# Human-Mobility Design: Reconsidering Mobility Infrastructures through Speculative Design

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**Abstract.** This paper is about introducing the framework of Human-Mobility Design to address the challenge of balancing technological innovation with human-centric considerations, outlining the necessity for a speculative lens to view, observe, understand the problem, and think about futuristic solutions. The framework shows the process and the course of research in a systematic way by defining the underlying concepts. The study illustrates the utilization of the framework and emphasizes the ethnography-informed speculative design as a useful approach to contribute to a more balanced and insightful discourse on the future of mobility in cities.

## Introduction

A mobility infrastructure is a physical network of structures, systems, and facilities that support human and goods movement in a community, as well as between communities. Its broad elements incorporate roadways, bridges, tunnels, rail lines, public transit systems (including buses, subways, and passenger rail), airports, and

seaports. It also holds other contemporary means of transport, such as bike lanes, pedestrian paths, and electric vehicle charging stations.

The importance of a mobility infrastructure is in the enhancement of economic growth, social integration, and environmental sustainability. Effective mobility infrastructures have been argued by Banister (2008) to relate not only to economic efficiency because of the seamless movements of goods and services but also to the well-being of society through enhanced access to essential services and opportunities for social interactions. Nieuwenhuijsen and Khreis (2016) go on to suggest that good design of a mobility infrastructure has the potential to deliver public health co-benefits, not only in terms of reduced pollution but also for increasing physical activity through an integrated active travel option that includes walking and cycling.

However, the issues of funding, maintenance, and integration of new technologies pose challenges that need to be addressed in order to fully optimize the benefits provided by a mobility infrastructure. A study by Duranton and Turner (2012) focused on the paradox of infrastructure provision, where greater capacity could lead to greater demand and could undo the benefits of having further infrastructure in place without appropriate planning and management.

Within the future development of mobility infrastructure, mobility is set to be more connected, automated, and tailor-made in a technologically developed world with societal expectations having equally grown. This progress is being helped by the use of autonomous vehicles, electric propulsion, and connected multimodal systems, which will become the new normal and significantly help in making transportation efficient and environmentally friendly. According to Litman (2020), big data analytics integrated with smart technologies will enhance optimized traffic and infrastructure utilization, which reduces congestion and emissions. Furthermore, Stephens et al. (2019) consider a prospective shift to Mobility-as-a-Service, collecting various forms of transport services into a readily accessible on-demand mobility service. This is expected to diminish dominance in private car ownership and instead increase shared and public transport solutions that accommodate individual needs by allowing various modes while at the same time ensuring sustainability. These are literally paradigm shifts in approaching mobility with efficiency, sustainability, and access, and all in seeing it from the mobility infrastructure point of view.

With the penetration of the likes of driverless cars and intelligent transportation systems into human life, there's a perfect recipe for a revolution in the way we experience mobility from point A to point B (Bansal and Kockelman, 2017; Lyons, 2018). Yet, the existing corpus of research disproportionately focuses on these developments in technology and largely subordinates human behavior and adaptation in framing the narrative on the future of mobility. This focus on technology alone is insufficient to really understand the future of mobility. A solely tech-centric view fails to consider how people will engage with, realize benefits

from, or possibly resist new forms of mobility, which leads to a gap in our collective knowledge. Notably, the role of speculative design in the exploration of human behavior within this context has been greatly overlooked. Without this speculative lens, the field lacks a fully developed tool for visualizing a range of possible future scenarios, from the individual to societal levels, and accordingly leaves policymakers, designers, and stakeholders less able to be well-prepared for the increased complexities brought on within the rapidly changing mobility landscape (Dunne and Raby, 2013; Auger, 2013). This only amplifies the urgency of more research that will balance technological innovation with human-centric considerations, outlining the necessity for a speculative lens to view, observe, understand the problem, and think about futuristic solutions.

Speculative design as a methodological tool helps explore human behavior, here within the mobility context, envision a range of future scenarios, from the individual to societal scales, as well as, prepare policymakers, designers, and stakeholders for the complexities of a rapidly changing mobility landscape.

In this paper, a framework called *Human-Mobility Design* is introduced to address this problem. The framework has been developed based on the experiences gathered in the research project aspern.mobil LAB (Tellioğlu et al., 2019; Tellioğlu et al., 2023) where one study has been established to evaluate the framework. The following describes the course of research in a systematic way by defining the underlying concepts and illustrating the processes of its utilization.

The paper represents the framework prior to the presentation of the study itself, discusses the findings, and draws some conclusions briefly.


## The Framework of Human-Mobility Design

The framework of so-called *Human-Mobility Design* (Figure 1) describes the main components of how to organize, interpret, and analyze information on the relationship between mobility infrastructures and human mobility behaviors over time. The main goal is to (re)design the existing infrastructures by involving humans (i.e., persons like residents, visitors, or other stakeholders) and their suggestions for change and enhancement based on their life, work, health, and financial situation. The framework is synergistic methodological build upon both (auto)ethnography and speculative design.
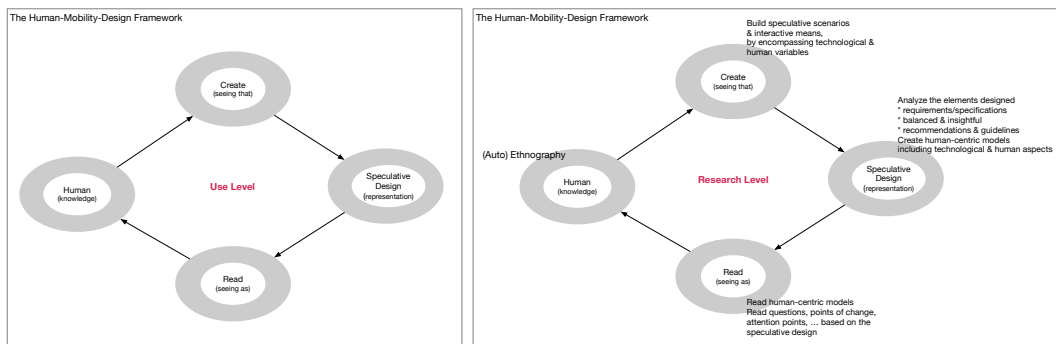
**Figure 1: The framework of Human-Mobility Design from the use perspective (left) and from the research and methodology perspective (right) (Tellioğlu, 2024).**

Firstly, through an (auto)ethnographic study, the mobility practices of a person ("knowledge") must be studied to create a common ground for further options and "speculations." On the one hand, (auto)ethnography acts as the basis for a strong empirical understanding of current mobility practices, attitudes, and societal norms; yet, on the other, this form of qualitative approach is able to provide the necessary granularity to understand the individual experiences framed within large socioeconomic milieus. It anchors the study in real-world observations and lived experiences by laying down the empirical groundwork.

In this framework, ethnographic research documents this person's mobility behavior, reasons for his or her choices, and aspects having an impact on his or her options and practices so far. The (e.g., thematic) analysis of the material delivers possible speculative scenarios that are used for further exploration in the next stage. Interactive ways integrated into speculative scenarios drive the person to think aloud new ways of mobility by expressing (sometimes surprisingly) new ideas for the (re)design of mobility infrastructures surrounding him or her ("seeing that").

Speculative design counterbalances the empirical focus of (auto)ethnography with a method for the ideational exploration of future mobility landscapes. At best, it is a way to study potential human reactions to imagined technologies and infrastructures, by way of which to develop a palette of user-focused future scenarios. This way created elements which are encompassing technological and human variables build up the speculative design ("representation") and are analyzed to create requirements and specifications for mobility infrastructures that are balanced and insightful and can be used to create recommendations and guidelines for future developments of mobility structures and services.

The speculative design created this way represents something that lies in the future of this person, is very personal, but has a general impact on the environmental development regarding mobility. This representation, which can be called also a human-centric model, is again read ("seeing as") by the very same person. It triggers possibly new questions, attention points, and points of change with a consequent set of actions or at least ideas for actions for this person. This brings the process back to the first point, which requires further ethnographic study

of the person's mobility choices and behavior and continuous further on with speculative design sessions.

Thus, in a combination of both aspects, namely the ethnography and speculative design, research activities with the aid of both dual methodologies result in balanced inquiry, which binds the empirical rigor of (auto)ethnography with the forward-looking explorative nature of the speculative design. This results in the production of a methodological synthesis that affords multifaceted understanding and contributes substantively to evolved dialogues in the societal and economic dimensions of future mobility.

The framework suggests several iterations of such study and design sessions by planning the according to timeline for each iteration. The ideas generated in the form of speculative design (in each iteration) can also be used as a representation of speculative ideas to share with other stakeholders, like policymakers, city planners, mobility planners, politicians, etc., to initiate change in mobility infrastructures and services.

# The study at aspern.mobil LAB

Starting in 2022, several residents in Seestadt Aspern have been contacted to include biography research based on (auto)ethnography with regard to mobility choices and behavior. After in-depth interviews with the 10 residents (see Table 1) the mobility-related factors are coded and analyzed. Based on the analysis results, especially connected to the location Aspern, the speculative design calculator (2), the future wheel (2), and the map (3) have been introduced to create speculative scenarios for further design sessions with the persons studied in the first round (Figure 2). To enable a continuation from the first interviews to the two-year later speculative design session, an additional step has been designed (1): I – my places – my mobility.

**Table 1: Residents in Seestadt Aspern involved in the ethnographic study on mobility.**

| Nummer | Geschlecht | Wohnort | Herkunftsort | Haushaltsgröße | Alter | Beruf/ Branche |
|--------|-----------|---------|--------------|----------------|-------|----------------|
| 3 | W | Wien, Seestadt | Kitzbühel | Unbekannt | 65 | Pension |
| 5 | M | Wien | Wien | Mit Frau und Kinder | 38 | Lehrer |
| 6 | M | Wien | Linz Umgebung | Unbekannt | 65-75 | Pension |
| 7 | M | Wien, Seestadt | Kottingbrunn | Mit Freundin | 25-30 | Cybersicherheit |
| 8 | M | Wien, Seestadt | Wien | Mit Frau | 60-70 | Lotterien |
| 10 | W | Wien, Seestadt | Steiermark, Bretstein | Mit Tochter | 40-50 | Mobilfunk |
| 12 | W | Wien, Seestadt | Wien | Singlehaushalt | 51 | Kunsttherapeutin |
| 17 | W | Wien, Seestadt | Innsbruck | Singlehaushalt | 62 | Pension |
| 18 | M | Wien, Aspern | Kärnten, Villach | Gemischt | 49 | Standortbetreiber (Nachhilfe) |
| 20 | M | Wien, Seestadt | Schweiz, Aargau | Mit Frau | 58 | Informatik |
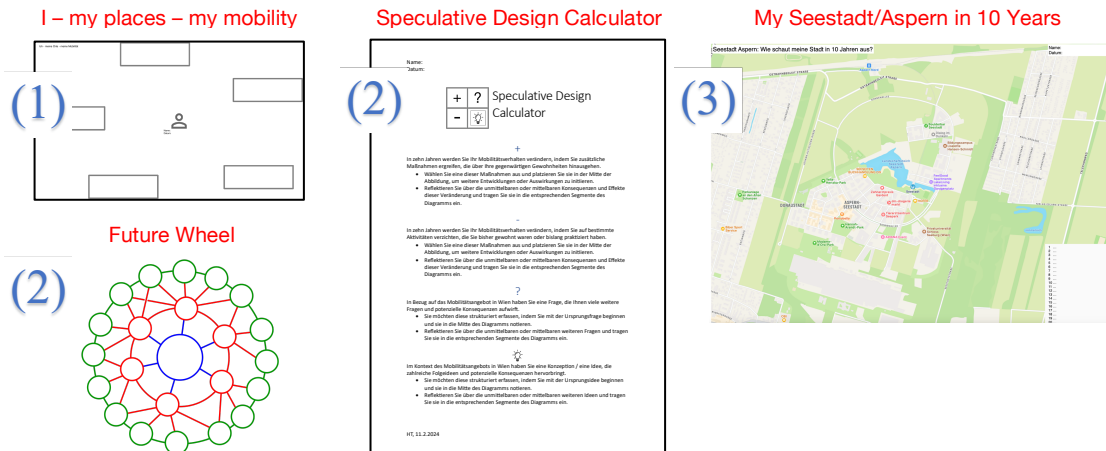
**Figure 2: Artifacts invented for the speculative design session with the residents at aspern.mobil LAB (2024).**

In the following, one example (Participant #5) has been selected to illustrate how the speculative design sessions have been carried out with him. The whole process of the speculative design process (took 2 hours in total) was audio-recorded for further analysis.

The first step was to fill in the (1) by thinking aloud (Figure 3). It helped to remember the current status of mobility, and activated him. It, at the same time, has created a common ground between him and the researcher present in the session.
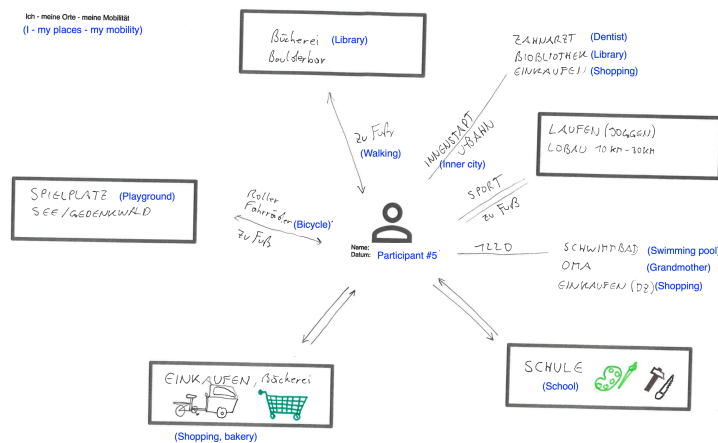


**Figure 3: "I – my places – my mobility" filled in by Participant #5. Translations added are in blue.**

The next step was to carry out (2) (Figure 4). The task in the speculative design calculator (+) was:

*"In ten years' time, you will change your mobility behavior by taking additional measures that go beyond your current habits. Select one of these actions and place it in the center of the diagram to initiate further impacts. Think about the direct or indirect consequences and effects of this change and place them in the appropriate sections of the diagram."*

The other tasks were analog to the task of (+) with the adjustments of removing one measure (-), having a question about mobility services (?), or having an idea about mobility possibilities 💡 .
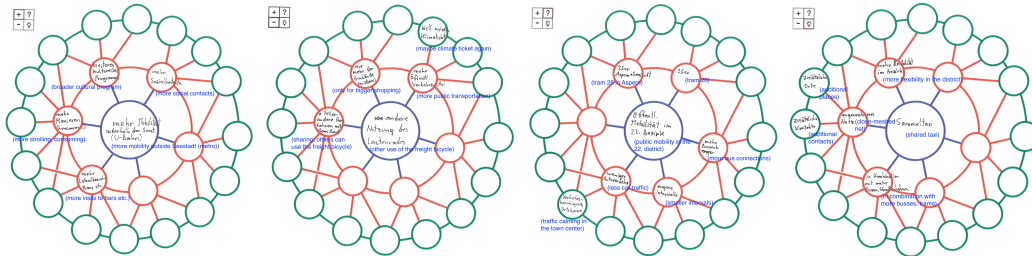


**Figure 4: The four future wheels (+, -, ?, 💡 ) related to the tasks defined in the speculative design calculator, created by Participant #5. Translations added are in blue.**

The final step was (3): My Seestadt/Aspern in 10 Years. Participant #5 filled in the map with several suggestions (Figure 5).
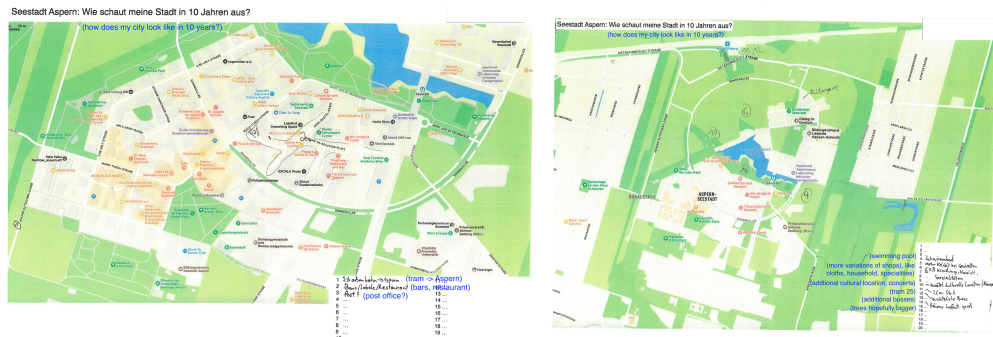


**Figure 5: The map of the future in Seestadt Aspern created by Participant #5. Translations added are in blue.**

# The findings and discussion

The study presented above shows how participants of such studies can contribute to the (re)design ideas of mobility infrastructures and services in their environment. Cumulating these ideas, especially embedded in the context of the persons while they are telling their story, provides a very useful set of options for future developments for city and mobility planners or other decision-makers. The key issue is to analyze the data and create a representation of all ideas accessible and understandable to outsiders, which is normally the responsibility of the researcher as mediator and translator.

## Ethnography-informed speculative design

The speculative design method that is informed by ethnography (as illustrated above) operates as some novel alliance, bringing the rigor of ethnographic observation into connection with the forwardness of speculative design

perspectives; the subsequent synergy makes for a powerful tool for understanding and shaping the future of social infrastructures such as mobility.

*Ethnography* is full immersion within and observation of communities to understand their culture, behavior, and interaction. When applied to mobility, ethnography can discover nuanced insights into how people and social groups relate to and move within the existing transportation systems, their unmet needs, and the socio-cultural forces that bear upon their choices (Ellis et al., 2011). This deep understanding is necessary for the formulation of technology not only technically sound but culturally resonant and widely adopted.

On the other hand, *speculative design* goes beyond the boundaries of current realities and technologies to possibly dream up possible futures (Dunne and Raby, 2013). This kind of design thinking is, in general, of great importance in breaking the boundaries of what could be possible in encouraging innovation. Speculating what future technologies or their impacts on societies could expand the design space to include a range of potential solutions, some of which at the current time may sound quite improbable but might become possible with change.

When these two approaches come together in *ethnography-informed speculative design*, the result is a multilayered framework of analysis, namely the framework of Human-Mobility Design. A framework that better enables understanding of current systems of mobility and their limitations but adds to this by providing visionary projections of the future scenario (Auger, 2013). Such scenarios are not just fantasies but use real observations and cultural insights, which are imaginative and, at the same time, realistic.

This provides salient insights that can deeply influence policy deliberation and design actions. This is an encouragement for policymakers and designers to think outside the conventional solutions in the direction of radical transformations that point toward more sustainable, efficient, and inclusive mobility systems by providing well-grounded but visionary alternatives (Lyons, 2018). Thus, speculative design informed by ethnography is not just a theoretical exercise but a strategic tool: it could drive major decisions in the field of urban planning and mobility policy that are both of an innovative character and deeply rooted in human experience.

# Conclusions

Summarizing the main findings results in three main aspects of the Human-Mobility Design framework: *Mobility infrastructures* are fundamental parts of our urban space and must be provided and maintained for continuous use. At the same time, they should facilitate new arrangements or combinations of mobility modes – even if they are offered by different service providers – for single citizens by having an eye on occurring clusters or patterns in the mobility behavior of residents or visitors as well as other stakeholders populating the same urban area. To simplify

the framework presented in the paper, we consider as individuals only *citizens*. After activating and making them aware of mobility options, citizens might have two goals: their personal goal concerning their mobility behavior and the common goal, which is about changes in infrastructures of urban mobilities, especially based on the citizens' requirements. Finally, the third aspect is about bridging the existing gap between technology-focused and human-centric approaches, ultimately contributing to a more balanced and insightful discourse on the future of mobility. The *(auto)ethnography-based speculative design approach* helps to address this issue, as shown in this paper.

The individual choice of mobility modes is strongly dependent on the existing infrastructure of mobility, besides the circumstances in the current life situation of the citizens, and the restrictions and possibilities given by their social environment, like family, work, economic, and health conditions. The infrastructure makes it possible to remain stationary in mobility choices and, furthermore, to move forward. Creativity in designing or reshaping infrastructures of mobility, especially if it originates from people who are supposed to be mobile themselves, and not from service providers or policy-makers, might facilitate unknown and unforeseen modes of mobility for people, even by inventing new paths, vehicles, shared ways of transporting, etc. So, both creativity and openness for new endeavors, as well as the infrastructure of and for mobility, drive one another towards more advancement and dynamicity in mobility options and services. Future research will address a broader application of the approach within the framework.

# Acknowledgments

# References

Auger, J. (2013): 'Speculative Design: Crafting the Speculation', *Digital Creativity*, vol. 24, no. 1, pp. 11-35.

Banister, D. (2008): 'The sustainable mobility paradigm', *Transport Policy*, vol. 15, no. 2, pp. 73-80.

Bansal, P. and Kockelman, K. M. (2017): 'Forecasting Americans' Long-Term Adoption of Connected and Autonomous Vehicle Technologies', *Transportation Research Part A: Policy and Practice*, vol. 95, pp. 49-63.

Duranton, G. and Turner, M. A. (2012): 'Urban Growth and Transportation', *Review of Economic Studies*, vol. 79, no. 4, pp. 1407-1440.

Dunne, A. and Raby, F. (2013): *Speculative Everything: Design, Fiction, and Social Dreaming*, MIT Press.

Ellis, C., Adams, T. E. and Bochner, A. P. (2011): 'Autoethnography: An Overview', *Forum: Qualitative Social Research*, vol. 12, no. 1, Art. 10.

Litman, T. (2021): *New mobilities: Smart planning for emerging transportation technologies*, Island Press.

Lyons, G. (2018): 'Transport's Digital Age Transition', *The Journal of Transport and Land Use*, vol. 11, no. 1, pp. 1-19.

Stephens, T. S., Auld, J., Chen, Y., Gonder, J., Kontou, E., Lin, Z., ... and Gohlke, D. (2019): 'Assessing energy impacts of connected and automated vehicles at the US national level—preliminary bounds and proposed methods', *Road Vehicle Automation*, vol. 5, pp. 105-115.

Tellioğlu, H. (2024): 'Speculative Design and Human Behavior in Seeding the Future of Mobility', *Proceedings of the International Scientific Conference on Mobility, mobil.TUM 2024 - The Future of Mobility and Urban Space*, April 10-12, Munich.

Tellioğlu, H., Berger, M., Kirchberger, C. and Strohmeier, F. (2019): 'Mobility Transformation: What does mobility mean in the future?', in H. Tellioğlu, L. Nathan and M. Teli (eds.): *Proceedings of the 9th International Conference on Communities & Technologies - Transforming Communities (C&T'19)*, ACM, New York, NY, USA, ISBN: 978-1-4503-7162-9, DOI: 10.1145/3328320.3328411, pp. 349-353.

Tellioğlu, H., Mikusch, G., Kirchberger, Ch., Keseru, I., Geurs, K. T., Buettner, B. and Vettori, B. (2023): 'Co-Creation Practices and Technologies for Open Urban Planning', *Proceedings of the 11th International Conference on Communities and Technologies (C&T'23),* ACM, New York, NY, USA, https://doi.org/10.1145/3593743.3593786, pp. 258-261.