Analysis of the Possibilities to Reduce Accidents of Inexperienced Drivers

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***Abstract*—Drivers generally tend to underestimate the risks involved with driving, and overestimate their driving skills and capabilities. Young drivers are especially at fault in that they have not been sensitized to the determinants of accident risks and are less able to judge what levels of risk are acceptable. A possible solution would be a change to the educational and training methodologies practiced in driving schools and training centers. Teaching focused on scanning and anticipating situations within a visual range and range of vision might help trainees reduce the risk of being involved in an accident. For example, trainees could be made aware of safe driving distances by the use of simulators. Higher attention could also be paid to the development of safe driving strategies, hazard recognition and higher order skills.**

***Index Terms*—Defensive driving, following interval, tailgating, traffic accidents, safe distance.**

I. Introduction

Road traffic accidents are often due to a poor analysis of the traffic situation; a vehicle's speed, the inability to react in critical situations, safe distance nonobservance and insufficient anticipation. Other unfavorable factors are a deterioration of discipline, arrogance and aggressiveness of drivers, a low level of prevention, maladjustment of driving to road building arrangement (turning, crossing, falling, rising etc.) and surface features of a road (wet, snow, ice, mud etc.). They can be caused by young drivers due to their inexperience, tendency to impulsive behavior, lack of respect for authority, overemphasis on personal abilities, assuming a risk in an effort to excel and improper training in driving schools.

From the statistics of the Czech Republic's Police [1], the biggest contributor of all accidents has repeatedly been speeding, not yielding the right of way and improper passing. Further features are that approximately 60% of accidents happen in urban areas and almost half of them are realized on motorways. Among most causes of accidents by reason of wrong driving style belongs to paying no attention to vehicle control and nonobservance of maintaining distance behind the vehicle in front.

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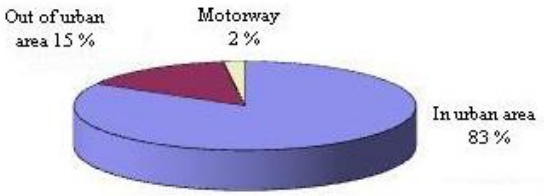

Figure 1. Accidents by the reason of safe distance nonobservance [1].

The Institute of Transportation Education and Training of the Czech Armed Forces performed a traffic survey about the keeping of safe distances in an urban area and on motorway in the year 2012. On the basis of 1238 vehicles surveyed, it can be stated that approximately half of them do not observe a sufficient safe stopping distance in an urban area. On the basis of 2334 vehicles surveyed on motorways results that 58% of vehicles under 3500 kg were also found to ignore stopping distances as were 48% of vehicles over 3500 kg. It repeatedly confirmed that drivers are unaware of proven patterns connected with reaction time, reaction distance and braking distance.

For the elimination of this incorrect driving style it is important to educate drivers in keeping safe distances behind the vehicle in front of them. It is needed to change the education and training methodology in driving schools and training centers. New inexperienced drivers could be trained to judge traffic situations better after completing training and take suitable behavior lessons for traffic collision avoidance.

II. Conditions and Methods for the Safe Stopping of a Vehicle

Critical situations in road transport are characteristic by traffic situations with very quick changes, suddenly appearing obstacles or changing road conditions. It often approaches failure dealing of drivers to this who cannot deal deliberately for lack of experience in critical situations at too high speed or due to lack of caution. First of all, situations or accidents rise from the nonobservance of safe distance and threaten other traffic participants. The mandatory safe distance keeping can be hardly specified, what distance drivers ought to keep because the safe distance differs in different situations. The distance between vehicles is defined in the legislation of the Czech Republic [2] like a sufficient safety clearance which a driver has to keep behind another vehicle in order to avoid a collision, in case of the abrupt reduction of speed

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or stopping of this vehicle. The safe distance is in direct connection with a speed of drive when driver may go only such speed so that was able to stop the vehicle on a distance whereon has a range of vision.

Variety of methods for right safe distance judgment between vehicles is suggested to drivers for satisfaction of this obligation. The oldest from methods is the method a car insertion into space between own vehicle and vehicle in front, depending on their speed. It means that at 60 km/h speed has to be the distance between own and in front ridden vehicle at least such, so that six cars could fit into it [3]. The next method is based on following the actual speed own vehicle on a tachometer, whereas safe distance between vehicles is a half of this speed in meters [4]. The most widely used is "method 21-22" when for sufficient safe distance on dry roadway is considered the two seconds interval which the own vehicle drives for this time towards a point (tree, sign, pole) which an ahead ridden vehicle passed [5]-[6]. Drivers may be guided for the safe distance observance by a traffic sign which marks on the road the recommended distance for vehicles ridden one after another under favorable traffic and weather conditions [7]. In reality, this sign is rarely seen and its use is neither further specified nor methodically explained to drivers.

A driver is generally obliged to keep such distance from vehicle ridden before him, object or event in every situation which no makes it possible to origin any danger. During insertion of a vehicle at overtaking it is important so that a driver kept the distance for the vehicle behind him which will enable to react safely at sudden deceleration of drive or sudden stopping of the first vehicle. Managing of these requirements depends on the speed of vehicle, state of traffic, road surface quality, weather, vehicle condition and its braking distance, field of view, visual range, range of vision and mental condition of driver. The safe distance is connected with reaction time, reaction distance, braking distance and stopping distance whose determination is given in Table I.

TABLE I. DETERMINATION OF THE TOTAL STOPPING DISTANCE DEPENDING ON THE SPEED [AUTHOR]

Vehicle speed	Reaction distance at reaction time 1,0 sec	Braking distance	Total stopping distance
30 km/h	8m	9m	17m
50 km/h	14m	14m	28m
70 km/h	19m	20m	39m
90 km/h	25m	25m	50m
110 km/h	30m	31m	61m
130km/h	36m	36m	72m

The total stopping distance for stopping of vehicle is formed by two factors - reaction distance and braking distance. Reaction distance is distance that the driver will drive for time from the moment when recognizes critical situation, over its processing, stepping on brake pedal up to the moment reaction braking effect of vehicle. After passage of reaction distance when the vehicle did not change a speed, the vehicle begins to slow on the braking distance. That depends on given speed, road surface condition (dry, wet, ice), quality of tires and vehicle weight.

Majority of drivers assume that they have fast reflexes, thereby minimal reaction distance. They are not aware that reaction time is depending on condition, concentration, age, experience and decision of driver. Reaction time also depends on position and visibility of a critical object in the visual field of the driver. This time can extend brake system condition of vehicle. Reaction time includes delay among perception of an obstruction, decision and reposition of a foot on the brake pedal. This time is not constant and moves according to particular conditions and outside circumstances. On base these reality can be stated that traffic accidents is needed to face with anticipation and not the reaction of a driver. The driver should react predictably, behave adequately to his experience and adjust his drive traffic and road conditions. Inexperienced drivers must be educated therefore how to improve anticipation of dangerous situations and how to avoid hazardous situations with a defensive driving style.

Knowledge and abidance by rules of the defensive drive is necessary principle for a safe drive. The base of defensive driving style is defense (vigilance) before unanticipated and dangerous negotiation by other drivers. It requires vigilance that something unanticipated will happen and readiness to evasive maneuvers. A driver must watch a roadway, given to course of road and judge situation in order to he was able to react in time and avoid possible collisions. A driver must respect regulations for road transport with a view to observance of a speed, safe distance between vehicles and overtaking at the sufficient visual range and range of vision.

View from vehicle must ensure the largest factor of a visual range and range of vision for a driver. The visual range is influenced by many factors in relation to an obstacle, primarily its size, position in the visual field, color, brightness, and contrast against background and whether or not the obstacle is stationary or moving. Specifying a visual range to an obstacle is the main factor in evaluating potentialities to preclude a collision [8].

It is possible to comprehend a visual range as the distance whereon a driver sees and judges other participants and objects in front of vehicle. A driver is not capable to evaluate their behavior and impact on his safety of driving. Range of vision is sector in visual field of driver in direction of his drive, in which he registers and already recognizes other road users, objects or obstacles and manages to evaluate their behavior and impact on his safety of running. Range of vision is restricted by the effective illumination range of headlamps at night. In [9], the author emphasizes that the driver is able to see a pedestrian in dark clothing at a distance of 40-meters if the area below the knees is illuminated by a low-beam headlight of at least 2 Lux intensity. Visual range is a basic structural element of range of vision.

III. POSSIBILITIES FOR THE PROPER DRIVING STYLE TRAINING

For safe vehicle control it is necessary the driver has abilities allowing him to recognize and negotiate dominant circumstances directly like traffic signs, traffic conditions and behavior of others traffic participants. Dangerous following in front ridden vehicle can create catastrophic consequences at drive in line of vehicles. If the control car will slow down, a driver of the second vehicle will usually react a little quicker deceleration. It gradually comes to situation that the eligible for braking of all vehicles is exceeded. Only well educated driver will realize in this case that it is needed to extend a separation distance more than normally, thereby to avoid an involvement to the multiple collision of vehicles. Combination of theoretic teaching, practical driving with commentary and measures for the decrease of driving skills overestimating are important therefore for young drivers' preparation.

Within theoretic education in driving schools is the duty to teach the main principles concerning the safe distance is following between vehicles, tire adhesion and stopping distance depending on adhesive conditions. The practical training on a training-ground is aimed only on the car check before drive, basic operations before drive and managing of basic driving skills necessary for vehicle handling [10].

Inexperienced drivers have not the possibility to acquire visual perception and practical proficiency at the determination of a proper distance from ridden vehicles on different road surface and different speeds, at practical training on a training-ground first of all.

All the mentioned methods for safe distance keeping are based on judgment, conscious activity of the driver and controlled concentrated attention. Therefore, it is supposable that it is not possible to pursue in practice. A driver is influenced with surroundings recognition within his visual range and range of vision and thinks about personal experiences at the same time (what was at work, what will be at home etc.). It is entirely unreal and furthest dangerous to suppose that drivers would be able to keep safe distance with the use of these methods in present road traffic.

It is needed to place the defensive driving training to the final system part of applicants training to a driving license obtaining, with a view to safe distance observance and practice of anticipation ability within visual range and right reaction within range of vision consequently. It can influence substantially their possibility to obviate or fully prevent a genesis of dangerous and crisis situations at wrong distance observance behind another vehicle. The adjustment of training to real conditions in real traffic should be supported with simulators, modified vehicles or models of obstacles on a training-ground that will enable to simulate the safe distance nonobservance, sudden deceleration and other unexpected events. The practical training should include practice of psychomotor skills for road holding and adjusting to the driving speed. Another important sphere is training of anticipated visual perception and cognitive abilities. The final phase of practice should be a confirmation of skills at hazard recognition and risk perception.

Hazard recognition can be described as detection, perception and dealing with traffic hazards. Young drivers cannot detect a hazard altogether, detection takes more time, identify distant hazards poorly and display a smaller range of horizontal scanning of the surroundings. These drivers look closer in front of the vehicle, check mirrors less frequently, utilize peripheral vision less efficiently, glance at objects less frequently and fixate more on stationary objects. Risk perception refers to the subjective experience of risk in potential traffic hazards. Young drivers perceive low levels of risk in specific driving situations and perceive themselves as able to deal with potentially dangerous situations. Drivers with a risky driving style perceive low levels of risk in certain traffic conditions and pose a threat to other traffic participants.

IV. The Crash Simulator at a Safe Nonobservance Distance

The structure of the training task on a simulator should at first be focused on the visual perception of the vehicle moving in front, its sudden braking (the brake lights on) and the subsequent braking reaction of the driver in the vehicle behind. At exceeding of critical limit for the distance must follow simulated rear crash, preferably with acoustical or light signal support in order to this consequence influenced more senses at a time. Fig. 2 presents a description of the crash simulator prototype modeling situations in failure to observe safe braking distances this was designed and constructed at the Institute of Transportation Education and Training of the Czech Armed Forces.

Figure 2. The crash simulator at a safe distance nonobservance prototype [author].

1 – The vehicle moving in front model
2 – The pitched platform
3 – The movable carriage of the simulator
4 – The timer of the simulator

The simulator consists of a vehicle moving in front model that is equipped with functional brake lights and capable of imitating the forward movement caused by the impact of a rear-end collision. The movable carriage and timer of the simulator are fixed on a pitched platform. The platform enables the carriage to be towed with the

use of an electric winch to the starting position. The carriage simulating the following vehicle is fitted with a functional hydraulic braking system and driver's operating pedals.

The system`s functionality is based on the calculation of corresponding braking distances, using the following formulas [11]:

$$s = v \times t_1 + (v - \frac{a}{2} \times t) + \left(\frac{v_1^2}{a}\right) \quad (1)$$

where:

- s total stopping distance of vehicle [m],
- v vehicle speed [m/s],
- v_1 speed at brakes reaction [m/s],
- a braking vehicle retardation [m/s^2],
- t_1 driver`s reaction time [s],
- t brakes` reaction time [s].

$$s_{vs} = v_t \times t_t + \frac{v_t^2}{a_b} \quad (2)$$

where:

- s_{vs} carriage of simulator braking distance [m],
- v_t carriage speed in time t_t [m/s],
- t_t time setting in the timer at intervals of 0,1 s,
- a_b braking carriage retardation [m/s^2].

$$v_t = a_t \times t_t \quad (3)$$

where:

- v_t carriage of simulator speed [m/s],
- a_t carriage of simulator acceleration [m/s^2],
- t_t time setting in the timer at intervals of 0,1 s.

$$a_t = g(\sin\alpha - f \times \cos\alpha) \quad (4)$$

where:

- a_t carriage of simulator acceleration [m/s^2],
- g acceleration of gravity [m/s^2],
- α platform pitch angle [٩,
- f rolling resistance coefficient.

$$a_b = \frac{v_t^2}{2s_t} \quad (5)$$

where:

- a_b braking carriage retardation [m/s^2],
- v_t carriage speed [m/s],
- s_t carriage path [m].

The principle of training on the simulator is first based on the determination estimated safe distance by a driver for given driving speed by an instructor. The next step is setting of the total stopping distance for the second vehicle (carriage) on the simulator timer which subsequently initiates the synchronous turning on of the brake lights on the first vehicle at estimated driver's reaction time 0,6 s of the second vehicle (carriage). If the distance estimate is correct, the vehicle (carriage) will stop safely. If the estimate is incorrect, the driver will be unable to react (brake) in time and, inevitably, crash into the vehicle model in front.

A driver should develop the safe distance observance on the basis of automatic behavior afterwards. He will need much less targeted effort and conscious attention for that than counting two seconds, when it is a completely controlled process. Corresponding behavior is then conditioned by the evocation of unpleasant experiences from training in a driving school at every dangerous approach to another vehicle. The distance keeping is based on an experience from the technical device, where it was simulated sudden braking ahead ridden vehicle and subsequent crash of own vehicle. These means enable training in dangerous and accident prone situations that cannot be verified in real driving. Especially young drivers should be able to recognize a traffic situation and automatically take a decision to safe driving maneuvers performance and prevention of a possible traffic collision after this way performed training.

V. Conclusion

Daily repeated information with detailed description of traffic accidents creates false sensation that the accidents with tragic subsequences are part of road traffic and it has no choice but to accept that. In reality, main causes of accidents are people, vehicles and traffic infrastructure. These unfavorable conditions in the area of road-traffic-safety can be improved with a package of considered and effective precautions only. Crucial factors are the driver, his behavior and training, vehicle quality, level of traffic facilities, corresponding legislation and checking activity in the sphere of its observance.

Young drivers can have superior driving skills and still cause many accidents. Teaching of anticipation ability, hazard recognition, risk perception and self-evaluation skills on the tail end of driving school appears to be promising way to reduce accident rates of these drivers. Additional training to skid managing instead how to obviate this dangerous situation is sometimes preferred by others drivers. That can raise reduced respect to worsened adhesive conditions and excessive self-confidence in personal abilities leading to hazardous driving and accidents rise.

Therefore, it is necessary to perform training of perceptual and scanning abilities for hazard recognition earlier in driving school, regarding lifestyle, social background, sex, age and other individual preconditions have an influence on attitudes or driving behavior and accident involvement of driver.

These findings are useful to apply to the adjustment of education and training methodology (range and content) of young drivers in driving schools or special qualification development of others drivers, with a view to the practice of automated skills at vehicle control.

The new initiative for improvement in the quality of practical training in driving schools should primarily lead to a positive change in attitudes and behaviors not only in the risk group of young inexperienced drivers. Secondly, it should decrease the number of traffic accidents in all drivers groups and it should enhance road-traffic safety.

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