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User-centered design criteria in next generation vehicle consoles

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Abstract

The purpose of this work is to gauge user opinions on vehicle dashboard design to ascertain the criteria important to consumers for the next generation of automobile dashboards. The results provide insight into the aspects of dashboard design that users feel are not beneficial and thereby lead to better informed dashboard designs in the future. Participants reviewed the physical ergonomics of their vehicles very positively. However, in dashboard design and instrument panel layout they were unsure of what an ideal dashboard would look like, often showing contradictory views. Controls on the steering wheel were also well reviewed but controls near the gear stick were not. In terms of vehicle technology Satnavs received good scoring for effectiveness but were reported as distracting. IVISs were negatively reviewed. Finally, automation was reviewed as potentially improving the daily lives of individuals but trust in automation is still a problem. Overall, this study showed that whilst dashboards are relatively well reviewed there are still issues to be addressed regarding in-vehicle technology and distraction, as well as improving public opinion on automated vehicles. Results represent the first stage in research studying current dashboards and distraction of in-vehicle technology and the design of automated dashboards of the future using virtual reality environments to create optimal console designs for drivers.

Keywords: Design; human; design method; technology; automation

1. Introduction

At the introduction of the first automobile, the design and organization of the dashboard was no great challenge due to the limited amount of information to display and the lack of complexity of essential information [2], items such as speedometers were optional extras. However, automobile dashboards are now increasingly complex with diverse functionalities that aid vehicle control and allow the user to stay within the law in terms of behavior on the road. This is due to the advancement of in-vehicle technology and the large number of elements required by law to be displayed on a vehicle dashboard. As a result dashboards are a medium through which vast amounts of information can be obtained [11]. The challenge is to create dashboards incorporating all the functions and information whilst keeping the display simple, efficient, safe and promoting an excellent driver experience [6]. The design of car interiors relies on firm knowledge of both physical and cognitive ergonomics. Combining knowledge of optimum comfort levels and accessibility as well as the workload of operation, allows the creation of optimum vehicle interiors. In addition, due to the increased availability of automobiles and the competitiveness within automotive manufacturing, companies have to consider the customers by following a user-centered design process to understand the user, the user's goals and their opinions [11] on the design in order to create popular designs and provide a commercial advantage over competitors.

Furthermore, we are now at a stage in technological development where the potential for in-vehicle technology is vast [12], including the opportunity to create customized user experiences e.g. digital displays over mechanical ones as a user interface [20]. Therefore, it is paramount to understand the underlying mental processes associated with situation awareness and distraction due to existing vehicle technology [6]. Distracted driving due to the performance of secondary tasks is a major cause of automobile crashes [9], hence it is

increasingly important for human factors research to design dashboards that reduce distraction related driving detriment.

Technological advancement has also led to the increased likelihood of an automated vehicle becoming the future of automobile development. Human factors research therefore has to consider not only the impact of current vehicle dashboards and existing vehicle technology, but also the impact of the emergence of automated driving dashboards and how consumers will respond to these [6].

1.1. Related work

The usability and ergonomics of vehicle dashboards is important to examine when considering the design and design improvements. A study in 2012 carried out a human response study to a range of car dashboards for ergonomic assessment and usability [2]. A basic, average and deluxe version of vehicle dashboard were used. The basic model showed serious problems with visibility of icons, understanding the meaning of symbols, complex and confusing instructions and the icons were too cluttered. The average model also showed unclear functioning of symbols, confusing instruments, captions appeared too similar and symbols that were unrelated to functionality. The deluxe model displayed serious problems in that a full knowledge of all the signs and captions was required to operate them fully and there was a lack of space for the luminous signs. Further problems included need for prioritization of instruments, understanding the captions and visibility problems. For usability, the basic model got no poor reviews whereas the medium and deluxe got two poor reviews. Problematically the study only used 4 volunteers, but the results have significance to research on automobile dashboards. From this study it is clear the design of automobile dashboards is still not optimum and the role of cognitive ergonomics in design is still to be fully explored and implemented regarding understanding and usefulness of dashboard elements.

More recently, an ergonomics-based design approach was used to assess helicopter instrument panels [1]. Their approach was based on established principles in determining the specific location and arrangement of components in a display; importance, frequency of use functional similarity and sequence of use. Interviews with pilots allowed for the evaluation of cockpit displays based on the frequency of use and ratings of importance as well as general opinions, preferences and experience with the display. The results of the interviews were utilized to create a range of optimized, alternative display layouts of flight instrument panels and better functional groupings based on user opinions. Finally the researchers were able to produce an optimum instrument panel arrangement for validation in future research [1]. Whilst this methodology was utilized for helicopter cockpits, similar principles can equally be applied to automobile interiors to help design more effective dashboards for drivers.

In addition to considering user opinions on dashboard design, it is also important to consider what users actually want and need from their dashboards. A recent study allowed participants to suggest ideas and create characteristics for future vehicles depending on the picture of the future the experimenter gave them [7]. They then used the conceptual

vehicles to find constructs of user needs and then to group these into user need dimensions for use in the user-centered design process. The study revealed nineteen need dimensions: Automation, Calmness, Comfort & convenience, Connectivity, Control, Driver support, Trip context, Driving pleasure, Efficiency, Environmental impact, Freedom of choice, Interaction fluency, Ownership, Personalization, Safety, Self-image, Simplicity, Technology, and Versatility [7]. These suggest several important themes that need to be explored in design, such as how technology can and should support driving, the freedom of choice consumers strive to have and the role of the vehicle as part of a larger system [7].

1.2. Current work

This study aims to further work to assess user opinions on current automobile dashboard displays and the cognitive ergonomics of the design through a questionnaire. Participants will be asked about their experiences with their own dashboards in terms of usability and preferences as well as assessing overall dashboard layout and functioning to gain a picture of the current effectiveness of vehicle dashboards. In addition, usability, distraction and impact of particular dashboard technologies will be addressed. The questionnaire will also provide an insight into user feelings on the future of driving regarding automation. Results from the study represent the first stage in research that will look at current dashboards and distraction caused by in-vehicle technology and the improvement in designing automated dashboards of the future.

2. Method

2.1. Participants

Participants in this study were all students at Queen's University Belfast. A total of 35 participants completed the questionnaire. 25 were at undergraduate level and 10 were at postgraduate research level. There were 24 females and 11 males in the sample. Undergraduate students completed the questionnaire to gain course credit. Participant ages ranged from 18 to 40 years old. All students were required to have a Provisional or Full driving license at the time of the questionnaire so that all had driving experience. Only 3 participants reported having either their provisional or full license for less than one year (8.6%), whilst the majority reported having a full license between 1 and 5 years (65.7%) or 5-10 years (22.9%). One older participant held a license for 20-30 years (2.9%). 27 participants reported being frequent drivers. Most drivers reported driving less than 10 hours per week (62.9%) or between 10 and 20 hours per week (25.7%), reported driving less than one hour per week and 8.6% drove more than 20 hours per week.

2.2. Materials

Participants were required to complete a 50-item online questionnaire using Toluna Quick Surveys website. The questionnaire consisted of 3 sections. In Section A 12 questions addressed participant's opinions on the layout and design of car dashboards in terms of location and grouping and the physical