



Visual and Task Demands of Driver Information Systems

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PURPOSE

- provide background material for the development of SAE Recommended Practice J2364 (Navigation Function Accessibility While Driving)
- provide information to enhance the safety and usability of driver interfaces for navigation systems

FINDINGS

Issue	Rationale	Evidence
Have navigation systems been a causal factor in crashes?	Entry and retrieval of destinations while driving should not cause crashes. This is consistent with the "when in doubt, err on the side of safety" principle and "When in doubt, lock it out." for nav systems.	<ul style="list-style-type: none"> • very little evidence, only coded in Japanese National Police Agency data • 1 navigation-related fatality and 58 injuries in 1st 6 months of 1998 in Japan (only data available) • estimated 8.3 fatalities and 481 injuries in U.S. in 1998 if market penetration and frequency of use matched Japan • Aside: Japanese regulations prohibit destination entry on the move
What is the relationship between visual demand and crashes?	Time spent looking inside the vehicle is not spent looking at the road for potential crash-inducing hazards.	<ul style="list-style-type: none"> • extrapolating from Wierwille's work: $\# \text{ U.S. deaths per year} = \text{growth.rate.in.VMT} \times (\text{target.year}-1989) \times \text{market.penetration.rate} \times [-.133 + .0447 \times (\text{mean glance t})^{1.5} \times (\# \text{ of glances}) \times (\text{glance frequency})]$ $= 21.1 \text{ fatalities/year in 2007}$ $\rightarrow 2110 \text{ injuries/year}$
How long does destination input and retrieval take?	Operating a navigation system should not be time consuming and interfere with maintaining speed and lane position, searching for hazards, or other crash-avoidance tasks.	<ul style="list-style-type: none"> • with manual controls and visual displays, destination entry takes 1 to 2.5 minutes • Point of Interest (POI) entry takes take 10% longer than street address or intersection methods • destination retrieval takes about 10 s (depending on the address and data base) • the worst interface for a task takes twice as long to use as the best • the number of lane departures when entering an address is almost 1 per trial
Do those tasks degrade driving performance?		

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How long do drivers prefer to look in a vehicle at an object?	From their experience, drivers have a sense of how long is too long (and how frequent is too often).	<ul style="list-style-type: none"> • experimental approach is for drivers to look at nonattention demanding targets for as long as they feel safe/comfortable to do so • also addressed by having drivers rate how safe/comfortable/secure they felt completing various tasks • concerns regarding terms to use (e.g., safe, comfortable) and English-Japanese differences • U.S. data suggests typical times of 0.8 to 0.9 s; Japanese data suggest 2.0 s; may be cultural or driving condition difference • Rockwell - "Drivers loath to go for more than 2 seconds without information from the road." • suggests total glance times should not exceed 5 to 10 s for drivers to feel safe
How much time do drivers spend looking at in-vehicle controls and displays?	For existing controls and displays, there are few interface-induced crashes, so those glance durations should be conducive to safe driving.	<ul style="list-style-type: none"> • mean glance durations typically do not exceed 1.2 to 1.5 s • glance durations are log-normal with dispersions of 0.2 to 0.6 s (information useful in calculating the probability of long glances)
<p>How often do lane departures occur for in-vehicle tasks?</p> <hr/> <p>What is the relationship between task completion time, glance statistics, and lane departures for existing interfaces?</p>	Lane departures can lead to crashes and therefore should be minimized. Since lane departures require a working interface and a vehicle or simulator to collect, surrogate (correlated) measures should be considered.	<ul style="list-style-type: none"> • The number of lane departures is 0 when the number of glances is less than 2 to 2.5. Otherwise, using time in s, the # of lane departures / trial <ul style="list-style-type: none"> = 1.3 (total glance time) = 3.6 (mean glance time) + 0.25 = 2.2 (number of glances) - 1. = 0.8 (task time) - 0.15 • very slight correlation between # glances and glance duration; treat glance duration as constant in rough estimates • S.D. of many measures is about half of their means (mean glance time, mean task time, total glance time) • mean task time = 1.9 * # glances + 0.5 = 1.6 * total glance time + 0.8. <p>(Total glance time = total eyes-off-the-road time.)</p>

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What do existing guidelines require concerning the use of navigation systems in a moving motor vehicle?	Designs should be consistent with accepted practice.	<ul style="list-style-type: none"> • British Standards Institute (BSI) guidelines use limits of modified Zwahlen diagram (max of 4 glances, no more than 2 s each) • Battelle guidelines suggest (1) the navigation function provides added value while driving, (2) the mean glance time <1.6 s, (3) the task requires 4 or fewer glances, (4) the function cannot be implemented using voice option, and (5) 2 or fewer control actions are required. • JAMA guidelines prohibit (1) displaying very narrow roads, (2) watching TV, (3) reading displays with scrolling characters, (4) displaying messages with more than 31 characters, (5) scrolling maps, (6) searching for addresses, (7) selecting destinations using a cursor.

KEY REFERENCES

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