Keynote: Japan TRIZ Symposium
September 8th 2012 – Tokyo – Japan
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How TRIZ can contribute to a paradigm change in R&D practices?

Master degree: TRIZ, a state of the art

PhD Thesis: How TRIZ can cooperate with 8 other Engineering Design methodologies

Full Professorship: Inventive Design as a new paradigm change in Engineering Design
Outlines of the Keynote
Our industrial world is in permanent change, which major challenges await R&D departments in the future?

Summary of TRIZ milestones

The TRIZ Consortium: 3 worldwide large companies unify their efforts

Why do we need a “new” software?

From IDM major stages to STEPS software

Major STEPS software interface

Short introduction

Our industrial world is in permanent change, which major challenges await R&D departments in the future?

Summary of TRIZ milestones

Teaching IDM

Some ongoing research

Conclusions/Questions

Short overview of a real industrial case study

10min + 20min Q&A

20min

15min

10min

5min
Short introduction
1. Context

2. From TRIZ to IDM

3. STEPS

4. Case example

5. Perspectives

My past and current “TRIZ” responsibilities

- Founder & president of TRIZ-France association
- Founder & past-president of European TRIz Association ETRIA
- Founder & Publication Officer of IFIP’s WG 5.4 on CAI
- Founder & current leader of TRIZ Consortium
- Scientific director of DEFI project (European funds)
- Member of the board of directors of the foundation InnovENT-E (Ministry of Industry funds for SME’s)

Timeline:


- TRIZ-France
- ETRIA
- WG5.4 of IFIP
- TRIZ Consortium
- DEFI project
- Project InnovENT-E
1. Context

TRIZ at INSA Strasbourg: from history to now

- 1946
- 1976
- 1985
- 1995
- 1998
- 2007
- 2012

Fundamentals of TRIZ:
- Notions of contradiction
- Notions of laws
- Methods, tools, techniques
- Meta-knowledge bases

OTSM: the first attempts to axiomatize and extend TRIZ

Extensions of TRIZ towards multidisciplinary problematic:
- Notion of problems
- Notion of partial solutions
- Notion of network (PB, CT)
- Towards an axiomatization of TRIZ

IDM: The first fruits of research and industrial partnership in Developing TRIZ

Other researches
- Researches on TRIZ
- Researches on OTSM
- Researches on IDM

Formalization of TRIZ & OTSM for industry
- Ontology construction, disambiguation of concepts;
- Computerization (STEPS)
- Notion of graphs
- Notions of TRIZ body of knowledge completeness
- Feedback CS→PB graph

1. Context
2. From TRIZ to IDM
3. STEPS
4. Case example
5. Perspectives
What is the current context in which we intend to contribute
Our Industrial world is in permanent change, which major challenges await R&D departments in future?

1930: Productivity
1970: Quality
1990: Innovation

1. Context
2. From TRIZ to IDM
3. STEPS
4. Case example
5. Perspectives

- Answering to demand
- Organize workshops
- Improve productivity rates
- Be competitive
- Ensure quality
- Optimize organization
- Organize innovation
- Manage knowledge increasing quantity
- Anticipate product/system’s evolutions
Our Industrial world is in permanent change, which major challenges await R&D departments in future?
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1. Context
2. From TRIZ to IDM
3. STEPS
4. Case example
5. Perspectives

How to act in anticipation of a more than probable future norm on innovation?

How to create a new way of designing inventively sufficiently robust to be adopted by enterprises?

How to create tools that will enable mass application of new inventive practices?

Our industrial world is in permanent change, which major challenges await R&D departments in future?
TRIZ postulates:
A short reminder about fundamentals
1. Context

Short (hopefully different) overview of what TRIZ is

### TRIZ : Key facts

Around 50 years of research (1946-1985) – performed in 300 schools/Laboratories (ex-USSR)
Data’s : 300 bio of inventors – 400,000 patents – 1500 Technical systems through their history

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**First observations (1956):**

- Inventors react according to similar mechanisms when they invent;
- These mechanisms are independent of their domain of expertise;
- Technical systems are developing in accordance with recurrent trends;
- Every step of these developments resulted in the resolution of one or several contradictions.

**First hypothesis:**

- It is possible to define the laws that govern the evolution of technical systems (help the inventor to anticipate);
- It is possible to construct methods to invent (help the inventor to solve its problems).
1. Context

Short (hopefully different) overview of what TRIZ is

2. From TRIZ to IDM

3. STEPS

- Contradiction
- Laws of engineering systems evolution
- Ressource
- Ideality
- Substances-Field
- 76 Standards
- Inventive principles
- Multisceen
- Separation methods
- ARIZ85C
- Miniture men
- Trimming techniques
- STC operators
- Database of effects
- Pointers to physical effects
Methods

Meta-Kn bases

Tools

Fundamentals (postulates, axioms)

- Technical systems (artifacts) are governed by objective laws.
- An inventive problem, if reformulated in the form of a dialectical contradiction, can be better solved.

ARIZ85C, Su-field modeling, Miniature men, STC operators

Matrix, Pointers of Effects, Algorithm for choosing inventive standards, ...

- 9 laws
- 11 methods for separating physical contradictions
- 40 Inventive Principles
- System of 76 Inventive Standards
- 1200 Effects (Physical, Chemical, Geometrical)

1. Context
2. From TRIZ to IDM
3. STEPS
4. Case example
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Short (hopefully different) overview of what TRIZ is
An attempt of definition: Russian acronym of Theory of Inventive Problem Solving. Theory elaborated by Genrich Altshuller stipulating that technical systems are directed by laws governing their evolutions. To evolve from a generation to another, a technical system solves its contradictions, towards its ideality, while minimizing the use of available resources.

1st Axiom: The evolution of technical systems is governed by objective laws. These laws are invariants of their evolution.

2nd Axiom: Any problematic situation can be translated in the elementary form of a contradiction (within the meaning of dialectic).

Corollary 1.1: The laws help to locate the state of maturity of the system and to better anticipate its evolutions.

Corollary 1.2: A direction of design in accordance with these laws has statistically more chances to appear relevant.

Corollary 2.1: An identified and formulated contradiction becomes an inventive opportunity when its resolution is refusing compromise.

Corollary 2.2: Impossibility of formulating a contradiction indicates that what appears as a problem might not be an Inventive Problem.
TRIZ postulates:
Laws of engineering
systems evolution
law 8: Dynamization

In order to improve their performance, rigid systems should become more dynamic. By dynamic we mean: evolve to more flexible and rapidly changing structures, adaptable to changes of working conditions and requirements of the environment.
Short (hopefully different) overview of what TRIZ is

1. System completeness
2. Efficiency
3. Harmonization
4. Ideality
5. Irregularity
6. Towards Supersystem
7. Towards Microlevel
8. Dynamization
9. Through S-Field involvement
9 laws have been disclosed by TRIZ founders, they can be used to discuss the evolution potential of any technical system.

1. System completeness

2. Efficiency

3. Harmonization

4. Ideality

5. Irregularity

6. Towards Supersystem

7. Towards Microlevel

8. Dynamization

9. Through S-Field involvement

Evolution potential

Maturity statement
TRIZ postulates
Contradiction
Contradictions typologies

**AC (administrative):** I wish [my table resists to heavy loads] but I don’t know how!

**TC (technical):** If I improve [mechanical resistance] of [my table] then [transportability] gets worse!

**PC (physical):** The [thickness] of the [platen] must be [thick] for having a satisfactory [mechanical resistance] and [thin] for a satisfactory [transportability].
TRIZ when observed as a method
Short (hopefully different) overview of what TRIZ is
1. Context

2. From TRIZ to IDM

3. STEPS

4. Case example

5. Perspectives

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**Short (hopefully different) overview of what TRIZ is**

**GEP8:** Volume of fixed object

**GEP33:** Convenience of use

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**MP**

**MS**

**DP**

**SC**

**IS**

**DS**

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**Application cross-section**

<table>
<thead>
<tr>
<th></th>
<th>Fine</th>
<th>Large</th>
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<tbody>
<tr>
<td>Space occupancy</td>
<td>😊</td>
<td>😞</td>
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<tr>
<td>Ergonomics of make-up</td>
<td>😞</td>
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15. **Dynamism**

a. Replace existing objects with flexible membranes.

b. Separate an object into several movable between each other.

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30. **Flexible membrane, thin films**

a. Replace existing objects with flexible membranes.

b. Separate an object into several movable between each other.

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**SCx:** Use of a mechanically constrained rubber base (in torsion) to switch from fine to large application surface.
Short (hopefully different) overview of what TRIZ is

Law 3: Harmonization

Law 8: Dynamization

Draw a portrait (face) of the Solution if following the law
The TRIZ Consortium

3 Large scale companies interested in TRIZ

Decided to unify efforts
2. From TRIZ to IDM

The origins of IDM methodology

Life Long Learning : IDM
«Inventive Design Method based on TRIZ and its associated software STEPS»
3 weeks training plus a professional project mentored by experts

A network of experts trained
Assisting IDM-TRIZ diffusion in companies worldwide
Understanding TRIZ limitations in industrial context
About initial and exhaustive investigations:

- TRIZ is not designed to investigate complex initial situations (gathering thoroughly all knowledge necessary and known to document/understand the diversity and the quantity of problems).
About contradiction’s quantity... and choice:

• TRIZ is designed for solving a single contradiction. How to disclose, represent and chose the most appropriate one since contradictions quantity increase exponentially with system’s complexity?
About a methodology to disclose a contradiction:

- There are no accurate ways to disclose appropriately a contradiction.

As you know, I’m a TRIZ expert, therefore I know the truth… The contradiction is…

Moreover

\( \forall i,m \mid i=2^m, \text{ if } M_{i,j} = 1 \text{ then } M_{i+1,j} = -1 \text{ and if } M_{i,j} = -1 \text{ then } M_{i+1,j} = 1 \text{ else } M_{i,j} = \infty \)

Figure 6 shows a possible matrix of influences.

\[
\begin{align*}
AP_1 & \quad V_{a_1} & 1 & 1 & -1 & \cdots & \infty & \cdots & \infty \\
& \quad V_{a_1} & -1 & 1 & 1 & \cdots & \infty & \cdots & \infty \\
& \quad \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\
AP_m & \quad V_{a_m} & 2m-1 & \infty & \infty & 1 & \cdots & -1 & 1 \\
& \quad V_{a_m} & \infty & \infty & \infty & -1 & \cdots & 1 & -1 \\
\end{align*}
\]

Figure 6: Matrix representing the influences between the APs and the EPs
About TRIZ corpus consistency:

- Are you aware of any “glossary” or “ontology” of TRIZ components? There are no logical links/coherence between TRIZ components.
Where is TRIZ’s best solution?

- There are no means in TRIZ to help the designer to decide, among a set of Solution concepts being all inventive, which one is the one to choose.
There is a need to efficiently deploy IDM methodology.

The industrial partners proposed:

To build a new software!
A first statement in which industrial and academic partners agreed on: There is a need for a software:

- To assist the animator in conducting inventive activities (to structure, to organize study data’s);
- To relieve users of tedious tasks;
- To ensure minimal (robustness) consistency of the approach;
- To permit the sharing of practices inside a community;
- To install a spiral of constant evolution in the development of the software through research.
Stage 1: Analysis of Initial Situation

Stage 2: Contradiction management

Stage 3: Solution Concepts synthesis

Stage 4: Solution Concepts selection

To high impact, inventive, solution concepts in which company is ready to invest for further developments.
1. Context
2. From TRIZ to IDM
3. STEPS
4. Case example
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Starting with an Initial situation

Step 1: Analysis of Initial Situation
Step 2: Contradictions management
Step 3: Solution Concepts synthesis
Step 4: Solution Concepts selection

- Problem graph
- Problems-Parameters
- Partial Solution-Parameters
- System completeness
- Multi-screen
- Maturity of the system
- Evolution Laws
- DTC Operator
- Parameters & Poly-Contradictions
- Suggested Contradictions
- Ariz
- Miniature men
- Separation methods
- Matrix
- Su-field
- "Solution Concept" cards
- Solution Concept Choice
- Detailed solution
3. STEPS

Starting with an Initial situation

Managing populations of contradictions
3. STEPS

Starting with an Initial situation

Managing populations of contradictions
1. Context

2. From TRIZ to IDM

3. STEPS

3.1. The Matrix

3.2. ARIZ85C

3.3. Su-Field

3.4. Miniature Men

3.5. Separation methods

4. Case example

5. Perspectives
A Solution Concept tree is built
(each branch is a solution concept card)
Conducting an industrial case: summary
Flexible schedule consisting in 10 sessions face to face and an equivalent amount of work “off sessions” by both INSA study leader and Company team members (based on a complex case situation)

1. Day 1: Problem Statement phase

   Phase consisting in drawing a problem statement through a problem graph and known partial solutions

2. Day 2: Data’s gathering and Contradiction analysis

   Phase consisting in entering into the detailed problem description through a key problem and disclosing all its related contradictions

3. Day 3: Contradictions treatment

   Phase consisting in engaging several contradictions (the most relevant ones) into a solving phase using TRIZ techniques. Solution concepts are drawn in this phase.

4. Day 4: Solution Concepts analysis

   Phase consisting in analyzing Solution Concepts and choosing a reduced set of them for further calculations based on the Problem network shrinkage they provoke

5. Day 5: Calculations & validations of the chosen solution Concepts

   Phase consisting in engaging R&D means to characterize technologically and qualitatively the solution concept’s feasibility
Crash retention in High speed trains

Summary of a case study
Case study in high speed train industry: Crash absorbing system

Competition arena in high speed train market

Problematic: How to efficiently absorb energy in crash situations?

Analysis of competition and state of the art of expert knowledge on the topic
All people knowledge and doc. (patents, articles) are studied

Construction of a problem graph

Interpreting the graph: define the core problem

Contradiction extraction & management

Towards calculation and 3D modelling of the solution concept for validation

Use of Pugh’s matrixes for automatic ranking of solution concepts

Use of TRIZ techniques for building solution concept

Summary of a case study
Teaching IDM to engineers in life-long learning
An official full version of STEPS software is necessary all along the training process.

### IDM experts
(3 w + 1 w on a mentored professional project)

1. **Basic TRIZ**
   - All classical components of TRIZ are studied in a comprehensive course with industrial exercises and team working + public presentation of the work (35 hours/5 days)

2. **Advanced TRIZ**
   - Advanced techniques of TRIZ are applied (Su-Field; ARIZ) on industrial situations with a mentoring and team working + public presentation of the work (35 hours/5 days)

3. **Management of complex situations**
   - IDM (extensions of TRIZ towards complex and multidisciplinary situations) are studied and applied on a professional basis in a real industrial project. A mentoring on the project is provided by a IDM-Expert and specific abilities of animating a team are provided through the exercise (2 x 35 Hours / 70 Hours)

4. **Case study + mentoring**
   - A mentoring on the project is provided by a IDM-Expert and specific abilities of animating a team are provided through the exercise (2 x 35 Hours / 70 Hours)
Some limitations of in which we are currently conducting research (ongoing PhD)
Limit N° 1 of our work: Team working for “human-built” problem graph is too long and not 100% accurate.

Limit N° 2 of our work: For a permanently evolving coherence of our work and error-free concepts manipulations, using computers is necessary.

Limit N° 3 of our work: There are still no means of measuring Inventive Efficiency in R&D teams (besides simply counting invested funds or patents), therefore how can we monitor the effects of IDM adoption?

Limit N° 4 of our work: Solution Concepts are always “hard to believe” especially by expert since they are outside what they classically admit as possible.
Quantity of scientific papers per years being published and using the keyword TRIZ in the title or the abstract.
What are we heading towards:

- **Research**: building new knowledge through partnership always keeping in mind its usefulness for society (industry);
- **Education**: train people at all levels with academic excellence in mind;
- **Expertise**: create a network of experts, able to practice, teach, assist industry with IDM-TRIZ model;

For all these 3 directions, our software **STEPS** is at the crossroads:

- **Educating** more efficiently, more rapidly using STEPS;
- Trying our new **research findings** using proto-STEPS for research and tests;
- **Practicing** IDM-TRIZ in industry through a growing community of practice using STEPS as a **methodological guideline**.
Thank you for your attention!
Time for questions now