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MANIFESTATION OF ALTSCHULLER'S PRINCIPLES IN SOME TECHNOLOGICAL DECISIONS FROM THE FIELD OF TRANSPORT ENGINEERING

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Abstract: *Solving inventive tasks and finding new more rational decisions is a current task, which covers all areas of activity in modern life. The new and more correct solutions can be used both in the methodology of educational training and in our daily scientific and technical practice. This paper deals with the manifestation of the Theory for Solving Inventive Tasks (TRIZ) of Altschuller in the field of transport equipment. The carried out analysis in the paper shows that the proper development of transport engineering can be ensured only when this development is in line with the established logical system and when there have been applied sound logical principles. Some of the newest technological solutions are analyzed in the field of transport engineering and the manifestation in them of the principles of the Altschuller logical system.*

1. INTRODUCTION.

The idea of the technique used in our daily lives is formed primarily from already existing devices. Its parameters are impressive: speed, power, size. Still the progress in improving the products we use are related to new ideas.

We formulate in this paper the idea that the application of a logical system of principles can help the process of design and production. All of us need a revolution in the approaches to solve problems, especially in the field of transport equipment. A pattern of development of technical systems is that it must be subject to clear logical principles, because otherwise it is very likely to get a regressive development, and as a result – inadequate technical systems, too, with shorter sevice life.

A simple technical problem converts into an inventive problem if its solution goes through the elimination of a fixed technical contradiction. If a single property of a system contradicts to some other in the same system then the development implies a deterioration of the system operation as a whole. In the process of evolution our brain has found empirical approximate solutions of simple problems. Evolution has not made mechanisms for exact solutions of complex problems yet. It is known that researchers and inventors make their suitable approaches to solve technical problems gradually but as a rule these approaches are

not many. Inventors tasks are infinitely numerous but the contradictions in them are often repeated.

2. PRINCIPLES AND METHODOLOGY OF GENTRICH ALTSHULLER.

In 1973 Genrich Altschuller (1926÷1998) formulated 40 typical principles to remove technical contradictions and for the development of technical systems [1÷3]. Such are the principles of fragmentation, export, local quality, asymmetry, union, universality, 'matrioshka', antiweight, apriori tension, apriori execution, apriori cushion, equipotency, contrary, roundness, dynamism, partial or excess solution, passage in another dimension, usage of mechanical vibrations, revesal of the harm into benefit, feedback, copying, use of porous materials and phase transitions, etc.

The following principles of the Altschuller logical system are considered as a manifestation in transport engineering in this paper:

(02) The principle of distinction (separating the interfering part or property from the object).

(03) The principle of local quality.

(20) The principle of continuous efficiency.

(22) The principle of utilizing the harm.

(24) The principle of the intermediary.

(25b) Used waste (energy, materials).

(28) Replacement of mechanical systems with electrical, magnetic, acoustic, etc.

(29) Usage of pneumo- and hydroconstructions (pneumatic or hydraulic systems).

Moreover, a system for logical search of technical solutions (applications of the Altschuller principles in particular) would largely increase the number of successful patents.

3. MANIFESTATIONS OF ALTSCHULLER`S PRINCIPLES IN TRANSPORT ENGINEERING.

In recent years new trends are observed in the development of transport vehicles and also of other machines, too. These trends of development include manifestations of the above mentioned Altschuller principles. Such examples of Altschuller`s principles belong also to a part of the issues that are being studied in our university.

3.1. Hybrid locomotives. Union Pacific (USA) began operation of diesel-electric hybrid locomotives (Green Goat) built by RailPower Technologies (Canada). A reduction is expected of the harmful emissions by 80÷90% and the fuel consumption to decrease with 40÷60% compared to standard diesel locomotives [4]. In this case there is a manifestation of principles 03, 20, 24, 28. The introduction of an intermediate unit between the diesel engine and the chassis will make it possible that both systems will operate at their optimal modes without any adverse effect between themselves.

In 1963 Bulgaria imported two custom-made diesel-hydraulic locomotives by an Austrian company. In such locomotives the diesel engine drives a hydraulic or hydro-mechanical transmission and thus it carries the drive wheels. They have two engines that are diesel with a maximum output of 1100 hp or a total of 2200 hp. The greatest locomotive design speed is 120 km/h. Here we have a manifestation of principles 03, 20, 24, 29.

3.2. Hybrid electro-hydraulic excavators. Another example for manifesting Altschuller principles (principle 29 - replacement of mechanical systems with pneumatic and hydraulic systems, principle 24 - of the intermediary, the third element, principle 20 - of the continuous efficiency, etc.) we find in the newest generation of excavators with hydro- and electric circuits (Fig.1) [5].

They use hydro- and electro-supply which consists of two intermediary elements: electric motor-generator and a hydraulic pump. The main role is of the diesel engine which

has less power that the analogical excavator with a conventional drive; the running mode is with the greatest efficiency. The engine drives an electric motor-generator and a hydraulic pump. The excess energy from the electric generator is stored in a capacitor.

The hydraulic pump feeds the hydraulic system which drives the boom, the lever, the bucket and also it moves the excavator by the left and the right hydraulic motors. Stopping the boom causes the electric motor-generator recuperates a part of the energy in the capacitor thus saving energy (principle 25b). In conventional excavators the energy supply from the engine is used for work and the fuel expenditure is very high. So in the newest generation of excavators the diesel engine has less power thus saving about 25% of the fuel consumption and the volume of the work done by the excavator increases by about 50%.

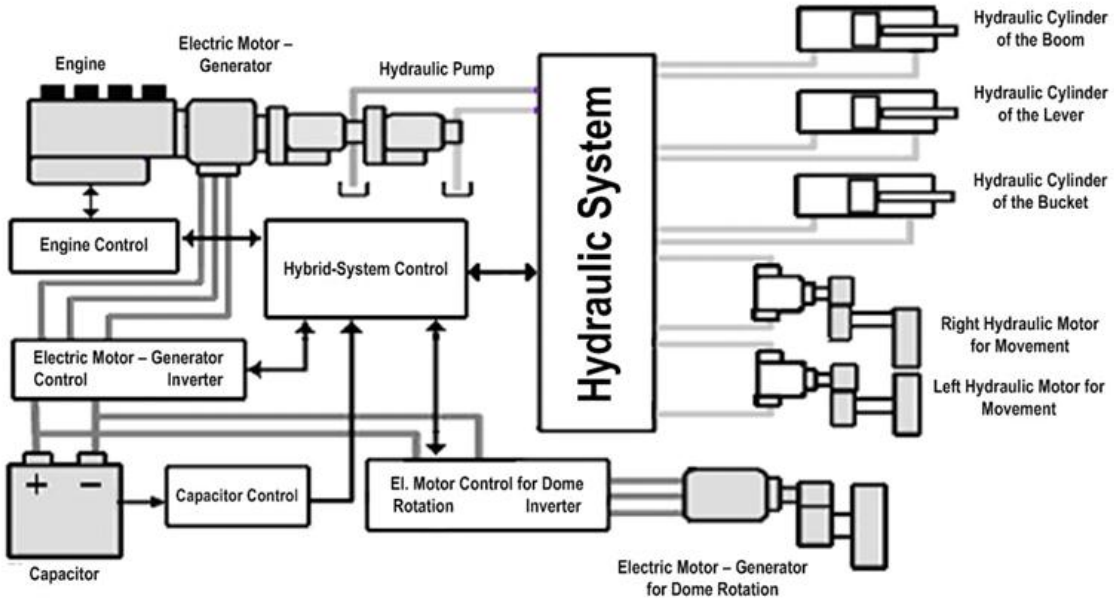

Fig.1. Scheme of the latest generation of hybrid excavators.

3.3. Hybrid hydraulic vehicles. A number of well-known companies develop hybrid hydraulic vehicles. The Valentin Technologies INGOCAR company develops a hydraulic vehicle with a hydraulic propulsion /drive (Fig.2) [6].

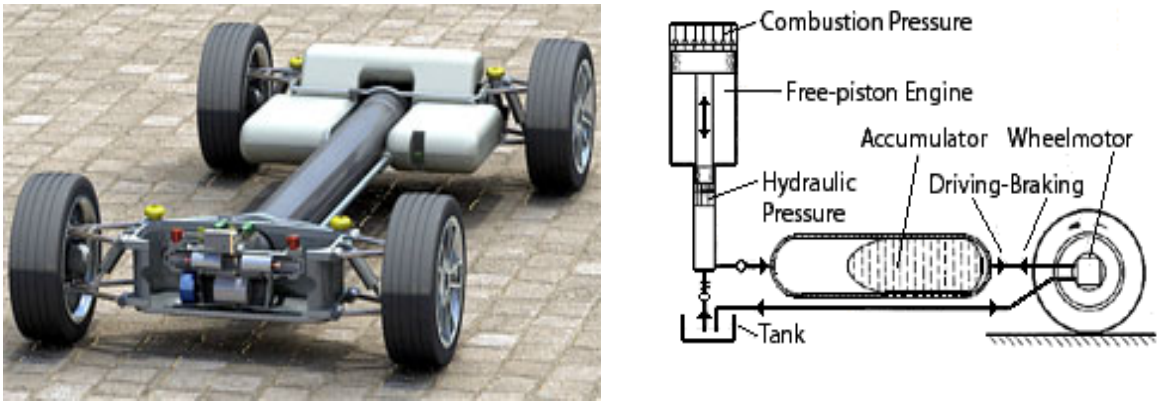

Fig.2. Hybrid hydraulic car of INGOCAR.

The top speed of the car is about 150 km/h. The brake system recuperates up to 70÷85 % of the energy during braking and it transforms it in hydraulic pressure. The internal combustion engine uses various fuels (gasoline, diesel, bio fuel) and it is of the type of the free piston because it drives just the hydraulic pump. In this case we have a manifestation of principles

03, 20, 24, 256, 29.

Such hybrid vehicles are co-developed by PSA Peugeot Citroen (Citroen C3) and Bosch. The air-based hybrid drive system of Citroen (Hybrid Air) is called N-Air-Gy. It is co-developed with Bosch (Fig.3A) [7]. It uses a small gasoline engine, a reservoir with pressurized air, a hydraulic drive and an automatic gearbox. The fuel consumption of Citroen C3 prototype is of 2.9 liters per 100 km and gas emissions of CO_2 of 69 g/km. The hydraulic drive system of Bosch (Fig.3B) is able to reduce the fuel expenditure with about 30% related to a standard internal combustion engine and in urban traffic by 45% [8]. Similar hybrid drives are also developed by Chrysler, Ford, etc.

Fig.3A. The prototype of Citroen.

Fig.3B. The prototype of Bosch.

3.4. A new scheme of hybrid electric car. Toyota company elaborates a new type of highly efficient hybrid engine with no crankshaft (the 'free piston') (Fig.4) [9].

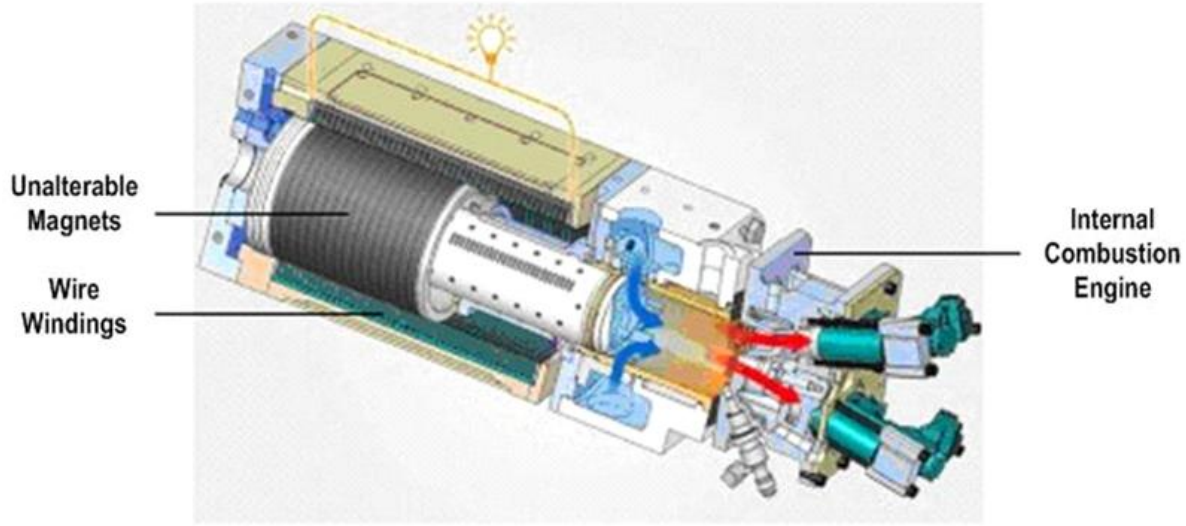

Fig.4. Toyota hybrid engine.

It is believed in Toyota that such engine with a power of 20 kW will be able to drive a small car with a speed of 120 km/h. Unalterable magnets move in wire windings. In this case we have a manifestation of principles 03, 20, 24, 28.

3.5. Automotive, mechanical engineering. Fig.5 shows an example of manifestation of Altschuller`s principle of distinction (02) to reduce the object weight. The detail in the figure is dense at first. The aim is to lighten the construction and to make it from less material. This can be done if the workpiece is made from a high-strength material. It is evident that the form

is fully preserved and the construction is lightweight. The new detail is made of highly tensile steel and thereby there is a significant weight reduction of the object. In car industry this Altschuller`s principle is manifested everywhere from 1995 until today.

Fig.5. Example of Altschuller-principle of manifestation.

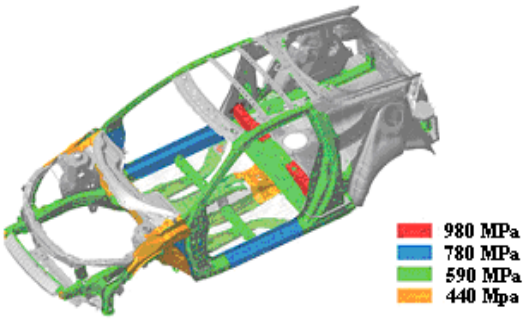

Fig.6.Steel-grades distribution related to their application.

Till 1995 car compartments were made from one and the same material. Then new materials began to be used: lighter but from stronger steels to reduce the weight. The strength is improved using stronger steels with tensile strength up to 980MPa. And where there is not such big loads the steels are of smaller strength of about 440MPa (Fig.6).

3.6. Car industry. An example of manifestation of Altschuller`s principle of injury utilization (as lifting aerodynamic force) and its transformation in an useful factor (as adhesive aerodynamic force) in cars is shown in Fig.7A (principle 22). This increases the speed and also to a greater stability on the road. Fig.7B shows the path of the air from under the car and is ejected by the turbines.

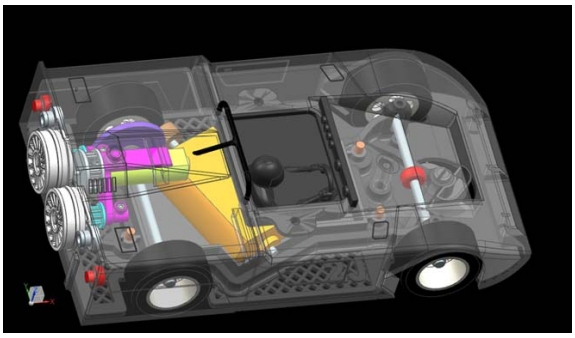

Fig.7A.Car construction with a turbine.

Fig.7B.The path of the air thrown out by the turbines.

4. CONCLUSION.

Lastly there can be drawn the following conclusions: (i) The rational development of technical and in particular the transport vehicles and systems can be secured only using correct logical systems of principles that with a proven regularity. Otherwise we have regressive (negative, deformed) ‘development’. (ii) Regular and widespread scientific, engineering, inventive and research activity can be realized only with the use of correct logical systems of true and proven practical principles.

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ПРОЯВЛЕНИЕ НА ПРИНЦИПИТЕ НА АЛТШУЛЕР В НЯКОИ ТЕХНИЧЕСКИ РЕШЕНИЯ В ТРАНСПОРТНОТО ИНЖЕНЕРСТВО

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Ключови думи: *транспортна техника, транспортно инженерство, принципи на Алтшулер*

Резюме: *Решаването на изобретателски задачи и намирането на нови по-рационални решения е актуална задача, която обхваща всички области на дейност в съвременния живот. Новите по-правилни решения могат да се използват както в методиката на образователното обучение, така и в ежедневната ни научно-техническа практика. В настоящата работа е разгледано проявлението на Теорията за решаване на изобретателски задачи (ТРИЗ) на Алтшулер в областта на транспортната техника. Направеното в работата разглеждане показва, че правилното развитие на транспортната техника може да се обезпечи само когато това развитие е в съзвучие с утвърдена логическа система и когато се прилагат издържани логически принципи. Разгледани са някои от най-новите технологични решения в областта на транспортната техника и проявлението в тях на принципите на логическата система на Алтшулер.*