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BECOME USER OF TRIZ TOOLS INSTEAD TO PLAY HIDE AND SEEK

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Abstract

The only possible solution for improving the dynamic properties of a car has long been considered to be optimization. Unfortunately this results in compromise: either an optimal family car, or an optimal sports car. Now, however, developers are making an increased effort to move away from the previous approach of looking for compromises towards the advanced application of their knowledge and use of innovations which can be considered as the unwitting use of trends and patterns of technology development. The challenge for breakthrough perfection of the dynamic properties of a car is to overcome the contradiction between ride comfort and driving safety and to achieve the best possible ride comfort and driving safety simultaneously. An expert on cars, who works without knowledge of the TRIZ approach, draws upon only his area of knowledge, therefore he tries to remove a local conflict (physical contradiction) through new resources (additional equipment to produce force) which results in high value but also unwanted complexity and high costs. This paper presents a case study which showed that improvement of the dynamic properties of the car achieved through the use of TRIZ tools is more effective than the current deployment of expensive raw power. An expert on the TRIZ approach has the mission of guiding the car expert on how to intentionally search for initiatives in successful patents from all areas of knowledge and warns that the removal of local conflict must to take advantage of local resources (drive and braking torque) which makes it possible to achieve high value at low cost. This article aims to convince innovators that, when they will intentionally use TRIZ tools, they enhance the effectiveness of own expertise and diligence.

Keywords: ride comfort, driving safety, TRIZ tools.

1. Causes, needs and tools for perfection

1.1. Epochal discovery

From time immemorial, people have tried unwittingly (without knowledge of laws) improve creations (products and processes) and among random successful cases which originated by way of trial and error, they were searching for "miraculous" common procedure.

Altshuller's epochal discovery of invention patterns under the laws of technology improvement (1946) was essential for understanding how to detect and creatively exploit previously hidden interdisciplinary context (TRIZ: the inventive problem solving theory), [1].

According to a contemporary vision, the driving force behind all the action (framing, development and demise) in nature is the ubiquitous attraction of perfection-ideality expressed in the form of the Law of perfection: $\text{Value} = \text{Function} / \text{Cost}$, (Maupertuis, 1746: the Law of least action), [2].

The Law of perfection was scientifically confirmed when Carnot in 1824 described the cycle of a perfect-ideal heat machine, which has the greatest possible (maximum) theoretical efficiency, and according to the second law of thermodynamics pronounced in 1850 by Clausius, it has zero disorder (entropy).

Thus, everything in nature (a great example is the brain) has an innate desire to get as close as possible to the unreachable goal, which is perfect efficiency as a result of perfect usefulness and perfect economy (zero effort and outcomes).

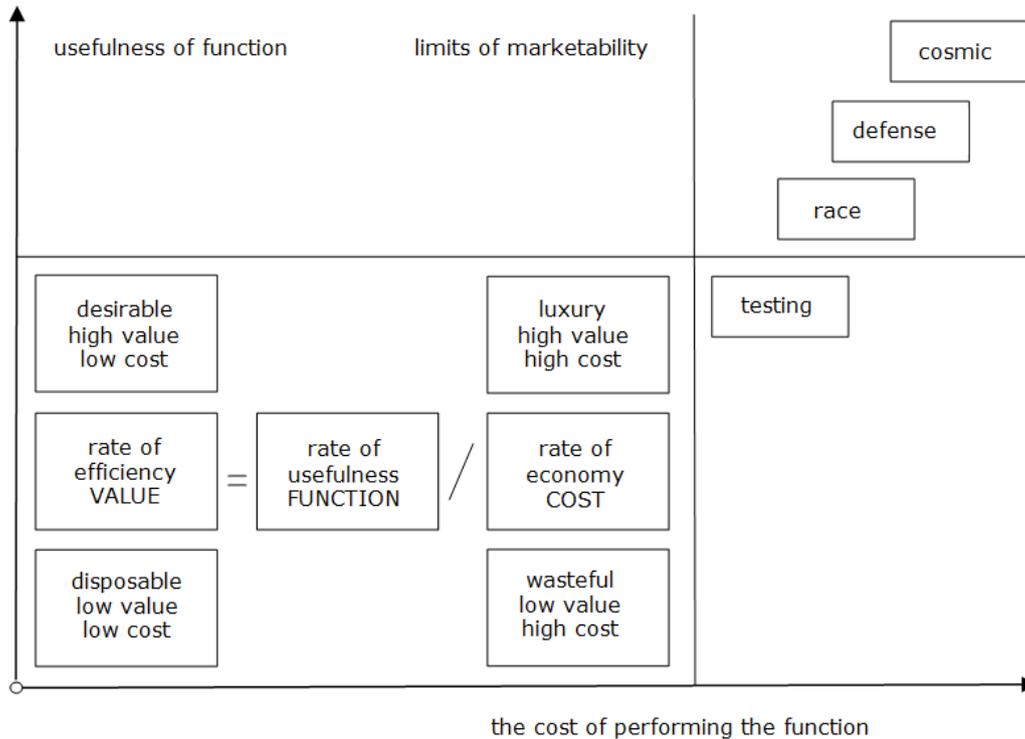


Fig. 1. The value of creations is a measure of their cost effectiveness in fulfilling of their function

The right innovations with the correct properties are popular and successful because they are economical, efficient and effective. They provide a lot for little and make good use of resources, so they are cost-effective for the purchaser (right needs) and are effective for the manufacturer (right goals).

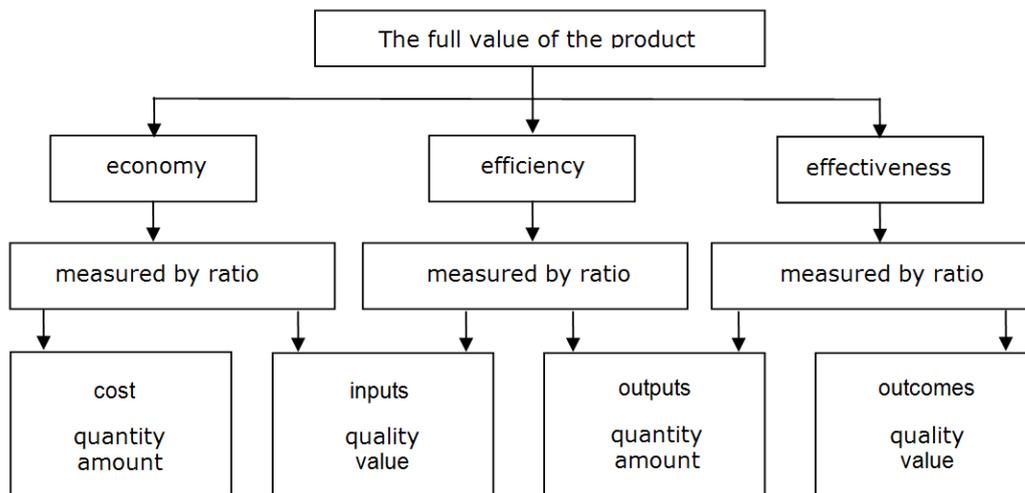


Fig. 2. The full value product is excellent (economical, efficient and effective)

1.2. Surprising results from brain research for the TRIZ approach

The mystery of the miracle of the emergence of something from nothing (the emergence of the universe) by the influence of the ubiquitous attraction of perfection in the form of the Law of perfection of the creators and creations contains in itself the emergence of the sub-consciousness

from matter (the emergence of the life-body aspect), the emergence of consciousness-feelings from the stimuli (the emergence of self-consciousness-thinking aspect) and the emergence of the super-consciousness-conscience from the desire for perfection (the creation of love-the spiritual aspect), while love is a manifestation of humility.

The TRIZ approach today is both science and art, which is in line with the laws of development-perfection of advanced logical thinking (dialectics), (Petrov 2002), [3]:

- the law of the unity (interpenetration) of opposites (contradictions);
- the law of transformation of quantity into quality (S-curve); and
- the law of the negation of the negation (spiral development, fractal vortex).

The worldwide initiatives (USA, EU, Japan, China) to advance brain research have these goals:

- the discovery of ways to improve the diagnosis, prevention, and treatment of brain disorders;
- the theoretical modeling of the brain and the development of brain-based artificial intelligence to improve computers;
- the integration of neuroscience with social and behavioral sciences to improve education, life management of a society and creative inventive thinking.

The Nobel prize for the discovery of the collaboration of sentient thinking in the right part of the brain with considering thinking in the left part of the brain obtained Sperry in 1981, [4].

Kahneman was awarded the Nobel prize in 2002 for discovery of slow and painful thinking in the upper part of the brain: neocortex (cerebral), and quick and easy thinking in the lower part of brain: limbic system (basal), [5]. There is lot of scientific evidences (superior pattern processing among others) in the article [6] that development of the brain follows the law of perfection.

Based on results from brain research Fig. 3 depicts a generic pattern of the consecutive steps to deliberately improve conscious thinking about creations taking suggestions from the sub-consciousness and inspiration from the transcendental super-consciousness (meta-cognition).

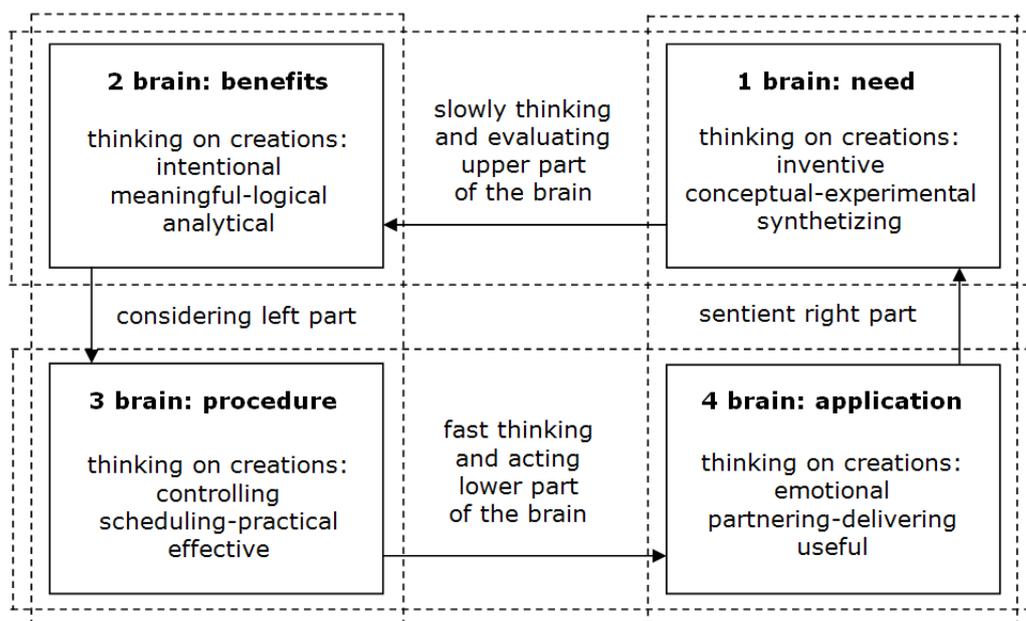


Fig. 3 A generic pattern of consecutive steps for the perfection of conscious thinking

One of the most important result from brain research is that the level of maturity of thought and communication (IQ-intelligence quotient) is inherit and remains almost the same throughout life, with an influence of only 25% on the ability to solve tasks and develop brakthrough innovations. So, the European Commision for Education recommended replace the inefficient ways of teaching in the schools via creative thinking [7]:

- 25% of the time should be given to development the expertise and perception of speech: (IQ-intelligence quotient),
- 25% of the time should be given to the development of mature toughness and will: (AQ-adversity quotient),
- 50% of the time should be given to the development of the perception of images and the ability for collaborative relationships: (EQ-emotional quotient), due to critical capability for successful solution of tasks, while it can be significantly increased using suitable exercise for developing the creativity using the TRIZ approach, which is suitable trigger for synergy of the individual benefits (ingenuity, toughness and sensitivity) by aligning their cooperation toward self-perfection $PQ = IQ \times AQ \times EQ$, where PQ-perfection quotient is a measure of maturity of perfection.

1.3. Perfection of knowledge

Thanks to the extraordinary increase in access to knowledge through the Internet, it is important to have a wider knowledge of the context of each instruction (everything is related to everything, the interdisciplinary approach). Not only does the value of knowing for the present (what is needed today) become important, but also the ability to predict the development of knowledge (what will be needed) and to be prepared for it in time.

When we consider acquiring knowledge from successful patents, the abstraction of company expert knowledge is a process involving knowledge transformation in which the real or quantitative attributes are replaced by abstract or qualitative attributes. As a result of this transformation, the transformed knowledge together with knowledge from outside of the company becomes applicable to a much larger class of systems than the original systems that provided the initial knowledge, [8]. The TRIZ approach enables identification and structuring of the knowledge in order to facilitate innovation via generic pattern of the knowledge life cycle in Fig.4.

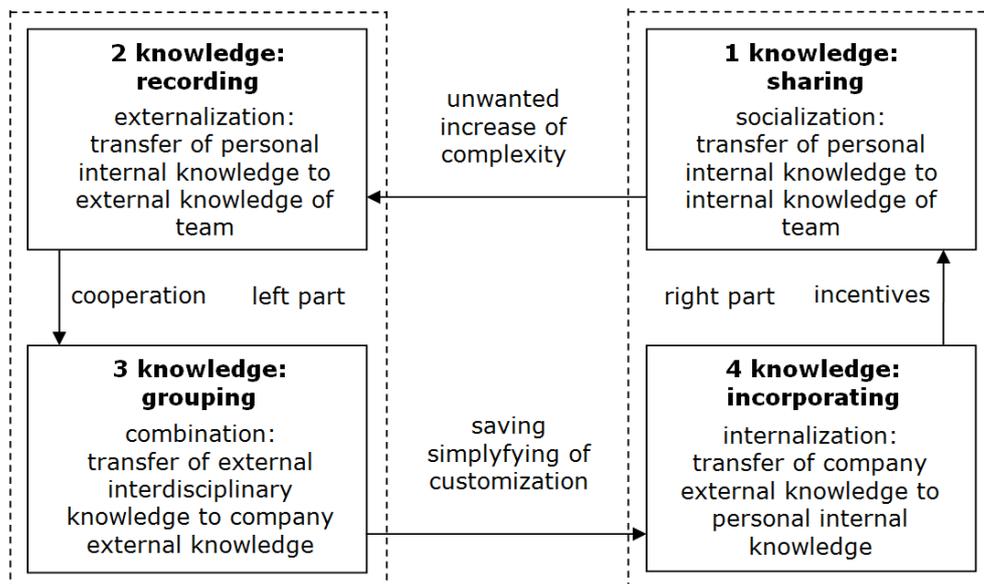


Fig. 4 A generic pattern of consecutive steps for the perfection of knowledge

The generic pattern of knowledge sharing is a cycle starting with the transfer of personal knowledge to the internal knowledge of a team, which we denote as socialization. The creators can practically share their unique experience of creating, when they put tacit experience into clear terms, rules and techniques based on the objective laws of the TRIZ approach.

The second step is externalization: the transfer of personal internal knowledge to the external knowledge of the team which can be recorded as the intellectual property of a company.

In the third step, a combination takes place: the transfer of external interdisciplinary knowledge to the company's external knowledge by means of collaboration with an expert from outside of the company under the supervision of TRIZ expert.

The fourth and final step (internalization) concerns increasing the usability and the level (quality) of personal knowledge by customizing-adapting the company knowledge.

2. TRIZ approach for perfecting the dynamic of the car

2.1. Conflict-contradiction between ride comfort and driving safety

Vehicle suspension system performance is typically rated by its ability to provide improved road handling (driving safety) and improved passenger perception of oscillation (ride comfort), [9]. The fixed setting of passive suspension properties is always a compromise between ride comfort and driving safety for any given road conditions on the one hand, and payload suspension parameters on the other. When engineers attempt to improve the car's ride comfort (A) so that no sudden changes in the position of the car body (under minimum acceleration), this deteriorates driving safety (B) in the form of undesirable jumps of the wheels. The traditional approach to improving engineering systems through optimization within their design concept without knowledge of the TRIZ approach allows only small and vulnerable improvements which are valid only for a narrow variation of the initial properties and results in unwanted compromises. Hence we have the concept of the family car that has good ride comfort (A_D) in Fig.5a, but poor driving safety (B_Z) and the sports car that has good driving safety (B_D), because it maintains the wheels in constant contact with the road (without jumps), but it has poor ride comfort (A_Z).

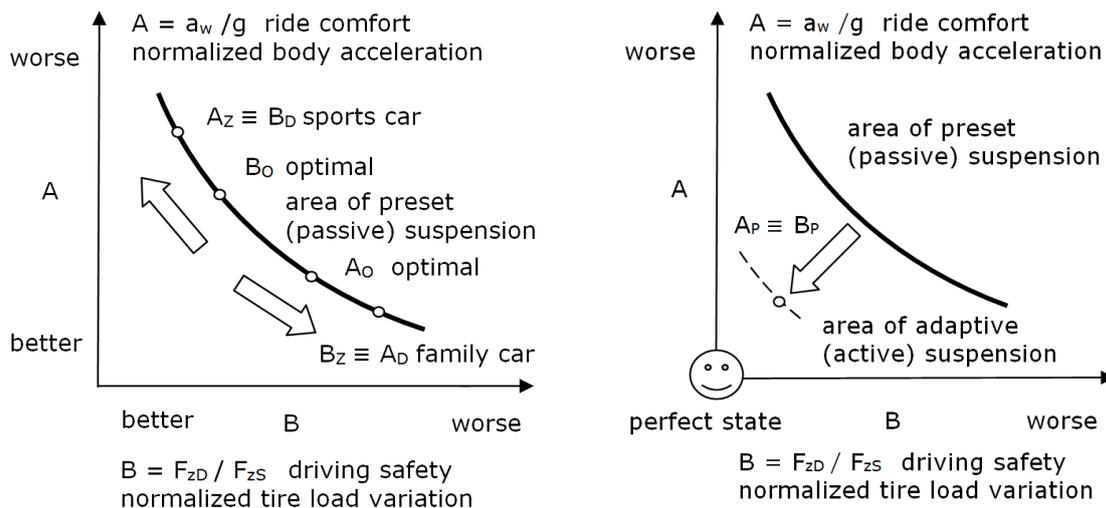


Fig.5 Target conflict-contradiction between ride comfort (A) and driving safety (B) for a) passive suspension, and for b) active suspension

The main objective of suspension systems is to reduce the movement of the car body (sprung mass). Therefore the challenge to achieve a breakthrough perfecting the driving performance of a

car is to overcome the contradiction (opposing ride comfort and driving safety), and to achieve the best possible ride comfort and driving safety ($A_P \equiv B_P$) in Fig.5b simultaneously.

2.2. Improvement of car without knowledge of the TRIZ approach

An expert on cars who works without knowledge of the TRIZ approach uses only his area of knowledge, therefore he tries to remove a local conflict through new resources (additional equipment to produce force). The result is a luxury car of high value but high costs (Fig.1). A Magic Body Control system [10] with a camera which scans irregularities in the road ahead. Then the Active Body Control system [10] uses a hydraulic piston to act on each steel coil spring to quickly and independently adjust the suspension on each wheel and provide the best possible ride comfort and driving safety ($A_P \equiv B_P$) on Fig.5b simultaneously.



Fig.6 a) Magic Body Control system and b) Active Body Control system

2.3. Perfecting of car using the TRIZ approach

Each problem is unique and needs a expert of TRIZ approach to interpret the knowledge from other areas (out of the box) to understand the language of the company expert and to adapt his knowledge to a new individual application. Knowledge management moves from the purely technological into the area of mature relationships and cooperative culture (Fig.7). So, the solution to knowledge management is more cultural than technological.

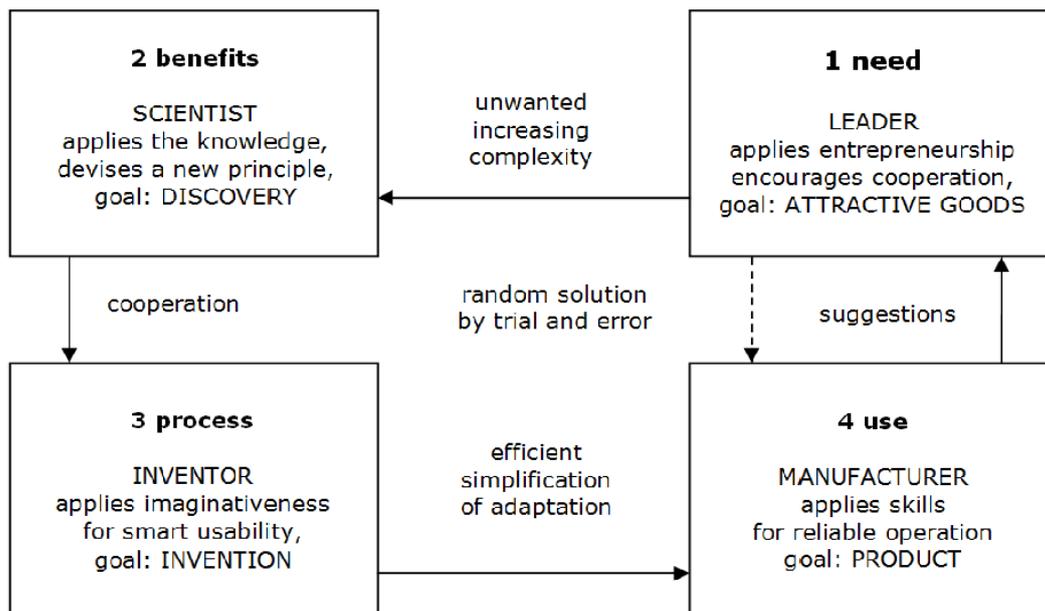


Fig.7 A generic pattern of consecutive steps for systematic cooperation

In the TRIZ approach the essence of the generic pattern of consecutive steps in Fig.8 (need, benefits, procedure, and use) for systematic perfection of vehicle dynamic properties: ride comfort (A) and driving safety (B) is to recognize and solve (overcome, remove) contradictions, [11].

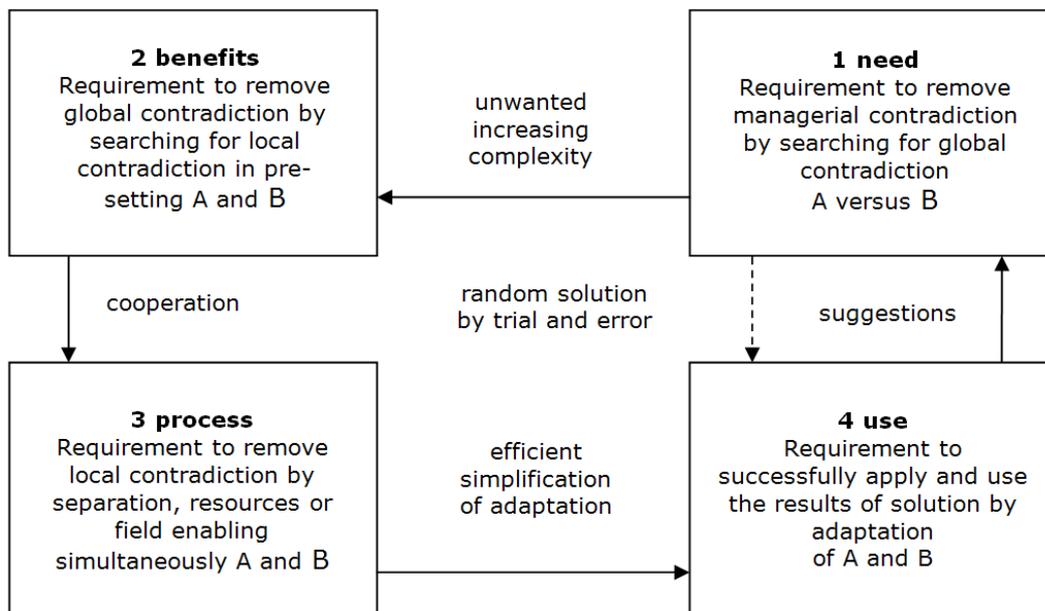


Fig.8 A generic pattern of consecutive steps for the perfection of creations

Step 1 - Why? analysis of challenges (need)

When the need arises to overcome market opponents or resolve a customer's requirement, the leader-manager first defines the managerial-administrative contradiction on the level of intention for a change. This is the contradiction between the requirements to improve the car and the absence of the conditions to do so (need to identify the targets, acquire knowledge of the process and ensure proper resources). The principle for overcoming the managerial-administrative contradiction is to seek out and remove the global-technical contradiction.

Step 2 - What? do the right things (benefits)

The global-technical contradiction at the system level of creation is the conflicting relationship between the features of the parts of the whole creation when improving one part: ride comfort (A) at the level of car body it worsens the second part: driving safety (B) at the level of the wheel. The overall principle for overcoming this global-technical contradiction is to search for and remove the local-physical contradiction.

Step 3 - How? do things right (process),

The local-physical contradiction at the single part (suspension) level: the suspension of the car body must ensure zero change in the force transmitted to the car body for its desirable zero heave, and at the same time to ensure non-zero change in the force which pushes the wheel onto the road. Then the car can provide the best possible ride comfort and driving safety ($A_P \equiv B_P$) on Fig.5b simultaneously.

The physical contradiction can be solved (overcome, remove):

- by separation of conflicting requirements: in space, in time, on conditions, and substitution,
- by use of resources: interdisciplinary information, energy, substance, space, effects and time,
- by transition from solid state to the field.

Step 4 - Who? collaborate with right people (use)

The expert of the TRIZ approach has the mission to guide the car expert on how to intentionally search for initiatives in successful patents from all areas of knowledge and to warn that the removal of local contradiction must take advantage of local resources (drive and braking torque) which make it possible to achieve the desired high value at low cost car.

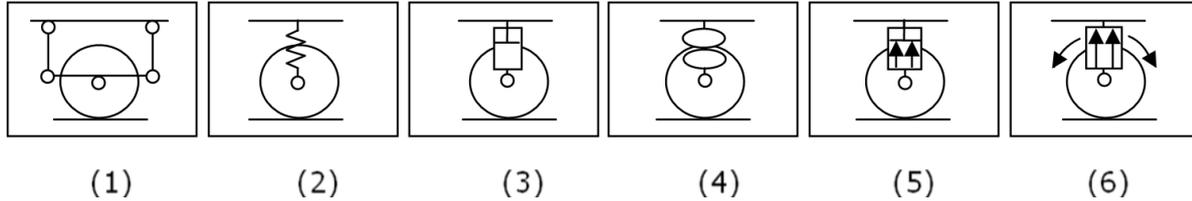


Fig. 9 The trend of suspension development to the control of driving and braking torque

Fig.9 shows the transition from the preset (passive) features of a mechanical suspension (1), (2) to a hydraulic suspension with self-adaptable change of magneto rheological fluid properties, (3) to a hydro-pneumatic suspension (4), to the adaptable (active) suspension with electronic management of features (5), toward the recent removal of unwanted movements of the car body (vertical heave, yaw, roll and pitch) for desirable ride comfort (A) by quick control of the drive and braking torque acting on the wheel motors using a LEAF system: (Leading Environmental Affordable Family car), [12] and ensuring the necessary wheel load for driving safety (B) simultaneously (6), (Fig.10). This is the evolution of the suspension system to the innovative breakthrough perfecting.



Fig.10 a) torque increase causes raising up the front of the vehicle, b) by torque decrease the front of the vehicle will be lower

3. Conclusions

The exceptional ability of the brain for conscious thinking (in collaboration of consciousness with the sub-conscious and super-consciousness) is associated with its connection to the ubiquitous effect of attraction of perfection.

The current understanding of the ability of the mass to act work (energy and its transformation in the field of mass) makes it possible to imagine the ability of brain to act in the massless field in the form of thoughts, ideas, and information, which is also a manifestation of the ability to act work (energy and its transformation) because the results of its application are advanced properties of creators and their creations.

The TRIZ approach was the result of exploring effective creations (products and processes) to find out which creativity principles were necessary to create these successful creations. Therefore, using TRIZ policy rules, concepts, and procedures allows us to improve the ability to create. The successful creator has the ability to think effectively, act ethically, communicate clearly, and manage efficiently. The efforts made so far to achieve success in the marketplace have mainly been aimed at breakthrough maturity of the products, but they will only be created by a mature creator

who has advanced feelings, thoughts and actions, and the breakthrough products will be accepted only by consumers with advanced needs in an environment with an advanced infrastructure. Our collective understanding of the world is becoming more comprehensive, complex and complete. This means that to carry out their work successfully, engineers have to take into consideration that a efficient way how to stay informed of new and emerging technologies, is cooperation. Digital Embodiment of Function [13] enables to more exhaustively use all new resources of engineering development.

Each successful innovation arises with respect for laws of perfecting, even if innovators working without the knowledge of TRIZ approach are unaware of it. When using the TRIZ approach, the advantage is that the creator achieves his goal more efficiently, with less effort, in less time and making the most efficient use of the resources available under the given conditions. The formula for breakthrough creations = Crazy ideas + Enthusiasm + Laws of perfecting + Collaborative relationships based on the high EQ-emotional quotient (Fig.11).

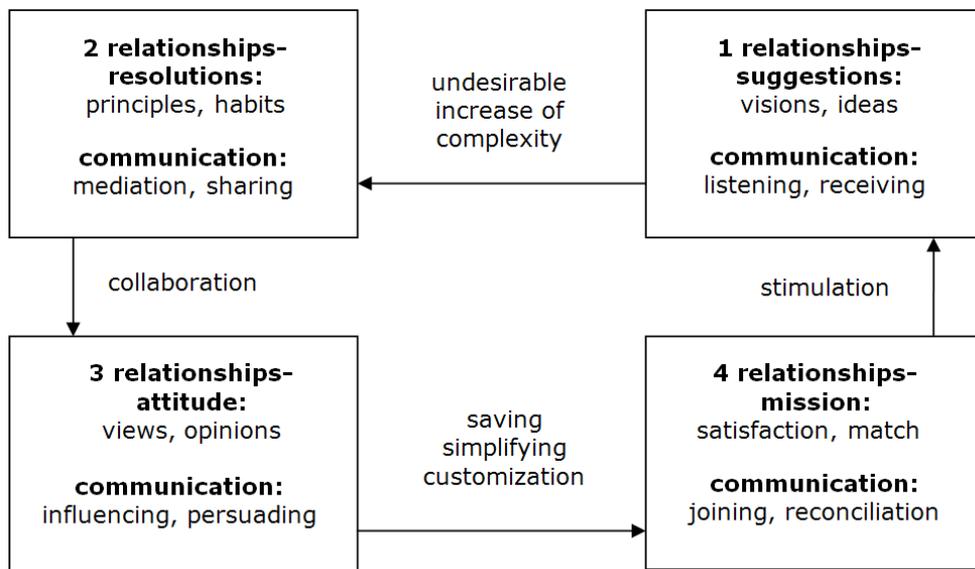


Fig.11 A generic pattern of consecutive steps for the perfection of collaborative relationships

The feedback between innovators, innovations and infrastructure is the mechanism responsible for the evolution of our civilization in the desired direction satisfying our higher needs toward correct relations-values for humble and satisfied coexistence.

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