Jun 29th, 12:00 AM

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Elliott Noel
University of Guelph, Canada

Blair Nonnecke
University of Guelph, Canada

Lana Trick
University of Guelph, Canada

Noel, Elliott; Nonnecke, Blair; and Trick, Lana. Evaluating First-time and Infrequent Use of In-Car Navigation Devices. In: Proceedings of the Third International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, June 27-30, 2005, Rockport, Maine. Iowa City, IA: Public Policy Center, University of Iowa, 2005: 376-382. https://doi.org/10.17077/drivingassessment.1187

EVALUATING FIRST-TIME AND INFREQUENT USE OF IN-CAR NAVIGATION DEVICES

Elliott Noel, Blair Nonnecke, Lana Trick
University of Guelph
Guelph, Ontario, Canada
E-mail: nonnecke@cis.uoguelph.ca

Summary: Learnability and memorability, important components of usability, are frequently overlooked by existing research with respect to in-car navigation devices. To remedy this, a protocol for evaluating the learnability and memorability of an in-car navigation device is presented. Representative tasks are identified and then used in conjunction with paired-user methods. The protocol is applied effectively to a device and problems are identified.

INTRODUCTION

In-car navigation systems are GPS-enabled electronic devices, which provide a variety of navigation-oriented services to drivers, such as displaying their location on a map or providing them with directions to their destination. While these devices are already in use, their actual market penetration is thus far low. A recent detailed survey by Metronomics, Inc., determined that less than one in five respondents who expressed interest in using navigation systems currently owned one. The widespread use of these systems is substantial, yet largely unrealized. In order for them to be successfully adopted on a wide scale, they must be usable.

Usability is important for any system or device that must ultimately interact with people. This is particularly true for non-technical users who may not be as technologically sophisticated as those designing and building them. There is another reason to be concerned with usability as it applies to certain domains such as that of in-car navigation systems, and that is safety. Cars present a host of dangers to occupants even without the added complexity of information systems. If such systems are to be useful and successful, they must provide their utility without further compromising anyone's wellbeing. This not only includes the user, be it driver or passenger, but also pedestrians and other motorists.

Much of the existing usability research in this domain is directly motivated by the question of safety. Burnett (2000) summarizes the underlying reasons succinctly. He explains that usability is an important design issue for in-car devices for two reasons. First, they are among the most sophisticated devices a driver is likely to encounter and second, much of the device's potential use is while driving. The existing body of research, while extensive with respect to certain dimensions of usability such as efficiency of use, does not adequately address learnability for first time users, or memorability for infrequent users. This work addresses these two important yet overlooked issues. We present here an overview of a methodology to facilitate the identification of learnability and memorability related problems, along with some results from our application of it to a particular navigation device.

METHODOLOGY

Selecting Usability Evaluation Methods

The first step in developing the methodology is selecting evaluation methods. The human-computer interaction (HCI) literature defines a usability evaluation method (UEM) as "a procedure for collecting relevant data concerning the operation of a user-computer interface and users' attitudes towards it" (Benyon, 1990). There are many methods from the HCI field that can be leveraged to this end. In order to select appropriate methods, criteria must first be established.

For the purposes of this study, there were three primary criteria for UEMs. First, they had to be conducive to and effective at evaluating learnability and memorability. Consequently, performance-oriented methods, those concerned with quantifying and measuring efficiency of use, were avoided. Second, the methods had to be applicable to existing devices, since car navigation devices are already available in the marketplace and in use. Thus, methods meant for the design stage were avoided in favour of those meant for later stages of product development. Third, they had to be end-user oriented, as opposed to expert-oriented. Focus is on how end-users fare with the devices, not the developers behind the systems, who are unavoidably biased. As a result, methods involving the observation and study of users performing real tasks were examined.

Usability evaluation methods are often divided into two categories—inspection methods, which rely purely on the evaluator's judgment (Nielsen, 1994), and user-testing methods, which rely on empirical observation of users. Inspection methods are typically useful earlier in the design phase (Nielsen, 1994), when prototypes may not exist, as a way of bringing usability feedback into the process. This category includes such methods as heuristic evaluation (Nielsen, 1993; 1994; Schneiderman, 2005), heuristic estimation (Nielsen, 1994), cognitive walkthrough (Nielsen, 1994; Schneiderman, 2005), and consistency inspection (Nielsen, 1994; Schneiderman, 2005). Since we were interested in methods involving users, inspection methods were rejected as a category in favour of user-testing methods.

Two user-testing methods were ultimately selected: the co-discovery learning method (Nielsen, 1993) and the teaching method. Both employ pairs of participants in order to elicit information indirectly through observation of their interaction rather than querying them directly. Issues that came up were vocalized, but without the discomfort or bias resultant from being queried by an experimenter. In the first variant, both participants are inexperienced, or, in the case of this study, first-time users. The experimenter provides pairs of participants with tasks, which they complete as a team. The teaching method variant substitutes one of the participants with an experienced user, who provides expertise to the novice user. In this case, observation focuses on the questions asked by the novice user to identify problems he or she encounters.

In addition, we chose to ask participants a few simple and open-ended questions regarding their experience, with follow-up questions left to the experimenter's discretion based on their responses. The initial questions served as a means of spurring discussion, rather than as a set of specific queries to be answered. Participants were encouraged to demonstrate using the device. This is consistent with Fetterman's observation (Fetterman, 1998) that open-ended questions "typically elicit avenues for further exploration," rather than quantifying a particular thing, as a specific, closed-ended question would. The questions afterwards supplemented the observations by providing the experimenter with an avenue to further explore interesting issues that came up, as well as make use of the participants' own judgment.

Tasks

The two usability evaluation methods selected above require tasks for the participants to perform. The tasks used are based on the most commonly used functions of navigation systems: orientation, destination entry, and direction following. Orientation is simply getting an understanding of where one currently is. On a navigation system, this involves initiating a display of one's current location, as well as manipulating or adjusting this display, by zooming or panning, for example. Destination entry is informing the device about where you would like to go, either by address, or by some general service, e.g., finding the nearest gas station. Direction following involves driving to one's destination while following the directions provided by the device.

The tasks were divided into two groups to facilitate the study. The first set is input-oriented tasks, which involve interaction with the device while stationary, while the second set is performed while driving.

Input-oriented tasks:

1. Orientation: Participant uses device to get a meaningful view of the current location. He or she adjusts the zoom level and centres the view on his current location.
2. Address entry: Participant puts the system into a direction-providing state, given an address. Once in a direction-providing state, participant changes the destination address, given another.
3. Service location: Participant puts the system into a direction-providing state for the nearest suitable service of some kind, a fast-food restaurant or gas station, for example.

Direction-following tasks:

1. Participant follows directions to destination in wholly unfamiliar locale.
2. Participant follows directions to destination in partially unfamiliar locale.
3. While following directions, participant is told not to drive down a particular road, as it is approached. Participant must continue to destination despite detour.

Note the distinction made between partially familiar and entirely unfamiliar routes. This distinguishes between two somewhat different scenarios. The first is driving in a foreign locale, such as one might do when renting a car while on a trip, and the second is driving in an unfamiliar part of a largely familiar area, such as visiting a part of town one normally does not frequent. It was expected that the user's behaviour with respect to the navigation system would different according to this property. As a result, distinct tasks were employed for each.

The Protocol

The protocol consisted of three phases. The first phase was a short questionnaire designed to extract basic information from potential participants. This included basic demographic information, such as age and profession, as well as more specific information, such as prior experience with electronic navigation devices and familiarity with different parts of the locale. Such "screening questionnaires" are a standard tool for user testing (Jeffrey, 1994).

The purpose of the questionnaire, aside from collecting basic data on the participants, was to filter out unsuitable participants. Participants between the ages of 40 and 60 were targeted, as they are more likely to be able to afford higher-end cars with fancy electronic systems. Information about participants' familiarity with various locales was used to aid in selecting locations with which they had appropriate degrees of familiarity for the direction-following tasks.

The second phase involved the use of the paired-participant methods, as outlined. Pairs of participants were seated together in the front of a car equipped with the navigation device already installed but not activated. Participants were instructed to activate the car's electrical system (but not the motor) and start the navigation device. They were then instructed to perform, one by one, each of the first set of tasks, working together.

Participants were not given any prior instruction with the device, and were not provided with manuals or other documentation. They were not permitted to ask the experimenter questions regarding the device. A reasonable amount of time was allotted for them to perform each task, until they either completed it or had explored and tried as much as they were willing to give up. Explanations and hints were not provided until after all tasks were completed (if participants were interested). Following the tasks, brief, informal questions were asked of the participants regarding their experience and opinion of the device. Follow-up questions were left to the discretion of the experimenter, in order to investigate any issues of particular interest that may have arisen.

The third phase had two variants, one focused on first-time use, the other on infrequent use. In the case of infrequent use, participants were brought back, in the same pairs, for another iteration of phase II, after a break of at least a month. They were asked to perform the same tasks together, with different destinations, to gauge how well they remember the interface from their earlier experience. The experimenter reviewed notes from the participants' first session in order to specifically observe how they cope with problems and issues encountered the first time around. Note that for the infrequent-use case, the gap between sessions was at least one month.

In the case of first-time use, phase III involved the second set of tasks, those involving direction following while driving. The teaching method employed pairing an inexperienced participant with a participant who had been through phase II. The inexperienced participant performed the tasks, inputting the destinations and following the device's instructions. The experienced participant answered questions and provided guidance if needed.

The protocol was applied using the Garmin Streetpilot 2620. It is a portable device easily installed on the dashboard of any vehicle and powered by an adapter from the cigarette lighter. It was chosen for its portability, since it can be quickly installed both in the experimenter's and the participants' cars, yet offers the full range of navigation features. It is controlled via four physical buttons along the side and a touch-screen.

RESULTS

Orientation

The orientation task was the source of the most significant problems. Due to the modal nature of the map, participants found it very difficult to find and use the correct mode to allow them to manipulate the map as desired. The zoom controls, once found, were easy to use; however, the panning controls were commonly misunderstood. Panning is accomplished by dragging or clicking on the screen where one wants to re-centre the display. Most participants assumed panning was accomplished by clicking on the side of the screen in the direction they wished to pan. This erroneous assumption was reinforced by the fact that the device would pan when the screen was touched, however, not always exactly as participants expected.

During their second use of the device, participants generally ran into the same problems. They remembered they had had trouble, but not how they had ultimately been successful. One participant remarked that it was "like seeing it for the first time."

Destination input

A variety of problems were uncovered during the destination input tasks. The most noteworthy was the device's tendency to lose state, forcing many participants to input the same addresses multiple times, to their annoyance. This was commonly caused by the user exiting the address input menus by clicking on a button that brings them elsewhere in the system, only to be surprised that their work was gone on finding their way back.

Participants were also confused about what the device required from them. In the address input screens, it was unclear whether one must include "street," "avenue," and so on, or whether one may abbreviate them. In addition, the device was very rigid in what it could accept, causing some participants to get stuck with no explanation.

Participants had a hard time recognizing the affordances of some controls, particularly the pull-down menus used in the destination input by service task. They did not recognize the pull-down menus for what they were, partly due to the fact that they did not look like pull-down menus used in other computing systems. This problem did not re-occur during the second session.

Participants generally had far fewer problems the second time around. They tended to remember choices, e.g., where they had selected something over another, but not more complicated mechanisms. Nobody remembered everything—everyone had to re-learn something.

Route following

The direction-following tasks were much less problematic, although some issues were identified. Participants overwhelmingly preferred the verbal instructions over the map display, as they found the map distracting. Many reported that they initially paid attention to the map, but learnt to ignore it once they became accustomed to the verbal instructions. Participants did comment that the instructions, which are provided as distances (e.g., "in 300 metres, turn right"), would have been far more effective if provided as times. They did not have a clear enough idea of distances to be able to use them.

The distinction between entirely unfamiliar and fully unfamiliar locale led to some interesting results. Participants were less likely to question the routes chosen when they were in completely unfamiliar places, trusting the device blindly. When they had some idea where they were, however, they would sometimes wonder out loud why the device was taking them where it was. Participants were more trusting of the device when they were tired.

Finally, there were some issues with inadequate lane-changing information. In a number of instances, participants missed turns because they had expected the device to warn then in advance to change into a lane. This problem also manifested itself when turn lanes ended, while the route continued straight on without informing the driver. Such problems are likely due in part to limitations in the map data.

General observations

Screen legibility was a big problem for most participants, as was the small size of some of the touch-screen controls. Most participants ended up taking the device down off the dashboard when interacting with it. The slow and inconsistent response time was also problematic, causing participants to sometimes press things multiple times when it appeared to not respond to their commands. This would result in multiple inputs having effect simultaneously when it finally did respond, causing further confusion.

The layout and overwhelming complexity of many of the more advanced features made it very easy for the novice users to lose their place and find themselves in obscure menus and options. The lack of an “undo” or “go back” function made exploratory learning much more difficult. Participants were very vocal about wondering how to undo their mistakes, often explicitly complaining about the lack of a “back” button.

CONCLUSION

The paired-participant methodology employed was very effective at identifying first-time and infrequent use problems. The methodology worked particularly well for the input-oriented tasks, while less so for the direction-following tasks, due to there being less interaction involved. The method contributes towards evaluating the overall usability of a navigation device by evaluating learnability and memorability. It is a valuable and useful component for a complete usability evaluation protocol.

ACKNOWLEDGMENTS

We would like to thank Auto21 and the University of Guelph for their generous support.

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