Designing Better Traveler Information Systems: Cognitive & Task-Related Factors

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Introduction

Well designed Automobile Traveler Information Systems (ATIS) can enhance the navigational performance and enjoyment of drivers. Current ATIS designs have made use of HF research and guidelines, with a large emphasis on safety. However, there are mismatches between the actual needs and goals of the drivers and the services and interfaces of the systems. We conducted a survey to investigate the actual driver goals, and found a number of ways that ATIS designs can be improved. Improvements can be made in terms of the display design, the use of landmarks, supporting the user's goals, and distinguishing between planning and driving tasks.

Display Issues

- Driving is a visually intense task that could have life-or-death implications
- Displays that speed up processing and minimize visual distraction from the driving task result in safer driving
- Augment or replace vision by audition. Inclusion of an auditory display leads to…
  - Faster reaction times (Srinivasan, 1997)
  - Increased attention to driving (Labiale, 1990)
  - Decreased route completion times & errors (Streeter, Vitello, & Wonsiewicz, 1985)
- Enhance Stimulus-Response (SR) Compatibility
  - SR compatibility enhances performance (Fitts & Seeger, 1953)
  - Driving tasks (e.g. left turns) may be performed better with compatible displays (e.g., instructions presented to the left ear)
- Design auditory displays to combat masking from traffic, car noise, weather, speech, music, etc. (Patterson, 1982)
- ❖Drivers prefer a dedicated in-vehicle display for navigation, rather than a laptop or PDA

NOTE: ❖ indicates findings from the survey

Use of Landmarks

- Using appropriately selected landmarks (e.g. "next traffic light") leads to decreased reaction times when using ATIS (Phillips, 1999)
- Landmarks…
  - can be seen from farther away than street signs, allowing more time to prepare for turn
  - can often be pre-attentively processed (recognition of a shape), while street signs require a cognitive component (reading the street name)
  - are more visible from a greater distance, and in less-than-ideal viewing conditions
  - allow individuals to make better cognitive maps of their routes (Jackson, 1998)
  - HF literature, testing needed to determine which landmarks are superior (and in which context)
- Redundant cues increase probability & speed of detection
  - ❖42% of drivers preferred turn commands that mention both the street name and the traffic light (e.g. "Make a left at Main Street, which is the next light")
- ❖61% of drivers would like to use familiar landmarks to describe directions to new locations

Goals of Driver vs. Goals of ATIS

- Assist drivers with navigation activities, both before and during driving task
- "Best route" should consider safety, probability of getting lost, condition of road (Cross & McGrath, 1977)
- ❖Drivers want navigation help for 2+ destinations (74%)
- ❖Support chunking of turn sequences in familiar areas for greater goal congruence (70%)
- The fastest route to a destination (which ATIS does now) is not always the goal of the driver
- What is important to drivers?
  - ❖Minimize route time only when under time pressure
  - ❖Avoiding stressful driving situations regardless of time pressure
  - ❖When not under time pressure, enjoying scenery is relatively important; fastest route is actually one of the least important criteria
- Do not assume time pressure. Minimizing route time may result in goal mismatch for >25% of trips made to…
  - ❖Entertainment or dining (for 96% of drivers)
  - ❖Shopping, running errands (95%)
  - ❖Work, school, appointments (65%)
- Moreover, when not under time pressure drivers are willing to add >5 minutes to route time, in order to…
  - ❖Avoid stressful driving situations (71% of drivers)
  - ❖Drive through a better area (66%)
  - ❖Avoid tolls (59%)
  - ❖Use familiar roads (54%)
  - ❖Reduce distance traveled (54%)

Planning vs. Completing the Task

- Planning and executing navigational tasks may be done in different contexts:
  - Planning may either be done away from the car, inside a parked car, or while driving a car
  - Carrying out the task of navigation may only be done while driving
  - Planning a trip may also occur while driving
    - ❖While driving to shopping, entertainment, or dining, nearly half of drivers change destinations en route more than 1 trip out of 4
- ATIS should support all contexts of route planning and completion:
  - In-car displays for driving, desktop display for home/office, PDA display for when you are on the go
  - Consider user preferences when trading off flexibility (e.g., PDA) & display richness/comfort (e.g., PC)
  - Task analysis can determine which tasks should be performed in-car and away from car
- Due to cognitive & perceptual demands of the primary task of driving, tasks should generally be performed away from the car if it is not needed in car
  - Weigh benefits of increased functionality in-car vs. the distraction it may cause
- Performing ATIS tasks away from the car may lead to better performance in the car (due to mental rehearsal)
- Drivers may wish to allocate part of the planning to the ATIS.
  - ❖39% drove without a pre-planned destination at least once in a 1-week period

Survey Nuggets

- ❖Most travel on an unfamiliar route at least once a week
- ❖56% use maps; 40% use directions to navigate
- ❖50% learn a route after one or two visits; 95% after 5 visits
- ❖63% in favor of logging their trips automatically (in order to provide better service)
- ❖Turn instructions: 22% prefer "at Main Street"; 26% "at traffic light"; 42% prefer both
- ❖"Directions users": Younger; urban; female; in a hurry
- ❖"Landmark users": Those who prefer "traffic light" also prefer using other landmarks to navigate
- ❖Under time pressure: avoid delays; minimize route time; avoid stressful situations
- ❖No time pressure: avoid stress; enjoy scenery
- ❖Fewer route changes and more time pressure when going to work, school, or appointments
- ❖Carpool more often when going to dining/entertainment; less carpooling when going to work
- ❖Females drive less; more unfamiliar routes; avoid using maps; prefer to use familiar places as landmarks for getting to unfamiliar places; find driving more stressful, and are more willing to add travel time to avoid stressful situations; more often under time pressure when going to work, school, appointments
- ❖Younger drivers more in favor of chunking turn sequences in a single command; travel unfamiliar routes more often; emphasize shorter route times over other factors (like stress, enjoyment, etc.); more often under time pressure

Survey

550 participants (60% F; 40% M)

50% from metro areas of 1,000,000+

Median age 37 yrs

Internet responses, from a pool of registered participants

Conclusions & Future Work

Survey results supplemented existing Human Factors literature to provide suggestions for the improvement of ATIS. The survey offered new information on landmark usage, planning, possible new features, and a host of other topics. Key recommendations include more refined auditory displays, enhanced use of landmarks when providing directions, and a recognition of the context and circumstances of the driving trip. The shortest route may not always be what the user desires on a given trip. Of course, user preferences must also be factored in, and there seem to be significant differences between different groups of drivers (male/female, urban/rural, etc.). Finally, it is important to distinguish between trip planning, and en route navigation, as they may be done in different contexts (at a PC vs. in the car). These tasks must be supported accordingly.

Additional survey data are being gathered. We plan to prototype an augmented ATIS based on the findings. Also, experiments should address the perceptual issues raised (e.g.,whether turn performance is enhanced via SR compatible instructions).