Night Driving – Issues to Consider[1]

Introduction:

Everyone knows that driving at night is considerably different than driving during the day. Objects are harder to see, drivers must rely on artificial lighting, and factors such as fatigue and alcohol consumption frequently play a role in motor vehicle collisions. In addition, there are a number of other, less commonly understood issues, which plaintiff's counsel should consider. These issues may arise in cases involving night time collisions where liability is at issue.

Basic Concepts Relevant to Night Driving:

When consulting with a Forensic Engineer and/or Human Factors expert, it helps to have a working knowledge of a few concepts that are frequently discussed in the literature. These concepts include:

- Perception-Response Time
- Eye Anatomy
- Effect of Aging
- North American Headlight Standards

Perception-Response Time

Many drivers falsely assume that they react *immediately* to roadway situations that they encounter. In fact, studies have shown that drivers take time to perceive the situation before reacting. Perception-response time has been defined as "...the interval between the appearance of some object or condition in the driver's field of view and the initiation of a response."[i]

The stages of perception-response time include:

1) Detection
2) Identification
3) Decision
4) Initiation of Response

For example, a driver who encounters a parked car in his lane must detect the object (see something), identify it (as a car), decide what to do (choose to brake or swerve to avoid) and then initiate a response (brake or change lanes). Each of these stages takes time and the total time is considered the perception-response time.

There is a discussion in the academic literature about a common human perception-response time. The consensus seems to be that there is not one common human perception-response time but there is,

[1] I am grateful to Robert Gilchrist, Certified Traffic Operations Engineer and P.Eng., of AT Safety Corporation for his assistance and guidance regarding the issues discussed in this paper.

very generally speaking, a usual perception-response time of 1.5 seconds for roadway situations that are familiar to the driver and occur in good conditions. One of the most highly respected academics in this area, Paul L. Olson, indicates perception-response times can range from 0.50 to 3.5 seconds and they can sometimes be longer.[ii]

Common perception-response times have been recorded as follows:

Table 3.3
Perception-Response Times of Passing Motorists to a Variety of Roadway Situations

Roadway Situation	85% Response Time (seconds)
C.R.B. "Roadworks Ahead" sign	3.00
Protruding vehicle with tire change	1.50
Lighted vehicle under repair at night	1.50
Parked police vehicle	2.80
Amphometer: Beaconsfield	3.40
Amphometer: Dandenong North	3.60
Amphometer: Gisborne	3.60
Amphometer: Tynong	2.54
Railway crossing: night (general population)	1.50
Railway crossing: night (rally drivers)	1.50
Railway crossing: day	2.53
Car following	1.26

[Source: Triggs and Harris (1982)]

As referenced by Paul L. Olson[iii]

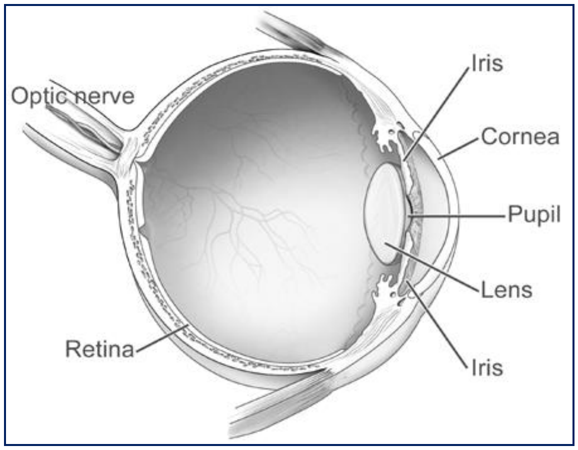
It should be noted that night time does not, *per se*, extend perception-response time. It is the factors which commonly occur at night, such as darkness, fatigue and alcohol consumption that extend perception-response time. Ultimately, if one of these factors affects a driver's ability to detect, identify, make a decision and respond, then the perception-response time has been lengthened.

Eye Anatomy

A basic comprehension of eye anatomy is essential to understanding how the eye functions in a night time driving scenario.

Light enters through the cornea which, together with the lens, brings it to a focus on the retina. The iris, which is the coloured portion, controls the size of the opening into the eye (the pupil), thereby allowing the eye to adapt to different light levels.

The retina uses specialized cells known as rods and cones to interpret the light and generates impulses which the optic nerve then sends to the brain where they can be perceived.



Anatomy of the Eye[iv]

The human eye functions much better during the day than it does at night. This is largely due to the fact that the cone cells, which are responsible for allowing us to see colour and detail, do not work well at night, as they respond to higher light levels.[v]

The human eye relies greatly upon "contrast" to decipher objects within the visual field. During the day, factors such as colour, texture, pattern, brightness and shading help to create contrast. At night, these factors are much harder for the eye to detect. A simple illustration of this concept can be attained by considering the difference in visibility between a pedestrian clad in white clothes at night and a pedestrian clad in dark clothes. There will be virtually no contrast between a dark clothed pedestrian standing against a dark roadway, so the eye will have difficulty in perceiving the individual. The pedestrian wearing white clothing will be much more visible due to the contrast in colour between his clothes and the roadway.

Effect of Aging

The effect of aging on one's ability to see is considerable. After age 65, most drivers experience reduced vision, which includes a decrease in acuity (ability to see detail) and the ability to withstand the effects of glare, reduced contrast sensitivity, and difficulty in changing focus quickly. Moreover, older drivers have difficulty with attention and are more easily distracted and slower at making decisions.[vi]

Additionally, certain medical problems which commonly afflict the elderly can also reduce vision. These include glaucoma, which decreases peripheral vision, and macular degeneration which can lead to a loss of central vision. Cataracts can also reduce light transmission and scattered light around the eye, leading to glare sensitivity.[vii]

Interestingly, there is some indication that patients who have undergone laser eye surgery may be prone to vision problems as well. According to Health Canada's website, a known complication of LASIK eye surgery is "poor quality of night vision due to halos and glare". [viii]

Canadian Headlight Standards

Automotive lighting is regulated in Canada by the federal government in the *Canada Motor Vehicle Safety Standard 108* (CMVSS 108). This standard is very technical and governs the positioning and direction of headlight beams. Aside from a few minor differences, the Canadian standard is the same as the United States standard.

Contrary to what one might think, low beam headlamps do not direct light straight out from the vehicle. Light is actually shone down and to the right. The purpose for this regulation is to decrease headlight glare for oncoming traffic, while at the same time still allowing a driver to shine light on to upcoming reflective signs which are commonly placed above the horizon.

The following diagram[ix] illustrates a typical U.S. low-beam pattern which has been superimposed on a road scene. The smallest circle illustrates the strongest area of light. As the shapes get larger, the amount of lighting decreases.

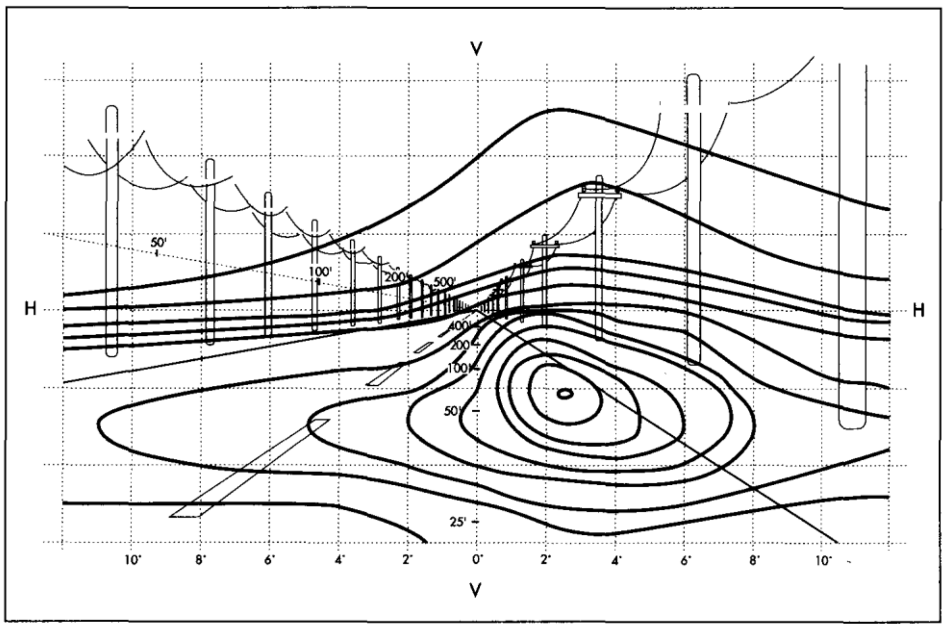


Figure 4.9 *Iso-candela diagram of a typical US low-beam pattern superimposed on a road scene.*

Note that high beam headlights do not conform to the specifications and aim light directly in front of the vehicle as well as higher. Note as well that these specifications do not apply to motorcycles.

Night Driving Issues that may arise in Litigation:

If an accident has occurred at night and liability is an issue, plaintiff's counsel may be well advised to consult with a forensic engineer and/or human factors expert. There are a whole host of driving and accident scenarios that may involve complex forensic issues relevant to liability. The following is a sample of issues that can arise:

- "Overdriving" the Headlights
- Pedestrian Visibility
- The "Moth Effect"

Overdriving the Headlights

Overdriving the headlights occurs when drivers travel so fast that their stopping distance is farther than the distance they can see with their headlights.

For example, it will take a car travelling 80 km/h approximately 60 metres to stop. However, the low-beam range for most vehicles is only 45 metres. The following diagram from the Ontario Ministry of Transportation illustrates this scenario.

Excerpt from the Ontario Driver's Handbook[x]

In the above illustration, the car will hit the pedestrian before it is able to stop.

Information about overdriving the headlights is found in the Ontario Driver's handbook but many drivers are unaware that they are overdriving their headlights. The fact that reflective road signs are visible so far in advance may in fact confound the problem because it gives drivers the sense that they can see farther.

Drivers who are professionally trained will presumably have received greater education surrounding overdriving the headlights. This will be particularly true for professional truck drivers who have to undergo additional training, receive special licenses and are subject to greater regulation.

Keep in mind as well that it can take a large truck a considerable amount of time stop. The following chart illustrates the total stopping distance for trucks.

Stopping Distance (Perception + Reaction + Braking = Total Stopping Distance)				
MPH	**Perception Distance**	**Reaction Distance**	**Braking Distance**	**Total Stopping Distance**
30	33 ft.	33 ft.	115 ft.	181 ft.
45	50 ft.	50 ft.	260 ft.	360 ft.
50	55 ft.	55 ft.	320 ft.	430 ft.
55	61 ft.	61 ft.	390 ft.	512 ft.

Chart illustrating Total Stopping Distance for a Tractor-Trailer[xi]

The above figures use U.S. measurements but establish that a truck travelling over 45 mph (72km/h) with only its low beams on will be unable to stop in time for a night time hazard in front of it. This, of course, assumes no other artificial light sources such as streetlights etc.

Note as well that these estimates assume that the headlights are <u>clean and dry</u>. Headlamps can become very dirty very quickly especially in wet weather. Studies have shown that "under wet and slushy conditions most cars had useful illumination reduced by more than half."[xii]

<u>Pedestrian Visibility</u>

Pedestrians are at an obvious disadvantage when utilizing our roadways. Canadian roads have been predominantly designed with vehicular movement in mind and automobiles move at a significantly higher rate of speed than pedestrians travel.

According to Transport Canada, on average, approximately 363 pedestrians are killed in traffic crashes each year.[xiii] A review of pedestrian deaths illustrates that many of the collisions were determined to be at least partly the pedestrian's fault. In investigating the viability of a pedestrian's claim, Plaintiff's counsel will need to look long and hard at the circumstances surrounding the accident, keeping in mind the potential Defendant driver's ability to see and react to the pedestrian (perception-response time).

In June 2010, Transport Canada published a fact sheet that summarized a study examining pedestrian crashes in Canada between the years 2004 and 2006. The study made the following observations regarding the effect of dark or dim light conditions:

The peak time for fatal pedestrian traffic crashes in general was 6 p.m. to 9 p.m. About 22% of all pedestrian deaths occurred during this interval, but the figure varied depending on age. For example, about one in three fatally injured pedestrians under the age of 16 was hit between 3 p.m. and 6 p.m. In contrast, one in three fatally injured pedestrians aged 20-24 years was struck between midnight and 3 a.m.

Pedestrians can be hard for drivers to see at the best of times, and low light only makes conditions worse. About 59% of pedestrians killed in traffic crashes were struck during darkness or dim light conditions. Low light was a factor in rural pedestrian crashes more often than in urban crashes.

Excerpt from Transport Canada's Fact Sheet TP 2436E - June 2010[xiv]

The "Moth Effect"

The "Moth Effect" is a term used to describe a collision in which the driver crashes into a parked vehicle that was stationary at the roadside. This phenomenon occurs at night and was originally a reference to accidents in which the driver seemed to be drawn to the rear lights of a parked vehicle like a moth to a flame.

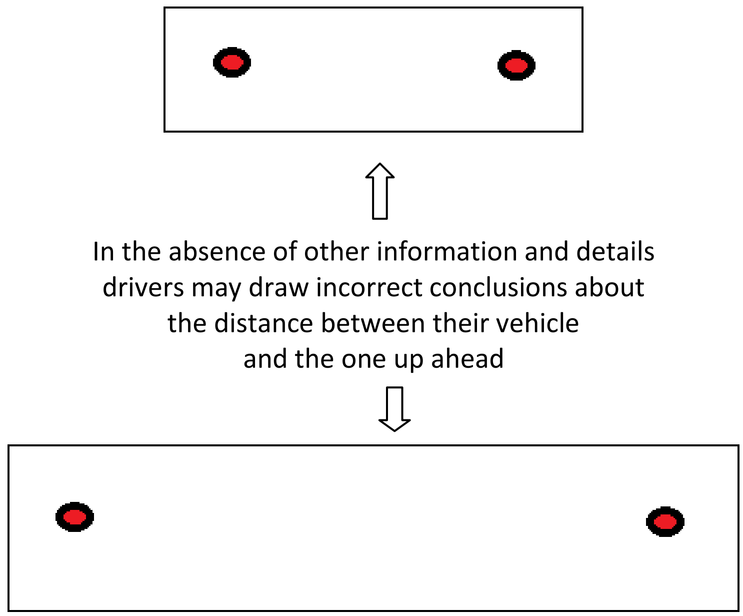
It seems unlikely that these accidents are caused by drivers going into a seemingly involuntary daze and being unable to take steps to avoid hitting a parked car. Rather, it appears that these accidents are caused by difficulties that drivers face at night in judging distance and speed. In addition, experienced drivers are familiar with following a motor vehicle in their lane and may not realize that the vehicle up ahead has stopped and pulled off onto the shoulder until it is too late.

Distance – How do drivers perceive distance at night?

It is very difficult for drivers to judge distance between their own vehicle and a vehicle ahead travelling in the same direction at night. If the road is unlit, the only visible detail of a vehicle up ahead may be the vehicle's rear lighting. In many cases, that will be two small red lights.

Assuming that the driver has detected the lights as belonging to a vehicle (the first stage of perception-response), the driver will then try to identify the size of the vehicle and how far it is ahead.

The spacing of the rear lighting will be used by the driver to estimate distance and this can, unfortunately, be very misleading. Assuming that the rear lights are the only distance cue, a large vehicle with lamps spaced two feet apart will appear to be more than twice as far away than a passenger car at the same distance. [xv]



Speed – How do drivers judge speed at night?

The driver will face a further challenge when trying to judge the speed of the vehicle up ahead. Indeed, it is very difficult to perceive speed at night, particularly when the other vehicle is moving directly toward or away from the driver as there is an absence of other visual cues.

Drivers rely on a *change in image size* as a cue for judging distance. Depending on the speed of the moving vehicle, however, the driver may not have enough time to recognize change in image size and react accordingly. The following chart illustrates the difference between viewing distance and image size and indicates that the rate of change of image size "... is not likely to be enough to capture the attention of an observer until the separation distance has closed to a considerable extent."[xvi]

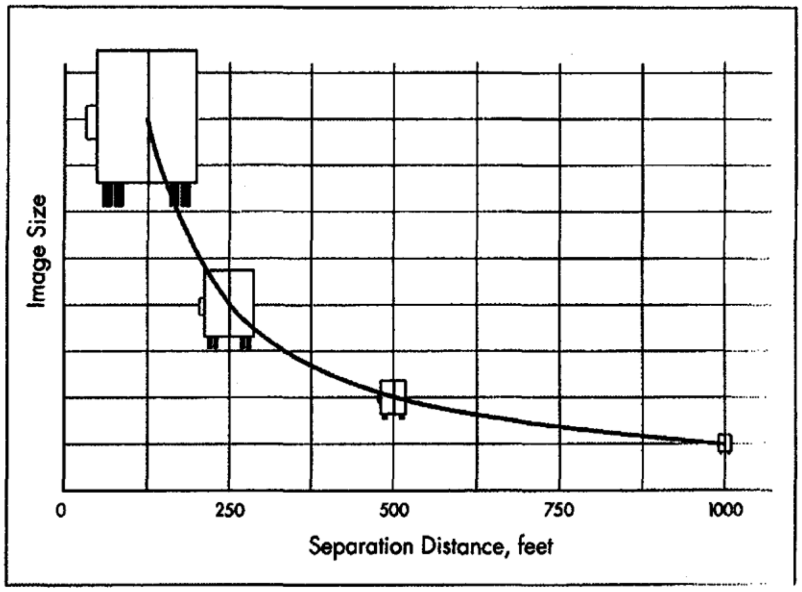


***Figure 6.1** The relationship between viewing distance and image size*

Using the above chart[xvii], a vehicle travelling 100 km/h will cover the distance of 1000 feet/304 metres in 10.9 seconds. During that time, the driver will have to go through the stages of perception-response which include detecting the lighting, identifying it as a vehicle (and its size and speed), deciding what to do, and initiating a response. If the driver is unable to detect that the object is a vehicle due to inadequate visual cues, the driver may not have time to properly respond. This problem will be compounded if the driver is only utilizing his low beams because the truck will not be within low beam range until there are only 45 metres separating the two vehicles.

As Paul L. Olson and Eugene Farber state in Forensic Aspects of Driver Perception and Response:

> "People who are not intoxicated run into stopped or slow-moving vehicles on occasion, sometimes leading investigators to conclude that they must have been very inattentive to have failed to see it. Detection is not the problem.... the driver must not only see something but must understand what it is and what it is doing. It is the latter failing that may cause someone to approach so close to a stopped or slow-moving vehicle as to be unable to avoid a collision, or to pull out in front of another vehicle that just happens to be going at a much higher speed than other traffic on the road."[xviii]

Professional truck drivers who stop to take a break at the side of the road or experience mechanical difficulties often create a dangerous situation. For this reason, truck drivers commonly receive training in how to park at the side of the road and use lights and flares to warn motorists of their location.

Similarly, emergency vehicles can both pose and face additional risks if they are not easily identifiable as having stopped at the side of the road. Research is being done into how to reduce these risks including determinations about what colour of lights should be used to allow motorists the opportunity to detect a parked or slow moving vehicle.

If the plaintiff may have suffered from the "moth effect" a forensic engineer and/or human factors expert will have to be retained due to the complexity of liability issues inherent in this type of accident. Counsel should also look for any other evidence relevant to the standard of care applicable to a professional driver in this situation. Remember that professional drivers are subject to enhanced training and additional regulations. They are expected to have enhanced knowledge regarding night time driving and visibility issues.

Conclusion:

Night time collisions are inherently more complex than day time collisions. With a basic understanding of the concepts discussed above, we, as plaintiff's counsel, will be better equipped to have meaningful consultations with forensic engineers and experts in the field of human factors. This knowledge will assist us in effectively representing our clients and in thoroughly assessing liability issues in night time collisions. I hope that this paper has been of assistance to counsel and that it may, as an added bonus, lead us all to be safer drivers at night!

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[i] Paul L. Olson. Forensic Aspects of Driver Perception and Response. Tuscon: Lawyers & Judges Publishing Company, Inc., 1996 at page 172.

[ii] Paul L. Olson. "Driver Perception-Response Time" C. 3 in Robert E. Dewar and Paul L. Olson. Human Factors in Traffic Safety. Tuscon: Lawyers & Judges Publishing Company, Inc., 2002 at page 44.

[iii] Ibid.

[iv] *LowVision.com*. LowVision.com, 2009. Web. September 29, 2010.

[v] Robert E. Dewar, Paul L. Olsen and Gerson J. Alexander. "Perception and Information Processing" C.2 in Robert E. Dewar and Paul L. Olson. Human Factors in Traffic Safety. Tuscon: Lawyers & Judges Publishing Company, Inc., 2002 at page 17.

[vi] Robert E. Dewar. "Age Differences – Drivers Old and Young." C. 8 in Robert E. Dewar and Paul L. Olson. Human Factors in Traffic Safety. Tuscon: Lawyers & Judges Publishing Company, Inc., 2002 at page 227.

[vii] Robert E. Dewar. “Age Differences – Drivers Old and Young.” C. 8 in Robert E. Dewar and Paul L. Olson. Human Factors in Traffic Safety. Tuscon: Lawyers & Judges Publishing Company, Inc., 2002 at page 211.

[viii] Health Canada. Healthy Living: Laser Eye Surgery for Vision Correction. 2007, Web. September 29, 2010. http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/med/surgery-chirurgie-eng.php#be

[ix] Paul L. Olsen. Forensic Aspects of Driver Perception and Response. Tuscon: Lawyers & Judges Publishing Company, Inc., 1996 at page 77.

[x] Ministry of Transportation of Ontario. Licencing: Safe and Responsible Driving – Overdriving your headlights. 2009, Web. September 29, 2010. http://www.mto.gov.on.ca/english/dandv/driver/handbook/section2.11.1.shtml

[xi] Thomas C. Doehrman. “Night Time Collisions Involving Large Trucks”. American Association for Justice Winter Convention Materials, Maui 2010 at page 435.

[xii] Paul L. Olsen. Forensic Aspects of Driver Perception and Response. Tuscon: Lawyers & Judges Publishing Company, Inc., 1996 at page 119.

[xiii] Transport Canada. Road & Motor Vehicle Safety Publications. “A Quick Look at Fatally Injured Vulnerable Road Users – Fact Sheet TP 2436E.” June 2010, Web. September 30, 2010. http://www.tc.gc.ca/eng/roadsafety/tp-tp2436-rs201002-1067.htm

[xiv] Ibid.

[xv] Paul L. Olson and Eugene Farber. “Judgments of Speed and Distance.” C.6 in Forensic Aspects of Driver Perception and Response. 2nd ed. Tuscon: Lawyers & Judges Publishing Company, Inc., 2003 at page 110.

[xvi] Ibid at 112.

[xvii] Ibid at 112.

[xviii] Ibid at 113.