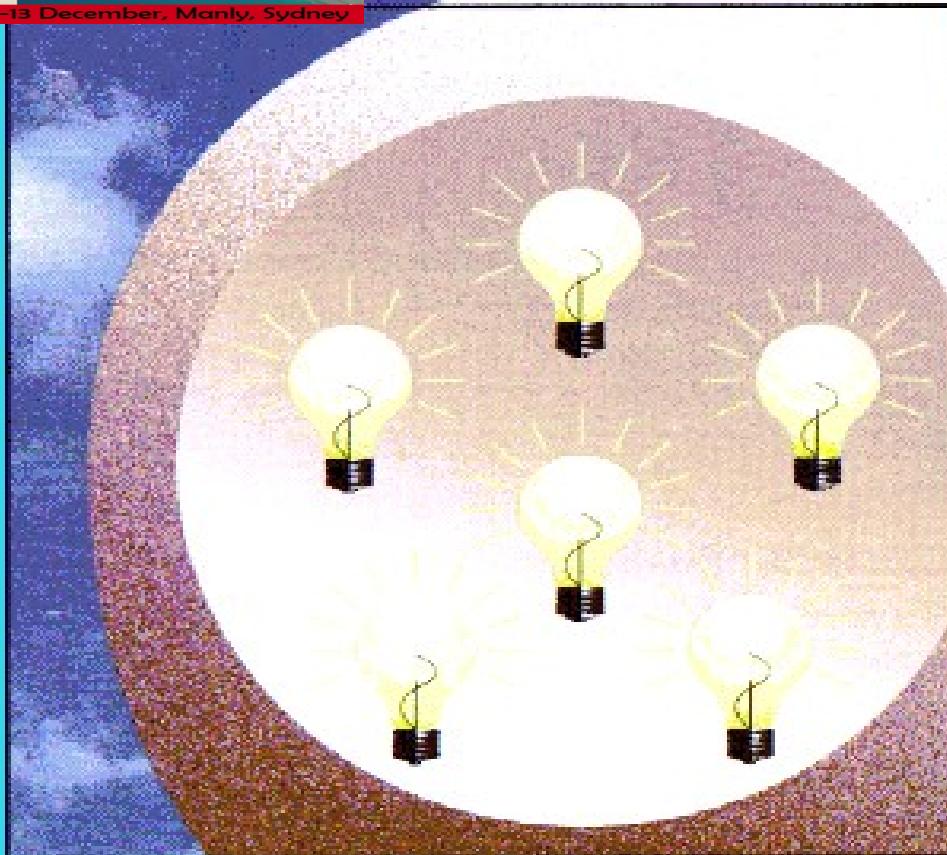


**Bohuslav BUŠOV
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Brno
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Czech Republic



TRIZ – trans-disciplinary innovation methodology

for educational and
practical innovation

Brno University of Technology (BUT Brno),
Faculty of Electrical Engineering and Communication (FEEC),
Department of Power Electrical and Electronic Engineering,

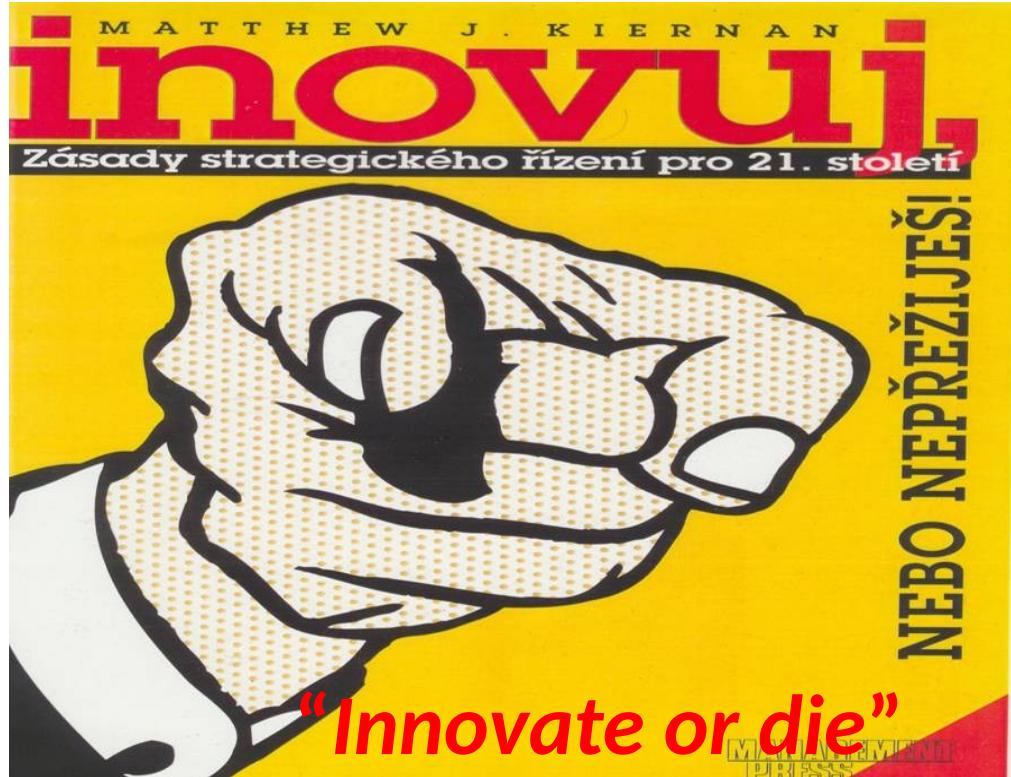
Education and Employment

- 1974-1976 Military academy – special service school, Slovakia
- 1976-1981 FEEC BUT Brno
- 1981-1983 Development Department of Electrical apparatuses, ABB, Brno
- 1983-1986 PhD student, FEEC, BUT Brno
- 1986-1995 Assistant at the FEEC, BUT Brno
- 1995-now Associate Professor at the FEEC, BUT Brno

Education in TRIZ

- Certificate TRIZ from a IMLab, 90 hour, Minsk, (1993),
 - Certificate TRIZ from MATRIZ, 40 hours, St. Petersburg, (2005),
 - Certificate TRIZ from ICG Training and Consulting, 40 hours, The Netherland (2009),
 - Certificate MATRIZ, 3 level expert, (2015),
- Consulting of 45 innovative projects in Czech Republic and Slovakia from 1996,





The innovation
guarantees
the future.

*Either we will innovate
or someone else will do it !*

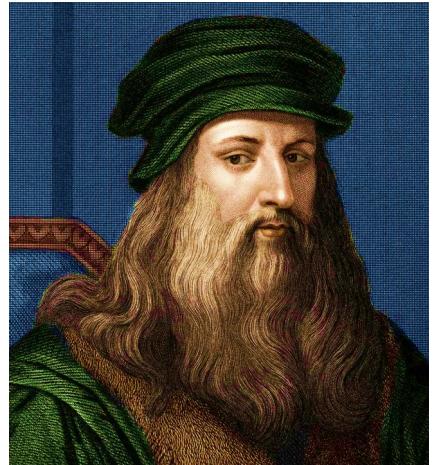


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I. Introduction (what classics say about innovation...).

Leonardo formulated 4 rules how to stimulate the brain to creative acts:

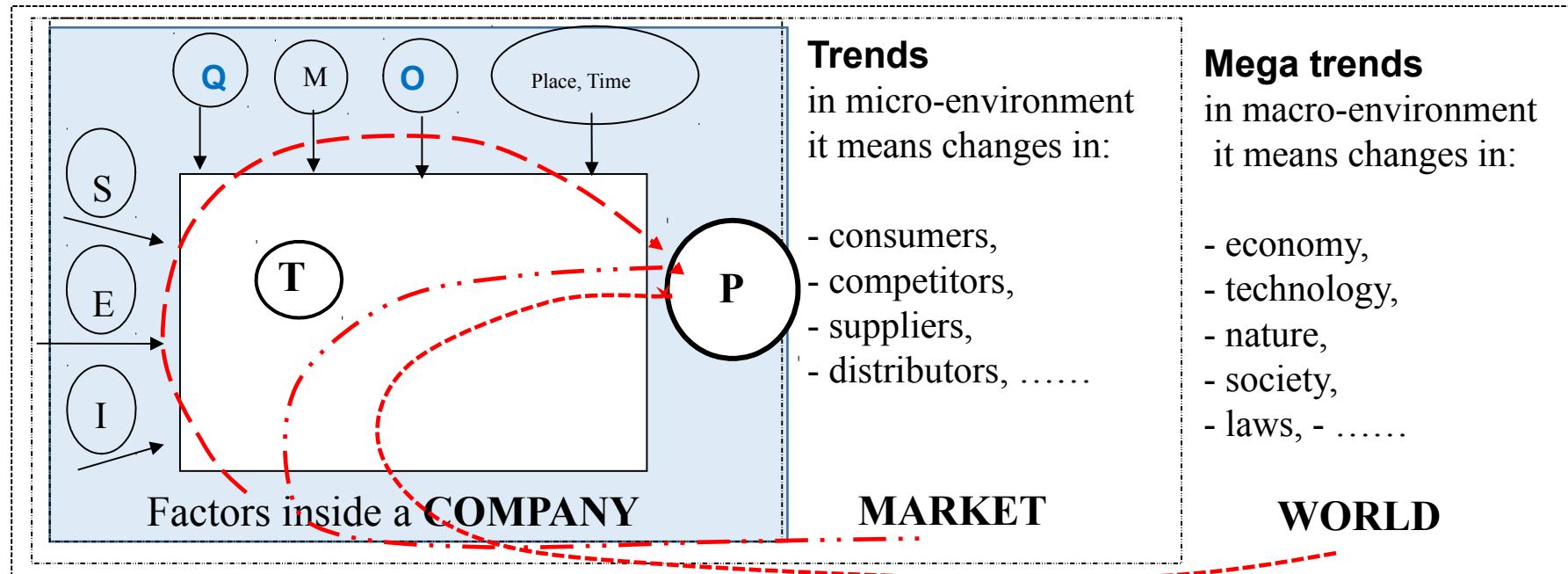


1. Study *science of art* (to get object knowledge - to know **WHAT**),
2. Study *art of science* (to master methods - to know **HOW**),
3. Develop all your senses (to stimulate creativity - to think **how DIFFERENTLY**),
4. Keep in your mind that “*everything is connected to everything else*”
(to apply *system approach* - to think **HOW** to do it **BETTER**).

Leonardo Da Vinci
*1452 – †1519

TRIZ offers methodology support namely for rules **2, 3 and 4**.

Production factors = Innovating factors are objectively influenced by Trends and Mega-Trends



Joseph Schumpeter
(*1883 - †1950)
Austrian economist

"The **development of economy** is initiated by **new combinations of production factors** inside of a company."

"Any positive changes of the production = innovating factors inside of company can be qualified as an "[innovation](#)."

(J. Schumpeter, 1939)

Key factors **Affecting** technology (**T**) and competitiveness of the final Product (**P**) are: **Q** - Qualified staff and **O** - Organization and management.

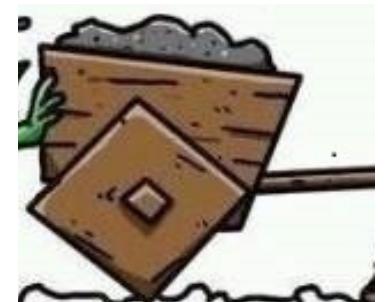
TRIZ is methodology supporting of **Q** and **O**.

II. Shortly about TRIZ - trans-disciplinary innovative methodology for education and practice.

Motto:

Engineers' work effectiveness does not depend only on their technical knowledge but also – in a growing extent – on their methodological knowledge of analysis and creative synthesis.

Unfortunately, up to now, intuition and **non-effective methods of probes and mistakes or brainstorming** have been used frequently for the creative task solutions.



On the other hand, today there is analytic and synthetic methodology derived from patent state of the art called

Teoriya Resheniya Izobretatelskikh Zadach – TRIZ
translated usually as Theory of Inventive Problem Solving



TRIZ methodology offers several helpful “wheels”.

TRIZ used for innovation of pressing of ceramic cores

Casting systems often include the **ceramic cores** produced by pressing.

1. **Analysis** of problem situation.
2. **Synthesis** of inventive solution with help of heuristics.
3. **Implementation** of real solution in company.
4. **Conclusion**



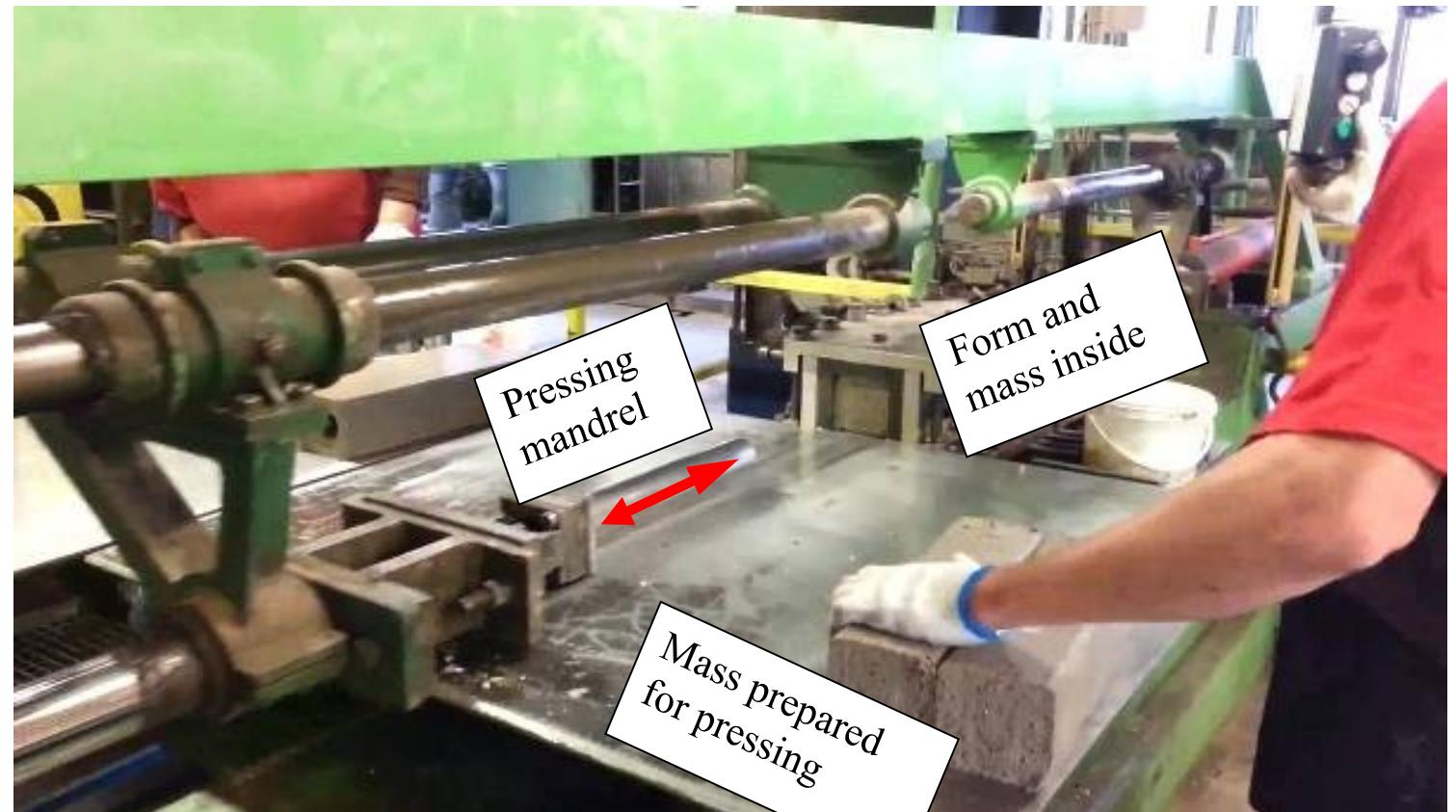
Ceramic cores (example)

1. Analysis of pressing process (operations, functions, problems, costs, time,)

Original pressing process

Problem to be solved:

The specific pressure on the pressed mixture during pressing process is relatively high,...., and therefore negative effect exists -- "sticking" of the pressed mass to the surface of the mandrel. To reduce this negative "sticking" effect, the ceramic core **cannot be pressed on one stroke** of the mandrel



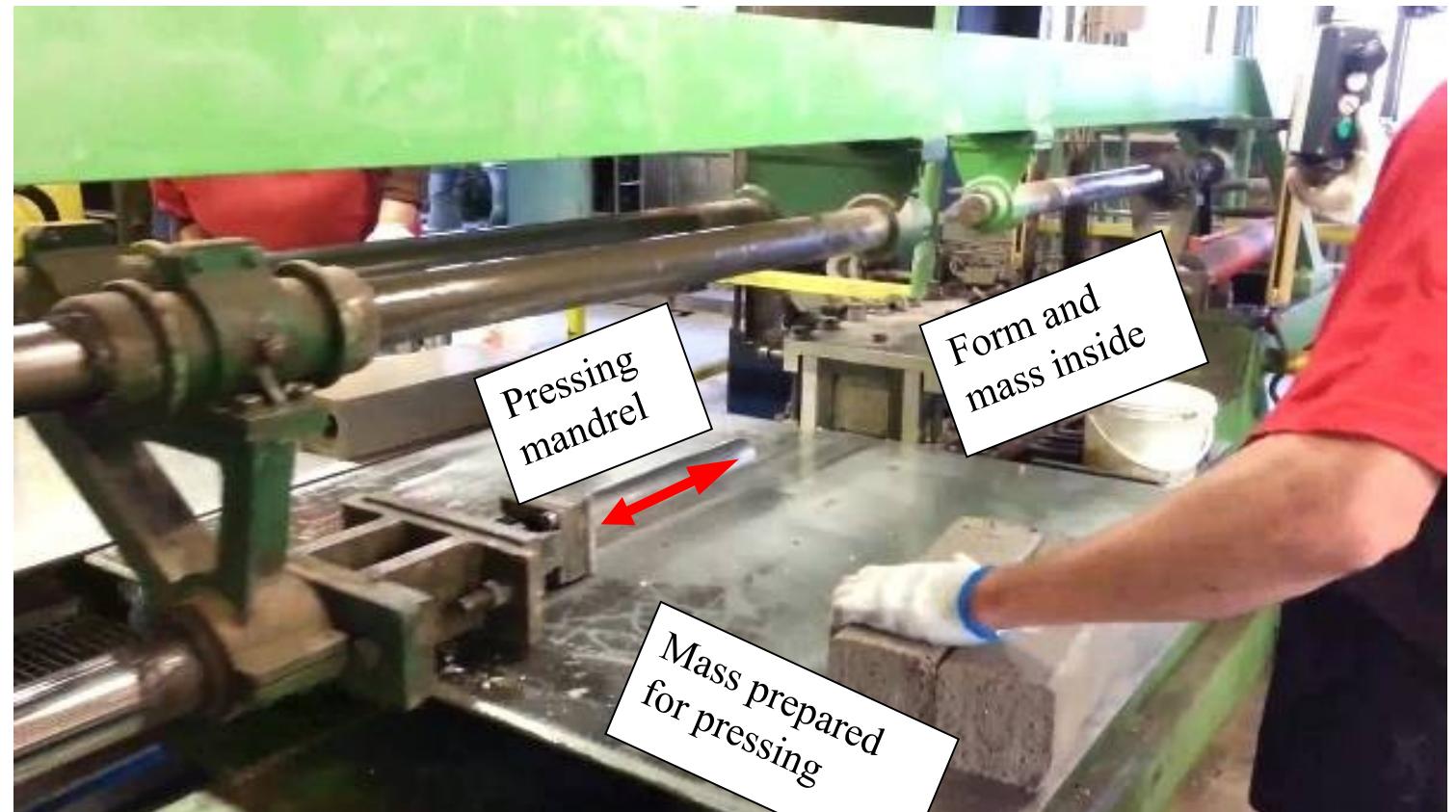
but has to be shaped in several sequential operations (Video 1).

1. Analysis of pressing process (operations, functions, problems, costs, time,)

Original pressing process

Sequence of all 13 operations:

1. Cleaning
2. Lubricating
- 3. Pressing**
4. Back motion
- 5. Pressing**
6. Back motion
7. Cleaning
8. Lubricating
- 9. Pressing**
10. Back motion
11. Cleaning
- 12. Pressing**
13. Back motion



Within framework **13 operations** only **4 productive operations** (4 x Pressing) are followed

by more **nonproductive operations** (3 x Cleaning, 2 x Lubrication, 4 x Back motion).

2. Synthesis of inventive solution of the problem to be solved: low productivity

RCA+ diagram has been prepared at first

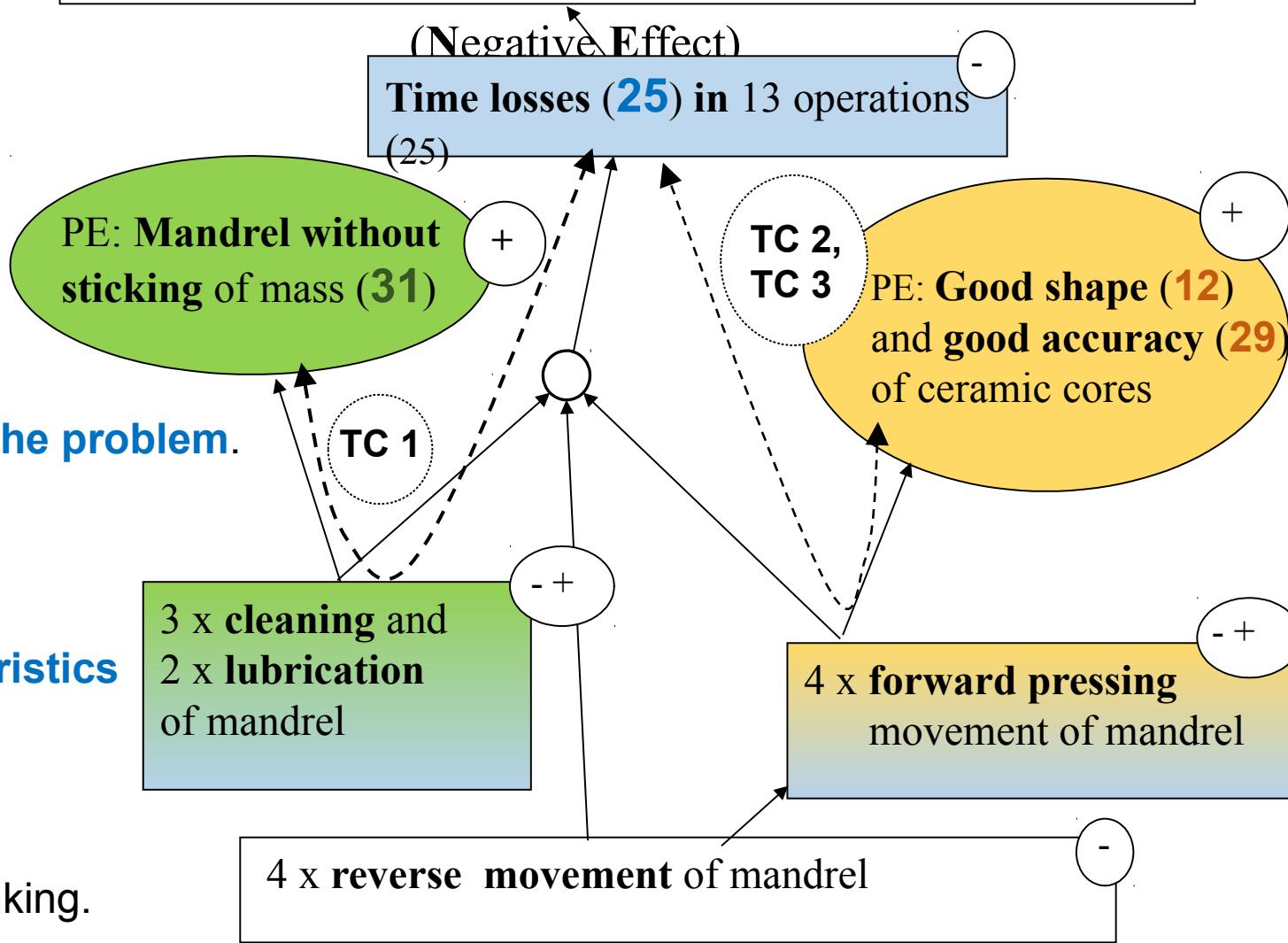
to “visualize” map of problem genesis
and (!)

to visualize several contradictions inside of the problem.

TRIZ methodology recommends several Heuristics
to solve contradictions.

Heuristics are usefull support of our creative thinking.

Low manufacturing productivity of ceramic cores (39),



Technical contradictions TC1, TC2 and TC3 are inventive tasks (!) derived from the problem.

Only first contradiction is formulated and visualized here:

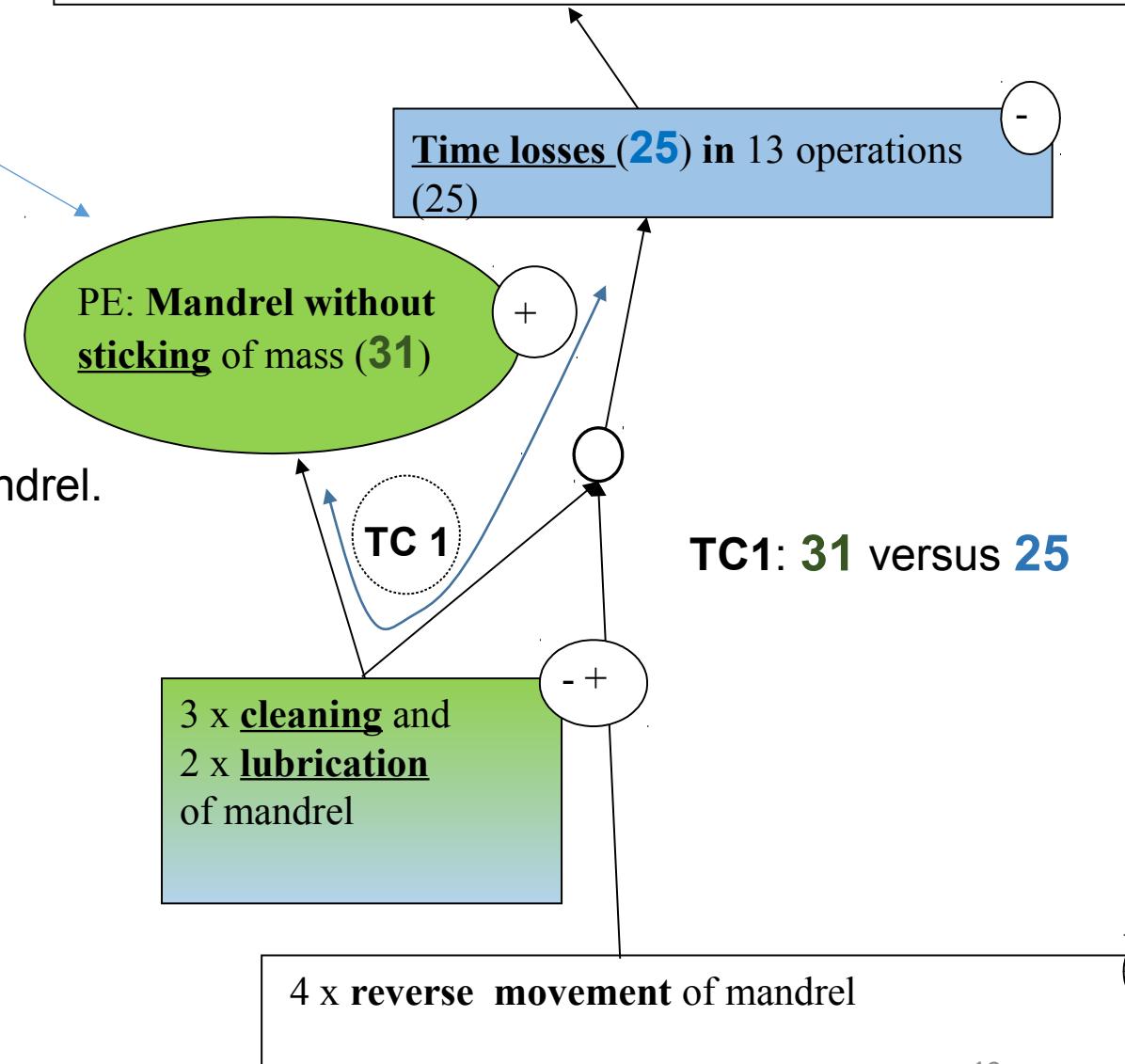
Formulation of Technical Contradiction – TC1:

1. PE: Reducing of harmful factors (31)
acting on the mandrel (sticking of the pressed mass).
2. Manner: by 3 x cleaning and 2 x lubrication of the mandrel.
3. NE: this manner results in time losses (column 25).

Heuristics recommended to find new a manner,
to find new inventive solution:

IP 18 "Mechanical vibration" and
IP 35 "Parameter changes"

Low manufacturing productivity of ceramic cores (39)
(Negative effect)



Both **Heuristics** were relevant and inspirative...

After TC1 the solver can locate and formulate *Physical Contradiction – PC1* as a cause of TC1:

Before formulation of **PC1** several preparatory mind steps are recommended:

- **Locate Positive Effect** (mandrel without sticking mass) in **Operational Zone** (the surface of the mandrel in contact with the mass), in **Operational Time** (during pressing), and then
- **Locate Negative Effect** (time losses) in **Operational Zone** (the surface of the mandrel in contact with the mass) and in **Operational Time** (during pressing).

The places OZ and the times OT of PE and NE coincide!

Therefore solutions should be searched in the **new space-time arrangement**, it means **in the structure of the pressing process**.

- **Recap available resources of substances and fields**: mandrel, mass, hands, lubricant, mandrel movement, gravitation, etc.
- **Formulate Ideal Result** (IR): Sources themselves in the place of OZ and in the time of OT should prevent occurrence of NE (time losses in production) and resources in place of OZ and in time of OT should keep of PE (mandrel without sticking mass).

Now **Physical Contradiction – PC1** can be formulated relatively easily:

The **mandrel has to be in contact** with the mass (not to lose time in production process) **and** the **mandrel should not be in contact** with the mass (to prevent harmful „sticking“).

The same content by another words:

The **gap should not be** between the mandrel and the mass (neither in time nor in space) not to lose time **and** the **gap must be** between the mandrel and the mass that the product was created without “sticking” mass.

PC is a contradictory tasks formulation ?

Yes, but **PC** it is best possible and **crucial formulation of the core of the problem to be solved !**

? Do we need creativity for solving such contradictory inventive tasks ?

Yes. And creativity can be supported by another heuristics, by so called **Separation Principles**.

3. Implementation of inventions into real innovation.

Practical solution of these contradictions (**TC** and **PC** transformed from problem to be solved)

based on

the recommended heuristics:

Vibration motor

was installed to generate

radial oscillations

of the **axially moved** pressing
mandrel.

Video 2:

innovated pressing process

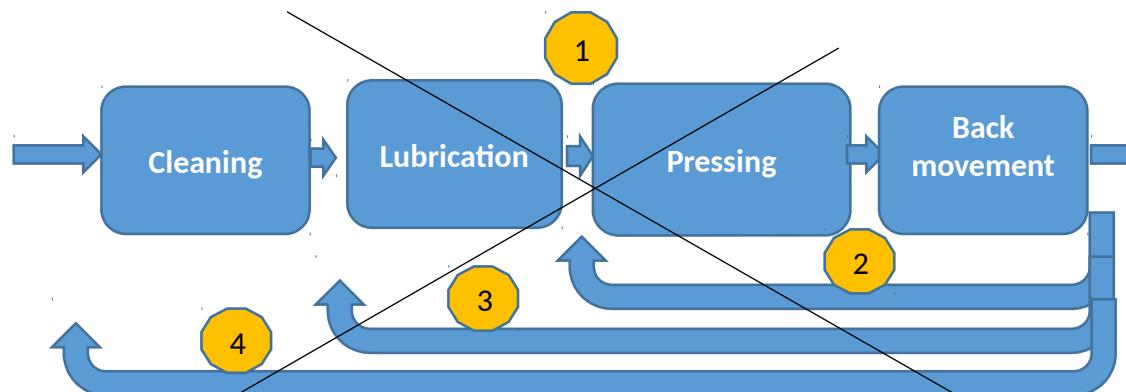


Only 2 operations: Pressing and Back motion

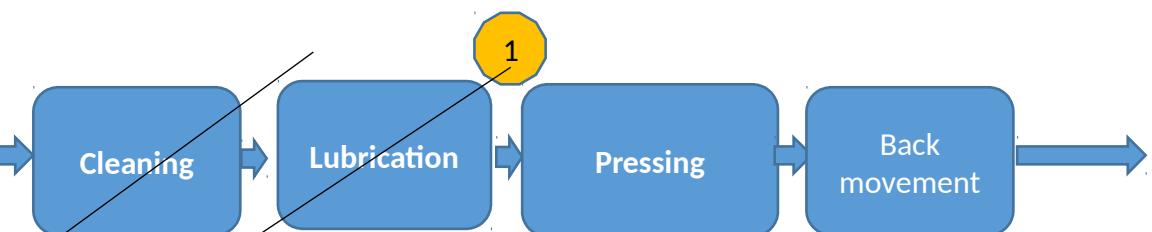
This relatively simple device and process innovation helped to **halve the original production time** and almost doubled the productivity

Pressing of cores	Mandrel movements	Number of operations	Production time /s/	Productivity /piece /7 hour/
Original	8	13	25	810
Innovated	2	2	12	1550

Original pressing process: 13 operations



Innovated pressing process: 2 operations



TRIZ in education and practice

TRIZ is already 35 years in the Czech Republic

Several tens of enthusiasts implement TRIZ from 1980's

TRIZ is LECTURED at technical universities in CR and Slovakia

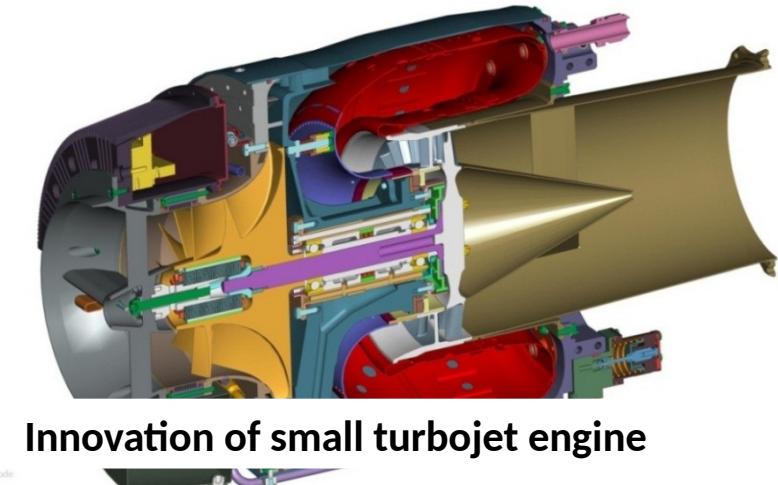
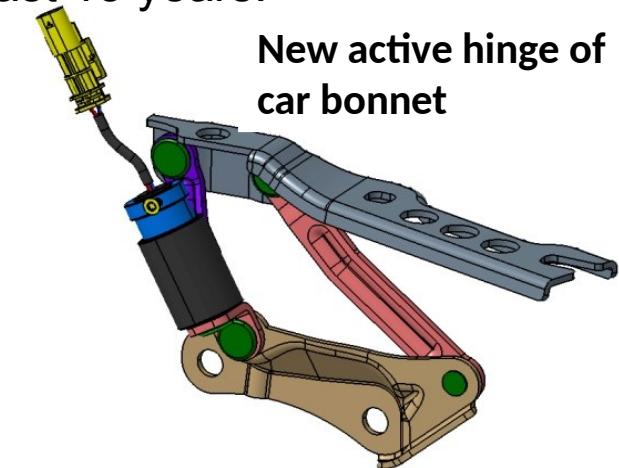
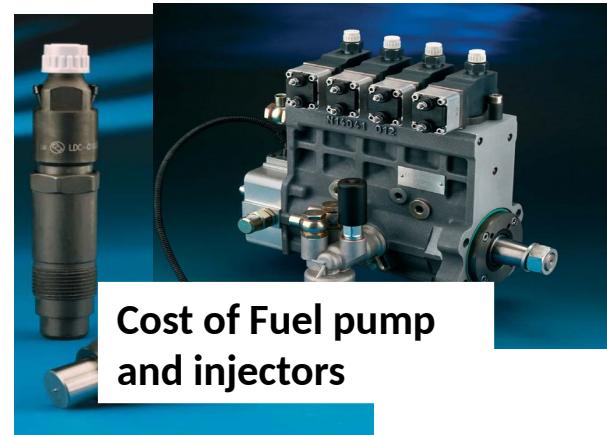
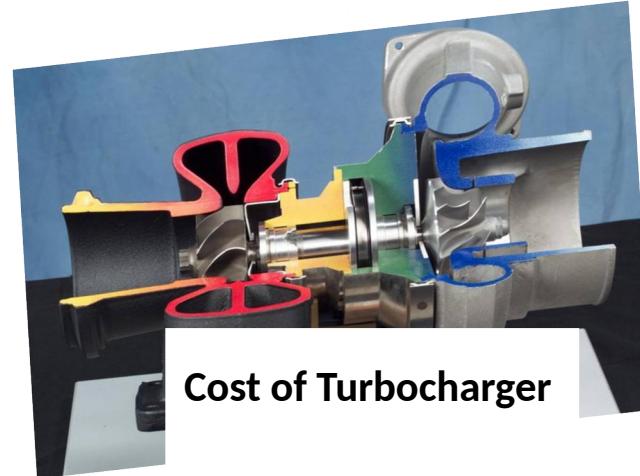
Optional TRIZ course
is lectured in BUT BRNO for:

- **Master degree** students FEEC from **1996** (10 - 30 students),
- **Ph.D.** students FEEC from **2016** (2-5 PhD),
- TRIZ will be offered as optional course **to all** students at Brno University of Technology.



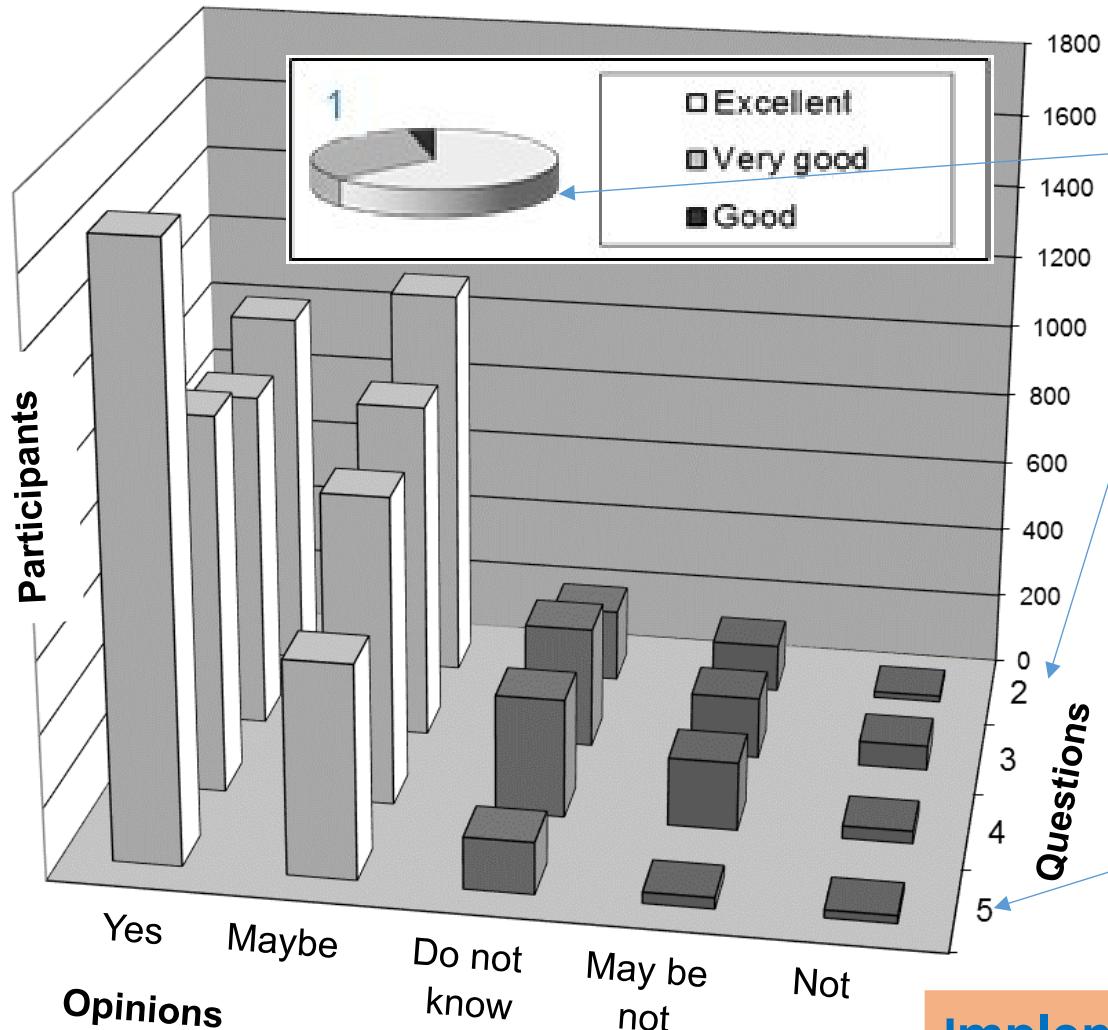
Several fans introduce TRIZ into innovation practice from 1990's.

More successful innovation / case studies we presented in conferences during last 15 years.



4. Instead of conclusion

Integrated answers of **2,540 participants** (companies 90% / universities 10%, Czech Republic, 27.11.2017) after informative **PRESENTATION** and short time educational **COURSES** with partial **APPLICATION** of TRIZ.



Asked questions:

1. How do you evaluate the **content and form** of TRIZ methodology and info about software?
2. How do you personally evaluate **applicability** of TRIZ in your company / school?
3. Would you be interested in occasional **consultation** of your innovative tasks?
4. Would you be interested in **studying and mastering** TRIZ methodology?
5. Would you **recommend** TRIZ to your son / daughter or school and university students **for studying and mastering**?

Implementation of TRIZ methodology is a **valuable target**.