SAFETY ISSUES WITHIN "HUMAN-AUTOMOBILE-ROAD-ENVIRONMENT" SYSTEM

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ABSTRACT
The work is devoted to studying some issue of different safety aspects of the "human-automobile-road-environment" system. Technical and "humanitarian" dangers developing within the "human-automobile-road-environment" system have been presented.

Key words:
human safety, "human-car- road-environment" system, dangers

ABSTRAKT
V práci sa venujeme štúdiu vybraných problémov zo systému "človek-auto-cesta-prostredie". Je tu popísané technické a "humanitárne" nebezpečenstvo v rámci systému "človek-auto-cesta-prostredie".

Kľúčové slová:
ľudská bezpečnost, systém "človek-auto-cesta-prostredie", nebezpečenstvo

1 INTRODUCTION

Automobile transport plays a great role in development of any country. During the last decade high growth rate of the world car park has been observed. It can be explained by the automobile high efficiency in comparison with other means of transportation, independence, well-developed road network, etc. Along with the positive role played by the automobile transport in the state development there are some negative aspects. Growth of the car fleet brings about increase in number of road traffic accidents (RTA), which result in growing number of dead and injured people,

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environmental deterioration, price rise for energy sources, decreasing of transport speed and so on. According to the United Nations Economic Commission for Europe, about 500 000 people die and more than 10 mln get injured on the world roads every year. Most of 310 mln. of disabled people living in the world are victims of traffic accidents and the number of casualties of automobile accidents is 10 times as large as of railroad ones.

2 THE HUMAN SAFETY

Safety is one of the most important requirements to modern means of transportation nowadays. The traffic safety is influenced by a great number of factors, which sometimes do not depend on the automobile design. Generally, the point is the "human-car-environment" (HCE) system. At further specification of the system approach it is possible to pass on to the "driver-automobile-road-environment" system. Each component element is significant in this system. For example, analysis of RTA statistics shows that RTA are caused by the driver in 50 - 60% ; by the automobile condition in 15 - 25%, by bad road conditions in 25 - 35%; by environment – in all the rest of the cases. Improvement of a human operator (driver) working conditions is a complicated problem because its solution lies at the intersection of technical, economic, biological, psychological and a number of other sciences. Therefore, the problem of providing operators with normal (acceptable) working conditions alone with high injury prevention in technological process requires application of the system approach for its studying.

Among the human safety issues in conditions of the "HCE" system functioning, it is necessary to emphasize so called "human factor" and technical element. Complex of means, including the automobile design elements, road maintenance, traffic management, which application and using is realized through human active actions, controlling a mean of transportation, are usually characterized as active safety elements of the "active safety" system, and a system of measures directed at reducing an accident severity – passive element – "passive safety". It is logical to state that the basis of the system active safety is the driver with a standard set of functions of the arbitrary system operator - information receiving and processing, decision making and realization of managerial actions in professional sphere [1]. Relevant increase of the safety level of the "human" subsystem is impossible without results of working conditions estimation, giving not only quantitative information about the state of the working conditions but permitting to determine the "weakest components" in the "HCE" system for target realization of organizational and technical measures on labour protection. Estimation of the measures efficiency is also important. The "human" subsystem safety within the "HCE" system depends on each of its elements. If the elements "car" and "environment" can be presently estimated by different parameters, then "human" as an element of the "HCE" system is not paid proper attention at estimating safety of the system as a whole.

Nowadays there formed certain ideas of degree of acceptable (reasonable) and unacceptable risks. The acceptable risk concept is in striving for such a minor danger,

which can be accepted by the society in the given period of time. The acceptable risk comprises technical, economic, social and political aspects and represents a certain compromise between the level of safety and possibilities to achieve it. According to the data given by some scientists the risk of loss on different means of transportation in relation to the total population makes:

- automobile transport - 0,0003;
- water, air transport - 0,000009;
- railroad - 0,000004.

Thus, it becomes evident that automobile transport is the most dangerous one. In this respect, nowadays the problem of traffic safety appears to be a global problem, being a major focus of interest of the UNO and other international organization. Within the implementation of the plan "Decade of Action for Road Safety 2011-2020" approved by the UN, the European Union and the European Conference of Ministers of Transport set the task to reduce the number of vehicular homicides by 50% by 2020. [2]

Safety psychology studies application of psychological knowledge to assure human activity safety, considering psychological processes, attributes and various forms of psychological states observed in the process of labour activity, particularly in the transport sphere. Traffic safety in modern conditions is one of the key elements in the system of assuring a general safety of the society vital activity. Insecurity at transport results in growth of RTA.

In most countries public opinion and official statistic data of traffic control enforcement agencies more often see the main reason of RTA in drivers' negligence and faults. In conclusions on research results an opinion is often expressed that practically all RTA could have been prevented if a person had behaved adequately. Meanwhile a human is the most reliable element in the transportation system. According to the World Health Organization (WHO), 9 of 10 accidents happen due to drivers' fault and the rest of them to some extent depend on drivers. At the same time many researchers believe that more than 2/3 of all the accidents happen due to people's fault and 1/3 are factors not depending on their will and activity.

Considering causes of injury growth in respect to the human factor, we can make a conclusion that technological expansion goes before the psychological measures on protection from its dangerous and hazardous effects. Experience suggests that the basic reasons of accident risk are often not a design weakness but organizational and psychological reasons, poor development of driver's discipline, poor attitude to safety, admittance of persons with high injury risk to driving, fatigue state or a special mental state of people. Operators' faults cause not only accidents with loss of material values but those connected with people injuries and death. When analyzing technical systems there used the notion "reliability", which determines a technical system performance efficiency in time through its parameters. Reliability of the operator's work is defined as a need of successful performance of his work or a task set at a certain stage of the system functioning during a given time interval at

certain requirements to the operation duration. The reliability of the object (automobile) is estimated through parameters of particular properties - failure-free performance, endurance, serviceability and safety, individually and in certain combinations.

A man is prone to error by his nature. Some aspects of human behaviour, undoubtedly, can be changed in the traffic safety context. Nevertheless, the frequency of faults can be reduced, changing the environment but not concentrating only at altering the human nature [3]. Contemporary opinions about traffic safety do not doubt that people must absolutely observe the important traffic safety rules and avoid dangerous situations. Human fault is defined as not performing the set task (implementation of a prohibited action), which causes damage of equipment or property or breaks a normal course of the planned operations. In a generalized view the faults are presented in Table 1.

Table 1. Types of faults in the "human-car" system.

Types of faults	**Character and place of manifestation**
Deign defects	Caused by unsatisfactory design quality
Operators' faults	Emerge at incorrect implementations of the set procedures by personnel
Manufacturing faults	Take place at the production stage as a result of: - unsatisfactory work quality; - improper choice of material; - product manufacturing with divergences from the construction documentation
Maintenance faults	Emerge in the operational process: - low-quality repair; - deficient assembling; - insufficient instrumentation and tooling-up
Control faults	Connected with mistaken acceptance of an element or appliance, which characteristics fall outside the tolerable limits, as a nondefective one.
Improper handling	Emerges as a result of improper goods storage or transportation
Faults in work site arrangement	Cramped working premises, high level of noise, improper temperature, insufficient lightning

Considering the automobile safety, according to comparative assessments of IIHS (Insurance Institute for Highway Safety) there should be taken into account statistics of accident risk and its consequences severity for the driver and passengers, damage in value terms, compensation payment in the case of death, permanent injury and for medical treatment as well [4]. Value indicators of the consequences for people many times increase losses form felonious takings (thefts), damage to the automobile and roadside constructions. Insurance outpayments directly or indirectly can serve an objective assessment at comparing different automobiles on their safety parameters.

According to the world statistics, distribution of RTA reasons are as follows:

– improper human actions – 60-70%;

- unsatisfactory road state and discrepancy of road conditions and movement character - 20 — 30 %;
- automobile technical failure - 10 — 15%.

At that, the most frequent reasons of RTA due to drivers' fault are: overspeeding, not keeping the distance, not observing movement priority, carelessness and drunk driving; due to pedestrians' fault, correspondingly: crossing the street at non-designated spots, walking along the highway, crossing the street in front of a closely moving mean of transportation, under the influence of dink.

At the same time the actual number of RTA caused by technical failure is more considerable. The most dangerous failures bringing about RTA more often are failures of breaking system (50%), steering system (14%), lighting and signaling system (16%). Safety depends on three important automobile characteristics: demensions, weight, means of passive safety permitting to survive in an accident and avoid injuries and means of active safety permitting to avoid accidents [3, 5]. However, at collisions heavier machines with respectively poor crash-test characteristics can show better results than light automobiles with the excellent ones. In compact and small cars there die twice as many people as in large ones. Experts note that RTA death rate is influenced by number of automobiles in the country. Thus, if in 2004-2005 there were 50-60 automobiles per 1000 people in Ukraine, in 2007-2008 (at the sales peak of up to 700 ths a year) this number increased to 150-160 per 1000 people. At comparing RTA death rate in Ukraine with the worst of the presented data (the USA) the death rate observed is one and a half time more (per 100 000 people), but taking into account the fact that "automobilization" in the USA is seven times as high, then the death rate in Ukraine per each purchased car is almost 11 times as high. At that, the annual mileage of transportation means per capita is 800 km in Ukraine and more than 12 000 km in Western Europe (Table 2)

Table 2. Death rate in RTA and number of automobiles in different countries.

Country	**Death rate in RTA (per 100000 people)**	**Number of automobiles (per 1000 people)**
Holland	4,8	417
Germany	6,0	519
France	7,5	565
Great Britain	5,4	426
Japan	5,0	543
Canada	8,8	563
Australia	7,8	619
the USA	13,9	765
Ukraine	21,5	160

At that, the death rate in road accidents in 2009 amounted for 71 person per 100 thousand of automobiles, while it was 10.3 deaths per 100 thousand in Germany and this index accounts for 16.2 in the European Union.

In the report of the Economic Commission for Europe (2011) there have been presented RTA statistics on Ukraine and some countries of the EU and the USA (Table 3).

Any safety of transportation means comprises two constituents: technical measures (active and passive automobile safety, median barriers, etc.) and organizational measures (traffic rules, the State Traffic Safety Inspectorate (STSI))

Table 3. Comparison of number of RTA in Ukraine and some European countries (Source: The UNECE Road Traffic Accidents Statistics 2011)

Country	**Area (km²)**	**Population (1000)**	**Number of accidents, casualties and injured people**					
			Accidents	Killed	Injured	Accidents caused by people in a drunken state (%)		
						Accidents	Killed	Injured
Albania	28748	3182	1208	303	1256	5,5	7,9	6,2
the USA	9363520	304060	1630000	37261	2346000	11,2	41,5	9,8
Slovakia	49036	5407	8343	606	10886	16,5	4,0	12,4
Switzerland	41285	7648	20736	357	25556	10,3	16,2	10,2
Czech Republic	78866	10424	22481	1076	28501	10,4	7,9	10,4
Russian Federation	17075400	141956	218322	29936	270883	8,3	9,9	8,9
Ukraine	603700	46078	51279	7718	63254	6,9	6,7	6,8

Existing technical means ensure a certain degree of safety at a relative speed of 60 km/h, that is, at front collision of automobiles moving at the speed of only 30 km/h. Thus, at speeds more that 30 km/h a modern automobile does not ensure safety even for the driver observing all rules. Only owing to introduction of the functional road classification Holland achieved reducing of the average number of accidents with injuries per 1 mln km of the automobile mileage. [World report on road traffic injury prevention. World Health Organization Geneva 2004]. Among the reasons of RTA there should be mentioned low driving culture, under-developed traffic infrastructure not keeping up with dashing automobilization, slackening of traffic safety control. According to the State Traffic Safety Inspectorate, every fourth RTA in Ukraine is caused by overspeeding and every fifth one – by violation of maneuvering rules, provided that the most number of road collisions is a consequence of deliberate violation of the traffic rules.

The situation with the organizational part of traffic safety is even worse: not only that the traffic rules are contradictive in themselves but practically their observance is considered to be not mandatory in our country at all because of actual lack of both objective and full control (video cameras are set only in some places and they don’t work permanently). But the worst of all is that such system can not be

effective even provided that it works) because it actually plays the role of a forensic pathologist (finds the guilty and counts the victims instead of preventing accidents). Practically in all documents accepted by international organizations designation of a leading department providing development and realization of the state policy in the field of traffic safety and carrying responsibility for it is recommended as a primary measure.

Essence of the main functions of the active automobile safety is absence of sudden failure of all its systems (failure safety) especially connected with possibility of the automobile manoeuvre and providing conditions for the driver to control the "automobile – road" system self-confidently as well. The main qualities of the automobile construction influencing the active safety are:

- configuration;
- stability (the automobile nonskid quality and ability to resist rollover at high driving speeds);
- steering response (the automobile service performance enabling to perform its control at the least consumption of mechanical and physical energy, at maneuvering in the plane for keeping or setting the driving direction);
- manoeuvrability (the automobile quality characterized by value of the least turning radius and dimensions);
- stabilization (ability of AWD (All-Wheel-Drive) system elements to resist the automobile wabble or the system ability to keep optimal position of the automobile natural axes at movement);
- breaking system;
- steering;
- correct alignment of the steering wheels;
- reliable tires;
- signaling and lightening systems.

The following factors can be mentioned among the road conditions reducing safety:

- lack of correspondence of the road geometric elements (trafficway width, bridge and over-bridge demensions, radii of the road curve in the plane, gradients, raised curves) to actual automobile driving speed;
- irrational combination of horizontal and vertical alignment at neighbouring sites, bringing along increasing and then an abrupt decreasing of the driving speed (curves in the radii plane at the end of down bills or horizontal lines, short horizontal lines on wavy traces);
- poor condition of the trafficway and shoulders (insufficient road coating evenness and roughness, loose soil of earth shoulders, mud from snow, rain, stones and other foreign objects on the trafficway); safety level decreases abruptly on roads with low adhesion;
- incorrect placement of solid obstructions (illumination poles, road signs, over-bridge supports, buildings, bus bays, etc.);

- insufficient information about the traffic way boundaries, traffic lanes, the stretch and form of dangerous road sections, character of potential hazard, actions recommended for the automobile control and movement restrictions, lack of barriers keeping the automobile from driving off the road and crossing the separating strip);
- poor visibility at night, glaze ice, fog, meteorological precipitation.

The World Bank estimates losses of the Ukrainian economy from RTA in $ 9 mlrd a year. It is estimated that in 2020, if the measures are not taken, the death rate in RTA will come to the third place after that one from cardiovascular diseases and severe stresses. According to the death rate in RTA Ukraine takes the fourth place in Europe. Every third person, who died in RTA in Ukraine is a young man under 29. Annually more than 5 thousand of Ukrainians die because of accidents on roads (taking into account only the injured who die at the RTA site but not at hospitals), and 40 thousand people more get injured in the accidents. During the years of independency totally 140 thousands died and 900 thousands have been injured on the roads.

3 CONCLUSIONS

So, to provide safety of the “driver-automobile-road-environment” system, fundamental changes of both the road state and drivers’ behviour on the roads are required. It is necessary to take measures on RTA prevention and teaching future drivers (during their studies at driving schools) as well as the accomplished ones, first of all, the driving culture and respecting other participants of traffic movement. On the basis of all the above-stated it is possible to generalize requirements to the driver: to ensure the automobile functioning in real road conditions efficiently, economically and safely. Obviously, the main determining factor both of the active and passive automobile safety is failure-free performance of all its essential systems, devices and units.

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Článok recenzovali dvaja nezávislí recenzenti.