10 At the end of the road: Total safety

How the safety concept of connected and automated driving systems is changing the streetscape

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" A major aspect of media effects and development appears in the case of the road as a means of transportation. Like writing or radio the 'content' of the road is always another medium or other media, whether pedestrians, equestrians, wagons or cars. Depending on the type of vehicle-medium, the nature of the road-medium alters greatly" (McLuhan 1960, Part III, 15).

1. ROAD SAFETY AS A DRIVING FORCE

Presentations that promote the development of self-driving cars often begin with what in Michel Foucault's words could be called a "theatre of pain" (Foucault 2012: 42).[1] While photos show demolished school buses and cars torn in half, the presenter intersperses these drastic images with figures: 1.2 million people are killed on the roads every year, making road accidents the leading cause of death for 15- to 29-year-olds worldwide (WHO 2015: 2). Automated driving systems are to put an end to end this tragedy: humans must hand over control of the vehicle to learning algorithms that are superior to human skills and are never tired, distracted or drunk.

Road safety is the main argument put forward – above and beyond economic interests – in asserting the added value bestowed on society as a whole by connectivity and automation of the transport system. Numerous acceptance studies throughout the world attest the fundamental importance of safety for implementation of the overall technology, and it would be difficult to find a policy paper in which this aspect is not repeatedly emphasized. Not even accidents with test vehicles or overrated assistance systems in production vehicles can detract from this view.

This chapter looks at road safety as driven by connectivity and automation, from the perspective of the streetscape – with all its participants. It is argued that this development, which has already set in, is bringing about a turnaround that could in fact turn the concept of road safety "upside down". Such a reorientation would not only affect road safety as such. In this chapter, it is argued that this could undermine the principle of the public sphere, which is based on visibility, and replace it with a new form of curated coexistence.

1.1 MOBILE ROBOTS AS THE KEY TO SAFETY

Connected and automated driving systems must be safe – or at least safer than today's cars. This is seen as a basic prerequisite for broad-based social acceptance of this technology (Lazarus et al. 2018). This aspect transcends cultural boundaries and has been demonstrated on a global scale. "Safety" was the most commonly used term in all studies surveyed in a review of the literature (Jing et al. 2020). On the one hand, this perpetuates the current situation, since vehicle safety is already today a major factor in decisions to purchase a new car (Vrkljan/Anaby

1 The most dramatic presentation of this kind for me was "Advancing the AV opportunity" by Mark R. Rosekind, Chief Safety Officer of ZOOX, at the Automated Vehicle Symposium in San Francisco on 12th July 2018. The presentation is not available online; the content is described in part in Shladover et al. 2019.

2011). On the other hand, the bar is not set very high when one considers how much more dangerous passenger cars are, for example, than buses used in public transport in the European Union (ERSO 2019: 26).

Even scientific studies are at times unreservedly optimistic; this is especially true of older studies. Fully automated vehicles are idealized and popularized as the “crashless car” (KPMG 2012, Allesandrini et al. 2015). They became the technological embodiment of “vision zero”, the goal of eliminating road fatalities entirely. This idea was soon rejected in view of the unchanging physical limits (Winkle 2015). Even simulation studies that documented increased traffic volumes as a result of fully automated car-sharing vehicles nevertheless insisted on the claim that “improvements in road safety are almost certain” (ITF 2015: 6). Here too, a fundamental contradiction was ignored. The relationship between the frequency with which road users are on the move or encounter each other and the risk of accidents, referred to as “exposure”, has been well documented for several decades. More activity leads to more accidents (Elvik et al. 2009: 35). Greater restraint has now been called for, since the idea that “autonomous” vehicles would bring about absolute road safety has already fuelled expectations among future users that are seen as untenable and highly problematic (Georgieva/Kolodege 2018).

These days, the wording is normally more restrained: in policy and strategy papers and in technical development publications, a connection between automation and increased (not absolute) road safety is no longer taken for granted, but on the contrary is seen as a prerequisite for the former’s approval. Many policy papers emphasize that the expected benefits of automation can only be realized with additional connectivity (in the context of C-ITS – Cooperative Intelligent Transport Services; cf. “Declaration of Amsterdam” 2016, European Commission 2017a, STRIA 2019, Meyer 2019). The authors point out that one should first of all speak of potentials that can also bring about new risks and misgivings (Feigenbaum et al. 2018). In terms of misgivings, the field of “cybersecurity” is usually emphasized. Hopes remain high despite these more recent relativizations, and each and every new technological add-on increases the need for investment and development. The view thus continues to be expressed that market entry should not be postponed for too long. Since connectivity and automation could potentially already save lives (if vehicles equipped in this way were already somewhat safer than conventional cars), compromises must also be made: “We can’t wait for the perfect” (Foxx in Shladover et al. 2019: 4). While this standpoint applies to assistance systems that support drivers, as will be shown below it cannot be transferred to levels of automation in which people are mere passengers.

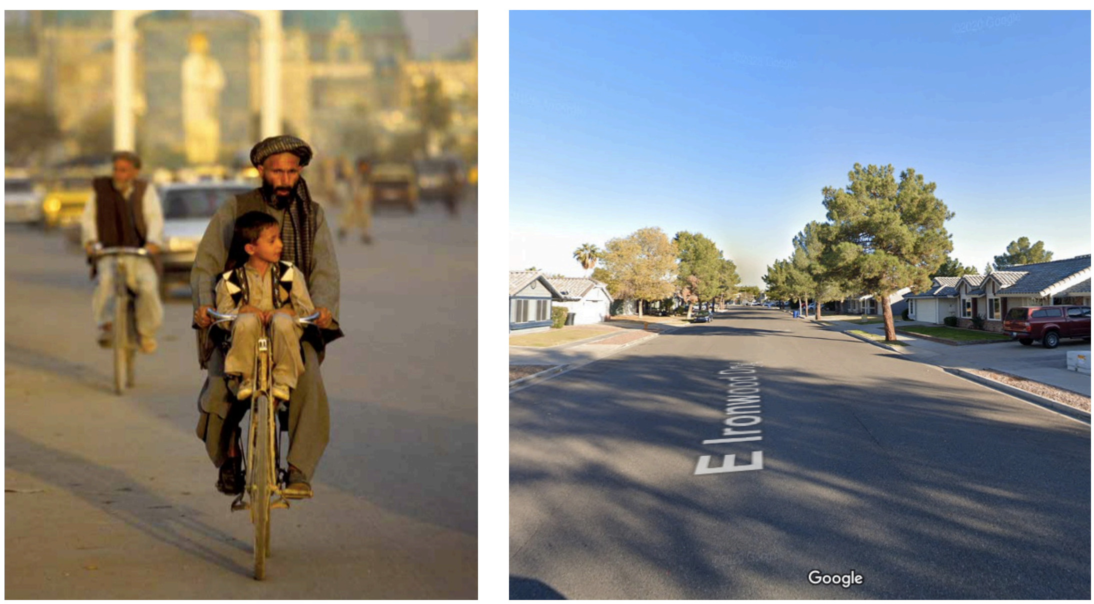
1.2 PERSPECTIVE ON ROAD SAFETY: WHO BENEFITS?

Scientific discourse has now begun to focus not only on the potentials, but also specifically on the technological limitations (Mitteregger et al. 2022, Soteropoulos et al. 2020). An automated driving system that can reliably perform all driving tasks mastered by humans is now seen also by the industry as becoming feasible only many years into the future, if at all (Krafcik in Marx 2018). It follows that possible contributions to road safety are likewise unevenly distributed.

The advance of new technologies and the accompanying sociotechnological transformation is a complex sociological process (Schumpeter 1939, Geels/Schot 2007) and in particular a communicative process (Rogers 2003), which to date has repeatedly been accompanied by new spatial and social inequalities (Grübler 1992, and Chap. 19 by Dangschat in this volume). In the case of automated driving systems, small-scale disparities are also evident that arise due to the differing technological requirements of streets and situations with varying degrees of complexity. The more homogeneous and monitored a road section is and the more is invested in its maintenance, the better suited it is for automated driving systems. In other words, motorways – preferably newly built, in highly developed industrial societies and with a good data network – are their ideal field of application. Slow-moving shuttles used as an extension of public transport services are an exception here, but they also call for accompanying infrastructural measures (cf. Chap. 14 by Allmeier et al. in this volume). These limitations can be compared against road accident statistics to differentiate the effectiveness of the "crashless car". It has already been pointed out that for operation as an extension of public transport services, the bar of road safety is set incomparably higher than for a mere continuation of automobility as such. The European rail system would even fall into the category of "ultra-safe systems", for which fundamentally different, at times paradoxical conditions for the use of new technologies would apply (Amalberti 2001).

Of the more than 1.2 million fatal road accidents that are repeatedly cited to highlight the social benefits of automated and also connected driving systems, young, poor people in low- to middle-income countries are disproportionately represented. This group accounts for 90% of road fatalities worldwide (WHO 2015: 4). The situation is the worst in Africa, above all as a result of the relatively low level of motorization. Pedestrians and cyclists are the most vulnerable group there, with a combined share of more than 43% of road traffic fatalities (WHO 2015: 8).

Figure 1: Symbolic image from the WHO of vulnerable persons in road traffic, and Google's test operations in Chandler, Arizona.



 Sources: left: WHO (2015: VIII); right: Google (2020).

Automation

The development of connected and automated vehicles is diametrically opposed to this initial situation. In the countries and regions most affected, no significant testing is carried out, nor are virtual test environments in place for the training of learning algorithms. For the development of sensor technology, only one publicly available dataset exists, which however is exclusively oriented towards optical sensors (Mitteregger et al. 2020, Kang et al. 2019).

Differentiation is also possible with regard to potential areas of application in existing road networks. In Austria – one of the leaders in road safety – motorways and expressways account for 8.8% of road fatalities. The majority of fatal accidents occur on former federal roads (204 fatalities), state roads (104) and other roads (66; BMI 2020). The total length of the Austrian road network in 2010 was 114,590 kilometres, of which about 2,185 kilometres were motorways or expressways, corresponding to a share of around 2% (BMVIT 2012). In Austria, and especially in other countries with a high level of road safety, it is also evident that the safety level of vehicle occupants has increased, while that of road users outside motorized vehicles has decreased or remained constant. The number of fatal accidents involving cyclists, for example, has also been increasing in Austria in recent years, while the corresponding figure for passenger cars has fallen (Statistik Austria 2017: 11). The accident rate – the number of accidents per kilometres travelled – is 6.7 times higher for pedestrians and 9.4 times higher for cyclists than for drivers of cars (Elvik 2009: 56).

In summary, it can be said that a great deal of technological and economic effort is only likely to bring about an increase in road safety in the medium term, only in countries that are already privileged, and here again only on a fraction of the road network. From a current viewpoint, the genuine global problems of road safety lie entirely outside the projected development of automated driving systems. Furthermore, no serious efforts are discernible to take the actual initial situation into account in technological developments.

Connection

The connection of vehicles in networks is intended to increase road safety in two areas. Firstly, connected and automated driving systems will be supported in detecting their environment. On certain stretches of road (e.g. at intersections, on motorways or at roadwork sites) or in conditions under which a driving system is overburdened (e.g. snow, rain or an accident scene), the sensors installed in the infrastructure, or those of other vehicles, provide additional information on the surroundings so that the vehicle can continue to be driven (Carreras et al. 2018, STRIA 2019). The use of sensor technology, especially on motorways, is currently under discussion. The aim is to specifically enhance the suitability of the road network or to close gaps on individual routes by investing in the infrastructure (Fig. 2). If, for example, the performance of automated driving systems deteriorates on a section of road that is in principle suitable for their use, the infrastructure steps in to compensate (Fig. 2, right). This necessitates networking of the vehicle and installation of appropriate sensors as part of the digital infrastructure.

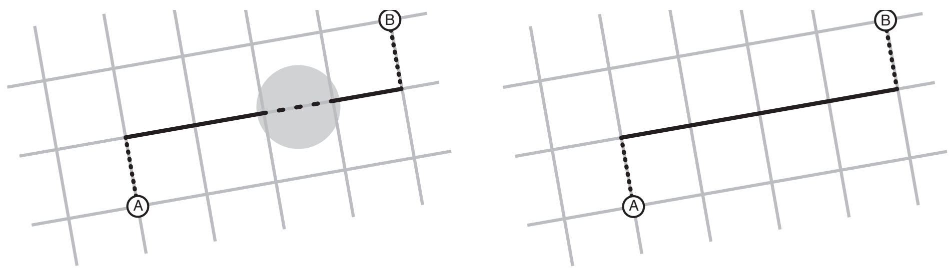
Although a uniform standard is still lacking, some stretches of road are already equipped with sensors in order to provide so-called "day-1 services" (e.g. information about roadworks or vehicle breakdowns). The relevant information is passed on to the driver via the networked vehicle (ASFINAG 2019, European Commission 2017a).

Day-1 services are also paving the way for the second area in which networking is to enhance the road safety of automated vehicles. With their help, accidents or incidents (and the driving system's reactions to them)[2] – and, in the more distant future, the current state of the vehicle surroundings and the driving system – can be comprehensively documented in real time. With communication between the driving systems or via a control centre, current information could be exchanged and taken into account for traffic control or route planning. In addition, connected and automated driving systems learn from each other (Casademont et al. 2019). It would thus be possible for the connected and automated vehicles from a specific manufacturer or those used by a specific transport operator – or even the entire transport system – to be optimized step by step. Such networked systems would become increasingly superior to humans with every kilometre covered, since according to the vision "all the unborn cars get born with the full wisdom of their forefathers" (Thrun in Shakland 2016).

2 It appears questionable as to whether the reaction mechanisms and decision-making principles of a system as complex as a highly automated vehicle or a networked fleet, which are based on learning algorithms, can ever be fully understood (Castelvecchi 2016).

In any case, the necessary digital infrastructure would generate considerable costs that could be passed on to the general public via the authorities (Polis 2018, Mitteregger et al. 2019). A comparable dynamism of externalizing the costs of an elitist system also existed at the beginning of the automotive era (McShane 1994: 203–228). Also on the part of the digital infrastructure, above all problems in the area of cybersecurity have been highlighted so far (Landini 2020).

Figure 2: Making a section of road suitable for automated driving systems by means of digital infrastructure



A section of the route is not suitable for automated driving.

Following adaptation of the infrastructure, the whole route can be covered by automated vehicles.

Source: the authors, based on Alkim in STRIA (2019: 21).

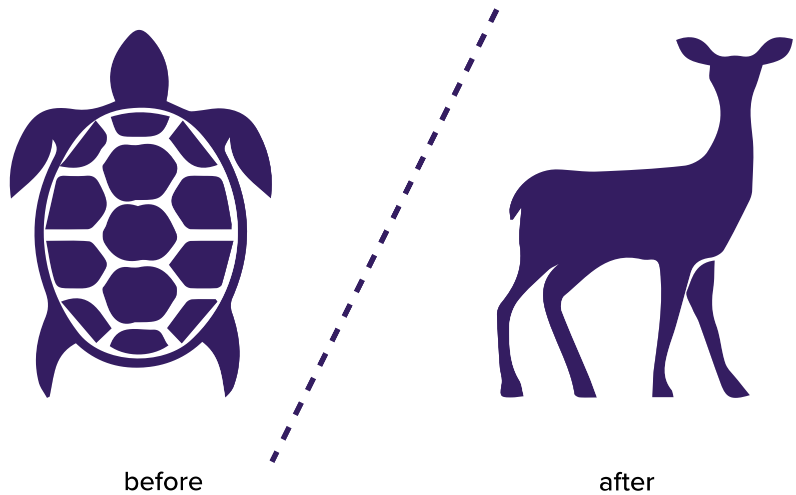
1.3 AN ENTIRELY NEW APPROACH

> *"The future of this new technology is so full of promise. It's a future where vehicles increasingly help drivers avoid crashes. It's a future where the time spent commuting is dramatically reduced, and where millions more – including the elderly and people with disabilities – gain access to the freedom of the open road. And, especially important, it's a future where highway fatalities and injuries are significantly reduced" (Elaine L. Chao in NHTSA 2017: i).*

The path that has now been taken with connectivity and automation of road vehicles is being described as a fundamentally new concept of road safety. The new goal is to use technical systems to prevent accidents occurring at all (cf. Rosekind in Shladover et al. 2019: 4). In essence, this amounts to a transition from passive to active safety systems: passive safety systems such as seat belts, bumpers or airbags reduce the severity of an accident (for the occupants), while active safety systems such as emergency brake assist or adaptive cruise control prevent an accident from occurring in the first place.

This logic corresponds to that of aviation, which makes comprehensive use of this principle. For the safety of passengers in the event of potentially catastrophic events, the seat belt or the characteristics of the fuselage play a merely subordinate role. Regular civil aviation owes its high level of safety to a system that has been created to detect the principal external risk factors and to prevent known causes of accidents resulting from human error. The main components of this system are seamless air traffic control and comprehensive weather data. Specifically, this means that passengers are not first and foremost adequately secured for flying through a thunderstorm, but that the thunderstorm is detected or anticipated and then avoided. Comprehensive assistance systems also support the pilots, who in many cases only assume a monitoring role. What would this logic mean for road traffic, and for the streetscape in particular?

Figure 3: Safety as a shell (passive safety) and safety as attentiveness (active safety)



Source: the authors

Connected and automated driving systems are still only in the early, formative phase of technological development (Anderson/Tushman 1990; Bergek et al. 2008; Mitteregger et al. 2022: 67f.). When we speak today of the effects of connected and automated vehicles, a discussion arises about the potential of conceptual designs: their actual function corresponds to that which would be expected for this early phase of development. Even under ideal conditions, the performance of sensors is either equivalent or inferior to that of humans in most aspects. In addition, their functioning is greatly impaired when the surrounding conditions are not ideal (poor visibility, worn road markings, etc.; Schoettle 2017). But even under favourable conditions, their performance is still limited: a study that evaluated tests in California demonstrated that rear-end collisions are more likely under test conditions when the automated driving system is activated and no human safety driver is behind the wheel (Boggs et al. 2020). This discussion carried out in the media and among the public at large is relevant, because fundamental aspects of operation are negotiated even at this early stage in the propagation of new technologies (Rogers 2003, Foucault 1981; cf. Chap. 4 by Manderscheid and Chap. 19 by Dangschat in this volume).

Current discourse on road safety is placing fundamental demands on connected and automated driving systems; these can be summarized as follows:

1. High theoretical capabilities (potentials) are ascribed to the concepts of connected and automated driving systems in terms of road safety.
2. This is supported by the assumptions that automated driving systems:
   a. could function more reliably than human drivers and
   b. will be cognitively superior to humans.
3. Connectivity could enhance surroundings detection and compensate for possible weaknesses of an automated driving system.
4. Finally, connectivity enables comprehensive reporting (of accidents, near-accidents, incidents and near-incidents), which would allow all parts of a system to learn from each other for further improved performance.

Finally, connectivity enables comprehensive reporting (of accidents, near-accidents, incidents and near-incidents), which would allow all parts of a system to learn from each other for further improved performance. The idea of a connected and automated transport system as a perfect passive safety system would require a genuine paradigm shift. This has been clearly formulated by the European Commission: road safety (and traffic flow) were for a long time organized by drivers and other road users. The system relied on observance of traffic regulations and traffic control measures. Connected and automated transport is turning this logic upside-down: a bottom-up system is now becoming a top down system (STRIA 2019: 8).[3]

It is inconceivable that such a fundamental reorientation would not lead to corresponding changes in the streetscape. This safety system, designed for perfection, would also influence all other activities that take place in the streetscape apart from transport. Herein lies the difference to aviation, whose safety systems are being adopted. This aspect of connected and automated road traffic concerns not only road safety in the narrower sense. What is at issue is the principle that is to be chosen by a society and that can secure safety in the public streetscape. This affects a wide range of subordinate aspects that cannot be reduced to a traffic-related discussion alone, nor can they be solved by technological means – as is the frequently problematized field of cybersecurity.

2. ROADS: TRANSPORT ROUTES AND LIVING SPACE

Reducing the streetscape to a function of mere physical circulation is a reductionism with well-known far-reaching consequences. Streetscapes are also valuable living space, and this dual significance inextricably links them to the very concept of "city" (Marshall 2009). The significance attributed to roads in an evaluation of the history of the city is outlined below.

The movement of things through and in streets enables the metabolism of dense human settlements: it has a primarily biological component when it comes to the steady flow of consumer goods. But it also has a decidedly cultural component when it comes to an exchange of works that are designed to outlive their makers. And finally, cities do not only live from the movement of objects. The flow of ideas in and through streets allows things to be communicatively called into question and one's own circumstances to be created – the social component, which arises in an exchange with one's vis-à-vis, the traveller (Arendt 1958; Reki 2004; Simmel 1908: 509–512). The flow (and stagnation) of people, things and ideas organized via streets sustains cities and urban societies and makes it necessary to constantly redefine one's own position.

Without the public space of the streetscape, dense conurbations would be uninhabitable or – as alternative concepts revealed by archaeologists show – would have to be fundamentally rethought (Hodder/Pels 2010). There is a functional aspect here too, because the inhabitants of dense urban spaces need attractive public spaces (the importance of which

3 "In road transport, e.g. where safety and efficiency have been organized for long time [sic] with the driver and other road users in charge of complying with traffic rules and traffic management, connected and automated road transport turns this concept from bottom-up to top-down: If the electronic control systems embedded in the vehicle take decisions instead of the human driver, the cognitive capabilities of an automated vehicle are determined by the performance of its perception systems, algorithms and knowledge base" (STRIA 2019: 8).

is further increasing in view of the global climate crisis and was recognized again during the Covid-19 pandemic) which can be used as an extension of residential and living space for sitting, talking or playing (Gehl 2009, EEA 2009). These two often competing demands on the streetscape – transport on the one hand and lingering on the other – have invariably shaped the development of streets and cities. However, this conflict of usage ultimately enables streets to be seen as "institutionalized human movement" (Rykwert 1986), with their design and usage revealing dominant power structures, identities and ways of life (Sheller/Urry 2006, Cresswell 2011: 551).

2.1 THE SIGNIFICANCE OF THE STREETSCAPE FOR URBANITY

"[C]ities are their streets. Streets are not a city's veins but its neurology, its accumulated intelligence" (Gopnik 2016).

In terms of quality of life, the significance of streetscapes as living space is not adequately described by a merely functional attribution. Ever since ancient times, streetscapes have been seen as part of the public space, which is what transforms the city ("polis") from a collection of stones ("urbs") into a community of people ("civitas") that acts according to certain principles (Fustel de Coulanges 1979). Entering the public space of the street means venturing out from the controlled security of private space: what is in the public domain can be looked at, criticized and modified – provided it is perceived by the public eye (Arendt 1958: 95). The social space of the streetscape is thus constantly created anew and modified (Massey 2005). It changes with its protagonists over the course of the day, through the seasons, on the basis of legislation and also with technologies that enable new ways of living (Gerhardt 2012: 32f.). This is the foundation of the "open, readily mutable nature of streets" (Appleyard 1987: 1).

As part of the public space, the streetscape is the scene of the formalized and spontaneous events and happenings of changing urban societies – where executions, music, protest, a football match or love can take place. Every modification to the streetscape thus has consequences for the city as a whole and for its society. The street thus becomes the stage of cultural struggles: wherever the right to protest is restricted, or access to the streetscape is denied to sections of society or the space is redistributed between pedestrians, cyclists and cars, the entire concept of the city is affected. Accordingly, a critical discourse concerning new technologies in public space is more than warranted, since – taking into account specific local characteristics – these can globally transform the streetscape through space demands, emissions and necessary new regulations. The passenger car is the best-known example.

2.2 SAFETY AND PUBLIC LIFE

In the search for "anthropological commonalities of mobility behaviour", Cesare Marchetti makes use of a biological determinism: humans live with an inherent tension that arises between a "cave instinct" on the one hand and the "fundamental instinct to expand their territory" on the other (Marchetti 1994: 75). Leaving the cave is thus invariably "arduous", since striving to move outside not only entails physical effort, but also carries the "danger of being attacked by predators or enemies" (ibid.). This bleak view of human existence raises the question of how animals endowed with such instincts were able to create settlements and develop villages into metropolises, which Marchetti then uses to substantiate his theory in the course of his text.

Some of the most frightening scenes in literature are based on an upheaval in the "mutable nature of the street", whereby the mass becomes a mob and turns against the individual or a minority. And even the freedom of public space always remains a privilege that can never be granted to all (Arendt 1958: 51). The cruel reality that results is that while homeless people, members of minorities or discriminated groups of people are in public space, their presence is ignored and their actions – and also their safety – are accordingly restricted (cf. Simmel 1903).

Marchetti's notion of a Hobbesian natural state of mobility remains questionable. However, the theory of constant time budgets thereby supported has resurfaced in discussions of the possible impact of automated vehicles (Almeida Correia et al. 2016, Maia/Meyboom 2018, Newman et al. 2016). What it shows, however – regardless of its inherent agoraphobia – is the importance of safety for the use of public space, because as significant as the streetscape may be as a transport and living space for cities, the protection it offers remains fragile.

"The street has always been the scene of [...] conflict, between living and access, between resident and traveler, between street life and the threat of death" (Appleyard 1987: 9). Contrary to Marchetti's thesis, the exposure or visibility necessarily associated with the public sphere has been linked to a certain form of security, based namely on density and diversity. Are humans not social animals that cannot survive on their own (Aristotle, Politics 1253a1–11)? And would the street bustling with cafés and bars not be preferable to the dark alley on one's way home at night in the vast majority of cases?

Immanuel Kant went so far as to declare the public sphere to be a constituent principle of his philosophy, according to which it functions as a critical "audience" and exposes all behaviour in which the individual acts to their own advantage and restricts or endangers others in their actions. All that must be done only in private, according to Kant, has a "fear of light": if such actions were to become public, there would be a risk that "the resistance of all would be provoked against my intention" (EwF 391, EwF 386; Gerhardt 2012: 163f.). It is thus necessary to encounter each other on an equal footing. Venturing into the public arena means taking a certain risk, since I myself will be dependent on the attention of others, and my actions will be critically examined. In return, with my attention I determine what is scrutinized and who is protected. Equal conditions only prevail where the watchful gaze can be returned.

2.3 EYES ON THE STREET

The best-known proponent from the sphere of urban planning of the position that visibility, safety and the public realm are intertwined is Jane Jacobs. She reminds her readers that safe streets cannot be the product of a centralized system of power, but are created by the individuals who use them. "Sidewalks and those who use them are not passive beneficiaries of safety or helpless victims of danger. Sidewalks, their bordering uses, and their users, are active participants in the drama of civilization versus barbarism in cities" (Jacobs 1961: 30). For Jacobs, there must be "eyes on the street, eyes belonging to those we might call the natural proprietors of the street" (ibid.: 35), i.e. people in the streetscape and the surrounding buildings. Together they provide the safety that makes life on the street – and thus in the city – at all possible.

Jacobs, too, bases her argumentation on a parity principle: it is the public itself that creates civilized coexistence. Where such a coexistence of equals has been breached, "no number of policemen, however large, can restore civilized coexistence" (ibid.: 31). Jacobs' fundamentally democratic stance is evident in her insistence on the principle of equality – and in her view that this also applies to the streets of New York's upper class, which are populated by all manner of servants, porters and dog-sitters (and now surveillance cameras to an increasing extent), who however are only there because they are paid for their activity. In truth, according to Jacobs, these places lack all incentives that would draw anyone into the streetscape of their own free will (ibid.: 40). The crucial point is that safety and security can only lead to "civilization" if they are generated by the public rather than being enforced by an institutionalized apparatus of power. All technical mechanisms and institutional bodies violate this principle.

In *Being and Nothingness*, Jean-Paul Sartre presents a detailed argumentation that is in keeping with Jacobs' subsequent observations on the streets of Greenwich Village in New York. Sartre insists that equality and liberty only exist where a gaze is returned (1962: 356). This dynamic of power loses its equilibrium when, for example, a person peers through a keyhole and sees without being seen. The architectural expression of this principle is the panopticon, which Foucault referred to as an icon of modern surveillance mechanisms (Foucault 2012).

2.4 THE END OF EQUAL CONDITIONS

Jacobs' aversion to the passenger car is closely linked to this line of argument. Her participation in the protests against urban motorways such as the Lower Manhattan Expressway, which the city planner Robert Moses wanted to cut through Manhattan, is legendary (Gratz 2010).

Jacobs' insistence on a connection between visibility on an equal footing, publicity and safety makes it clear that a car-centred urban structure not only affects road safety in the narrower sense, but also reveals a more profound effect that was responsible for "perhaps the greatest transformation of the city in the last thousand years" (Marshall 2005: 3): motorized individual transport has undermined the principle of parity of public space in practically all cities. While the occupants of a car of course perceive people in the streetscape, all visual encounter is drastically shortened. The form of a person in the vehicle is partly obscured from others by reflections in the windows. Voices heard from the outside are muffled by the vehicle's body; all sound that enters the interior has to compete with the noise of the engine. The person inside the vehicle is protected and lays claim to a space of at least ten square metres, while all oth-

Figure 4: Lower Manhattan Expressway, New York City (model)

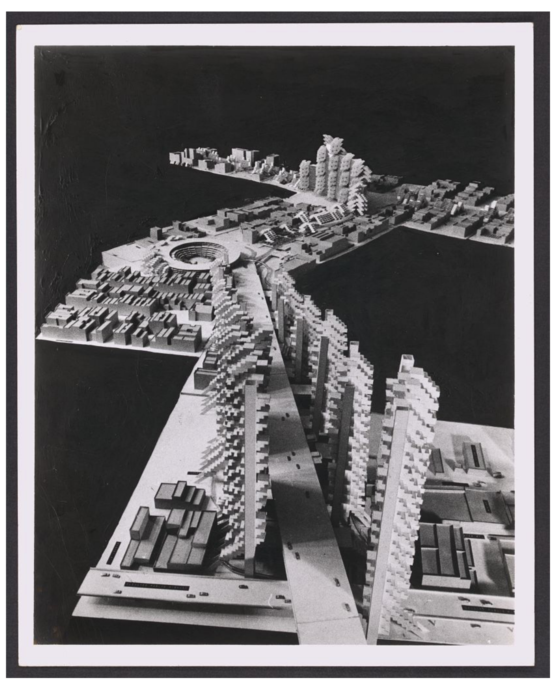


Photo: Paul Rudolph, Lower Manhattan Expressway, New York City, c. 1970. Model, perspective; Library of Congress, www.loc.gov/item/2010647138/.

ers are confronted by tonnes of steel. Under these unequal conditions, the situation that had existed up until the onset of motorized individual transport, in which the busiest streets were invariably also the most important places of social encounter in a city, came to an end (ibid.: 3f.).

A serious attempt to restore the safety of the road that was lost due to the car thus would not only bring about a reduction in road accidents, it would help restore equal conditions throughout large parts of the road network and thus a spatial situation in which safety encourages public activity. A look at the past, however, tells a different story. Since changing concepts of freedom have been accompanied by changing opportunities for mobility, new mobility has gone hand in hand with new forms of surveillance throughout the course of history.

3. FROM SURVEILLANCE TO SOCIAL ENGINEERING

> *"[The] movement of persons and of 'things' (goods) will become the focal points of the transport system. All people will be connected to the transport system, as will be all goods (via the 'Internet of Things'), and they will collect and share information" (European Commission 2017b: 10).*

In the feudal system, all those who could not be assigned to a particular lord were branded. Statistical census methods and prisons became widespread at a time when nation states were emerging and mobility was increasing, even for the poor. The passenger car, as a private space on public ground, is said to have helped the judiciary make increasing inroads into previously private spheres of life (Cresswell 2006, Foucault 2007, Seo 2019).

With increasing mobility, the principle based on reciprocity of social controls in societies was gradually taken over by institutions and technological innovations. In a future scenario published in part in *Mobilities* (Urry 2007), John Urry reflects on connected and automated vehicles and mobility in a "digital panopticon". Urry later also regarded this scenario as "increasingly necessary" in view of the global climate crisis (Adey/Bissel 2010: 6) and speculated that Singapore could become the first place to attain this condition. Contrary to Urry's thesis, it is argued here that not a sudden appreciation of the fragile ecosystem, but a reformation in road safety could be the driver of such a scenario.

3.1 THE NEVER-PERFECT SYSTEM

What would such a system look like? As Urry also emphasizes, this connected and automated transport system would be exclusive (cf. Urry 2008: 273f.). As pointed out above, firstly, the considerable investments necessary on the part of the public sector would be a limiting factor, and secondly, medium-term technological feasibility would restrict its use to a mere fraction of the existing road network. For John Urry, automobility is losing significance in favour of the climate. The line of development reconstructed here does not give high priority to such a transformation.

According to the current discourse, automation and networking are contributing to the disappearance of established boundaries – such as those between public and private transport or between freight and passenger transport – in the course of a "hybridization" (Lenz/Fraedrich 2015, Mitteregger et al. 2022: 44). Ultimately, the question "Does a certain route require the presence of a human, or can it be delegated to machines?” will therefore take precedence over today’s fundamental question “Which means of transport do people choose for a certain route?” (Mitteregger et al. 2022: VIII). Already today (and especially as a result of the Covid-19 pandemic), a wide variety of mobile robots are in use, with which people delegate not only routes but also tasks – and here especially in the area of safety – to machines (Mitteregger 2020). In this connection, the technological limitations described above arise from the complexity of the streetscape, but apply to the small, slow-moving robots used on pavements only to a much lesser extent if at all.

However, this is not a “trend book”, but the excess of existing principles. One goal that is already emerging is that of uniting the production and quality standards of the automotive sector with the capabilities of IT companies, thereby creating a new standard for all manner of automated mobile applications. Safety is seen as an essential factor here and is mentioned as a possible USP – “automotive safety” – at conferences of the technology developers (cf. Kopetz 2020).

A traffic system designed for active safety, in which vehicles can comprehensively access historical and current data, could be designed to avoid intersections, streets or neighbourhoods for example that are not considered safe. These would be bypassed, just like thunderstorms in air traffic. Ideal routes would pass along streets with easily predictable conditions. In the streetscape, the probability of predicting the behaviour of other people and objects plays a similar role to that of physics for autopilots in aviation. The entrance to a school, where masses of people not normally guided by reason alone are encountered twice a day, would be given a wide berth by this system. What approach should be taken towards individuals or groups of people that the safety system classifies as displaying problematic behaviour?

Paradoxically, in such a system more traffic could actually lead to more safety. To make better predictions of people’s behaviour in the streetscape, the density of measuring points within the space would have to be increased so that behaviour could be better predicted or manipulated.

Figure 5: A selection of current applications of connected and automated driving systems

 Sources: 1: Australian Centre for Field Robotics (2017), 2: the authors, 3: knightscope (2021), 4: Casei (2018), 5: peloton-tech (no date)

If such measurements are not performed by sensors installed in the infrastructure, they could be carried out by a large number of mobile robots.

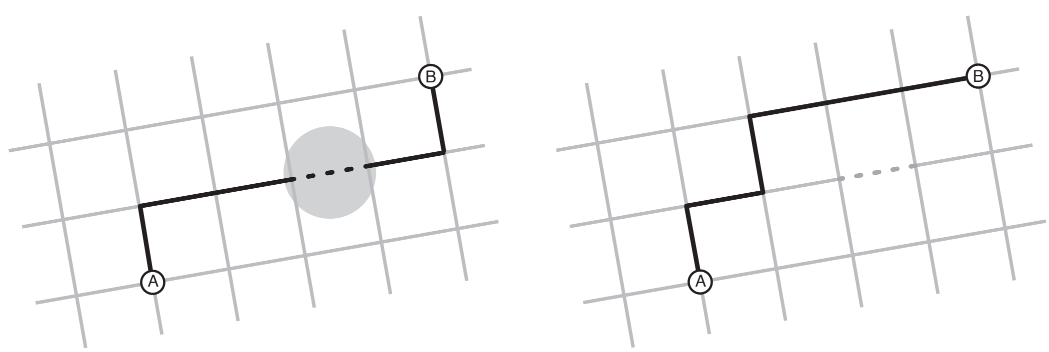
In this connection, the purely traffic-related aspect of safety in the streetscape has long played a subordinate role. New fissures in society would be inevitable as a result of targeted avoidance or as a result of a multitude of sensors at neuralgic points (or times). These would no longer be comprehensible to humans, however, since they have their origins in opaque datasets that serve for the training of artificial behaviour (cf. Castelvecchi 2016).

For security systems that rely on comprehensive reporting, it has been shown that in the course of the complete recording of data, every incident and even every near-incident can be presented "apparently convincingly" as a problem (Amalberti 2001: 113). The underlying understanding here has long been critically viewed: a technological concept promises highly theoretical potential for performance and safety, while faulty human behaviour has a negative effect on performance and must be controlled or eliminated. To date, in the transport sector this logic has been restricted to delimited fields such as industrial, mining or logistics locations, and air and rail traffic. With connected and automated driving systems, it would affect the public space of roads for the first time.

3.2 A NEW ROAD MEDIUM

The streets of the modern age, which still constitute most of our built environment today, are in many ways the perfect stage for the innate striving of this era for "absolute movement" (Jormakka 2002). Our epoch has been shaped by the tension inherent in this paradigm – the veneration of speed, rationality, grand narratives and plans on the one hand, and a constant drifting of the desired order into chaos through ever-increasing movement on the other. The street of

Figure 6: Modified choice of route for avoiding unsafe traffic situations



A section of the route causes unsafe traffic situations.

Following modification, the entire route can be covered with automated driving.

Source: the authors, based on Alkim in STRIA (2019: 21).

the 21st century may emerge under the paradigm of "total safety" (Zuboff 2019: 398–415). As already stated, this is not something fundamentally new, a departure from existing paths driven by external parameters, but is the exaggeration of a familiar principle. Connected and automated mobility services, which enable situation-dependent, spontaneous and flexible forms of usage, are exacerbating the rift between chaos and control. The development path shown here does not lead in a direction that sets out to solve existential problems of our time such as climate change or social and economic inequality. The streetscape of this new safety system would not be built in concrete as in our modern era. Control and order are achieved through data and endless “nudging” (Thaler/Sunstein 2009; for a critique see Stickler/Sodl 2019) – a gentle influencing of people’s behaviour in the streetscape. The public space of the street in this curated world would be unrecognizable.

Hannah Arendt was at pains to point out that a coexistence of people that is designed for communality needs a “common world” which can be seen as a basis and point of departure for critical reflection (Arendt 1958: 52–55; Madanipour 2003: 114–151). This common basis can comprise things, conventions, or a shared history and laws. There is a need for a “we” that structures coexistence and that can never be dogmatic, but serves as a basis for critical reflection. Where order is established through the targeted, personalized influencing of behaviour, it may be assumed that this basis will dissolve. Whoever defines the goals of such a system must accept that their attainment will remain turbid. People in the public space of the streetscape would become mere objects, and the asymmetry of the knowledge generated would be immense (Zuboff 2019).

The public sphere and resilience

Venturing out into the public sphere calls for an “experimental attitude”, since “life is problem-solving” (Gerhardt 2012: 221). The goal of total safety, implemented in a top-down safety system in the streetscape, undermines this principle in a hitherto unknown quality. Automobility has already shaken the foundation of this principle. Streets that are seen as vibrant and diverse nevertheless continue to offer equality, freedom and safety, since it can be expected that all behaviour will be subject to critical public scrutiny.

Similar to Urry’s scenario, the conditions that favour implementation of such a system can be created in the “competition of cities” based on a reward system of “city rankings”. A curated juxtaposition, familiar to date mainly in the form of gated communities, could even fare better in these rankings than a public sphere characterized by hustle and bustle and disorder. Ever since the emergence of sedentary cultures, human development has invariably been linked to the development of large cities. The constantly increasing complexity of settlements has made the search for solutions to urban problems a major driving force (Hall 1998: 7). Cities with advanced economies have departed from manufacturing and the turnover of goods in favour of service production, and have further developed into information societies (Castells 1989, Hall 1995, Hall/Pain 2009). We speak today of complexity and creativity as being the central resources of these cities. They are distinguished from cities and regions that are dependent on raw materials, are specialized and susceptible to market dynamics, and usually prosper for only a short time. Where public space is deprived of its mutable character and an external entity holds sway – extensively shaping, evaluating and exploiting – these places likewise become the plaything of external forces.

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