CLW 2012: The Second Workshop on Cognitive Load and In-Vehicle Human-Machine Interaction

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ABSTRACT
Interactions with in-vehicle electronic devices can interfere with the primary task of driving. The concept of cognitive load helps us understand the extent to which these interactions interfere with the driving task and how this interference can be mitigated. The workshop will address cognitive load estimation and management for both driving and interactions with in-vehicle systems, and will also endeavor to provide guidance on problems, goals, hypotheses and approaches for future research in this area.

Categories and Subject Descriptors
H.5.2 Information interfaces and presentation: User Interfaces. H.5.1 Multimedia information systems.

General Terms
Design, Experimentation, Human Factors, Measurement.

Keywords
Cognitive load, estimation, management, driving.

1. INTRODUCTION
In-vehicle human-machine interaction (HMI) requires varying degrees of visual and cognitive resources. Concerns over excessive visual demands in the vehicle have existed for some time. More recently concerns over the impact of HMI on drivers' cognitive resources have gained attention. While multiple definitions of cognitive load (also called cognitive or mental workload) appear in the literature (see [1] for a brief review), it is commonly defined as the relationship between the cognitive demands of a task and the cognitive resources of the user [2]. A central question in designing HMI for in-vehicle devices is how the HMI will impact the driver's cognitive load [3]. In-vehicle devices are often operated while the vehicle is moving. While the primary task of the driver is to ensure driving safety, the availability of such devices often lures drivers into getting engaged in peripheral tasks while driving. Poorly designed HMI requires an increased level of cognitive resources, reducing the driver's ability to dedicate sufficient cognitive resources to the driving task, and can lead to possibly disastrous consequences. The Yerkes-Dodson Law provides a theoretical background for modeling the effect of driver cognitive load on driving performance, and can be seen as a pivotal concept in the detection and management of cognitive load [4]. While research results on in-vehicle cognitive load are frequently presented at automotive research conferences and in related journals, CLW 2012, the second in the series [5], will provide a unique forum for focused discussions on this topic.

2. WORKSHOP GOALS
The workshop has four goals:

1. **Explore the concept of cognitive load:** While the concept of cognitive load has been used by a number of researchers working on in-vehicle HMI (as well as those working in other fields), the definition of cognitive load sometimes seems illusive. What exactly is cognitive load? The workshop will explore different points of view on this question.
2. **Explore issues in cognitive load estimation:** Estimating cognitive load while driving is a challenging task. Clearly, our understanding of estimation is tightly coupled to our definition of cognitive load. However, whatever the definition we use, estimation (on-road [6][7], and laboratory-based [8][9]), focuses on three types of measures: performance, physiological and subjective. The workshop will explore the practical use of these measures in on-road studies and those performed in a laboratory setting (both using immersive driving simulators and other techniques).
3. **Explore issues in cognitive load management:** How can we design in-vehicle HMI such that the driver has the cognitive resources to safely operate the vehicle, even while interacting with in-vehicle devices? Researchers and practitioners have explored a number of approaches for workload management [10], from simply turning off HMI in certain situations, to introducing novel interaction methods which hopefully do not introduce undue cognitive interference with the driving task (voice interfaces [11][12], augmented reality [13][14], mediation [15], tactile interfaces [16], subliminal notifications [17], etc.). Other work [4] suggests that effective implementations of these and

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other systems need to adapt to the driver's state. The workshop will explore various aspects of managing the driver's cognitive load.

4. **Explore paths for future research and development:** In light of current approaches to cognitive load estimation and management, what research and development avenues should be explored in the next 2-10 years? Workshop participants will discuss (a subset of) problems to be explored, goals to be set, hypotheses to be tested, and approaches likely to be fruitful in testing these hypotheses.

The workshop organizers will bring together a number of experts from government, industry, and/or academia to address topics on exploring the concept of cognitive load (goal 1). Furthermore, we will solicit research papers exploring issues in cognitive load estimation and management for interactions with in-vehicle devices (goals 2 and 3). Authors will be encouraged to also include at least one paragraph addressing paths for future research and development (goal 4). Additionally, position papers on goal 4 will also be solicited. Topics of interest will include:

- Cognitive load estimation in the laboratory,
- Cognitive load estimation on the road,
- Sensing technologies for cognitive load estimation,
- Algorithms for cognitive load estimation,
- Performance measures of cognitive load,
- Physiological measures of cognitive load,
- Visual measures of cognitive load,
- Subjective measures of cognitive load,
- Methods for benchmarking cognitive load,
- Cognitive load of driving,
- Cognitive overload and cognitive underload,
- Approaches to cognitive load management inspired by human-human interactions.

3. WORKSHOP ORGANIZATION

3.1 Before the Workshop

3.1.1 Program Committee Recruitment

The program committee will be recruited from the extensive list of academic and industry contacts of the organizers, in the HCI, speech, ubiquitous computing, and human factors and ergonomics communities. We will primarily target our colleagues who were part of the PC in 2011.

3.1.2 Publicity and Soliciting Papers

The workshop will be publicized using a dedicated website hosted by the University of New Hampshire. The Call for Papers will be distributed via the following channels:

- ACM CHI mailing list,
- Ubicomp mailing list,
- SIGdial mailing list,
- WikiCFP,
- HFES Surface Transportation Technical Group Newsletter,
- Contacts of program committee members in their respective fields.

3.1.3 Paper Submission, Review and Selection

Papers will be submitted and reviewed using the EasyChair conference management system [18]. This will allow for online paper submission and simple management of reviewer assignments and feedback. The organizers will make the final paper selection based on reviewer recommendations. Note that EasyChair is a free service hosted by the University of Manchester CS Department; therefore no funding will have to be secured for its operation.

3.1.4 Final Pre-Workshop Activities

The list of accepted papers will be posted on the workshop website in early October. The organizers will create a mailing list to distribute accepted papers to workshop participants prior to the workshop. Participants will also be encouraged to use the mailing list to initiate interactions before the workshop.

3.2 During the Workshop

3.2.1 Sessions

This all day workshop will have three sessions.

Session 1: What is cognitive load? The first session will feature 2-4 experts who will discuss their views on the concept of cognitive load: what it is, how to estimate it, and what its role is in exploring in-vehicle HMI.

Session 2: Cognitive load and in-vehicle HMI research. Session 2 will feature poster presentations by workshop participants. These will be preceded by a one-minute-madness session, allowing each presenter to briefly introduce his/her poster. The presentations will focus on cognitive load estimation and management, specifically the topics listed at the end of section 2.

Session 3: What's next? In the final session we will invite participants to discuss the results of the first two sessions in small groups. We will propose three seed questions for discussion:

1) How are the research problems, goals, hypotheses and approaches identified in the first two sessions related to each other?

2) What are the societal forces that are shaping the direction of our research?

3) In light of answers to the first two questions, what are some desirable partnerships and collaborations that would promote progress towards solving the major problems identified in this workshop?

The conclusions from the small-group discussions will be presented in a closing round-table discussion.

3.2.2 Collecting Feedback

As in 2011, at the end of the workshop organizers will solicit feedback from participants in anonymous written form. Participants will be asked to evaluate the relevance and ultimate value of the workshop using responses on a Likert scale. Suggestions for improvements will also be solicited.

3.3 After the Workshop

3.3.1 Online Report

Based on the notes taken during the workshop, the organizers will create a report about the workshop's outcomes and post it on the workshop website. The organizers will also prepare and post a separate report about participant evaluations.

3.3.2 White Paper(s) on Future Work

The organizers will initiate an effort to prepare one or more white papers to provide guidance on future work in the field of cognitive load as it relates to in-vehicle HMI. As there are various intended consumers of this guidance, from fellow researchers and developers, to industry, to funding agencies, more than one white paper might be appropriate, each with a different focus and format.

3.3.3 Workshop at AutomotiveUI 2013?

Assuming that participant feedback indicates that the workshop was successful, the organizers will contact participants for suggestions for a workshop to be held at AutomotiveUI 2013.

4. ACKNOWLEDGMENTS

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