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# Workshop on The Mobile Office

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**Abstract**

This workshop discusses the balance between safety and productivity as automated vehicles turn into 'mobile offices': spaces where non-driving activities are performed during one's daily commute. Technological developments reduce the active role of the human driver that might, nonetheless, require occasional intervention. To what extent are drivers allowed to dedicate resources to non-driving work-related activities? To address this critical question, the workshop brings together a diverse community of researchers and practitioners that are interested in questions as follows: what non-driving activities are likely to be performed on one's way to work and back; what is a useful taxonomy of these tasks; how can various tasks be studied in experimental settings; and, what are the criteria to assess human performance in automated vehicles. To foster further dialogue, the outcome of the workshop will be an online blog where attendees can contribute their own thoughts:

<https://medium.com/the-mobile-office>.

**Author Keywords**

Automated vehicles; Autonomous vehicles; (semi-) autonomous vehicles; Distraction; Interruptions; In-car activities; Mobile Office.

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## Workshop Themes:

### Non-Driving Activities:

Identify the non-driving work-related activities most likely to occur in a (semi-) automated vehicle.

**Taxonomy:** Classify non-driving activities according to their design, user modalities, and safety requirements of (semi-)automated vehicles.

### Experimentation:

Correspond the relevance of standardized non-driving tests in current research with non-driving activities.

**Criteria:** Determine the criteria in terms of human performance (and use satisfaction) on standardized tasks and potential implications to real-world implementation.

## ACM Classification Keywords

• Human-centered computing~User models • Human-centered computing~Usability testing

## Introduction

Current trends in vehicle automatization are reducing the frequency and urgency with which human drivers need to contribute to the driving tasks. Given these trends, we expect that at least some drivers will perform more and more non-driving activities in the automated vehicle (cf. [11]). In particular, this workshop focuses on work-related activities that take place during one's daily commute. This trend is consistent with general trends that users multitask in various settings ([8]), that they perform non-driving activities in non-automated vehicles (e.g. [3; 10]), and that meta-reviews have noted an increase in non-driving related tasks as automation increases [20]. Allowing drivers to perform non-driving activities might be risky, as it might decrease the human driver's situational awareness, and their reaction time to critical events (cf. [20]). At the same time, not allowing drivers to do non-driving wactivities might result in underload, and might have a detrimental effect on alertness and therefore safety (e.g., [1]). Given this conundrum, further dialogue is needed within the research community on what these "mobile offices" of the (near) future might look like. How do we get the balance right between safety and productivity and play?

To focus the discussion, it is important to be explicit what we mean with an "automated" or "autonomous" vehicle, as a wide variety exists. To structure them, several bodies have provided frameworks that define explicit levels of automation (LOAs) for vehicles [5;13]. Generally, they have specified the extent to which

vehicle handling is delegated to automation and, reciprocally, the level of engagement expected of users. Unfortunately, current recommendations for expected levels of user responsibility tend to be prescriptive. They do not take into consideration that the mode of operation might change over time and that users might not have the correct understanding, or belief, of the level of automation [6]. In addition, these frameworks do not take into account the diversity of non-driving activities that are likely to engage users of non-automated vehicles.

A focus on vehicle automation, and not on the non-driving activities that are likely to take place in the cockpit of a (semi-)autonomous vehicle, has severely limited our ability to design for the needs of future automotive users. To begin, designing interfaces to enable and facilitate non-driving activities rely on first knowing the activities that are permissible and those that are not. For example, hands-free interfaces for voice communications is premised on the belief that manual handling is a limited resource that should not be diverted away from manual handling [17;18;19]. What are the cognitive resources that should not be diverted away from the supervision of (semi-)automated vehicles? This question is likely to be answered by human factors research and user studies.

Nonetheless, most research tend to focus on determining human performance in terms of vehicle resumption. Although this is understandable from a safety perspective (driving is the safety critical task), as automation improves, it is to be anticipated that human involvement with the driving task reduces in frequency and urgency. In effect, this might make the driving task act more like an "interrupting task" (cf.

[9]). It will also require implicit non-behavioral measurements of user-state, e.g., EEG [3;8]

Given the focus on driver distraction, to date non-driving work-related tasks are often seen as of secondary concern to experimentalists. In effect, they tend to be either generic or overly specific. On the one hand, standardised tasks (e.g., n-back task [14], working memory span task [15], surrogate reference task [4]) might be too basic. Thus, findings based on them might have minimal effect in the real world, after we account for the diversity of possible scenarios and applications. On the other hand, tasks that are contrived for evaluating human behavior in automated driving (e.g., Twenty Questions [12]; calendar entries and video transcription [16]) might be overly specific and, hence, limited in their generalizability. Given the rapidly changing nature of technology and traffic design, striving towards a universal test battery would be valuable, but might perhaps not be feasible. Nonetheless, establishing a bridge between basic standardized tests and potential non-driving activities is ready achievable and likely to enable current research to deliver robust insights.

Vehicle automation promises to free automotive users to perform non-driving work-related activities that consume mental resources. A good starting point would be to determine what these activities are. Based on such identification, one can work their way "backwards" towards determining the non-driving tasks that can be readily implemented in experimental research and interface design. This proposed "Workshop on The Mobile Office", will identify what these tasks are and how they can be tested for or simulated in user testing environments.

## **Objectives of the Workshop**

The primary objective of the workshop is to provide a consistent platform for the design for and the evaluation of the viability of non-driving work-related activities in (semi-)automated vehicles across different LOAs. Several relevant themes will be discussed with our workshop activities to achieve this (see sidebar for a selection of themes).

In doing so, we hope to gain a higher awareness within the automotive-UI community of why it is relevant to think about in-car distraction and the car as a "mobile office". This will result in a community of joint interests where the focus will not merely be on one's ability to resume vehicle handling but, rather, on the challenges necessary to support non-driving activities in a safe and effective manner.

## **Topics to be addressed in Group Discussion**

In line with our more general themes, the following are research questions that can be discussed:

- What are the research/design challenges that would need to be addressed in (semi-) autonomous vehicles, related to the car as a "mobile office"?
- Which in-vehicle non-driving task are likely to be performed in (semi-) autonomous vehicles, and how can users be enabled to perform them effectively without affecting safety?
- What is the current approximate for this task that is considered state-of-the-art in user-testing?
- What measures or evaluation methods are useful to inform this design? Which of those have "worked" for participants in the past? Which ones did not?

- Why should we consider these issues at all as a research community? Why is this worth thinking about deeply?

A group discussion will be held where discussants will answer questions like the ones above. Based on their replies, participants will be divided into pairs or trios to write a short article on their view on non-driving work-related activities, the likely challenges faced in enabling this in the driver's cockpit of a (semi-)automated, and potential solutions or necessary research to mitigate these challenges.

### Schedule

A tentative schedule of the workshop is indicated below.

From	To	Topic
00:00	00:15	Introduction by organizers and introduction by attendees.
00:15	00:30	Introduction and discussion of theme "The mobile office".
00:30	01:15	Brainstorm about relevant topics to discuss, based on participants' interests and important questions for research and design (e.g., which level of automation?).
01:15	01:30	Introduction to blog posts.
01:30	02:30	Break-out discussion groups.

02:30	03:00	Report back on topics.
03:00	03:30	Attendees can write / finalize their blogpost as a pair or group.
03:30	4:00	Present blogposts and next steps.

### Expected Outcomes

Currently, there are many public opinion pieces and blogposts on autonomous driving and driver distraction. However, these are not always informed by research. We want to provide a perspective that benefits from the diversity of the community, while at the same time being informed by research. Thus, we will motivate participants to work towards providing a public perspective (i.e., blogpost) that is informed by this workshop discussions, which will be available for stakeholders and other interested persons outside of the research community. For example, car designers, engineers, in-car technology developers, journalists, politicians. The blogs will be share publicly on medium: <https://medium.com/the-mobile-office>. Before the start of the workshop, the workshop organizers will have placed example blogs here to start the discussion.

Besides the blogposts, the taxonomy of non-driving activities will be expected to contribute towards the development of a roadmap for the design of future automotive user-interfaces. We believe that vehicular LOAs should not only be defined in terms of how users are expected to be able to resume control but, rather, in terms of which activities they might be expected to perform, and how this can be done safely and satisfactorily. Non-driving activities that are previously

assigned to a high LOA could be situated in a lower LOA given the appropriate design interface. For example, it was not permissible to use a mobile telephone until

handsfree interfaces were developed. A complementary re-definition of the LOAs that is focused on non-driving activities would, hence, motivate design innovation.

## Biographies

**Lewis Chuang** is an Akademischer Rat at Ludwig-Maximilian-Universität München, within the Institute for Informatics. He employs gaze tracking and psychophysiological methods (i.e., EEG) to understand how humans seek out and process information when interacting with closed-loop machine systems (e.g., vehicle handling). He studied psychology at the Universities of York (BSc) and Manchester (MPhil) and received his PhD in neuroscience at the University of Tübingen. See <http://lewischuang.com>

**Stella Donker** is an associate professor at Utrecht University, within the division of Experimental Psychology and Helmholtz Institute. She received her PhD in Medicine at the University of Groningen in 2002. She worked as a PostDoc at the Biomemechanical Engineering department at the University of Twente. Since 2007, she coordinates Utrecht's MSc in applied cognitive psychology and all industry internships. One of her research interests is in dual-tasking in (semi-)autonomous driving.

**Andrew Kun** is an associate professor of Electrical and Computer Engineering at the University of New Hampshire and a Faculty Fellow at the Volpe Center. His primary research interest is in-vehicle human-computer interaction. He received his PhD from the University of New Hampshire. He is a member of IEEE and ACM.

**Christian Janssen** is an assistant professor at Utrecht University, within the division of Experimental Psychology and Helmholtz Institute. He received his PhD in human-computer interaction from UCL (2012), and MSc in Human-Computer Interaction and BSc in Artificial Intelligence from the University of Groningen. Some of his major research interests are in multitasking and (driver) distraction, including in automated driving settings. Methodologically, he appreciates the coupling between empirical studies and formal models of human behavior and thought. For more information see [www.cpjanssen.nl](http://www.cpjanssen.nl)

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