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INVESTIGATING ADM IN SHARED MOBILITY

A design ethnographic approach

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The automated decision-making (ADM) systems that are invested in emerging transport technologies are designed to variously replace our actions when driving and to further enable us to combine and share different modes of transport. Recent discussions and debates concerning the ethics, sustainability and responsibility issues related to ADM have called for attention to the social implications and possible unexpected outcomes of its implementation in everyday life (AlgorithmWatch, 2019). However, algorithms for ADM-powered mobility solutions are rarely being developed with the social life of the end-users in mind, but rather in confined laboratory-like settings (Raats et al., 2020). For instance, our existing research has shown how in such lab studies algorithm developers put themselves into the role of the future users, to focus mainly on the momentary and individual use of the technology, with the objective of making it as efficient and easy to handle as possible.

In this chapter, we demonstrate how a design ethnographic approach to future algorithm-powered mobility solutions opens up possibilities to research social implications of ADM from a situational perspective, by investigating the context in which ADM is deployed rather than simply observing the technology itself and how it is used. We do so by contrasting everyday mobility decision-making (we call it EDM) with technological ADM solutions that have been developed for connected and shared transport solutions in an envisioned new 'mobility as a service' paradigm (Wong et al., 2020), to be able to discuss implications for further development of human-centred artificial intelligence (AI) in transport. The methodology and empirical insights described later derive from our project *Design Ethnographic Living Labs for Future Urban Mobility – A Human Approach* (AHA II). In this project, we combined ethnographic, co-design and Urban Living Lab approaches to engage communities and citizens in the design of future mobility services, based on local knowledge, community values and people's anticipations and expectations

about future smart mobility technologies. In this chapter, we concentrate on how we combined ethnographic fieldwork of people's EDM with future-oriented probing workshops to better understand the context and social implications of future ADM-powered solutions to shared and connected mobility.

The nearly universal use of smartphones has been hailed 'as the single greatest innovation for transportation in the last decade' (Wong et al., 2020: 1). Furthermore, the development of autonomous vehicles (AVs) and app-based applications for shared and connected mobility has been described as 'a new paradigm where mobility is no longer consumed as an asset (i.e., based on private vehicle ownership), but rather accessed on demand' (Wong et al., 2020: 1). Mobility, in this emerging paradigm, is developed as a service, where the user is expected to receive information, book and pay for a choice of different mobility services through an integrated digital platform, defined as Mobility as a Service (MaaS) (Mladenović, 2021). These ideas are fuelled by the growth of urban planning for city centres without privately owned cars and subsequently new infrastructures for combined modes of transportation that pull together a network of bike-sharing, scooters, buses, trams and automated and connected vehicles. From a technical perspective, shared and combined mobility systems for transporting people aim to minimise the number of vacant seats in vehicles in order to reduce the number of used vehicles, using concepts such as ridesharing, carpooling and car-sharing, managed by a growing number of on-demand app-based services (Curtis Lesh, 2013). At the heart of the emerging strand of research on efficient transport systems lies the development of algorithms for planning and operating such systems. Through simulations and data analysis, researchers hope to create options for people's travel that are so efficient and optimised that they will support the preferred choice of transport (Furuhata et al., 2013; Mourad et al., 2019). However, as we will demonstrate through our following examples, sharing and combined transport is far from solely being a technically driven practice since sharing practices are closely tied to the relational and social dimensions of the context in which it is embedded.

The AHA II project focuses on mobility within a mile from people's homes. Within urban planning and transportation research, this part of people's everyday mobility, as shown in Figure 13.1, has been pinpointed as a challenge for the transformation from privately owned cars to shared and connected mobility. From this technologically driven perspective, it is believed that poor connections from public transport nodes to people's homes are the main reason for people's preference for the privately owned automobile (Curtis Lesh, 2013; Shaheen and Nelson, 2016; Mohiuddin, 2021; Lu et al., 2021).

Current technological transport research and development focus on the possibilities of shared autonomous and connected vehicles to fill the alleged gaps in transportation systems during the first and last mile of travel (Gurumurthy et al., 2020; Ohnemus and Perl, 2016). The design ethnographic approach in the AHA II project moves beyond solely technology-driven optimising solutions by taking into account the experiences of people, families and community and including mobility practices that do not necessarily involve connectivity and data analytics. In

FIRST MILE   LAST MILE

FIGURE 13.1   The 'first mile and last mile challenge' refers to access and service quality at the outset of users' journeys. It refers to transport options used during the 'last mile' of urban commuting and is connected to debates on automated, connected and shared ADM-powered vehicles and services and what is needed for people to trust these.

Source: Designed by Kaspar Raats.

doing so, the project aimed to generate a locally grounded, in-depth understanding of travellers' practices, experiences and EDM. The ambition was to investigate the context of future ADM mobility technologies, in order to reveal any contradictions between the design vision imbued in the technologies and people's everyday mobilities. These tensions, between the design of technological systems and the ways people use them, make future mobility a good example of how ADM-powered automated and connected vehicles can be grounded in real-life situations that are not limited to automated and digital solutions. Thus, it provides opportunities to investigate the relationship between the technical design of ADM and social and real-life-based EDM, to subsequently create mobility solutions that resonate with local values and priorities.

A design ethnographic approach to ADM in everyday mobilities

Our interest in understanding how ADM-powered mobility would be adopted and appropriated among passengers in future shared and connected transport systems. This led us to develop a design ethnographic approach to investigate the context of ADM in everyday lives by combining the practical methods of ethnographic research into existing practices, routines and local knowledge and values with future-oriented co-design activities and probing.

Design ethnography is a methodology used across technology design, design anthropology and other participatory design disciplines in academia as well as in industry and consultancy contexts. As a practice, it can involve engaging ethnographic methods in order to understand everyday life circumstances and blending these with design methods, including design futures workshops, prototyping or speculative scenario creation. Design ethnography is often intended to be applied and interventional rather than simply a process of discovery and reporting. However, design ethnography is used differently across different disciplines because it is always made meaningful through the specific research questions, approaches to ethnography, analytical concepts and theoretical paradigms that shape research projects, findings and interventions. For example, when developed as part of design

anthropology research (Smith and Otto, 2016; Pink et al., 2020), design ethnography is likely to take on board the critical perspectives of that subdiscipline, including critiquing and undermining narratives of technological solutionism through ethnographic attention to everyday experience and imaginaries and participatory design practice (Chapter 2, this volume).

This is the case in the AHA II project, where design ethnography brings together the theory, methods and intervention of ethnography and design to create a collaborative approach that involves both citizens and stakeholders from cities, public transport and the automobile industry. It involves not only using ethnographic methods, interviewing people and following them in their daily lives and communities but also working with participants and stakeholders in workshops, to co-create knowledge, imagine future technologies and codesign prototypes and services. The AHA II Urban Living Lab approach is closely related to human–centred and co-design approaches to cross-sector development, integrating research and innovation processes in real-life communities and settings (Marvin et al., 2018).

The AHA II approach as shown in Figure 13.2 entails a critical understanding of dominant existing and imagined future shared mobility systems powered and optimised by ADM-driven technologies, in order to re-frame what have become
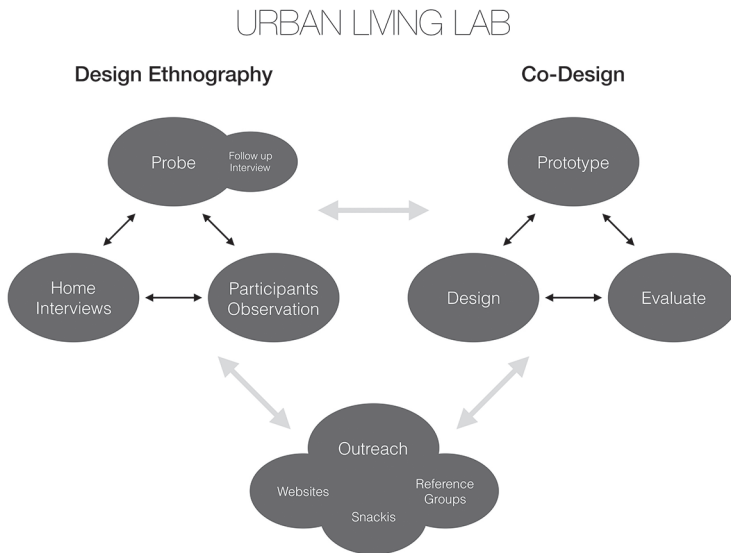

FIGURE 13.2   AHA II has developed a design ethnographic urban living lab approach to exploring future mobilities together with citizens in two residential areas in Gothenburg and Helsingborg in Sweden. The approach brings together a collection of methods and techniques to support human–centred activities and perspectives to innovation situated in a real-world context.
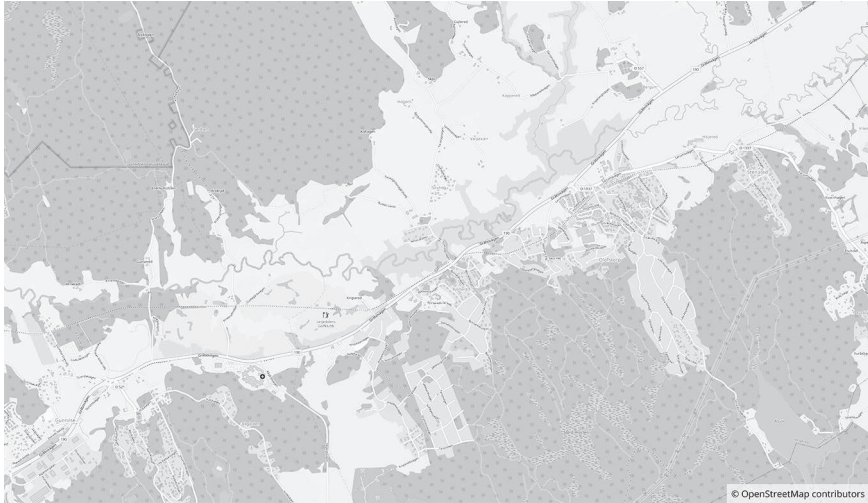
Source: Designed by Esbjörn Ebbesson.

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FIGURE 13.3   One of our Urban Living Labs in the AHA II project, Bergum Gunnilse, a peri-urban area outside of Gothenburg.

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standard, one-size-fits-all solutions to products and services. In turn, these re-framings can be turned into shared mobility systems that attend to the needs revealed by our explorations of the context of ADM-technologies in people's everyday lives, their experiences, routines and foundations for habitual decision-making. In a context where shared and connected mobility systems are advanced in combination with AVs to address the 'first and last mile challenge', investigating shared mobility practices became a key strategy through which we grounded ADM research in concrete situations. Moreover, we situate questions about shared mobility in a specific *place*, showing how its specific material and social qualities influence future mobility and mapping out what happens within the space of the 'first and last mile'. In the following two sections we present our ethnographic fieldwork in a residential area in the outskirts of Gothenburg in Sweden, and our subsequent probing activities and workshops.

The socio-spatial dynamics of choosing modes of transport – complicating the first and last mile

Our fieldwork was undertaken in Bergum Gunnilse (see Figure 13.3), an area composed of a set of clusters of residential housing, in a hilly semi-rural landscape and stitched together along a main road that connects the areas and links to the city.

In a first ethnographic research stage of the project, we combined individual online interviews with an on-site visual ethnography that involved following the participants through their neighbourhood. A total of 20 participants were involved

in this stage; they were recruited by the snowball method through local neigh-bourhood associations, as well as recruitment events outside the local supermar-ket. Aged 14–77 years, the majority of the participants were working parents of school-aged children, most of them lived in detached houses with one or several cars. In our online in-depth interviews, we focused on participants' biographical narratives, residential trajectories, perceptions of their neighbourhood and existing mobility and sharing practices that inform their everyday mobilities. Through these interviews, we learned about participants' EDM, their motivations and the social context for their choosing specific modes of mobility, as well as their representa-tions of different forms of (future) mobility.

We situated these elements within the specific surroundings that informed how participants envisaged mobilities through a method of what we call 'two-car drive-alongs'. This involved participants driving their own cars while two researchers followed them in a second car. The participants chose the starting point and guided the researchers through a selected area. They determined their routes in relation to relevant places and roads identified through a set of initial questions posed by the researchers. While driving, participants and researchers communicated via mobile phone and the whole encounter was both video and audio recorded. We used a Volvo XC90 hybrid as the 'following car', an iPhone 5 connected to the car's SPA [Scalable Product Architecture] infotainment system, using the car's microphone and speakers to interview participants. The interview was recorded using an audio recorder (Sony icd-ux570) placed at the centre of the car. The leading car and the space around were filmed with a GoPro Max 360 camera. We experimented both using a static camera positioned with a suction cup on the windshield attached behind the rear-view mirror and using an arm/tripod to film following partici-pants' indications from the passenger seat. This enabled us to address the particular local conditions and gave us specific insights into the processes of anticipation, negotiation and decision-making involved in navigating the local area, how its material features impact the organisation of mobility and the limits of car travel in this context.

Our research focused on a neighbourhood which is too dispersed to be walkable and where car travel is the dominant practice. Rather than attempting to reproduce 'naturally occurring' mobilities, the two-car-drive-along technique produced a situ-ation where participants are invited to identify and string together the places and routes most important to (their) mobility in their area. Guiding a second car in con-voy invites participants to make decisions about relevant places and questions and to make explicit self-evident practices and embodied knowledge about the place. This approach was tailored to provide meaningful interpretations of the layout of the spe-cific area and how these affect mobility decision-making. Interviews and drive-alongs allowed us to learn about: how participants' existing and imagined mobility decision-making practices were embedded in the socio-spatial context; how social relations and the specific qualities of local space intervened considerably in both their choices of modes of transport and in how they envisioned ADM. Indeed, while in dominant industry and policy narratives the 'first and last mile' often appears as an opportunity,

rather than a challenge, our ethnographic research demonstrated that the first and last mile of people's travel was a dense and socially complex space in a way that moreover challenges the concept of the 'last mile challenge' in itself.

We argue that attention to EDM – in the context discussed here in the form of ongoing everyday mobility decision–making – is vital for understanding the context of future ADM implementation. In this section, we demonstrate ethnographically how such decision-making evolves *as part of* the social and physical environment as it dynamically unfolds when people go about solving their everyday logistics. Our ethnographic findings showed how the transportation decisions people make in the first and last mile of their daily travel are formed as part of a complex and dynamic web of socio-spatial relations. How people organise their first and last mile of travel to and from their homes is embedded in individual, social, institutional as well as physical contexts. For instance, the last mile may be intensely invested as a personal time-space that serves multiple purposes and/or marks transitions between social times. One of our participants, Amanda, uses the last stretch to work to walk and have time for herself, despite there being faster options available:

> I take the Blå Express to Svingeln and then I walk . . . it takes 25 minutes to walk to my work. So it's good because you get some exercise and you are really . . . prepared to start working when you arrive . . . I have music or a podcast in my ears and I walk pretty fast. So I go ten minutes earlier from home so I get this music time. Also often in my work it is also nice to close what has happened . . . and walk it off.
>
> *(Amanda, 41, 4 kids)*

However, the last mile may also become an opportunity for socialisation. As Simon mentions, 'when you live here, you will get to know people, everybody knows each other and people speak to each other in the street'. Thus, Simon coordinates his walking to the bus stop to be on the same bus as his friends and uses this time to socialise.

In many cases, the first and last mile question is made partly redundant by single-mode transport, especially car travel, for which, in many cases, the last mile 'challenge' is not the decisive factor. This is in part explained by the fact that usually combined trips become concentrated within the first and last mile space, requiring a certain level of coordination which extends beyond individual decision-making.

INTERVIEWER: okay and so when you go to school you take the bus as well, right?
SIMON: usually- when they used to drop the dog off at the.-
MOM: . . . the kindergarten for dogs
SIMON: . . . I usually go with them there and sometimes they drop me off at the bus so then I take the bus to school. . . .
MOM: if it is very late then we- we dropped him off at school; he is quite tired in the morning so it happens quite often that we take him [Simon] to school first and then drop off the dog

Approaching future mobilities through interviews also revealed how people's imagined 'needs' for future automated shared or on-demand mobility are inseparable from much wider social, spatial, institutional context. For instance, since Pernilla's children lost access to the school bus, rather than cycling as she used to, she combines her trip to work with driving them to school and adjusts the beginning of her workday accordingly.

> [My children are] 9, 11, 13. And before, the local authorities paid for a taxi . . . to school but this year they didn't get it. So if they are going by themselves . . . they have to wait 50 minutes at the school. So we usually drive them now, which means I have to drive or my husband had to drive, and then come to work later. . . . they really would like to take the bicycle I think, but it's not possible with this traffic. It's a lot of traffic and there is no bicycle path, and it's quite a dangerous road.

Pernilla's family's experience also highlights how choices concerning modes of transport are far from being a matter of individual choice or personalisation but are embedded in complex family logistics, spatialities and diverse social relations. In the area, coordinating and facilitating children's mobility is a central motivation for multiple car ownership within households. Antonia drives her kids to school and drops off their bikes on the way down at the bus stop on days where they finish early so they can take a tram and bus back and cycle the last 3 km from the bus stop home along a dirt road. In the winter, she prefers to coordinate with her husband to pick up the kids either at school or at the bus stop.

> We always have the bike stand in the back of the car, because I always need to drive the bikes very often. But it's less now during winter or fall, because when they come home it's dark, this a dirt road – so there are no like lights or anything – and forest.
>
> *(Antonia, 39, 2 kids)*

Moreover, the specificities of the topography of first and last miles critically impact on how travel is envisioned and organised. In Bergum Gunnilse, the first mile would typically be the distance home from the bus stop on the main road, which could involve a 5 km uphill hike in low visibility without a pedestrian path. Steep hills, narrow roads that struggle to absorb the population growth in the area, darkness, weather and wilderness were frequently mentioned to justify individual car use. Moreover, the lived environment was also part of participants' mobility and was a consideration when they discussed how they envisaged future everyday local uses of technologies like AVs.

> I just have a hard time seeing how self driving cars would work in real life. I would want to know the technology behind how it works if unpredictable things happen around the car. And if you would go on a tiny road, like the

last two kilometres to the Lake where I like to go . . . it's looking out for ani-mals, since it's in the forest. And then also driving up the steep hills with the tiny stones in the ground I need to make sure that I can drive up safely, and not having the car getting out of my control and sliding down the hill again.

(Emma, 20)

The combined and complexly coordinated mobilities, including in the first and last sections of journeys, and local mobilities, demonstrate how the framing as a 'first and last mile challenge', implying singular, point-to-point mobilities, is in itself problematic.

Probing future ADM-powered mobility solutions – complicating sharing

While elements of EDM can be prompted in interviews and on site visual eth-nography techniques, experiences of speculative future ADM-powered mobility solutions are more aptly investigated through probing techniques.

Sharing is promoted in dominant narratives in the form of the emergence of a 'sharing economy' (Pouri and Hilty, 2021) which is viewed as a 'solution' towards access and sustainability through the application of ADM-powered digital services (Wong et al., 2020). However, our interview research revealed that sharing is already practised in a variety of EDM forms, most of which are quite different from the 'shar-ing economy' understanding of commercial transactions monetising underused assets. Sharing is mostly limited to relevant groups and communities, where it is imbued with symbolic meaning and serves a function of social integration. To take this fur-ther, we developed probing techniques to explore how sharing might be envisaged as part of everyday mobility futures. Probing (Gaver et al., 1999) does not only question experiences, representations and expectations regarding ADM and sharing practices but also proves more effective in eliciting future imaginations (Hutchinson et al., 2003) while allowing people to think about their experiences in a new way and thereby propose improvements (Mattelmäki, 2006; Wallace et al., 2013).

To be able to reflect our ethnographic insights in people's everyday transport decision-making in more technology-driven design visions of efficient and opti-mised ADM-powered mobility solutions, we combined the ethnographic inter-views with participatory co-design online workshops to probe towards future imaginaries of relevant mobilities. Participants in the ethnographic fieldwork were invited to recruit friends, neighbours, colleagues or teams members that shared activities or residential spaces in the area to participate in workshops where we first talked about their common experiences in the area and past and present sharing practices, then introduced the idea of a shared autonomous pod as a backdrop to co-design ideal future mobility solutions. We conducted seven workshops with an average of three participants in each.

We chose to structure the probing around a shared autonomous pod since it reso-nates with future visions of self-driving vehicles that bring people to or from other

modes of transportation in technology-driven imaginaries of futures with no privately owned cars, as well as with our ethnographic insights in how people in the area coordinated shared transport in everyday mobilities. In this way, we could probe how a future ADM-powered technology could be integrated in existing mobility practices. The activity was supported by a map of the area inserted into an online collaboration platform Mural (see Figures 13.4 and 13.5) that allowed participants to insert drawings and Post-it notes and thereby superimpose layers of present and future mobilities on the geography of the area; ideas were collected and readjusted on the same platform throughout the discussion. Basing the activity on existing relationships and shared experience further reduced abstraction and grounded imaginary situations in real-life social contexts. As shown in Figure 13.4, we asked the participants to visualise destinations they visited, areas they had mentioned to be challenging and other places they felt relevant. To connect these to future visions we asked them to also, for example, mark potential self-driving vehicle pickup spots, destinations the vehicles would enable to visit and places where they thought the self-driving vehicles would struggle.

Bringing together participants who already share transport in our co-design probing workshops suggested that some of the existing sharing practices and the symbolic and social meanings they involved (revealed in our ethnographic work discussed earlier) might be supported by ADM. However, the use of automated technologies and platforms to generate shared mobility systems and practices was restricted by questions of participants' trust in ADM to be able to monitor the social dimensions of travel and concerns about other humans. A key example of
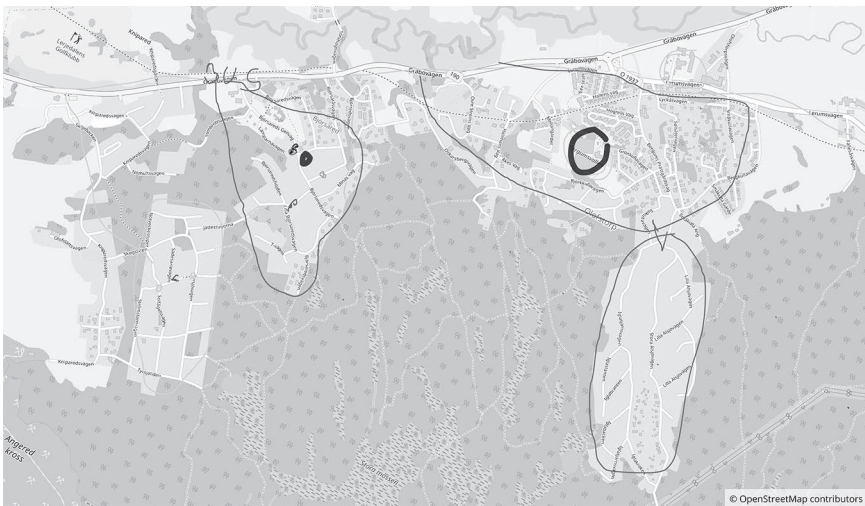

FIGURE 13.4   Map drawings from a workshop with Felix, Jonas and Olaf, whose children play in the same football team.

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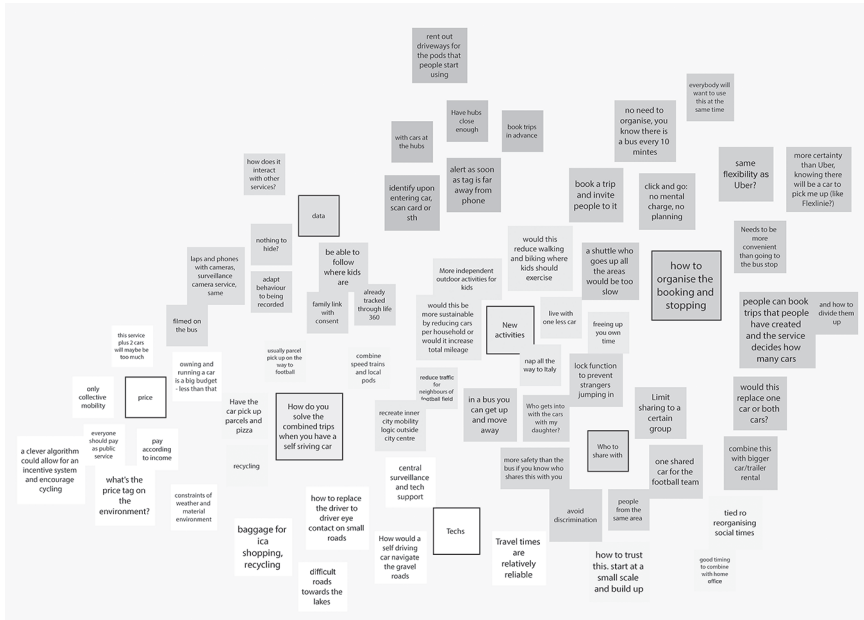
FIGURE 13.5   Idea collection and themes from workshop with Lina, Yvonne and Elsa. Ideas were collected by the researchers throughout the discussion and subsequently grouped into themes, edited and completed by the participants.

Source: Reproduced here with the permission of the workshop participants.

this is the shared responsibility of driving children to sports practice, which occupies significant portions of parents' time in the area.

FELIX: One case would be to go to the football practice; we are all involved in that. Already today, Olaf and me, we live in the same area so we usually drive together and depending on timings we have some kind of sms group where we just call out and ask if somebody wants to come to the training. It would be a pretty straightforward case to just transform that to a self-driving service . . .

JONAS: How do I know that the car is not letting anyone into the car if I send my kids to their practice? How do I know if the kids arrived to the practice?

FELIX: Yeah, how do I know about the human security? Do I know if it's a private drive, so no one else hops on? If it's Jonas' kids, then it's ok.

OLAF: The pod could only open the doors at certain geographical locations. . . . Then you pre-program the pod to get a higher security. Then the car could go on a 'milk-run', to just go around and pick up people.

FELIX: We have a football list, so we have names, and can we get a proposal of what kids will go, then the service could plan out the rides of where and who to collect. Then it would be a logistic support.

Sharing and trust in automation are thus mutually restrictive. In real-life contexts where sharing is involved, trust in other users is the primary theme that the discussions centred around when it came to using an AV service. In co-design workshops, when faced with concrete scenarios, trust in other humans tended to be more problematised than trust in AV technology.

YVONNE: Self-driving cars seem less dangerous than regular cars, or taking the bike. If in an accident you are still more protected than on a bike since you have metal shielding you.

LINA: It's not the accidents people are scared of, it's the people sharing the car. Scared of being harassed. I wouldn't be afraid sending my kids off in it, not around here at least.

YVONNE: Maybe the car can be connected to the activity so it only picks up people at the activity at a set time. So it won't pick up any adults. – This is booked just for this event, or this is just a public round for everyone. People should need to identify themselves in some way. . . . The regular one would be for anyone. But for recurring events, a dedicated round could be made.

Trust in AVs appears as processual and experience-based in the participant's stories. Rather than questioning the inherent qualities of the algorithm steering the ADM technology or the legitimacy and efficacy of the organisation developing it, participants stressed that the key condition to be comfortable with ADM technology is that they would have to 'see it at work' and progressively get used to it through repeated use in real-life situations.

JONAS: I should probably use this service quite a lot of times before I leave my kid to use the pod themselves. But my real need is to send them off by themselves, so I can stay at home and do other work, or drive one of my other kids. I would need to go with them the first time they use it.

These elements are reinforced by the idea that trust in ADM-powered AV services is often mediated and placed by one person for another person (a child, elderly parent, etc).

DAN: I've got a son, he goes to school in Gunnilse and then next year he is starting at the [school in the city]. We were kind of thinking of . . . getting him on the bus by himself. . . . So we just try to decide where's the fine line whether they are too young or not too young. The other thing is that, unlike his sister he is probably less focused in what he is doing and probably walking along holding his phone or something. Not having an eye on where the trams and buses are in town. . . . [W]hen she was on the tram she [his sister] did it really well, and the busses and everything. She is now quicker than the Resplanare [planning app]. . . . That is where we want to get to anyway with [him], but we have started to see that. yeah. we have to drive . . .

NINA: We also . . . our oldest goes to another school in Hisingen. She wants to take the bus [which] I think it's really good as she knows her way around Gothenburg now or this area. But I have the same feeling about our son who is in fourth grade. He would lose himself somewhere.

The relevance of ADM is also relational to how existing mobility patterns and sharing practices participate in social integration. For instance, when parents drive children to after-school activities, the shared mobilities involved are inextricable from their social groups, symbolic meanings and performative functions. 'Sharing' in this sense differs from the 'sharing economy' understanding of commercial transactions, as demonstrated in the following example:

AMANDA: In another group, some of the parents always took the best time and then we had to talk about it because nobody wants to go at 10 in the evening every week. . . . In this group, everybody says 'I can drive, I can drive' so we have . . . more the problem that people feel sorry 'Oh I haven't driven this week'.
LENA: I think [for us] it's the same as in Amanda's group. . . . I think it works fine but you need to take some time during the day to send texts and sometimes you don't know if anyone can take them or not like half an hour before they have to leave. So you need to text and organise. . . . they can always go by bus so if no one can drive. And sometimes I think 'why don't they take the bus all the time' – because they can do that. I think we are so involved in our kids and we really want to be part of it and we really want to show each other that we are good parents and I think that is part of it. I think it would be good if someone just said 'they can go by bus, that's fine'.

Our design ethnographic approach demonstrates how the realistic possibilities for future shared ADM-powered mobility solutions are best envisioned in the context of a wider set of social and socio-spatial relations and circumstances. This means that through our focus on understanding everyday transport sharing, we realised that successful ADM implementation has to be guided by how trust in other users develops in real-life situations and the fact that people need to 'see it at work' and progressively get used to it through repeated use in real-life situations.

Re-framing ADM-powered mobility

The design ethnographic research in the AHA II project shows that optimising the first and last mile by creating seamless efficiency between different modes of transportation is not a clear-cut answer to existing problems and needs, because such an approach extracts expectations and representations from the concrete socio-spatial situations and questions in which they occur. In Bergum Gunnilse, the last mile is a challenging trip through difficult terrain that discourages light mobility or transit use. Given the geography, the last mile may require considerable effort.

Most importantly, the first mile is a matter of coordination and family logistics. This often results in choosing the car which will be used as part of a strategy to combine trips. Moreover, the last mile is not always a problem that needs solving but rather an opportunity for sociability, exercise or quality alone-time – it involves central features such as popular shortcuts and informal meeting places. Within the last mile, people find close neighbourhood ties, or a pre-school, playground or a bus stop.

Taking this physical and social context into consideration suggests a different framing for ADM to that suggested by the technology-driven agendas behind algorithm development, which see it as being designed to serve individualised, seamless and momentary uses (Raats et al., 2020). Our design ethnographic approach points out a series of contrasts between development and user rationalities between ADM and EDM. Where developers focus on the inherent qualities of algorithms rather than user needs and real-life user contexts, people focus on how the algorithms perform in their context. To participants, potential use was more dependent on the ways in which they could modulate encounters with other users (of the AV and public road space) in already existing mobility decision-making practices, than it was on the quality of the automation itself.

We suggest that this is where a design ethnographic approach that combines ethnographic research with future-oriented probing can become useful in the development process of future ADM mobility technologies. In turn, this approach can be developed in response to recent calls for human-centred algorithm development (Baumer, 2017). Ethnographic interviews show that sharing practices (digitally supported or not) exist and are meaningful. However, probe workshops show the possibilities and limits of extending and automating such sharing practices in the future, since sharing is mostly limited to relevant groups and communities, where it is imbued with symbolic meaning and is part of social integration. A viable combination of technology development and design ethnography could be to create iterations of what is known of existing situated practices that produce use cases for developers to process and then deliver ideas for probing workshops.

Based on what we have learned through our studies of mobility algorithm developers' individualistic framing of the perceived user, tested in confined spaces to reduce the level of complexity, it is clear that the outcomes of implementing such algorithms into the socially and materially embedded first and last mile are uncertain. Our research demonstrates that a technology that works fine in the confined spaces of algorithm development is by no means guaranteed to solve any problems in everyday social life. If the problems ADM is set to solve in terms of optimisation and efficiency are not anchored in how people would activate it in their daily routines, it will only create new problems.

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References

AlgorithmWatch (2019) Automating Society – Taking Stock of Automated Decision-Mak-
    ing in the EU. Available at: https://algorithmwatch.org/en/automating-society-2019/
    (accessed 28 May 2021).
Baumer EP (2017) Toward Human-Centered Algorithm Design. *Big Data & Society* 4(2).
    https://doi.org/10.1177/2053951717718854
Curtis Lesh M (2013) Innovative Concepts in First-Last Mile Connections to Public Trans-
    portation. In: *Third International Conference on Urban Public Transportation Systems*. Paris,
    17–20 November. https://doi.org/10.1061/9780784413210.007
Furuhata M, Dessouky M, Ordóñez F, Brunet ME, Wang X and Koenig S (2013) Ride-
    sharing: the State-of-the-Art and Future Directions. *Transport Research Part B* 57: 28–46.
    https://doi.org/ 10.1016/j.trb.2013.08.012
Gaver B, Dunne T and Pacenti E (1999) Design: Cultural probes. *Interactions* 6(1): 21–9.
    https://doi.org/10/cfnt8c
Gurumurthy KM, Kockelman KM and Zuniga-Garcia N (2020) First-Mile-Last-Mile Col-
    lector-Distributor System Using Shared Autonomous Mobility. *Transportation Research
    Record* 2674(10): 638–47. https://doi.org/10.1177/0361198120936267
Hutchinson H, Mackay W, Westerlund B, Bederson BB, Druin A, Plaisant C, Beaudouin-
    Lafon M, ConverSy S, Evans H, HaNsen H, Roussel N, EiderBäck B, LindquiSt S
    and Sundblad Y (2003) Technology Probes: Inspiring Design for and with Families. In:
    CHI'03 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. Fort
    Lauderdale, FL, 5–10 April, 17–24.
Lu Y, Prato CG and Corcoran J (2021) Disentangling the Behavioural Side of the First and
    Last Mile Problem : The Role of Modality Style and the Built Environment. *Journal of
    Transport Geography* 91. https://doi.org/10.1016/j.jtrangeo.2020.102936
Marvin S, BuLKeley H, Mai L, McCormick K and Voytenko Palgan Y (2018) *Urban Living
    Labs. Experimenting With City Futures*. London: Routledge.
Mattelmäki T (2006) *Design Probes*. Publication Series of the University of Art and Design
    Helsinki A, 69/2006. Aalto: Aalto University.
Mladenović MN (2021) Mobility as a Service. In: Vickerman R (ed) *International Encyclope-
    dia of Transportation*. Amsterdam: Elsevier, 12–18.
Mohiuddin H (2021) Planning for the First and Last Mile: A Review of Practices at Selected
    Transit Agencies in the United States. *Sustainability* 13: 2222. https://doi.org/10.3390/
    su13042222
Mourad A, Puchinger J and Chu C (2019) A Survey of Models and Algorithms for
    Optimizing Shared Mobility. *Transportation Research Part B* 123: 323–46. https://doi.
    org/10.1016/j.trb.2019.02.003
Ohnemus M and Perl A (2016) Shared Autonomous Vehicles: Catalyst of New Mobility for
    the Last Mile? *Built Environment* 42(4): 589–602. https://doi.org/10.2148/benv.42.4.589
Pink S, Osz K, RaaTs K, Lindgren T and Fors V (2020) Design Anthropology for Emerg-
    ing Technologies: Trust and Sharing in Autonomous Driving futures. *Design Studies* 69.
    https://doi.org/10.1016/j.destud.2020.04.002

Pouri MJ and Hilty LM (2021) The Digital Sharing Economy: A Confluence of Technical and Social Sharing. *Environmental Innovation and Societal Transitions* 38: 127–39. https://doi.org/10.1016/j.eist.2020.12.00

Raats K, Fors V and Pink S (2020) Trusting Autonomous Vehicles: An Interdisciplinary Approach. *Transportation Research Interdisciplinary Perspectives* 7(c): 10. http://dx.doi.org/10.1016/j.trip.2020.100201

Shaheen S and Nelson C (2016) Mobility and the Sharing Economy: Potential to Facilitate the First- and Last-Mile Public Transit Connections. *Built Environment* 42(4): 573–88.

Smith RC and Otto T (2016) *Cultures of the Future: Emergence and Intervention in Design Anthropology*. London: Routledge.

Wallace J, McCarthy J, Wright PC and Olivier P (2013) Making Design Probes Work. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems – CHI'13*, Paris, 27 April–2 May. https://doi.org/10/ggc5sd

Wong YZ, Hensher DA and Mulley C (2020) Mobility as a Service (MaaS): Charting a Future Context. *Transport Research Part A* 131: 5–19. https://doi.org/10.1016/j.tra.2019.09.030.