NPO法人 日本TRIZ協会 Japan TRIZ Society (JTS)

TRIZ シンポジウム 2012
The Eighth TRIZ Symposium in Japan

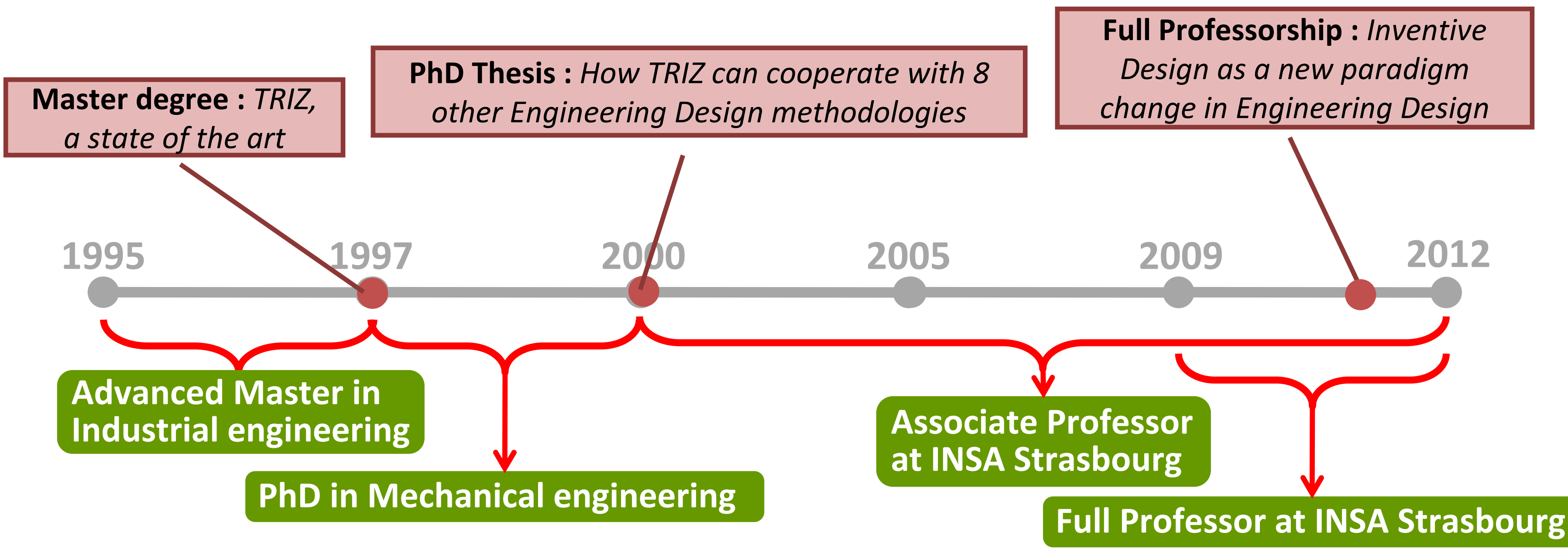
INSA STRASBOURG

# Keynote : Japan TRIZ Symposium

September 8th 2012 – Tokyo – Japan

Denis Cavallucci, Professor at INSA Strasbourg – France

## How TRIZ can contribute to a paradigm change in R&D practices?



# Outlines of the Keynote

**10min + 20min Q&A**

- Teaching IDM
- Some ongoing research
- Conclusions/Questions

**5min**

- Short overview of a real industrial case study

**15min**

- Why do we need a “new” software ?
- From IDM major stages to STEPS software
- Major STEPS software interface

**10min**

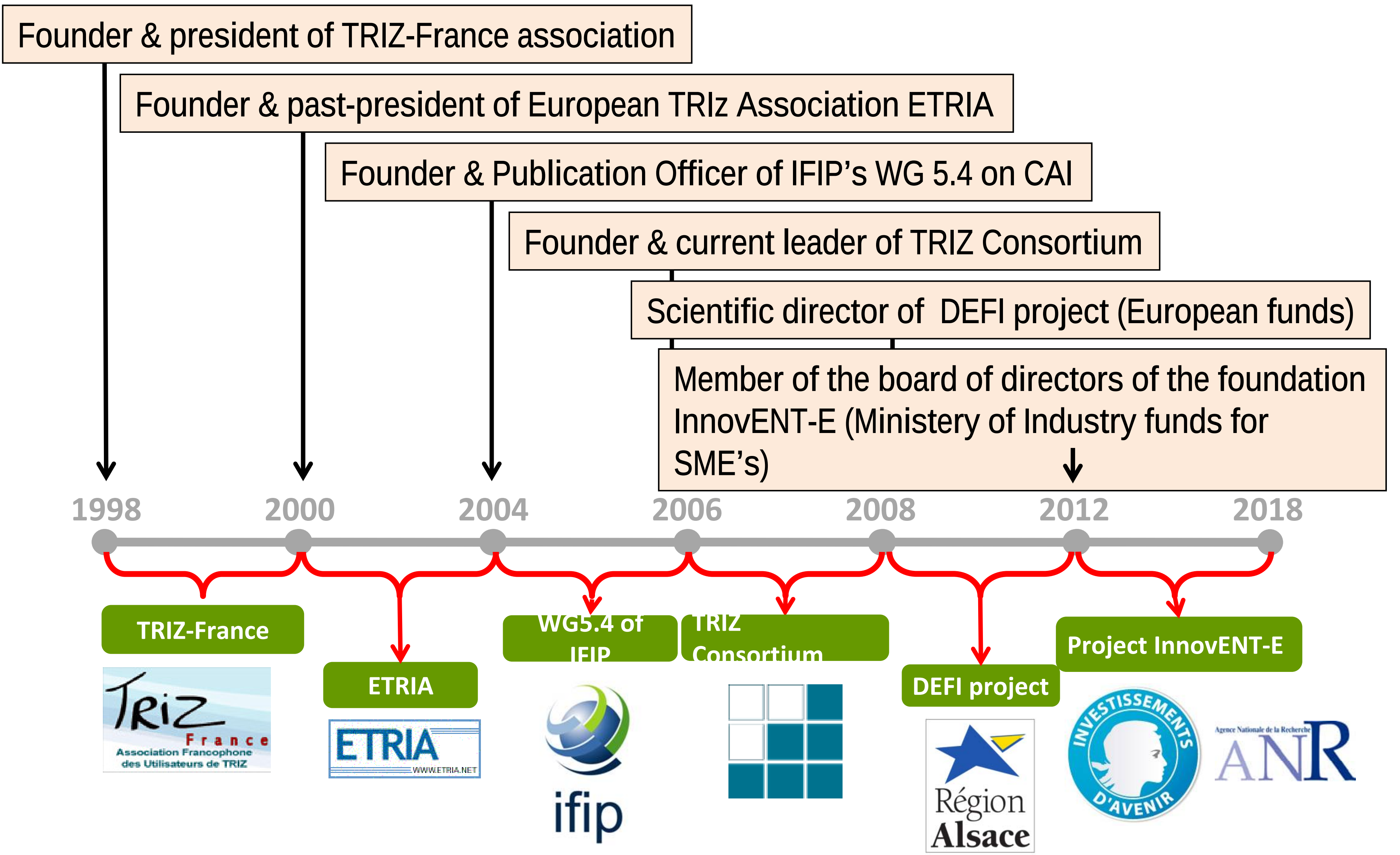
- The TRIZ Consortium : 3 worldwide large companies unify their efforts
- 5 major drawbacks of TRIZ

**20min**

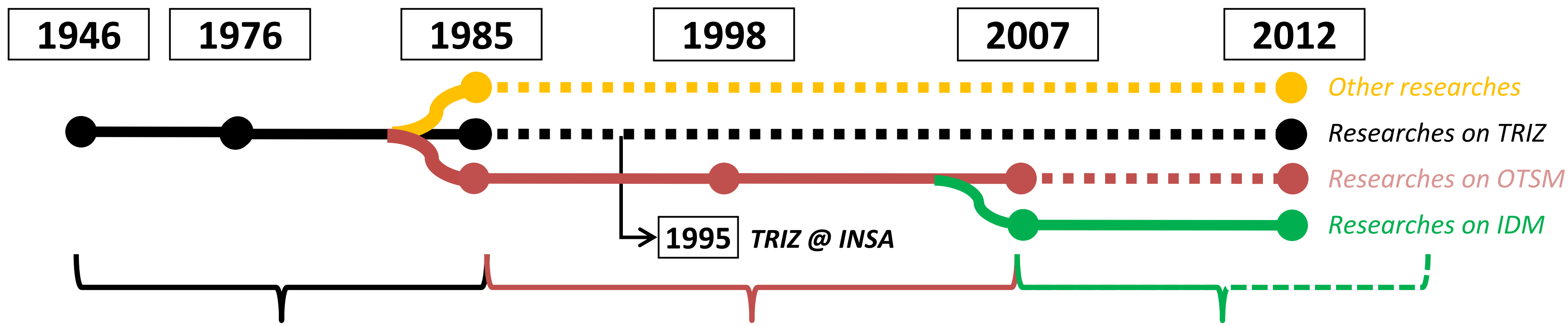
- Short introduction
- Our Industrial world is in permanent change, which major challenges await R&D departments in future ?
- Summary of TRIZ milestones

# *Short introduction*

My past and current “TRIZ” responsibilities



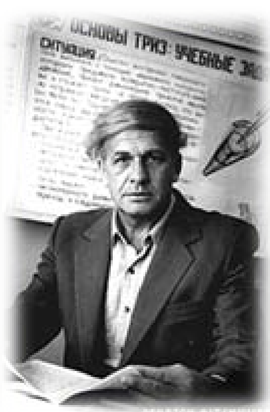
TRIZ at INSA Strasbourg : from history to now




**…gins : Altshuller's TRIZ**

**OTSM : the first attempts to axiomatize and extend TRIZ**

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



Fundamentals of TRIZ :

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


Extensions of TRIZ towards multidisciplinary problematic :

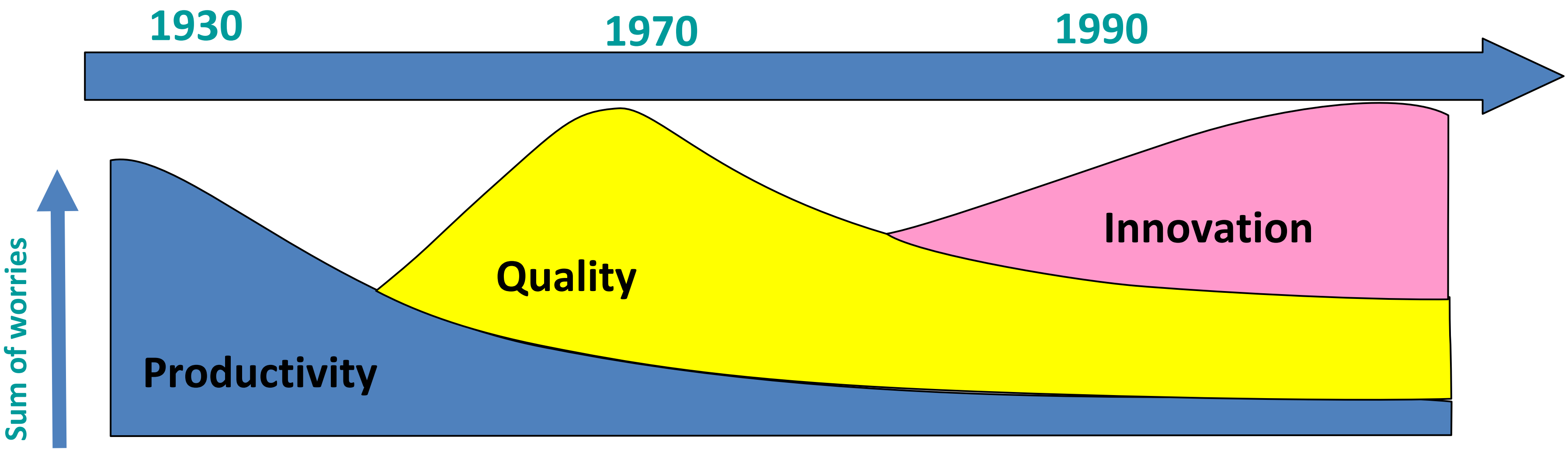
- Notion of problems
- Notion of partial solutions
- Notion of network (PB, CT)
- Towards an axiomatization of TRIZ

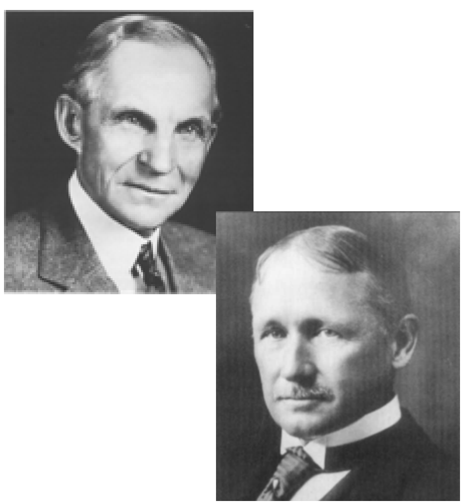
Formalization of TRIZ & OTSM for industry

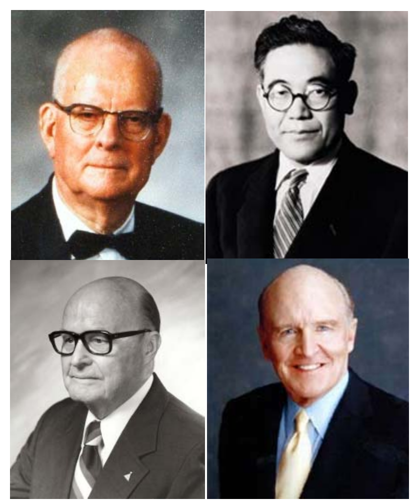
- Ontology construction, disambiguation of concepts;
- Computerization (STEPS)
- Notion of graphs
- Notions of TRIZ body of knowledge completeness
- Feedback CS→PB graph

# 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 ?



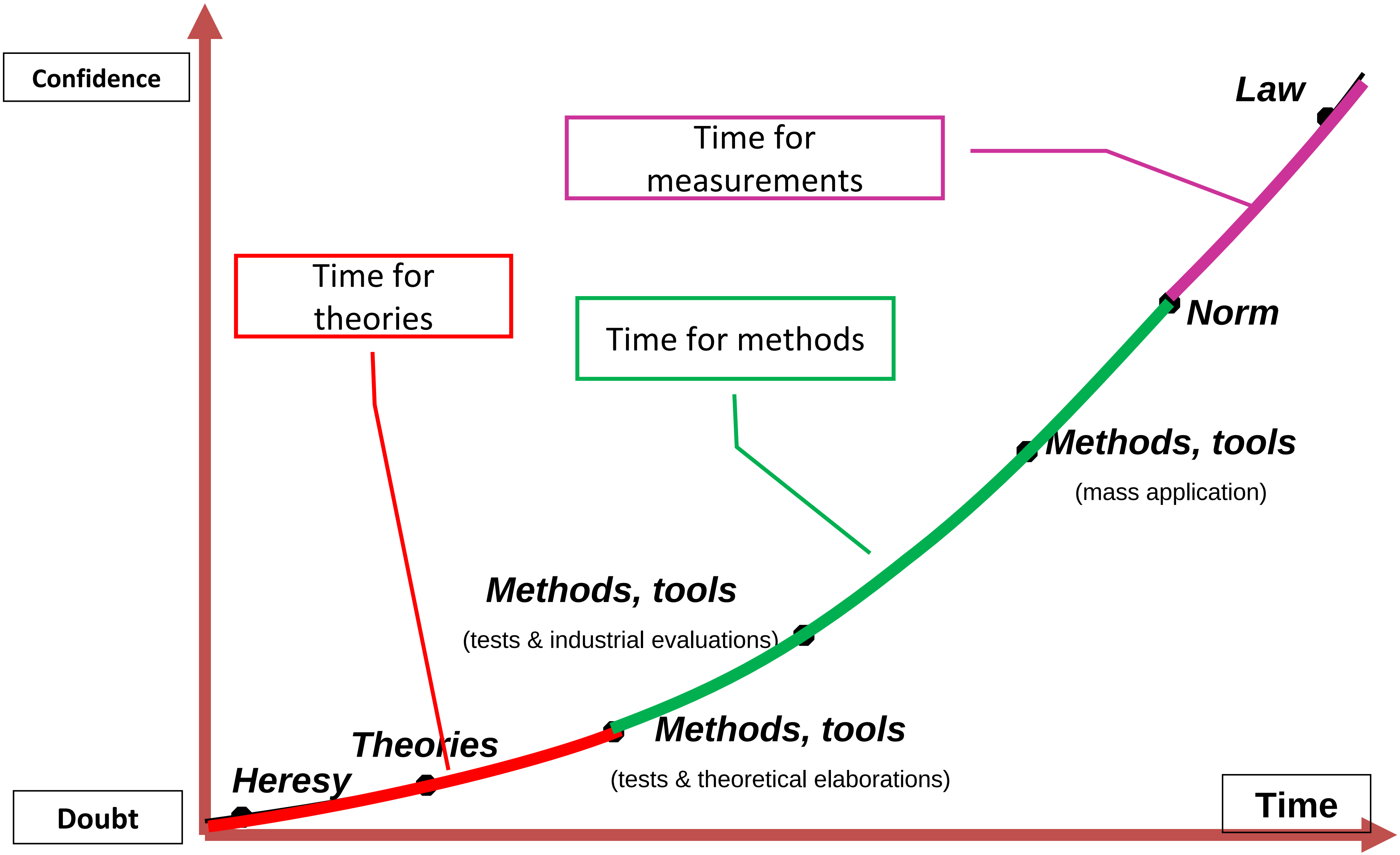


- Answering to demand
- Organize workshops
- Improve productivity rates

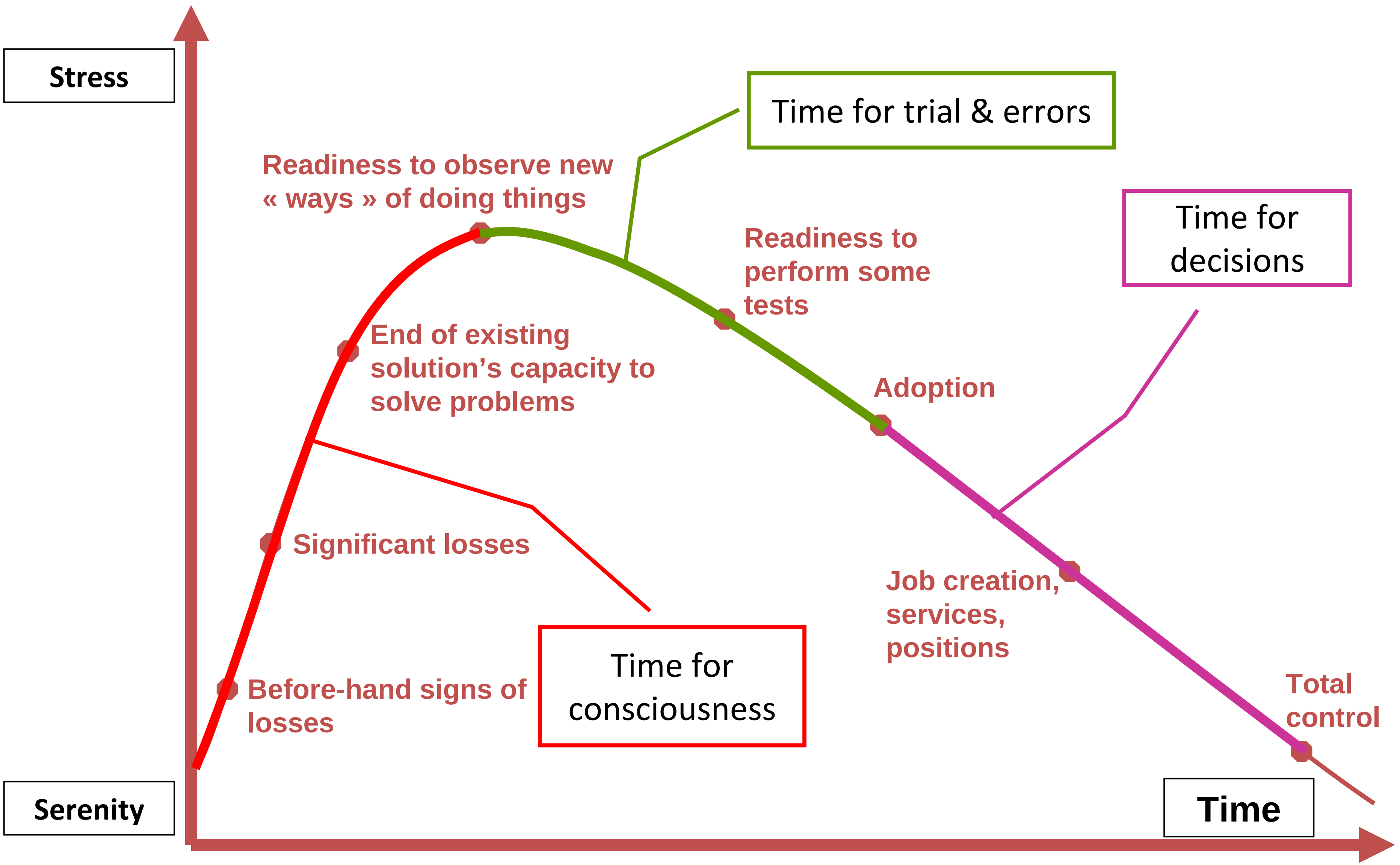
- Be competitive
- Ensure quality
- Optimize organization

- Organize innovation
- Manage knowledge increasing quantity
- Anticipate product/system’s evolutions

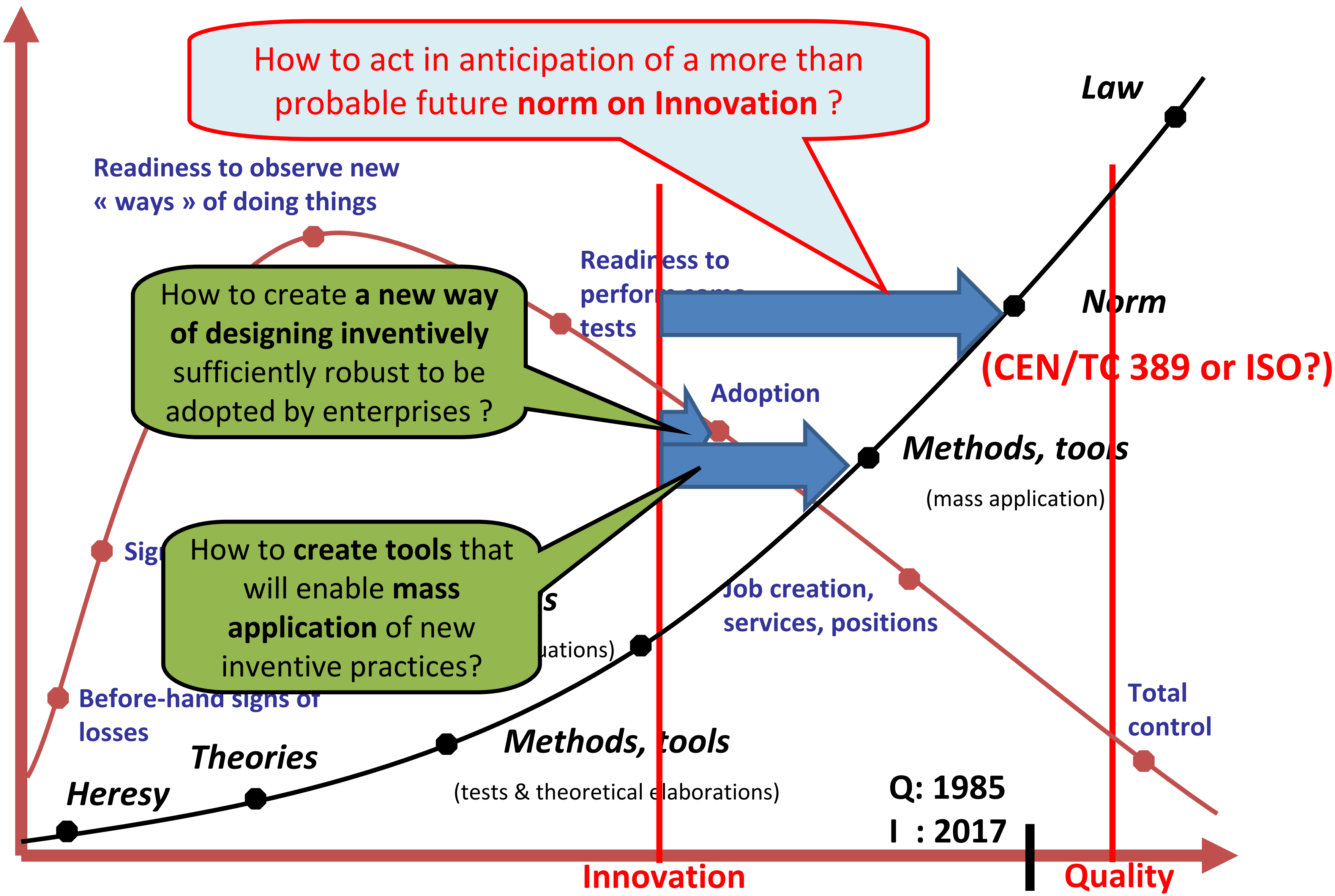
Our Industrial world is in permanent change, which major challenges await R&D departments in future ?



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



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



# TRIZ postulates:

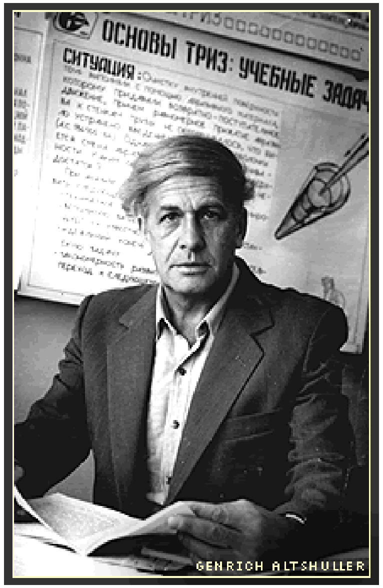
## A short reminder about fundamentals

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




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).

Short (hopefully different) overview of what TRIZ is

Substances-Field

76 Standards

Multisceen

Separation methods

ARIZ85C

Ressource

Miniture men

Inventive principles

Ideality

Laws of engineering systems evolution

Trimming techniques

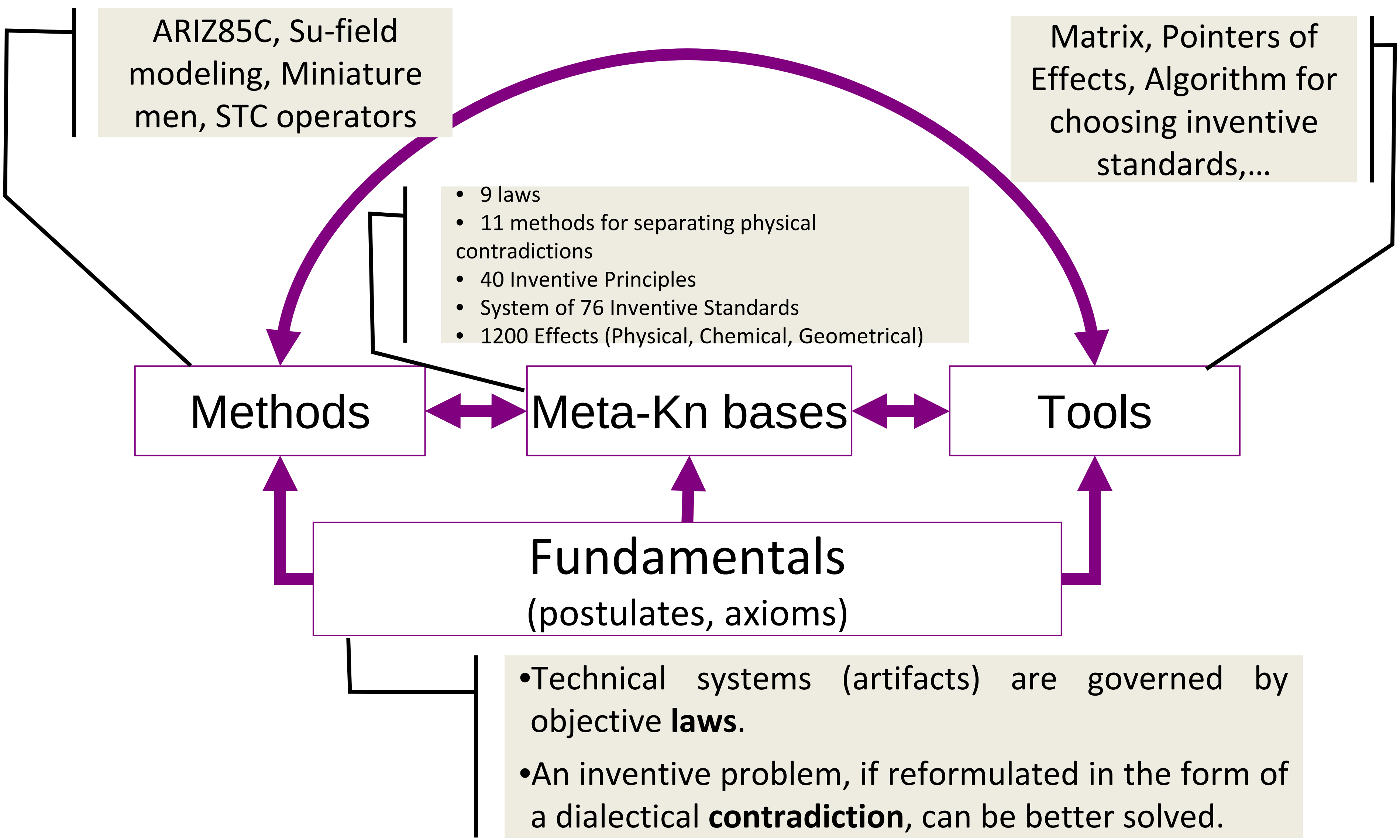
STC operators

Database of effects

Pointers to physical effects

Contradiction

Short (hopefully different) overview of what TRIZ is



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.

**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.

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

**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*

Short (hopefully different) overview of what TRIZ is

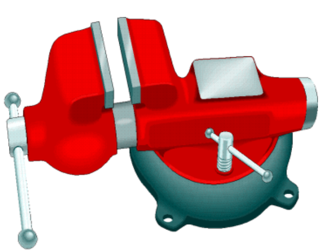
# law 8: Dynamization

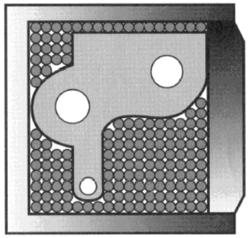
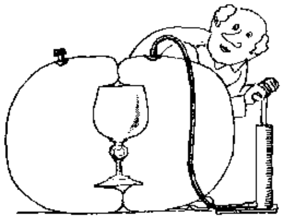
**In order to improve their performance, rigid systems should become more dynamic. By dynamic we mean: evolve to more flexible and rapidly changing structures, adaptable to changes of working conditions and requirements of the environment.**







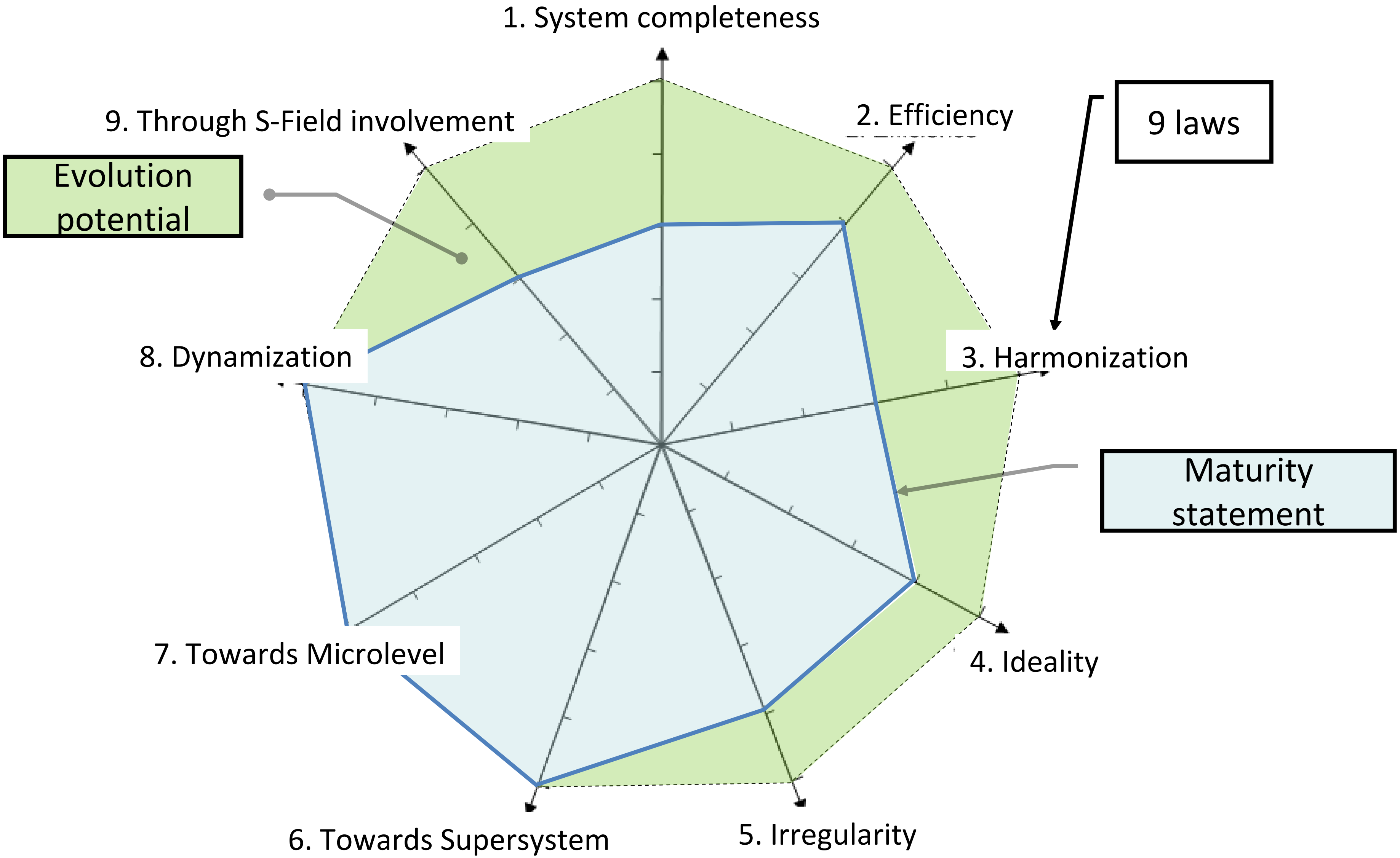


Short (hopefully different) overview of what TRIZ is

Short (hopefully different) overview of what TRIZ is

**9 laws** have been disclosed by TRIZ founders,
they can be used to discuss the evolution potential of any technical system



# TRIZ postulates

## Contradiction

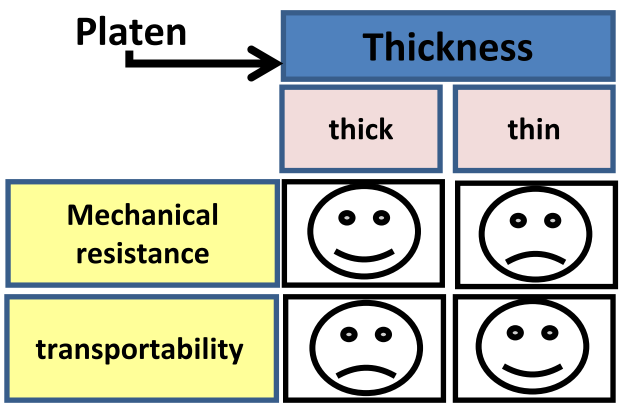
Short (hopefully different) overview of what TRIZ is

# 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 !

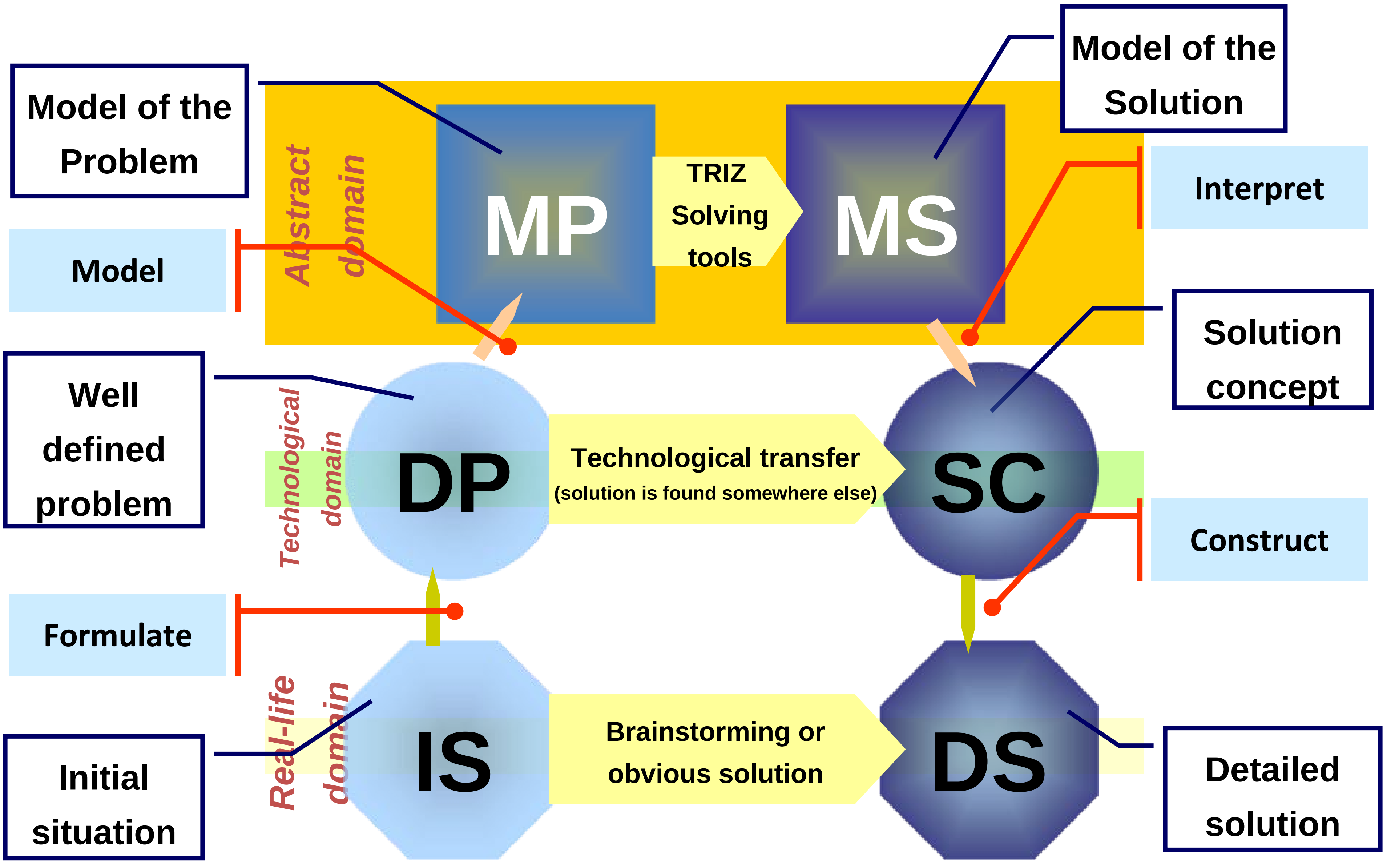
***PC (physical):*** The **[thickness]** of the **[platen]** must be **[thick]** for having a statisfactory **[mechanical resistance]** and **[thin]** for a satisfactory **[transportability]**.



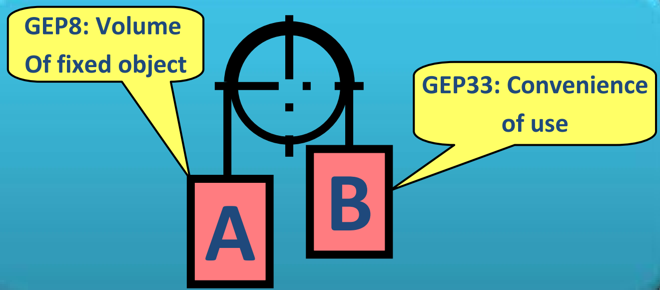
# TRIZ

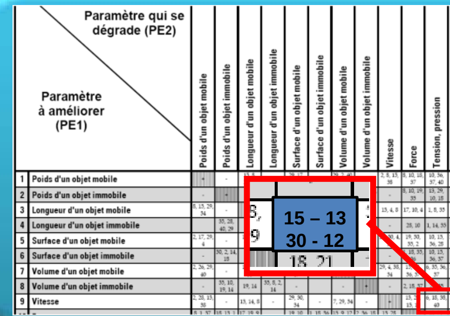
***when observed as a method***

Short (hopefully different) overview of what TRIZ is



Short (hopefully different) overview of what TRIZ is

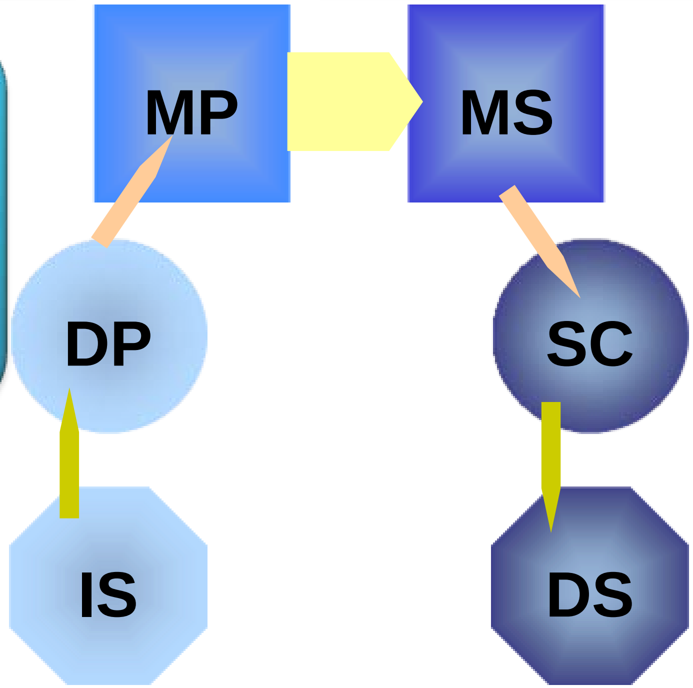


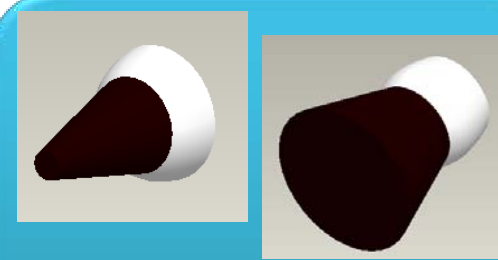




**30. Flexible membrane, thin films**
a. Replace existing objects with flexible membranes.

**15. Dynamism**
b. Separate an objet into several ones movable between each others.

| | Appliction cross-section | |
|---|---|---|
| | fine | large |
| Space occupancy | ☺ | ☹ |
| Ergonomy of make-up | ☹ | ☺ |



**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

Arms → Lenght

| | Long | Short |
|---|---|---|
| Shirt stability | ☺ | ☹ |
| Easyness of hanging | ☹ | ☺ |

Law 8 : Dynamization

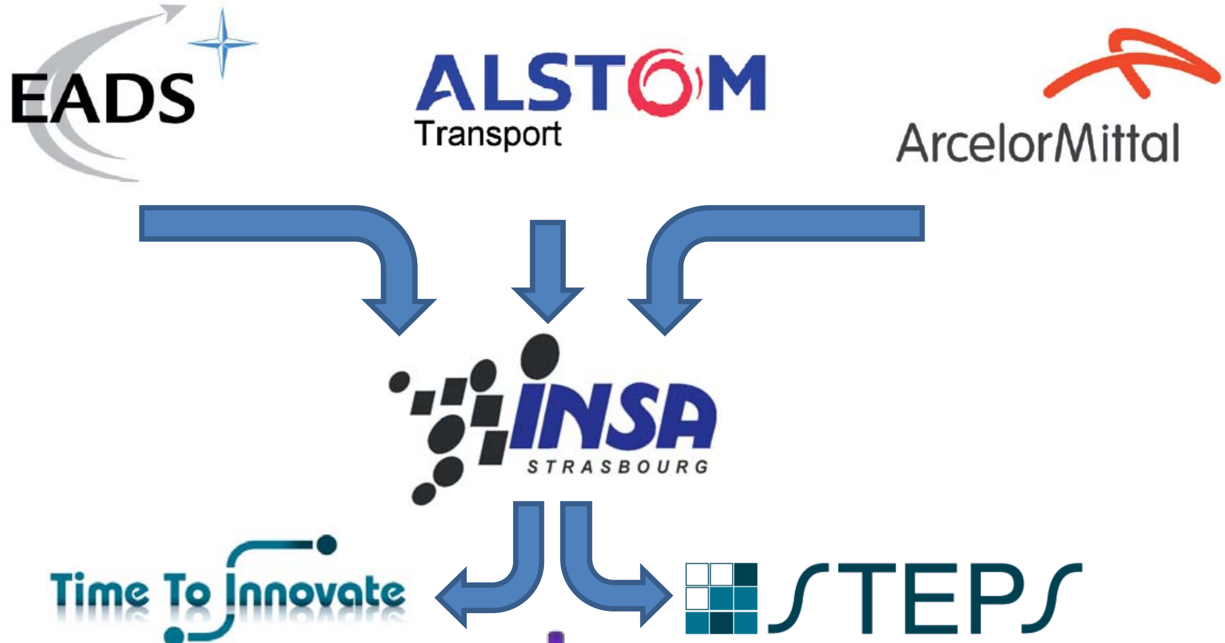
Law 3 : Harmonization

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

The origins of IDM methodology

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**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*

+

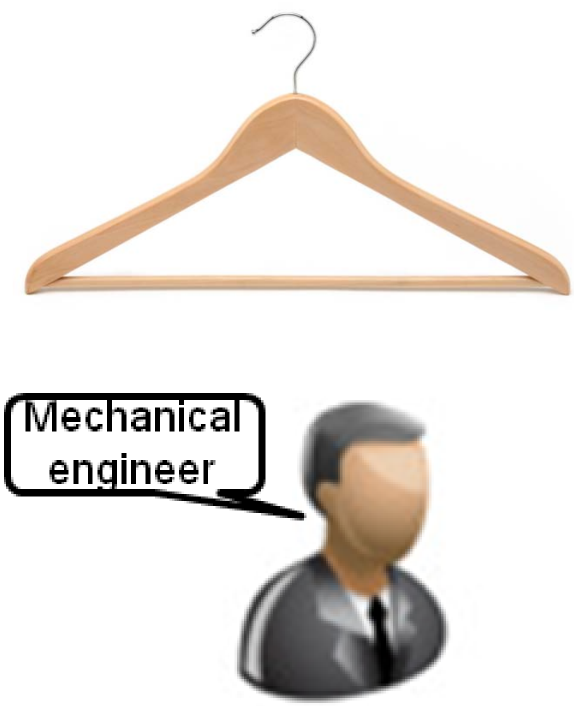
**A network of experts trained**

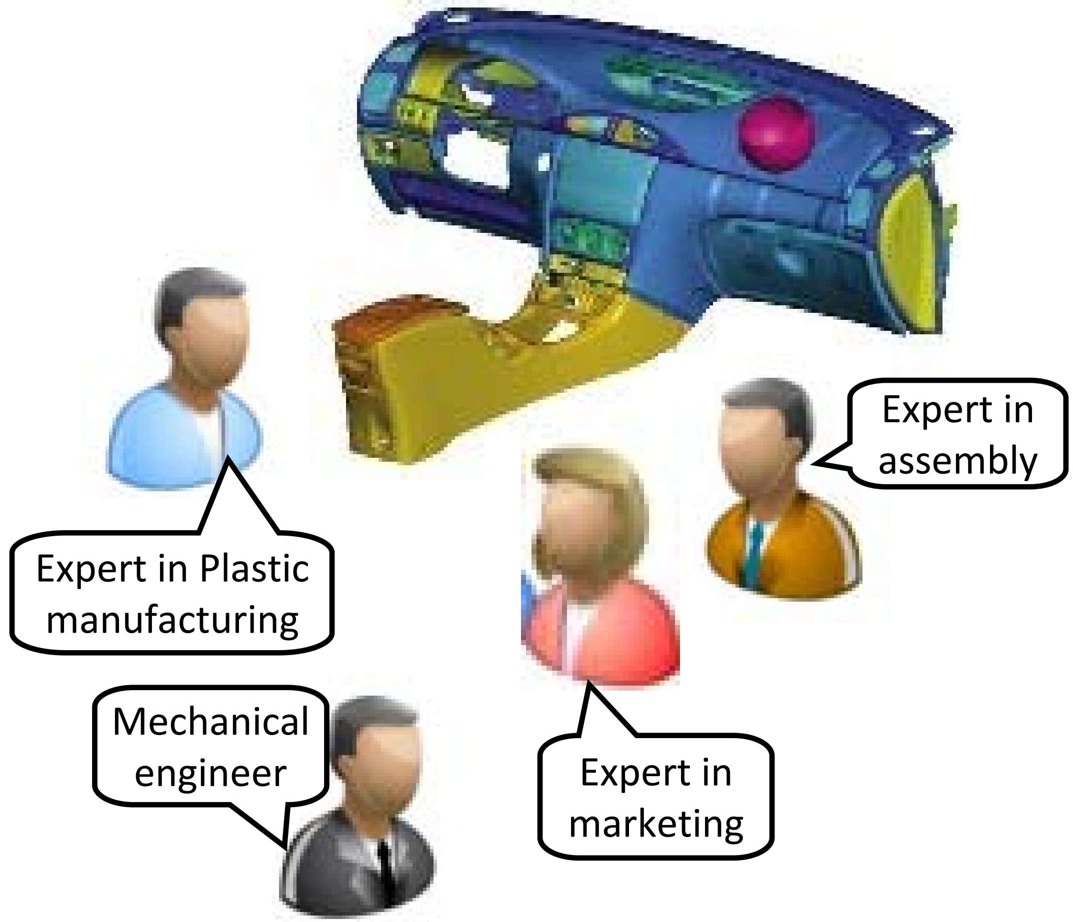
*Assisting IDM-TRIZ diffusion in companies worldwide*

# *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).



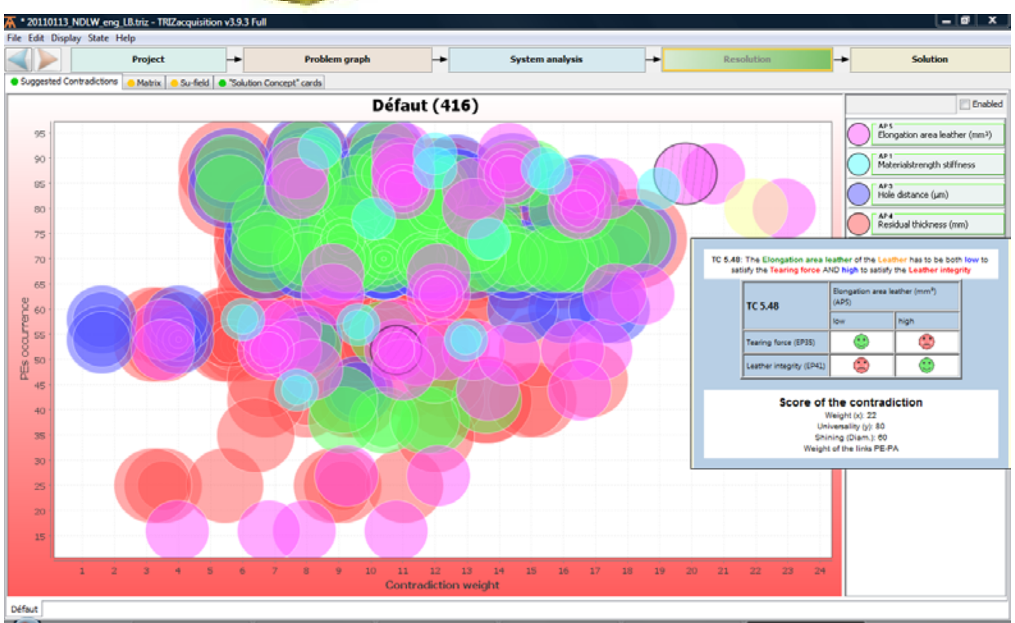



5 major drawbacks of TRIZ

# 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 ?

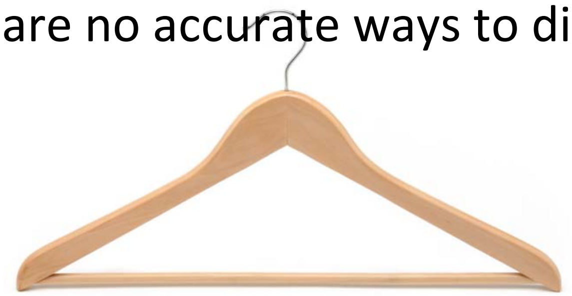
| | Arm's length | |
|---|---|---|
| | long | short |
| stability | ☺ | ☹ |
| ease of placing clothes on | ☹ | ☺ |



5 major drawbacks of TRIZ

# About a methodology to disclose a contradiction :

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




*Let $i=2q-1$ or $i=2q$ and $M \in \Re^{2m \times k}$ be the matrix of influences*
*$Mij=1$ means that $AP_q$ has a positive influence on $EP_j$*
*and $Mij=-1$ means that $AP_q$ has a negative influence on $EP_j$*

Moreover

$$\forall i,m \mid i=2*m,\ if\ M_{i,j}=1\ then\ M_{i+1,j}=-1\ and\ if\ M_{i,j}=-1\ then\ M_{i+1,j}=1\ else\ M_{i,j}=\infty$$

Figure 6 shows a possible matrix of influences.

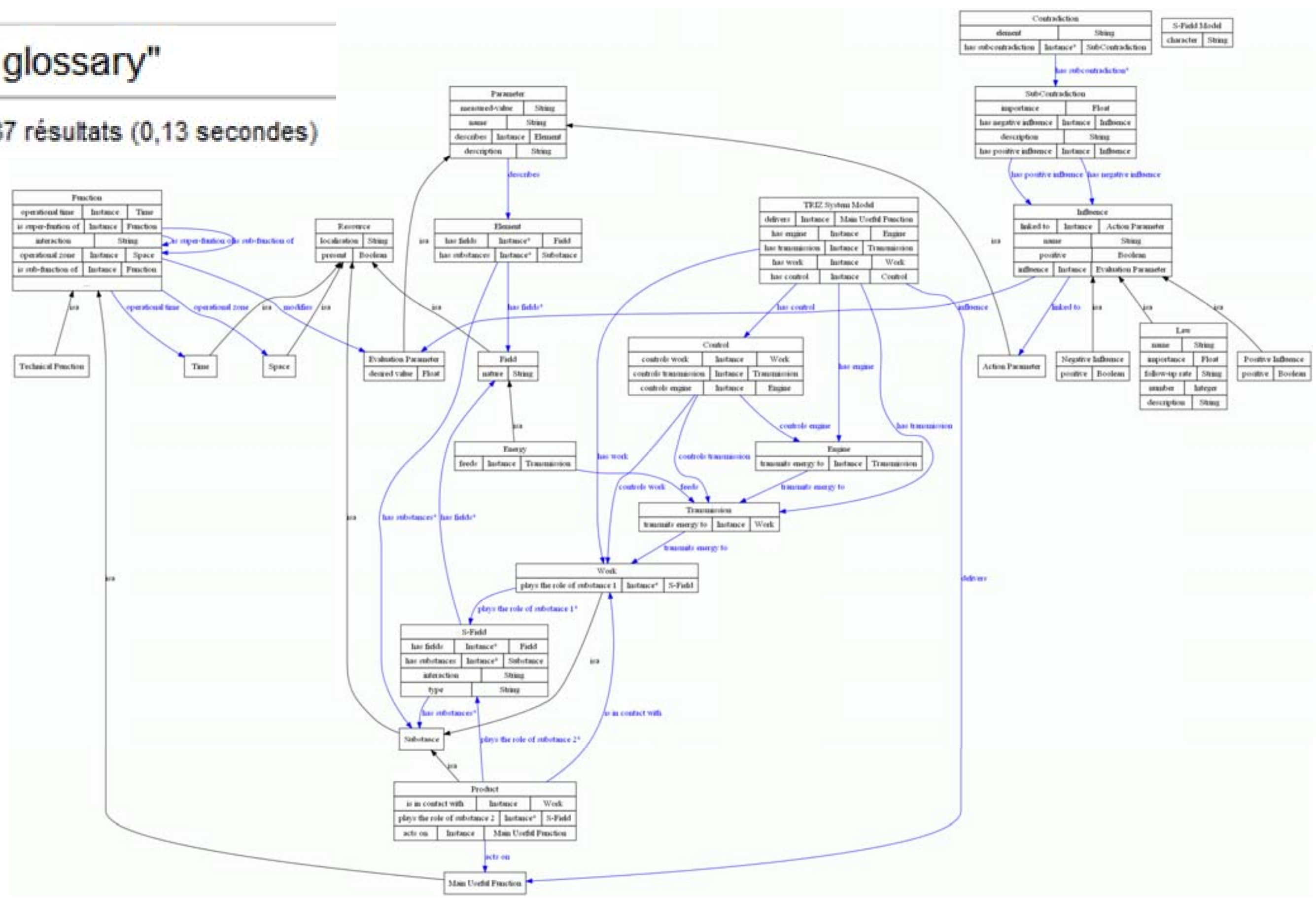
$$\begin{array}{ccc} & & \\ AP_1 & \begin{array}{c} Va_1 \\ \overline{Va_1} \\ \cdots \end{array} & \begin{array}{c} 1 \\ 2 \\ \cdots \end{array} \\ AP_m & \begin{array}{c} Va_m \\ \overline{Va_m} \end{array} & \begin{array}{c} 2m-1 \\ 2m \end{array} \end{array} \begin{pmatrix} 1 & -1 & \cdots & \infty & \cdots & \infty \\ -1 & 1 & \cdots & \infty & \cdots & \infty \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ \infty & \infty & \cdots & 1 & \cdots & -1 \\ \infty & \infty & \cdots & -1 & \cdots & 1 \end{pmatrix}$$

***Figure 6: Matrix representing the influences between the APs and the EPs***

5 major drawbacks of TRIZ

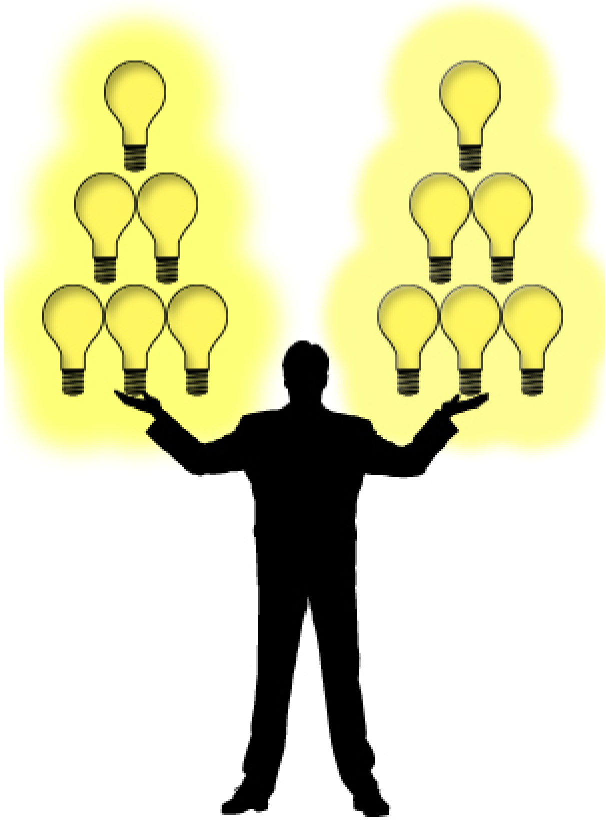
# About TRIZ corpus consistency :

- 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 !***

Why do we need a 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.

IDM's 4 major Sages

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

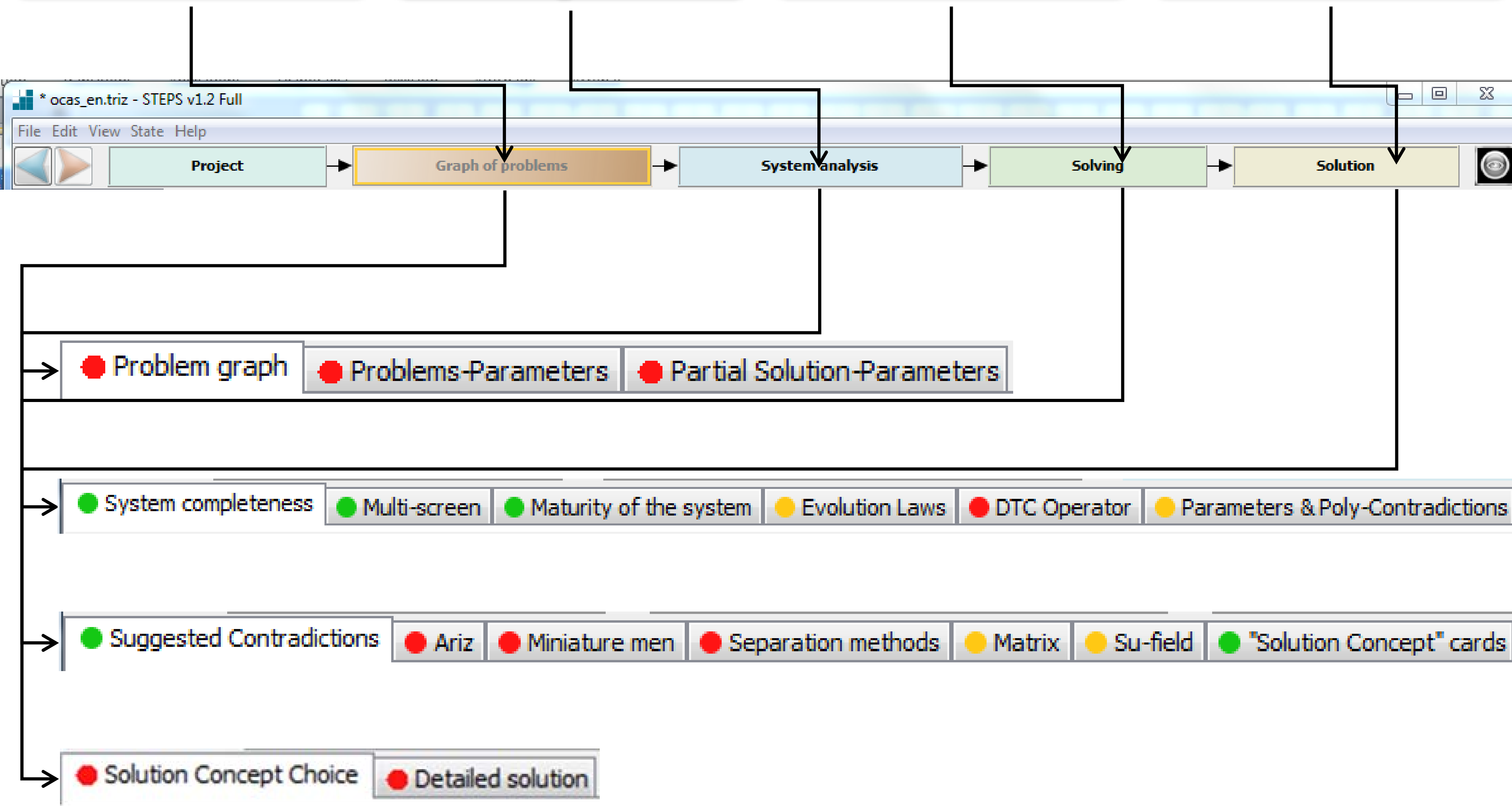
Starting with an Initial situation

**Step 1 : Analysis of Initial Situation**

**Step 2 : Contradictions management**

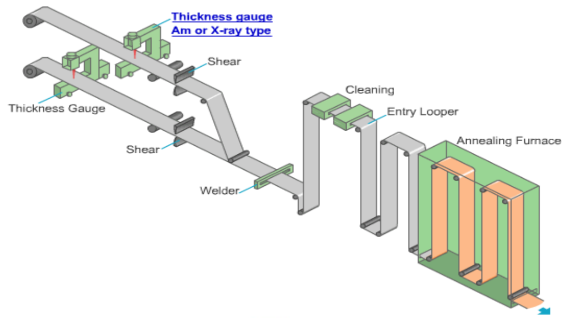
**Step 3 : Solution Concepts synthesis**

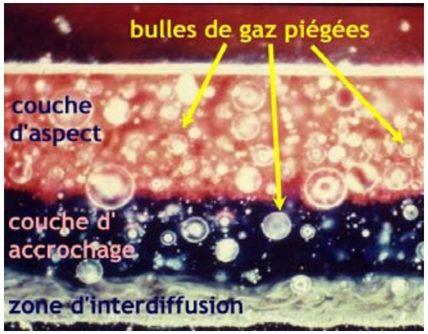
**Step 4 : Solution Concepts selection**

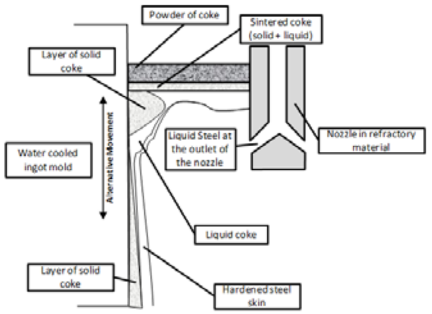


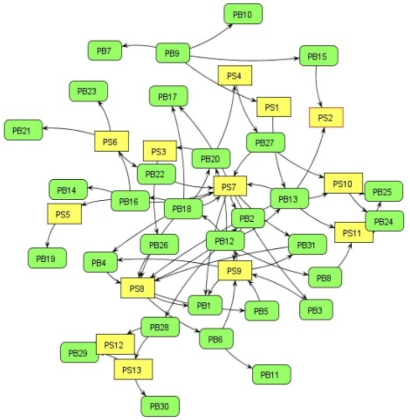
Starting with an Initial situation

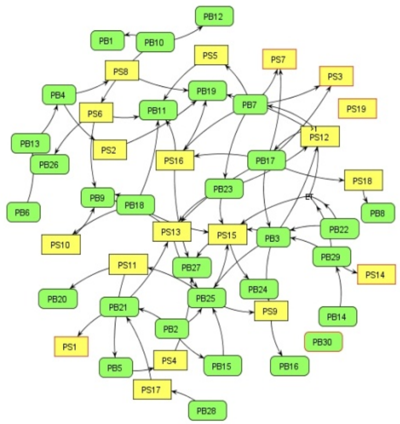
Managing populations of contradictions

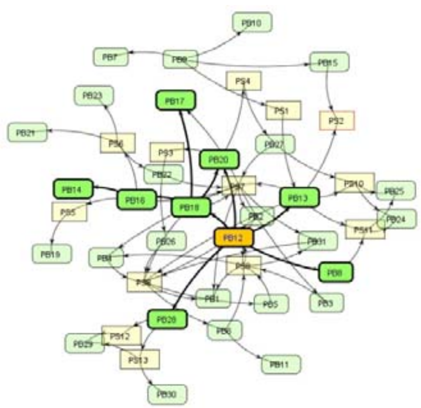


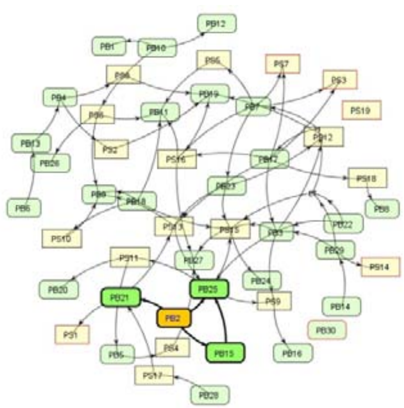



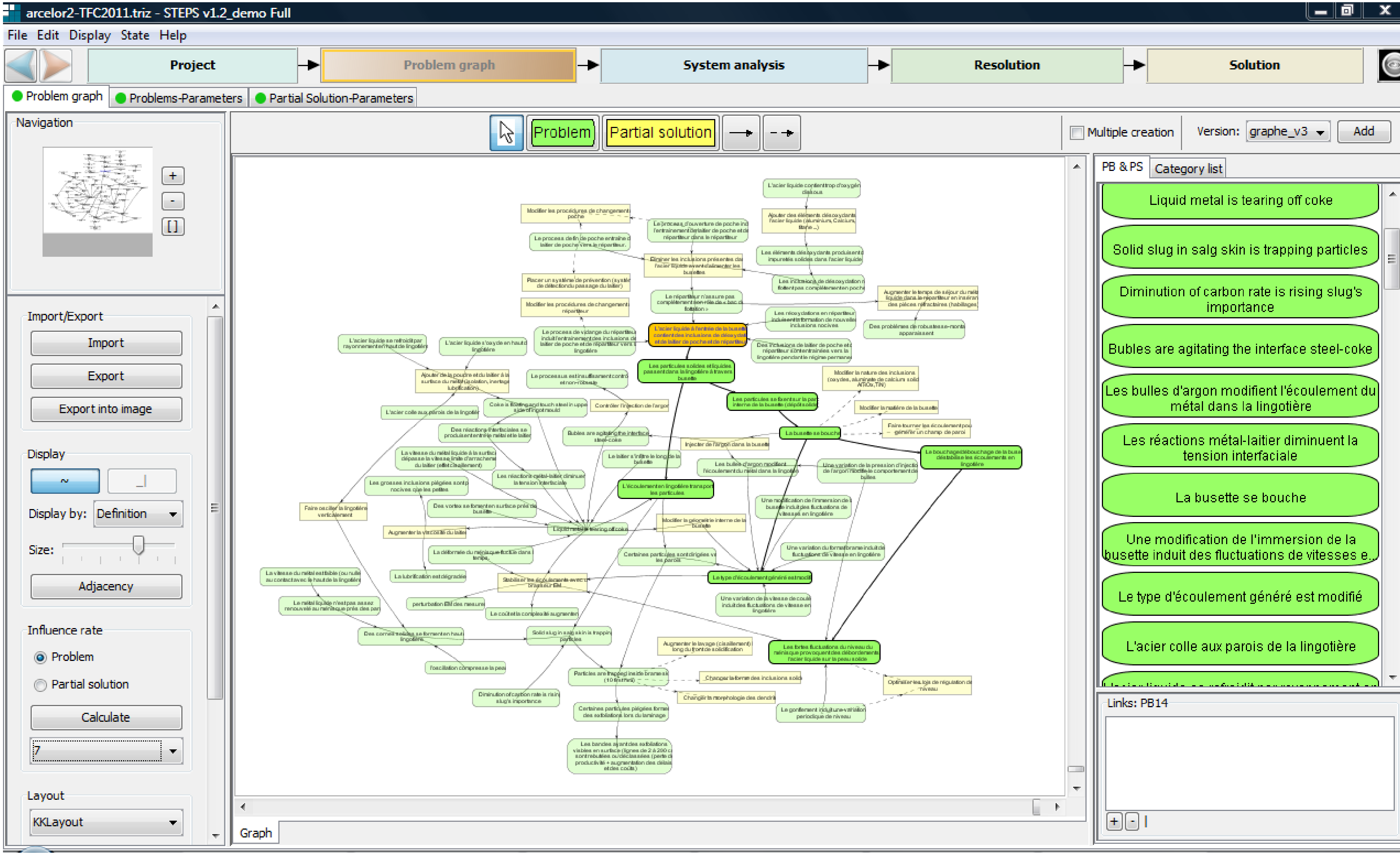






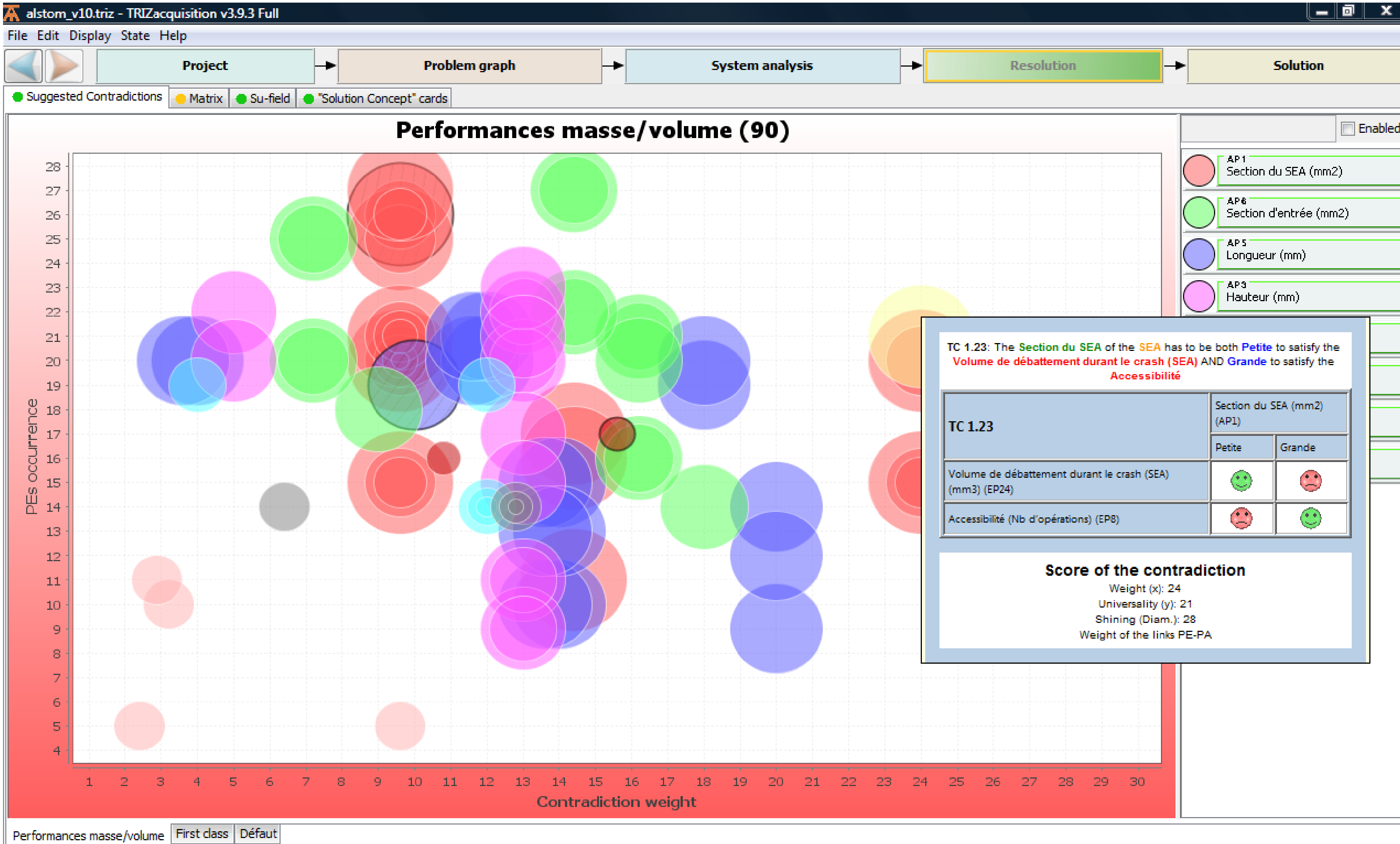
Starting with an Initial situation

Managing populations of contradictions

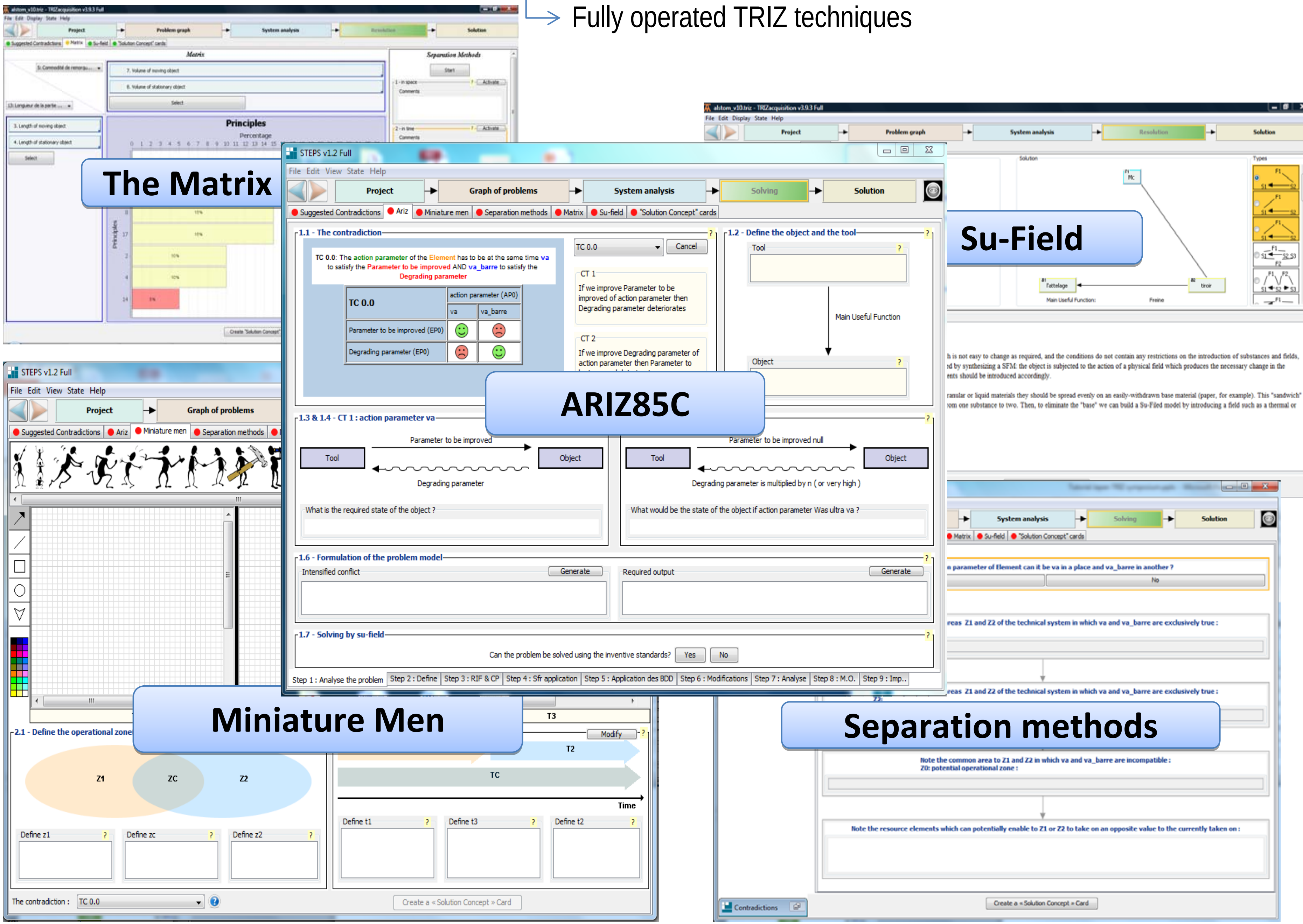


Starting with an Initial situation

Managing populations of contradictions



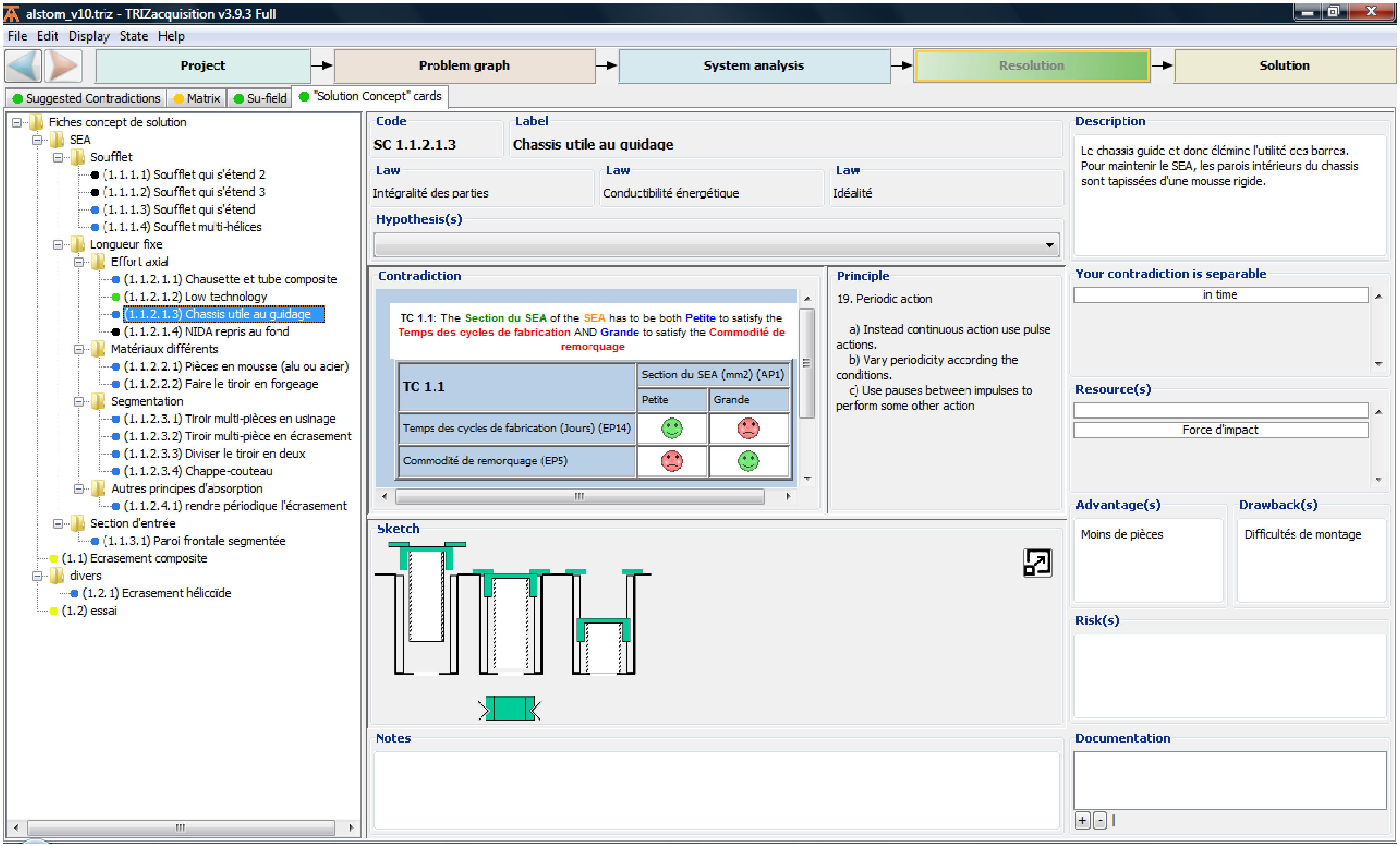
Fully operated TRIZ techniques



STEPS's Solution Concept cards

# A Solution Concept tree is built

## (each branch is a solution concept card)



# *Conducting an industrial case : summary*

Summary of a case study

| Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 | Day 8 | Day 9 | Day 10 |
|---|---|---|---|---|---|---|---|---|---|

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)

**Problem Statement phase**

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

**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

**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.

**Solution Concepts analysis**

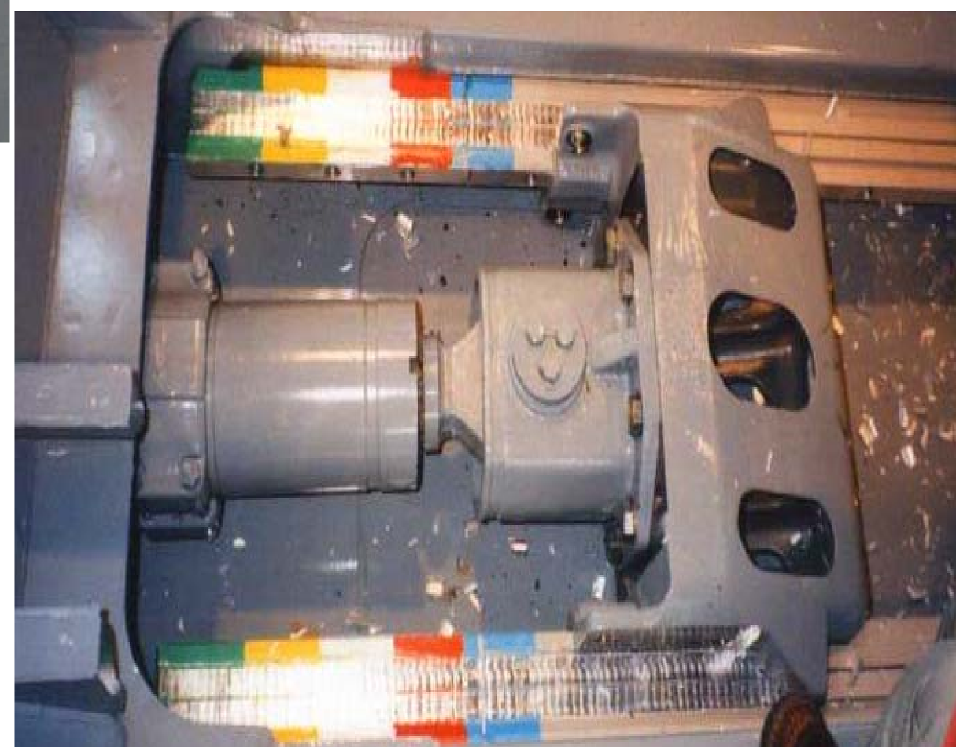
Phase consisting in analyzing Solution Concepts and choosing a reduced set of them for further calculations based on the Problem network shrinkage they provoke

**Calculations & validations of the chosen solution Concepts**

Phase consisting in engaging R&D means to characterize technologically and qualitatively the solution concept's feasibility

Summary of a case study

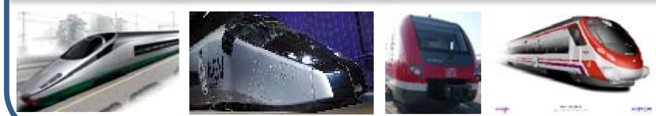

**Crash retention in High speed trains**



## Summary of a case study

**Case study in high speed train industry : Crash absorbing system**

**Competing arena in high speed train market**



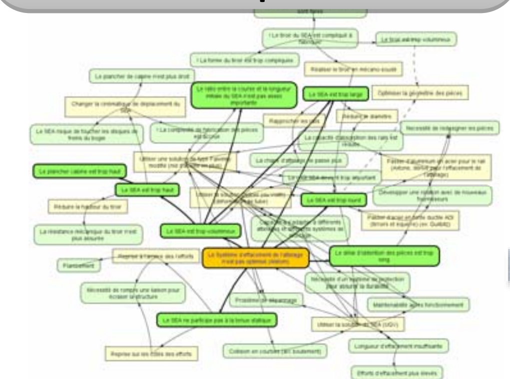
**Problematic : How to efficiently absorb energy in crash situations?**

**Analysis of competition and state of the art of expert knowledge on the topic**

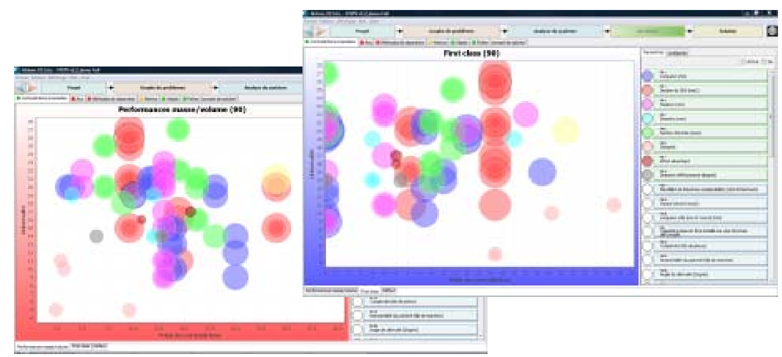
*All people knowledge and doc. (patents, articles) are studied*

**Construction of a problem graph**

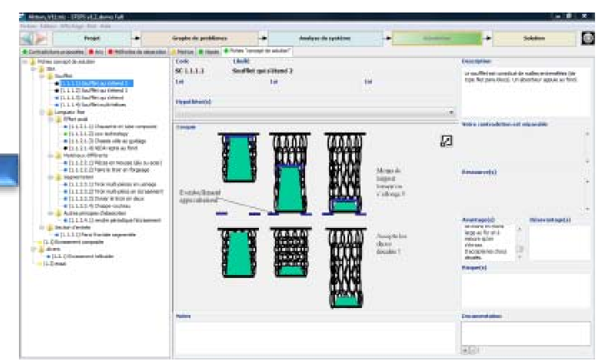
**Interpreting the graph : define the core problem**



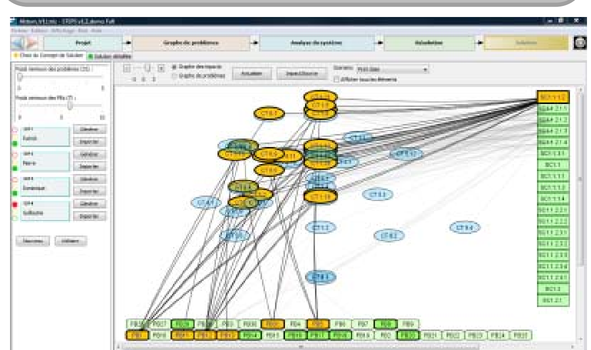
**Contradiction extraction & management**



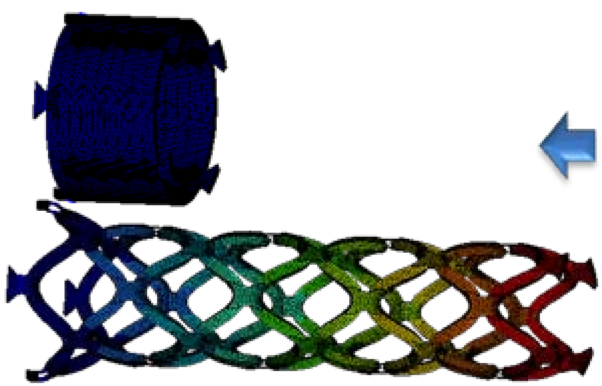
**Use of TRIZ techniques for building solution concept**



**Use of Pugh's matrixes for automatic ranking of solution concepts**



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



# Teaching IDM
## to engineers
## in life-long learning

Teaching IDM

STEPS

IDM-TRIZ powered by STEPS

An official full version of STEPS software is necessary all along the trainning process

# IDM experts

(3 w + 1 w on a mentored professional project)

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Basic TRIZ | Advanced TRIZ | Management of complex situations | Case study + mentoring |
| STEPS | STEPS | STEPS | STEPS |

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)

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

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)

# Some limitations of in which we are currently conducting research (ongoing PhD)

Conclusions

**Limit N° 1 of our work :** Team working for "human-built" problem graph is too long and not 100% accurate

Achille Souilli's PhD

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

Wei Yan's PhD

**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 ?

Ali Taheri's PhD

**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.

Thongchai Chinkatham's PhD

→ Conclusions

| Year | |
|---|---|
| 2012 | (77) |
| 2011 | (217) |
| 2010 | (125) |
| 2009 | (86) |
| 2008 | (79) |

View more | View fewer

| Author Name | |
|---|---|
| Tan, R. | (61) |
| Cavallucci, D. | (22) |
| Cascini, G. | (19) |
| Cao, G. | (18) |
| Rousselot, F. | (15) |

View more | View fewer

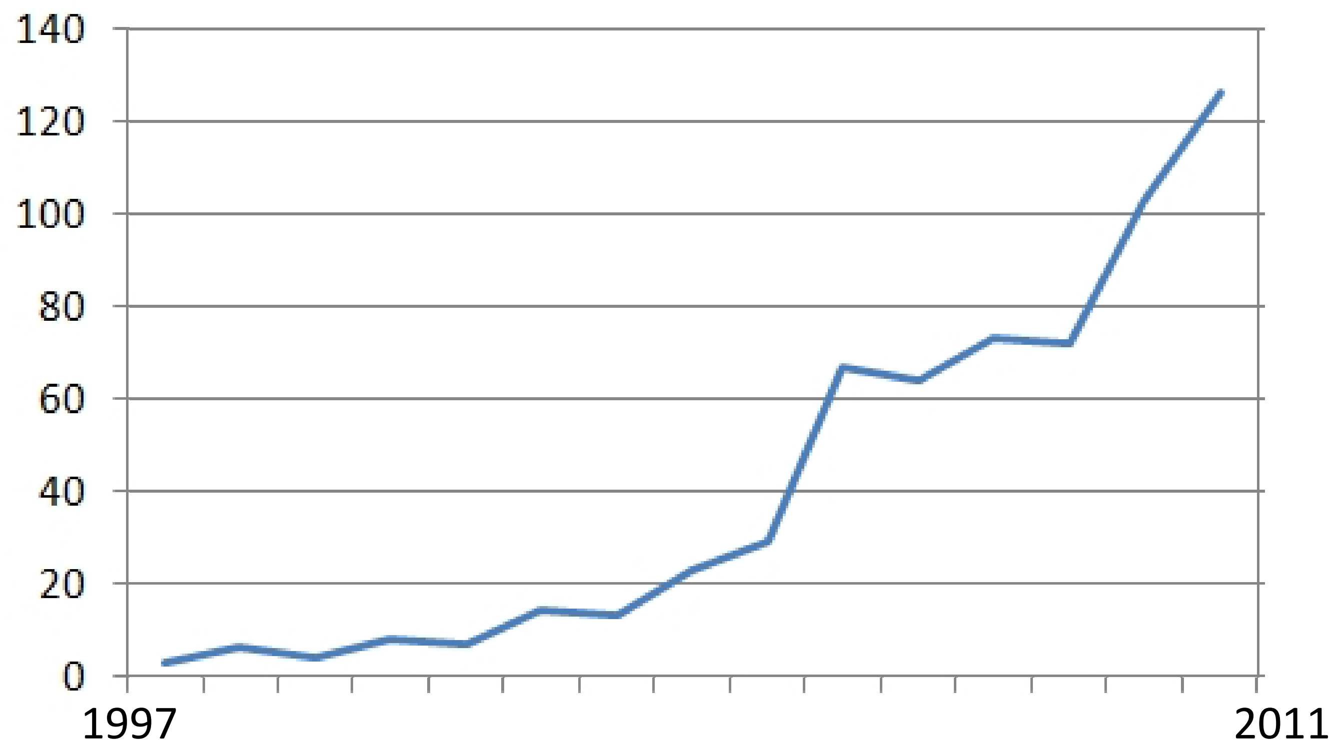
| Subject Area | |
|---|---|
| Engineering | (581) |
| Computer Science | (208) |
| Business, Management and Accounting | (108) |
| Decision Sciences | (67) |
| Mathematics | (59) |

View more | View fewer

| Document Type | |
|---|---|
| Conference Paper | (497) |
| Article | (299) |
| Conference Review | (12) |
| Review | (11) |
| Article in Press | (6) |

View more | View fewer

# Quantity of scientific papers per years being published and using the keyword TRIZ in the title or the abstract



Conclusions

## 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