POLITECNICO DI MILANO

SARDEGNA RICERCHE

TRIZ
Le potenzialità di un approccio sistematico all'innovazione: ingegnerizzare la creatività

Gaetano Cascini
gaetano.cascini@polimi.it

Gaetano Cascini – short resume

- 1999 : PhD in Machine Design – First acquaintance with TRIZ
- 1999 – 2008 : Assistant Professor at University of Florence
- 2008 – now : Associate Professor at Politecnico di Milano

- Past:
  - 2003-2005 : Founder and first President of Apeiron, the Italian TRIZ Association
  - 2005-2009 : Founder and Vice-Chair of the IFIP 5.4 Working Group (Computer-Aided Innovation)
  - 2006-2009 : President of the European TRIZ Association (ETRIA)
- Currently:
  - Coordinator of the Marie Curie Project IAPP (PIAP-GA-2011-286305): FORMAT (FOrecast and Roadmapping for MAnufacturing Technologies).
  - Member of the Editorial Board of the Journal of Integrated Design & Process Science.
  - Member of the Editorial Advisory Board of the Int. Journal of Design Creativity and Innovation.
  - Member of the ETRIA Executive Board
  - Chair of the "Computer-Aided Innovation" WG and Publications and Events Officer of the TC-5 Committee (Computer Applications in Technology) of IFIP (International Federation for Information Processing)
  - Author of 100+ papers presented at International Conferences and published in authoritative Journals
  - Author of 10 patents (assignees University of Florence, Whirlpool Europe, Bracco Imaging, Logli, SCAM, Meccaniche Fiorentine, Otlav/Politecnico di Milano)

Fondazione Politecnico di Milano

INNOVAZIONE SISTEMATICA

Centro di Competenza per l'Innovazione Sistematica

- **Training and coaching in industry:**
  - ABB SACE – 3 case studies + Training & Coaching
  - Alenia Aermacchi – Training & Coaching
  - Alluflon – Moneta – Training & Coaching
  - Bracco Imaging – 1 pilot project (3 Patent Applications)
  - Coster Group – Training
  - Electrolux Professional – Training & Coaching
  - Enel – Training
  - Esaote - Training
  - Intertaba Philip Morris – Training
  - Intier Motrol - Training
  - John Bean Technologies – Training
  - Krona Koblenz – Training & Coaching
  - Micron – Training & Coaching
  - Procomac – Training & Coaching + 1 Technology Forecasting
  - SACMI – Training & Coaching
  - Samsung - Advanced Training + Keynote presentation
  - Tecniplast – Advanced Training & Coaching
  - Whirlpool – 1 pilot project (1 Patent)
  - Zoppas Industries – Training

Innovazione Sistematica
www.innovazionesistematica.it

Obiettivi & Programma

- Goal:
  - Condividere le potenzialità di un approccio sistematico all'innovazione
  - Venire a conoscenza dell'esistenza di metodi efficaci per sistematizzare il problem solving inventivo
- Program:
  - Contesto: Perché un metodo per l'innovazione
  - Ostacoli: Cosa frena l'attività inventiva
  - Metodi: Come rendere sistematica la generazione di soluzioni inventive
  - Impatto: Best practice di innovazione sistematica nell'industria

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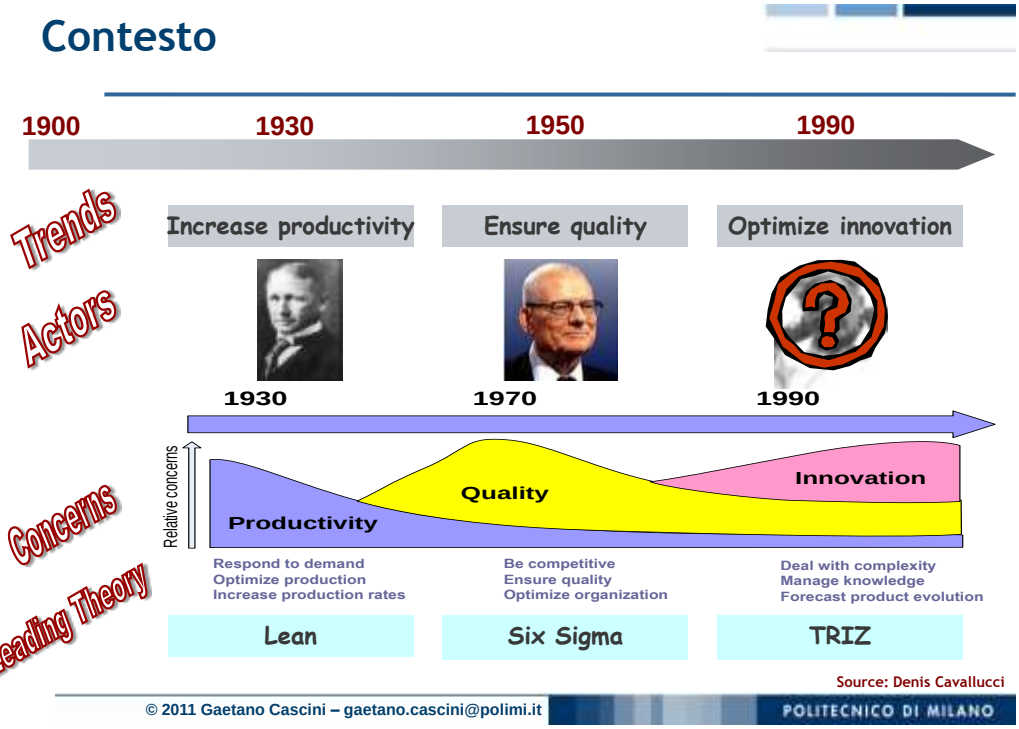
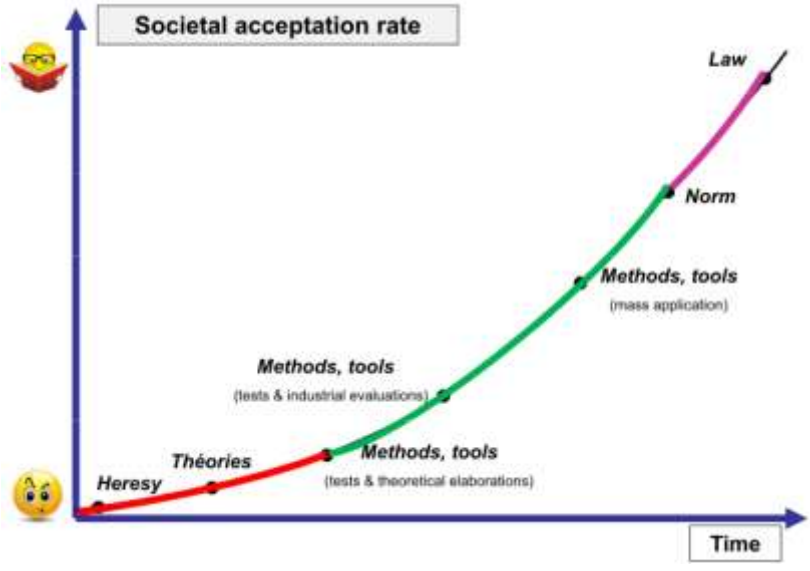
Contesto:
Perché un metodo per l'innovazione

Contesto



Source: Denis Cavallucci

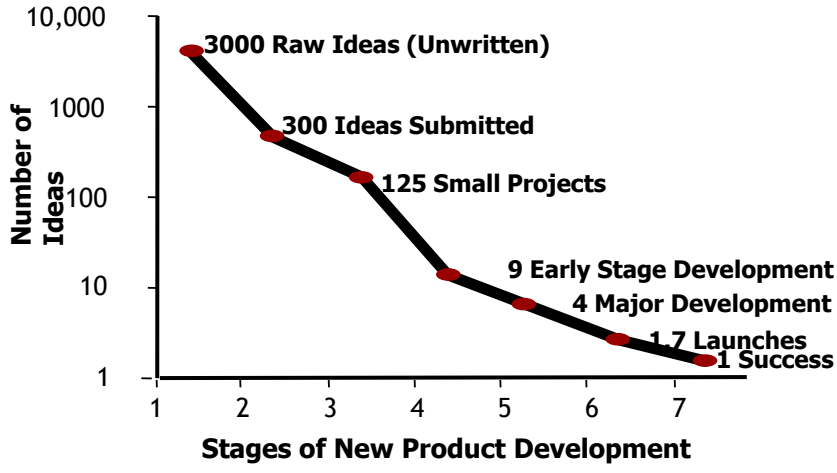
Contesto: teorie e società



Source: Denis Cavallucci

Cosa c'è dietro ogni innovazione che arriva sul mercato?

- "From raw ideas to success products"

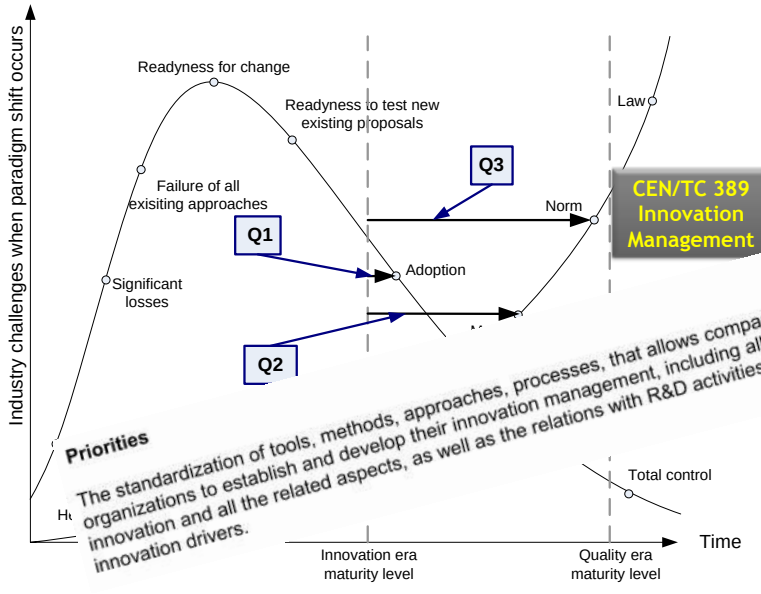


Source: G. Stevens and J. Burley, "3000 Raw Ideas = 1 Commercial Success!" *Research•Technology Management*, 40(3): 16-27, May-June, 1997.

Innovation Background

- Wasting time to solve useless problems

Contesto: teorie e società



Q1: What research will favour the adoption of a paradigm change related to innovation in industry?

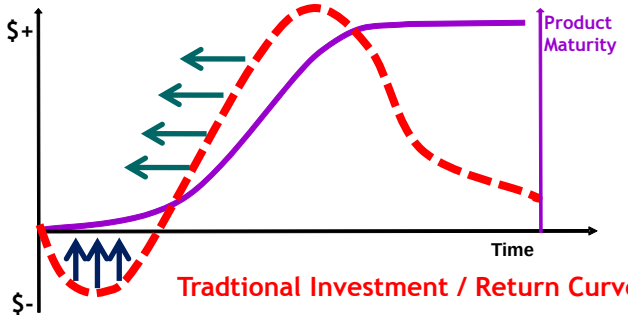
Q2: What research, leading to mass ar… …ation of new and tools in try, is to be … in the age …novation?

…hat research, …eading to legitimated measurement means, is to be conducted to provide support for industry progresses?

Source: Denis Cavallucci

Innovazione: Obiettivi e Ostacoli

- Incrementare l'efficienza dei processi di innovazione
  - Ridurre o eliminare lo spreco di risorse (tempo, soldi…) in inutili trial and error
  - Meglio un'idea che funziona di tante idee ancora da verificare
  - Per affrontare la complessità ci vuole metodo



Tradtional Investment / Return Curve

- Ostacoli:
  1. Inerzia psicologica
  2. Trial & Error: mancanza di un approccio strutturato
  3. Decisioni e compromessi

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Ostacoli:
Cosa frena l'attività inventiva

Obstacle 1

Psychological Inertia

- Which is the minimum size of a CD player?

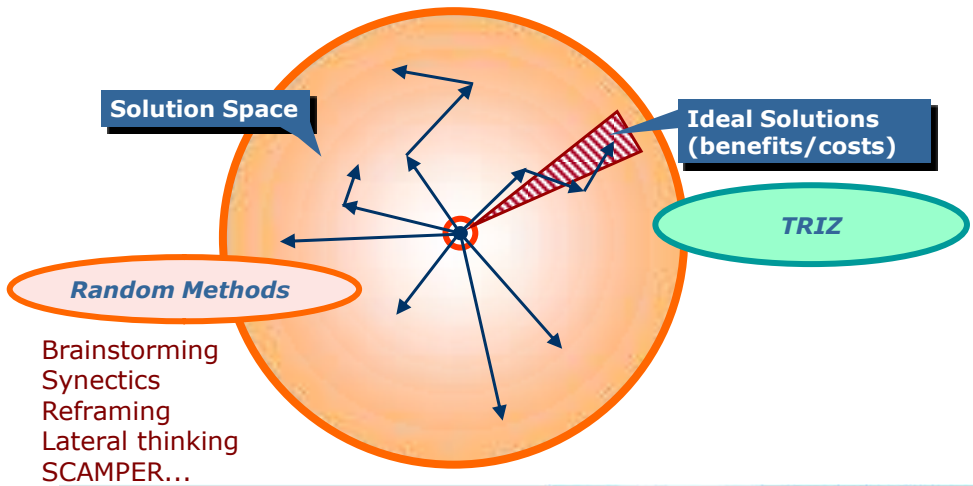
- Which is the minimum size of a A4 printer?

Obstacle 1

Inerzia Psicologica ➔ Trial & Error

"You've got to kiss a lot of frogs before you find your princess..."

"It is difficult to find a black cat in a dark room especially when the cat is not there."



Obstacle 2

Mancanza di un approccio strutturato: non sempre

Scuole elementari

Problema: Come dividere 50 ciliegie fra 3 bambini?

Obstacle 2

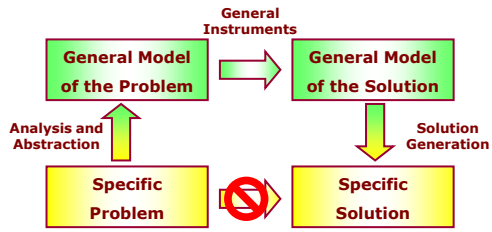
Mancanza di un approccio strutturato: non sempre

Typo di Problema: aritmetico

Modello del problema: 50:3

Strumento: divisione

Modello di soluzione: 16,666…



Soluzione:
Si distribuiscono 16 ciliegie a ciascun bambino

Obstacle 2

19

Mancanza di un approccio strutturato: non sempre

Liceo/Istituto Tecnico:
Cosa succede se si mescolano acido solforico e idrossido di calcio?

Obstacle 2

20

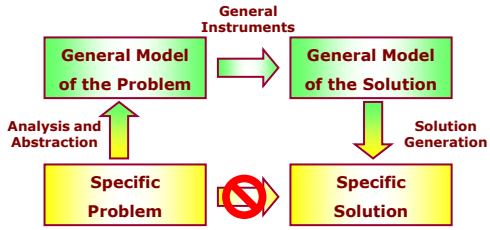
Mancanza di un approccio strutturato: non sempre

Tipo di problema: chimico

Modello del problema: $H_2SO_4 + Ca(OH)_2$

Strumento: leggi di ossido-riduzione

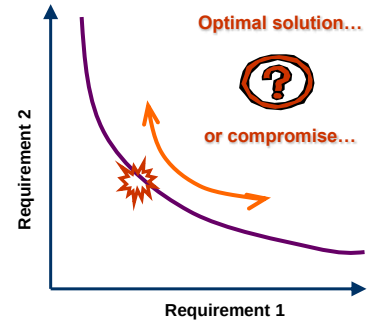
Modello di soluzione: $CaSO_4 + 2\ H_2O$



Risposta:
Solfato di Calcio e Acqua

Obstacle 3

Decisioni e compromessi



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Metodi:
Come rendere sistematica la generazione di soluzioni inventive

Теория Решения Изобретательских Задач
Theory of Inventive Problem Solving

Genrich Altshuller
(1926-1998)

Analysis of hundreds of thousands inventive solutions

- 99% of inventions use already known solution principle
- Less than 1% are really pioneering inventions
- Breakthrough solutions emerge from resolving contradictions
- Inventors and strong thinkers use patterns
- Creative problem solving patterns are universal
- Creative ideas can be produced in a systematic way

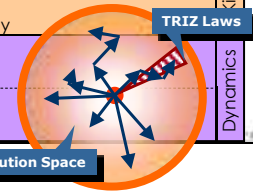
Теория Решения Изобретательских Задач
Theory of Inventive Problem Solving

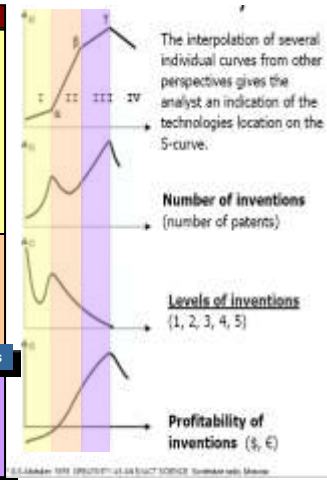
- The architecture of TRIZ is based on:
  - Three Postulates:
    - Postulate of Objective Laws of Systems Evolution
    - Postulate of Contradiction
    - Postulate of Specific Situation
  - Main models:
    - Models of the problem solving process
      - *Hill model (abstraction-embodiment)*
      - *Tongs model (from current situation to ideality, barriers identification)*
      - *Funnel model*
    - Description of systems, problems, solutions
      - *ENV model*
      - *Model of function*
      - *Substance-Field Model*
      - *Model of contradiction*
    - "System operator" (multi-screen approach)
      - *Round about problems*
      - *Resources search*
  - Instruments:
    - ARIZ (Algorithm of Inventive Problem Solving), main instrument of Classical TRIZ for Non-Typical Problems, which integrate all others TRIZ instruments
    - System of Inventive Standard Solutions
    - Pointers to Physical, Chemical, Geometrical Effects

Postulate 1

Laws of Engineering Systems Evolution

Laws of Technical System Evolution		
1	Law of System Completeness Corollary: Controllability Trend of elimination of human involvement from systems Trend of increasing dynamicity	Static
2	Law of "energy conductivity" of a system	
3	Law of harmonizing the rhythms of parts of the system	
4	Law of increasing ideality	Kinematics
5	Law of uneven development of the parts of a system	
6	Law of transition to a super-system Trend Mono-Bi-Poly	
7	Law of Transition from macro to micro level	Dynamics
8	Law of increasing Su-Field inyteractions	



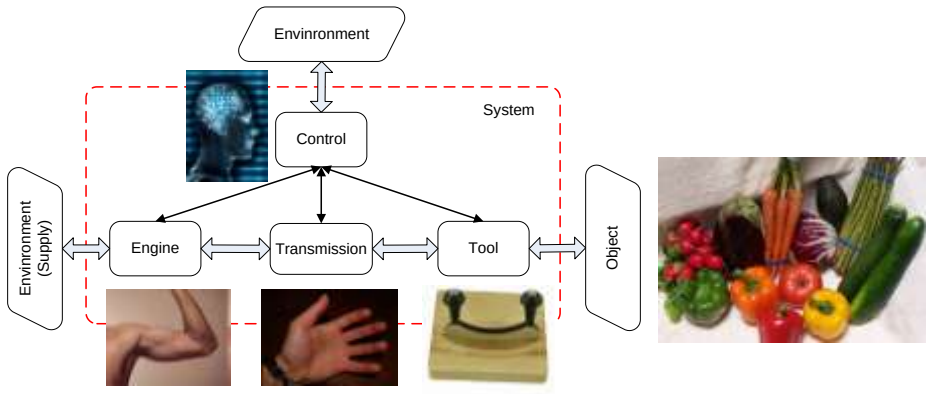


- Conclusions for practice:
  - Good solutions are developed in accordance with the objective laws of system evolution

Postulate 1

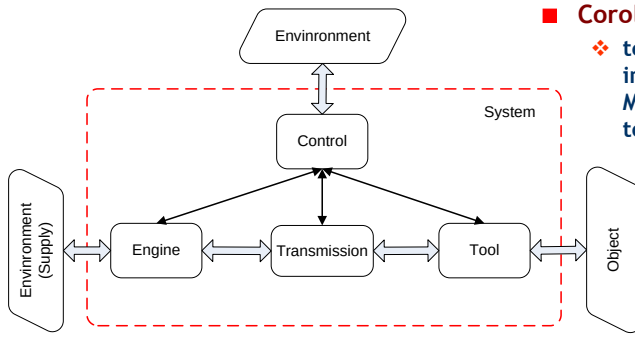
1. Law of System Completeness

In order to deliver its function, a Technical System must include, internally or externally (e.g., through the contribution of a human operator), four elements:
- a Tool, which is the working element delivering the function of the TS, i.e., exerting a certain effect on its object;
- an Engine, i.e., the element providing the energy necessary to produce the expected effect of the function;
- a Transmission, i.e., the element transmitting energy from the Engine to the Tool;
- a Control, i.e., an element governing at least one of the previous elements.

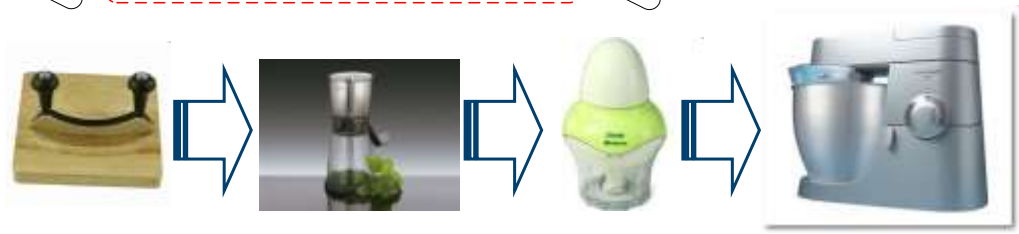


Postulate 1

1. Law of System Completeness (corollary)

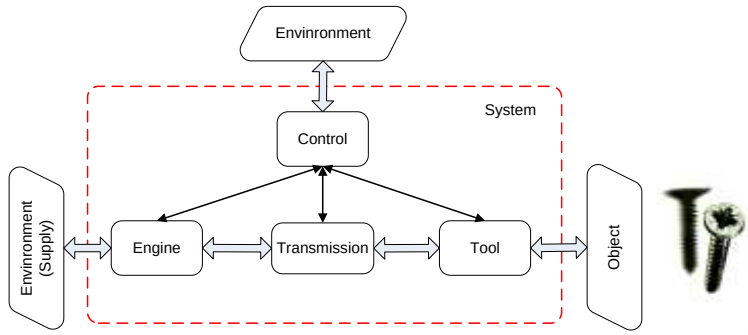


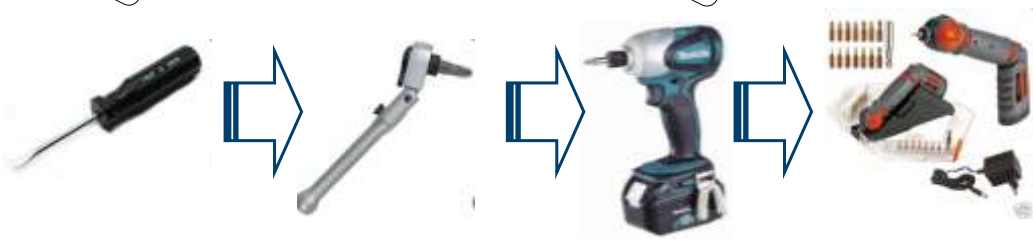
- **Corollary:**
  - technical systems evolve by integrating all the elements of the Minimal Technical System in order to reduce human involvement



Postulate 1

1. Law of System Completeness (corollary)

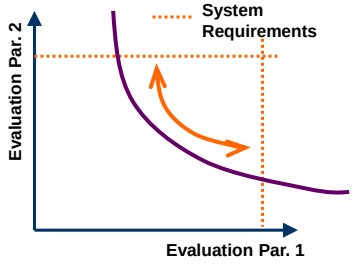


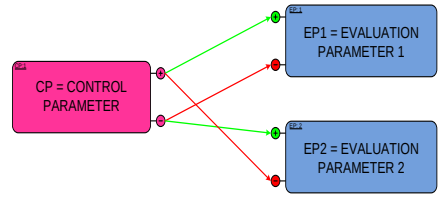


Postulate 2

Contradictions

- System evolution implies the resolution of contradictions, i.e. **conflicts** between a system and its environment or between the components of the system itself





- Conclusions for practice:
  - To solve a problem we should first discover underlying contradictions
  - To achieve maximum benefits, contradictions should be resolved, not compromised
  - Overcoming contradictions is a driving force behind technology evolution. Resolving contradictions instead of compromising or optimizing, results in breakthrough solutions

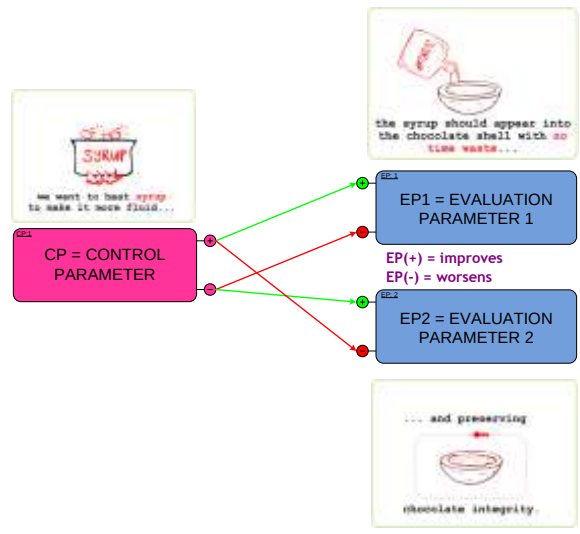
Postulate 2

Contradictions

Contradictions

"Technical" Contd:
TC1: EP1(+) - EP2(-)
TC2: EP2(+) - EP1(-)

"Physical" Contd:
CP = V ➔ EP1(+) - EP2(-)
CP = anti-V ➔ EP1(+) - EP2(-)



Postulate 2

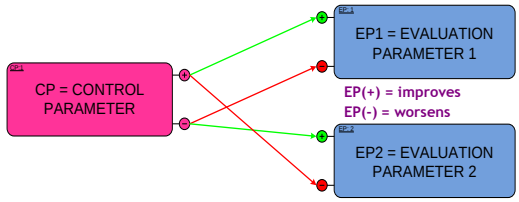
Contradictions

Contradictions

"Technical" Contd:
TC1: EP1(+) - EP2(-)
TC2: EP2(+) - EP1(-)

"Physical" Contd:
CP = V ➔ EP1(+) - EP2(-)
CP = anti-V ➔ EP1(+) - EP2(-)

Problems from different domains, sharing the same contradiction, can be solved by means of the same solving principles



tetris "Creativity is not a born gift. Every engineer can learn to be inventive."

http://www.tetris-project.org/

- 5 Animations
  - TRIZ History
  - Nina @ school/university/work
  - Theory of Inventive Problem Solving
- Handbook
  1. Introduction(s)
  2. Laws of Engineering Systems Evolution
  3. Algorithm of Inventive Problem Solving
  4. Su-Field Analysis and System of Inventive Standards
  5. Tools and Principles for solving contradictions
  - Appendix (Step-by-step solved problems)

Lifelong Learning Programme

Freely accessible animations in English, French, German, Italian, Latvian, Chinese, Spanish, Russian, Japanese, Romanian, Korean, Farsi (Iranian)

Freely accessible educational materials in English, French, German, Italian, Latvian

Structure

- Definition: short definition of the selected topic (T);
- Theory: theoretical aspects related to T;
- Model: conceptual model and graphical representation of T;
- Method/Tool: operative instructions about how to use/implement T;
- Example: exemplary application of T;
- Self-Assessment: exercises to assess the reader's level of understanding about T;
- References: further readings about T.

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Impatto:
Best practice di innovazione sistematica nell'industria

TRIZ Applications

- Fields
  - Product development
  - Industrial research
  - Scientific research
  - Industrial strategy
  - Non technical applications…
- Target:
  - Products
  - Processes
  - Services
- Where:
  - Big companies
  - Small and Medium Enterprises
  - University

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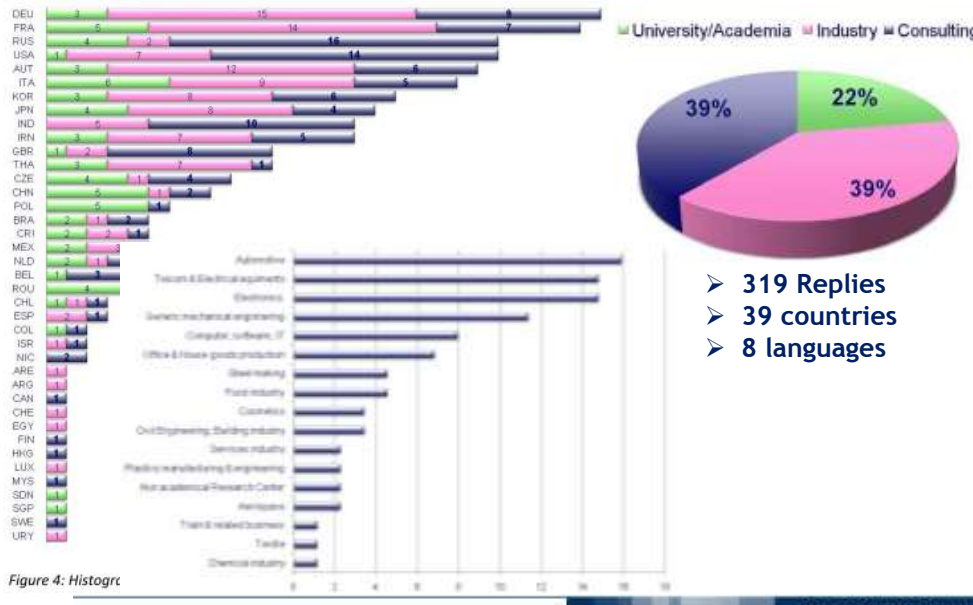
INNOVAZIONE SISTEMATICA

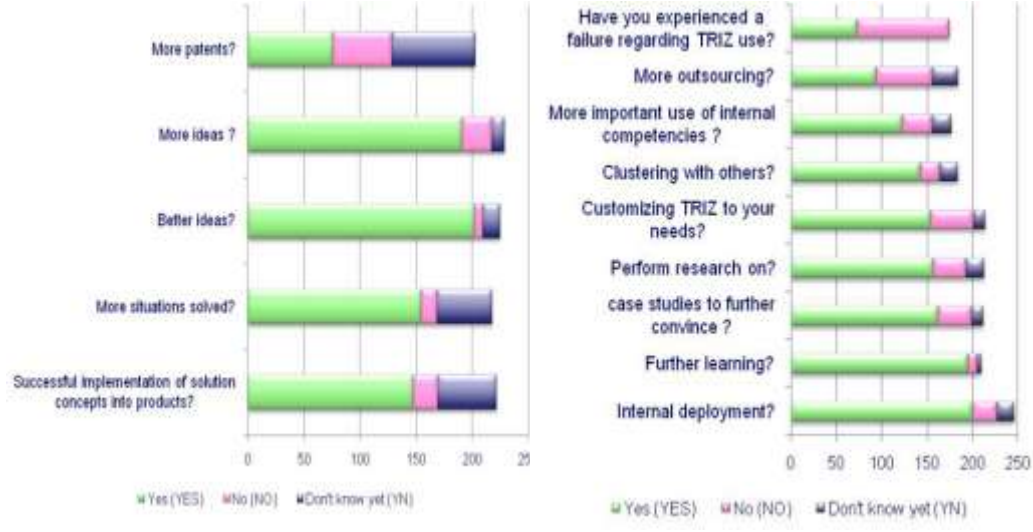
TRIZ Survey by ETRIA (European TRIZ Association)



- 319 Replies
- 39 countries
- 8 languages

Figure 4: Histogr

TRIZ Survey by ETRIA (European TRIZ Association)



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TRIZ in Industry

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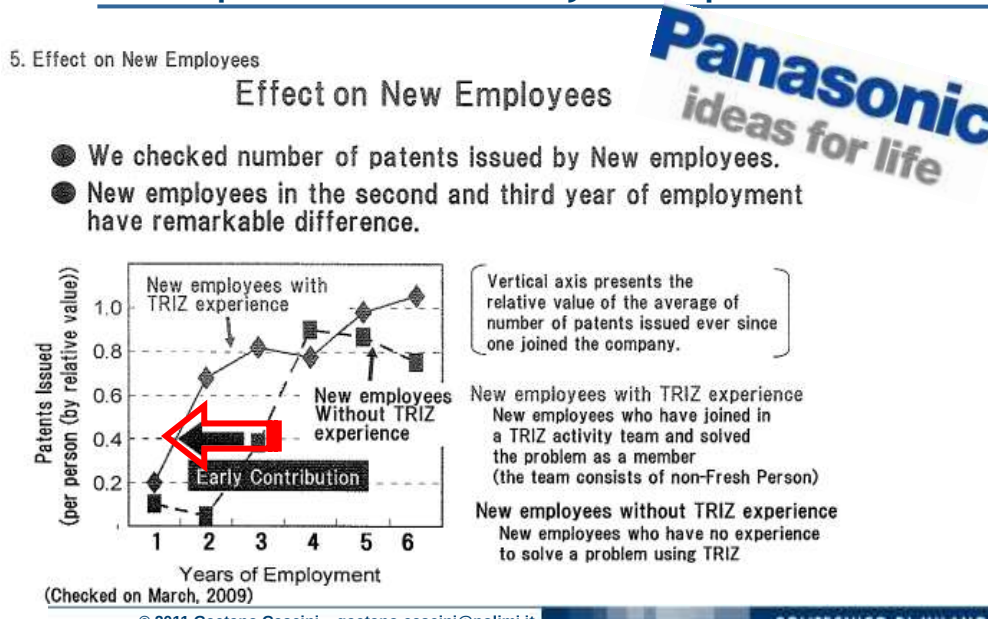
TRIZ Experiences in Industry: examples



TRIZ in Industry

TRIZ at Intel

- 1996-2001 Early exploration stage — Curious early adopters
  - 1996, Santa Clara Technology Development - Began TRIZ software pilot/training. Two very successful projects – "Sputnik" and "Bubbles"
  - 1998 Introduced to Assembly Technology Development and Flash Business
- 2002-2004 Early deployment and seeding in Mfg. — Champion - Evangelist
  - 2002 First TRIZ class in Assembly/Test Mfg. – Cavite, Philippines
  - 2003 First class in Fab/Sort Mfg. – Kiryat Gat, Israel
  - 2004 Classes in more sites (Fab/Sort and Assembly/Test)
- 2005-2006 Adoption – Manufacturing world-wide — Leader - Proliferators
  - 2005 First classes to Level-2 and Level-3
  - 2006 All Level-1, Level-2 classes delivered internally
- 2007-2008
  - Manufacturing expansion
  - R&D Introduction
  - Connectivity with other methods
- 2009 -> into the future
  - Expanding existing use
  - New fields of application
  - Synergy with other methods:
    - Lean, Six-sigma, TOC…

Courtesy Amir Rogel, Intel Principal Engineer

TRIZ in Industry

Key Learning

- If it's a new program with no track record, start with small wins. Need to show that program adds tangible value
- Constant & regular 1/1 with key stake holders is essential
- Networking is essential. It has to start now, not later
- Trust comes with networking and interactions based on proven track record. Programs can move relatively quicker
- Understand factory/customer issues, gear towards needs
- Disciplined follow-up/through: key to ensure sustainability
- Risk taking is a norm as success is not guaranteed
- Persistence is necessary
- Passion is key

Networking, Persistence, Risk taking, Passion

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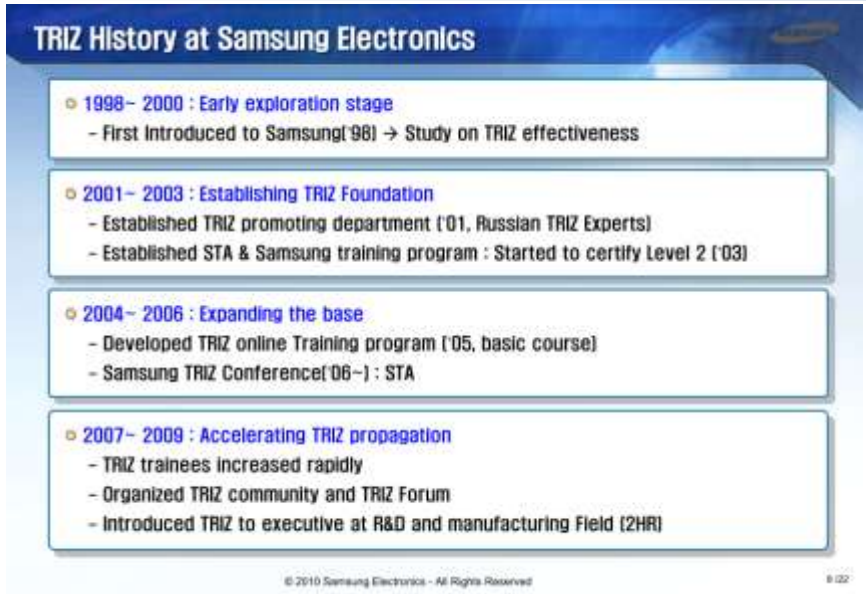
TRIZ Experiences in Industry: examples



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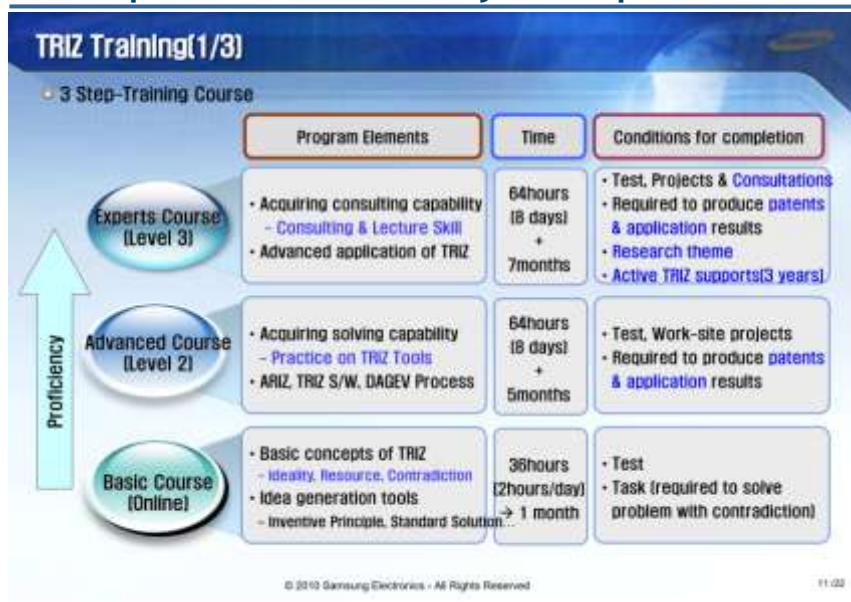
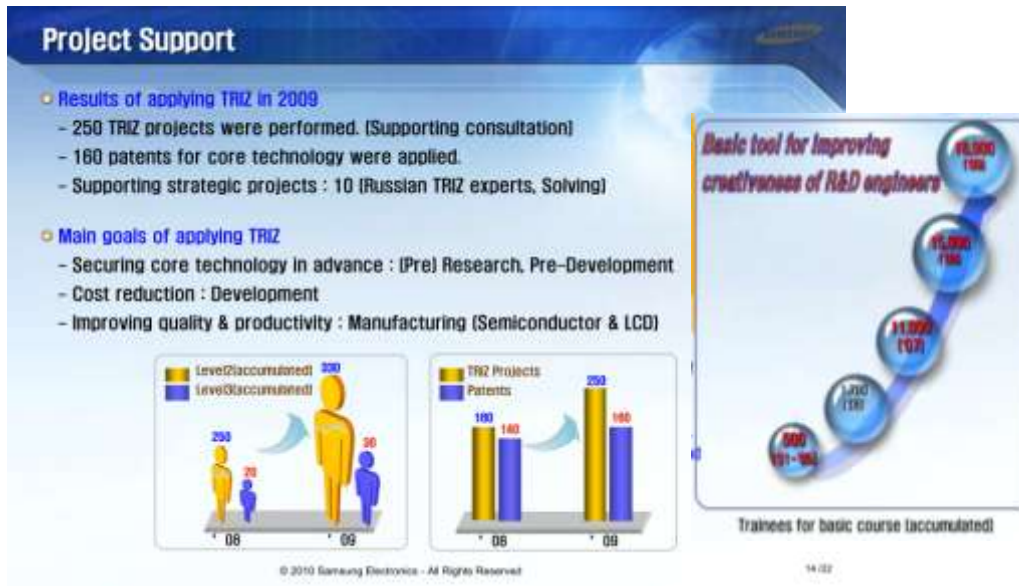
TRIZ Experiences in Industry: examples



TRIZ Experiences in Industry: examples



Web Resources

Web Sites:

http:///www.innovazionesistematica.it (Centro di Competenza Italiano)
http://www.tetris-project.org/ (TETRIS Project: TEaching TRIZ at School)
http://www.etria.net/ (European TRIZ Association)
http://www.computeraidedinnovation.net (IFIP WG5.4 Computer-Aided Innovation)
http://www.matriz.ru (International TRIZ Association)
http://www.aitriz.org/ (Altshuller Institute for TRIZ)
http://www.triz-journal.com/ (TRIZ journal)
http://www3.sympatico.ca/karasik/ (anti Triz-Journal)
http://www.triz.co.kr/TRIZ/intro.html
http://www.trizminsk.org/
http://www.thinking-approach.org
http://www.seecore.org/

Thanks for your time!!

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