

# Global TRIZ Conference 2011 in Korea

(KOREATRIZCON 2011)  
10-11, March, 2011



## Towards an Inventive Mode of Design in R&D departments

*Lessons from TRIZ*

Denis Cavallucci (denis.cavallucci@insa-strasbourg.fr)

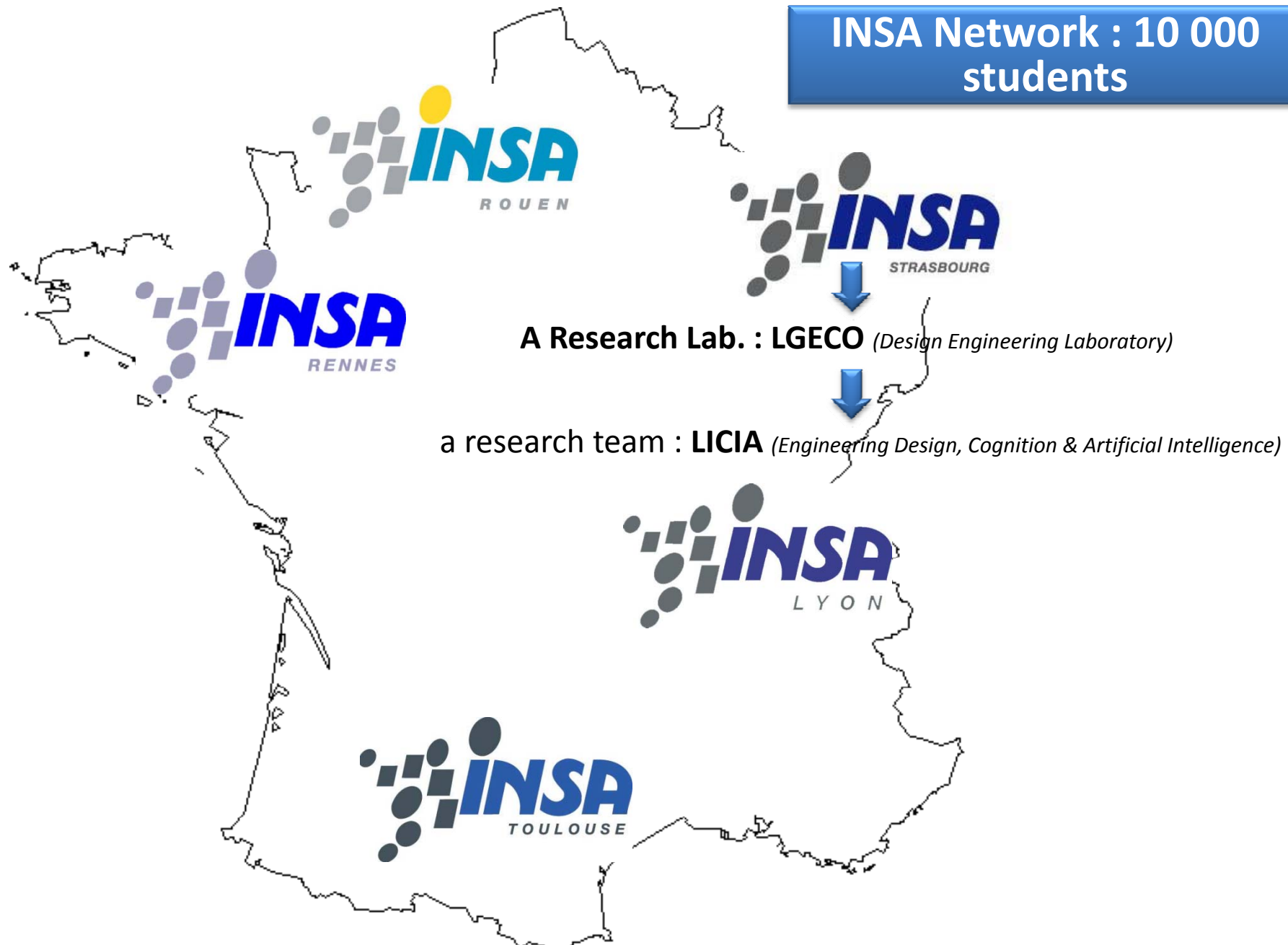
2nd Global TRIZ Conference 2011 – March 9th – Seoul – South Korea

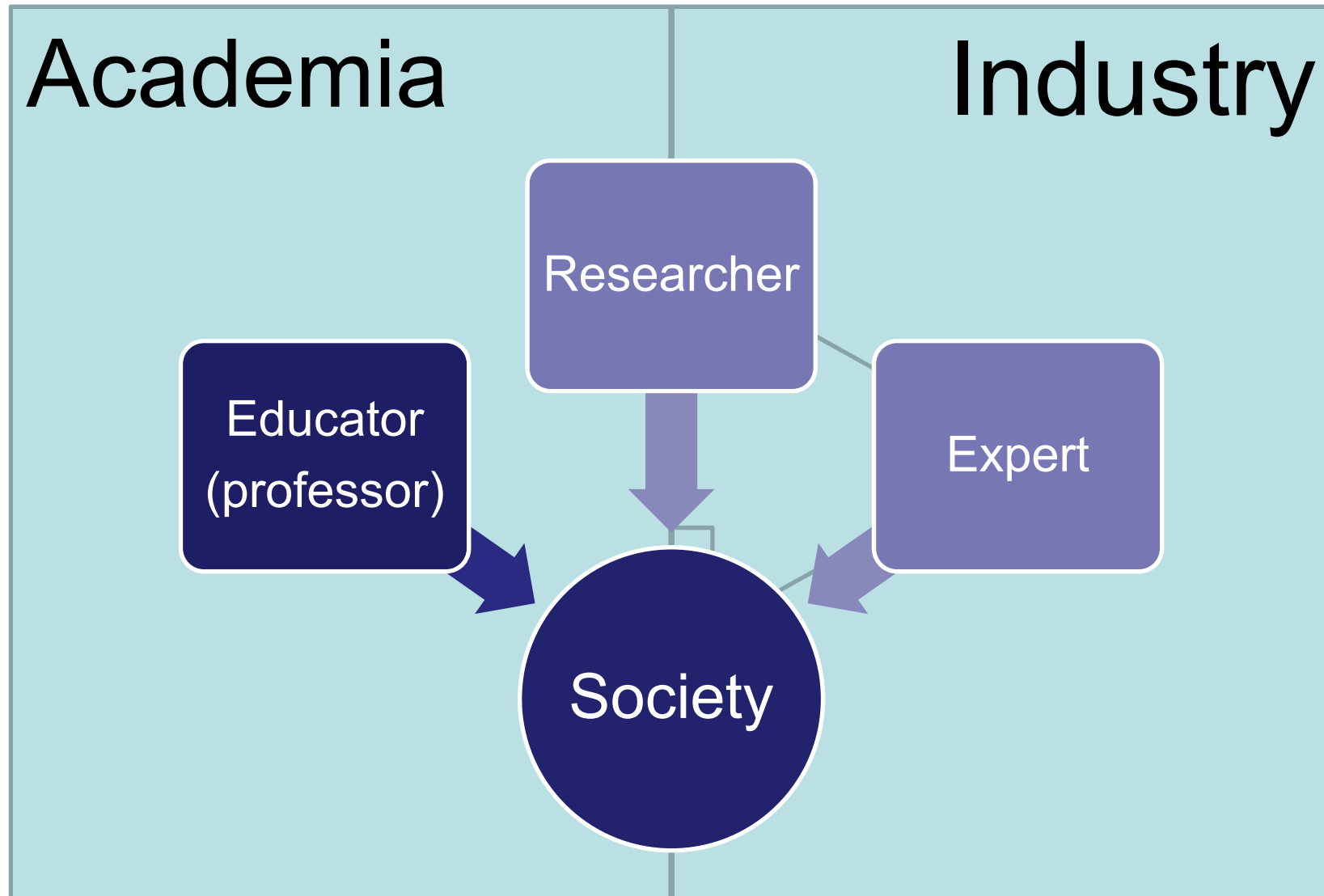
- 1 Introduction part – (industrial eras : what do they impose us)
- 2 TRIZ basics & limitations & beyond – (TRIZ worldwide survey & TRIZ Consortium)
- 3 Towards a Computer Assistance of Inventive practices – (TRIZAcquisition project)
- 4 Conclusions, perspectives, debate



***Introductory  
Session***

INSA Network : 10 000 students





**Now**

Professor at INSA Strasbourg : Teaching TRIZ for the past 15 years ;  
Conducting Research activities in relation with TRIZ.

**1995-96**

Ms degree “TRIZ : a state of the art”

**1996-99**

PhD “TRIZ & existing Design theories”

**1998**

Co-founder of TRIZ-France

**2000**

Co-founder of European TRIZ Association

**2003**

Co-founder of INSA’s AMID  
Advance Master in Innovative Design

**2004**

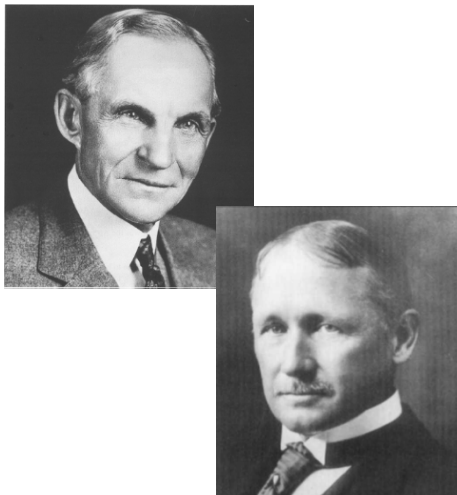
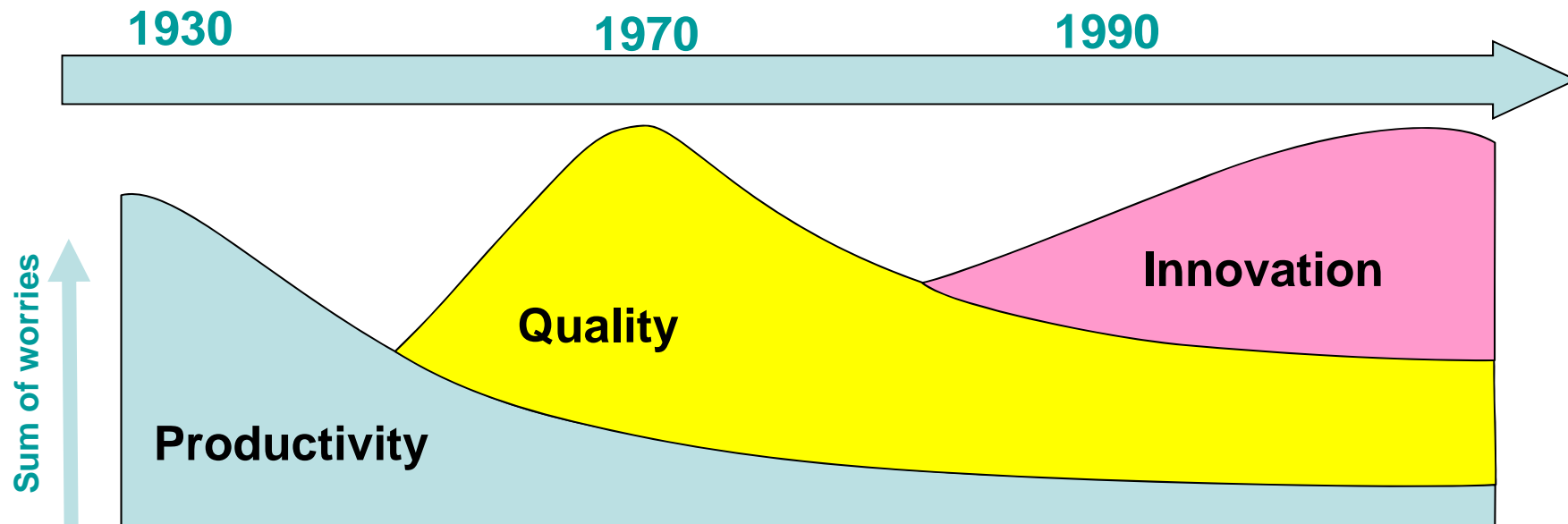
Co-founder of IFIP WG 5.4  
Computer Aided Innovation

**2006**

Co-founder of TRIZ Consortium

**2011**

“Habilitation / qualified” for PhD mentoring  
and full professor application



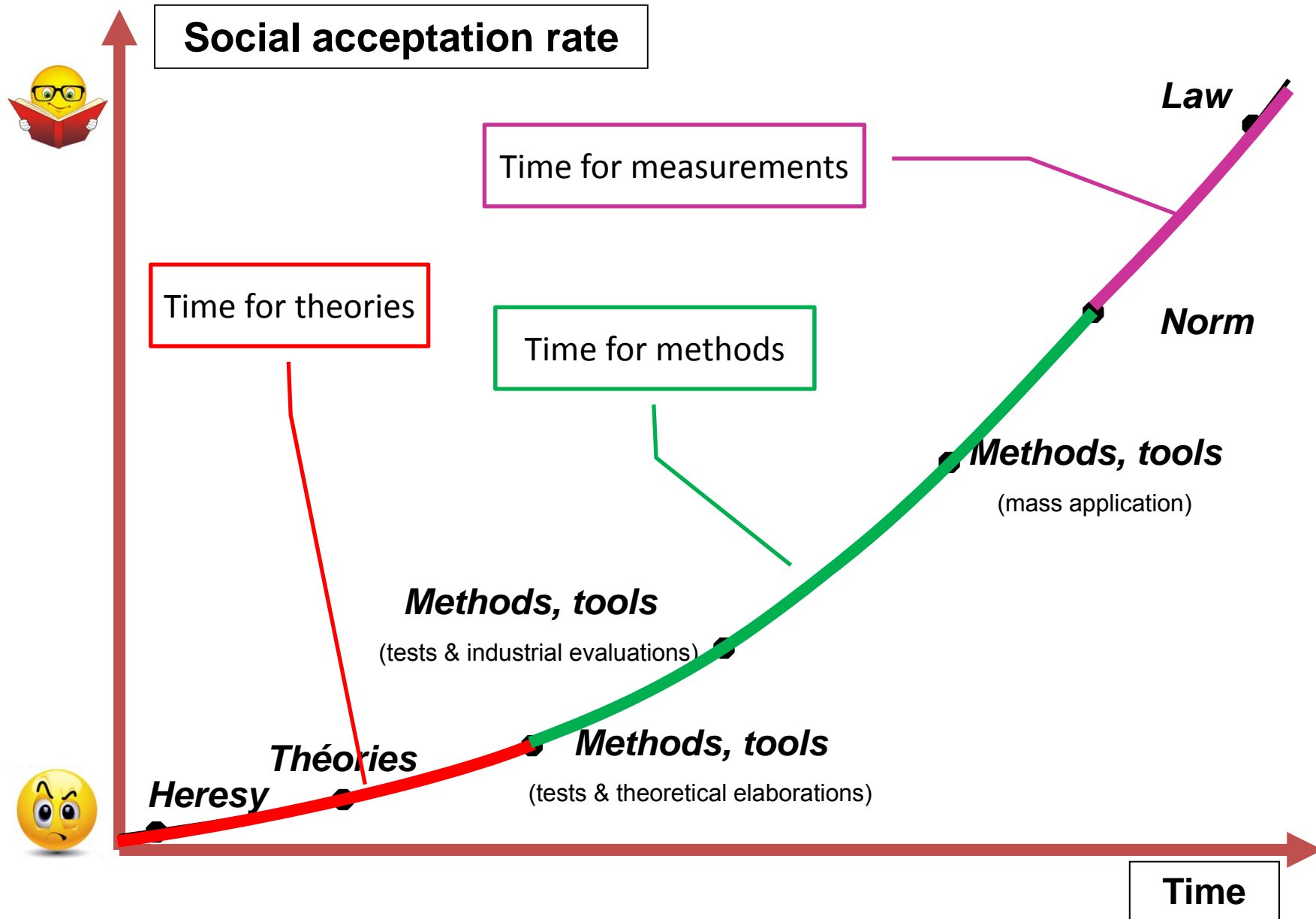
- Answering to demand
- Organize workshops
- Improve productivity rates

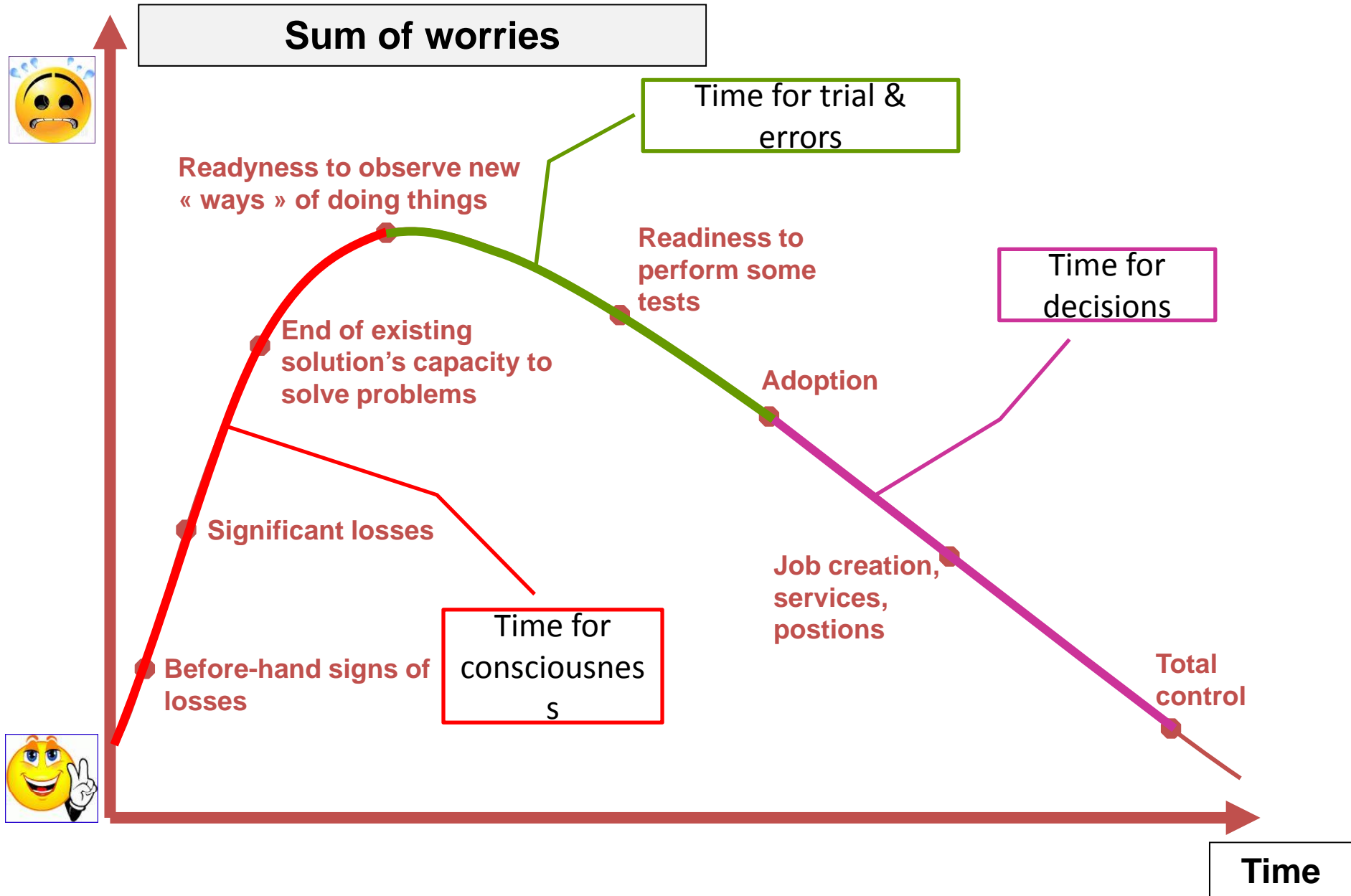


- Be competitive
- Ensure quality
- Optimize organization

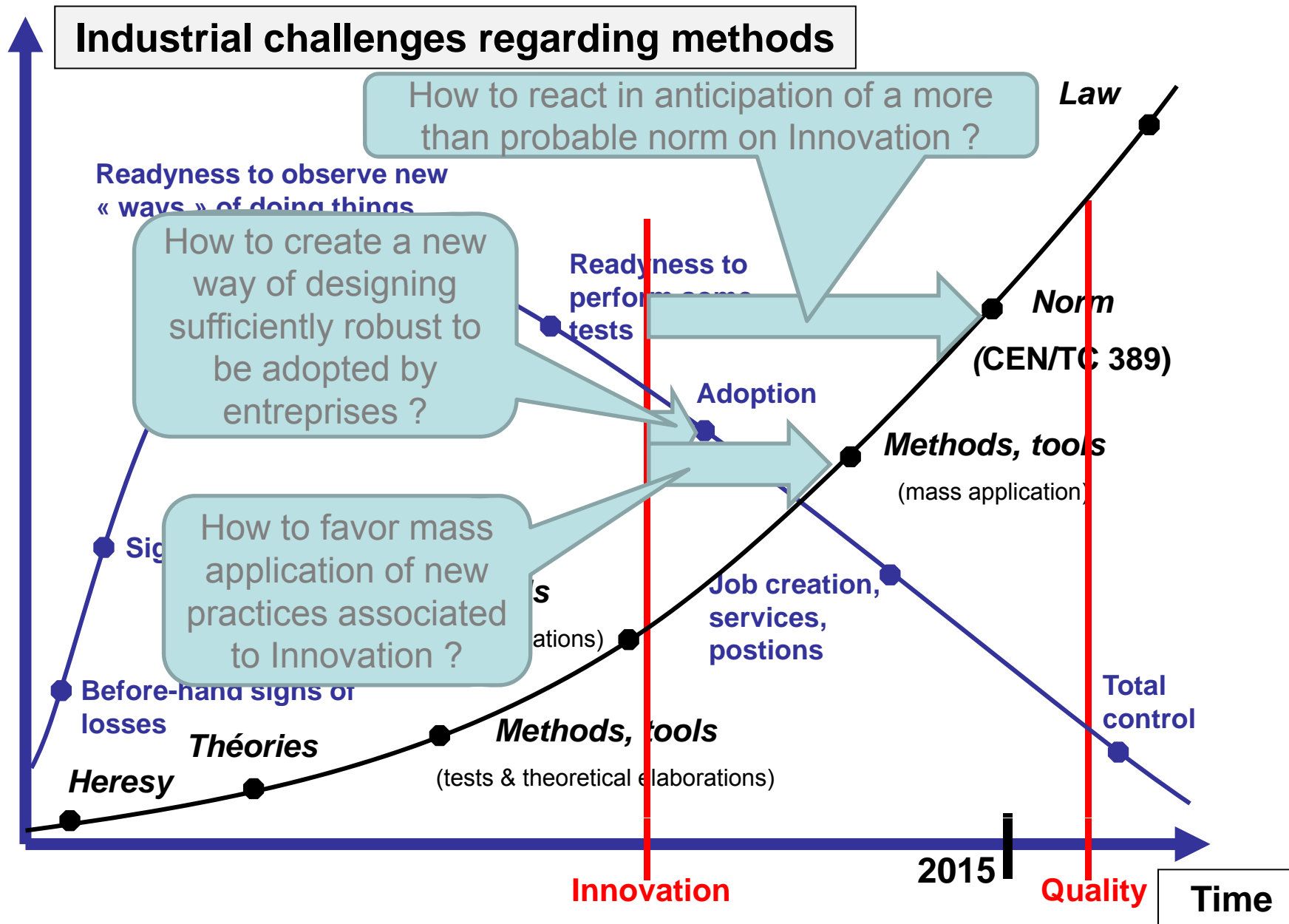


- Organize innovation
- Manage knowledge increasing quantity
- Anticipate product/system's evolutions





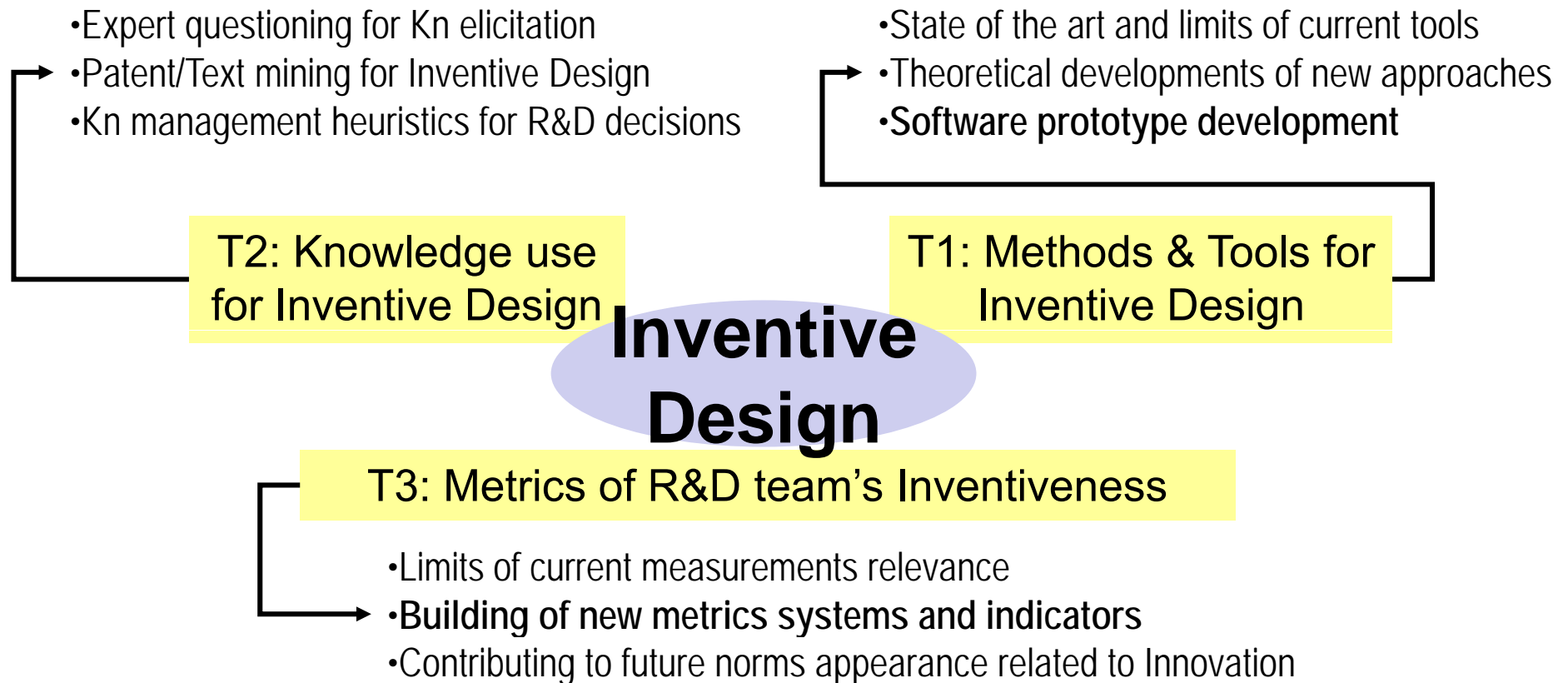




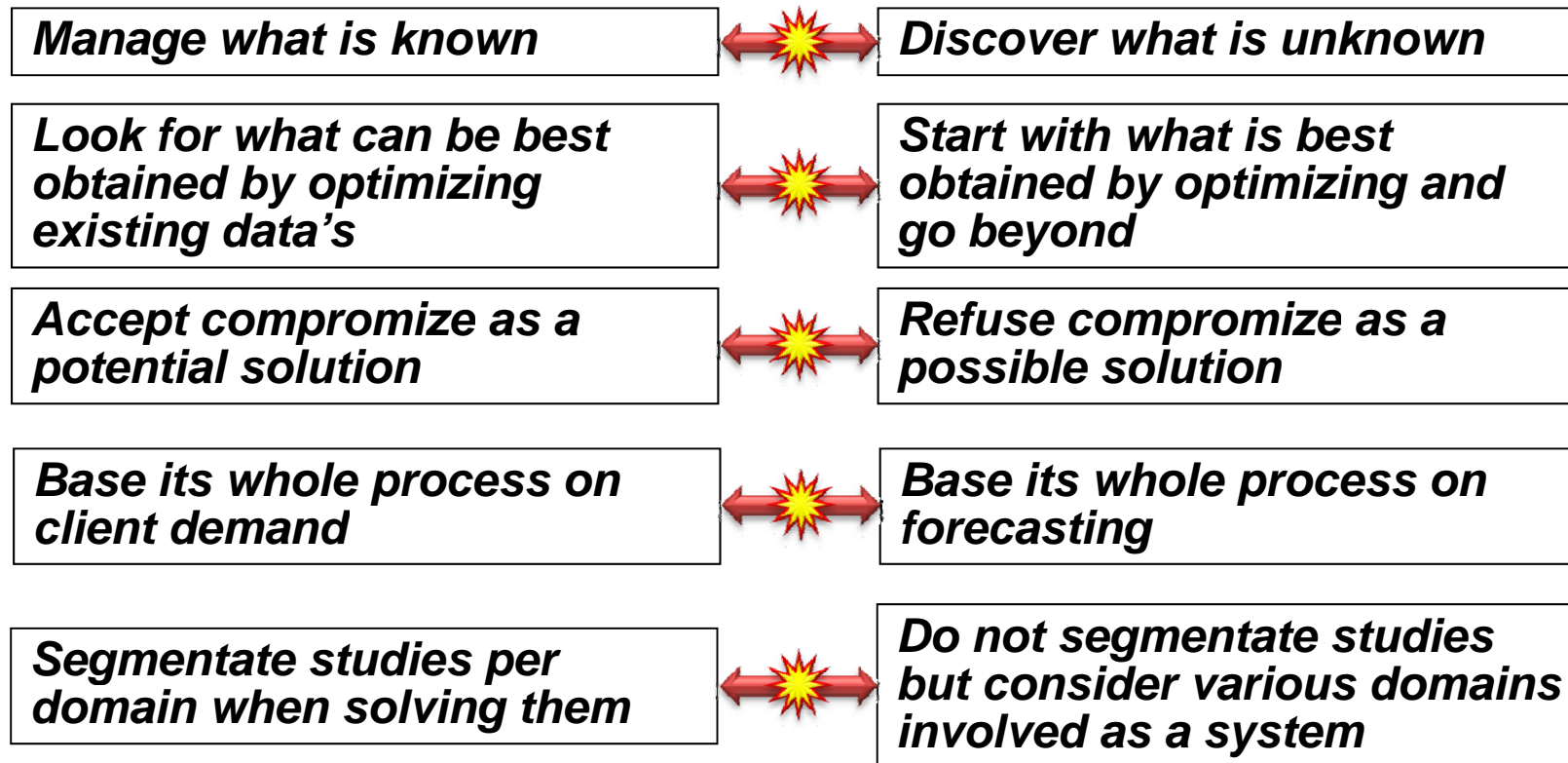
# A brief overview of our research topics

Within LICIA (Engineering Design & Artificial Intelligence) - (A research Team of LGéCo)  
Laboratoire de GÉnie de la Conception (LGÉCO) *Design Engineering Laboratory*

40 researchers : (7 Full Prof. – 25 Ass. Prof. – 8 teachers – 22 PhDs – 7 Administrative staff.)

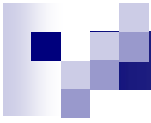


## Routine Design &amp; Inventive Design : Opposition or synergy ?



*It is legitimate that quality driven approaches fulfil the expectations of optimization, they have been elaborated just for that ! Nevertheless, today's expectations are concerned with the problematic of innovation.*

*The right question is : When dealing with necessarily innovative projects (open to invention), what to you do ?*



***TRIZ :***  
***from where we are***  
***to where we (should) go***

## TRIZ : 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.

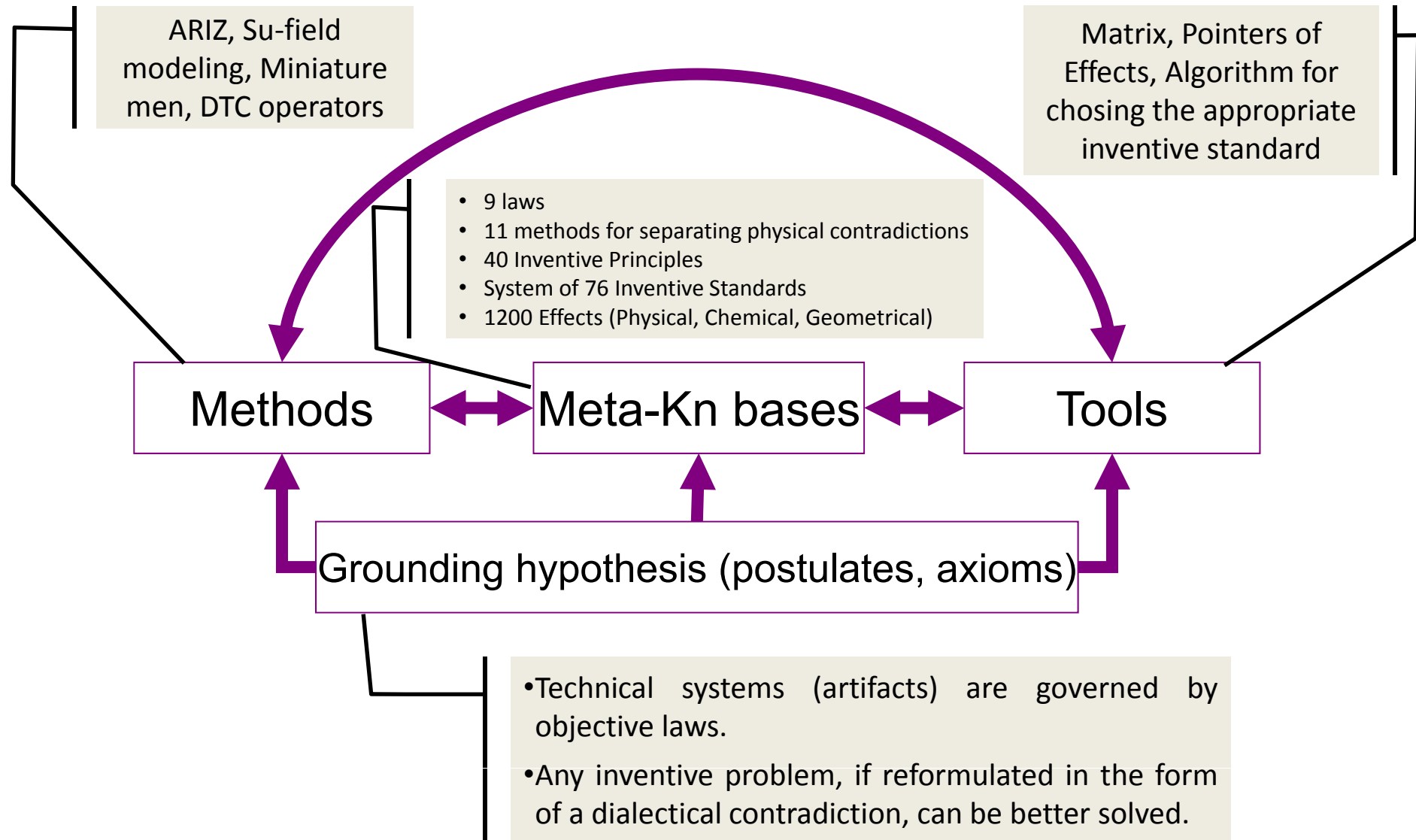
**Corollary 1.2:** A direction of design in accordance with these laws has statistically more chances to appear relevant.

**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.

# System of elements describing TRIZ as a theory



## TRIZ Worldwide survey project in a few slides

- 🌐 **An impulse** : Worldwide TRIZ communities starts to grow in quantity
- 🌐 **A legitimate organizer** : ETRIA and its worldwide coverage
- 🌐 A first group of **corresponding persons** (one per country)
- 🌐 A second group of **survey fillers** (one per company)
- 🌐 Statistical data's are **based on** :
  - **437** collected **answers**
  - A total of **314** kept after filtering doubles, incomplete or doubtful **answers**
  - **302 organizations** are concerned
  - Within a total of **39 countries**
  - The 302 organizations are cumulating nearly **3 million individuals**
  - Total of **persons involved in TRIZ** within these organizations are **5405**

## Particular thanks to all countries coordinators



Ellen DOMB *United States of America*



Denis CAVALLUCCI *France*



Vladimir PETROV *Israel*



Mateusz SLUPINSKI *Poland*



Oscar ISOBA *Argentina*



Hugo SANCHEZ *Nicaragua*



Iouri BELSKI *Australia*



Juergen JANTSCHGI *Austria*



Marco Aurelio DE CARVALHO *Brazil*



Sulieman M. ZOBLY *Sudan*



Carsten GUNDLACH *Germany*



Toru NAKAGAWA *Japan*



Noel LEON *Mexico*



Simona Mariana CRETU *Romania*



Tan Kay CHUAN *Singapore*



Jose M. Vicente GOMILA *Spain*



Tom VANEKER *The Netherland*



T.S. YEOH *Malaysia*



Gaetano CASCINI *Italy*



Bohuslav BUSOV *Czech Republic*



Hongyul YOON *South Korea*



Peter SCHWEIZER *Switzerland*



Jorge OLIVEIRA *Ireland*



Paul FILMORE *UK*



Paul-Armand VERHAEGEN *Belgium*



Pentti SODERLIN *Finland*



Nikolay SHPAKOWSKI *Belarus*



Holger ABEL *Costa Rica*



Tanasak PHEUNGHUA *Thailand*



Runhua TAN *China*



Jaime AGUILAR *Colombia*



Mahmoud KARIMI *Iran*



Oleg FEYGENSON *Russian Federation*



## Particular thanks to all language translators

Polish – Polski **Mateusz SLUPINSKI**

Japanese - 日本語 **Fumiko Kikuchi**

Czech – Český **Bohuslav BUSOV**

Korean – 한국어 **Hongyul YOON**

Spanish – Español **Holger ABEL**

Chinese - 简体中文 **Jing XU**

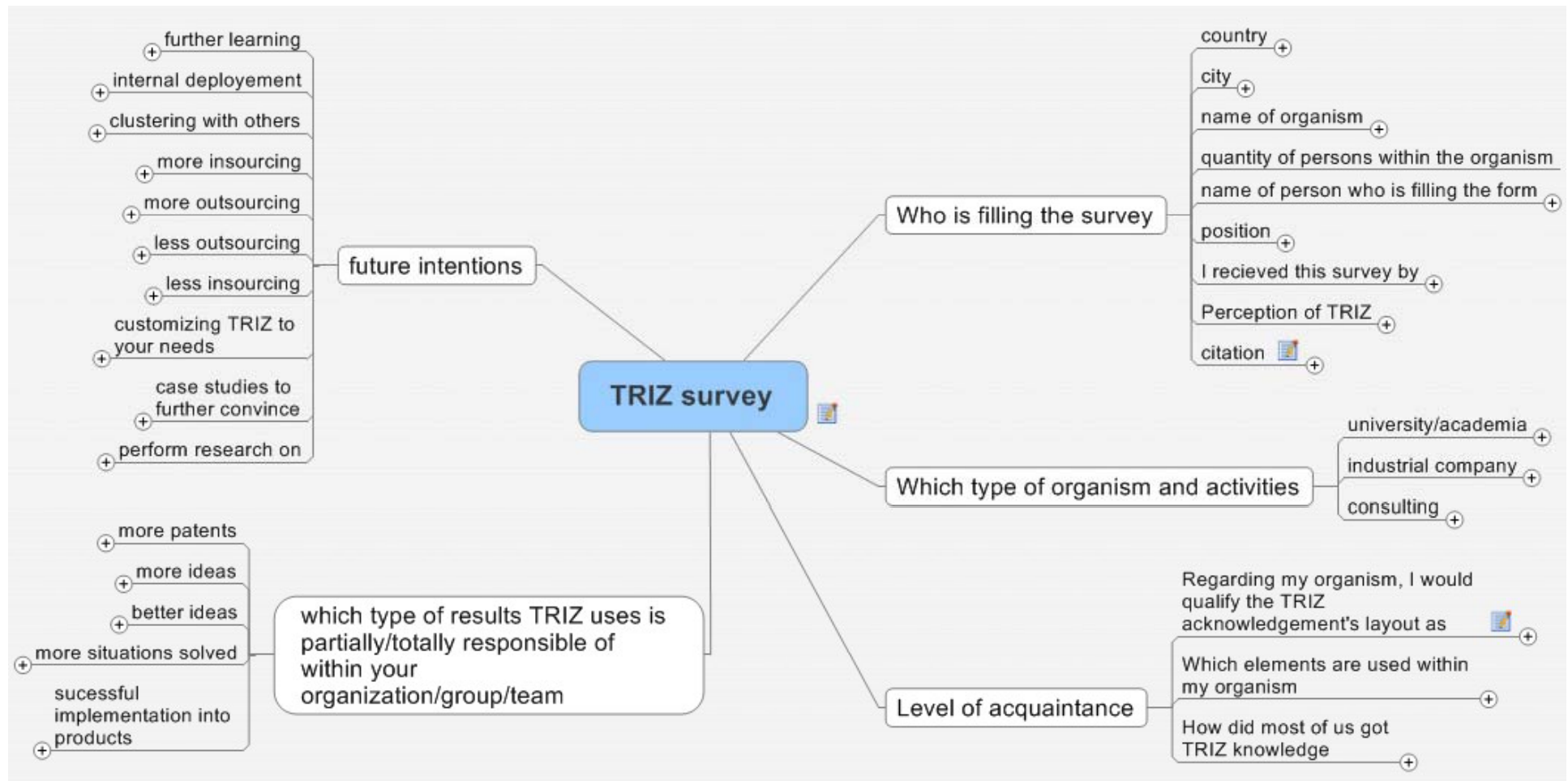
Persian - فارسی **Mahmoud KARIMI**

Russian – Русский **Sergey Malkin**

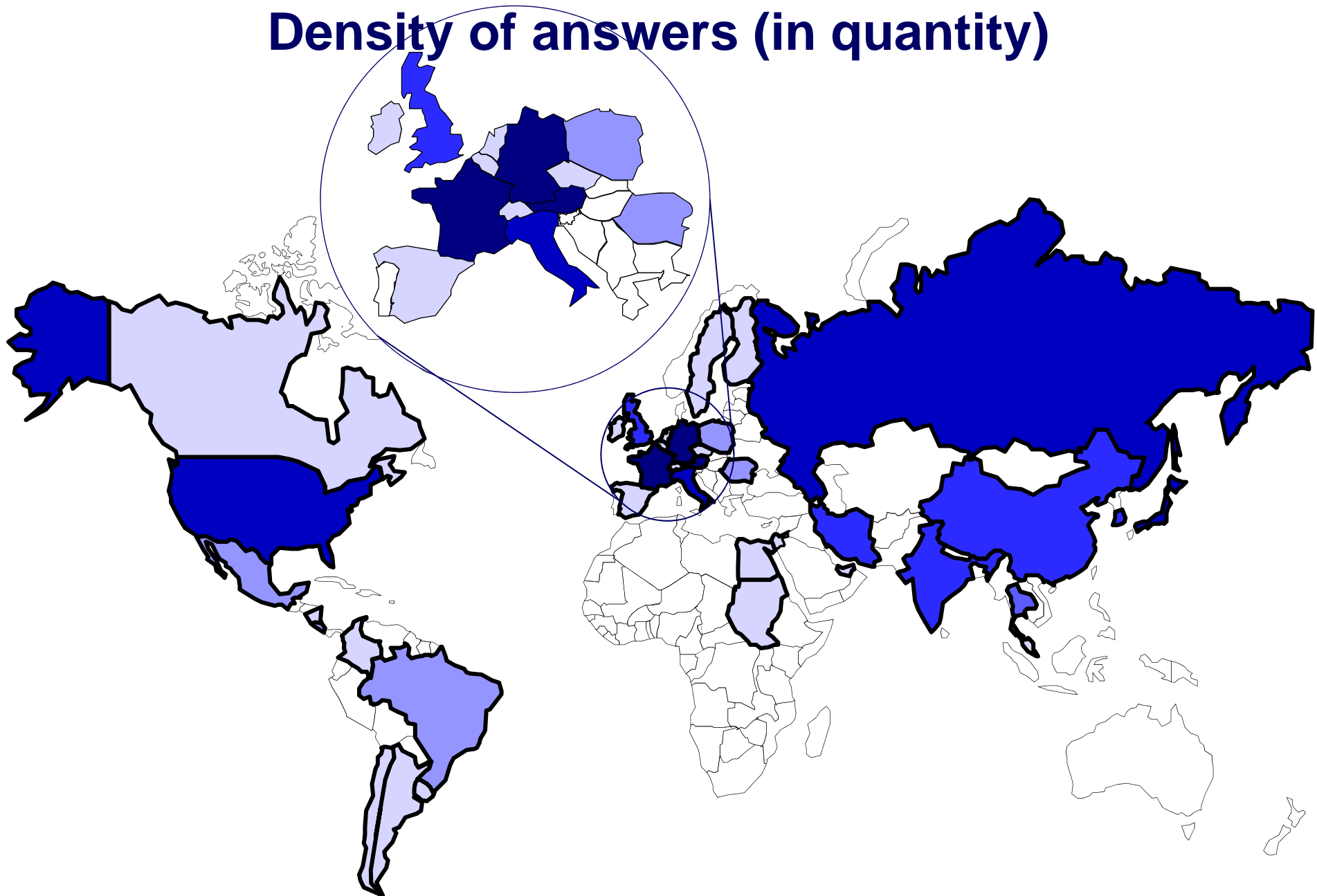
additional thanks to :

**Ellen DOMB** and **Graham Rawlingson** for their assistance with english language !

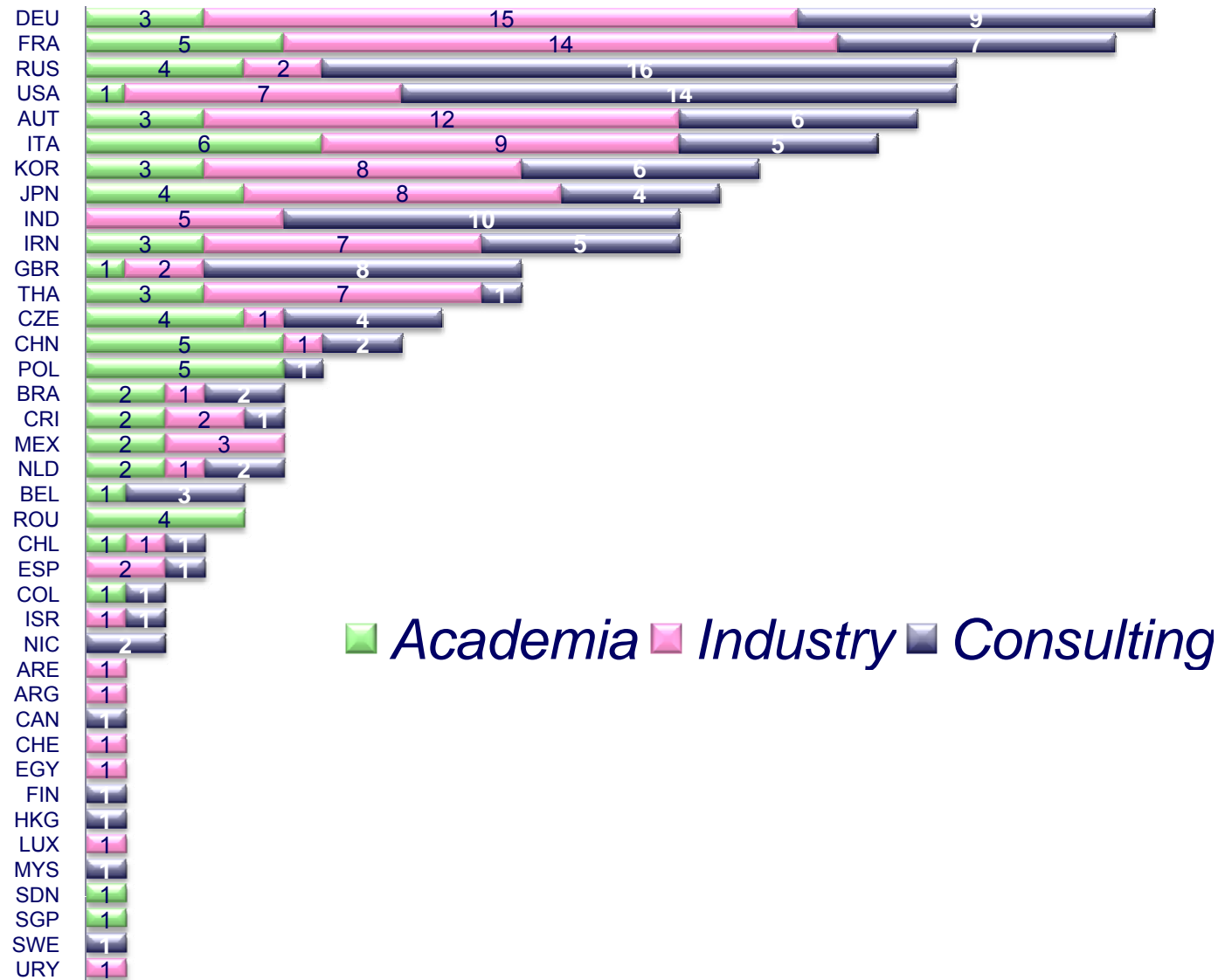
- The survey consist in a system of **54 questions** divided in **5 chapters**;
- Approximately **20 min** to fill it;
- The target: **Representants of organisations** using (or having used) TRIZ or its derivated tools/methods/theories.
- The survey was open **from May 15th until July 28th 2009**



## Density of answers (in quantity)








# Industry/Academia/Consulting distribution



## Lessons learned from the survey participants

To the question : «According to your experience, what does "the world of TRIZ" currently need for better deployment and use?»

5 groups of advises are adressed to TRIZ communities:

-  **Ranked 1st (40):** A clearely established education system at all levels, for all type of potentially interested people (CEO, Engineers, scientists, educators, ...)
-  **Ranked 2nd (39):** A rebuilding of TRIZ in direction of a simplification
-  **Ranked 3rd (34):** Sharing sucessfull results through available materials (meetings, books,..)
-  **Ranked 4th (33):** Publicity and professionally organized marketing campaign around TRIZ's existence (for the all communities)
-  **Ranked 5th (28):** Organized academical research activities to rebuild the groundings, build new knowledge resulting in new tools, methods, curriculums in universities.

**Most cited words** : Simplification, Change, Evolution, Education, Results, ...

## Some quotes from the survey participants

To the question : «According to your experience, what does "the world of TRIZ" currently need for better deployment and use?»

We also have :

- Stop being so parochial
  - stop using the word TRIZ
  - Less manifestations of hyper-developed egos and arrogance
  - more easier cases and less stubborn attitudes of my way of TRIZ vs Your way of TRIZ
  - more feet on the ground
  - get rid of the jingoism that is ruining 6 sigma deployment in SMEs.
  - A vision and a leader as Jack Welch for 6 sigma in GE
  - A LEADERSHIP !
  - unity
  - Use TRIZ to elimination of poverty
- and...
- I wish I knew

**To summarize, for a sustainable development, TRIZ :**

**Point 1**: is in need to be rooted in academic curriculum/syllabuses.

But prior to this, there must be a reviewing of its contents in a bi-directional way :

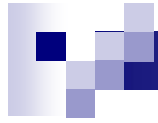
- Coherence/Completeness
- Simplification

**Point 2** : sharing obtained results among users in :

- publishing
- networking

**Point 3** : popularizing TRIZ using professional communication campaigns and means

- TV / newspapers / media in general
- Voice of authority testimonies



***TRIZ :***  
***it should be taught***  
***in Universities***



## In universities

Fifth year in  
mechanical dept.

Module CE5

14h theory

+

14h hands on

## Life long learning

F0 : hear about

F2 : introduction

F3 : hands on

F10 : mastering TRIZ  
(classical way)

AMID (11 weeks) : Mastering  
Inventive Design Practices for  
strengthening corporate  
innovation strategies  
(Advanced Master in Innovative Design  
(7th promotion))

Education Case studies in which INSA students have been involved (90)







***TRIZ :***  
***it should be taught***  
***Life Long in Organizations***

## *About the title “master” ?*

*The title “master” can only be delivered if the institution organizes the courses by or in association with a university habilitated to candidate for receiving an authorization from a government’s ministry of research and education . (extract from E.U policies)*





***TRIZ :***  
***You must be able***  
***to prove***  
***your results value***

# Advanced Master in Innovative Design 2008-2009



Stéphane BOUR

Professional Project Defence Presentation  
7th of May 2009




**Chalumeau Pro** Réf. 470

**RIEN DE MOINS QU'UNE  
RÉVOLUTION !**
**PLOMBIER,  
CHAUFFAGISTE,  
FRIGORISTE...**

**VULCANE  
EXPRESS**
**RÉVOLUTION DANS LA PUISSANCE  
ET LES PERFORMANCES**

Avec sa cartouche **MAP//Pro** (Réf. 2400) et une température de chauffe de 2400° C, pour une puissance pouvant atteindre 3,5 kW (lance Ø 28), **VULCANE EXPRESS**, grâce à la qualité de sa **flamme turbo**, enveloppante, **répartit encore mieux la chaleur** sur le pourtour du tube à chauffer.

Son **rendement élevé** et l'**absence de fausse flamme** garantissent des performances optimales... jusqu'à u dernier gramme de gaz !

**RÉVOLUTION DANS L'ERGONOMIE !**

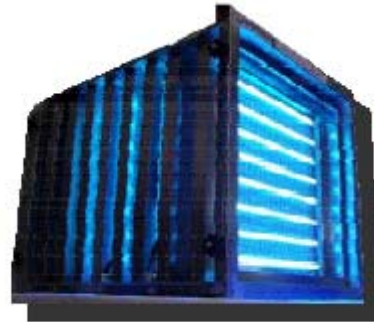
Ses 400 petits grammes en font un produit **facile à manipuler** pour un **indice de pénibilité réduit**. Sa **poignée confort** bi-matière et plus généralement son ergonomie étudiée lui confèrent un **look inimitable**; il est beau tout simplement...



## Dispositifs OPTIFOOD®

L'installation d'une unité\* BLOWIND  
de traitement de l'air  
améliore la conservation des fruits

  
BLOWIND  
ENTREZ DANS UN NOUVEL AIR!



\*Dispositif combinant filtration  
mécanique et photocatalyse

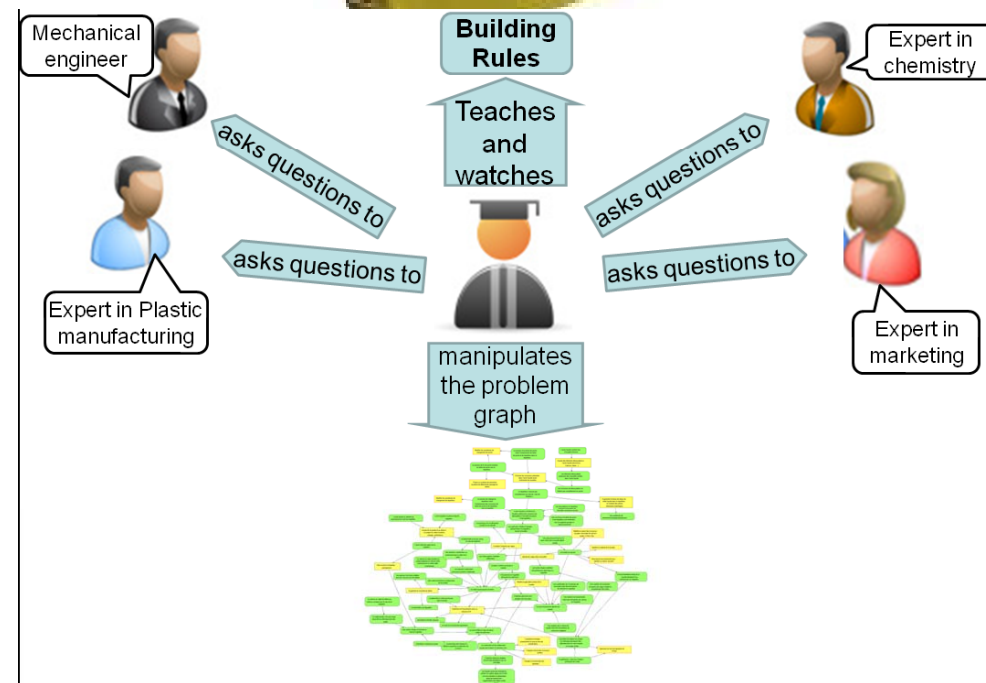
Avec      Sans  
Unité BLOWIND  
(après 3 semaines de stockage à 18°C  
– HR 70%)



***TRIZ :***  
***What about***  
***what it cannot do ?***

## TRIZ has limitations :





- TRIZ is not designed to investigate initial situations (gathering thoroughly all knowledge necessary and known to qualify the problem).

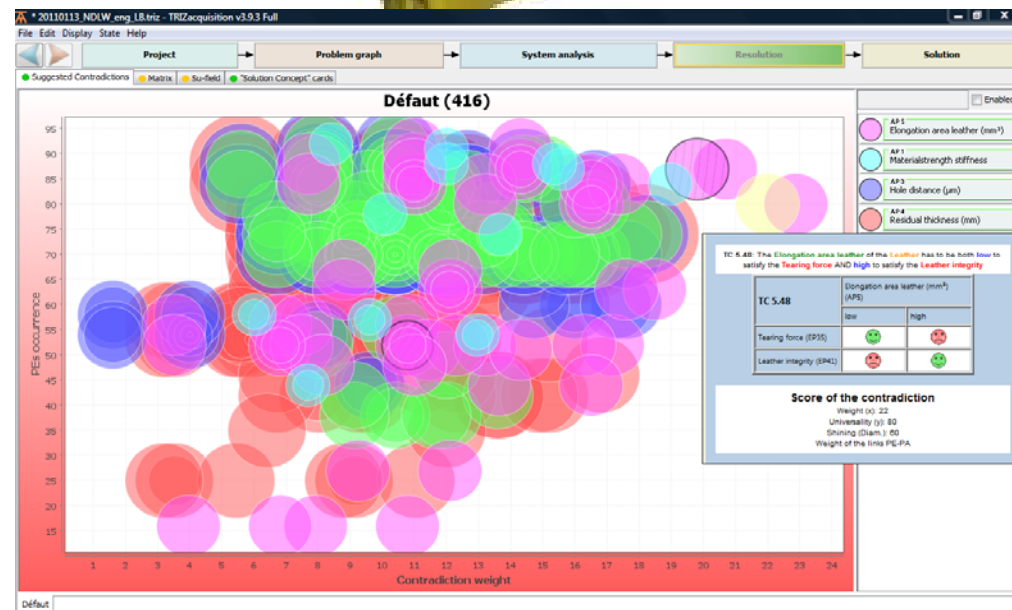


## TRIZ has limitations :

- TRIZ is designed for solving a single contradiction. How to chose the most appropriate one since contradictions quantity increase exponentially with any system's complexity ?



	<b>Arm's length</b>	
	long	short
stability		
ease of placing clothes on		



## TRIZ has limitations :

- 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...



Let  $i=2q-1$  or  $i=2q$  and  $M \in \mathbb{R}^{m \times k}$  be the matrix of influences  
 $M_{ij}=1$  means that  $AP_q$  has a positive influence on  $EP_j$   
 and  $M_{ij}=-1$  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.

$$\begin{array}{c}
 AP_1 \\
 \vdots \\
 AP_m
 \end{array}
 \begin{array}{c}
 Va_1 \\
 \overline{Va_1} \\
 \dots \\
 Va_m \\
 \overline{Va_m}
 \end{array}
 \begin{array}{c}
 1 \\
 2 \\
 \dots \\
 2m-1 \\
 2m
 \end{array}
 \left( \begin{array}{cccccc}
 1 & -1 & \dots & \infty & \dots & \infty \\
 -1 & 1 & \dots & \infty & \dots & \infty \\
 \dots & \dots & \dots & \dots & \dots & \dots \\
 \infty & \infty & \dots & 1 & \dots & -1 \\
 \infty & \infty & \dots & -1 & \dots & 1
 \end{array} \right)$$

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

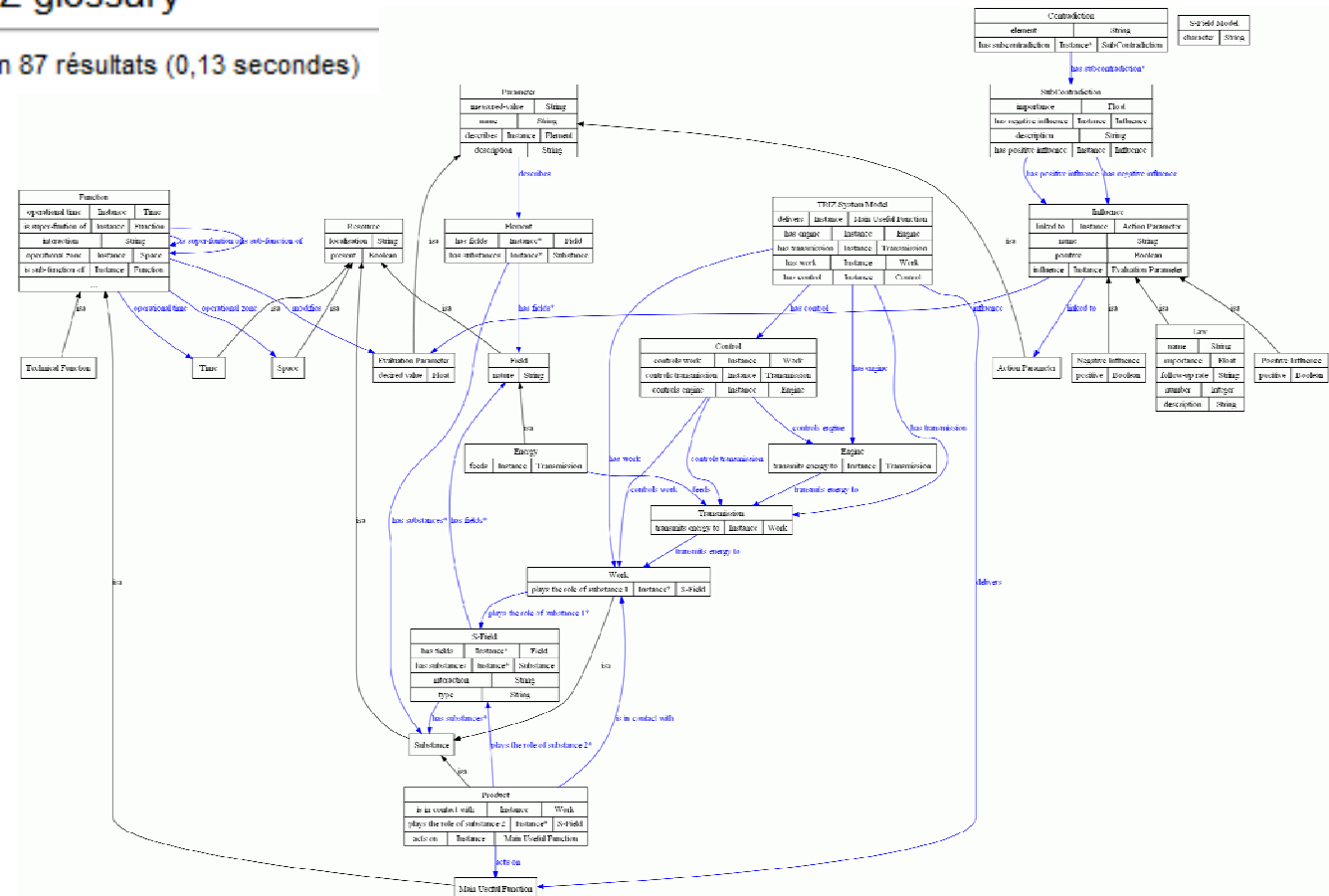
## TRIZ has limitations :

- Are you aware of any “glossary” or “ontology” of TRIZ components ?  
There are no logical links/coherence between TRIZ components.



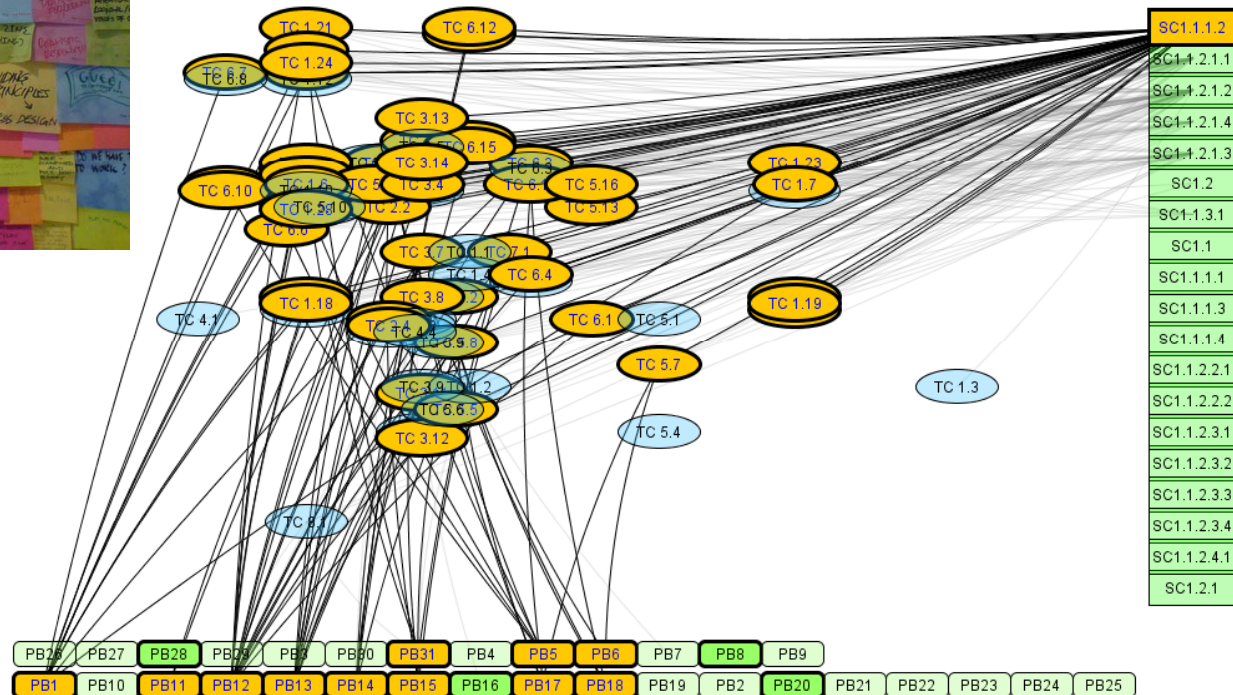
"TRIZ glossary"

Environ 87 résultats (0,13 secondes)



## TRIZ has limitations :

- Are there means within TRIZ to declare if a Solution Concepts is “the one” to implement further ?

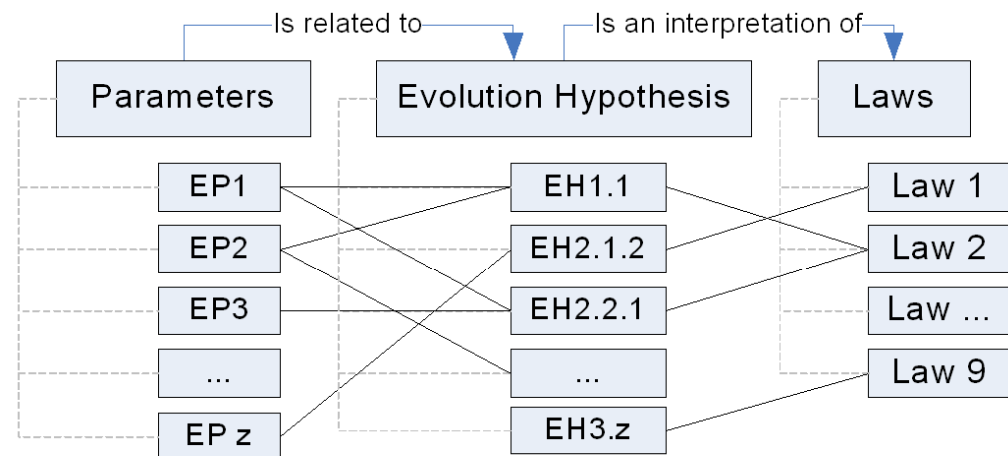




## TRIZ has limitations :

- Laws and contradiction are the two “pillars” of TRIZ, but are there links between them ?

*I know the laws... I know the contradiction, and the way they are linked is obvious (to me...)*





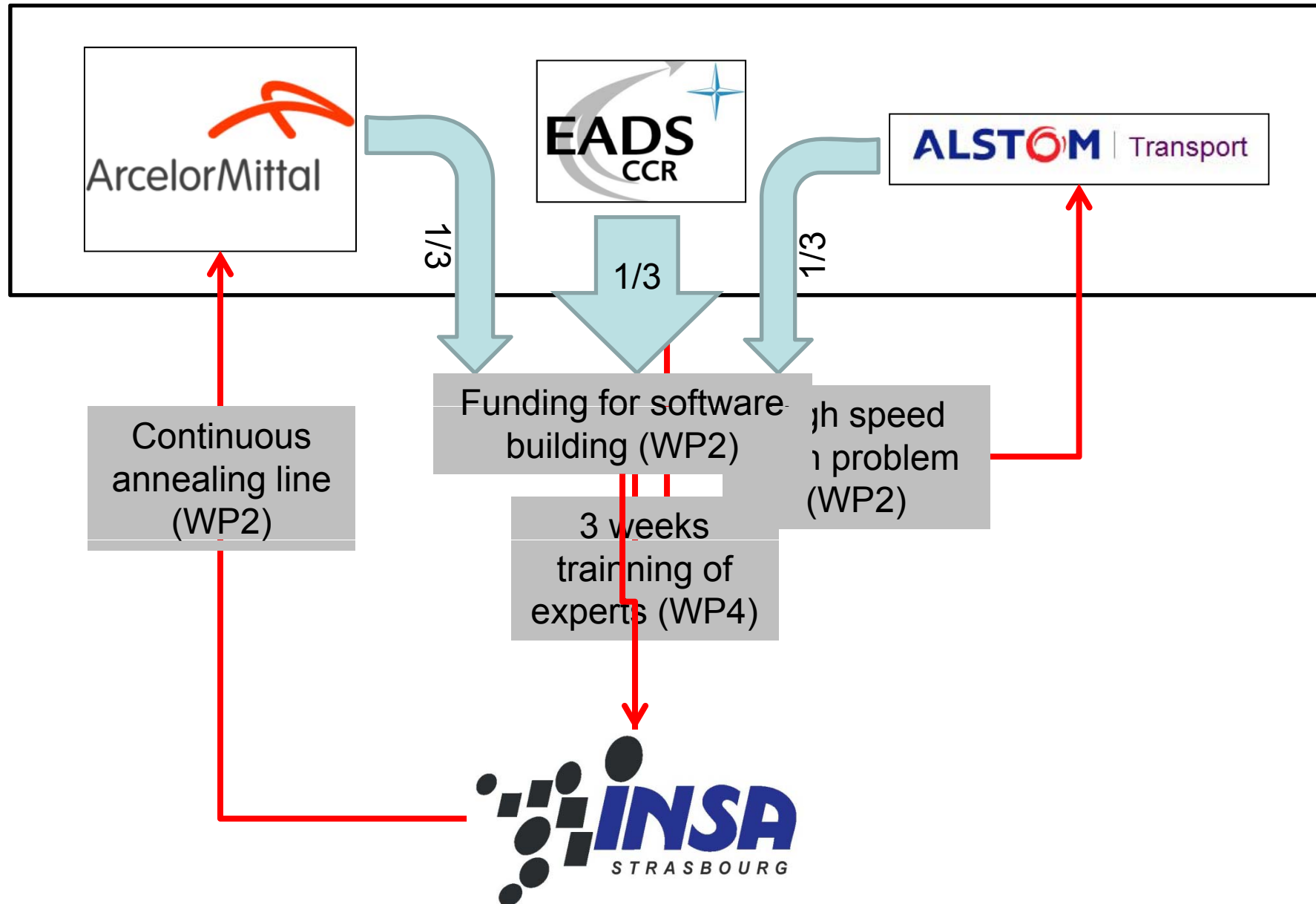
***From TRIZ  
to IDM***

***(Inventive Design Methodology)***







The TRIZ consortium was constituted upon a common willingness between several partners and INSA to organize Inventive Design practices inspired by TRIZ and its developments within the context of organizing Innovative processes.

### **Within the scope of the Consortium, it is proposed :**





- 🌐 To Organize the exchange (2 steering committee/yr ; 2-4 work package meeting/yr)
- 🌐 To Identify common interests and expectations;
- 🌐 To Study the opportunities of cooperation;
- 🌐 To Organize the construction of shared deliverables within the capacity provided by the Consortium means.



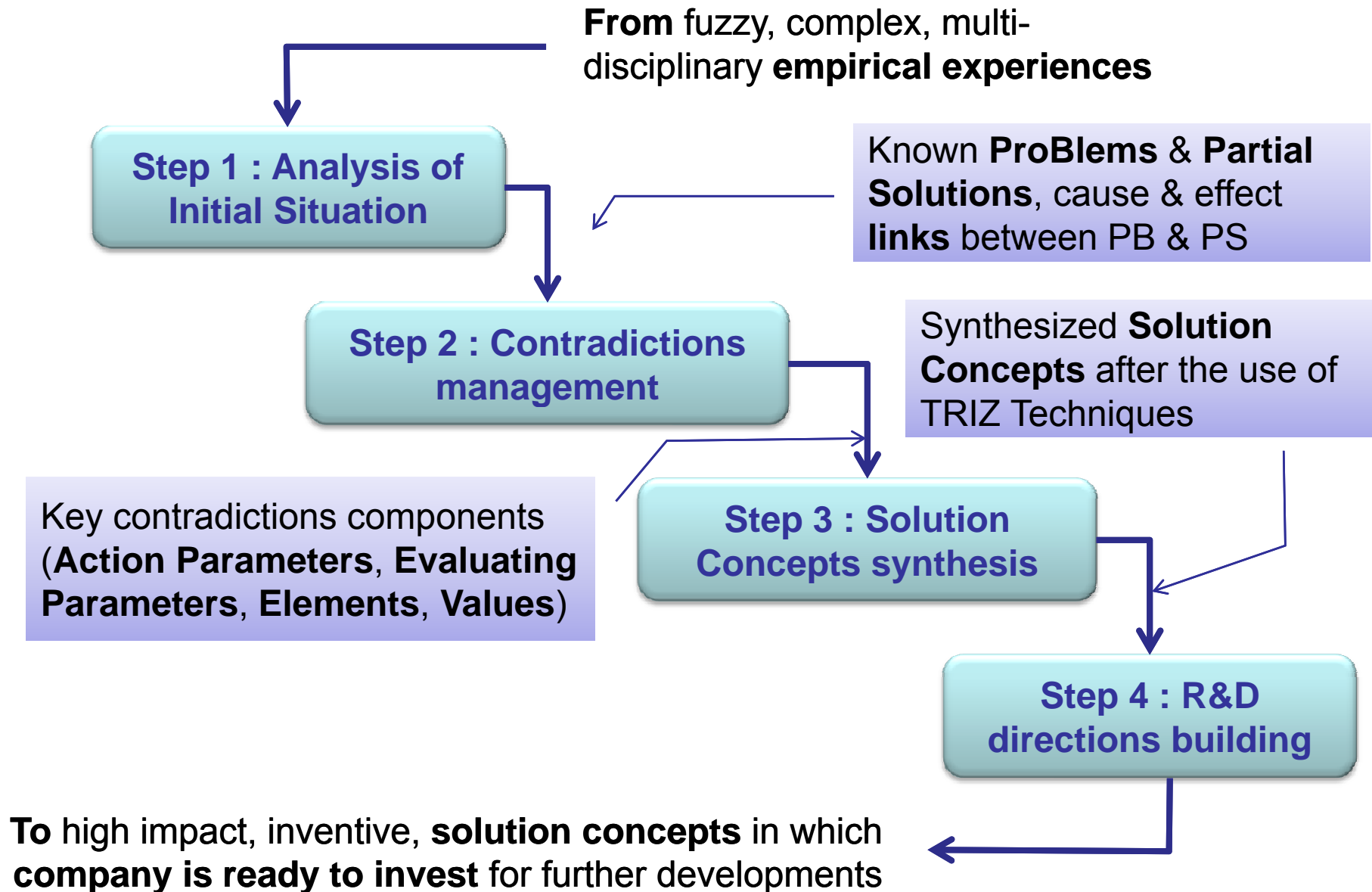
## TRIZ Consortium's fundamentals and the way its is ruled:

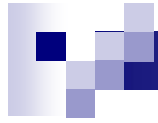
-  Partners are not competitors with other Consortium members
-  Partners are sharing common interests regarding Design, R&D and Innovation, TRIZ
-  Partners are sharing common interests regarding Life Long Training and Benchmarking
-  Partners are sharing common interests regarding Computer support tools
-  Partners are sharing common interests regarding the development of new methods
-  Partners are engaging to share with others on these questions

## The Consortium has identified 4 necessary work packages :

-  *WP1: Education* (to teach companies individuals, accompany their growth in expertise);
-  *WP2: Expertise* (to provide experts to assist Case Studies management);
-  *WP3: Impact* (to understand, analyze and think practices evolutions);
-  *WP4: Methods & Tools* (to build methodologies of action, Software demonstrators to assist expert practices).







# Overview of Inventive Design Method Major Stages





***Computer assistance  
to Inventive Design  
practices***



TRIZ-related softwares	Axiom 1 (laws)	Axiom 2 (contradiction)	Links A1 → A2	Strong point	Points of improvement
	List + examples	∅	∅	Web usage and internal database	Divergent process, methodological heaviness
	Just list (+hidden with other operators)	Tacit via graphical model	∅	Problem formulation	Divergent process, lack of mastering experts usage
	List + examples	∅	∅	Ergonomy of interface + attempts of patents usage	Divergent process, better for simple cases
* 	List + examples	Didactical explanation	∅	Rigorous learning interface (Classical TRIZ way)	Advanced research beyond TRIZ?
	List + examples	Didactical explanation	∅	Structure of TRIZ contents presentation	Need of an expert (E-book like)
	List	∅	∅	Originality of scientific effects usage	Low structuration of problem formulation and understanding

\* For Iwin software, we only have demo and website info, so as meeting with M. Duan in 2005 in Shangai)

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

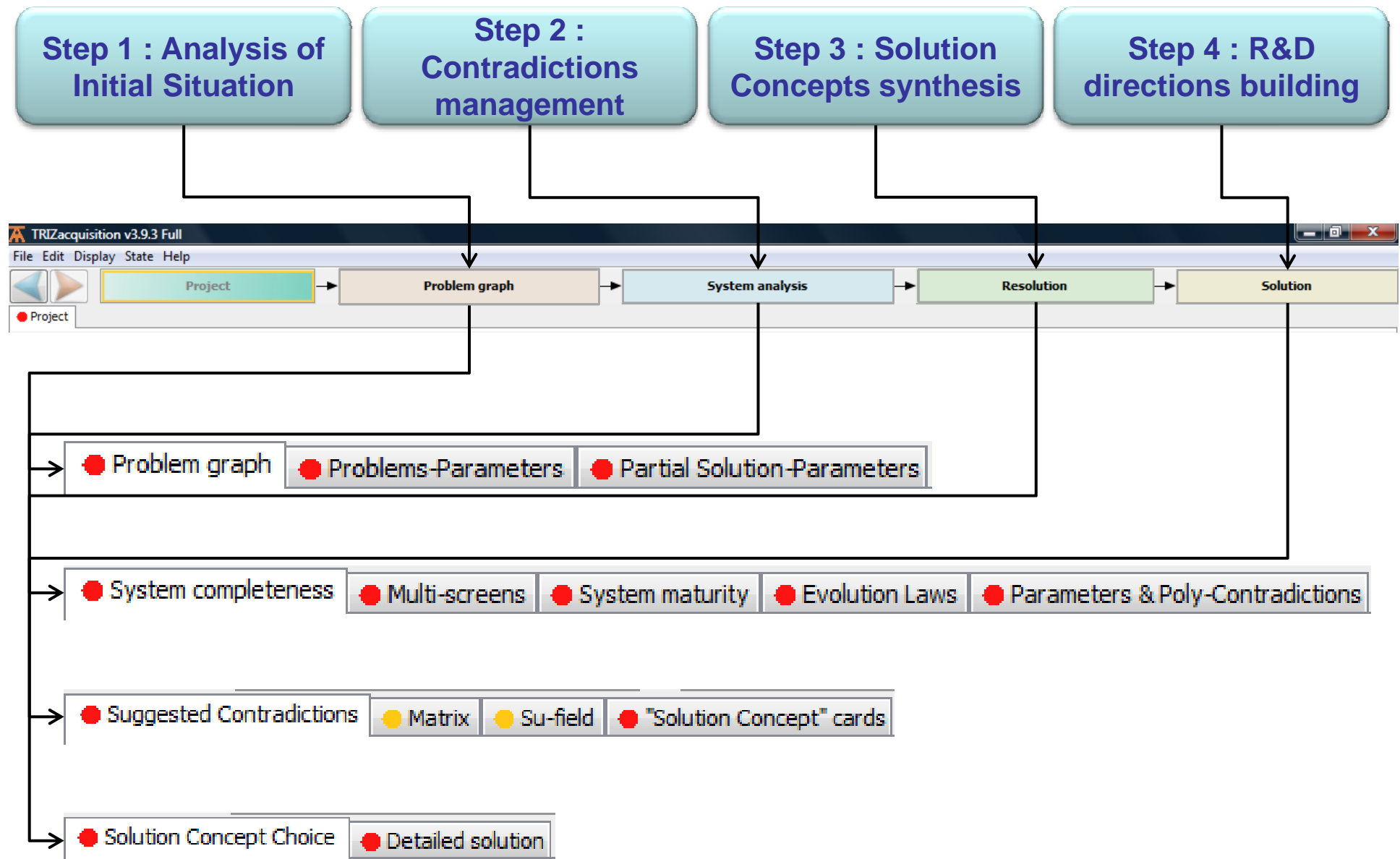
- To assist the animator in conducting inventive activities (to structure, to organize study data's);
- To relieve users of tedious tasks;
- To ensure minimal (robustness) consistency of the approach;
- To permit the sharing of practices inside a community;
- To install a spiral of constant evolution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

## TRIZAcquisition project :

- Is based on a research cooperation plan between researchers and industrials;
- Researchers are from engineering Design Science, Artificial Intelligence and Computer science;
- Industrials are EADS, ArcelorMittal, Alstom;
- At present stage, TRIZAcq is a functional prototype to be distributed on a wider scale;
- The goal of INSA is NOT to commercialize TRIZAcq but to pursue its scientific development in close cooperation with its users.

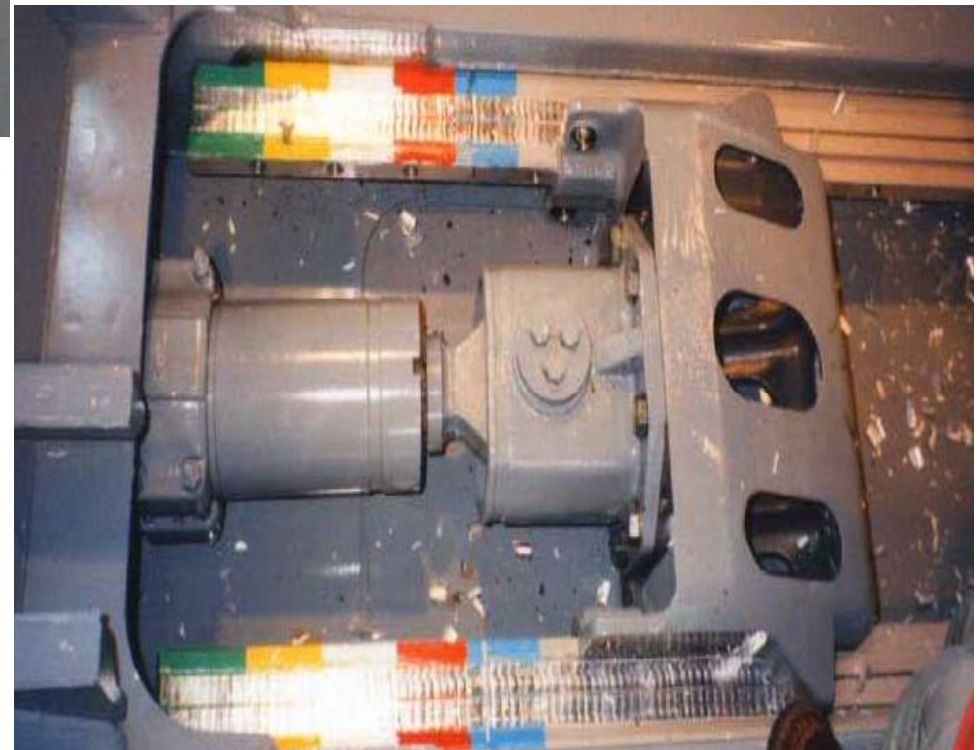
For any further detail, please contact Simon Fuhlhaber ([simon.fuhlhaber@insa-strasbourg.fr](mailto:simon.fuhlhaber@insa-strasbourg.fr)) responsible for the development of TRIZAcquisition

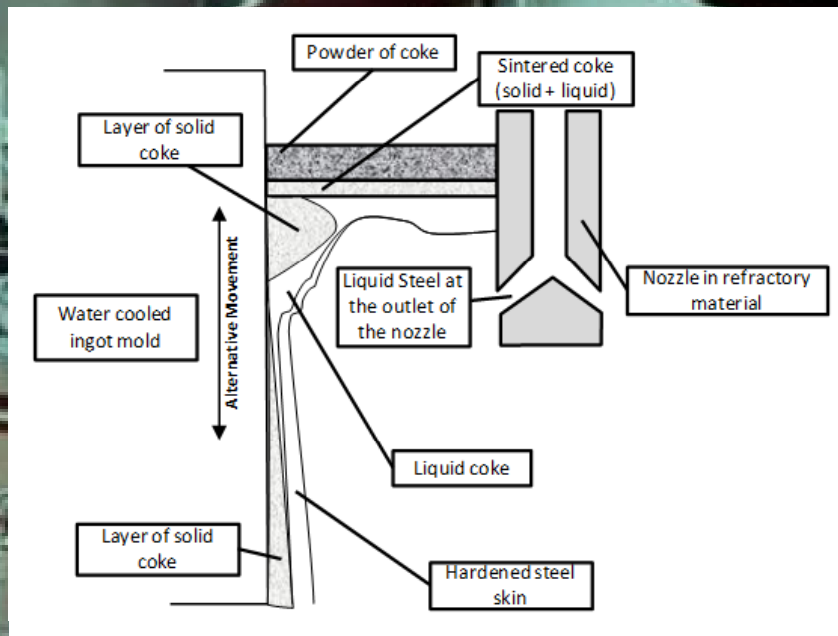
# Software assistance for IDM studies



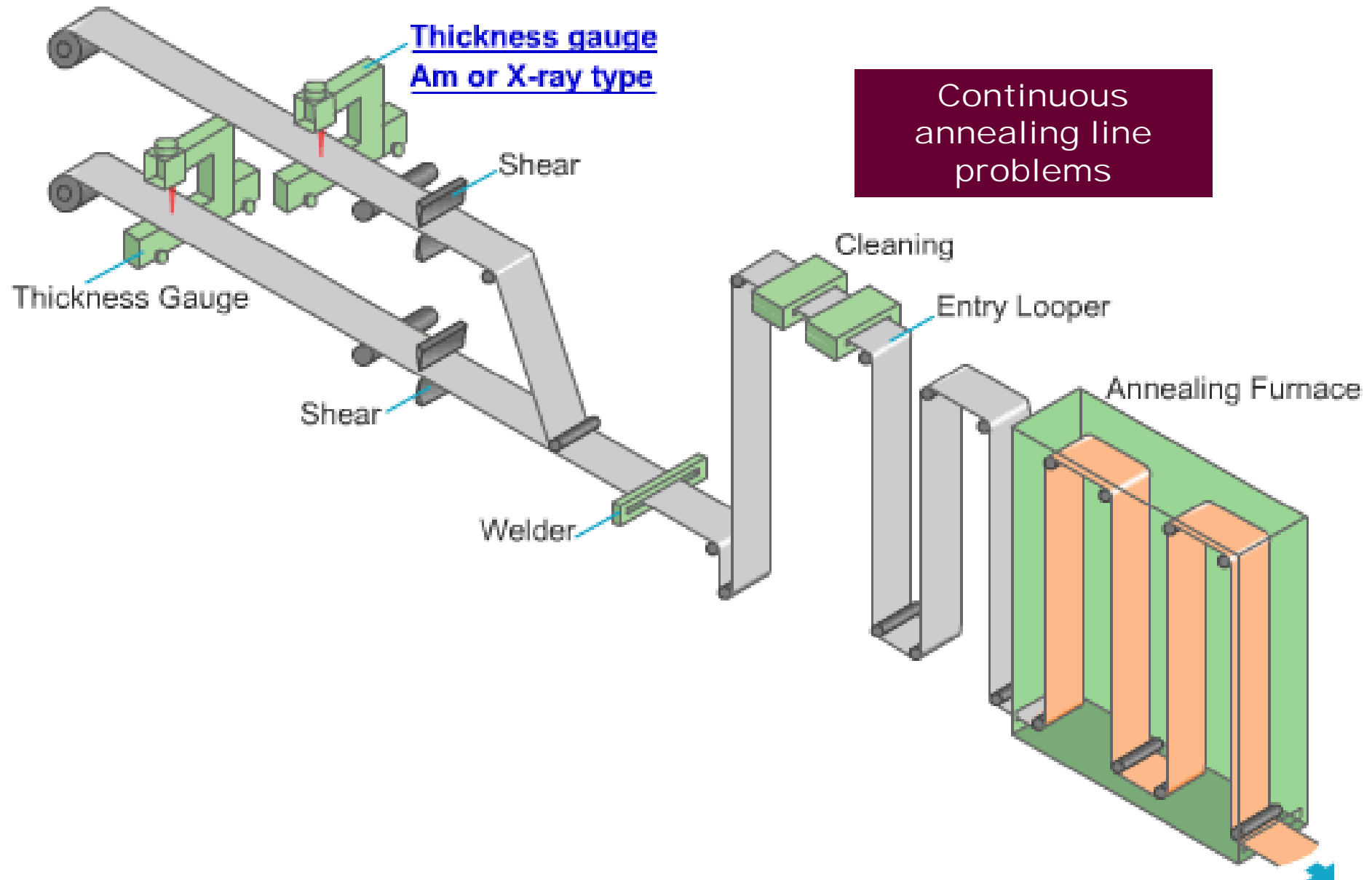


Crash retention  
in High speed trains

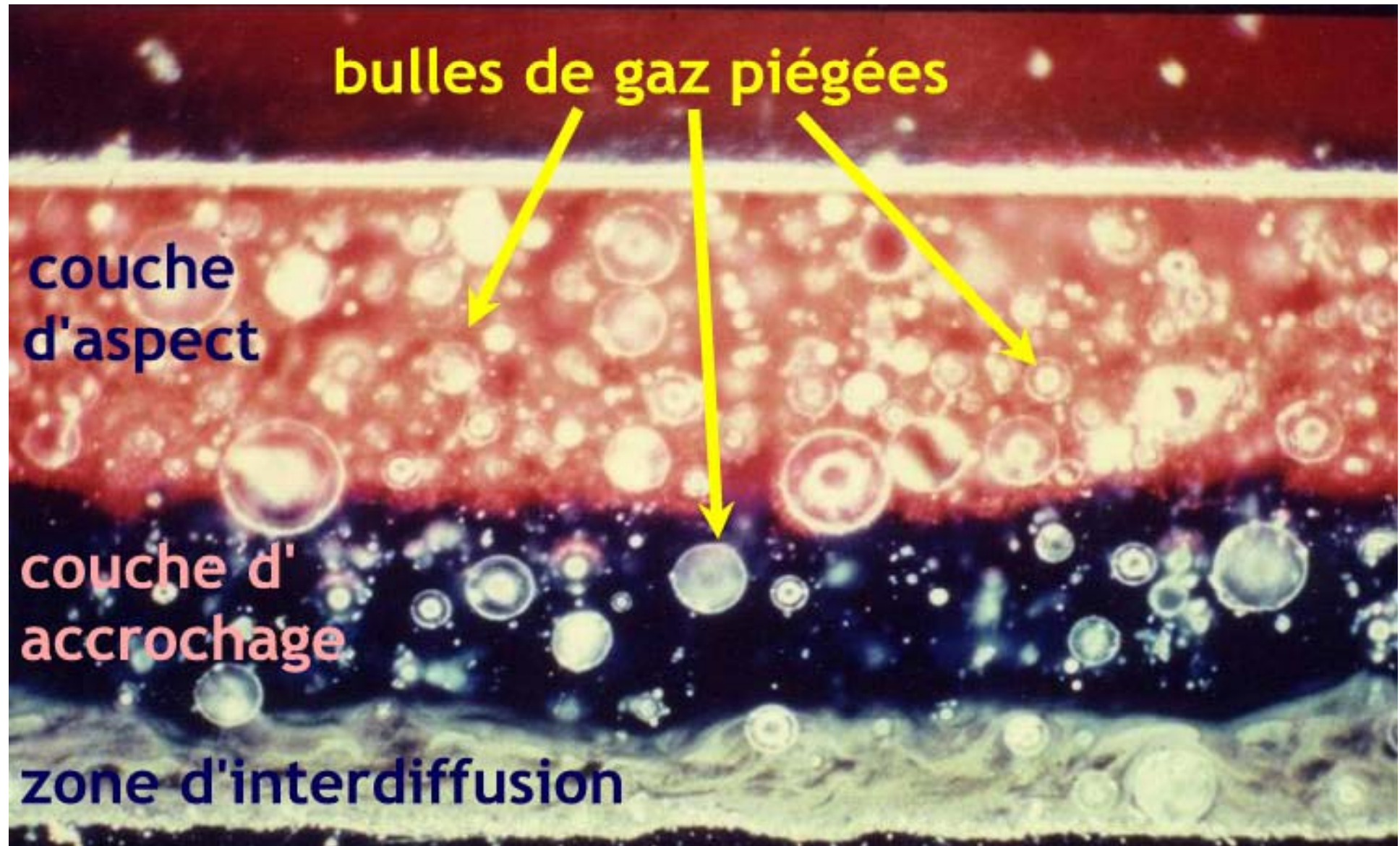




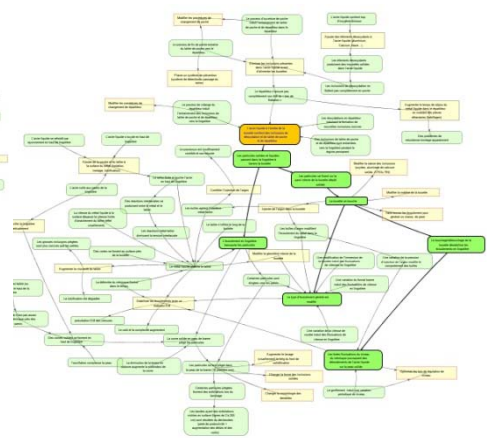
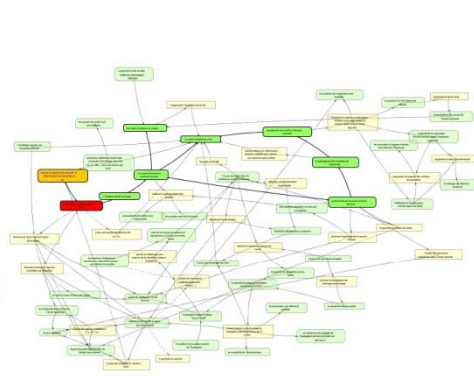
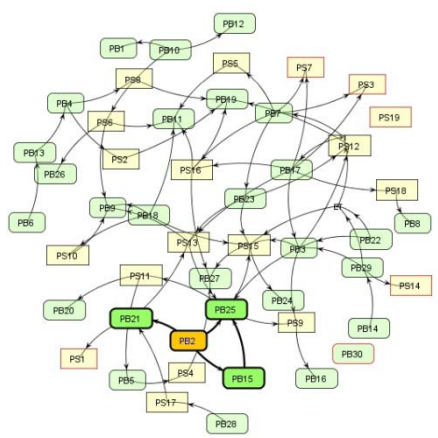
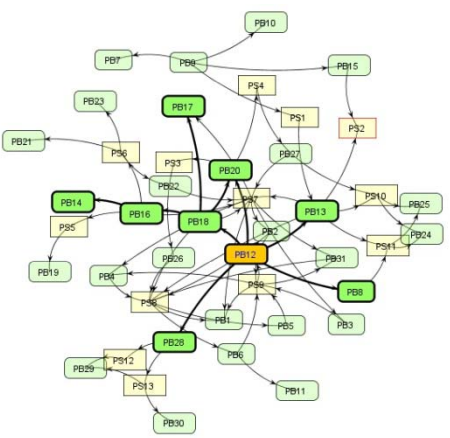
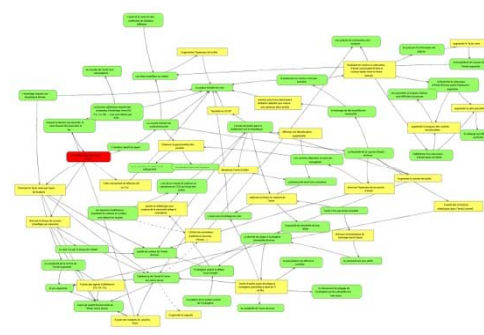
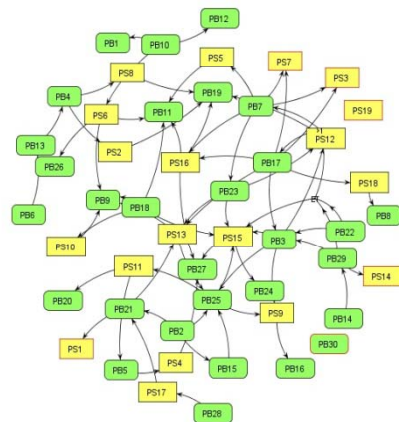
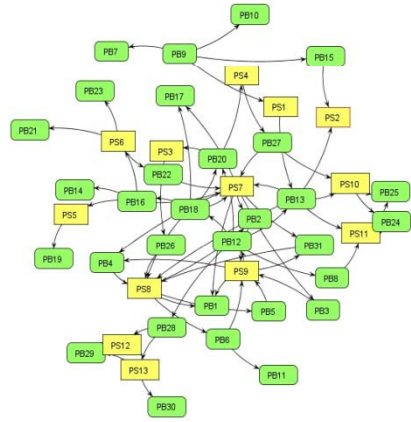
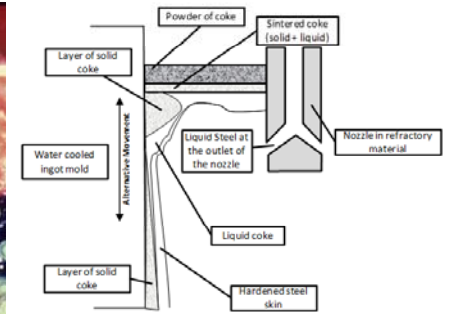
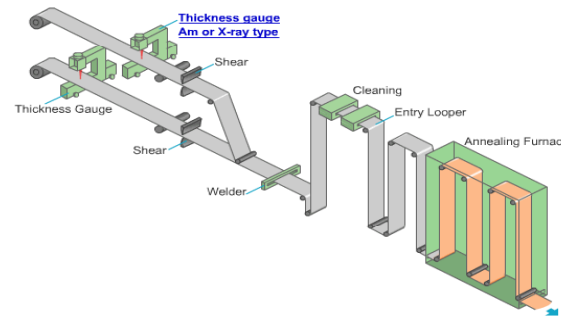
Slivers Defects in steel casting

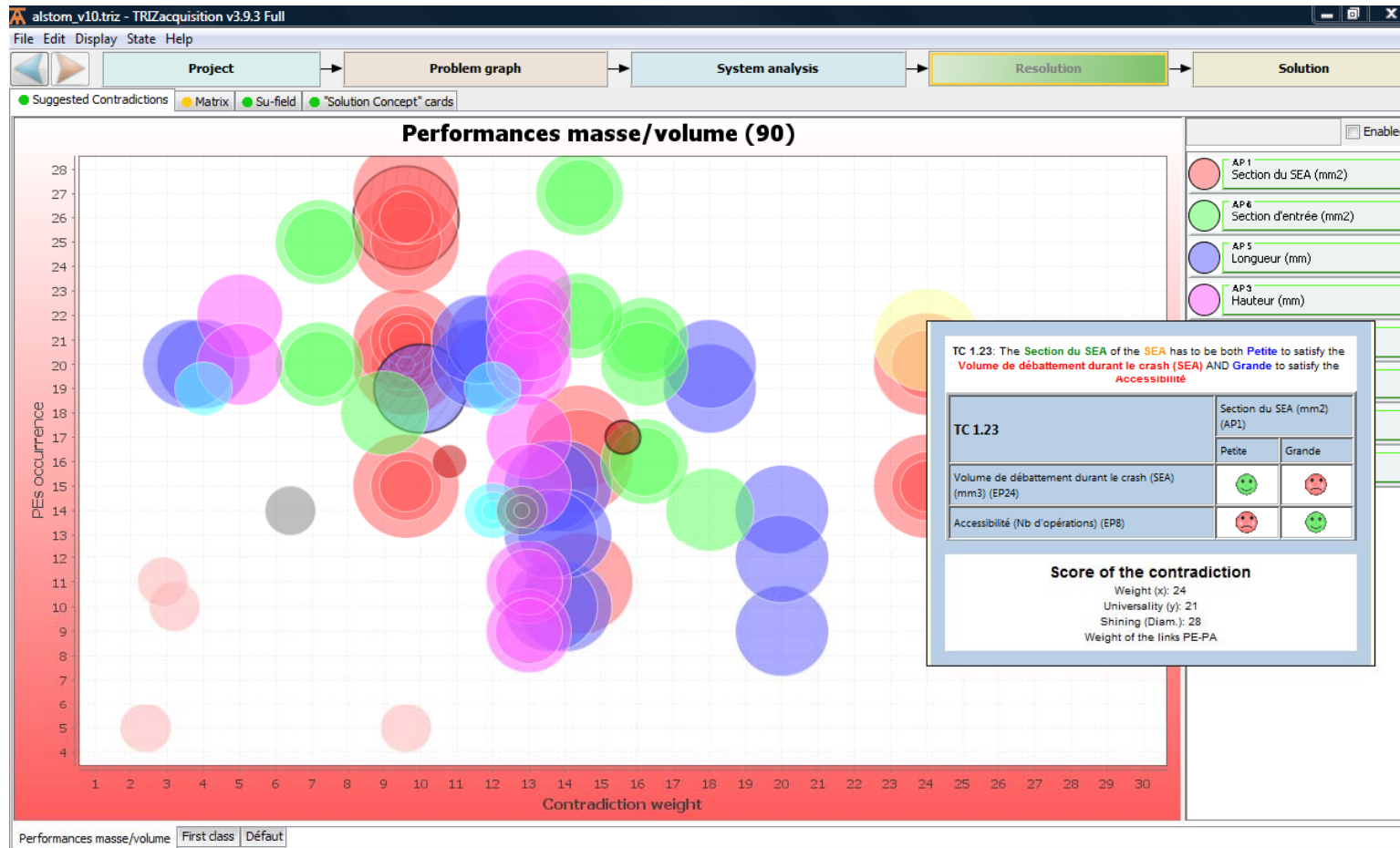
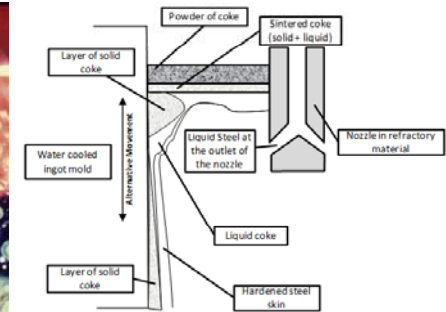
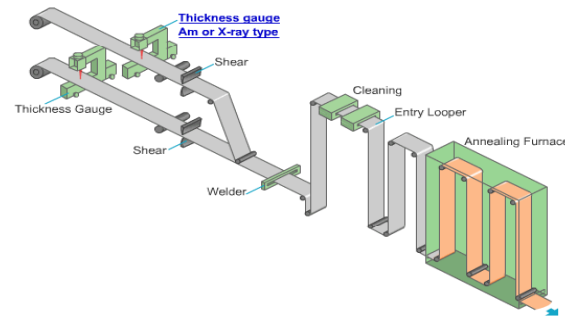


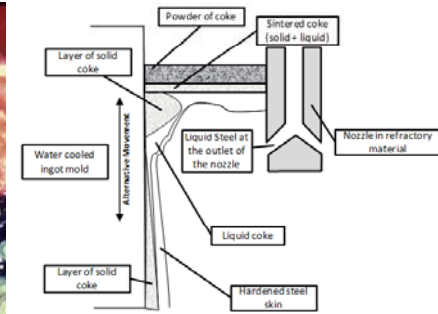
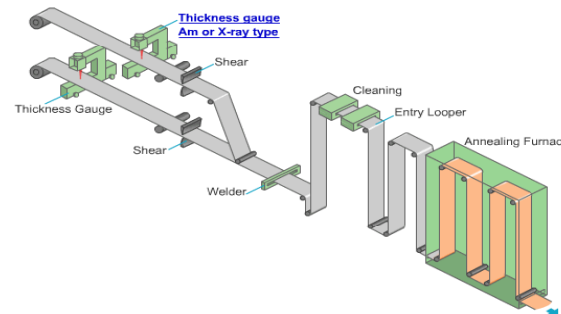
## Thickness reduction in steel enameling technology











**Principles**

Principle	Percentage
1. Length of moving object	25%
2. Length of stationary object	20%
3. Length of moving object	16%
4. Length of stationary object	16%
5. Length of moving object	10%
6. Length of stationary object	7%

**Contradictions**

TC 5.10: The Length of the  $L_2$  SEA has to be both **Petit** to satisfy the **Conductibilité énergétique** AND **Grande** to satisfy the **Conductibilité de la partie non-effilée** (SC) (SPS)

**Standards**

- 1.1 Synthesis and decomposition of the SPMs
  - 1.1.1 Synthesis of SPMs
    - 1.1.1.1 Transition to External Complex SPM
    - 1.1.1.2 Transition to External Complex SPM
    - 1.1.1.3 Transition to SPM by using external environment
    - 1.1.1.4 Transition to SPM by using external environment
    - 1.1.1.5 Minimum mode of action
    - 1.1.1.6 Selective minimum mode
  - 1.1.2 Decomposition of SPMs
    - 1.1.2.1 Elimination of harmful interaction by modification
    - 1.1.2.2 Elimination of harmful interaction by modification
    - 1.1.2.3 Elimination of harmful interaction by modification

**Principe**

15. Periodic action

a) Instead continuous action use pulse actions.  
b) Vary periodically according the conditions.  
c) Use pieces between impulses to perform some other action.

**Code**

SC 1.1.2.1.3 Chassis utile au guidage

**Law**

Law	Law	Law
Ingrédients des parties	Conductibilité énergétique	Idealité

**Hypothesis(x)**

**Contradiction**

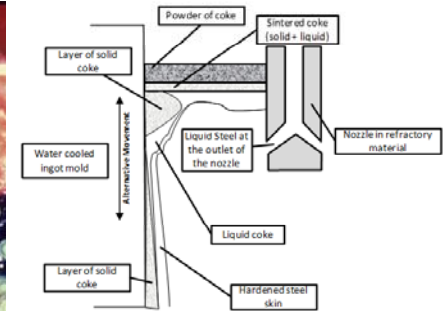
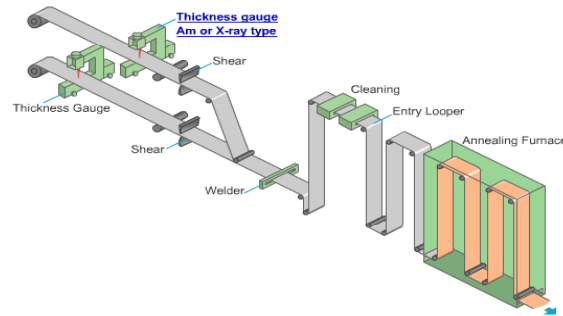
TC 1.1: The Section du SEA of the  $10^3$  has to be both **Petit** to satisfy the **Temps des cycles de fabrication** AND **Grande** to satisfy the **Conductibilité de renouveau**

**Principe**

15. Periodic action

a) Instead continuous action use pulse actions.  
b) Vary periodically according the conditions.  
c) Use pieces between impulses to perform some other action.

**Sketch**



alstom\_v10.triz - TRIZacquisition v3.9.3 Full

File Edit Display State Help

Project → Problem graph → System analysis → Resolution → Solution

● Solution Concept Choice   ● Detailed solution

Minimum weight of the problems (31): [Slider 0-5]

Minimum weight of the EPs (18): [Slider 0-10]

EXP 1 Patrick Generate Import  
EXP 2 Pierre Generate Import  
EXP 3 Dominique Generate Import  
EXP 4 Guillaume Generate Import

Scenario: Performances masse/volume

Graph of impacts (selected) / Problem graph / Actualize / Impact/Source / Display all the elements

Graph



***Conclusions  
&  
Debate***

# Conclusions

## Impacts on R&D teams practices:

- Confidence in the problem space coverage  
*(all known angles for problem description are investigated)*
- Openness to unknown solutions  
*(while conscious that Conventional Design has reached its limits)*
- Robustness/traceability of built arguments when discussing with hierarchy  
*(a better capacity to justify budget, expenses, R&D choices)*

## Limits :

- Time of problem statement, data gathering  
*(still not conventional in enterprises)*
- Ensuring exhaustively contradictions gathering of a given domain  
*(still expert dependent, depending on known facts)*
- Speaking a common language, including in our relation with management  
*(necessity to rapidly convince to work further)*

## Future research directions :

- Assisting experts analyses with data/text mining procedures ;
- Teaching new research results to engineers and observe the impact of their practices evolution ;
- Continuing to formalize the whole process and test it in organizations.