THE DESIGN DRIVER IN CRASH LITIGATION

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ABSTRACT

The design driver is somewhat impaired and performs at about the 90th to 99th percentile; only 1 to 10 percent of the drivers are even worse. Traffic engineers need to look at road situations through the eyes of the design driver. This paper offers some insights with examples based on the author's experience in lawsuits involving driver performance.

The design driver is the "reasonable worst case." A driver's performance may be reasonable if 1) another driver who is not a worst case has performed similarly, and if 2) there is some location-specific condition that makes this crash foreseeable. An example and an exception are given.

The design driver is not an analytical engineer, but rather has impressions of the road and its environment that may override what the traffic-control devices are indicating. At locations that are unexpected, confusing or deceptive, signs and markings may fail to make a bad design safe for the design driver. Reconstruction may be needed.

The design driver may fail to stop at an intersection that does not look like one from a distance, or because he has become "velocitated" over many miles of high-speed, boring road. He may mistake a two-way stop for a four-way stop, especially if the STOP signs are double-indicated and a flashing beacon has been installed. A CROSS TRAFFIC DOES NOT STOP plaque under the STOP sign may help remove this illusion.

Traffic engineers should be alert for clues as to the design driver's impressions in various road situations.

Introduction

More than a quarter-century has passed since a pair of engineering psychologists, Alexander and Lunenfeld, authored their seminal work *Positive Guidance in Traffic Control* (1). As they explained,

> This approach joins the highway engineering and the human factors technologies to produce an information system matched to the facility characteristics and driver attributes. It is based on the premise that a driver can be given sufficient information where he needs it and in the form that he can best use to avoid hazards. (1)

Since then, editions of the American Association of State Highway and Transportation Officials' (AASHTO's) authoritative *A Policy on Geometric Design of Highways and Streets* have drawn extensively on the positive guidance literature for their material on driver performance. For example, see Reference 2, p. 46. AASHTO advocates "assessing all guidelines to consider the practicality of designing for the 95th- or 99th-percentile driver, to represent the performance abilities of an older driver" (Ref. 2, p. 55). (The references to percentile here mean that only 1 to 5 percent of the drivers are performing at an even lower level). The design driver is not the average driver, who is performing at the 50th percentile. The AASHTO concept of the design driver focuses on the elderly, but the performance of a driver could be impaired by many other factors, including unfamiliarity with the road, lack of driving experience and judgment, impairment by drugs or alcohol, exhaustion, distraction, etc. Recently the Institute of Transportation Engineers published two excellent sources of information on the design driver (3, 4). The latter document (p. 26) gives an example of a "design driver" who becomes overloaded by the requirements of driving, due to 1) unfamiliarity with this road, 2) operation under less-than-ideal conditions of darkness or rain or snow, and 3) less-than-average perception, information-processing and response capabilities because of advanced age.

The purpose of this paper is to offer some thoughts on the design driver from the author's experience in giving expert opinion and testimony in lawsuits involving driver performance.

The Easy Aspects of Looking at the Road from the Point of View of the Design Driver

Geometric designers and traffic engineers need to be able to take the design driver's point of view. There are at least two aspects of this that are relatively easy, as they lend themselves to a more-or-less rational determination of appropriate values at high percentiles. One of these is braking perception-reaction time, recommended by AASHTO to be 2.5 seconds and stated to "exceed the 90th percentile of reaction time for all drivers" (Ref. 2, p. 111). The other is the height of driver eye, taken by AASHTO to be 3.5 feet for both stopping and passing sight distances (Ref. 2, p. 127).

A recent lawsuit in an Atlantic state involved a work zone where a Type III barricade had been installed to mark a detour, as shown in Figure 1. It had been placed at a two-way-stop controlled intersection, where it partially obstructed visibility for a driver waiting at a STOP sign and looking to the left to spot available gaps in cross-traffic. This barricade has openings 8- to 12-inches high between the rails, allowing some view of oncoming traffic. However, two drums had been placed behind the barricade and significantly blocked the view between the lower two rails. A woman driving a passenger car on the stop-controlled approach pulled out into the path of a car and was injured in the wreck. Drums are 36 inches high. From a design point of view, the need was to assess the sight distance remaining to the design driver with a 3.5-foot height of eye. This was not done, however, as investigations performed after the crash were by men sitting in full-size pick-up trucks, with a 5 to 5.5-foot height of eye. The plaintiff's expert stated that their opinions of adequate sight distance failed to consider the design driver.

Figure 1. Type III Barricade Has Drums Behind It That Restrict Sight Distance

The Design Driver is Not the Average Driver

It seems that many engineers and most attorneys believe that roads should be designed and operated for the average driver. This idea has no merit at all, as it is obvious that 50 percent of the drivers do not measure up to the standard of the average driver. Half the drivers would not be up to the task confronting them, a ridiculous criterion for road design and operation. When we design and operate our roads for the design driver, then the vast majority of drivers enjoy some margin for error.

One southeastern state specifically ignores the design-driver concept in its *Manual on Uniform Traffic Control Devices* (MUTCD) where it states, regarding the State Highway Secondary System, "Most of these roads and streets are used principally by local motorists who are familiar with conditions, and consequently, they will not need as extensive markings as required for primary routes." The operation of these roads is for the principal users, the majority who are local. The minority who are unfamiliar are never warned of their need for extra caution on these roads.

The reconstruction of a particular crash often is performed using average values of perception-reaction time, such as 1.5 seconds, because of the impossibility of determining the actual time required by that driver in that circumstance. However, the driver owes no duty to others to be performing at the 50^{th} percentile, so his interests in the lawsuit may be unfairly attacked by the reconstruction. It is better to use a range of perception-reaction times that includes the design value of 2.5 seconds.

The Difficult Aspects of Looking at the Road from the Point of View of the Design Driver

A driver may be performing below average in ways not related to AASHTO's design values of perception-reaction time or height of eye. Unfamiliarity with the road is one example of impairment. An engineer who has been on a construction project for many months may find it difficult to look at a road from the point of view of the unfamiliar driver. An elderly driver needs much more illumination at night than does a young one. Do young engineers need to wear sunglasses during their nighttime inspections? An associated question is “Just how impaired is the design driver?” It is obvious that we cannot be expected to design and operate our roads to be safe in the presence of a driver with a blood-alcohol content of 0.42, who is just about to slip into a coma behind the wheel. Another example follows.

A recent lawsuit in an eastern state involved a work zone on a divided highway, where a queue had formed due to construction activity. An adult male driver crashed his Suburban into the back of the queue at 65 miles per hour and killed the plaintiff’s two sons. The driver was a diabetic and took three drugs daily. Before the collision he had driven through four miles of advance warnings, including two portable message signs with flashing warnings and including warning signs at seven different locations on both sides of the road. He testified that he did not recall seeing any of these. Prior to the collision he never applied the brakes and never swerved. When questioned, he remarked that he only remembered a bright, white light in his eyes before the crash. There is no reason to believe that this driver was performing at a level as high as that of the design driver. Probably no generally accepted methods to control traffic would have averted this crash.

The Design Driver as the “Reasonable Worst Case”

Dewar (Ref. 3, p. 7) refers to the design driver as the “reasonable worst case.” The devil is in the interpretation of the word “reasonable,” seen so often in the law. A useful guideline here might be that a driver’s performance is reasonable if 1) another driver who is not a worst case has performed similarly, and if 2) there is some location-specific circumstance--a rationale for the performance that is unrelated to the driver’s impairment--that makes this crash to some extent foreseeable. An example is given next, followed by an exception to this guideline.

In a southeastern city an adult female heroin addict was driving to her Methadone clinic. She approached an intersection with a divided highway that had a 200-foot-wide median, so wide that the signalization was designed as two separate intersections. The signal heads for the far intersection were 208 feet beyond those for the near intersection. During three of the phases of the cycle the near signals were showing red while the far signals were showing green. As she approached the near intersection, the far signals were closer to her cone of best vision, both laterally and vertically. She entered the near intersection on a red signal, at a time when the far signal was green, and had a right-angle collision with a car that was crossing the near intersection on a green signal.

Applying the suggested rules for the “reasonable worst driver,” the author 1) was able to find a prior similar crash by a driver who was *not* a heroin addict, was *not* on their way to a Methadone clinic, was apparently not a “worst case” or impaired in any way. Then, 2) the 1974 and 1983 editions of the FHWA’s *Traffic Control Devices Handbook* (5, 6) specifically warn of the need to limit the visibility of signal indications, normally through the use of optically directed lenses, at wide intersections or closely spaced ones. The city had failed to do this. The location failed to meet the requirement of the *Manual on Uniform Traffic Control Devices* that, to be effective, a traffic control device should convey a clear, simple meaning (7). There was a rationale explaining the heroin addict’s crash other than impairment due to addiction.

A Reasonable Driver Could Be the First to Experience This Type of Crash

The previous section suggested that a driver's performance is reasonable if another driver who is not a worst case has performed similarly. There are exceptions to this. A lightly traveled location that is hazardous because it is unexpected or deceptive or confusing to reasonable drivers may go for years without mishap because at the moment of potential conflict there is no conflicting vehicle present. Decades may pass before a reasonable driver is fooled at just the moment a conflicting vehicle happens to arrive, and the first such crash occurs. A example follows.

In a southeastern state a 21-year-old university student with four years of driving experience was driving after dark in an area less than 10 minutes from her home. It was a rural area, undeveloped, with very little traffic, but within commuting distance to two cities. She felt that she was not familiar with the area, as she had driven there only about three times previously, always after dark, returning home from visiting a friend. Each time she would turn onto a certain State Secondary road and would see before her a straight road with a STOP sign glowing at an intersection about 900 feet away. Closer, about 600 feet away from where she turned in, there was an intersection where a road curved away from her road, to the right. (The location was the mirror image of the hazardous intersection shown in Reference 1 as Figure 10). Well before the curve, on her straight section, a CURVE RIGHT warning sign was in place, but she never noticed it. At the intersection there was no sign facing her, nor was there a sign for traffic approaching her as it came around the curve. (There was a YIELD sign for oncoming traffic on the straight road). However, she believed her straight road to have the right of way over the fork to the right, such that a vehicle approaching around the curve toward her needed to yield to her as she proceeded straight.

On this night she once again drove straight toward her STOP sign, but this time a car approached around the curve and struck hers, injuring her to the point where the career she hoped for was now out of reach. The investigating officer cited her for failing to yield, but later dropped the charge because he believed the intersection to be confusing. He then went to the state DOT and asked them to reevaluate the intersection. She sued the state DOT, alleging that the intersection was negligently designed in that neither of the two drivers was facing a YIELD sign.

The author testified for the plaintiff, in deposition and at trial, that the intersection was hazardous as it did not meet driver expectancy. The engineering literature (1) had warned of this problem for 25 years. The defendant state DOT countered that 1) her crash was the only one that had occurred in the 32 years since the intersection had been constructed, 2) the Curve Right sign was adequate guidance, and 3) the LEFT TURN YIELD sign in this state's MUTCD was not needed, as "only locals would be using" these lightly traveled Secondary roads. The author rebutted this, citing page 52 of the 1990 edition of the AASHTO *Policy* (2) to the effect that 1) unfamiliar drivers should be considered, and 2) drivers "read the road" and believe what they see even if signs and markings conflict with what the road itself is indicating. He showed the jury his design for signing and striping to remove the confusion. He explained that this hazardous location could be free of crashes for long periods because, with traffic very light, a driver could fail to understand the need to yield and yet never have a collision, because the chance of a conflicting vehicle arriving at just the crucial moment was remote. In the three times she drove the intersection, this woman never did come to understand how the state DOT intended for it to operate. She was fooled again and again. After repeated trips, she was still not a familiar driver.

The jury agreed with the plaintiff's two experts and the two troopers who testified, and awarded her $500,000. Her performance had been reasonable, even though no other driver had previously experienced a similar crash.

The Design Driver is Not an Analytical Engineer
"The search for personality characteristics associated with traffic accidents has met with little success, partly because personality tests lack precision" (Ref. 3, p. 27). However, the author's experience is that some crashes seem to be caused by drivers who act on impressions and, perhaps, feelings. In these cases the driver seems not to be making an objective analysis of the traffic situation, and seems not to be looking a few seconds into the future to anticipate what could be about to happen. There is a potential problem here if engineers, with their training and inclinations always to be analytical and logical, always thinking, are entrusted with the task of taking the point of view of drivers who are guided by their overall impressions of the road. A particular problem is that, in certain situations, these drivers are unlikely to be much influenced by signs and pavement markings, as discussed next.

The Design Driver "Reads" the Road
For many years the editions of the AASHTO *Policy* (e.g., Ref. 2, p. 57) have included this statement:

> Because drivers "read" the road and the adjacent environment and make decisions based on what they see (even if traffic control devices making up the formal information system indicate consistencies with the driver's view), a highway segment that is inappropriately designed may not operate safely and efficiently.

This means that warning signs and restrictive pavement markings may fail to make a bad design safe, especially if the location has characteristics that are unexpected or confusing or deceptive (8). Faced with this fact, the engineer may be tempted to adopt a "we" and "they" attitude. "We" have installed our traffic control devices, and if "they" don't base their decisions on them, then they can't blame us for a bad outcome. This is an attitude to be avoided, as the design driver is our most critical "customer." It is our job to try to meet the needs of this driver, to the extent our agency can afford, even if it means reconstructing a location at considerable cost. Another reason to avoid this attitude is that the United States operates on the jury system. In fact 90 percent of the jury trials in the world take place in the U.S. Jurors are not selected from a pool of analytical engineers. They may be sympathetic to drivers who were "reading the road" and have acted on their impressions, particularly if similar crashes had already occurred. Two-way-stop controlled intersections are especially interesting in this regard and are discussed next.

The Design Driver and the Two-Way Stop Intersection
Right-angle crashes at two-way-stop controlled intersections tend to be due to the following factors:

- Failure to stop
  - The upcoming intersection does not look like one from a distance
  - The "velocitated" driver doesn't expect to have to stop
- Failure to enter safely after stopping
  - The driver mistakes the crossing for a four-way stop
  - Sight distance along the major road is insufficient for the major-road speeds

These are now discussed in turn. An approaching design driver, unfamiliar with this stretch of road, may fail to stop, in spite of STOP AHEAD warning signs, if the intersection itself--the cross pavement-- is not visible and identifiable as an upcoming intersection. Figure 2 is an example, where the intersection ahead is hidden by horizontal and vertical curvature.

Figure 2. The Intersection Itself--the Cross Pavement--Is Hidden by the Curvature (9)

Even if the road is straight and there is no obstruction of the view of the intersection, there is still a potential problem if the intersection does not look enough like an intersection, perhaps due to lack of commercial development on the corners. It may be important to “daylight” the intersection, opening it up by clearing away trees on the right-of-way. Other indicators of an intersection might be added, such as large street-name signs suspended overhead.

A driver may become “velocitated” and fail to stop at the intersection. After driving many (more than about 20, perhaps) miles at high speed on a boring stretch of rural road, the design driver may find it difficult to concentrate on the driving task and may lose any expectancy of needing to stop in the future.

Once we have succeeded in getting the driver to stop, the next tasks are for that driver to

- Understand that cross-traffic is not stopping, and to
- Pick a safe gap in cross traffic

In the author’s experience, it is not unusual for the driver cited for failure to yield to tell the investigating officer that he thought the intersection was a four-way stop. This seems to occur often enough to be a “reasonable worst case,” at the level of performance of the design driver. Here we get an important clue that the design driver may not be analytical enough to look left and right to see if cross-traffic has STOP signs. The design driver has the impression that it is a four-way stop, and is willing to stake his life on this impression by pulling out in front of a

crossing vehicle, especially one that is slowing somewhat for the intersection. Why does the driver mistake the intersection for a four-way stop? Perhaps because there are four-way-stop intersections in the area, and the driver has built up an expectancy of them. It can also occur when engineers have decided there is a problem with failure to stop, and have double-indicated the STOP signs and perhaps have gone so far as to install an Intersection Control Beacon over the center of the intersection. All these devices may give the design driver an impression--a feeling--of four-way-stop control. This shows that it is important to study police reports to see whether right-angle
crashes are due to failure to stop, or due to failure to make the right decisions after stopping. If the problem is the latter, but the engineers are dealing with it as though it were the former, the extra STOP signs and the beacon may result in more crashes than before. The 2000 MUTCD (10) offers the CROSS TRAFFIC DOES NOT STOP plaque, shown in Figure 3, to help the traf-

Figure 3. This Plaque (W4-4P) Under the STOP Sign May Help the Design Driver (10)

fic engineer to cope with the illusion of four-way stop control.

Conclusions

Psychologists have given us the concepts of positive guidance and have made some progress in describing the design driver, especially those impaired because of advanced age. Those of us who are active in litigation frequently investigate crashes, speak with drivers and witnesses, and study many police reports. There is an opportunity for us to look for clues as to the nature of the "reasonable worst driver" in various roadway situations, and thereby contribute to the profession's knowledge of the design driver.

Author's Information

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Endnotes

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