X International Symposium
"ROAD ACCIDENTS PREVENTION 2010"
Novi Sad, 21st and 22nd October 2010.

UDK: 625.745

''ROAD ENVIRONMENT AS A FACTOR OF ROAD SAFETY – do we understand the concept?''

Uroš Brumec[1], Egon Herman[2], Nina Verzolak Hrabar[3], Marko Polič[4]

Abstract: The contemporary findings about situation awareness (SA) as »the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future« (Endsley, 2000:5) should be taken into account in discussions about road safety. Anything that diverts driver attention from the activities critical for safe driving may cause a crash (Regan et al., 2009). Unfortunately quite often traffic environment is even polluted with distractors aimed at capturing drivers' attention, like billboards with advertisements and other irrelevant messages. Considering that humans receive about 60 % of all information through eyes, in traffic even more, about 90 % plus, the visual quality of road environment is important. As human brain has limited capacity for information processing tasks, too much distraction or unnecessary information in the environment overloads drivers processing capacities. In this paper we are analyzing possible influences of environment distractors on drivers' reactions, their possible consequences and possibilities for prevention.

Key words: human factors, traffic safety, driver distraction

1. OVERFLOWING DRIVERS' MENTAL CAPACITIES

Already in the mid 1950 George Miller wrote his famous article *'The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information'* where he postulated a fixed capacity for the human ability to receive information, believing that this limit lies at around seven items. Half a century later this 'channel capacity' is even more present, though we may discuss the exact number of items or better chunks. Attention, as selection of information from the environment, is the crucial process in this regard. From the different kinds of attention relevant for our problem we should mention *controlled attention* and *stimulus-driven attention,* the later covering situations when person is involuntarily attracted to an environmental stimulus (Klingberg, 2009). Another relevant concept is working memory referring to our ability to remember information for a limited period of time.

[1] DDC Consulting & Engineering Ltd., Kotnikova 40, P.O.B. 258, SI – 1000 Ljubljana, uros.brumec@ddc.si
[2] DDC Consulting & Engineering Ltd., Kotnikova 40, P.O.B. 258, SI – 1000 Ljubljana, egon.herman@ddc.si
[3] DDC Consulting & Engineering Ltd., Kotnikova 40, P.O.B. 258, SI – 1000 Ljubljana, nina.verzolak-hrabar@ddc.si
[4] University of Ljubljana, Faculty of Arts, Department of Psychology, Aškerčeva 2, SI – 1000 Ljubljana, marko.polic@ff.uni-lj.si

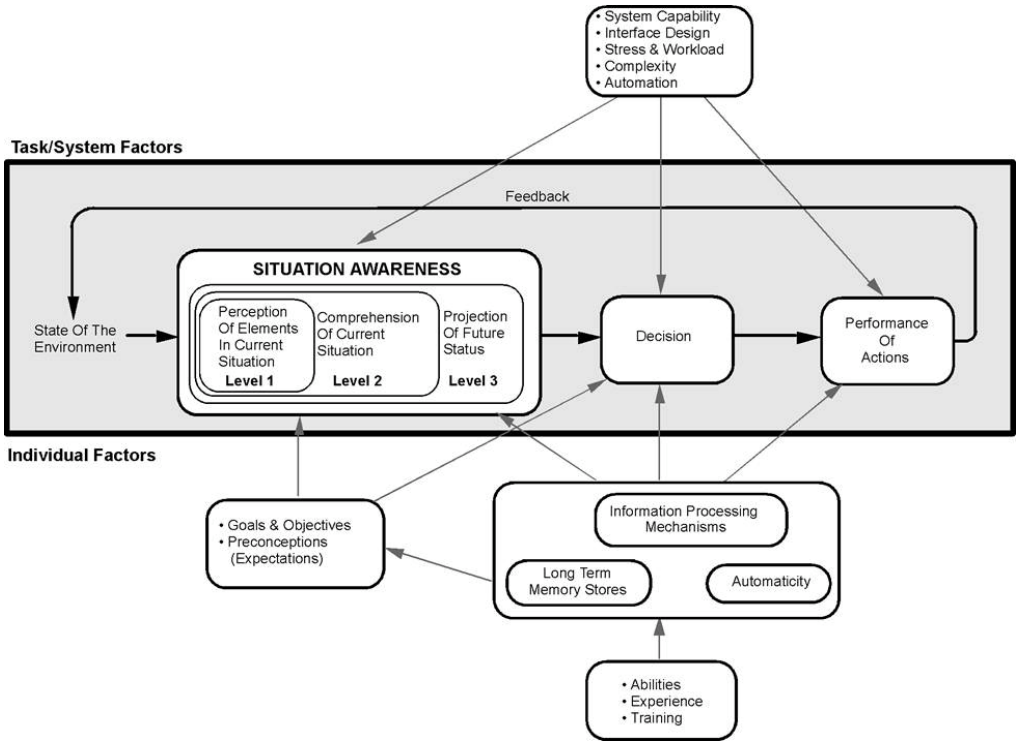

Fig. 1 Model of Situation Awareness (SA) in Dynamic Decision Making [Endsley, 2000)].

Mica Endsley (2003), leading expert in planning, developing and assessing systems is discovering new ways and understanding of human decision-making and action, postulating Situation Awareness (SA) as '*the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future'* (Endsley, 2000:5). Her ideas, though applied more in aviatics than in other kinds of traffic systems are very relevant for our discussion of drivers distraction, what is evident from the starting idea that contemporary technical systems offer more information than is needed and that the needed one is hard to discover. Therefore, the system is too complex and should be simplified to be able to master it. Need for the solution of practical decision problems leads to this development. Contemporary systems should not only provide needed information but it must be cognitively and physically usable. SA simply means that we know what is going on activity. Endsley (2000) believe that elements of SA differ depending on the field, but its nature and mechanisms could be described generically. Three levels of SA could be distinguished (Figure 1), the first one referring to the cues perception. Without perception of the important information our image of the situation would be incomplete or false. Endsley (2000) indicate that 76 % of the pilot errors appeared because of the problems with perception of the important information. Yet SA construct exceeds mere perception and take into account how human combine, interpret, store and retain information. It is necessary to integrate multiple pieces of information and determine their relevance for the person's goals. But this is not the end of the story. On the highest level of SA, the ability to forecast future events and dynamics is taking place. Only this enables relevant decision-making. SA is certain internal model of the state of the environment and based on it humans decide what to do about the

situation. SA depends on the limitations of the working memory and attention. Use of the attention in the complex environment offering multitude of competing cues is critical for determination of those aspects of the situation that will become the content of SA. In a way conception of SA present a model of a task confronting decision maker, in our case drivers.

2. VISUAL PERCEPTION IN TRAFFIC

Driver perception of the environment and traffic signs depends on his/her psychophysical condition and motivation. Drivers' eyes are constantly in motion and they are scanning the visual field with purpose to discover all important places, objects and appearances (features) necessary for driving. Driver is focusing his attention to what is happening on a distance s/he will reach within 3 seconds. Depending on speed this distance is between 20 to 80 meters. With increasing speed, the effect of ''tunnel vision'' is appearing, so the driver simply does not see what is going on both sides of the car. The angle of visual field in which we can detect the events, is for adult person with healthy eyes around 180°, at the speed of 50 km/h the angle of visual field is around 150° and at 150 km/h the angle is only around 50°. So, in limited time we can perceive and process only limited quantity of traffic information. Thereby, if we set on one pole more traffic signs, or if we set up several traffic signs one after another, drivers are not capable to perceive, process and comprehend their message.

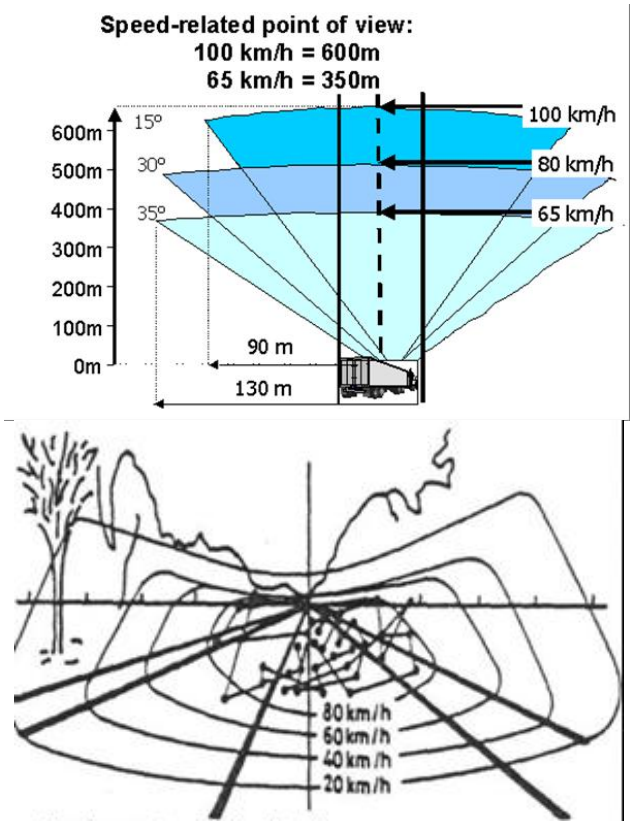

Fig.2 Visual perceiving in relation to speed

3. ADVERTISING BILLBOARDS AS DISTRACTORS

In the paper we are discussing distraction caused by billboards along the roads. At this moment they are legitimate way of advertising, but the question is, if they influence road safety. While driver distraction is defined as '*the diversion of attention away from activities critical for safe driving toward a competing activity'* (Regan, Young and Lee, 2009), the main aim of advertising billboards is just attracting attention to their content. Because, as we already mentioned, human brain has limited capacity to attend to multiple tasks at the same time, driver distraction is important issue in traffic safety. Driver attention could be redirected willingly (in our case, s/he want to read advertisement) or involuntarily (advertisement capture driver attention, what is its 'task'). Lee, Young and Regan (2009) mentioned that nearly 80 % of crashes and 65 % of near-crashes included inattention as contributing factor. We believe that – though not prevailing – also advertising billboard could present this secondary task causing a crash. Because of a distraction, a driver is delayed in the recognition of information and relevant response. Attention diverted by billboards will not always produce a crash, but may in especially demanding situations, what could not be forecasted.

Fig. 3 Billboards along the roads. They could divert drivers' attention either voluntarily or involuntarily. If a driver would like to read all billboards on the right, s/he should stop the car (taken 21.8.2010: http://www.znak.si/digitalni_tisk/city_light/index.php?nsclid=7cBFZGzG2pT_tmB6dooMTgg.)

Advertising agencies are even advertising their sites with the number of passing cars. They are interested in sites with dense and frequent traffic. But these are also more demanding sites for the drivers.

One of the agencies advertise its services with their findings that 83 percent of population aged over 14 on their way perceive billboard. We should be worried if some of them were drivers, because it means that they were not attending the traffic.

Fig. 4 Advertising billboards on one of the Maribor main city roads (taken 21.8.2010: http://www.live-media.si/index.php?page=lokacija)

To attend the crossroads, other road users, traffic lights and billboards is not an easy task. Are drivers able to cope with it?

3.1 Correlation between driver distraction, traffic endangerment & environmental degradation

There is no detailed analysis of drivers' distraction, diverting of attention and parallel with that the endangerment of participants in traffic in Slovenia (yet). All conclusions of resembling studies from abroad shows that psychological influence of commercial advertising alongside the road has an impact on drivers distracting them and diverting their attention away from the traffic and events on the road. Nevertheless, in the quoted studies nowhere is explicitly or clearly mentioned that commercial advertising could be the cause of accidents. Causes of road accidents vary and differ, but in general they always appear when one or more influential factors necessary for safe driving, deviate from normal to such an extent that they can no longer be tolerated or accepted. Therefore we can define traffic accident as a sudden, unexpected, unintentional event on the road, in which there was at least one vehicle in motion involved and in which damage occur or at least one person was injured or killed.

According to the latest Human Factor understanding, we must consider, when dealing with road safety (Road Accident Investigation – RAI), inspecting the roads (Road Safety Inspection – RSI) or auditing road project (Road Safety Audit – RSA), with regard of ''DIRECTIVE 2008/96/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on road infrastructure safety management'', the complexity of human mind and its function.

When dealing with accidents we must understand what triggers drivers' reaction, when they are involved in accident, incident or ''near accident''. In this sense road safety experts must ask themselves, what is the reason that lead to drivers' operational error, which finally resulted in an accident. At the moment we are dealing with *''Post-Accident approach''* where the place of accident is the final point and so, we are focused on conflicts + consequences. Looking from

a human factors point of view, we should deal with this problem with *''Pre-Accident approach'',* where the place of accident is the trigger point and we should be focused on triggers + prevention.

Fig. 5 Typical drivers' information overload and degradation of environment

3.2 Accidents on Slovenian motorway A1 at Trojane tunnels

As an example we could take a closer look at the section of motorway A1, which over a period of time became quite overloaded with commercial advertisement billboards (''Jumbo-posters''). Those billboards are placed close to tunnel entrance and ''attracts'' drivers to restaurant specialties and with that you have on left and right side billboards which are trying to convince the road users of their superior service. When considering that you have a motorway with several tunnels, which demands extra attention from driver, it is unacceptable, even ethically or morally doubtful, to expose drivers to additional overload and distract them.

Fig. 6 Location of billboards in front and above the tunnel

In the area of tunnels there were 8 registered road traffic accidents in 1½ year time. Unfortunately we do not have information how many incidents or "near accidents" happened during this time. If we are considering distractors in front and above of the tunnel entrance (commercial advertising – also illuminated at night) with Pre-accident approach in mind, we can truly ask ourselves how many accidents were caused or contributed by those distractions (see table and figure 7 on next page).

Table 1. Number of accidents on section A1*; (source: DARS)*

Running No.	*Date*	*Time*	*Section of A1*	*km*
1.	*27.11.2008*	*4:35*	*0043*	*6,600*
2.	*25.12.2008*	*16:20*	*0043*	*6,575*
3.	*7.3.2010*	*8:00*	*0043*	*6,450*
4.	*13.12.2008*	*11:00*	*0667*	*3,700*
5.	*10.11.2009*	*19:40*	*0667*	*Trojane tunnel - left*
6.	*10.3.2010*	*11:40*	*0667*	*3,300*
7.	*11.3.2010*	*8:43*	*0667*	*4,000 (Trojane tunnel - left)*
8.	*6.5.2010*	*19:15*	*0667*	*3,400*

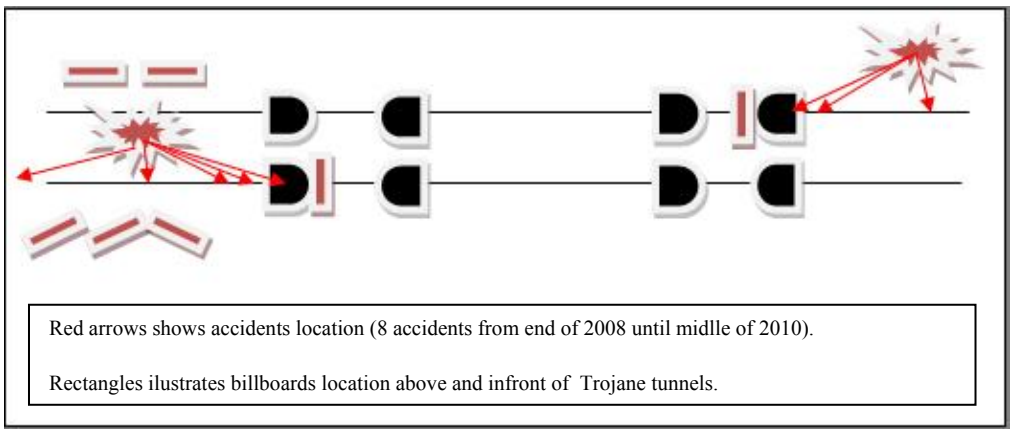

Fig. 7 Schematic presentation of increased accidents location in front of the tunnels and billboards location

Causes of accidents are rarely fully investigated and registered as they really happened; for example: vehicle breakdown (bad brakes, used tyres, damage of steering mechanism …), influence of weather (bad or poor visibility, glare, ice, rain …), influence of road environment (road features, affects of distractions …), influence of road (road alignment, road surface …), influence of driver (psychophysical state, alcohol, drugs, tablets, telephone …). Mostly we can read in accidents reports that drivers' errors (around 90 %) are the cause of accident, but we do not know what triggered them (if those really were drivers' errors). So when investigating the accidents, inspectors/police should take notice, drawings and pictures of distractors (commercial advertising) location and content present before and at accident location as well.

4. SLOVENIAN LEGISLATION REGARDING OBJECTS FOR INFORMING AND ADVERTISING

With implementation of ‘’Tourist and other information signs’’, came also the new term: *‘’objects for informing and advertising’’*, which deals with everything that has something to do with visual or hearing information and is not included in Regulations on Traffic Signals and Road Furniture on Public Roads.

As traffic safety is one of the most fundamental concern of traffic systems and it must be assured for all in Road Traffic Safety Act is written among other: ‘’… on or beside the road it is forbidden to set up anything that could obstruct the traffic flow, jeopardize its safety, harm humans or pollute the environment or in any way divert attention of participants in traffic’’.

Other law, Public Road Act, in a more detailed way specifies that advertising outside cities is prohibited in protected area alongside the road. This area is depending on road classification, between 15 and 40 meters (secondary roads – 15m, main roads – 25m, fast roads – 35m and motorways – 40m). Alongside state roads in cities the billboards could be placed, but with restriction. So they must be outside the area intended for traffic signs and not (min. 100 m) before and (50 m) after canalized junction, which is defined in Regulations of the Road Design. Road Agency can in some cases in accordance with law, allow advertisement alongside the road, when the information is significant for road users and there is no official sign for it.

Fig. 8 Educational (informing) information for road users (taken 26.08.2010: http://www.runter-vom-gas.de/default.aspx)

Because the legislation is to loose, defenders of advertisement (mostly advertising agencies) find the way to set up billboards outside the protected area of roads. As the distance (outside cities) is quite great they put giant billboards (to incredible 90 m²) alongside roads. Usually billboards are also illuminated, though a building permit is needed for illumination. According to this, we can really ask ourselves about appropriateness of those permits, as often this billboards are in rural areas (field or pasture). And what about degradation of nature and environment, light pollution and of course deliberately targeting the drivers’ attention?

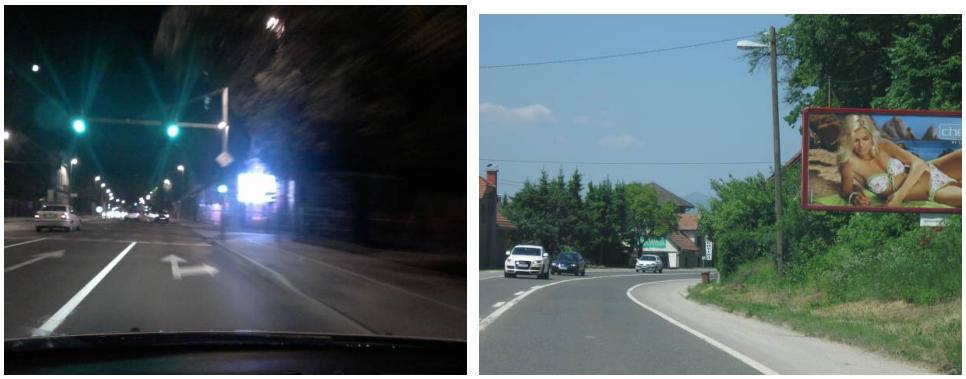

Fig. 9 Light pollution (LED displays) and drivers' distraction

Also the state and its inspectors (traffic, environmental, building …) could intervene, but there is obviously no interest. They do not take into account that in Slovenian Strategic Plan is written, how the cultural, natural etc. amenities of Slovenia will be protected and obligation of their care is emphasized. While driving through Slovenia you can see environmental catastrophe, not the beauty of our country. So we rather not ask ourselves – does anybody understand the concept of road safety?

Fig. 10 Degradation of environment and drivers' distraction

5. CONCLUSIONS

Findings about human mental capacities and driver distraction on one side and advertising aims on the other clearly revealed that overload of our roads with advertising billboards and other distractors are detrimental to traffic safety. What is the solution? In Slovenia are in preparation Regulations regarding objects for informing and advertising alongside state roads, which will define terms and ways of setting up those objects, their purpose, form, size etc. Unfortunately due to conflict of interests between safety and profit (lobby – personal interest – financial benefits) we are still far from good solutions and their implementation. We believe and hope that concern for natural environment and traffic safety will prevail. Perhaps responsible persons will look abroad for good example e.g. Denmark and learn something from it.

What is the most important is the fact that people should, or better, must be aware/told about negative consequence of distraction alongside roads. People must know what could

happen to them (and others), if they will look at billboards (any type of commercial advertising) when they are approaching the crosswalk where pedestrians (vulnerable road users) might cross the road, or at intersection where they should pay attention to traffic signals and traffic around them, or looking left when negotiating the right turn/corner … So if government has no interest and no understanding of what influences road safety, than people should demand (constitutional right) to be safe and protected from deliberate distraction and diverting of attention. People must be aware that billboards posted everywhere are not something normal they should get used to and endure it.

So, we must educate and inform the public about their rights and about the threat commercial advertising brings to road users. In the case of accident, drivers must demand that road features including commercial advertisement are included in the police report with photographs, so it can be furthermore inspected how did they contribute or even caused/triggered the accident. If proven responsible persons for setting up the distraction can be legally persecuted.

At the end perhaps just a thought to think upon. When driving on two-lane road, the only thing that keeps you separated from oncoming traffic are a few centimeters of white paint and you feel relatively safe. So this is the power of visual perception. Now think how powerful and dangerous are commercials because they are deliberately made for alluring your attention – even when you are driving.

6. REFERENCES

[1] Endsley, M.R. (2000). *Theoretical Underpinnings of Situation Awareness: A Critical Review*.

[2] In Endsley, M.R. and Garland, D.J., eds.: Situation Awareness Analysis and Measurement. Mahwah: LEA, pp. 3-32.

[3] Endsley, M.R., Bolte, B. and Jones, D.G., (2003) eds.: *Designing for Situation Awareness*. London: Taylor & Francis.

[4] Klingberg, T. (2009). *The Overflowing Brain.* Oxford: Oxford University Press.

[5] Lee, J.D., Young, K.L., Regan, M.A. (2009). Defining Driver Distraction. In: M.A., Regan, K.L., [1] Young, J.D., Lee (Eds.). *Driver Distraction: Theory, Effects, and Mitigation.* London: CRS Press, 31-40.

[6] Lee, J.D., Regan, M.A., Young, K.L. (2009). What Drives Distraction? Distraction as a Breakdown of Multilevel Control. In: M.A., Regan, K.L., Young, J.D Lee (Eds.). *Driver Distraction: Theory, Effects, and Mitigation.* London: CRS Press, 31-40.

[7] Regan, M.A., Young, K.L., Lee, J.D (2009). Introduction. In: M.A., Regan, K.L., Young, J.D Lee (Eds.). *Driver Distraction: Theory, Effects, and Mitigation.* London: CRS Press, 3-7.

[8] World Road Association/PIARC: Road Safety Manual.

[9] World Road Association/PIARC: Human Factors Guideline for Safer Road Infrastructure.

[10] Vision Zero Magazine, January 2010: Driver Distraction.

[11] Regulations on Traffic Signals and Road Furniture on Public Roads *(Off. Gazette of the RS, No.46/00, 110/06)*.

[12] Public Road Act *(UPB1; Off. Gazette of the RS, No.33/06)*.

[13] Regulations of the Road Design *(Off. Gazette of the RS, No.91/05)*.

[14] Road Traffic Safety Act *(UPB5; Off. Gazette of the RS, No.56/08)*.