

Future Mobility Scenarios with Design Fiction: Autonomous Vehicles as Social Agents

Abdullah Tarik Celik¹ and Gülay Hasdoğın²

¹ Industrial Design Department, Istanbul Technical University (ITU), Harbiye Mahallesi,
Taskisla Cd., No:2, 34367, Şişli, Istanbul, Turkey

² Department of Industrial Design, Faculty of Architecture, Middle East Technical
University (METU), 06531 Ankara, Turkey
tarik.celik@itu.edu.tr

Abstract: This article aims to envisage a future world with Autonomous Vehicles (AVs) from a speculative perspective and uses design fiction as a method. Even though there are future studies about how AVs are going to be operators in the traffic by taking the role of the driver, this article suggests that AVs are going to be referred not only as transportation vehicles but also, they will become a part of social life through their increased agencies. We argue that this might be a significant concern for the areas that are in relation with the design of AVs considering socio-technical transitions towards future. Two design fiction workshops with designers were organised to develop future scenarios including AVs. As a result, the scenarios created by designers were analysed and characteristics of the scenarios were identified considering the social and contextual aspects of the storyworlds. Finally, the study discusses design considerations for AVs based on the future contexts and lifestyles as well as the social role that AVs can fill by changing the meaning of journey in the future scenarios.

Keywords: design fiction, autonomous vehicles, future mobility, socio-technical transitions, social agents

1. Introduction

Mobility can be defined through financial status, leisure and independence, and the diversities that these aspects create [1]. People can transport using different vehicles and their preference for mobility may vary; for example, there are automotive admirers, motor enthusiasts or boat-lovers. Moreover, Artificial Intelligence (AI) is a growing technology, and it has been a part of the transportation industry. AI-based features impact the vehicle design, the infrastructure, the user of the vehicle and the

related systems [2]. Designers and engineers design mobile vehicles for better usability and increased safety; and as a result, the tasks are gradually taken over by automation. Autonomous Vehicle (AV) is a result of this process in which the driver is no longer needed, and automation of driving is expected to cause a shift in the mobility industry [3].

With the increasing level of autonomy in the transportation industry, the research about future mobility is improving rapidly. In this sense, scenario-building techniques are used for investigating future mobility [1, 4] which are beneficial since the problem involves complexity and uncertainty [5, 6]. If we observe the case for AVs, it is valuable to build scenarios for a future with AVs to find out new perspectives on this issue. This way of future design thinking creates a wicked problem, and it might be an area where speculative design, which is a design approach in which designers explore the future from a critical lens [7], might be effective. Speculative design is an umbrella term for such design thinking methods and by using it, designers work on plausible future scenarios [7]. Moreover, design fiction which is useful to demonstrate social contexts by using *diegetic prototypes* to “demonstrate a technology's need, viability and benevolence” [8]; is a method to investigate future scenarios. Design fiction implies techniques like prototyping and brainstorming and it supports them with different approaches from art, cinema, or philosophy; it creates spaces for integrating recent technologies from a societal perspective [7].

Vehicles' effects on social life and the feeling of being in a mobile vehicle are discussed by Thrift [9], he defines the car as containing another world in itself considering the features such as sound systems, AC, ergonomics etc. Although the mobile vehicles' effect on social life is inevitable, there is not sufficient information about the interaction design of autonomous agents as well as their role in everyday life [10, 11]. Yet, the greater number of social science studies related to this area focuses on ethical, lawful, and bureaucratic issues [12]. As an example of using speculative design to explore the futures, Forlano [13] used speculative design interventions to explore driverless futures. By using design as a way of investigation [14] and design fiction to build future narratives, this study reflects on a step beyond the existing literature about AVs by elaborating the discussion on social relationships with and through AVs.

2. Literature Review

Our literature review is threefold; (1) Vehicle Automation and Social Life, (2) Future Scenario Studies considering AVs' Existence, and (3) Design Fiction. In the first section, we mentioned vehicle automation as well as other technological improvements in the mobility area and their effects on society and individuals. In the second section, we described previous studies that are building on future scenarios involving AVs and in the last section, we briefly explained the literature on our adapted methodology design fiction.

2.1 Vehicle Automation and Social Life

Vehicle automation is one of the technological improvements that is expected to be a part of future mobility [15]. The main technologies that are expected to be a part of future mobility are electrification, connectivity, and automation; and innovative mobility services will support them [16]. *Electrification* and *innovative mobility services* have already started to be used for vehicles, and it is public. As for *connectivity*; even though it is a developed technology, its use has not spread around the world yet [16] and; automation still has a lot of barriers to pass [15].

Regarding expectations with AVs, both positive and negative ones should be considered. They can be beneficial to society by diminishing the number of traffic accidents, they may magnify total vehicle travel by forming freedom in terms of mobility of non-drivers, serving an effective and satisfying experience, creating advantages in terms of payments, and increasing the duration of travels by sprawling the cities [17]. Also, they can expand vehicle sharing [18] which may lower the number of people who own a vehicle as well as total vehicle travel [17, 19]. For AVs' decent operation, an infrastructure that provides connectivity is necessary and less traffic congestion, simpler road design and narrower lane widths can benefit from an autonomous transportation system [17, 20]. On the other hand, some challenges that AVs' presence can encounter are unaffordable prices and operation costs, the difficulty of leaving driving activity, especially for car enthusiasts, and the requirement of ground-breaking changes in terms of legislation and social perspectives [21].

Most of the future mobility literature argues that vehicle automation and sharing services were meant to perform collectively [18] which is also dependent on the acknowledgement of AVs by society [22]. There is a possibility of meeting socially awkward situations at the time of pick-up and drop-off actions of shared travels; and users may tend to own a vehicle since they enjoy the activity of driving as well as personalising the vehicle, build the feeling of safety and trust by using the vehicle in emergency cases, and signal a public status through their vehicle [17]. On the other hand, some user groups may socially benefit from AVs' existence such as non-drivers (the elderly, children or the disabled), frequent travellers who can enjoy the decreased costs of sharing services, high-risk drivers, drunk or tired drivers [17], and long-mile travellers [23].

The user's relationship with the AV is questionable due to the ambiguity of who owns the driver role. Driving is expressed as a relatively dumb activity since it limits other interactions due to the required repetition of the same movements. Thus, in contrast to assumptions about travel time seeing it as a wasted time [24]; people undertake multiple forms of work and leisure-related activity whilst on the move [25]. With specific reference to urban driving, Laurier [26], mentions how drivers use slow-moving traffic to undertake business-related work, dividing attention between navigating stop-start traffic, mobile phone calls and paperwork. In the case of AVs, if the vehicle has full autonomy, indeed the interaction design may focus on how users spend time during the journey, excluding the driver role. In such a situation the issue of trust comes to the front since this is an AI-based improvement [27]. Rödel, et al. [28] also state that the handling of the trust issue becomes more difficult as the autonomy level of the vehicle rises. The vehicle also should improve a relationship in

which it can learn the goals and expectations of users; and understand and perform according to users' needs [27].

Because cars already have anthropomorphic features and autonomy makes them even more human, anthropomorphic design approaches should be considered in the discussion around AVs [11]. Anthropomorphism can be used for designing smart products [29]. Verberne, Ham and Midden [30] state that trust can be augmented when the chauffeur of AV acts and resembles human beings. AVs can have personal attributes such as name, gender, and voice as trust increases when the vehicle contains anthropomorphic manners [31]. Hence, communicating with the users through anthropomorphism increases trust which may create areas for affirmation of AVs [32].

Strömberg, et al. [33] mention the display of new relations between users and vehicles as the level of automation increases; and Pettersson and Ju [34] state the necessity for new types of interactions between the user and autonomous agents. Thus, the design of AVs should match with their social context [33], and it is necessary to uncover this technology's possible directions from a social perspective. Our study explores AVs' social reflections on society not only in traffic but also in social life. Furthermore, we are not sure about calling this traffic since we do not consider AV only as a moving vehicle on the ground in this study. Finally, as the user groups of AVs develop, they will also be affected by their designs, and we can say that there is a mutual adaptation within this process between society and the vehicles' design.

2.2 Future Scenario Studies Considering AVs' Existence

There are two main paths expected for AVs' deployment; the *evolutionary path* follows a progressive increase while the *revolutionary path* encounters a breaking point where AVs spread more around the world, and it is possible that the world can follow both paths interchangeably [21]. There are also definitions based on the driving options: *something everywhere* view upholds leaving the driving activity to humans on required occasions, which lets AVs operate everywhere around the world but with limited features; *everything somewhere* view supports that it is not possible to let humans and AIs operate together [21]. The latter declares that in the long term, human drivers may not be trusted as operators of vehicles. Hence, AVs are not going to operate everywhere but some districts will benefit from full automation which may result in sharp differences in mobility levels of cities.

There are several scenario-based studies about future mobility and AVs' integration into civil life. Fulton, Mason, and Meroux [35] based their study on three revolutions (3R) that could shape future mobility: electricity, automation and sharing. They depict three different scenarios for the mobility of the year 2050. Another future mobility scenario study is by Townsend [36] which wraps up four alternative scenarios of future transportation. Each scenario is defined in a different year and in a different city. Four future mobility scenarios are named as *Growth*, *Collapse*, *Constraint* and *Transformation*. Considering the other scenario examples, the *Transformation* and *Growth* scenarios are affected mostly positively by future innovations like the 3R scenario of Fulton, Mason, and Meroux [35]. Townsend [36] brings up possible regional issues like horizontal settling and parking issues which

might be important for system designs, and his example of aggravating driverless AVs shows how ownership can be problematic for AVs' functioning.

2.3 Design Fiction

Design fiction is quite a new research area. There are some variations about the definition of the term *design fiction* and there also are arguments on how it should be applied. The most frequently used one is Bruce Sterling's definition "design fiction is the deliberate use of diegetic prototypes to suspend disbelief about change." [37] Even though the main purpose is creating fictional scenarios, diegetic prototypes are at the heart of this definition. The authors of the book *Speculative Design* Dunne and Raby [38], state that speculative design is something that stays more on the critical side of production. In comparison, design fiction is closer to the atmosphere of the real world with its "realistic" probes. Sterling also agrees on design fiction's potential of being more practical. Although it forfeits the feeling of miracle and some sense of the miraculous, it relates more with technological or social disagreements [39]. Since the design fiction process is also a productive ideation, it might be inspirational for designers as well. Bleecker also states that design fiction is a way of ideation through sketches, mockups etc. [39]. It helps to materialize the imagination via narrating and making the outcomes potential concepts [40]. It also adds a futuristic view since it is related to fiction such as Lindley et al. [41] state that a successful design fiction process establishes the observer in a plausible future that lets him/her anticipate in a purposeful manner. Therefore, producing concepts within a fictional storyworld is our main purpose for using design fiction and here design is not aimed towards solving issues but envisioning and discussing problems [42] about AVs from a "socio-technical innovation level" [43].

Grand and Wiedmer [44] state that there are three ways to apply design fiction as a research strategy: building storyworlds, embodying storyworlds, demonstrating and visualizing the action process. Design fiction primarily arises with a what-if question that directs a storyworld [45]. Similarly, Auger [46] defines the term *perceptual bridge* which is meant to create a link between the fictional world and the real world to ease the audience's understanding. Design fiction actually builds this perceptual bridge with probes. Interestingly, movies in the industry can be design fictions as well since they involve probes. For instance, Li [47] discussed design fiction narratives within the movie "Her" from a posthumanist perspective, and the author based the discussion on the diegetic prototypes (probes) produced within the movie. Even if the terms like *perceptual bridge*, *probe*, *diegetic prototype*, *what if question* differ; they address the same through design, the fictional world.

3. Methodology

The future mobility scenarios that were explored in the literature review mostly focused their study on how the infrastructure of AV systems would function through electrification, automation and sharing. On the other hand, they studied less how

people would deal with AVs and how AVs would impact their lives. This study uses design fiction to characterize and discuss potential ideas for future AVs considering the changes in mobility, transportation and user needs, and our starting point was creating fictional worlds with AVs' presence in future social life. Hence, we selected our methodology as *Research through Design Fiction*, which allows us to create knowledge through design by combining the principles of research through design [48, 49] and design fiction [14, 50, 51].

We organised two workshops to retrieve direct insights from junior designers. Since we were looking for outcomes like design scenarios and proposals, we have chosen fresh industrial design graduates as participants who are familiar with creating personas and scenarios. Rather than experienced industrial designers working for industrial production, junior designers fit better for pushing imagination and creating fictional worlds. Applying design fiction through workshops is a prevalent method [52] and the main motivation behind the decisions of workshop design was to let the participants create *empirical data through design* that will allow us for further discussion. Three types of data are collected during the field study: data generated by designers through workshops, workshop observations and discussion of workshops with designers. Finally, the data is coded following a thematic analysis [53].

The workshops have been organized via video-conference tools. During the workshops, the participants worked on the activities which they performed on the collaborative working tool *Miro*. Both workshops lasted approximately two hours and were conducted by four participants each. The first workshop was performed about a month before the second.

Workshop Design. The workshops were conducted in four phases, shown in Figure 1. Following our methodological literature; first, we needed to create a fictional world where AVs might be used. Following that purpose, *brainstorming* was the first session of the workshop. At the beginning of the session, we announced that “*We are in the year 2040 when it is possible to have fully autonomous vehicles working with the necessary legislation changes and high technology*” and we asked them to build their storyworld through post-its. Our decision was based on similar studies [38, 50], where the author(s) hypothetically made a change in the legislations to create a storyworld and the rest (the artefacts and other design fiction outcomes) pivoted around that. Inspired by these examples, we can imagine a whole different world with AVs that has the appropriate conditions for AVs' activity. Moreover, six areas politics, economics, social life, technology, environment, and transportation, were defined to ease participants' thinking process, see Figure 2. We aimed to produce probe/s through workshops that represent the fictional world just as Coulton et al. [50] state “(design fiction) narrates worlds not stories”. In their study, they convey the narrative through other probes such as prototypes, users, and trial maps.

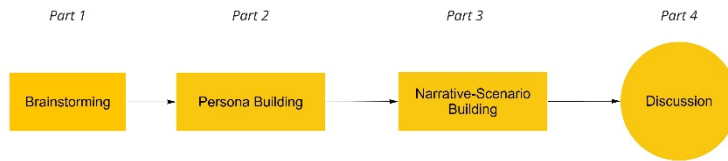


Fig. 1. Workshop Flow

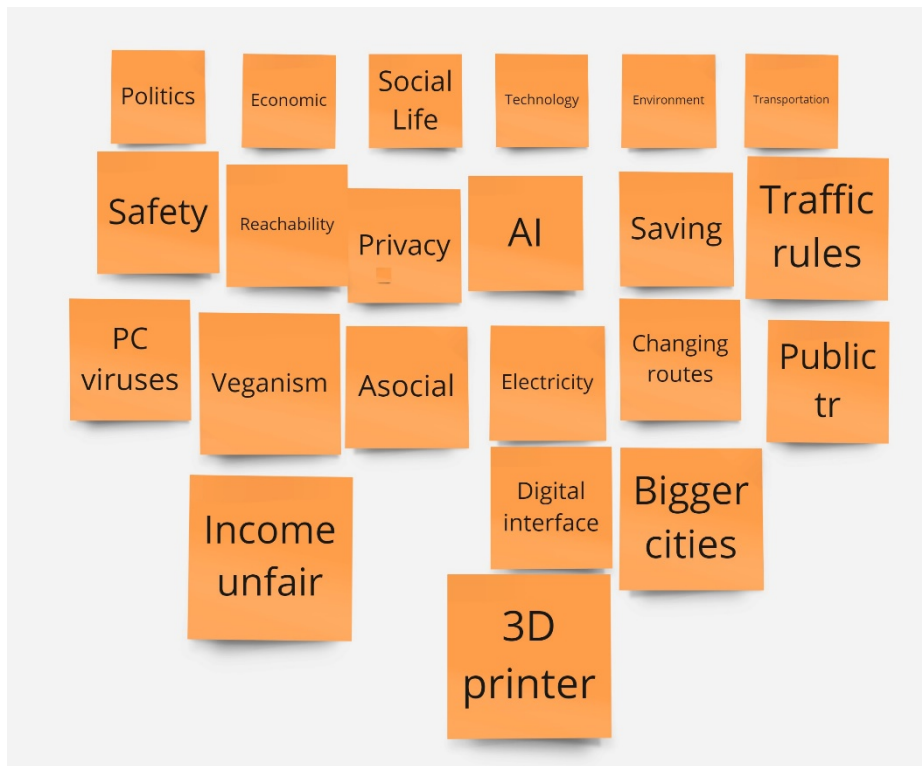


Fig. 2. Brainstorming of WIP1, (translated to English by the researchers)

Persona, the second session of the workshop was based on character creation and this character would be the protagonist of the narrative and scenario. For the sake of not shaping the imagination of the participants, we did not explain the persona directly as the user group of AVs. By completing the first step, the participants already had some visions about the future world. In addition to that background, we created the exercise for participants asking them to determine some information about this character such as wishes, personality, interests, habits, age etc. (see Figure 3).

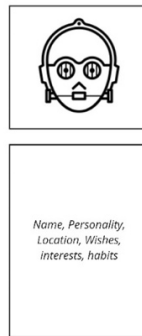


Fig. 3. Persona template (English version, translated by the researchers)

Narrative-Scenario, the third and fourth sessions of the workshop, was the place where a sequence comes up including the character of the narrative and its setting. For this activity, we created inspiration cards that are categorized as social and technological, see Figure 4. Using cards for inspiration a technique used in future scenario building tools [54, 55] to help the participants build their narratives. To relate these cards with the scenario-narratives we created a template in which narrative-based outcomes (text and sketches) and cards can be demonstrated together, see Figure 5. The participants were free to create new cards if the cards were not sufficient for them.

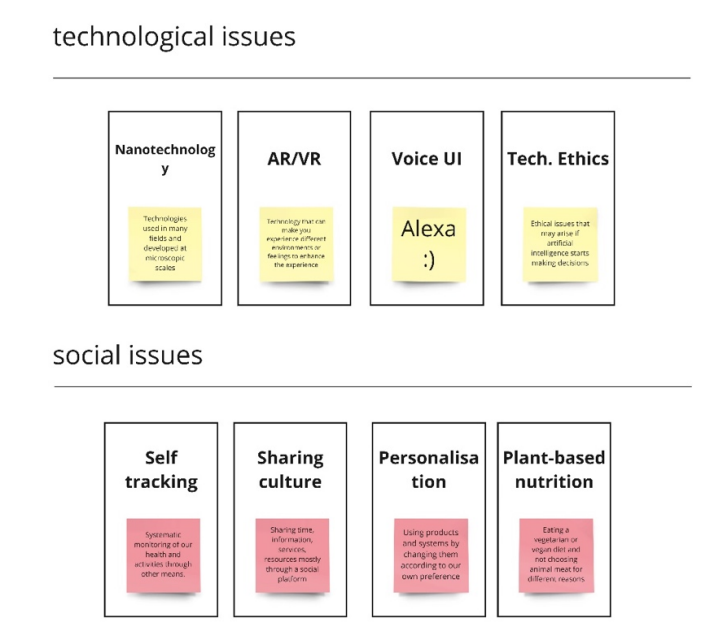


Fig. 4. Inspiration cards (English version, translated by the researchers)

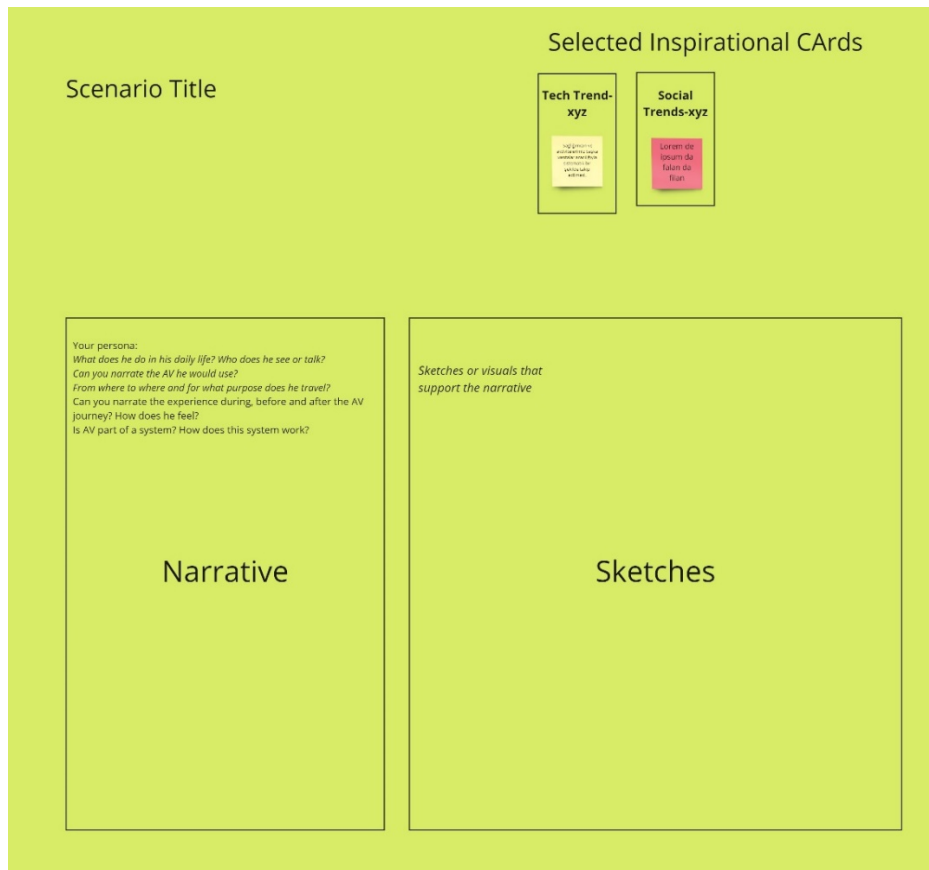


Fig. 5. Scenario-Narrative template (English version, translated by the researchers)

By conducting workshops through collective activities such as brainstorming and narration we aimed to create collective outcomes that took inspiration from each other. Therefore, to encourage group constructive collaboration we decided that at the end of every activity, participants should present their own way of thinking. The *discussion* was the last session of the workshop in which the participants talked about the experience they had, the cons and pros of the workshop and commented on each other's works.

4. Findings and Discussion

In this study, primarily we had two main categories of outcomes: *Storyworlds with AVs* and *Features of AVs*, see Figure 6. The former is about the aspects of the storyworlds with AVs, whereas the latter is directly about AVs. However, as we elaborate on the data, we realized that we need another category in the intersection of

these; *Social Role of AVs*. The reason behind this decision was the fact that AVs are assigned as social agents by the majority of the participants and these data were neither directly about the aspects of the storyworlds nor the feature of AVs.

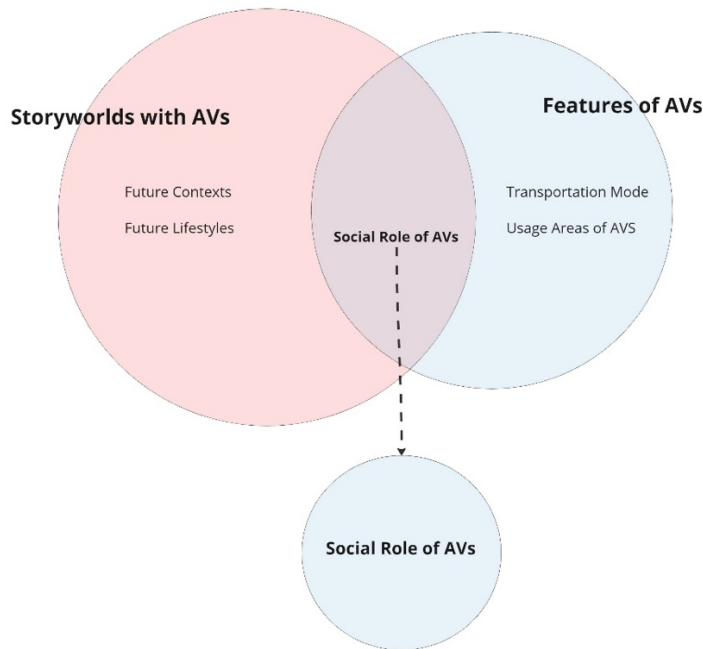


Fig. 6. Structure of the findings

Moreover, we sub-categorized the titles for further discussion. *Storyworlds with AVs* are divided into future contexts and future lifestyles and *Features of AVs* are divided into transportation mode and usage areas of AVs. Then we demonstrated the related categories for each participant in Table 1. Participants are abbreviated as WIP1 (Workshop 1, Participant 1) (WxPx= Workshop x, Participant x) for the rest of the article.

In Table 1, future context refers to the main theme of the storyworld, whereas the future lifestyle refers to the main lifestyle within the participants' narrative. Moreover, the participants created concepts (usage areas of AVs) and AVs have roles of carrying something or someone as well, and they did not define AVs just as ground cars, but they considered them as moving through different modes like flying or on the rails. Within the future narratives, most participants did not assign roles to their AVs as mobile vehicles, but they defined them as social agents. Considering even the current cars can do more than the mission of carrying, the scenarios indicate that AVs' role as a vehicle will fade more. It might be expected that peoples' relation to AVs might get weak since they even leave the mission of driving to the vehicle.

However, the scenarios suggest that as their capacity of autonomy increases, we see them as intelligent vehicles and create relationships beyond interactions.

Table 1. Categorization of Workshop Outcomes

Workshop Participants/ Features of Scenarios	Storyworlds with AVs (First category of the outcomes)		Features of AVs (Second category of the outcomes)		
	Future Context	Future Lifestyles	Concept (Usage Areas of AVs)	Transportation mode	Social Role of AV
W1P1	Individualization	Remote Working	Office AV	on the ground	Living and Working Area + Assistant
W1P2	Trans-humanism	Mutualistic life with non-humans (products)	Transportation system for an autonomous city	flying, floating, on the ground	Socialisation Area
W1P3	Individualization	Immobile	Delivery system with AVs	flying	Delivery vehicle
W1P4	Dictatorship	Controlled life	Public transportation AV	railroad	Efficient time spender
W2P1	Individualization	Remote Working	Work and Travel AV	on the ground	User assistant
W2P2	Digitalization	Digital Consumption	AV for Food Delivery	flying, on the ground	Only-business related interactions with user
W2P3	Digitalization	Adaptation to Digitalization (elderly)	Autonomous bus	on the ground	Support sustainable lifestyle
W2P4	Unhealthy environment	Nomad	Travel friend AV	on the ground	Friend

4.1 Storyworlds with AVs

The future contexts of the scenarios reflect the socio-technical environment of the scenarios. Individualization and digitalization were the prominent themes whereas the others' approaches were more political with themes such as trans-humanism and dictatorship. In this section, we elaborated on the lifestyles created by the participants since they reflect the themes as well as their connections with AVs.

Remote Working, Immobile and Nomadic Lifestyles. During the workshops, it was seen that AVs can give a new dimension to working habits. In both workshops, participants created distance working personas and the combination of remote working style with AVs created interesting results. In their book about AVs, Lipson, and Kurman [56] state that the interior of AVs will create a flexible area for work,

leisure, and socialisation. As an example of this from our workshops, W1P1 designed his AV as a moving office so that the persona can set meetings, work individually and sleep within the vehicle. His workaholic persona was occupying several sectors so the interior ambience should be flexible. The participant used AR/VR to change the ambience of the AV depending on its required function since his AV can perform as an individual office as well as a meeting place, in necessary situations. Also, W2P1's persona is a remote worker, and she does that while travelling around the world with an AV. Additionally, W2P1's persona was a creative writer, which led the discussion into the issue of creative jobs of the future; whether AI-based products are going to replace humans in creative jobs as well. In her narrative, the persona gets help from her AV to be more creative. This might be a positive scenario similar to the situations when people get help from the internet as an inspiration source. On the other hand, it is also an example of how AI-based products replace a human's role.

Gilroy [57] states that 'cars are integral to the privatisation, individualisation and emotionalization of consumer society as a whole', and a lifestyle that is physically isolated from the outside world has been developed in the workshop considering AV's existence. For example, W2P4 used the expression 'less human to human connection' to describe that case during the workshop. It is interesting because she actually meant the physical connection by that. At that level of high technology, indeed the physical meetings and connections seemed to have a severe decrease. Bissell et al. [10] declare that AVs may create new spaces for social interaction and individuality as well. To exemplify, W2P2 stated that with the rise of individuality, people have more isolated lives, and this may lead to an increase in the number of pet owners. She even thought of pets as potential users of AVs during brainstorming, even though she did not use that in her scenario.

The individual lifestyle idea was supported by the idea of an "immobile lifestyle." The participants questioned the immobile lifestyle based on the issue of health. As it was indicated before, technological improvements are leading people to a less mobile lifestyle because of connectivity. W1P2 mentioned that his persona always stays home since he can handle everything this way. Although this lifestyle may create issues in terms of privacy and security, in future scenarios these were considered less. Health issues are the results of various issues that were expressed by participants. Even though the medical technologies are improved with services like person-specific treatments as W1P2 stated, technological improvements have also negative effects on health issues due to issues like radiation and W2P4 considered that digitalization might also create a rise in the optical problems which was also one of the motivations behind her persona wearing a protective costume (Figure 7). Going even further, she stated that this might also affect fashion trends and clothing choices globally and it makes sense considering how masks became a part of life during the pandemic.

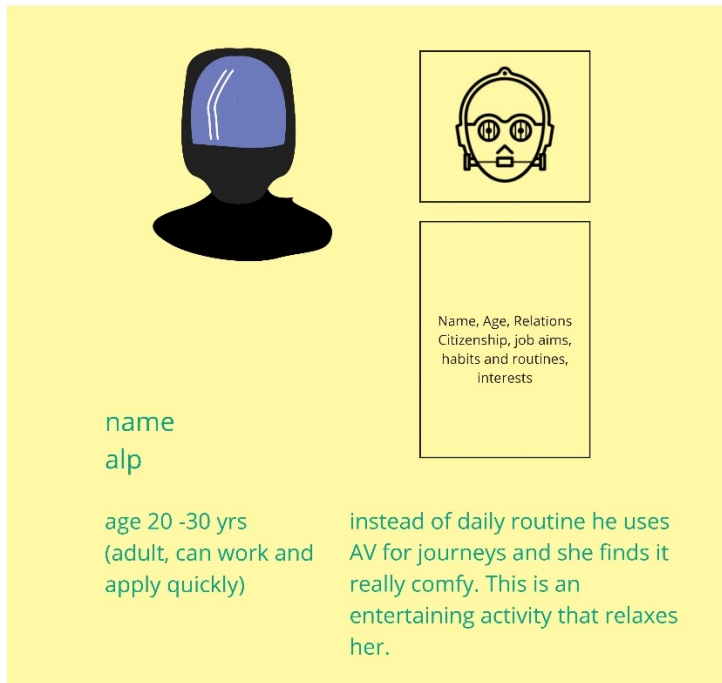


Fig. 7. W2P4's persona avatar, who is wearing a protective costume to prevent from radiation and descriptions (English version, translated by the researchers)

Mutualistic life with non-humans (products). Slightly different from other lifestyles, W1P2 focused on human-product (non-human) relationships within the daily life of his/her cyborg persona. This is related to AVs from an indirect perspective, since due to ownership of AVs the persona can spend more time at home.

The term *cyborg* was used by W1P2 during the persona creation phase which was before presenting inspiration cards. Later, the participant supported the narrative using the inspirational card 'having mechanical body parts'. Moreover, the needs and habits of a cyborg may also open new perspectives for designers. For example, the same participant also mentioned possible symbiotic relations between smart products and people:

"I dreamed that he liked to do sports at home and that he had a symbiotic relationship with some living things at home, and I thought of these living things as products as if they were looking after each other mutually with living things. It's like creating its own habitat inside the house. Here he is having problems in personal relationships. I thought it produced its own energy at home from algae." (W1P2)

As the products get smarter the meaning of human-product interaction is changing. It is possible to say that humans are interacting with products similar to the way they do with humans since they can communicate with products through speaking, gestures, and touching. AI's effect in this situation is inevitable and it is

going to cause a major change in people's lifestyles [58]. Thus, designers add anthropomorphic features to products to respond to users' needs while communicating with smart products.

Controlled life. WIP4 structured her narrative within a political ideology, then worked on her persona and narrative. She defined the lives of citizens of this world as 'controlled lives'. She expressed this as 'Everything is scheduled and in order, people are connected to their timers and reminders.' Everything happens in time within this world and people have minimalized emotions. Citizens have no free will; hence they are living in a routine like robots, but they are happy.

Digital Consumption. Recently; digitalization created a huge shift in shopping habits with the integration of the e-commerce sector. Even though it has never been at the centre of the discussion, participants considered the spread of 3D printers and discussed the practice of buying digital models of products to print at home. This kind of consumption practice requires a system design that enables owning a 3D printer at home with proper material qualities etc. However, when the increase in hours that people stay at home is considered, that does not seem hard to grasp as a certain behaviour with sufficient technological possibilities.

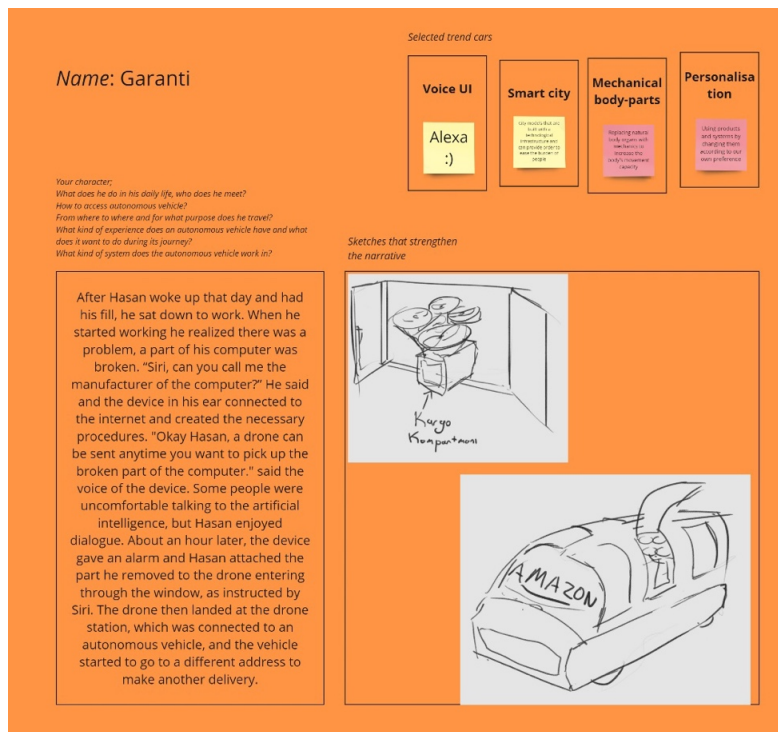


Fig. 8. Sketches of the flying AVs from WIP3's narrative-scenario sheet (English version, translated by the researchers)

Delivering products with AV is already becoming a reality and some of the participants thought about how this idea can be adapted into the future. For example, W1P3 designed a flying AV for cargo deliveries (Figure 8). In this concept, the flying AV contains drones, and these drones leave the vehicle for delivery and come back when the delivery is done. W2P2 proposed that there could be veterinary AVs to help the increasing population of pets considering the rising individuality. The participant stated that pet owners do not seem to find time to fulfil their pets' needs when they are busy, so these specialised AVs can have a role in the future. Formerly, it was discussed that a half-human can be a user of AV and this time a non-human being becomes the user of AV.

Another possible use of AVs for delivery is mentioned by W2P2 and it is included in her scenario in which the persona owns a vegan restaurant. The AVs' role here is being a food container and delivering the food from the restaurant to the clients. AV should be equipped to keep the food at the required temperature during the delivery. In this scenario, the AV belongs to the restaurant, but it is also possible to see the AVs owned by on-demand delivery services.

Adaptation to Digitalization (elderly). W1P3 focused on issues of the transition process to a future with AVs and his focus on the transition process affected some participants to consider this process as well. His persona was elderly trying to adapt his lifestyle to a highly technological world that includes AVs.

Adaptation to technological changes is one of the biggest barriers against the transition process of AVs. During the workshops, the generation gaps, and the differences in speed of adaptation are mentioned. W1P3, who built the scenario of an elderly persona during the transition process, stressed out the lack of knowledge these people need to overcome for easy adaptation. The situation can be observed from a wider technological perspective rather than just an AV-based perspective. Thus, W1P3 defended that informational support should be given to the artisans and locals for the adaptation to high technologies. They might benefit from technological improvement while they carry on with their traditional professions. On the other hand, teenagers are adapting fast to the new life standards. This polarity may create new social problem areas for system and service designers.

4.2 Features of AVs

According to the results, participants prioritized two features of AVs; their function (usage area) and their mode of transportation (on the ground, flying etc.). Moreover, participants considered the system design where the AVs function by considering issues such as infrastructure and connectivity.

The participants have stated three main concepts of AVs; AV as a colleague and assistant (W1P1, W2P1, W2P4), AV for delivery (W1P3, W2P2), and AV for public transportation (W1P2, W1P4, W2P3). Here, using AVs for public transportation and delivery were already the first trials of the application of AVs in the industry. Although these are important outcomes, we are more interested in the first category which we elaborate on in the next section.

One of the most crucial steps for AVs' existence is having the proper infrastructure setting for their functions and more than half of the participants mentioned this issue. For AVs' proper workability, Principles of connectivity; V2I (Vehicle to Infrastructure), V2V (Vehicle to Vehicle) and V2X (Vehicle to Everything) must work, and they require a decent infrastructure to function [59]. For their most effective use, AVs need a smart city infrastructure. In this context; the *evolutionary path* which supports that AVs spread progressively and *something everywhere* view which supports that AVs function with their all capacity but in limited regions can be considered [21]. It can be speculated that AV deployment might happen similarly to the deployment of historical ages which had not been experienced at the same time in every society.

On the other hand, participants have different visions of how and where AVs may move in cities. WIP3 declared that we understand AVs only as road vehicles because we only hear car companies making improvements about them. This might be a common fact about understanding AVs but in the workshop, designer participants demonstrated that they have a broader vision. Participants discussed the definition of roads considering AVs' existence. For example, WIP3 proposed that AVs' and peoples' routes should be separated, and some intersection points may be designed for their meeting. The same participant also considered the environmental side of this issue and put the idea of structuring AV routes in a way that does not harm nature. These ideas are inspirational starting points for the system design of AVs. Even though these proposals are on a regional scale these are considerations that directly indicate design issues.

Moreover, one of the reasons the participants designed flying, floating or railroad AVs is that they do not seem to operate on the ground with the current road systems. Thus, it makes it easier to adapt them to current cities when they do not build upon the current system. Although there are examples for creating a new route for public transportation vehicles, the routes where AVs fly, or float are also possible.

4.3 Social Role of AVs in Future Scenarios

We realised that while participants were creating their narratives, they did not just see the AVs as moving objects, they gave them a place in their social lives as well. Based on this fact, we focused on the social role of AVs in future scenarios as a discussion point by elaborating on how participants defined new relationships with AVS, and how they adapted AVs to their lifestyles.

The changing meaning of *journey*. The majority of participants stated that we will be able to spend time inside the vehicles efficiently and that will be a reason we will spend more time inside of AVs than the current vehicles. This statement also matches with the idea that proposes to use AVs as living areas, and according to WIP4's future concept, AVs will allow a space inside the vehicle to catch up time in daily routine. WIP4 defined his/her AV idea as a public transport vehicle and people will be able to do things like doing make-up, brushing teeth etc., inside of the vehicle. The same participant defined his/her motto as "no driving pleasure, yes reaching satisfaction." Since everything is scheduled in the storyworld he/she defined, there

will be no more problems in reaching meetings, events etc. and AVs will be the extra time creators. Thus, she defined AVs as a 'time creator' in her storyworld:

"In the AV journeys, people can finish their own work that they could not find time to perform. They can brush their teeth, read newspapers, and have family/neighbour conversations. That is the interaction that they can have in AVs."
(W1P4)

The majority of participants talked about AVs' possible benefits for efficient time management. This acceptance is provocative because at this level of AV discussions; AVs' function as a transportation vehicle is on a secondary level. According to Gilroy [56], cars recharacterized mobility and expanded neural experience, and we argue that AVs are going to redefine these as well as the time replaced by non-driving. The activity of driving creates a strong bondage between the driver and the car. However, the feelings related to driving might be lost or changed as AV's function as a vehicle fades away and the meaning of the journey changes. About that, it is beneficial to remember W2P4's words 'The actual journey starts after the user gets off the AV. Because when she (her persona) is inside of it she does not feel like it is a journey, it is like a simulation.' Hence, the definition of journey ought to change with AVs and within a new definition of journey, the roads, routes, streets etc. must be redefined as well.

Bissell et al. [10] mention earlier studies about autonomous mobility and its possibility of creating novel ways of private and professional life experiences. W1P1's 'office AV' allows the persona to use the interior as an office and living area, even for sleeping on required occasions. In some situations, AV becomes a place to conduct meetings with other colleagues. Thus, AVs' emphasised role is defined as living and working space rather than assistant or friend in W1P1's scenario. De Souza e Silva [59] mentions hybrid spaces where the digital and physical environments are merged via technological devices. For example, *PokemonGo* which is a mobile game that requires users to mobilise physically to collect Pokemons digitally is an example of hybrid space. Similarly, by taking into consideration W2P4's thoughts AVs can create such spaces through AR/VR which causes to blur the line between digital and physical spaces [59]. Moreover, Ishii [60] declares that the interfaces that link us to digital spaces affect our perceptions of both physical and digital spaces. Thus, the journey may become a simulation or a phase where the user has to spend a defined time. Regarding this, W2P4 mentioned that she thinks her persona's journey starts after she gets off the AV since being inside of AV does not signify travel anymore by questioning the meaning of the journey while inside of AVs. What W2P4 does is go even further and totally eliminate the AVs' transportation function. Indeed, this is a very provocative perspective which redefines travel behaviour.

W1P1 mentioned defining spaces with multiple AVs. For example, an AV gamer party where each AV hosts a different game and allows people to socialise through their AVs. Even though it is just an idea, it is a quite unfamiliar perspective to look at AVs. Until now, all the ideas in the article were structured in an individual context. However, with this idea, it is possible that AVs can allow socialisation. AVs for efficient space management can be considered as another inspiration point. AVs themselves define interior spaces but when they come together in different manners,

they define different and larger spaces together; not just physically but also virtually. We already know that caravans can come together to define a community. However, when AVs are together, they might create also virtual and hybrid realities.

AVs as Social Agents. It is not novel to see the cars or mobile vehicles structuring social lives as Sheller [61] relates this to their omnipresence and confidant position in daily life. Moreover, he also establishes driving as a practice that blends the human and non-human. We explain this as the togetherness of the driver and the vehicle. Thus, vehicles' presence and the activity of driving already refer to anthropomorphism. Sheller [62] names the conventional car 'autonomobilised person' considering people's attributes to vehicles as a member of the family, caring for them and referring to them as gendered things.

Emotions such as pleasure, fear, frustration, euphoria, enthusiasm, and jealousy are critical when people decide to buy and modify vehicles [62]. Thus, the vehicle is a belonging after the moment of purchase, and this continues as the user spends more time with the vehicle. Inevitably, vehicle companies influence these feelings through advertisements and cars are also strong signals of expression. This also created a department called "car cultures," which has been embedded in life practice for more than a hundred years. As the vehicles' capacity increased and replaced humans in activities they were called cyber-cars by Thrift [9] and this definition also comes from their increased capacity for interaction. Based on the results, it is visible that some participants were creating their scenario by asking the question 'What does AV mean to my persona?.' Since AV is an AI-based technology it has intelligence and when it is combined with factors like individuality and mobility; AVs became friends, slaves, or assistants of the personas of the scenarios, which is indicated as social robots [11]. Sheller [61] states that transportation companies promote 'humanised' vehicles to 'cyborgs, even though he was talking about non-AVs like Audi A8's advertisement promoting their vehicle to be more than a car with its intuition. For instance, W2P4 stated that AV and the persona plan the journey together, the participant emphasised the part that the persona does not dictate AV but rather they do it together. Moreover, the participant stated that the persona does not live in AV; but she lives with AV. Here, the main challenge can be creating a balance to change the ambience physically and digitally together. De Souza e Silva [59] calls this concept a '*hybrid reality*' that came out by joining the social practices in digital and physical space together with mobility.

W2P1's persona travels around the world with her AV while working freelance. It is also a combination of freelance work and slow travel, which is why it was meaningful to call it a 'nomadic lifestyle.' This kind of social role takes AVs' place from a vehicle to an anthropomorphic object that is socially active, which shows that AV is much more than replacing driving activity in the consciousness of people. Sheller [61] declared that car designers were trying to design vehicles that are mobile pods; this approach can be realised and enhanced with AVs. It is not a new idea to promote cars' interior as a dwelling space due to the feeling created by the exterior and interior design of the car which reflects on the personality of the driver as well [62]. Sheller [61] gives examples of that such as Chevrolet's 1950 advertisement and GMC's PAD and adds that driving was not advertised as the main function of the car even years before. W1P2 considered the possibility of increasing capsule houses in the future.

Building on that, thinking about AVs as capsules opens up interesting scenarios. An AV apartment idea where the AV flats can park themselves and become a part of the apartment is discussed as another proposal for owning less space for parking AVs. This can be another smart city stereotype for the future.

Two different participants mentioned that with AVs on the roads, it will be possible for people with no driving ability to have independent mobility. This independence will create new user groups such as the elderly, children, and disabled who would travel alone in a private vehicle [17]. During the discussions, the participants also questioned the jobs of taxi drivers, minibus drivers etc. considering the fact that driving as a profession will be lost. New job types like not driving these vehicles but controlling them at systems level might be adapted with remote working which has already started rising.

6. Conclusion

In this study, we benefitted from design fiction's potential to build scenarios and design fiction workshops enabled to create design interventions that shows impact in socio-technical level. Because cars' existence reshapes city life by impacting the manners of dwelling, socialisation and travelling [63]; new lifestyles such as nomadic, individual, and immobile were built anchored to AV's existence. This enabled us to discuss distinct aspects of daily life such as working habits and consumption practices within the reflected future social life through AVs. As the main outcome of the scenarios, we propose that AVs might be a social member as their acceptance grow in the social life and when the driving activity dissolves the vehicle's moving ability will become less important. Thus, AVs' existence can affect the meaning and context of journeys in a radical manner. The discussion around narratives that envision AVs in future scenarios can be beneficial for designers of various levels, strategic managers, and policymakers; since the fictional scenarios are provocative and triggers discussion spaces about the future and current relationships between spaces, systems, services, products, and humans.

The study shows that anthropomorphism will be a crucial topic to build trust between AVs and people. 'First, it has been made by humans; second, it substitutes for the actions of people and is a delegate that permanently occupies the position of a human; and third, it shapes human action by prescribing back.' [64] (p.235). Supporting Latour's words each participant assigned a social role by adding anthropomorphic features to vehicles. AVs became assistants and friends to their users, and especially considering a more individual future this seems pretty reasonable. Hence, the findings of the study address that in the storyworlds it is possible to see more humanised products as well as more robotized humans since the participants created cyborgs as personas and defined symbiotic relations with products.

De Souza e Silva [59] states that the social value of an interface mostly develops when it is planted in social practices, but it does not appear right after its delivery. Thus, this study lets us reflect on the lifestyles that arose from AV's existence. This is where design fiction shows its power; it is not easy to think directly about a future

with AVs in the first place. We know that even though today's AV image still looks like a developed car, with users' emerging needs and reflections on them it will evolve into something else. The contextualization of a future with AVs may help designers create strategies and concepts related to the future of transportation. Designers should also adapt themselves to the requirements of the newly occurring lifestyles due to the presence of AVs. When designers are dealing with humanised products such as AVs it is not enough to study the case from the HMI (Human-Machine Interaction) perspective. They should expand their perspective and consider them as social agents. Thus, they should also be aware of their capacity for creating novel relationships with people.

Possible usage areas of AVs mentioned by participants are public transportation, delivery of goods, moving office, living areas and events with AVs. Some of these areas such as public transportation and delivery of goods are already in use and expected to be used in the future as well. However, moving offices or events with AVs shows that with AV's involvement in daily life, there will be new lifestyles and habits. We observed that AVs do not just impact social life but also become a part of it. Moreover, with the rise of AI-based technologies, it might be the case for other smart products as well. Thus, perhaps the products may become the personas of the future.

Finally, our study has several limitations. First, this study is not iterative enough and the sample is not broad enough since it is done only twice with eight participants in total. Richer results can be achieved through wider samples and more iterative processes. Second, all the participants were junior industrial designers, participants from diverse backgrounds and experiences may impact the results. Although it is not the main point of this study, for more elaboration in terms of design results design fiction can be used for the idea generation part; and can be continued with detailing the design process.

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