

Driver Acceptance and Use of a Speed Limit and Curve Advisor

2011-01-0550

Published
04/12/2011

M. Lucas Neurauter and Robert E. Llaneras
Virginia Polytechnic Inst. & State Univ.

Donald Grimm and Charles Green
General Motors Company

Copyright © 2011 SAE International

doi:[10.4271/2011-01-0550](https://doi.org/10.4271/2011-01-0550)

ABSTRACT

This research examined driver acceptance and behavior associated with Speed Limit and Curve Advisor systems, including influences on speed choice. Drivers experienced messages from an emulated Speed Limit and Curve Advisor system during a 2-hour public road drive. Driver tolerance for system errors and message conflicts was also studied by manipulating the accuracy of the information provided by the system. Messages were presented using either a Head-Up Display or on an in-dash Driver Information Center. Results indicate that drivers liked having speed limit information continuously available to them while driving, but the information provided by the Speed Limit Advisor did not significantly influence or alter drivers' speed choice or deceleration profiles in comparison to driving without the system. The vast majority of drivers reported that they relied on both in-vehicle and external sources of information, and incorrect information provided by the system (e.g., speed limit presented was higher than the posted speed limit) or missing speed limits (i.e., no externally posted speed limit information) did not appear to significantly influence drivers' speed choice. This was the case at transition points surrounding speed limit changes, as well as during extended periods of driving with no externally posted speed limit signs where drivers may have desired to confirm the legal speed limit. Unreliability in the system (represented by inaccurate or missing information) was found to lead to decreased trust in the system, but did not significantly change drivers' basic perception of the utility of the concept. Driving profiles related to approaching and negotiating curves were also not influenced by the presence or absence of Curve Advisor messages.

INTRODUCTION

This research examined driver acceptance and behavior associated with two in-vehicle advisory systems: a speed limit system and a curve advisory system. The Speed Advisor presents in-vehicle information relating to the external posted speed limit via a Head-Up Display (HUD) or Driver Information Center (DIC). This information is continuously available to drivers with changes in posted legal speed limits updated at the physical location of the external speed limit sign. The Curve Advisor informs drivers of the presence of a curve ahead by providing drivers with the curve direction and advisory speed in advance of curves. Both systems (Speed Limit and Curve Advisor) were functionally simulated and controlled by the experimenter (via a "Wizard of Oz" approach), allowing information updates to be "artificially" triggered and key system parameters to be manipulated, including the reliability (error rates) of the system. The primary objective of this research was to determine if a speed advisory system and/or a curve ahead advisory system is beneficial to drivers, if drivers perceive the feature to be useful, and to assess the extent to which these features influence drivers' speed choice.

METHOD

Twenty-four drivers in two age groups (30 to 40 years of age, and 55 years and older) received speed limit and curve advisor messages during the course of a 2-hour drive through public roadways in the Blacksburg, VA area. Drivers were generally unfamiliar with the route which included 32 speed limit changes and 26 curves. Drivers were not initially alerted to the presence of the Speed and Curve Advisor system or the purpose of the study, which was to understand the impact of

providing speed limit and curve information on driver performance, as well as to assess whether drivers found the information useful and beneficial. Several factors were experimentally manipulated, including the reliability of the system (90% versus 50% accuracy) and the location of the in-vehicle display (HUD versus DIC). The study used a mixed factorial design with three between-subjects and one within-subject factor, leading to a $2 \times 2 \times 2 \times 2$ factorial. Between-subjects independent variables included **System Display Type** (HUD versus DIC), **System Reliability** (90% correct information versus 50% correct information), and Age group (Middle versus Older). **System State** (On versus Off) was the only within-subject factor.

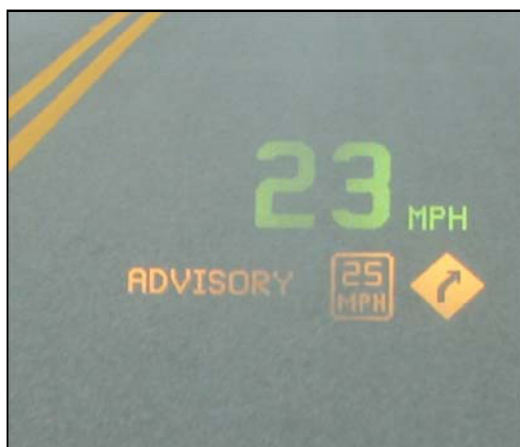


Figure 1. Speed and Curve Advisor Messages Presented using a Head-Up Display

The study was performed using an instrumented 2002 Buick LeSabre equipped with a HUD mounted above the dashboard and a secondary DIC integrated above the original DIC to present speed and curve advisory system messages. The Speed Advisor provided in-vehicle information relating to the external speed limit, with changes in speed limit provided at the physical location of the external sign (no preview). Additionally, drivers who experienced the HUD were also notified if their speed exceeded the road's speed limit when the vehicle speed, which normally displayed as green, turned to amber. The Curve Advisor presented a directional curve icon in advance of the curve (Figure 1). Additionally, if available, an advisory speed replaced the speed limit information, at the physical location of the external sign. Both systems were emulated using a Wizard of Oz approach. This was accomplished by mapping the route in advance to note the location of all speed limit changes and curve segments. A computer automatically triggered the system messages at the appropriate points along the route according to the distance the vehicle had traveled (the accumulated distance was reset by the experimenter at known landmarks to account for any variance). Vehicle instrumentation captured sensor network information, video, external

roadway views, and Speed and Curve Advisor system views (refer to Figure 2).



Figure 2. Captured Video Views

PROCEDURE

Participants were informed that they would be evaluating several advanced vehicle features during a 2-hour drive. Once in the vehicle, participants were provided a brief orientation of the vehicle's basic controls (seat adjustments, mirrors, etc.), including features such as cruise control and OnStar. For participants in the HUD condition, the image was adjusted to be at an appropriate height for each driver (based on their preference). Testing was conducted on roads throughout the New River Valley using a defined 90-mile route selected on the basis of its relatively high frequency of speed limit changes and curves (i.e., 32 speed limit changes and 26 curves). The route included speed limit increases and decreases across a range of speeds, as well as single and multiple curves (back-to-back or a series of curves), and external sign advisory speeds.

All participants drove the same route (broken into three segments), and in the same order. The initial roadway segment, a four-lane highway with a speed limit of 55 mph, allowed participants to become comfortable with the vehicle. Drivers were exposed to the Speed and Curve Advisor system messages during the remaining two trip segments; system state (on versus off) was counterbalanced across the two route segments. During the trip, changes in speed limit messages were issued by the system as drivers approached the physical location of the external speed limit sign. Curve messages were not necessarily tied to the physical location of an external curve sign, but were provided in advance of the curve apex. In addition, the presentation of in-vehicle speed limit information was deliberately altered to provide false information at key points during the drive in order to examine the extent to which drivers would rely on the system relative to the externally posted signs - even when it was providing