them. And finally, it is shown why and where, despite the resistance, it is worth going on with our support for TRIZ and other methods.
The Author first discuss how we, human being, perceive our environment. The following figure shows our mental procedure of perceiving an environment and forming our problems. After filtering information from environment, we form my vision “how it is” and compare it with my vision “how it should be”. If there is a difference, we have a problem.

When we can live with the difference, the problem is no longer an acute problem. Different professionals have their preference on how they reduce the difference. Thus, “We do not want to solve problems. We only want to prove that we are right.”, the Author writes. If it turns out that we are not right, we feel uncertainty, fear, distress, and conflict, and then show psychological defense reactions (See the following figure, left). Defence is a very natural reaction for every living things, the Author says. We often show resistance to the problem focus because of hidden profit (economic, emotional, etc. even without awaring of it) and fear against next goal when the problem is solved (See the figure right). The strongest opposition is always based on emotions (usually fear), and these emotions have various origins.

Then the Author goes ahead to discuss about the nature of methods, and of TRIZ in particular. The Author writes: “Methods do not only match with all the above causes, they even expect us to change the way we think. They question the way we have always thought! Isn't this terrifying?”. Concerning to TRIZ he writes as follows:

**Besides the normal NIH (Not Invented Here) Syndrome, I have three more hypotheses why TRIZ has taken off so slowly:**
1. TRIZ is not just a new idea, it is a method and against our traditional way of thinking.
2. TRIZ takes time to learn and needs continuous training.
3. For an average R&D employee there is no opportunity to use it often enough to become a TRIZ expert.

[*** I would like to discuss about these points later.]

Concerning to the reality of TRIZ in industry, the Author writes four typical cases. All of them are very
In a company that develops and produces installations for the building industry, the R&D manager buys CAI software and an intensive training for a team of volunteers. All R&D members get a short introduction in TRIZ and a presentation for what it could be useful. From the volunteers at the end remain two champions who regularly support other projects very successfully. After three years, the R&D management changes. One of the champions retires early and the other finishes a post graduate course and changes to another company. The new R&D manager is no fond of methods and newly hired employees are not interested in them either. After 3 years of successfully using TRIZ, there is no more TRIZ experience and no more interest in TRIZ in this company.

After 8 years of experience in selling CAI software, the Author writes about three preconditions for TRIZ to be successfully introduced. They are: (1) A champion (better a team of champions), (2) Management support, and (3) Budget to invest in education and probably also in software. The Author also writes: “Most successful are companies where there is a team of consultants that support &D project teams in solving problems with TRIZ and other methods. Besides mastering the methods, the consultants’ personalities are important. They must be people everybody likes to cooperate with. It is also important that these consultants work for free. Because the project leaders don’t want to spend money when they do not know in advance what kind of ideas will come out.”

On the basis of all these observations, the Author advises/proposes to promote TRIZ in the following ways:
(a) First accept the reality that TRIZ is (for different reasons) not attractive for most of the rest of the world.
(b) Do not try to change the world. Be patient. For the acceptance of new ideas, it always takes much more time than we expect. And if you are the pioneer in your company, move on slowly and carefully so that others can also follow you.
(c) If you want to be successful, sell the people what they really need, not what they say they want.
(d) Continue to be a little bit unreasonable!

*** This talk was so interesting that it raised a lot of discussions just after the presentation, though I cannot recall them now. I myself got more and more frustrated (i.e., finding differences) during the talk. Even though the environment may be different in Europe from in Japan, we should (or may/can) promote TRIZ better by slightly adjusting the TRIZ methodology itself and by adjusting ourselves, I feel. Corresponding to Authors’ points I have some short comments here (some of which I raised during the discussion):

(1) TRIZ is a new methodology, many of its methods are new to us but some are more or less similar to our original thinking and only few are ‘against’ our traditional way of thinking. Most of TRIZ is already westernized without losing its essence.
(2) TRIZ should be and already is made simpler and unified (in the form of USIT, in my case). Thus learning time is shortened already (2-day USIT training is enough), though continuous training (and self-training) is necessary/much desirable.
(3) We should not try to train every (or average) R&D employees to become TRIZ (or USIT) experts. We should train a smaller percentage of R&D people as TRIZ (or USIT) experts who can guide and support all other R&D people in the real projects.
(4) It is important to raise voluntary pioneers of TRIZ into TRIZ champions. Wider penetration of TRIZ information (e.g. by Web site) is necessary to get larger number of volunteers, and deeper information/training need to be available for training them into TRIZ champions.

Martin Jandt (recent Industrial Engineer graduate from Technical University Berlin, Germany) and Eckhard Schueler-Hainsch (Daimler Chrysler AG, Germany) [28] gave a presentation on “The Introduction and Application of TRIZ in Industrial Businesses in Germany - an Investigative Study”. The motivation of the Authors was the perception that “TRIZ is applied in some German industrial companies but successfully only in a few of them” and the question “Why successful only in a few?”. So the Authors made a questionnaire and made interviews to 17 TRIZ pioneers in industries for one hour each. The companies are of various sizes and the people interviewed are at various levels. The most interesting points for me is the Authors’ categorization of 4 types of TRIZ users. They are:

(A) Internal consultants (6 cases): The most common form, with respondents favorite
recommendation. Coaches are organized inside the company in a central department and have experience in moderating TRIZ workshops. They train the other business units and projects throughout the company. The typical size would be 5-10 internal TRIZ coaches for 5000 employees.

(B) Management support (4 cases): The most successful way of implementation, but only a rare occurrence. The acceptance of TRIZ and a positive, open attitude towards innovation are conditional on each other. Highly hierarchical structures are a hindrance, as well as controlling based only on operating figures.

(C) Isolated propagators (5 cases): These people usually generated their TRIZ knowledge in their free time out of their own interest. Typically located on the operative level, they lack the influence to introduce TRIZ on a broader scale and without the backup of their managers, the typical result is a period of frustration after great initial enthusiasm. Most of these solitary advocates feel obstructed in their efforts to promote TRIZ, even though they still value it as a powerful method. If they left, the interest in TRIZ would die off completely. This group is not so much a final status such as the other groups.

(D) Pilot project failure (2 cases): The pilot project had failed. In general, with new methods one doesn't get a second chance. That's why this group gives the strong recommendation to seek the advice of a professional consultant for the first pilot project since the typical reason for a failure is having an inexperienced moderator hosting the first workshops.

*** All these descriptions may be common in many other countries, I feel.

Robert Adunka (Siemens AG, Germany) [18] gave an interesting presentation on "Lessons Learned in the Introduction of TRIZ at Siemens A&D". In the beginning of the paper, the motivation is written in the following way:

Siemens has some experience with TRIZ as its Corporate Technology department was and is still dealing with this issue. However, companies like Samsung and Intel showed a different approach to TRIZ methodology which gave them a huge advantage over their competition. Automation and Drives is one of the biggest groups of the Siemens AG. It was searching for opportunities to improve their innovation rate. One of these opportunities could be TRIZ. It had therefore to be proven that TRIZ methods could be used with the A&D products and that the methods are accepted within the company. Therefore the Invention on Demand Workshop concept was implemented to show whether the presumptions were correct.

The Author's Abstract is now quoted here:

Since October 2005 so-called Invention on Demand Workshops are conducted at Siemens Automation and Drives (A&D). These workshops were done for two reasons: On the one hand methods like TRIZ had to be tested for their ability to solve problems deriving from the Automation and Drives product portfolio, and on the other hand it had to be proven that the employees themselves were willing to use those methods in problem solving processes. Both issues could be answered positively. On the basis of that experience a concept for a methodical curriculum for the employees of Siemens A&D was developed.

The Workshops were held every other week, free for the attendees and their departments due to the support by the 'Strategic Tasks' group. The ST group apparently organized the participants and the problems to be handled, and facilitated the workshop. In the fiscal year 2005/2006, 25 Workshops were held with the participation of 244 Siemens employees. The 'Invention on Demand Workshops' are organized in three categories as shown in the following slide. Each category has different goals and hence uses slightly different methods. Actually, 10 workshops were held for Solution on Demand, 7 for Innovation on Demand, and 8 for Patents on Demand.
For the 'Solution on Demand' Workshop, the following slide shows the input required, the methods used, and the outputs to be delivered. (TO stands for 'TechOptimizer', the TRIZ software tool by Invention Machine Inc.) (I suppose that each workshop has one category, one real problem, about 10 employees; but I cannot find how many days and how many facilitators.)

Different methods are tried/used in facilitating the workshops. The following table summarizes the methods used in each category of workshop, with the classification of their easiness to learn/apply. As you see various creativity methods, like De Bono's methods, are used besides TRIZ methods.
A case of problem and its solutions are demonstrated in the following slides.

As the results of these 25 Workshops, they obtained 1238 ideas and 243 invention disclosures in the fiscal year 2005/2006. This result is clearly seen in the graph of number of invention disclosures, taken from the company's official 'Customer Report'. The Workshops contributed much in the significant increase in the fiscal year 2005/2006.

After getting this positive results, the A&D has started 'Innovation Tool Academy' for training the employees. It has the four levels as shown below:

Level 0: Introduction course: Awareness of methods. 0.5 days for executives, while 1.5 days for engineers.
Level 1: Basic course: Use of basic methods. 5 days

Level 2: Advanced course: Use of advanced methods. 5 days

Level 3: Professional course: Use of professional methods. 15 days.

*** This paper is very impressive. Regular events of workshops would make so much load on the organizers, but would give so much effects on the employees and so much results. 'Invention on Demand' is a model in which the (TRIZ) promoters accept (or invite) users for helping them to solve their problems and at the same time the promoters can refine the methods and their own capability and can teach/penetrate the methods. For conducting such a workshop regularly, the promoters usually need to go around to talk to managers and engineers in various departments.

David W. Conley (Intel Corporation, USA) [21] gave a presentation with the title of "Intel Corporation’s Expert TRIZ Field Guide". This presentation attracted a lot of interest of audience mostly because of Intel’s recent very active promotion of TRIZ, in which the 'TRIZ Field Guide' is just one supporting document. At the beginning the paper writes about the background in Intel as follows:

Intel has been utilizing TRIZ for manufacturing process innovation since 2003 and has increased the number of our TRIZ trained engineers by 10 times over the past few years. The organization realizes the advantage of harnessing TRIZ as one tool to pursue the applied science of innovation and expand our industry leadership beyond product innovation and into manufacturing improvement.

And a slide of presentation shows some more about the TRIZ situations in Intel:

- Was looking for structured methodology to support innovation
- Began incorporating TRIZ in 2003
- Realized advantage of the applied science of innovation
- Increased our TRIZ trained employed by 10X over the past 3 years:
  - 90% Level 1
  - 6% Level 2
  - 4% Level 3
- Where TRIZ efforts are targeted:
  - 95% used for manufacturing process improvement
  - Internal business process improvement
  - Product design application

[*** During the discussion, there were a lot of Q&A. Besides the Author, Amir Roggel answered some of them as the TRIZ leader in Intel: In 1990s Intel actively introduced and used TRIZ software tool with some success, but such usage was apparently limited in some divisions and some people and did not spread company wide. More recent TRIZ activities started in 2003 by inviting TRIZ consultants (GEN3 Partners) and putting emphasis on training of TRIZ. The Level 1 through 3 in the slide stands for the level set by MATRIZ (i.e., International Association of TRIZ, initially organized in Russia in 1989). The total number of TRIZ trained employees in Intel was of the order of one thousand. Amir Roggel only is working for TRIZ full time, while all others have their own jobs besides TRIZ. ]

Now I will quote the Author's Abstract and introduce you his 'Expert TRIZ Field Guide':

After completing the course work required for MATRIZ Level Three Certification the author began organizing and studying the class notes by creating an internal document summarizing the overall TRIZ problem solving methodology and process. The resulting 80 page Intel TRIZ Expert Field Guide is intended to improve standardization and efficiency in the execution of TRIZ based innovation and complement Intel's manufacturing improvement efforts. This paper describes the TRIZ Expert Field Guide’s content, methodology and utilization within Intel.

The table of content of the Field Guide is shown in the next slide.

[*** It is a pity that this table has 14 items just saying 'proprietary material'. I feel there can be some
other expression, e.g. Case studies using Altshuller's Matrix, Method XX for forecasting, etc. --- Since ETRIA TRIZ Future Conference is a sort of academic conference, we would like the Author to reveal their 'new' method. Otherwise conferences are of no value, I think.]

The Author illustrates two case studies in the presentation slides. One of them is a problem in the field of Human Resources software (The Author writes its source as: internal consulting by Juan Aranda inside Intel). The problem and its solution are shown as follows. Usage of the 9-Window Method is convincing in this case:

![9 Screens for Business Application/Solutions Intel/HR example***](image)

1.) Employee changes job code

2.) Current benefits database does not allow job code change - new benefits calculations and data entry required

Software limitation was requiring significant rework for Intel's Human Relations department
This presentation was nice and stimulated much the audience. Industries in USA have recently become active in 'restarting' the introduction of TRIZ.

Albert J. H. van der Kuij (Sensata Technologies Holland BV, The Netherlands) [35] gave a paper on "Introduction of TRIZ in the Sensata Technologies Holland Organization". I will just quote the Author's Abstract here. [*** Sorry but I cannot understand this paper well.]

This text is explaining the DfSS structure we are currently implementing at the Sensata Technologies Holland organization. Striving for continuous added value by applying QFD and FMEA tools and use of TRIZ for analyzing resources available and create new products and services directed to ideality.

Guillaume Vendroux (Alstom Transport, France) [47] gave a Keynote Speech with the title of "Innovation Management within Alstom Transport". Alstom Transport is one of the world leaders in railroad equipments, such as engines, carriages, control systems, etc. and has established the record speed of 574.8 km/hr. The Author defines Invention as 'the first tangible idea of a new product or process', while Innovation as 'the first successful attempt to apply an invention'. And he talks how to manage innovation. He shows the following slide. Even though each component may be NOT new, the system can be an Innovation. And major railway innovation will be 'System', just like the Record Train, he says.
He points out three keys for achieving innovations. They are (1) Define a vision and stick to it (e.g. 25 kV electrification), (2) Cross fertilization (among fields or subsystems), and (3) Succeed in the transition (from ideas to industrial reality).

"Innovations start with People", the Author says and shows the management system in Alstom. First they have a system (and criteria) of selecting/promoting experts in various levels. Master Experts (at Level 5) are top selected engineers (of <0.5 %) and form ‘Core Competency Networks (CCN)’. Senior Experts (at Level 4) are selected engineers (of 4%) working in each field and form ‘Technology Centers of Excellence (TCoE)’. The roles of CCN and TCoE are described in the following slide.

Then the process and organizations for defining the vision and developing the systems are shown in the following slide. (Though details are not explained, we can learn a general structure of development in this slide.)
Juergen Jantschgi (University of Leoben, Austria) and Johannes Fresner (STENUM GmbH, Austria) [29] gave a presentation with the title of "Joint Application of TRIZ in Groups of Several Companies in Austria: Approach & Case Studies of Cross-Company Workshops". This presentation was very interesting for me because their experiences in Austria are much parallel with mine in Japan in my TRIZ/USIT training workshops conducted under multi-company settings since 1999. I will quote the Authors' Abstract first:

Typically TRIZ is used in workshops run by consultants in individual companies. The participants of these workshops are recruited from different departments - mostly R&D, production quality and marketing.

The approach which is presented in this paper is a slightly different one. During the last years several workshops with pairs and groups of firms have been conducted by the University of Leoben and its partners. After a phase of trust building one or two problems from the participating companies were chosen. They were presented by the problem owners, the problems were reformulated using a function analysis based approach. Then ideas were generated by all participants using TRIZ tools like the Inventive Principles, the Matrix or the Trends of Technical Evolution.

The paper shows the approaches, some results and testimonials of some participants regarding the methods chosen and the benefits of the approach - to work together with people from other branches (in so-called cross-company workshops).

This paper deals with two different settings of cross-company workshops. (A) 5-day SUPPORT training workshops with about 10 participants (each time) coming from different companies. (B) 2-day TRIZ workshop with 6+6 participants coming from two companies for the purpose of exchanging TRIZ know-hows and problem solving skills. I will explain (A) and then (B).

(A) ‘SUPPORT’ was an EU project carried out by 16 (academic and industrial) partners from 6 EU countries for 24 months starting at the end of 2002. The project developed a course with the material (see the slide below) containing 7 modules covering Sustainable development and TRIZ. Though the course was originally designed for 7 days of training, Austrian companies wanted to shorten it into 5 days. Thus the Sustainable development part was shortened into 1 day while keeping the TRIZ part for 4 days. On the basis of the product of SUPPORT project, a workshop series was carried out in Austria by the three
Austrian SUPPORT partners (i.e., University of Leoben, Joanneum Research Graz, and Stenum GmbH). Two workshops were conducted so far, one in Leoben in 2006 and the other in Linz in 2007. In total about 20 people (from 15 companies) took part (see the photo below). The Authors write as follows:

In the first two days of the SUPPORT course generic problems and problems from literature are used. Then the participants are openly asked for problems from their experience. The problem of confidentiality is discussed and the problem of intellectual property rights on potential solutions. Our policy is that the company which presents the problem also fully owns the solution. In all the courses so far, this was not a problem. The participants selected their problems according to their company’s policies. ... Several very interesting ideas and results have been taken in the workshops. Still it was not that easy to get the permission to publish these ideas.

The paper reports a case study of real problem actually solved: The problem concerns to a brush holder for starter motors for cars (see the photo below). "The brushes are spring loaded. The requirement is to make the part smaller to reduce space requirements. At the same time the number of starts the part can do shall increase. This means that the spring which holds the brush should become shorter. However, as the brush becomes shorter because of wear, it would loose tension rapidly." The participants asked to apply TRIZ tools such as definition of main parts, useful & harmful functions, resources, function analysis, innovation checklist, etc. Then in the next step, they defined technical contradictions for using Contradiction Matrix and obtained Inventive Principles. In this process they derived several solution ideas. Then the Authors write:

After that the problem was discussed and rephrased as the following physical contradiction:

- the spring should be short (to reduce space) and long (to provide pressure).

This formulation almost instantaneously led to the conclusion, that the spring should be segmented in space and/or time.

A sketch of one of the ideas was drawn during the workshop (Figure 6 [skipped]) and within the next week the engineers of Hoffman Elektrokohle found a proper solution. This solution was appreciated as a success by the whole group. In the meantime it is also patented by the company. (Figure 7) [See below.]
In the last years the University of Leoben also carried out several "pure" TRIZ workshops with companies. These workshops normally have the duration of 2 days. Depending on the setting of the task specific analysis and idea generation tools out of the whole TRIZ toolbox are applied. Special attention hereby is turned that employees from different departments and with different background (education) are taking part. Several of the companies discovered that this exchange of knowledge is one important surplus by doing such workshops. So the idea for organizing workshops together with other companies was born and offered.

Under the coordination by University of Leoben, two companies had a TRIZ workshop together. Company A is producing household compressors, and had experiences of several TRIZ workshops with external consultancy and of intensive internal usage of several TRIZ tools since 2003. On the other hand, Company M is producing all-wheel gearboxes and experienced 3 TRIZ-workshops with external moderation for new concepts of their products since 2005. The concept chosen was two one-day joint workshops, where each company can define two problems to work on. The paper describes as follows:

The timetable therefore was very strict. Each of the problems had to be described, analyzed and ideas had to be worked out in half a day.

The inviting company was responsible to prepare a comprehensive presentation of the problem in advance. Then the invited company had to choose the persons they wanted to take part in the workshop. The number of participants was limited to 6 persons from each company. The workshops were moderated externally (University of Leoben). In order to use the experiences the inviting company together with the moderator was in charge of selecting the TRIZ tools for each problem. ...

Results: Although that the time limit was a real challenge - and in the opinion of the author there was too less time - for all the 4 problems some interesting and new ideas were developed. In two cases increased co-operation and knowledge exchange was defined. Both companies declared their interest in continuing and extending the approach of cross-company workshops.

*** The concept of 'cross-company workshops' for solving real industrial problems by using TRIZ is reported here well and with much success. This is a nice and useful way for penetrating TRIZ widely. Since 1999 I also have conducted 3-day or recently 2-day USIT Training Seminars for solving real industrial problems with the open participation from multiple companies. The Agreement among the participants on the confidentiality and rights of results has been established already. In two days, TRIZ and USIT are taught to engineers (mostly beginners of TRIZ/USIT) and three real brought-in problems are defined, analyzed, and solved in parallel group works using USIT. Please refer to the paper by Toru Nakagawa [14] in this conference (and some more details posted in this Web site, "TRIZ Home Page in Japan").

7. Usage of TRIZ in Academia

Victor Berdonosov and Elena Redkolis (Komsomolsk-na-Amure State Technical University, Russia) [3] gave a paper on "TRIZ-Fractality of Mathematics". The Author, Victor Berdonosov, has so far reported 6 papers in a series (3 at ETRIA TFC, 2 at Japan TRIZ Symposium, and 1 at TRIZ Fest in Russia) on the topic related to 'TRIZ-fractality of knowledge and its use in education', and I read 5 of them. Reading the present paper (and the presentation slides), I now feel I have understood his points for the first time.

The main motivation for the Authors is to solve the fundamental contradiction in education. That is the contradiction between the Volume of delivered knowledge and Time required for mastering. The Authors' approach is to understand the structure inside the knowledge (or to systematize the knowledge), especially in terms of its fractal nature (i.e., self-similarity in building up) and in terms of TRIZ principles in the building-up rules. The purpose of the present report is shown in the following slide:
According to Benoit Mandelbrot, the Authors see the fractal nature in everything in nature, e.g. plants, crystals, animals, etc. Fractality means a scheme of development realized by self-recurrence, self-imitation of an initial specimen or a pattern. Fractal development, in general, needs three components: they are 'the seeding grain', 'constructional material', and 'the rules of construction'. This can be seen in the fractal model of fern, shown in the following figures. The three figures on the left show the one-step realization of the iteration of fractal image construction. The four right figures show the growth (or development) of the fractal model of fern.

The Authors see similar fractal nature not only in the natural systems but also in the systems of knowledge and in artificial systems. The Authors also think of 'TRIZ-fractality' where 'the rules of construction' are related to (or come from) the TRIZ principles. They believe that knowledge and artificial systems in general can best be understood in such terms of 'TRIZ-fractality'. Thus the main theme of this paper is represented by the following slide:

Now the Authors take the discipline of numerical computation as a case to systematize the knowledge in the scheme of 'TRIZ-fractality'. The knowledge of this field may be usually shown in a hierarchical classification, as roughly shown in the following slide:
For understanding this field of knowledge, the Authors advocate to see that the system of knowledge has developed itself step by step in the scheme of TRIZ-fractal growth. We should assume only two criteria according to which evolution of the system of knowledge of Numerical Methods proceeds, the Authors say. The first criterion is 'increase of mathematical model's adequacy to its real physical prototype'. The second is 'increase of ideality of existing model's realization'. These criteria are of course associated in TRIZ concept of ideality.

The Authors then examine Numerical Methods one by one. The most basic model is linear equation systems. Such linear equations systems may be used in explaining some behaviors of nature; though they are good in some narrow ranges of variables, they are often found not adequate in wider ranges of parameters (where a compromise is to use multiple linear equation systems depending on the regions of parameters). Thus a contradiction appears: increase of closeness of solution to test data led to unacceptable increase of volume of calculations. For solving this contradiction, a measure of 'transition to another dimension' was installed where 'another dimension' means transition to the category of non-linear equations. Similarly, the model of non-linear equations was found not adequate enough and it moved on to non-linear equation systems. The scheme of evolution of Numerical Models along this first criteria of 'adequacy' can be summarized as shown in the following slide, the Authors write.

The Authors also considered the evolution of Numerical Methods along the second criteria of 'increase of ideality of existing model's realization'. For example, the basic method to solve 'Linear equation systems' is the Gaussian method. It is known that the Gaussian method needs calculations of order of n-cubed, where n represents the number of parameters. Thus, if n becomes larger (e.g. >100) the calculation time (or rate of convergence of calculation) increases much more rapidly and becomes intolerable (or unrealizable). The Authors describe the contradiction as: 'While increasing the rate of convergence of the Gauss Method, the number of the real world objects [in the] macro models decreases intolerably'. To
solve this contradiction it was proposed to use the method of transition to another dimension, i.e. in this case to use iteration methods. In this manner, various methods have been developed for the purpose of better realization. Since this second criterion is different from the first one, the evolution of the Numerical Methods can be shown in a two dimensional map.

Such kind of two dimensional map is named 'TRIZ-Fractal Map'. A case study of the 'TRIZ-Fractal Map' has been established by the Authors as illustrated in the following figure. [Here I quote only the bottom half (i.e. basic part) of the map, in order to save space.]

The Authors intend to use this Map for designing the strategy of teaching students in this particular field. They write the strategy in the following slide:

- Students study all TRIZ tools before.
- Then the evolution of mathematical models of a prototype (technical object) system for numerical methods description trained.
- Students pass to training of vertical lines of development of numerical methods

The basic strategy is to teach first the various modeling methods (in the horizontal way in the Map) along its evolution, by explaining a model, its limitation (or contradiction), the way of overcoming, and then the next model. For understanding the evolution process, study of TRIZ principles (at least the concept of contradiction and its solution) is necessary/much desirable beforehand, the Authors believe. Then the evolution of the Numerical Methods in the vertical direction should be taught for each model. In this manner, students can learn the field of Numerical Methods much easier in a systematic manner, the Authors believe.

*** Evolutionary development of knowledge in a particular field (or discipline) is described here nicely. Every scholar or specialist of the field may have had the understanding in such a way but have not shown explicitly. I now understand the Authors terms of 'TRIZ-fractality' and that systems of knowledge (in various fields) can be organized well in such a concept. It took five papers (and two and half years) for me to understand the Authors' theory.

Simona-Mariana Cretu (University of Craiova, Romania) [6] gave a presentation with the title of "TRIZ
Method Introduced to the Calculation Field”. This paper is related to the determination of the ‘global mobility of mechanisms’, necessary in the mechanical and robotics fields. Maybe we should better see the problematic cases first. The following diagram shows the Sarrus mechanism, where six plates (1, 2, ...) are connected with hinges. A table (or something) of this mechanism can easily be folded down in the z direction; thus it has the global mobility \( M = 1 \). 

The following diagrams shows the planer mechanisms. The left and center mechanisms have \( M = 1 \), but the right mechanism has \( M = 0 \) (thus does not move).

For determining the global mobility, Cebbychev-Gruber-Kutzbach’s mobility criterion has long been known, but there found various cases (including the Sarrus mechanism shown above) which need modification of the calculation, the paper writes. Now I will quote the Author’s Abstract:

This paper deals with determining the global mobility of mechanisms using the TRIZ (Theory of Solving Inventive Problems) method. We present the formulae for a quick calculation of the global mobility and the signification of the notion ‘mobility number’ for mechanisms. This study underlines that by using this method it isn’t necessary to eliminate the passive elements, the passive limbs of parallel robots and the symmetry that do not change the movement of the next element which must be assembled in an open chain have to be eliminated. We testify to the correctness of the new procedure by giving some examples.

According to the Author, the methods known for the calculus of the mobility of mechanisms are grouped into two categories: one based on setting up the kinematic constraint equations and their rank calculus while the other quick calculus, i.e. Cebbychev-Gruber-Kutzbach’s mobility criterion and its derivatives. The former is reliable but complex.

Thus the Author applied TRIZ to solve this problem. She used TRIZ Contradiction Matrix. The contradiction of ‘reliability’ vs ‘device complexity’ (or ‘ease of operation’) has led the TRIZ Inventive Principles. They are Principle 27 (‘cheap short-living objects’), 17 (‘another dimension’), 40 (‘composite materials’), and 13 (‘the other way round’), 35 (‘parameter changes’), 1 (‘segmentation’), respectively. With these hints the Author used the Principles in the following ways:

Principle 1 (‘segmentation’): we can segment the mobile or reference elements with the rank greater or equal to 2, so that the number of the elements, including those appeared by segmentation, become equal to the number of simple kinematic joints.

Principle 27 (‘cheap short-living objects’) + 17 (‘another dimension’): We operate only mentally, by simple action upon the mechanism: for a short time we suppose that all the elements are disjoined and free in space, including the segmented elements: one single frame remains fixed: after this, we recompose the mechanism.

I will not show the Author’s final equation of the mobility, because it takes a long space and because I (and many readers) can not understand it fully and cannot judge its correctness. In the paper, the Author shows pictures of a didactical model of the Sarrus mechanism and explain how the mobility
equation should be understood: for this purpose, the Author temporarily cuts the plate 1 (see the figure above) into two halves to demonstrate the open edge system's mobility and then join the halves again to constrain the mobility.

*** It is somewhat surprising to see that TRIZ Contradiction Matrix can give useful hints in this kind of purely academic area of deriving a theoretical equation.

Iouri Belski (Royal Melbourne Institute of Technology, Australia) [2] gave a presentation with the title of “TRIZ Course Enhances Thinking and Problem Solving Skills of Engineering Students”. The Author writes: ‘The author has been teaching the basics of TRIZ thinking at the Royal Melbourne Institute of Technology (RMIT) since 1997, but only in 2006 has he been able to introduce the course fully devoted to the tools of TRIZ as a university-wide elective.’ I will quote his Abstract here:

Forty two engineering students at RMIT were enrolled in a course on the Theory of Inventive Problem Solving (TRIZ), which was conducted over 13 weeks in semester 2, 2006. It was found that most of the students were unaware of any thinking and problem solving tools before the course. Results of the student surveys showed that students’ perceptions of their abilities in problem solving changed vastly as a result of the course. Many students believed that their thinking had changed as a result. Students reflected that they would have never expected themselves to come up with the ideas they thought of and suggested while conducting their final project, if they had not been formally taught the tools of problem solving. It was also found that this course on TRIZ thinking tools impacted students’ problem solving ability much more than the discipline courses.

The Author's course seems to be well organized and intensive as shown in the following slide. The class hours are 2hr x 2 x 13 weeks = 52 hrs, as I understand.

The four tools taught are summarized in the following four slides.
The seven-step process taught and requested to use in the final 3-weeks group projects is as follows:

1. Situation analysis.
2. Revealing the system’s stage of development.
3. Identifying the ideal solution.
4. Idea generation.
5. Failure prevention.
6. Adjusting the super-system and sub-systems in accordance with the solution found.
7. Reflection on the solution and the process of the solution.

The Author reported the results of students’ survey and students reflections. The most important results is demonstrated in the following graph. This data comes from ‘RMIT Course Experience Survey (CES)’, officially and independently conducted by the university during classes in week 10 of the semester (and completed by 34 students out of 42 in the case of this course (OENG1045)). For the sake of comparison, all the discipline courses of the School of Electrical and Computer Engineering are summed up to form ‘BP200’ for which 656 students completed the survey. The graph shows the students opinions on the common question of ‘This course contributes to my confidence in tackling unfamiliar problem?’ In the case of ordinary (discipline) courses (BP200, Red), the students answered neutral (33%), agree (31%), disagree (16%), strongly agree (12%), and strongly disagree (7%). On the other hand, in the case of this TRIZ-based course, the students answered strongly agree (65%), agree (32%), and neutral (3%).

*** This is an amazing contrasting results, proving the success of the Author’s class.

Denis Cavallucci and Francois Rousselot (INSA Graduate School of Science and Technology, France) [5] gave a presentation with the title of “Evolution Hypothesis as a Means for Linking System Parameters and Laws of Engineering System Evolution”. The paper is based on an intensive research on TRIZ theory and on a trial of tool development, but somewhat not easy for me to understand the proposed concepts. The main motive of the paper is to bridge the gap between the recognition that Laws of Engineering Systems Evolution (LESE) constitute one of TRIZ’s main axiom and the realization that no available tools or techniques clearly present a use of LESE. The following table summarizes the Authors’ findings where LESE are tacitly or explicitly present within elements of TRIZ body of Knowledge (BofKn):
The Authors write that as it is now commonly agreed, three axioms constitute the ground of the [TRIZ] theory; they are:

Axiom 1: Technological systems evolve not randomly but according objective laws of evolution. -- These laws do not depend on human. They should be observed, formulated and used in order to develop efficient methods of problem solving.
Axiom 2: Technological systems evolve not randomly but they have to overcome contradictions. -- In order to get breakthrough idea we should find a way how to overcome contradictions.
Axiom 3: Each specific problem must be solved in accordance with restrictions of the specific problematic situation, with peculiarities of each specific case and could not be solved in general. -- A robust solution is a solution that involves as less new resources as possible.

As stated in Axiom 2, a contradiction stands out in the way of the technical system moving ahead. Thus the Authors have made it a research target to create a link between the contradiction and the law in order to better identify which contradiction blocks which law. The Authors describe their ways of linking in somewhat abstract terms.

A contradiction (TC) is characterized as TCn(APx; EPn; EPm), where an active parameter (APx) at a specific value (Va) is leading an evaluation parameter (EPn) to evolve in a satisfactory way whereas the opposite value (~Va) (where ~ represents V's antonym) is leading another evaluation parameter (EPm) to evolve in a satisfactory way, and the "mirror" situation is "true". Thus the initial scheme for linking contradictions and laws would be as shown in the diagram below-left. For assisting the linkage, the Authors propose to create the notion of "Evolution Hypothesis (EH)" as a component of the reflection for linking contradiction to laws, as shown in the scheme below-right.

[*** One should note that the Contradiction "TC" in this paper is written in the combined form of ordinary "Technical Contradiction" and "Physical Contradiction". I recall Larry Ball's Course Material (and his Keynote Lecture presented in Japan TRIZ Symposium 2007) saying this a "Complete Contradiction" or simply a "Contradiction".]

The Authors explain the concept of Evolution Hypothesis (EH) as follows:

EH's are literal interpretations of a given law, expressed as a sentence. This sentence is the result of a possible direction the technical system may undertake in his evolution. The semantic interpretation of law will obviously bring more detailed and specified elements (parameters, values, new elements) than the generic expression of a law (its postulate). By

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<table>
<thead>
<tr>
<th>Elements from TRIZ</th>
<th>Type of presence</th>
<th>Where</th>
</tr>
</thead>
<tbody>
<tr>
<td>BofKn</td>
<td>Tacit</td>
<td>From past to present and from present to future</td>
</tr>
<tr>
<td>Multi-screen analysis (MSA)</td>
<td>Tacit</td>
<td>Within the transformation logic from initial situation to solution model</td>
</tr>
<tr>
<td>Matrix</td>
<td>None</td>
<td>Through Inventive Standards use, and IFRs formulation</td>
</tr>
<tr>
<td>Substances-field modeling</td>
<td>Tacit</td>
<td>Through the structure of classes and sub-classes</td>
</tr>
<tr>
<td>ARIZ-85C</td>
<td>Tacit</td>
<td></td>
</tr>
<tr>
<td>System of Inventive Standards</td>
<td>Explicit</td>
<td></td>
</tr>
<tr>
<td>Inventive Principles</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Separation Principles</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

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observing and analyzing how these elements may refer to a list of parameters aiming at evolving in an appropriate direction, it is possible to establish a semantic proximity unifying a parameter to a specific EHx.

The Authors refined the EHs into three types, but I will skip the description here. The Authors also linked laws with design situations (i.e., S-curve status of the present as well as the future systems) and introduced weighting factors for evaluating the relevance of laws to the design situation. The Authors developed some software tool which implements all these concepts, even though I do not have space to describe here. The Authors actually had their students used the tool in their project classes.

In a graduate class, 103 engineering students of 5th year came from 7 different departments. The class had 14 hours of theory for teaching new procedure (largely inspired by TRIZ's fundamentals) and 14 hours of projects (2 hours x 7). Students form groups of 3 to 4 members and tackled to solve simple problems of their choice. A students' case study for improving scuba fins is illustrated in the paper.

The problem was analyzed with the law of completeness of the system and then with the Multi-screen analysis (MSA), resulting four EH1's (See the slide shown below-left). Then with the situation analysis on S-curves, three more second-phase Evolution Hypotheses (EH2s) were derived (See below-right). Then in the third phase of EH formulation, some redundancies between EH1 and EH2 were eliminated by giving fusion hypotheses EH3: EH3.1 (by combining EH1.4 and EH2.8.1): A blade with n cuts (as ideally necessary); and EH3.2 (by combining EH1.3 and EH2.9.1) A blade the capacity to adapt itself to the needs.

Then, starting with the parameters gathered in the MSA stage, the contradiction set were formulated as shown in the slide below-left. Then the obtained parameters (EPs) were linked with EHs (See below-right).
Passing through all previous steps, the tool gives the information of importance of the contradictions (See the slide below-left). After identification of the predominant contradiction, classical TRIZ tools have been used for resolving the conflicting requirements with a non-compromised orientation of reflection. The concept of tubular shear thickening fins was obtained by the students as shown in the slide below-right. This concept was rated level 4 since there are no-existing in widely distributed and produced product in industry are working based on this principle, the Authors write.

*** The Authors write that their processes and software tools were well accepted by the engineering students. But I am not yet convinced with this approach in its easiness and clarity.

Toru Nakagawa (Osaka Gakuin University, Japan) [14] gave a presentation with the title of "Education and Training of Creative Problem Solving Thinking with TRIZ/USIT". I will quote my Abstract first:

Experiences of teaching under-graduate students and training industrial engineers on how to think creatively in problem solving are reported. The contents are based on the TRIZ methodology but have been further reorganized and unified into USIT (Unified Structured Inventive Thinking) for easier to learn and apply. Case studies, published by engineers in technologies and obtained by students for everyday-life problems, are found useful in both teaching/training situations.

The following slide shows the outline and intension of my presentation:
USIT (Unified Structured Inventive Thinking) was developed by Ed Sickafus and further extended by Nakagawa. It is a structured and unified method of problem solving, having the data-flow structure of ‘Six-Box Scheme’ (see the slide below-left) and the process structure shown in the flow chart (slide below-right). On USIT, please refer to my previous papers.

Training of USIT to industrial engineers has been well established already as shown in the following two slides.

On the other hand, teaching undergraduate students need much more time and efforts especially when the students have very little experiences in technology and in industries, and do not have high motivation at first (see the slide below-left). The 3 types of classes I am teaching in my university (in the Faculty of ...)
Informatics) are summarized in the slide below-right.

Under these situations, I have found that for (rather junior undergraduate) students it is useful to solve everyday-life problems creatively for themselves by using USIT (and TRIZ or more). An example of such problem solving is demonstrated in the slide below-left for the problem ‘How to fix the string found shorter than the needle at the end of sewing’. My conclusion is shown in the slide below-right. For more detail, please refer to the paper posted already in this Web site.

Anna Korzun (MCSIAQRES, Belarus) [33] gave a presentation on "OTSM-TRIZ as a Technology of Training of the Expert in Education". I will quote the Author's Abstract first:

One of the problems of vocational education is the special case of a global problem - we can teach only that knowledge, which is already obtained, however this knowledge becomes outdated quicker, than it is claimed in professional activity. In this article the basic problems of organization of professional pedagogical education in college are analyzed. The author of the article carried out a ten-year experimental work creating the alternative model of training the specialists in education (preschool level) in a pedagogical college in Minsk (The Republic of Belarus). As a result this alternative model was accepted in a certain educational institution, and the program and electronic version of the manual for the teacher and students were developed. The model of work organization which is described in the article, is only one of many possible. The problems, which were solved within the framework of this work, can appear to be standard for those people who will create a course of professional training in other areas.

The peculiarity of the course is that educational technologies for students (future teachers) are worked out simultaneously with educational technologies for children under school age.

This paper reports the Author's ten-year work (1995-2005) carried out in Minsk within the framework of 'Jonathan-Livingston Project'. The Author has been struggling to establish an innovative course within much centrally-controlled education system. Since I feel some difficulty to understand this paper, I would...
rather like to show you several slides showing the Author's activities. In the second photo, the Author standing at the back is advising her students.

The experiment, which we will in this presentation about was organized in pedagogical college in Minsk (Republic of Belarus) in 1995 - 2005.

The experimental work was carried out within the framework of participation in the project "Jonathan Livyagina" and by means of the participants of the project.

Head master of the college Nikolai Poleschuk

Strategy of the course: the maximal attraction of students' research activity for work with new information.

The search work within the framework of a lesson

Our achievements

The work of the leader of the "Pedagogy of Creativity" project was awarded a prize from Special fund of the President of Belarus "For the Personal Contribution to Development of Gifted Youth Abilities."

The first manual for tutors of a kindergarten, with a signature stamp of the Ministry of Education, was published in the publishing house "University". It includes practical materials, created by students: games, trainings, scripts of lessons.

This manual has received a signature stamp «Recommended the Center of the Educational Book at Ministry of Education RB»

Thomas Bayer (Wittenstein AG, Germany), Antonia Spohr (PhD Student Eberhard-Karls-University of Tübingen, Germany) [1] gave a presentation on "Rhetorical Topics and TRIZ - Progressive Methods with Unnoticed Capacity?". Since I am not familiar with 'Rhetorical topics', I would like only to quote several slides which may represent this talk. I hope they are self-explanatory.
8. Patent Studies

Sergei Ikovenko (GEN3Partners and MIT, USA) [26] gave a presentation on "TRIZ Tools within IP Strategic Framework Development". This paper is an extension of his paper presented at ETRIA TFC2005 [26]. The Author has established 11 Intellectual Property (IP) Strategies, as shown in the following slide:

<table>
<thead>
<tr>
<th>#</th>
<th>Type of Patent Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The Competitive Patent Circumvention Strategy by Trimming</td>
</tr>
<tr>
<td>2.</td>
<td>The Competitive Patent Circumvention Strategy by History Estoppel Research</td>
</tr>
<tr>
<td>3.</td>
<td>The Antidote Strategy</td>
</tr>
<tr>
<td>4.</td>
<td>The Picket Fence Strategy</td>
</tr>
<tr>
<td>5.</td>
<td>The Toll Gate Strategy</td>
</tr>
<tr>
<td>6.</td>
<td>The Submarine Strategy (old and new)</td>
</tr>
<tr>
<td>7.</td>
<td>The Counter Attack Strategy</td>
</tr>
<tr>
<td>8.</td>
<td>The Stealth Counter Attack Strategy</td>
</tr>
<tr>
<td>9.</td>
<td>The Blanketing Strategy</td>
</tr>
<tr>
<td>10.</td>
<td>The Bargaining Chip Strategy</td>
</tr>
<tr>
<td>11.</td>
<td>The Cut-Your-Exposure Strategy</td>
</tr>
</tbody>
</table>

The Author explains Strategy #1 in the following way.
As an example the Author shows the case of ionizing toothbrush. The following slides show the original competitor's product, its Functional model, Model with trimmed functions, and then the idea of new product.

The Strategy #4 is explained as follows:

The Picket Fence Strategy

- The Picket Fence Strategy is designed for a case when your competitor has a key fundamental patent. You may invent a series of patents that represent smaller incremental innovations about the core technology.

- The incremental innovations represent the preferred products in which the core technology may be used commercially. They may become a barrier to the effective use of the technology by the owner of the original technology.
I do not have space here to explain all other strategies, nor the Author in his paper/presentation. The full description of the IP Strategies can be seen in GEN3 Partner's Training Manual.

Roberto Nani (Scinte s.n.c. Ranica, Italy), Daniele Regazzoni (University of Bergamo, Italy) [40] gave a paper on "TRIZ Tools to evaluate marketing strategy and product innovation: A new start-up case study of silicone technology". I will quote the Author's Abstract first:

This paper relates about the use of TRIZ to translate and manage the Silicone-based Gasketing Technology into new fields of application such as human necessities: baking and butchering, kitchen equipments and health care. The paper is formed by two main parts. The first part describes the approach used to identify new technological branches, starting from the intrinsic and extrinsic features of the reference technology. The second part of the paper thoroughly describes a case-study regarding a specific kitchen-targeted silicone product. Said approach is structured in order to define a new set of products, services targeting developers, start-ups and managing of Intellectual Property (IP).

The first part of the paper is interesting (though somewhat difficult to understand). Here the Authors show a systematic method how to identify a new field of application of the technology currently present at hand. The case study shows that the SME had the molded silicone technology of packaging gaskets and wanted to find a new field of application of their own technology without dismantling the corresponding manufacturing unit they already have. The Authors used a method of systematic survey of patent database as explained below, and their conclusion can be demonstrated in the following two quite different categories of products:

The Authors use several models expressed in the algebraic form of patent database query, using keywords appearing in the Title, Abstract, and Claims, and IPC (International Patent Classification). I will quote the expressions a bit abbreviated way without showing too much detail.
The first model is called 'Kinetic Model [M]' expressed in the following formula:

Kinetic Model [M] = f (Class C of the present technology, Intrinsic characteristic ρ of the Class C) = (mould*) AND (flex*)

Applying this query to the patent databases, the Authors obtained the main IPC classes as shown in the below-left figure. Namely the two main classes are found to be B29C (Shaping or joining of plastics: Shaping of substances in a plastic state, in general: after-treatment of the shaped products, e.g., repairing) and B65D (Containers for storage or transport of articles or materials, e.g., bags, barrels, bottles, boxes, cans, cartons, crates, drums, jars, tanks, hoppers, forwarding containers: Accessories, closures, or fitting therefore: Packaging elements: Packages).

The second model is called 'Potential Model [K]' which is represented in the following formula:

Potential Model [K] = f (Subclass S of the present technology, Extrinsic feature E representing its function) = (gasket) AND (seal*)

The result of this query is illustrated in the below-right figure. The main IPC class is found to be F16J (Pistons: Cylinders: Pressure vessels in general: Sealings).

The difference between these main IPC classes of the Intrinsic view and Extrinsic view is used as the key to find new field of application (See the slide below). (However the logic here is not clear to me, to my regret.) The Authors focus their attention to the category F16J15/10 (Sealing with nonmetallic packing compressed between sealing of surfaces), marked in yellow in the above-right figure.

Then the Authors use a query of joining [M] and [K] together: especially the query of surveying the Intrinsic feature of the patents in the IPC F16J15/10. After such a survey, the Authors use a new keyword 'convertible' as a key feature of application. Thus they use the query:

[M] AND [K(B29C OR B65D)] AND (convert*)

And the Authors used various keywords taken from the TRIZ 40 Inventive Principle to set in the place of 'convert*'. They say all these surveys are stimulative for idea generation.
The way of using Patent databases in this paper is interesting to me. The latter half of the paper is a case study of designing the holes of convertible colander using ARIZ. The solution generation in this part looks not straightforward, I feel.

Lothar Walter, Ralf Isenmann, Martin G. Moehrle (University of Bremen, Germany) [17] gave a presentation on "Bionics in Patents – Semantic-based Analysis for the Exploitation of Bionic Principles in Patents". I will quote the Authors' Abstract first:

In this paper we present a sophisticated method to exploit bionic inventions in patents with the help of semantic patent analysis. This method enables users to visualize similarities in patent content in a semantic patent map. These maps could be used for strategic decision-making, e.g. for developing technologies and commercial usage and for providing new insights to researchers and practitioners involved in bionics. A case study of US-based patents between 1976 and 2006 clearly shows that most bionic inventions are patented as medical applications in the area of surgery. Other fields of technological applications, however, apparently do not make use of bionic ideas for solving inventive problems. As a result, bionics may provide great potential for solving technical problems that needs to be exploited, e.g. perhaps to be carried out with the help of TRIZ.

This paper has two aspects: one is a method to analyze and visualize the similarities among a large number of technical documents, and the other is the analysis of the field of bionics by using a patent database. 'Bionics' is the term made of biology and technics (meaning engineering), and sometimes also called 'biomimetics'. Authors write:

Nature's inventions have always inspired human achievement and have led to technological progression often in the form of smart products, intelligent processes, effective algorithms, and cleverly structured systems. There are numerous examples of such successes inspired by nature such as the use of fins for swimming. Other examples were inspired by biological capabilities with greater complexity including the mastery of flying that became possible only after the scientific principles of aerodynamics were better understood.

... However, there is consensus that bionics could be structured in terms of applied analogical research into three main areas: ... (See the following slide.)

For examining the status of bionics in the patent data base, the Authors searched with the keyword of 'bionic' in the USPTO patent data base. For the years from 1976 to 2005, they obtained 147 patents which have the term 'bionic' in the description part of the patent text. The dates of issue is distributed as shown in the following graph (left). The patents have USPC classes as shown in the following table (right).
The Authors first analyzed these 147 patents with a semantic analysis software tool, Knowledgist 2.5 of Invention Machine Corp. The tool scans the text and extracts the 'Subject-Action-Object (SAO)' structures, such as the ones shown in the following slide. Total 17588 SAO-structures were found.

Then the similarity values were evaluated for all the patent pairs, where SIM(i,j) is defined essentially as:

\[
\frac{\text{number of overlapped SAOs in } i \text{ and } j}{\text{SAO-structures (i) + SAO-structures (j)}}
\]

And then by using the multidimensional scaling implemented in the SPSS-module PROXSCAL, the patents are plotted according to their similarities as shown in the following map. The triangle dots (41 patents) are patents of US Class 607, the square dots (20 patents) US Class 623, and the circular dots (86) other classes.
In conclusion the Authors write: 'In principle we found that most bionic inventions are patented as medical applications in the area of surgery. Other fields of technological applications, however, apparently do not make use of bionic ideas for solving inventive problems.'

Bert Miecznik and Markus Glaser (Wittenstein AG) [39] gave a presentation on "TRIZ for Reverse Market Research". The term 'Reverse Market Research' (or also 'Reverse Inventing') stands for a new approach for finding innovative new markets of one's own competent products, as proposed in this paper. Now I will quote the Authors' Abstract first:

Conventional strategic market research is a highly costly method to gain results of an often high uncertainty level. We developed and tested a cost effective TRIZ-based concept we call "reverse inventing" for an improvement of this situation. Reverse inventing is a logical process comprising the steps of situation analysis, abstraction of strengths, transformation into searchable queries, comparison with existing knowledge bases such as patent databases, and evaluation of obtained results. We found the method highly effective to deliver surprising, yet high quality and customer benefit and value oriented ideas for new market opportunities outside our classical search horizon.

The following slide, supporting the above Abstract, summarizes the conventional market research and the proposed 'reverse market research' in comparison.
Besides the step-by-step instruction of the new method, 'reverse market research', the present paper shows a case study using their star product 'FITBONE'.

Step (1) is to choose your company's product which is strong and most differentiated and to analyze its strength and to set the research target. The Authors have chosen FITBONE (International patent, May 2003). The FITBONE is a fully implantable distraction system which gradually increases the distance between two bone segments through a telescope-like device. This miniaturized, mechatronic actuator also stabilizes the two bone segments after the bone has been separated to create a reproduction (or "growth") zone (See figure below-left). The internal drive system consists of an electromechanical segment, and an integrated electronic module which receive electric power through high frequency transmission from the outside. There is no connection between the implant and the skin (See figure below-center). This completely internal system allows a comfortable, painless treatment in which the risk of infection is virtually eliminated, and where the risk of a formation of scar tissue is significantly reduced. See, in the figures below-right, a sample result of bone distraction process using this device.

Step (2) is to abstract the strength of the invention (i.e. product) in the terms of TRIZ Inventive Principles. In this case, Principle 7 (Nesting), Principle 15 (Dynamization), and Principle 28 (Mechanical substitution) are found appropriate. Then, Step (3) is to find typical keywords which represent these Inventive Principles in patent databases. For this purpose, Darrell Mann's Synonym Table (Mann, 2006) is useful (See the table below). Among these keywords (or catchwords), those shown in the right slide are selected for representing the essence of the present invention.

<table>
<thead>
<tr>
<th>#</th>
<th>Inventive Principle</th>
<th>Catchwords for patent database search</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Nested Doll</td>
<td>Nest, telescopic, sleeve, hierarchical, retract, stack, tunnel</td>
</tr>
<tr>
<td>15</td>
<td>Dynamization</td>
<td>Dynamic, stationary, design-point, optimize, variable, flexible, rigid, stiff, relax, tee, adapt</td>
</tr>
<tr>
<td>28</td>
<td>Mechanical Substitution/Another Sense</td>
<td>Electrical, magnetic, laser, nuclear, optical, wireless, scent, aural, acoustic, visual, kinaesthetic, gastric, (micro)wave, field</td>
</tr>
</tbody>
</table>

In Step (4), using these catchwords together, patent database (in this case German Patent DB) was searched. Actually, the search was done with the expression: (telescopic? OR nest?) AND (variab? OR adapt?) AND (electric? OR wireless?). 606 hits were obtained. Then, in Step (5) these patents were classified according to their IPC, as shown in the figure below-left. This revealed some clear clusters of potential candidate businesses to be considered. Several of them are listed in the table below.
Step (6) is to commercialize the ideas. The Authors are currently applying their existing project management process for this step.

*** This method seems very attractive. The Authors write in their conclusion: The method has proven its effectiveness in supplying high quality ideas for opportunities in short time, and at virtually no cost other than for work time.

9. Quality and TRIZ

Atsuko Ishida (Hitachi Consulting Co., Japan) [27] gave a presentation with the title of "Innovation and Quality Need to Go Together for Capturing Value". I will quote the Author's Abstract first:

Both of innovation and quality are required for capturing value or making profit from products. For the issue, I define capturing value, innovation and quality improvement on the Dr. Kano's quality model 'Attractive quality and must-be quality'. Using these definitions a product lifecycle model for capturing value that is composed of innovation and quality improvement is introduced. In the model, TRIZ is positioned as an accelerator for innovation. Process management programs and public relations are introduced as accelerators for quality improvement.

In the following slide (top-left), Dr. Kano's model is reproduced. Using this model, the Author interprets the meaning of 'Innovation' (see top-right slide), 'Quality improvement' (bottom-left), and 'Incremental Innovation' (bottom-right) respectively as shown in the slides.
Then the Author shows the lifecycle model of products as shown in the following fugue. In this lifecycle model, the three activities, i.e. innovation, quality improvement, and incremental innovation, are positioned in different phases of lifecycle. On the basis of this understanding, the Author strongly advises that 'Innovation and quality need to go together for capturing value.'

A full case study was shown in the presentation, even though not cited in the paper. The case study demonstrates a full course of generating an innovative new product system and improving its quality. The new system is a food traceability system using the world smallest RFID chip, i.e. μ-chip. Since the slides are well-organized and self-explanatory, I will quote here all the seven slides of case study without further explanation.
6-2 Consumer's needs in food market

Safe
Traceable
Cheap

Food Safety Awareness (by Food Security Bureau Japan, May 2005)
- 90% responded with concern of pollutant and agricultural pollution
- Increase in concern over next 3 points from 2005
  - Genetically Modified food products
  - BSE

6-3 Find business ideas using the business idea database

Customers (farms and consumers)
- Improving point
  - Increase a working skill of a specific field
  - Automate business process as much as possible
  - Secure continuity of work

Technical seeds (μ-chip)
- Category of technology
  - Reduce time/pace
  - Change media

Business idea database

Business ideas
- Dispatch information continuously and frequently.
- Make a system to avoid risk and correspond trouble speedily.
- Improve works in a customer's place to set up a quality level.
- Change a service or a product into a form that has an influence on user's consciousness.

Food traceability system using μ-chip

6-4 Food traceability system using μ-chip

Stock farm
- Warehouse
- Factory
- Supermarket
- Direct sales

μ-chip

Consumer

Information retrieval

Speeding up collection of products in case of problems
Speeding up response for consumer inquires

6-5 What is innovative?

- Item level tracking because of very small chip
- Secure and reliable because of using non-rewritable chip and network-base data management
The paper written by Edgardo Córdova López and José Gregorio Hernández Delgado (Instituto Tecnológico de Puebla, México) [22] was read by Guillermo Robles, with the title of "In Search of Seventh Generation of Quality, a New Paradigm TRIZ". The paper describes the evolutionary processes of the quality in the following 7 generations: (1) Quality for inspection, (2) Insurance of quality, (3) Total quality process, (4) Improvement continues of the quality, (5) Reengineering and total quality, (6) Management of the intellectual capital, and (7) Conscience and systematic innovation. [*** It is difficult for me to explain the Authors’ description here in a short space.]

10. Miscellaneous and No-Presentation Papers

The following three papers were not presented at the conference even though they are published in the Proceedings. I will not review them here simply because of my shortage in time.

Darrell Mann (Systematic Innovation Ltd, UK) [13]: "Capturing The Voice Of The Customer Before The Customer Knows What They Want".

Boris Axelrod (ALGORITHM Ltd., Russia) [19]: "Systems approach: modelling engineering systems using Interactions Causality Scheme".

Pavel Livotov (European TRIZ Association, Germany) [38]: "Integration of Method of Systemic Constellations into Moderated Educational and Problem Solving Workshops with
11. Concluding Remarks

By writing these reviews of papers presented at ETRIA “TRIZ Future 2007” Conference, I feel I have learned a lot again. There are a number of important and interesting papers. The followings are my remarks for conclusion:

(1) In the area of TRIZ methodology itself, we have nice papers such as written by Valery Souchkov et al. [43], Simon Dewulf [24], Dmitry Kucharavy et al. [12], Pavel Jirman et al. [30], and Guenther Schuh et al. [16]. Papers on OTSM by Nikolai Khomenko [11] and on GTI by Greg Yezerski [45] are supposed to have a lot of implications which I do not yet understand well.

(2) We also have good papers which are extending TRIZ to integrate with other relevant disciplines/methods: with design methodology by Markus Deimel [7], and with Toyota Production System (TPS) by Dmitri Wolfson et al. [44]. Hansjuergen Linde et al. [37] has developed WOIS into a systematic and general methodology for technical and business innovation.

(3) Case studies of TRIZ are reported by HeeChoon Lee et al. [36] and by Wolfgang Sallaberger [49], among others who report examples for demonstrating their other main points.

(4) Concerning to the promotion of TRIZ in industries, Peter Schweizer [42] discussed on the difficulty in current European situations. Proactive promotion of TRIZ has been reported vividly by Robert Adunka (Siemens, Germany) [18] and by David W. Conley (Intel, USA) [21]; these two reports are the most encouraging results publicized in the present conference. Keynote by Guillaume Vendroux [47] is important for innovation. Juergen Jantschgi et al. [29] reported a trial of cross-company TRIZ workshop for solving real industrial problems.

(5) Education of TRIZ (or problem solving with TRIZ) is reported by Victor Berdonosov [3], by Iouri Belski [2], by Denis Cavallucci et al. [5], and by Toru Nakagawa [14]. Anna Korzun [33] has been teaching TRIZ-way of thinking to teachers of preschool children.

(6) In the area of patent studies, Sergei Ikovenko [26] talked about TRIZ tools for different types of IP strategies. On the other hand, papers by Roberto Nani et al. [40] and by Bert Miecznik et al. [39] reported to use patent databases for finding innovative new markets of a technology at hand.

(7) Atsuko Ishida [27] discussed that innovation (with TRIZ) and quality need to go together, with a case study. In the present conference no other presentations discuss on the TRIZ application to non-technological fields and software-related fields.

(8) One of the strong points of TRIZ in Europe is its foundation of TRIZ research in the universities. And European universities seem to have good collaborative relationships with industries in their home countries. Cooperation among universities, industries, and consultancies is the nice basis for further development of problem solving methodologies including TRIZ.

(9) ETRIA TFC is trying to keep its high quality by reviewing the contributed papers by scientific and industrial/practioner committees. (TRIZCON and Japan TRIZ Symposium perform the reviewing process in different ways.) ETRIA TFC is very open-minded in making the Proceedings in PDF downloadable from their Web site by the ETRIA members. Starting this year, the presentation slides of almost all the presenters are made downloadable by the ETRIA members. This arrangement was very helpful for me to write this Report; many of the figures shown in this Report are taken from the slides.

(10) I feel that with a bit more efforts ETRIA TFC can obtain more participants. Posting the abstracts of all the accepted papers in 2 or 3 months advance in the Conference Web site must be helpful for obtaining
larger number of participants.

Anyway, a lot of significant works have been reported in the Conference. We can learn them and use them for our own future work. Thanking again for all the people who made this Conference possible and fruitful, I wish this Personal Report convey information and messages of TRIZ to many people all over the world.

ETRIA Executive Board has already announced about the next Conference as:

ETRIA "TRIZ Future 2008" Conference will be held
on November 5-7, 2008 at the University of Twente in Enschede, The Netherlands.
The due date of Abstract submission is April 1st, 2008.

Please note also:

TRIZCON2008: to be held by the Altshuller Institute for TRIZ Studies on Apr. 13-15, 2008 at Kent State University in Kent, Ohio, USA.
[Unfortunately I will miss TRIZCON2008 because the dates hit the first week of my classes in the new academic year.]

The Fourth TRIZ Symposium in Japan 2008: to be held by Japan TRIZ Society on Sept. 10-12, 2008 at Laforet Biwako, near Kyoto, Japan.
Call for Papers will be announced soon, and Abstract submission due is May 15, 2008.
Please visit Japan and join us to present/participate in this Symposium.

Note: I wish to introduce about 10 selected papers in Japanese translation and have already obtained from the authors and the conference organizers the permissions of Japanese translation and of posting them in this Web site together with their original English versions. It will take some time for me to get voluntary help by Japanese readers and to post the papers.

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List of Papers Published in the "Proceedings of the ETRIA TRIZ Future Conference 2007"

List of Papers in the Proceedings: [PDF (4 pages, 18 KB)]

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