TRIZ
sistematizzare creatività e problem solving
in azienda

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© G. Cascini – TRIZ: come sistematizzare la generazione di idee

Politecnico di Milano – KAEMaRT group

KAEMaRT (Knowledge Aided Engineering, Manufacturing and Related Technologies)

Established and coordinated by Prof. Umberto Cugini since 1979

2 Full Professors, 2 Associate Professors, 3 Research Assistants, 4 Research Fellows,

12 PhD Students with background in Computer Science, Physics, Engineering and

Industrial Design (more than 200 fellows since the origins)

Mission: to investigate new solutions for industrial applications and to develop
innovative methods, tools and prototypes

The group is involved in courses at the Faculties of Industrial Engineering, Industrial
Design and Management and Production Engineering.

www.kaemart.it

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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 : Vice-Chair of the IFIP 5.4 Working Group (Computer-Aided Innovation)
- 2006-2009 : President of the European TRIZ Association
- 2007-2009 : Member of the MA TRIZ Presidium

Currently:
- Member of the ETRIA Executive Board
- Chair of the “Computer-Aided Innovation” workgroup and Communication Officer of the TC-5 Committee (Computer Applications in Technology) of IFIP (International Federation for Information Processing)
- Author of 80+ papers presented at International Conferences and published in authoritative Journals
- Author of 8 patents (assignees University of Florence, Whirlpool Europe, Bracco Imaging, Logli srl, SCAM srl, Meccaniche Fiorentine)

Centro di Competenza per l’Innovazione Sistematica

Soggetti aderenti al Centro di competenza:
- Alintec
- Politecnico di Milano
- Università degli Studi di Bergamo
- Università degli Studi di Firenze
- Ceris-Cnr di Torino
- PIN Scrl Servizi didattici e scientifici per l’università di Firenze

Training and coaching for TRIZ introduction in industry:
- ABB SACE - 2 case studies + Training + 4 pilot projects
- Alenia Aermacchi - Training + 2 case studies
- Bracco Imaging - 1 pilot project (3 Patent Applications)
- Coster Group - Training
- Enel - 2 Training activities
- Philip Morris Intertabac - Training
- Intier Motol - Training
- Procomac - Training + 1 Extended Technology Forecasting + 2 case studies
- SACMI - Training + 2 pilot projects
- Tecniplast - Advanced Training & Coaching
- Whirlpool - 1 pilot project (1 Patent)
- Zoppas Industries - Training
Program & Goal

Goal:
- (TRIZ newcomers) To understand what TRIZ and Systematic Innovation are. Get awareness of TRIZ tools and techniques. Appreciate strategic and operational applications of TRIZ.
- (TRIZ practitioners) Share TRIZ experiences and approach.

Program:
- Background
- TRIZ Origins
- TRIZ Postulates and Key Concepts
- TRIZ Applications
- TRIZ in Industry
- Warnings & Suggestions

Innovation Background

From raw ideas to success products

![Diagram showing stages of new product development]

**Innovation: Main Goals & Obstacles**

- **Goal:** Improve the efficiency of Innovation Processes
  - Reduce or eliminate waste of resources (time, money...) for useless trials and errors
  - Develop one valuable solution is much better than many ideas to be validated
  - Manage complexity of modern systems

- **Obstacles:**
  - Psychological Inertia
  - Trial & Error: lack of a structured approach
  - Design conflicts

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**Psychological Inertia ➔ 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."
Lack of a structured approach: not everywhere

Primary school

Problem: How to distribute 50 cherries between 3 kids?

Should your kids solve the problem by “intuition” and/or by “experience”??!!

Type of Problem: arithmetic

Model of the problem: 50:3

Tool: division

Model of the solution: 16,666…

Solution: distribute 16 cherries to each kid
Lack of a structured approach: not everywhere

High School:
What does it happen by mixing Sulfuric Acid with Calcium Hydroxide?

What would you suggest?
Let’s try and see?!?

Lack of a structured approach: not everywhere

Type of problem: chemical
Model of the problem: \( H_2SO_4 + Ca(OH)_2 \)
Tool: laws of chemistry, oxide-reduction
Model of the solution: \( CaSO_4 + 2 H_2O \)

Solution:
Calcium Sulfate + Water
Design Conflicts

TRIZ
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
Laws of Engineering Systems Evolution

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.
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
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

Evaluation Par. 1

Evaluation Par. 2

System Requirements

CP: 1
CP = CONTROL PARAMETER

EP: 1
EP1 = EVALUATION PARAMETER 1

EP: 2
EP2 = EVALUATION PARAMETER 2

Contradictions

“Technical” Contd:
TC1: EP1(+) - EP2(-)
TC2: EP2(+) - EP1(-)

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

The syrup should appear into the chocolate shell with no time waste...

EP1 = EVALUATION PARAMETER 1
EP1(+) = improves
EP1(-) = worsens

EP2 = EVALUATION PARAMETER 2

... and preserving chocolate integrity.
Contradictions

“Technical” Contd:
TC1: EP1(+) - EP2(-)
TC2: EP2(+) - EP1(-)

“Physical” Contd:
CP = V \rightarrow EP1(+) - EP2(-)
CP = anti-V \rightarrow EP1(+) - EP2(-)

Contradictions

Postulate 2

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

Specific situation - Resources

- Each stage of evolution of a system takes place in a specific environment (context, situation) which influences the evolution (transformation) of the system and provide specific resources

- Conclusions for practice:
  - Good solutions must (first of all) take into account the resources available in the specific situation
The architecture of TRIZ is based on:

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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)**

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

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

- Inventive Problem Solving
- Technical Problems
- Non-Technical Problems
- Problem Solving
- Troubleshooting
- Failure Prevention
- Management Conflicts
- New Business Concepts
- Maturity Assessment
- Technology Forecasting
TRIZ Applications

- **Fields**
  - Product development
  - Industrial research
  - Scientific research
  - Industrial strategy
  - Non technical applications...

- **Target:**
  - Products
  - Processes

- **Where:**
  - Big companies
  - Small and Medium Enterprises
  - University

Exemplary case studies: innovation & problem solving

- **Bracco Imaging:**
  Method and device for localized thermal ablation of biological tissue, particularly tumoral tissues or the like (3 EP applications)

- **Whirlpool:**
  Low frost chest freezer (1 EP patent)
Exemplary case studies: problem solving for SMEs

- Scam:
  High performance connecting rod (1 IT patent)

- CIVE - Vetrerie Toscanne:
  Glass mosaic production (process innovation)

Exemplary case studies: technology forecasting

- Procomac:
  Sterilization technologies for aseptic filling
Exemplary case studies: technology forecasting

- Meccaniche Fiorentine: walkers

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TRIZ in Industry
Some companies using TRIZ (at least a preliminary experience with)

- Avon
- BMW
- Boeing
- Borden
- Case
- Caterpillar
- Clorox
- Cummin
- Daimler-Chrysler
- Datacard
- Delphi
- Dial
- DuPont
- Electrolux
- Edi Lilly
- Ford
- Fujitsu
- General Motors
- Heidelberg
- Hitachi
- Honeywell
- HP
- IBM
- Intel
- ITT
- Johnson & Johnson
- Kimberly-Clark
- Kodak
- LG
- Lockheed Martin
- McDonnel Douglas
- Motorola
- NASA
- NEC Electronics
- Pfizer
- Pilkington
- Procter & Gamble
- PSA Peugeot Glacio
- Raytheon
- Rockwell
- Rolls Royce
- Samsung
- Sanyo
- Sara lee
- Shell
- Siemens
- Gillette
- Toyota
- USPO
- Xerox

Source: David Silverstein, Neil DeCarlo, Michael Slocum

TRIZ in Industry

TRIZ in Whirlpool: breve storia

- 1997: viene acquistato il sw Invention Machine TechOptimizer™
- 2001: progetto Technoledge
  - coinvolte 6 persone (10%-20%) e un program leader full-time
  - attività di training e primi progetti pilota
- 2002-2005: consolidamento e diffusione. Applicazione in vari progetti in ambito R&D.
TRIZ in Industry

Invention disclosures of the last years

TRIZ Experiences in Industry: examples

Project Support

- 250 TRIZ projects were performed. (Supporting consultation)
- 160 patents for core technology were applied.
- Supporting strategic projects: 10 (Russian TRIZ experts, Solving)

- Securing core technology in advance: (Pre) Research, Pre-Development
- Cost reduction: Development
- Improving quality & productivity: Manufacturing (Semiconductor & LCD)
TRIZ Experiences in Industry: examples

Samsung TRIZ Conference 2009

- Held in Nov 2009 at SAIF fair (every year)
- Conference Theme: Innovation Booster, TRIZ
- About 200 attendees from STA & Subsidiary companies: TRIZ trainees & users
- Agenda
  - Invited speech by Dr. Cascini
  - TRIZ issues in STA companies
  - Best practices
  - Confirmation of TRIZ certificate (Level 2 & Level 3)

TRIZ Experiences in Industry: examples

Patent Leadership

- Patent leadership in the industry


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Samsung Valid Patent Status in U.S.

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Warnings and Suggestions

■ “Simplified TRIZ” is probably better than nothing, but very far from ideal!!
  ○ Using the Inventive Principles as “Stimuli” for brainstorming sessions has nothing to deal with TRIZ
  ○ Problem formulation requires repeatable models and procedures

■ Even if TRIZ learning is a long process, avoid using wrong procedures and tools just because it’s faster!!
  ○ Is it really worth to use the Contradiction Matrix?
  ○ Skipping a proper identification of the underlying contradictions can be faster, but it’s certainly useless and dangerous!!

■ Currently available “TRIZ software” tools don’t substitute education
  ○ Can you avoid studying Romanian/Russian/Korean just having Word on your pc??
  ○ Why do we study Maths, since we have calculators?
Web Resources

Web Sites:
http://www.innovazionesistematica.it (Centro di Competenza Interuniversitario)
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.altiriz.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!!