Transportation in Transition

Theses on the Future of Urban Mobility and the Role of Mobility Design

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We live in a transformative time, a fact that has achieved wide recognition. The phrase *great transformation* was originally coined by Karl Polanyi (1973), referring to the profound change that led to the evolution of capitalist market societies and nation states. Today, in discussions of sustainability, the term *great transformation* refers to the directed, systemic, and collaborative socio-ecological reshaping of our society at a time when the synergy of megatrends such as population growth, urbanization, climate change, digitalization, and multiple geopolitical upheavals, all taking place within inherently limited planetary boundaries, have up to now taken the shape of a chaotic transformation *by disaster* (Rammler 2016; Beer and Rammler 2021).

With a focus on mobility, and with the above-described background in mind, this essay asks: what kinds of challenges are likely to confront the design field in relation to such a socioecological transformation of mobility *by design* (Rammler 2015, Bormann et al. 2018)?

One focus is on the influence of urbanization and the associated densification and scarcity of space on the mobility of the future and the resultant challenges for the design of transportation systems, especially given the urgent necessity for climate-neutrality and post-fossil-fuel approaches.

Given this situation, an additional focus is on the likely future tasks and working approaches of mobility design, which can for the moment be regarded, firstly, as an intermediary interface discipline between the most diverse urban, spatial, and transport-related disciplines; and, secondly, between design and planning practices and the user experience.

Thesis 1: Cities Are the Modernization Laboratories of Solar Culture: The Urban Mobility of the Future Must Be Space-Saving, Postfossil, and Climate Neutral

Given the multiple negative externalities associated with the burning of fossil fuels, the fossil-run battery of spaceship Earth—to cite the neat formulation of Buckminster Fuller (1973)—has reached the end of its lifetime. In the coming years, the resultant vulnerabilities, distribution conflicts, and demands for resilience and adaptation can be expected to dramatically escalate (Rammler et al. 2022). The only alternative to the present situation is to quickly start up the main engine of the spaceship, which is to say to affect a conversion of our primary energy source to a regenerative, and ultimately a solar, one. This has massive implications for the tasks facing the redesign of our transportation system, currently bound up with fossil fuels.

Another key factor for future mobility is urbanization, or the densification of a steadily growing world population in a restricted geographical space. Today, a large proportion of the world's population already lives in urban regions. This proportion is expected to grow. This means that the future of mobility will be determined primarily in the city of the future. Alongside energy provision, habitation, and the resource or circular economy, urban mobility is one of the core themes that require new approaches to problem-solving if we are to advance toward a viable total concept for sustainable urban development (Schwedes and Rammler 2012; Rammler 2017: 59f. WGBU 2016). The increasing scarcity of space and the resultant distribution conflicts concerning urban life opportunities also means that the prospects of mobility for an increasing number of people, together with growing demands for prosperity, can only be satisfied by increasing efficiency in the utilization of infrastructures and vehicles.

The *conversion of energy culture*, and our approach to dealing with increasing *space scarcity* are the two most important transitory elements of urban development in the twenty-first century. On this basis, we can distinguish at least three design guidelines (Schwedes and Rammler 2012) that are vital for a sustainable future mobility:

- *SunCity* is an urban model for the post-fossil-fuel recultivation of the planet and the decarbonization of the energy flows of the urban organism, in particular its traffic and transport flows.
- *ElectriCity* marks a paradigm shift toward the electrification of all urban subsystems, in particular, that of mobility. In the future, it is regeneratively produced electricity that will

make it possible for us to renounce fossil fuel energy sources and their combustion emissions.
- *NetCity* refers to an information-based, decentralized network culture of complementary energy and data flows, and the resultant new possibilities for the management of collaborative and usage-efficient product, or the sharing economy. Manifest is the particular importance of digitalization for the facilitation or optimization of new interfaces for overall systemic innovation between hitherto separately operated urban functional systems, such as mobility and the energy system.

Up to this point, modern, Western-style cities have been thoroughly fossil-fuel-based; their origins, formation, and development have been conditioned by the use of fossil fuel energy sources. Logically, and given the political priority of attaining climate neutrality in the transport sector as quickly as possible, Western societies—which remain strongly wedded to the automobile—should begin where the principal problem emerged under the conditions of spatially dispersed, strongly suburbanized settlement and commercial structures: with the oil dependency of a gigantic fleet of vehicles, and with a rapid attempt to reduce consumption and transform drive forms.

At the same time, and in the urban context in particular, public transport, with its capacity for bundling, will remain »the backbone of the transformation of transport« (Rammler 2011), if only because escalating space problems render impracticable the wasteful space economy of stationary and moving private and individual car traffic that has prevailed up to this point (Rammler 2017: 59f.). Then there is the new mobility—concepts such as ridesharing, the renaissance of cycling, micromobility, the logistics of delivery—and new concepts for local mobility, components which together form a set of instruments for a *functionally integrated urban transformation of transportation*.

Against this background, three strategies can now be distinguished which, when interlinked, point toward the future by providing innovative concepts for the design of mobility systems, mobility utilization, and mobility products.

Thesis 2: Efficiency Strategies Quickly Reduce Resource Use

Here, it is mainly a question of increasing resource productivity through the accelerated reduction of the use of vehicles based on the internal combustion engine, and the optimization of the cycles of the materials employed, which can be referred to as »efficiency strategies« in connection with the usual discussions of environmental policy. But the enhancement of efficiency is and remains a transitional strategy, which must diminish in importance over time. Potential for savings can be found in the area of weight reduction, the minimization of aerodynamic driving resistance and tires, and in the optimization of engine performance.

The technological potential that lies dormant in these areas continues to be enormous. In the past, under unvarying regulatory conditions, improvements in the efficiency of automotive engineering have been lost to the rebound effects or been canceled out by changes in behavior brought about by the reduced user costs of more efficient vehicles (i.e., drivers use cars more frequently or accept greater distances) (Rammler and Sauter 2016). Indispensable against this background is that technical regulation on the production side be complemented by fiscal policy recommendations that have an impact on behavior, such as carbon-dioxide taxation or a toll system.

Thesis 3: The Conversion Strategy Requires a Revolution in the Construction, Design, and Propulsion System of Individual Vehicles

Efficiency strategies must be supplemented by a change in propulsion systems based on a technological paradigm shift in automobile construction worldwide. The guiding principle of this conversion strategy must be a vehicle design that is completely restructured technologically in relation to the internal combustion engine. The automobile of the future will be extremely lightweight, safe, and powered by electricity. Modular and flexible construction concepts and innovative interfaces and concepts in the interior based on new digital technologies will mean transport options with higher functionality, individualization, and networking within the larger transport system. The automobile of the future will be characterized by superior design values and aesthetic appeal, and its components will be reusable in the framework of an automobile economy that is, in turn, integrated into a total circular economy. Arguing in favor of this, unequivocally, are the large resource backpacks that are required by the new propulsion concepts.

It remains an open question how the electronic motor will be powered. It could be a fuel cell or the still prevalent battery electricity, with the battery being charged by a power grid that is technologically modernized and restructured for flexible sector coupling. In the coming years, a competition may emerge between the electric battery and hydrogen (H2) fuel cells. It seems extremely likely that both sectors will soon see considerable advances. Appropriate in the current situation, however, would be cooperation between the two contexts of use rather than a competition between the two technologies, which could lead to a premature closing off of options.

Nevertheless, there is no »savior vehicle« in the offing. No new vehicle technology—not even the electric automobile—will be able to replace fossil-fueled automobility in its current form through a single, fully functional equivalent without violating sustainability requirements in essential ways or giving rise to new resource bottlenecks. Individual mass motorization can never become a global mobility model, regardless of the technological basis involved (Rammler and Weider 2011; Rammler et al. 2021; Brunnengräber 2020). All the same, it is vital that the technology of electrical automobility be developed in all of its variants at an accelerated tempo.

Thesis 4: The Integration Strategy Has the Task of Ensuring that the Transport and Energy Systems Are Embedded in the Conversion Strategy

Cities are networks of infrastructures. With regard to transport and energy systems, the aim of the integration strategy is a radically altered linking and integration of (individual) vehicles into the total organism of urban energy and material flows. This system-innovative technological and infrastructural approach should therefore be referred to as an integration strategy. Conversion and integration strategies belong together; they are two sides of the same coin. They are the decisive and the most effective point of departure for the post-fossil-fuel restructuring of transport, but at the same time the most difficult.

Above all, the electrification of urban mobility requires a comprehensive reconceptualization of *energy-systemic integration* and must clarify the following questions: How and where will the required energy be provided in a regenerative way? What role will be played by wind power, solar thermal energy, hydropower, and biomass power generation in various regions? How will regenerative energy be stored, thereby compensating for natural production fluctuations? What role could be played by sector coupling between energy provision and decentralized automobility? Will new supply infrastructures be required, or can the conventional power network, albeit modernized, be used as a distribution infrastructure?

Clearly, the realization of the conversion strategy for both technology lines—hydrogen fuel cells and battery electricity—have far-reaching implications for the reorganization of energy provision overall. It is also clear that in the future, mobility, energy provision, and household energy use will need to be conceived as a total system. This could allow new players to become active in the arena of automotive policy. From this perspective, the petroleum and electricity industries clearly become competitors. Conceivably, precisely the parallel development of the technology lines of hydrogen fuel cells and battery electricity could lead to a cooperative perspective. In this model, the electricity sector would be responsible for passenger transport based predominantly on battery electricity. The petroleum industry would assume responsibility for the hydrogen infrastructure.

The *integration of the transportation system* must clarify the following questions: Which intermodal service and utilization innovations would be in a position to address the range problem, which cannot be fully eliminated, in relation to new vehicle concepts based on electrical drive systems (rail-street cooperation)? What role could be played by new driving assistance and traffic guidance technologies for the optimization and bundling of the traffic flows of both private and collective modes of transport? How can interaction—meaning intramodal cooperation—between the subsystems of public transport be improved, and how might collective-public and individual-private mobility concepts such as the automobile and the bicycle cooperate better in the future? What role is played by the first and last miles, and which transport services, beyond the private automobile, provide users with adequate functionalities from a user perspective?

In the mid- and long-term, the integration of the transport system will be of enormous significance for the sustainable and post-fossil-fuel reinvention of urban mobility. In the metropolitan regions of southern Asia, in particular, as well as in Germany, sustainable economic and social development will be impossible without the reliable backbone of a highly efficient and high-performance mass public transit. Given the massive competition for space, the establishment of a Western-style monoculture based purely on the automobile—even on a zero emissions basis—in densely populated Asian metropolitan regions would be counterproductive; in contrast, the accommodation of individual and collective transport seems highly promising. In regions that are still playing catch-up vis à vis modernization, density problems are decisive. This becomes striking when we compare the density levels of the Chinese province of Guangdong with those of the German Federal State of North Rhine-Westphalia. In the foreseeable future, approximately 100,000,000 people—roughly the same population as Germany and the Netherlands combined—will be living in the mega-urban region of the Chinese Pearl River Delta, which is roughly the same size as North Rhine-Westphalia (Schwedes and Rammler 2012).

Thesis 5: The Future of Urban Mobility Lies in the Development of Integrated Mobility Systems

Integrated, versatile, and regionally adapted mobility concepts are the urban mobility solution of the future. An *investment and modernization offensive* for collective transport modes (local public transport, long-distance and regional trains, rail freight transport) is the linchpin of a politics of sustainable mobility. Given the central importance of mobility for modern societies, such an investment is defensible in all regards. The linking of so-called micromobility (bicycles, e-bikes, light electric vehicles, light electric transporters, Segways, etc.) and collective transport will be a mainstay of the urban mobility of the future. To summarize, it is shaped by just a few seemingly simple developmental requirements:

- the realization of a high degree of mobility with maximally economical transport expenditures in the context of density-oriented spatial and settlement planning;
- the facilitation of local mobility by giving planning preference to pedestrian and two-wheel traffic;
- the construction of a correspondingly high-performance infrastructure of pedestrian and cycling routes;
- a planning, design, and political focus on collective transport as a digitally systemic inter- and multimodal mass transport;
- the continued use of autonomous, flexible individual transport resources, such as the automobile, bicycle, or scooter, in the framework of digitally mediated, platform-based usage innovations; and
- the electrification of all transport links and vehicles based on an ultimately regenerative energy production.

With the above as a basis, we must now ask: What does mobility design look like? What tasks and design challenges result from the image of a future mobility that was sketched above?

Thesis 6: Mobility Design Means the Design of Systemic Innovations in Mobility

Since the dawn of civilization, the artifacts, systems, and constructive context of mobility have been key focuses of design intelligence and creativity. According to the social anthropologist Arnold Gehlen, man »would have been unable, with his given biological constitution, to maintain himself in raw nature. His activities, therefore, are aimed primarily at the transformation of the external environment as a consequence of simple organic necessity« (Gehlen 1961: 93). According to this theory concerning the emergence of technology, the development of individual technologies and of entire systems for mastering space can be conceived as attempts to substitute for, disburden, or surpass human organs: »The carriage, the riding animal, relieve us of the burden of walking, and vastly out-do its capacities. With the pack animal, this disburdening principle becomes tangible. The airplane, in turn, compensates for the organic wings we cannot grow ourselves, at the same time far surpassing all organic flight« (Gehlen 1961: 93).

The residence of the human being in the limitlessness of space and the limitations of time provided ample motivation to invent the wheel and—speaking metaphorically—to reinvent it repeatedly, creating an entire arsenal of artificial organs designed to overcome space, with whose assistance the limitations of the human body could be surmounted. This has been especially the case since the inception of modernity, with its particularly emphatic affinity for mobility (Rammler 2001). The methods for overcoming space, the phenotypes of their technologies and infrastructures, represent the most impressive testimony of this radical transformation in the transition to modernity. Mobility was a central field of innovation and design during the first great transformation that led toward the capitalist market economy, as well as during the emergence of the modern nation state, and it is also of fundamental importance for the currently emerging sustainability transformation in what is now a globalized world.

Design can and must continue to play a central role in this process. Against this backdrop of a diverse, sociotechnically networked world, design will need to be conceived to a greater extent than before as the *design of systems and of transformation* for the shaping of complex processes of change. The mobility design of the future will have nothing in common with earlier transportation design, with its orientation toward the private automobile. Whereas now it is solely a question of products, in the future it will be a question of giving form to usage concepts and entire mobility systems; where today everything revolves around styling, it will be a question of function and of an unpretentious straightforward aesthetic of quality; and where currently it is a question of maximum variety and the formation of variants for a growth-fixated market logic, it will be a question tomorrow of nondesign, of de-design, of sustainability, radical resource traceability, and superior material value. In relation to these requirements, mobility design can be conceived as an integrative discipline on the basis of analytical-holistic and conceptual-interdisciplinary collaboration between the engineering, social, and design disciplines. Its task is to develop ideas and to contribute to the design of innovative mobility systems, forms of use, and products.

Exemplifying this paradigm is the Institute for Transportation Design (ITD) at the Hochschule für Bildende Künste (HBK) Braunschweig.[01] In both research and teaching, the ITD went far beyond the pure product design of modes of transport to focus on the design of mobility service provision and research into new mobility systems. The precondition for this was the interdisciplinary structure of the ITD, with research, training, and project work drawing not just on design research, but also to an equal degree on the discoveries of the transport and engineering sciences, economic and futurological research, sociology, and psychology. The focus of work at the ITD was on user experience, which is to say on the human being as an individual, on his or her activities, routines, and needs, which must be taken into account in design work. Design work was centered on function alone, but also on usage and usability. The primary focus was not on the design of products, but instead on sociotechnical courses of action.

01 The Institute for Transportation Design (ITD) was organized and led by the author of this essay as its founding director and manager of the degree program bearing the same name.

Alongside the design fields devoted to products, services, and systems, the ITD was subdivided into five scientific working focuses, in which research and design projects, contract work, and consulting work were bundled together. Each work area was structured in a fundamentally interdisciplinary way, remaining open in relation to other focuses while maintaining a methodological orientation toward a core discipline.

The focus on »design, construction, and innovative material usage,« with its subareas design research, design conception, product construction, materials science, and production processes, constituted the center point of the institute's activities, and was concentrated on the construction and design of future-oriented vehicles, components, infrastructures, and systemic interfaces. In the focus on »Mobility and Society,« the ITD used the methods of the social sciences to analyze user behavior and transportation users, as well as social and psychological factors of influence, but also the cultural trends that influence human mobility as framework conditions. The colleagues working on the focus »Future Research« identified possible scenarios for mobility development, for which they also deployed creative methods from design research. The use of non-fossil-fuel energy sources in transportation was a central topic for the department of »Innovation and Transformation.« The focus here was on questions of technical feasibility and technology acceptance, but also on the social practicability of new technologies and services. Building on an identification of cultural, social, and political barriers and path dependencies, the aim was to identify innovation pathways for a post-fossil-fuel energy and mobility culture. The profile of the ITD was rounded out by a focus on »Human-Machine Interaction.« Developed here were approaches and concepts for the design of human-machine interfaces (driver-vehicle interaction, user-infrastructure interaction). Altogether, the model of a symbiosis between theoretical-scientific analysis and the practical design of future-oriented mobility concepts has proven itself over a period of many years as a fruitful research and design approach. These research activities have resulted in numerous publications, which form the basis for the discussion presented here.

Mobility Design for the Future

Essentially, the question of the mobility of the future is a question of our lifestyles and levels of need, but it is ultimately a question of a different conception of prosperity and happiness, one that will be reflected, finally, in altered patterns of mobility, transport technologies, and settlement and temporal structures. Today's economy of waste and acceleration is a phenomenon of the superabundance of the fossil fuel epoch, and it has made us lazy and extravagant. However, mobility begins in the mind. Ironically, we will only be able to achieve the transition to a post-fossil-fuel culture provided we behave as though it has long since become a reality: as a temporary phase of scarcity which bundles our creative potential and compels us to begin without delay with the sustainable design of our society.

Mobility design is essentially the politics of transformation. If the necessary conversion succeeds with this centerpiece of the modern world, then it will succeed in all other areas of need. Even more important today than research into mobility is its courageous and radical design. We already know enough to act with confidence. In Germany, current levels of technology, competency, and prosperity afford us the necessary leeway. Rather than lamenting the lack of alternatives, it is high time that we use the available leeway to engage in experimentation. We can begin immediately, doing things differently piece by piece, rebuilding Germany into a radical blueprint and model for a sustainable culture.

Literature

Beer, Felix and Rammler, Stephan: »Zwischen den Zeitenwenden: Transformative Resilienz als Leitbild der Zukunftsgestaltung.« In: *Politische Ökologie* 39, 166, 2021: *Resiliente Zukünfte: Mut zum Wandel*, pp. 17–24.

Bormann, René; Fink, Philipp; Holzapfel, Helmut; Rammler, Stephan; Sauter Servaes, Thomas; Tiemann, Heinrich; Waschke, Thomas; and Weirauch, Boris: *Die Zukunft der deutschen Automobilindustrie: Transformation by Disaster oder by Design?* Bonn 2018.

Brunnengräber, Achim: »Die ressourcenpolitische Absicherung des E-Autos: Zur Rohstoff-Governance in Deutschland, der Europäischen Union und im Lithiumdreieck Argentinien, Chile und Bolivien.« In: Brunnengräber, Achim and Haas, Tobias (eds.): *Baustelle Elektromobilität: Sozialwissenschaftliche Perspektiven auf die Transformation der (Auto-) Mobilität*, pp. 279–306. Bielefeld 2020.

Fuller, R. Buckminster: *Operating Manual for Spaceship Earth*. Lars Müller 2008.

Gehlen, Arnold: *Anthropologische Forschung*. Reinbek 1961.

Polany, Karl: *The Great Transformation: The Political and Economic Origins of Our Time*. Boston 2001.

Rammler, Stephan: *Mobilität und Moderne: Geschichte und Theorie der Verkehrssoziologie*. Berlin 2001.

Rammler, Stephan; Weider, Marc (eds.): *Das Elektroauto: Bilder für eine zukünftige Mobilität*. Berlin 2011.

Rammler, Stephan: »Systemisch denken—vernetzt handeln: 10 Thesen zur Zukunft intermodaler Mobilität.« In: *ITS Magazine for Intelligent Traffic Systems*, 1, 2011, pp. 13–14.

Rammler, Stephan: *Schubumkehr: Die Zukunft der Mobilität*, 2nd edition. Frankfurt am Main 2015.

Rammler, Stephan: »By Design or by Disaster?! Die doppelte Transformation: Gedanken zur Nachhaltigkeit in der Weltüberlebensgesellschaft.« In: *tri: Was haben wir gelernt? Bauen, Energieeffizienz und Weisheit. 20 Jahre tri*, pp. 9–21. Bregenz 2016.

Rammler, Stephan and Sauter-Servaes, Thomas: »Mobilität.« In: *oya*, 37, 2016, pp. 52–54.

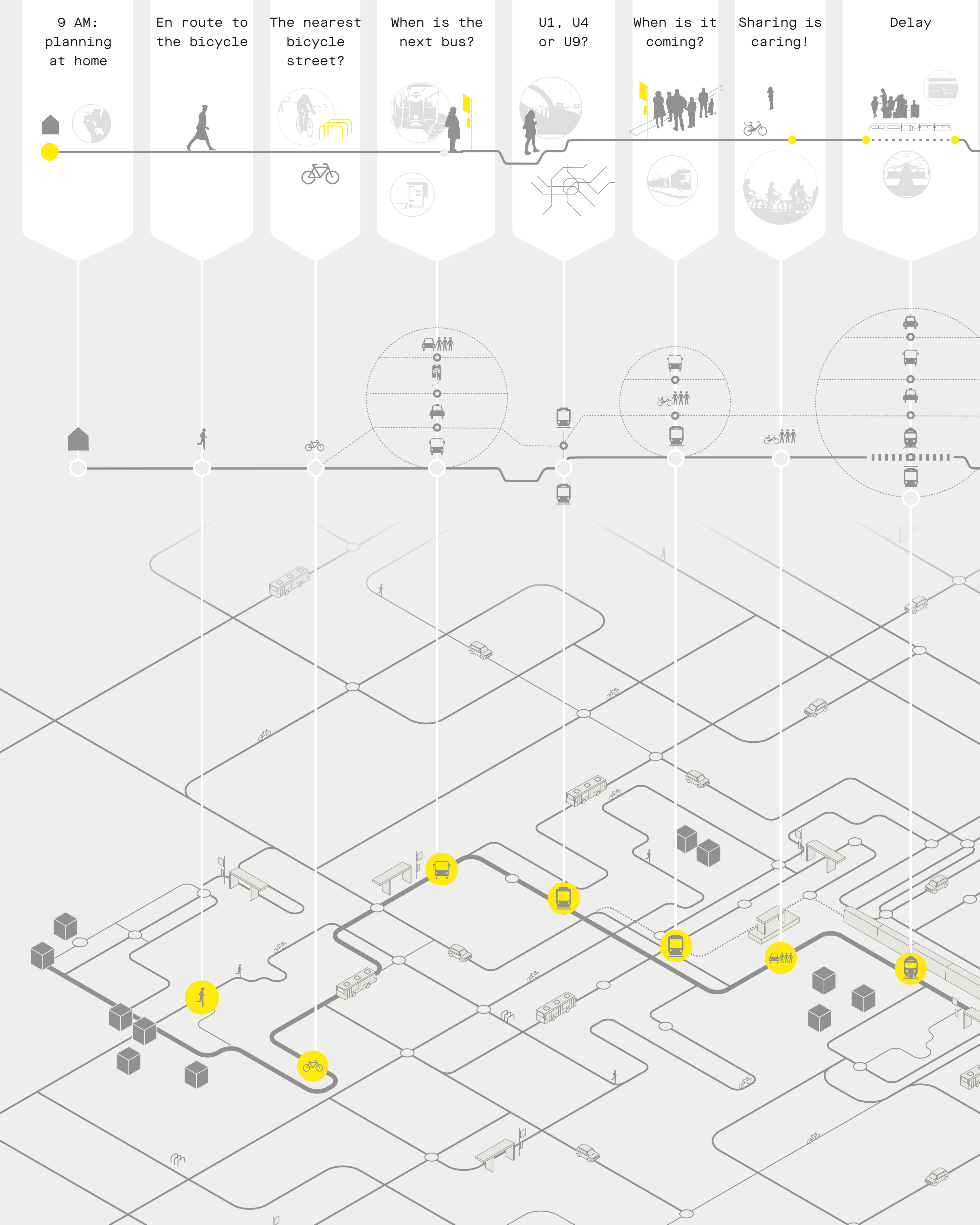
Rammler, Stephan: *Volk ohne Wagen: Streitschrift für eine neue Mobilität*. Frankfurt am Main 2017.

Rammler, Stephan; Thomas, Dirk; Uhl, André; and Beer, Felix: *Resiliente Mobilität: Ansätze für ein krisenfestes und soziales Verkehrssystem*. Bonn 2021 (FES diskurs), http://library.fes.de/pdf-files/a-p-b/18367.pdf.

Rammler, Stephan; Thomas, Dirk; Kollosche, Ingo; and Flores, Sabine: *Mobilitätsgerechtigkeit als Leitkonzept der Verkehrspolitik: Die sozial-ökologische Transformation der Mobilität gerecht und inklusiv gestalten*, edited by the IZT—Institut für Zukunftsstudien und Technologiebewertung gemeinnützige GmbH. Berlin 2022.

Schwedes, Oliver and Rammler, Stephan: *Mobile Cities: Dynamiken weltweiter Stadt- und Verkehrsentwicklung*, 2nd expanded and revised edition. Berlin 2012.

Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen (WBGU): *Der Umzug der Menschheit: Die transformative Kraft der Städte*. Berlin 2016.


9 AM: planning at home
En route to the bicycle
The nearest bicycle street?
When is the next bus?
U1, U4 or U9?
When is it coming?
Sharing is caring!
Delay

Tuk-tuk
At work
Is there a shuttle service nearby?
Car sharing
Taxi
City train
Autonomous driving
6 PM: back home