Collaborative Technology Appropriation in the Car: Challenges and Lessons Learned

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Abstract
People frequently adopt and shape technology around them to simplify interaction in private or professional life. So far, research on technology appropriation hardly paid attention on restricted environments such as the automotive context. In order to support collaborative technology in the car, we have to understand what technology appropriation means in this specific *critical* context. Therefore, we present relevant examples of a field and a lab study, where potential unexpected needs have been satisfied through user's adaptation of two collaborative navigation prototypes. In this position paper, we derive some lessons learned and discuss relevant questions to inform the design of collaborative navigation appropriation between familiar and unfamiliar driver-passenger pairs.

Author Keywords
Automotive context, collaboration, technology appropriation

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

Technology appropriation can be profound: Latino *street mechanics* for example created the Low Rider car, which revolutionized their culture. Draxler et al. [3] also highlighted that appropriation is "*highly cooperative, situated, socially embedded, and often connected to particular work situations*". Besides investigating everyday appropriation practices in private contexts (e.g., [1,5]) and *traditional* business settings, also highly challenging and specific contexts such as healthcare (e.g., [2]) and beyond have been in the focus of research [6] .

However, what does collaborative technology appropriation mean for more restricted environments such as the automotive context, in which appropriation can be considered as *critical* matter? Specifically, in this context, one challenge is that certain technologies like, e.g., infotainment systems, are used while the driver needs to attend to his/her primary task, i.e., driving. Furthermore, passengers may interact with the same system in a complete other way. Hence, the way how the driver and passengers adopt and adapt technologies in the car can be considered as a critical process because of the everlasting danger that systems might be used in a way that causes additional distraction from the driving task.

In our research, we put special emphasis on the collaboration of driver and front-seat passenger and on how to support this collaboration with technological means. For instance, drivers and front-seat passengers often work together when orientation becomes difficult, e.g., when the driver has problems understanding the output of the navigation system. In those situations, navigation becomes a collaborative endeavor [4]. This means, for instance, that a passenger and a driver to interact with the GPS system to resume routing and exchange their interpretations about the provided information.

Hence, if we think about future collaborative in-car systems, it is important to uncover and anticipate the possible dangers of using technology in unpredicted ways – or to overcome barriers to use future technology-as-designed. On the one hand, collaborative technology appropriation might lead to more distraction, when, for example, a collaborative in-car system that fosters collaboration between driver-passer pairs is used in a different way than intended by the designers. For instance, the speed indicator is not used to check the speed to stay below the current speed limit, but to go as fast as possible or allowed by means of a speed game with other commuters. On the other hand, designing for the unanticipated needs that have been achieved through the users' adaption of a such a device as well as adoption to several circumstances, has the potential to reduce driver's workload and distraction.

In this position paper, we draw attention on some lessons learned as well as relevant questions to inform the design for collaborative navigation appropriation between familiar and unfamiliar driver-passenger pairs.

Study I

In an explorative in-situ study, we used a tablet based navigation app that provides more details about the route that could be communicated (via the front-seat passenger) to the driver. This was achieved by providing diverse landmarks that refer to specific locations and various demanding situations (e.g., a

construction site, a pothole, or a narrow road), aiming to support the driver in navigating and driving related tasks. Our aim was to go into the wild in order to use the prototype to investigate collaborative navigation practices between familiar individuals in real driving situations (see [7], for a detailed description of our prototype). In our setting we used an additional navigation system, in order not to distract the driver with our second device.

Against the handheld way of using a mobile device, three-quarters of the front-seat passengers tried to put the tablet on the dashboard on the passenger side or on their knees. In the second case the prototype was slightly inclined in order to easily see the screen without having to move the head too much. Especially, on rural roads, the participants even lifted the device several times as well as moved in forward and backwards, which caused a special distraction for the driver. As mentioned after the trip, the participants intended to gain a shared view of the current driving situation and upcoming demand situation.

Our data revealed that contradictory information of navigation devices (i.e., an unexpected indication of a lane change on the driver's display) breached the couples' interaction and led the front-seat passengers to adopt the usage of his device. Notably, in those particular cases, the "ad hoc" collaborative practice was supported through a shared display interaction, i.e., by putting the tablet into a position visible for both, the driver and the front-seat passenger. The shared display interaction was also used by couples, i.e. specifically requested by the drivers to gain more information about upcoming demand situations during longer waiting periods at traffic lights or on rural roads, where no one was driving behind the couple.

Study II

In a driving simulator study, we investigated a so-called shared gaze approach in order to support driver and front-seat collaboration during a navigational task. Thereby, the gaze of the front-seat passenger was captured and visualized for the driver as a dot in the simulated driving environment (see [8] , for study results), i.e. the driver could see where the front-seat passenger was looking at in the scenery. The assumption was that the visualization makes it easier for the driver to understand what the front-seat passenger is referring to during navigation.

Overall, this assumption was confirmed by the study results, however, we could also discover some issues with the approach: While drivers only got to see the gaze of the front-seat passenger, front-seat passengers did not only see the visualization of their gaze, but were of course also aware whether this visualization was accurate. Hence, we found that front-seat passengers sometimes adapted their gazing behavior, e.g. by intentionally looking above a certain object in the scenery in order to compensate for such inaccuracies. In one condition of the study, the front-seat passengers could also decide on their own, whether and how to show their gaze to the driver by pressing a button. Here we found that the passengers did use their gaze in quite different ways, which strongly influenced the helpfulness of the gaze visualization and also the distraction level for the driver.

While some passengers showed their gaze to the driver as intended, i.e., merely when referring to a spatial reference point in the scenery, others did describe the spatial reference points verbally and used their gaze to point in the direction the driver needed to turn. This turned out to be a strategy, which made it much more difficult to understand for the driver in time at which point s/he should turn. Additionally, we observed another strategy, where front-seat passengers used their gaze to point to the spatial reference points, but also to indicate the direction where to go.

Challenges and Lessons Learned

In contrast to the conventional handheld use of a mobile device study I revealed that it is essential for future collaborative designs to combine a tablet with a, in the best case, movable fixation unit. Our data show that the mobile device (i.e., a tablet) was not only moved by the front-seat passengers to generate a shared view for them and the driver, but also to provide a better view for themselves. With regards to unexpected user needs in the automotive context, we could learn that the position of the tablet is important for the use itself (i.e. slightly inclined in order to easily see the screen without having to move the head too much) as well as to gain a shared view of the current driving situation and upcoming demand situation, in particular on rural roads. Moreover, the position as well as the representation of information has to be in a way not to distract the driver. Therefore, it is essential for future systems have the possibility to place the movable device in a flexible way in order to address the needs of both the driver and the front-seat passenger in different driving conditions.

Taking evidence from our data, there has to be a wide range of different positions necessary in order to support collaborative behavior accurately. Therefore, the design and integration in the car of such a movable device is a special challenge for future collaborative designs because this mechanism not only has to provide the possibility to move the device in different places, but also has to be integrated in the interieur concept of passenger cars. The observed technology appropriation of our device leads to another important usage scenario of future collaborative designs. This is in our case a collaborative navigation system that is shared by both, the driver and the passenger, in order to enhance interaction and therefore, increase the navigation efficiency and safety. The integration of this functionality in the overall concept of the collaborative device represents therefore another important challenge that has to be addressed in future research.

Apart from the above described influences on the collaboration in the car the relationship of the driver and front-seat passenger could also influence the way of interaction. Although the participants were familiar with each other in our setup, our data suggested the assumption that a similar behavior/usage is expected for unfamiliar individuals. In order to prove this assumption another future challenge could be to define an appropriate experimental setup. If there is a difference in collaboration a further challenge is to design and develop a prototype that addresses the needs of familiar as well as unfamiliar individuals by offering a shared view, maintaining privacy and minimizing the distraction at the same time.

In study II we could find that an unintended use of the shared gaze approach by the front seat passenger

indeed led to problems with regard to the helpfulness of the approach and distraction of the driver. Instead of referring to a spatial reference point, some front-seat passengers used their gaze to point in the direction the driver needed to turn, which sometimes caused confusion. We think this stresses the importance of evaluating new technologies for the car domain in an early phase. And it shows that technologies for support driver and front-seat passenger collaboration may indeed be used and experienced in different ways, which all needs to be taken into consideration when designing such technologies.

From the results we could learn that the shared gaze approach was not as intuitive as we thought for the front-seat passenger and that s/he was sometimes even overextended by the task. In a follow-up study, we already took this into consideration by instructing the front-seat passenger in more detail. Furthermore, we are currently considering an automated visualization of the gaze depending on the gazing behavior of the front-seat passenger.

Another point is that study II was performed in driving simulator. While this study provided us with some initial results, we are also aware that an investigation in the real world is a next step as the shared gaze approach may be adapted in another way when further features of a real world setting come up. Also, in contrast to study I, subjects in study II were not familiar with each other because we wanted to avoid that "ready-made" navigational strategies would blur our results. But how would the technology be adopted if driver and front-seat passenger are familiar with each other? For example, in study II it was mentioned by some front-seat passengers that they would afraid that the driver could see where they were looking at when it has nothing to do with the task (e.g., "*What if a beautiful woman passes by and I look at her?*"). This may be even a larger problem if the approach is used by a couple.

Our Contribution

The contribution of this position paper is twofold. First, we want to point out the importance of technology appropriation in a more critical environment such as the automotive context by presenting specific results from our research, where potential unexpected needs have been satisfied through the user's adaptation of two collaborative navigation prototypes. Second, we hope to provide a deeper understanding of how to address collaborative technology appropriation in the car with the described lessons learned and discussed challenges.

The People Behind

Perterer Nicole is a Research Fellow at the Center for HCI. She holds a Master's Degree in Psychology and Educational Science from the University of Innsbruck. Within her ongoing PhD work, she researches how interaction and collaboration can be facilitated in the car. In particular, she is interested in "collaboration phenomena" in the car context and what are the main challenges for developing social-sensitive and collaborative in-car designs.

Sandra Trösterer is a Research Fellow at the Center for Human-Computer Interaction (University of

Salzburg). She holds a Master's Degree in Psychology from the Karl Franzens University Graz. Apart from using eye-tracking as methodology to investigate driver distraction, she is interested in the use of gaze as means for interaction with systems and as means to foster driver and front-seat passenger collaboration.

Manfred Tscheligi is a Professor for HCI & Usability at the University of Salzburg, directing the Center for HCI. His work is based mainly on the interdisciplinary synergy of different fields to enrich the interaction between humans and systems. In an established cooperation he is also heading the recently formed Business Unit Technology Experience at the Innovations Systems Department at the Austrian Institute of Technology (AIT) in Vienna.

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