



Methods of creative work

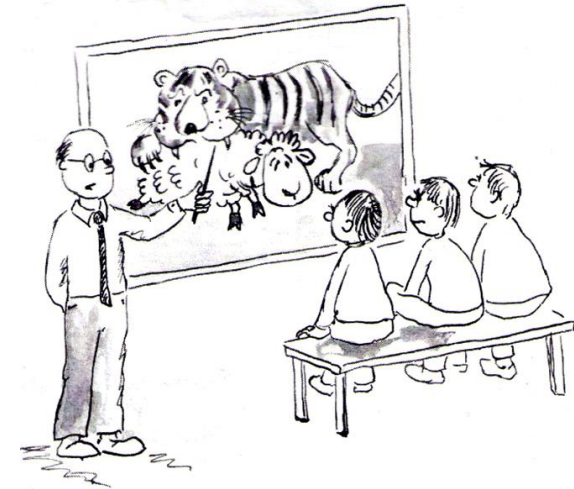
Šimon Kovář

Department of textile and single-purpose machines



What is creative activity?

Define the term creative activity.



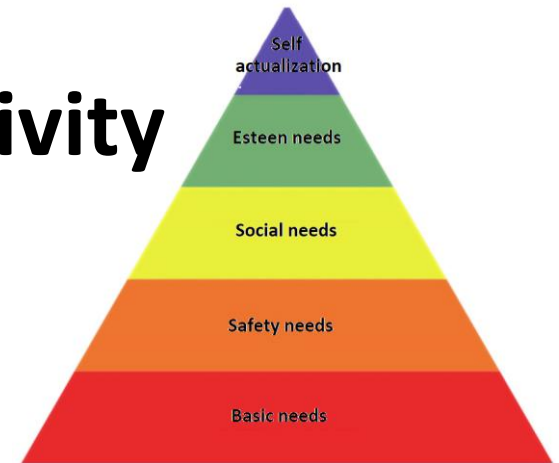
*There are two basic ways to solve the problem.
The first one is the commissioning of someone
else's solution*

The creative activity can be understood as:

- Collaboration of spirit and reason in favor of being.
- Mental and intellectual activities leading to a resulting reduction in the level of arrangement of the system as a whole.
- The information process ends with a real result.

Prerequisites for creative activity

- **Motivation** – ego or love for your neighbor
- **Talent** - competence
- **Target** – define targets
- **Problem** – thinking productive and unproductive
- **Preparedness** - information
- **Environment** – influence of environment



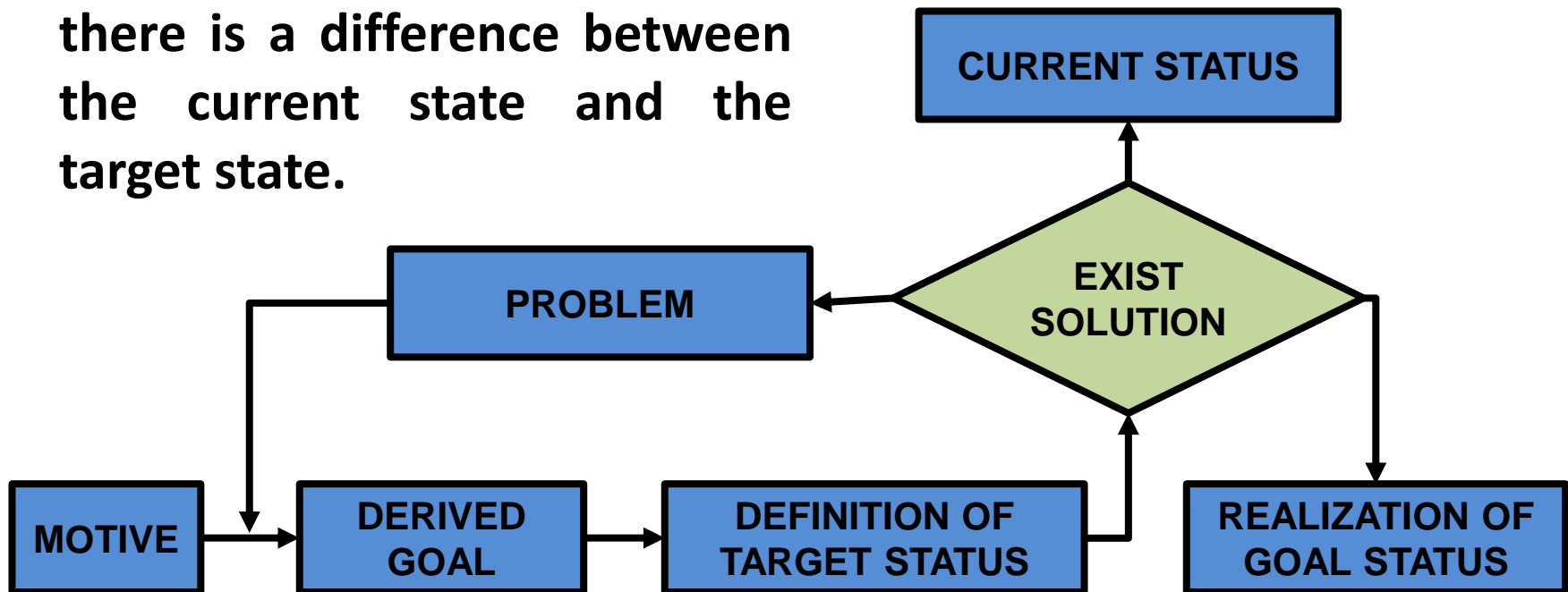
Maslow's Hierarchy of Needs

*I would like to bring innovative solutions.
Do you have detailed instructions?*



Initial assumptions of creative activity: *Problem*

The problem arises when there is a difference between the current state and the target state.



Basic types of thinking

Unproductive thinking: These are activities where nothing new is discovered. Use of known knowledge, updates, application of known procedures and schemes.

Productive thinking: These are activities where we need to discover new knowledge.

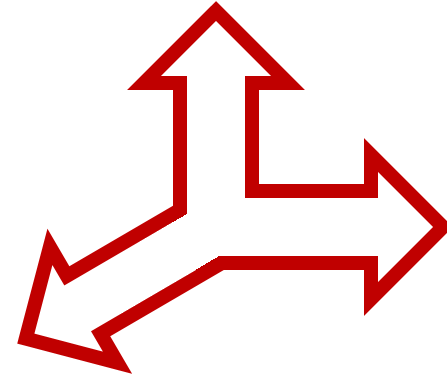
Convergent thinking: There is only one solution to the problem.

Divergent thinking: There are more possible solutions to the problem.

Phases of solving technical problems

1. Formulation of technical assignment.
2. Collection of information.
3. Finding the solution.
4. Constructional solutions.

At all stages, we can apply the principles and methods of scientific thinking: Analysis, synthesis, induction, analogy, deduction, abstraction, boundary, concretization, generalization, contradiction, intuition and imagination.



What is creative space?

The creative space can be defined by three areas (3D).
These areas are:

- **Communication** - literature, conferences, internet, videoconference, etc.
- **Analogy** – derived from models
- **Methods** – trial and error, morphology, synergetics, ARIZ, TRIZ

Creative subject

Creative subject = researcher
„ Creative people are optimistic“

Parts of creative subject:

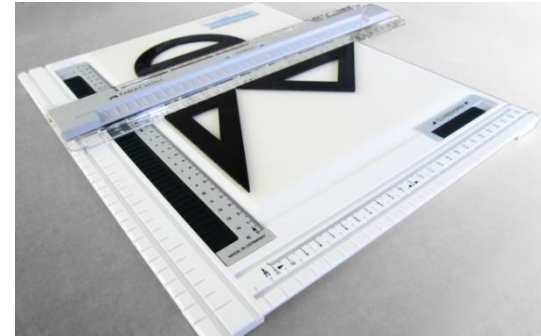
- Creative relationship to reality – **wants to create.**
- Creative potential – **can to creative.**
- Creative experince – **able to creative.**

Methods to improve creative qualities

- **Study methods** – focused mainly on acquiring „books“ knowledge by studying, reading professional works, prognostic studies.
- **Training methods** – practice problém solving.
- **Inspiring methods** – imitation, acceptance, kritical reassess.
- **Harmonization methods** – the balance between extreme poles in different situations.
- **Mode methods** – organization of activities for stimulation of creative development, preparation of top athletes.
- **Conditioning methods** – for high daily performance, passive and active rest.

Methods increasing the creative performance of individual

- **Construction method**
- **Method of specifying the problém** – systematic research of problems.
- **Indicative methods** – orientates the developer in a promising direction.
- **System-analytical methods** – maximum number of possible solutions using different systematic analytical procedures.
- **Japanese methods** – a lot of information, the transition from idea to image.
- **ARIZ, TRIZ** – problem solving tactics.



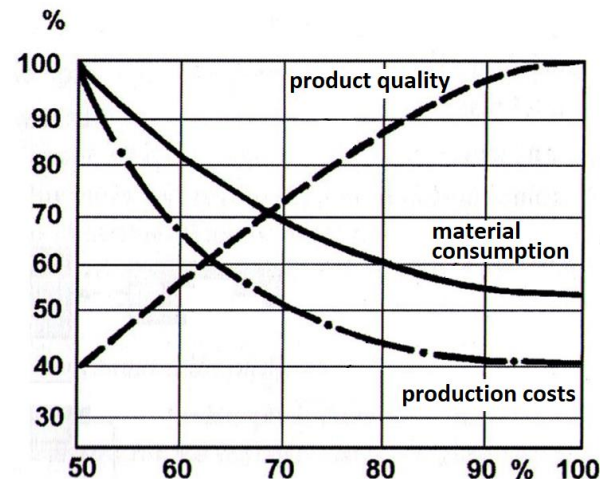
Konstruktion method

Design is a **creative activity** mostly performed by an individual. The construction task is a series of **partial tasks**. These tasks are repeated. There is a certain pattern of thought process in **solving** and **linking** partial **tasks**. These are interconnected by **internal** and **external links**.

The **target** is **keep** or **increase quality** in case to **reduce** material and **production costs**.

Structural systematics:

1. Analysis
2. Synthesis
3. Evaluation



Structural systematics

Analysis:

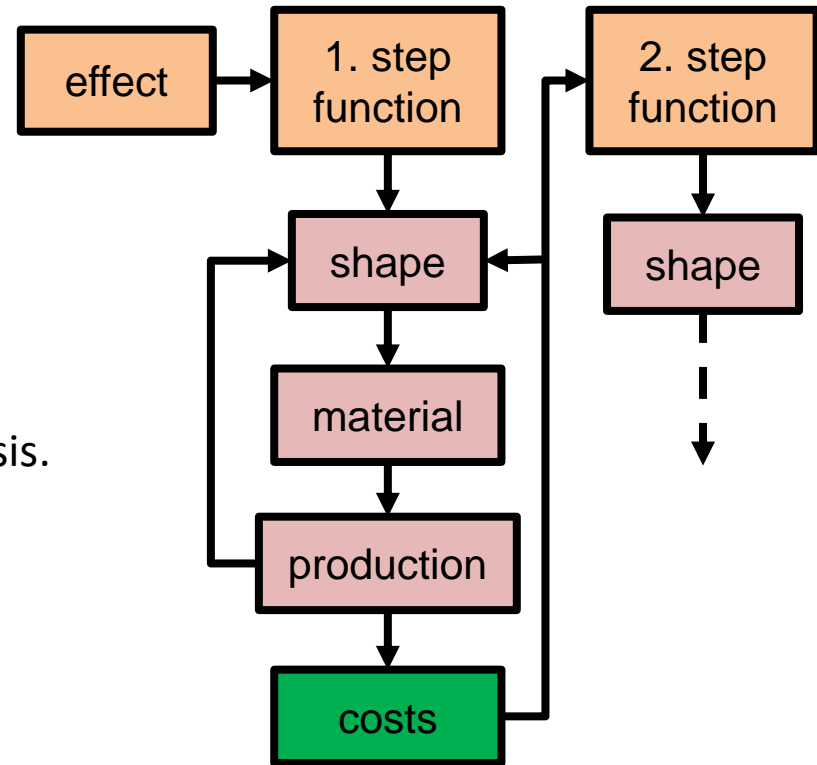
- Factors Overview,
- classification of factors,
- sources of information,
- mutual relationships between factors,
- technical and operational conditions,
- processing the conclusion of the analysis.

Synthesis:

- creative thinking,
- partial solution,
- limitations,
- combined solutions
- programmed solution.

Evaluation:

- evaluation methods,
- evaluation of production, sales and operation.

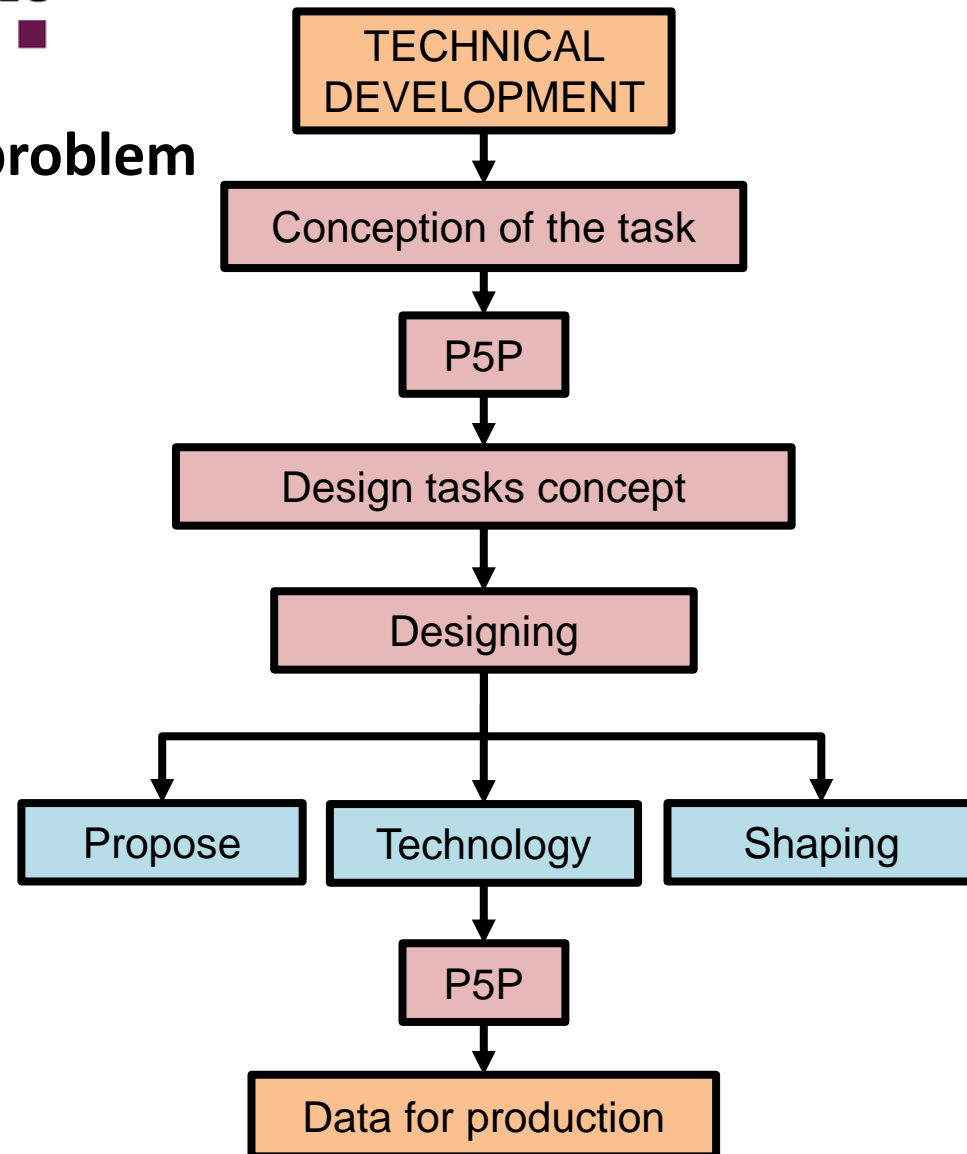


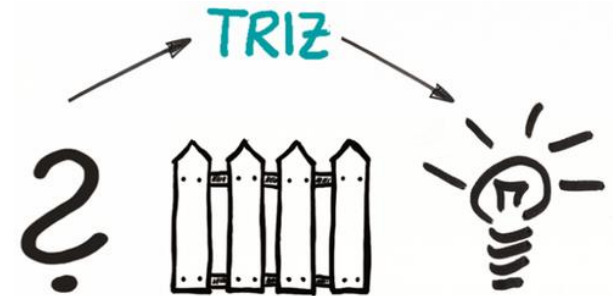
Scheme of construction solution development

Steps to solve a construction problem

Time sequence of work tasks **P5P**:

- basic principle of the task,
- determination of working principles,
- improvement of working principles,
- optimization,
- materials for implementation.





TRIZ Method

It is the creation and solution of innovative assignments. It was initiated by studying **patents** by generalizing **successful solutions**. It is a method that leads to a rapid finding of a strong solution to the problem without taking **long-term** solutions.

TRIZ including:

- Mechanisms for transforming the problem into the resulting solution.
- Mechanisms that suppress and prevent the search for a strong solution among many variants.
- It has an extensive information fund.

TRIZ methodology is used by companies such as ELMARCO, NASA, Siemens, BOSCH, General Motors, Procter and Gamble, Alcan, Schneider Electric and many others. Also TU Liberec.



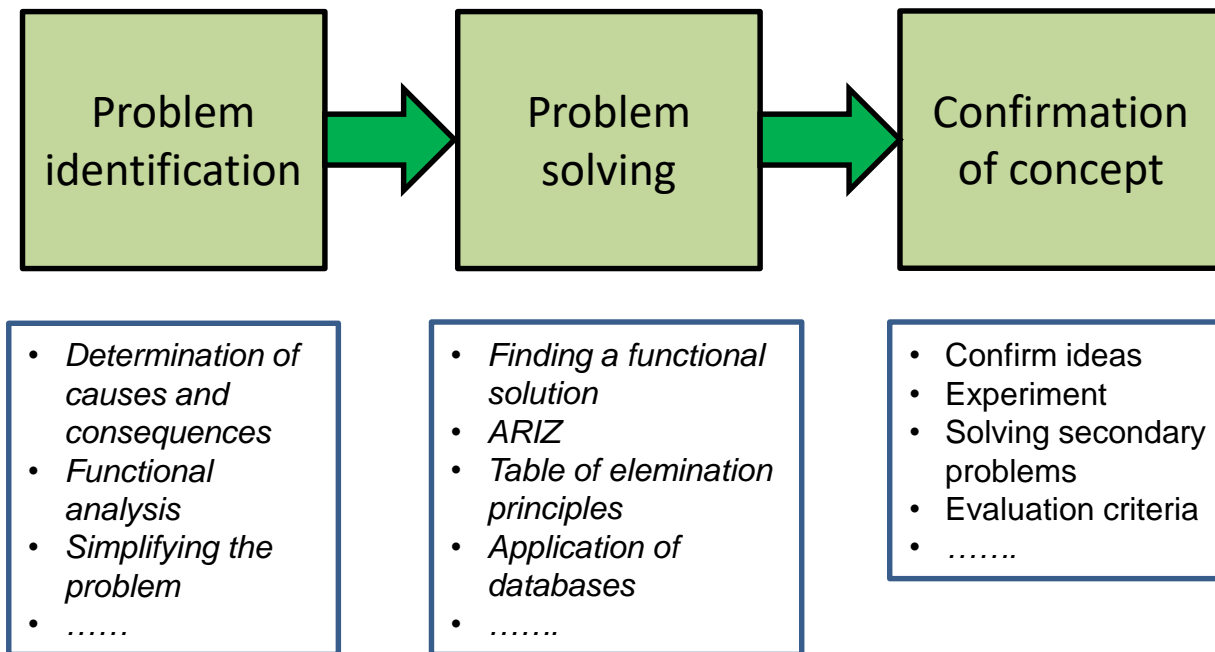
TRIZ Method

<p>01) DIVISION (balance preserving)</p> <p>a) ship built, made of removable / replaceable bulkheads b) multi-angle engine of internal combustion c) toy made from large blocks</p> <p>e) breakable chocolate f) multi-grip galgors g) biodegradable paper sheets h) multi-blade cartridge razors i) multi-blade air screws of aircraft j) wind power plants</p>	<p>08) ANTI-WEIGHT (a lot of examples in books of TRIZ)</p> <p>a) anti-arsenic b) fish bladder (fish submerged in water) c) floating balloons, etc.</p> <p>m/s V = 2000 2000</p>	<p>15) DYNAMICS</p> <p>a) automatically extensible doors, air-locks, etc., reacting when it is needed b) automatic gears in mobiles c) undercarriages in cars of variable stiffness characteristics, tuned exactly to terrain conditions during the driving d) electronic controllers for carburetor, electronically controlled fuel injection to terrain conditions</p>	<p>22) "BLESSING IN DISGUISE" (CONVERT HARM INTO BENEFIT)</p> <p>a) burning out, rain in outskirts fire b) blow out of the front top of the blizzard c) permafrost materials are to be "treated" with liquid nitrogen</p> <p>blow out of the front top of the blizzard blow out of the front top of the blizzard blow out of the front top of the blizzard</p>	<p>28B) SUBSTITUTING OF MECH. SYS. WITH ELECTRO-MAGN. SYSTEMS</p> <p>B) magnetic borne pressure of the machined materials C) mobile fields instead of static fields</p> <p>object's pressure magnetic pressure magnetic pressure</p>	<p>34) DISCARDING & RECOVERING, (REJECT & PARTS REGENERATION)</p> <p>a) dissolvable medication capsules made of (biologically inert material) around the drug b) rocket's stages subsequently discarded during the flight c) constalch-baked packages for dry products</p>
<p>02) TAKING OUT</p> <p>a) taking of notoriously noisy power unit, or compressor out of the main boat b) ferris wheels, blades) connected with internal ducts for air ventilation system, taken out of the building, i.e. placed on the buildings elevations c) stand of bin's predator, precisely registered on a bird, and played back, can be used scanning away the birds, notoriously flying near or around the airports</p>	<p>09) PRE-ELIMINARY ANTI-ACTION (COUNTER-ACTION)</p> <p>a) surrounding sounds b) piezoelectric active earphones c) piezoelectric active earphones d) anti-impact system for cutting tool</p>	<p>16) EXCESSIVE (OR PARTIAL) ACTION</p> <p>a) in close fit of both piston and cylinder of the engine b) to spray excessively paint, and then to remove the excess of the paint c) to fill the fuel tank, and then to remove the excess of fuel</p>	<p>23) FEEDBACK PRINCIPLE</p> <p>a) input signal b) output signal c) closed loop with negative feedback d) feedback</p> <p>input signal output signal closed loop with negative feedback feedback</p>	<p>29A) PNEUMATICS & HYDRAULICS</p> <p>a) basically, as well as pneumatics b) pneumatic automobile lym, pneumatic (air-light) dampers, automobile airbags, pneumatic "discs", driving of operational actuators, for instance: in automatic welding of packaging covers made of plastic wrapping on the figure above, in blue: approximate section of automobile pneumatic tyre</p>	<p>35) CHANGING STATE, PARAMETERS, PROPERTIES OF MATERIALS</p> <p>1) high temperature 2) low temperature 3) product ready for further processing (for submerging in liquid chocolate)</p>
<p>03) LOCAL QUALITY</p> <p>a) dustless extraction of coal - fine dust is captured for tiny droplets, made to the water b) fogger droplets outside of the cone keep the dust in the cone c) weighed container produced for readings of computers, printers, etc.</p>	<p>10) PRE-ELIMINARY ACTION</p> <p>a) parking of hard disc reading/writing heads (when it is needed) b) blowing off of the (potentially clogged) nozzles in printing cartridges</p>	<p>17) ANOTHER DIMENSION</p> <p>a) in horizontal plane to should be rearranged in 3D plane b) to stack vertically containers, etc. c) sphere of complex structures of electron shells, atomospheric phenomena</p>	<p>24) INTERMEDIATE MEANS, "FITTING" PRINCIPLE</p> <p>a) in electronic circuits b) fitting either of: - impedance, - resistance, - capacitance c) fitting of input means to the receiver to receive its impedance</p>	<p>29B) PNEUMATICS & HYDRAULICS</p> <p>a) automobile brakes, in driving of plane elevator, where the precision of driving is needed, as well as enormous force transition b) hydraulic communicating vessels c) S₁ F₁ = S₂ F₂</p>	<p>36) PHASE TRANSITION</p> <p>a) binary, phase transition cycle for refrigerator construction b) heat carrier c) liquidated ammonia, heat carrier d) condensed in external liquid heat exchanger</p>
<p>04) ASYMMETRY</p> <p>a) pneumatic tyre asymmetrically reinforced from outside, due to contact with pavement curb b) left or right-handed rules of priority, in right of road c) slanted concrete mixer, blender d) asymmetrically built conveyor e) asymmetrically defined functionality of the "trap-the-door" mechanisms f) asymmetrically built car, due to either left- or right-sided driver's sit</p>	<p>11) BEFOREHAND CUSHIONING</p> <p>a) for instance: a method of "dressing" of the cut tree branches (this action, actually forces a tree to beforehand reaction, to gather healing substances) pressing band b) driver's airbag c) masking of the chosen elements, within patches on the object, before its painting</p>	<p>18) MECHANICAL SELF-INDUCED VIBRATIONS (IN RESONANCE)</p> <p>a) piezoelectric engine - 9 conceptual design b) electric circuit of induction c) spring based tighteners for set of two discs d) both sided metal plating of rigid ceramic material fasten to lower disc quartz generators, in electric circuits</p>	<p>25) SELF-SERVICE PRINCIPLE</p> <p>a) self-servicing lamp b) constant temperature of halogen lamp c) constant temperature of halogen lamp d) constant temperature of halogen lamp</p>	<p>30) FLEXIBLE FILMS, FOILS, MEMBRANES</p> <p>a) not waste material of water b) wrapping packaging c) inflatable balloons, domes, barriers d) air-pumped bubbles</p>	<p>37) THERMAL EXPANSION</p> <p>1) thermal shaft fitting 2) state of thermal balance 3) thermal shaft fitting 4) state of thermal balance</p>
<p>05) MERGING</p> <p>a) several computers combined into functioning network b) a hedge made of pallets c) textiles made of wool/polyester/cotton fibres d) nozzling lines combined into coverage of house roof e) mobile concrete mixer, mobile crane, refrigerator merged into single mobile machine unit, combining of the stationary machines with mobile undercarriages</p>	<p>12) EQUIPOTENTIALITY</p> <p>a) a sequence of linear movements is replaced by single sinusoidal movement or section of arc b) heavy element of the press, lifted up, and carried away usually in sequence of linear movements is replaced with press deflected on remotely fasten long arm c) press deflected on remotely fasten long arm d) bidirectional conveyor, blades of roller to cool down stuck inner object, then to heat up other bigger outer object, which allows the former one</p>	<p>19) PERIODICAL ACTION, OR PULSED ACTION</p> <p>a) hammer drill b) ground laser, against layers c) pseudo-analogous driving (PWM) (Pulse Width Modulation) d) pulse DC power unit e) equal conventional DC power unit f) step motors</p>	<p>26) COPYING, IMAGING PRINCIPLE (application of optical mapping)</p> <p>a) use of ultrasound mapping b) magnetic resonance mapping c) X-rays radiography d) in mapping of material structures the application of: - infrared mapping - ultrasonic mapping - basicity of optical methods e) use of fluorescence and of scintillation's materials</p>	<p>31) POROUS MATERIALS</p> <p>a) aerated concrete (porous concrete) in kitchen filters b) polyurethane c) catalytic surfaces in chemest d) "vacuum" as a "construction" building material e) catalytic surfaces in chemest f) catalytic surfaces in chemest</p>	<p>38) STRONG OXIDANTS</p> <p>a) oxygen b) ozone c) indirectly H₂O d) oxidation of iron's surface (iron with over-heated vapour under pressure at 300°C degree) the surface with protection layer obtained due to oxidation</p>
<p>06) UNIVERSALITY</p> <p>a) helmet in use, rendered as b) universal handy-tools c) sets of universal kitchen robots, mixers, blenders, with operating actuators (rasps, juice extractors, etc.)</p> <p>a1) spade a2) frying pans a3) Swiss Army knife</p>	<p>13) INVERSION (UPSIDE DOWN)</p> <p>a) in reversing the working mode of vacuum cleaner (then, vapour could be used in cleaning carpets) b) to turn mounted object upside down, on assembling line c) clamping (object is move, while motionless turning tool, against milling (mobile milling cutter) d) binary tree's structure is sought from root to leaves in one (in-depth) search algorithm, while another algorithm seeks thought nodes from leaves to root</p>	<p>20) CONTINUITY ACTION OF USEFUL ACTION</p> <p>a) jetting oil, opening, bypasses of catridge, in both directions b) in returning direction (without die mode) c) steam turbines of generators for one power plants, working continuously (in optimal mode), while the others are in stand-by d) in aim of storing of energy for afternoon hours (mode: pumping of the water into upper reservoir on morning, while emptying upper reservoir into lower one on afternoon)</p>	<p>27) INEXPENSIVE SHORT-LIVED OBJECTS (CHEAP CAUDACY, & OF DISPOSABLE MATERIALS)</p> <p>a) kitchen utensils, dishes, b) disposable syringes, c) plastic bags, d) printing head packaging wrappers, etc. integrated with job catridge (formerly, each printer possessed built-in printing head) (presently, each of ink cartridge has its own printing head)</p>	<p>32) COLOUR CHANGING (ALTERNATING)</p> <p>a) in tapping process for inner surfaces of engine pistons & cylinders, the probing of phosphorescent distribution can be used</p>	<p>39) NEUTRAL ATMOSPHERES, INERT ENVIRONMENTS</p> <p>a) CO₂ extinguishers b) N₂ or He-protection atmospheres in processing, and production c) N₂ or He₂ protection atmospheres in storing of products, and materials, both raw and processed</p>
<p>07) EMBEDDED STRUCTURES (nested "Dobles" - Matryoshka)</p> <p>a) rotors of ultrasonic welders</p>	<p>14) SPHEROIDALITY, CURVATURES</p> <p>a) applications of: - linear movements - by circular movements b) bearing rollers, spirals, shafts, splines, stem-domes c) application of arcs in architecture (stem-domes in vaults of building) d) circular agitators (psychrotors / magnetors) of ultrasonic welders e) extensible, retractable measuring tape</p>	<p>21) SKIPPING, QUICK MODE, OR PACE OF REALIZATION</p> <p>a) woodcutting - in a pair of gears b) laser treatments of biological tissues (both extremely soft and extremely hard) with the help of femtosecond laser beams c) laser treatments of biological tissues (both extremely soft and extremely hard) with the help of femtosecond laser beams d) laser treatments of biological tissues (both extremely soft and extremely hard) with the help of femtosecond laser beams e) laser treatments of biological tissues (both extremely soft and extremely hard) with the help of femtosecond laser beams</p>	<p>28A) PRINCIPLE OF SUBSTITUTING OF MECHANICAL SYSTEM WITH FUNCTIONALLY EQUIVALENT ELECTRO-MAGNETIC SYSTEMS</p> <p>a) mechanical pressure b) magnetic field c) fastening</p>	<p>33) HOMOGENEITY</p> <p>a) elements of blades, rotors, air screws in wind turbines constructions; b) yacht's & catamaran's constructions; c) elements exposed to ultra-strong, severe stress</p> <p>moreover, the similarities can be applied, regarding: - comparable materials hardness, chemical reaction, structures - comparable thermal expansion's coefficients, - comparable electrical conductivity, metal glass constructions, - comparable electro-chemical potentials (in case of electro-chemical borne corrosion) - same fatigue characteristics, and amortization specifics</p>	<p>40) COMPOSITE MATERIALS</p> <p>1) elements of blades, rotors, air screws in wind turbines constructions; 2) yacht's & catamaran's constructions; 3) elements exposed to ultra-strong, severe stress</p>

A technique of engineering creativity and inventive thinking in solving the problem



Solution procedure of method TRIZ



Algorithm ARIZ

is an algorithmic approach to **finding inventive solutions** by identifying and resolving contradictions. This includes the "system of inventive standards solutions" which Altshuller used to replace the **40 principles and contradiction matrix**. A number of TRIZ-based computer programs have been developed whose purpose is to provide assistance to engineers and inventors in finding inventive solutions for technological problems.

Methods increasing the creative performance of team

- **Discussion method** – the need to apply in a collective, to be recognized, to dominate, to compete, and to win.
- **Deferred evaluation method** - We divide the intellectual activity into two basic activities - **the creation and evaluation of ideas**. These activities are continually alternating and intertwining. There may be premature rejection of thoughts that could be divorced into usable form. Brainstorming, Discussion 66, Creative Confrontation

Basic rules of Brainstorming

The brainstorming father is Alex Osborn. Brainstorming defined by defining five basic rules:

1. Prohibition of criticism
2. Unleash fantasy
3. Mutual inspiration
4. Quality over quantity
5. We are all equal

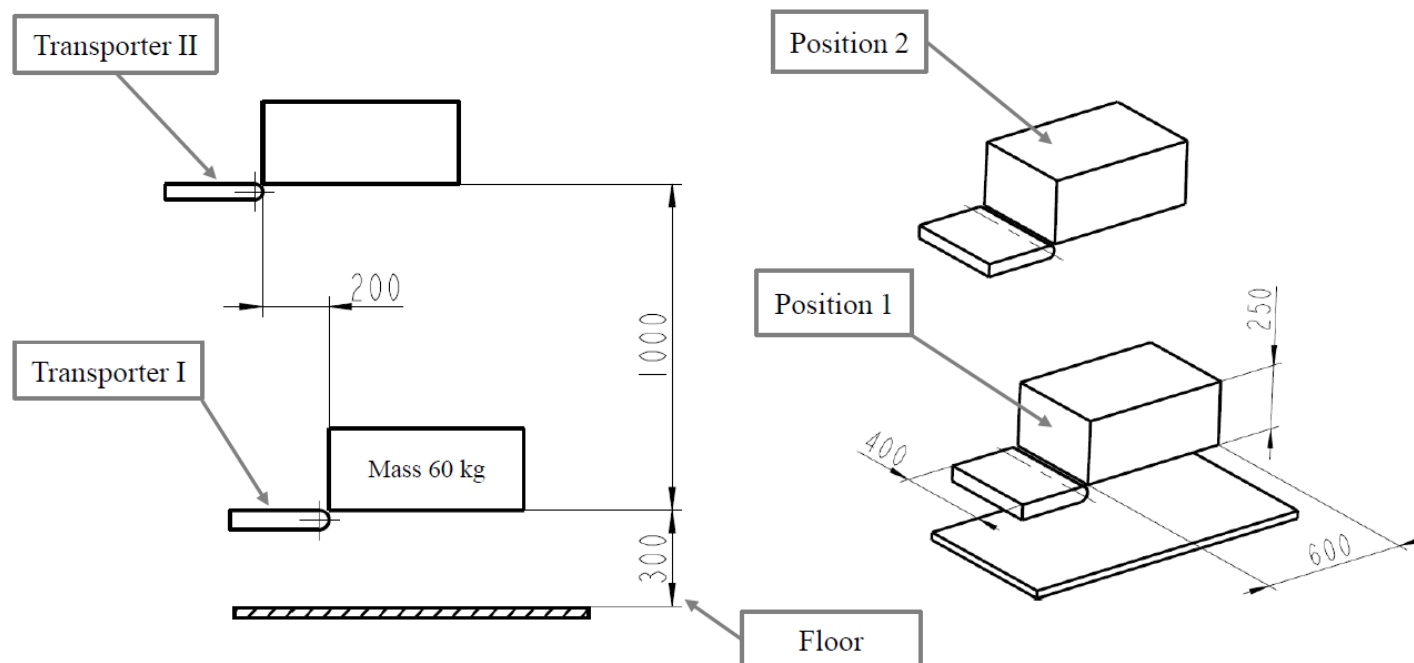
General structure of brainstorming

- **Introducing brainstorming rules:** It is necessary to become familiar with the rules of brainstorming.
- **Problem and assignment definition:** It is essential to specify the technical problem as well as to clarify this problem as accurately as possible.
- **Warm-up:** It is important for tuning, synchronizing and unleashing creative potential. It can take the form of a game or a competition.
- **Brainstorming:** The session itself can take place in a circle or in a U-shaped group. Some ideas need to be recorded (record, write). During the session it is strictly forbidden to evaluate, otherwise everything can. Copyright does not apply here. It is good to develop the idea. To build on the ideas of others, to develop them.
- **Evaluation:** It is necessary to summarize the knowledge and ideas from the session itself and to evaluate them. Submitted is an analysis and draw conclusions.

Example:

Assignment:

Design a device for moving a body of $m = 60 \text{ kg}$ mass, from position 1 to position 2. Body dimensions are $400 \times 600 \times 250 \text{ mm}$. The height difference is $z = 1000 \text{ mm}$. Vertical shift is $y = 200 \text{ mm}$. Time for body manipulation is $t_{max} = 12 \text{ s}$. Create required 3D and 2D documentation.



Example:

- a. **Introducing brainstorming rules:** Submission of a clearly defined problem. The team manages the moderator (organizer, director and inspirator).
- b. **Specify the problem:** Example of a technical problem.
- c. **Warm-up:** Before starting your own brainstorming, it is good to activate gray cerebral cortex so-called mental warming. There are many social games that meet this. At the same time, it also serves to relax the atmosphere. An example of such a social game may be „Name fixing“. Good for memorizing the names of the participants so that it is not necessary to have namespaces ahead of you (only if the participants do not know).

Example:

- d. **Brainstorming:** The session itself takes place in a U-shaped group so that everyone can see it well on the board. The lecturer will take up the role of moderator. The group chooses writers of ideas. Also, drawings will be used to draw ideas, to illustrate the solution. It will be written by each author himself. Seance will take approx. 40 minutes. Strict prohibition of negative emotions, ridicule, criticism. It is important to develop ideas from third parties, boldness and fantasy.
- e. **Evaluation:** It is necessary to critically evaluate all ideas and choose those that are real. Then there must be a detailed analysis of selected solutions, from many points of view. These aspects are the subject of another exercise (lectures).

Conclusion

- Each creative work has a positive influence on its surroundings.
- Through creativity we move our everyday life for the better.
- In everyday life, creativity is a way to solve problems.
- It is a certain exercise in the mental approach to the problém.

Questions:

- What is „Creative activity“.
- Describe the creative team and the roles of its members.
- Describe „Brainstorming“.
- Which methods do you know for increase individual creative performance.
- Which methods do you know for increase team creative.



Topic of the next lecture:

**„Evaluation of variation solution and
selection the best solution“**

Thank You



Used literature and sources of information:

[1] Beneš, M., Valášek, M.: Metody tvůrčí práce, 2. rozšířené vydání, BEN 2008, ISBN 978-80-7300-192-6.

[2] Brainstorming. Available from:

<http://www.outofbox.cz/blog/11-brainstorming-opravdu.html>