REFERENCE

Hammond, C., and M.G. Wade. *Deer Avoidance: The Assessment of Real World Enhanced Deer Signage in a Virtual Environment*. Report No. 2004-13. Minnesota Department of Transportation, 2004.

INTRODUCTION

Deer crossing warning signs are installed throughout the United States (See Figure 1). Unfortunately, the impact of these signs on driver behavior (i.e., vehicle speed choice) has not been studied extensively. In general, it is commonly assumed that these signs have little attention value. The research project described in this summary investigated, through the use of a simulator, the driver vehicle speed choice and eye scanning behaviors when confronted with traditional and enhanced (See Figure 2) deer crossing warning signs.

Figure 1. Traditional deer crossing warning sign.
Photo reference: 2003 Manual on Uniform Traffic Traffic Control Devices

Figure 2. Enhanced deer crossing warning sign.
Photo reference: Document summarized

SIMULATION DESIGN

This research project involved 52 volunteer drivers. Forty of the participants had a mean age of 24 years old and 12 participants had a mean age of 69 years old. About half the participants were male and the other half female. Thirty-five of the volunteers identified themselves primarily as city drivers and 17 as rural drivers. The volunteer selection process was not documented.

The simulation that the drivers were confronted with was designed to represent an existing 27-mile segment of rural Highway 23 near Marshall, Minnesota. The simulator consisted of a full-size 2002 Saturn SC2, a high-resolution projection of the road, and rear and side mirrors with screen and LCD panels. Vehicle-related audio and vibrations that simulated

the actual experience of driving were also used. The simulation excluded existing intersections, but did include vehicular and motorcycle traffic flow, primarily in the oncoming lane. A deer was also simulated on the roadside but only at the beginning of the experiment with each volunteer. The stated objective of this approach was to make the drivers aware of the potential for a deer but also to reduce any game-like environment due to the anticipation or threat of deer "obstacles." However, the participants were not directly informed that this study related to deer vehicle collisions in any way.

Various deer crossing warning sign designs were placed along the straight roadway segments in the simulation. Other standard traffic signs were also randomly dispersed throughout the corridor. Four deer crossing warning sign designs were presented to each driver, in no particular order, but within two to three miles of each other. The sign designs included: 1) an enhanced warning sign with lights flashing, 2) an enhanced warning sign without lights flashing, 3) a traditional deer crossing warning sign, and 4) a cluster of four consecutive enhanced warning signs with lights flashing spaced 650 feet apart. Overall, the first three sign designs were presented three times during the simulation and the fourth design was simulated twice.

The participants in the study were randomly assigned to either a daylight or a half-light (i.e., dusk/dawn) simulated driving condition. They were also told to drive as normally as possible and typically completed the simulation (which included all four scenarios described above) within 30 minutes.

SIMULATION RESULTS

Useful eye scanning and vehicle speed data were collected from 47 of the 52 study participants. The eye scanning behavior of the participants was measured and scored near each deer crossing warning sign design. The scores that were documented were based on a Likert scale. The scale used assigns a one for a decrease in scan levels (indicated by looking down or at distractions), a two for normal driving (some glancing about), and a three for increased scanning to roadsides or other vehicles. Table 1 shows the average Likert score results around the sign designs evaluated in order of appearance throughout the simulation.

The results in Table 1 indicate that the average score for the eye scanning was near two (i.e., normal driving) for each of the situations noted above. Overall, only eight individual incidents of increased scanning actually occurred during the simulations. However, there were 517 opportunities for these to occur (i.e., 47 participants approaching the 11 situations indicated in Table 1). It was concluded by the researchers that none of these increases appeared to be related to the warning signs. However, no statistical analysis on the eye scanning was completed.

Table 2 contains the mean and standard deviation of the simulated vehicle speeds near the 11 locations of the four sign scenarios considered. The average vehicle speed for each participant was calculated for a 1,000 foot roadway segment measured from 500 feet before and to 500 feet after each warning sign location. The overall average and standard deviation for the vehicle speeds of all 47 participants was then calculated for the 11 sign locations (See Table 2).

Table 1. Average Eye Scanning Level Near Each Warning Sign Design (Likert Scale)

Deer Crossing Warning Sign Design	Average Likert Scale Score
Traditional Sign #1	2.0
Traditional Sign #2	2.1
Traditional Sign #3	2.0
Enhanced Sign (lights off) #1	2.0
Enhanced Sign (lights off) #2	2.0
Enhanced Sign (lights off) #3	2.0
Enhanced Sign (lights on) #1	2.1
Enhanced Sign (lights on) #2	2.0
Enhanced Sign (lights on) #3	2.0
Enhanced Sign Cluster (lights on) #1	2.1
Enhanced Sign Cluster (lights on) #2	2.1

Table 2. Mean Simulated Vehicle Speed (mph) for Various Signs Designs and Locations[1]

	Traditional Sign	Enhanced Sign (lights off)	Enhanced Sign (lights on)	Enhanced Sign Cluster (lights on)
Sign Location #1	61.63	61.38	59.66	60.78
Sign Location #2	60.59	61.62	59.27	61.28
Sign Location #3	63.41	62.41	59.71	NA[1]
Overall (SD)[1]	61.87 (5.16)	61.80 (4.80)	59.55 (4.66)	61.03 (3.75)

[1]Please note that the locations indicated are different for each sign. Each participant experienced all 11 sign design-location combinations within the simulation. SD = Standard deviation. NA = Not Applicable.

The average vehicle speeds for all four signs were very similar. The overall range of these mean vehicle speeds appears to be 2.32 miles per hour (mph) near all four sign designs (see Table 2). The smallest mean vehicle speed occurred near the enhanced sign design with the lights flashing (59.55 mph), and the largest overall speed average occurred near the traditional deer warning sign (61.87 mph). The average vehicle speed near the traditional deer crossing marking sign also had the highest overall variability of the data collected near the four sign designs being considered. The researchers noted that the difference between the highest and lowest overall mean vehicle speed was statistically significant. They also believed that the nature of the simulated experience may have produced more modest results than would have occurred in real driving conditions. The basis for this last conclusion was not described or compared to actual field results.

RESEARCH STUDY CONCLUSIONS

The researchers made the following conclusions. First, it was concluded that there were no consistent differences or patterns in the vehicle speed or eye scanning characteristics of the different participant demographics (e.g., age, sex, or experience). Second, the highest average vehicle speed and variability was measured when drivers were presented with the traditional deer crossing warning sign. Third the enhanced warning sign with lights flashing recorded the lowest average speed, and fourth, there were no significant changes in eye scanning behaviors for the different sign designs. It should be noted that impacts of dynamic signs (i.e., those that are activated by certain events) have been shown to have a larger impact than traditional signs or those with constantly flashing lights. Whether the lights on the signs were constantly flashing or only started after the vehicle was within a particular distance is unknown. The potential relationship, if any, between eye scanning and vehicle speed is also unexplained. It should be noted that only 29 of the 47 participants recalled seeing a deer at the beginning of the simulation. Only one of the 47 participants indicated they understood the purpose of the study.

DVCIR CENTER FINDINGS

This research project had approximately 50 participants drive by 11 simulated deer crossing warning sign scenarios (with four different designs) in about 27 miles. One of the designs was a cluster of signs with flashing lights. An explanation of what the flashing lights meant on the enhanced signs was not provided to the participants.

This is a small simulator study, but appears to be the first to consider the attention value (through eye scan tracking) of traditional and enhanced deer crossing warning signs. The results support what is generally accepted, based on best practices, about the lack of impact traditional (rather than dynamic) "occasional hazard" warning signs have on driver behavior. Previous studies focused on temporary or enhanced signing (with additional information) were reviewed in the original DVCIR Center toolbox (See www.deercrash.com). These previous studies were considered inadequate for a number of reasons. More recent studies that focused on the use of dynamic signing to warn of animal activities and roadside detection systems connected to dynamic signs are summarized separately for the toolbox update (See www.deercrash.com).

The results of this simulation study indicate that the signs with flashing lights apparently had no additional attention value than a traditional deer crossing warning sign. This result is unexpected and could be related to the small number of participants and the experimental design. The traditional deer crossing sign, enhanced sign (with lights off), and cluster of enhanced signs (with lights on) all produced similar average vehicles speeds (e.g., within one mph of each other). The individual enhanced sign (with lights on) produced the smallest average vehicle speed and the traditional deer crossing warning sign had the highest average vehicle speed. The overall range of average speeds for the different signs designs was small. No comparison was made to typical (i.e., no sign) average vehicle speed or variability.

Overall, the results of this research project generally agree with anecdotal observations about the impact of occasional hazard warning signs on driver behavior. There have been almost no studies completed on the deer crossing warning sign, but this project is a good start. It is suggested that a larger field-based study be completed to support this simulation study and confirm or refute its results. However, it should also be noted that the poor installation practices of current deer crossing warning signs also likely influenced, to some extent, the results this project and will impact the results of any future study. There is no quantitative safety basis for the installation of many of these signs.