Insights from a series of projects related to accessibility in an AV mobility landscape

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Automated driving systems have the potential to provide increased mobility for groups of people previously underserved. This brief paper presents insights from a series of projects specifically targeting accessibility in a public transport landscape containing automated vehicles (AVs). The work has been carried out in close collaboration between both private, public, and academic actors as well as with interest groups promoting specific critical users. Automated driving systems must be identified as a piece of a broader travel experience where Universal design and inclusion should be guiding principles.

Additional Keywords and Phrases: automated driving systems, accessibility, traffic interaction

1 INTRODUCTION

Out of the major trends that we see affecting the area of mobility, in the form of electrification, sharing, connectivity and automation, the latter has the potential to lead to significantly changed conditions in terms of accessibility. It is a recurring theme that future automated driving systems (> SAE level 3) have the potential to enable mobility for groups of people who cannot, are not allowed, or do not want to drive vehicles on their own, such as the elderly, children or people with various types of disabilities [1].

However, there is limited insight into the extent to which automated driving systems can actually live up to the promise of an inclusive and accessible mobility system, both from a primary user perspective but also when considering secondary users (or 'involuntary users') such as VRUs in a mixed traffic context [2]. This topic has been central for a constellation of Swedish partners including academic, public, and private actors, gathering around the following research question:

- What are the implications of a Universal design perspective when considering the development of (higher level) automated driving systems?
    - Related to primary use (e.g., passengers)
    - Related to secondary/involuntary use (e.g., VRUs)

Providing a brief definition, ‘Universal design’ (or ‘Design for all’) can be described as the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability [3, 4]. With this, it is closely connected to accessibility and inclusiveness.

2 METHOD

With Universal design as guiding principle, a smaller consortium was formed consisting of public companies (connected to regional development, public transportation, and medical journeys), private stakeholders, academic institutions, and national interest groups promoting specific accessibility topics (e.g., people with visual impairment, people using wheelchairs). By initiative from this core constellation, a range of projects have been conducted on the theme of accessibility and inclusion of driving automation systems, making use of national- and regional funding opportunities and adding partners according to theme and scope. Following is a chronological list of these projects:

- Automation for increased accessibility (Drive Sweden)
- Pre-study: AV shuttle at hospital campus (Region Västra götaland)
- System-of-systems for medical journeys (Vinnova)
- Strategic initiative: VRUs (RISE)
- Guidance for travel with AVs (Drive Sweden)

For the sake of brevity, this document will not present any detailed description on the methodology adopted in the various projects, but in summary, the exploratory nature of the research topic and current state of development of automated driving systems has called for a basis in qualitative research approaches such as workshops, focus groups, interviews, analytical tasks, and small-scale experiments.

3 RESULTS

While leaving out detailed results from the specific projects, there are overall findings and insights that are of relevance for the broad topic of inclusiveness of automated driving systems as well as external human-machine interfaces (eHMI). In the process of analyzing AVs as part of general public transportation, a key insight is the importance to consider the entire user experience, where overall accessibility is only as good as its weakest link along a journey. Based on activities such as field workshops with crucial user groups (e.g., from home, all the way into a specific medical ward and back again), there are multiple aspects to consider in order to make the trip attractive (or even viable). Figure 1 shows one of the (condensed) user experience journeys based on people using wheelchairs, with common tasks and challenges that occur along the way.

In terms of interactions, multiple touchpoints will occur both as a passenger onboard a vehicle and as a VRU (interacting with vehicles, infrastructure applications, people etc.). These touchpoints are typically managed by different actors (such as public transport operators, healthcare providers, and application providers), resulting in the overall experience and accessibility of a journey to be neglected. For example, the journey - in the perspective of the public transport provider - would end at the bus-stop, while the hospital would only consider you as a patient once checked-in at the reception, leaving a first/last-mile situation in between. In this wider journey context, AVs (such as shuttle buses) could serve as a solution both in terms of locating your final destination as well as providing actual transportation.

Regarding traffic interactions with AVs, there are many perspectives and requirements that must be included when pursuing inclusive solutions. Any eHMI should not only provide clear information, but also be located so that it is widely accessible (e.g., for children or people using wheelchairs). To cater for wider accessibility, there is an argument for multimodal eHMIs, but also the possibility of creating complementary solutions in line with what is already common in other situations (e.g., auditory or tactile solutions for people with visual impairment).

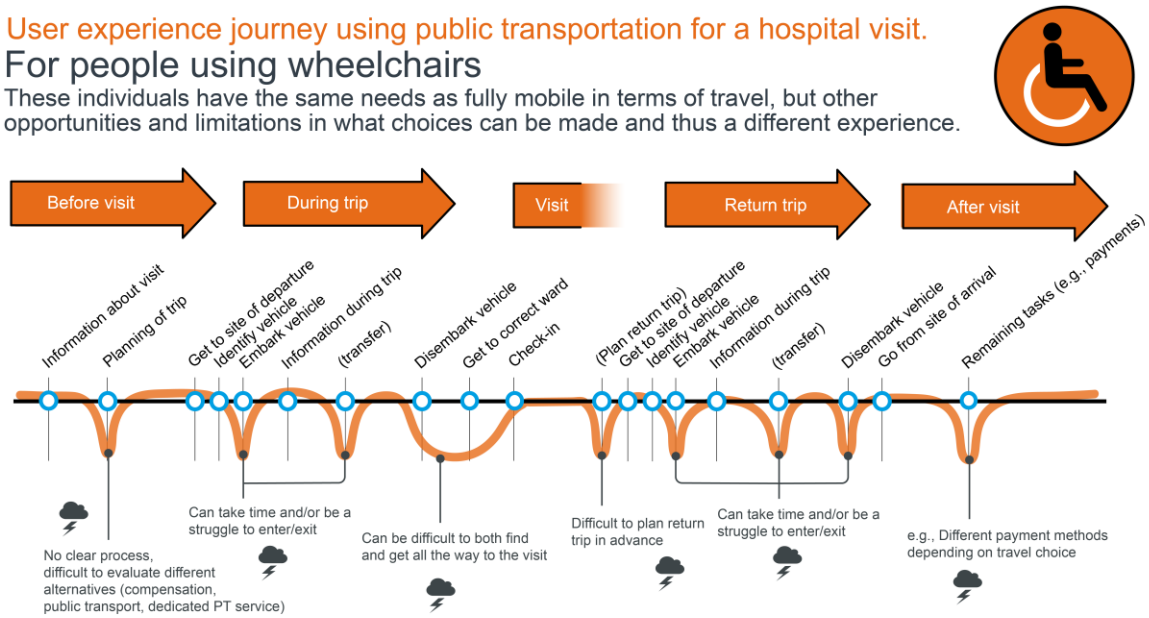

Figure 1: Example of a public transport user experience journey to- and from a healthcare appointment, based on people using wheelchairs.

4 DISCUSSION

When specifically addressing human road users' traffic interactions with AVs, there is a strong case to be made that automated driving systems must at least result in an improvement in terms of safety and intuitiveness in traffic. Increased safety can be argued to be a result of more capable and consistent automated driving systems compared to humans. Perceived safety and intuitiveness on the other hand are closely connected to the situated traffic interactions where VRUs must be able to engage in successful negotiations with AVs. Accessibility and inclusiveness come into play when we start to categorize VRUs into different types and groups. It is here that we need to be careful - and collaborate with individuals and organizations - in order to know what generalizations can be made and what is best left undefined.

Each traffic interaction that occur will be within a context. This context could be separated between factors that are less or more stable over time, ranging from 'macro' (e.g., culture, traffic legislation, education), to 'meso' (e.g., infrastructure, vehicle designs, personalities), to 'micro' (e.g., mental states, weather conditions, intentions). While it is impossible to foresee or design for every possible scenario, there is be a quite novel

opportunity to actively design the behavior and features of AVs. Movement and vehicle dynamics will be present no matter what (and continuously fundamental for traffic interactions), but there is also the possibility to add interfaces (eHMIs) coupled to the states and intentions of the AV. Following the topic at hand, such solutions must then be designed to cater for a wide range of user pre-requisites, at least when considering traffic interactions in the public space.

The overview presented here is only a brief comment to the ongoing discussions on inclusive traffic interactions in a future mobility landscape including automated driving systems, where people will both experience these vehicles as passengers and VRUs, and ultimately judge them from this combined perspective. As for Universal design, there must be a continuous exploration of how AVs (in combination with other solutions) can enable the mobility system to be accessed, understood and used to the greatest extent as possible.

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