Steering Stories: Confronting Narratives of Driving Automation through Contestational Artifacts

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ABSTRACT

In this paper, we problematize popular narratives of driving automation. Whether positive or negative, these propagate simplistic assumptions about human abilities and reinforce technocratic approaches to mobility innovation. We build on narrative approaches to participatory research and adversarial design, to explore how design-led confrontation can create opportunities for reflection on implicit assumptions and narratives that stakeholders may refer to when discussing and making decisions about automated driving technologies. Specifically, we discuss the results of four focus groups where we used contestational artifacts to promote critical discussions and confront taken-for-granted beliefs among stakeholders. We reflect on the results to distill methodological insight and design recommendations for conducting adversarial participatory design research as a way towards confronting dominant narratives. Together with the methodological approach, the main contribution of this work, we also provide a set of narrative tensions that can be used to question common beliefs surrounding automated driving futures.

CCS CONCEPTS

• **Human-centered computing → HCI design and evaluation methods**; **Participatory design**.

KEYWORDS

Adversarial Design, Narratives of Technology, Critical Design, Automated Driving, Political Design.

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1 INTRODUCTION

Current socio-technical imaginaries of future mobility predominantly focus on the idea of *autonomous vehicles (AVs) as 'the' solution to numerous traffic and societal issues* [5, 9, 56, 63, 90]. These are grounded on the belief that AVs would allow to save lives and reduce injuries, by reducing human error; reducing costs, preventing car crashes; increasing transport efficiency; and providing unprecedented mobility opportunities for diversely abled people [60, 90]. Underneath this whole rhetoric, one assumption echoes: *'the driver is the problem'* [9]. Whether the argument is to improve driving and traffic efficiency or to reduce car accidents, the driver is depicted as the villain of all transportation issues, and autonomous driving is narrated as a way towards salvation [67], i.e., human drivers are responsible for 90% of road crashes, thus autonomous vehicles should be able to reduce road deaths and injuries by a similar percentage [28].

This imaginary is constantly constructed and sustained by popular narratives [9, 31], such as magazines, movies, newspapers, talk shows, and more, that build on and reinforce positive views of automated mobility futures aggressively promoted by the automotive sector through carefully crafted branding strategies [48]. In these, mobility issues are attributed to the –limited– capabilities of the human driver, and automated systems are presented as more competent 'solutions'. This view, which relates to narratives of technology in general [78] and artificial intelligence (AI) in particular, subtly leverages the beliefs that the public holds towards artificial systems and the possibility of these outperforming humans, up to the point of becoming 'beings' capable of surpassing human intelligence [7]. Thereafter, driving automation technologies, and more specifically the concept of AV, are intertwined with a particular ideology of technological progress that revolves around the promise that human beings can, and should, be relieved of tasks such as driving [88]. While present for a long time in mobility imaginaries [50], the recent developments in AI dramatically sped up AVs improvements [72], making them among the most hyped emerging technologies in business, government, research, and innovation agendas [69]. Yet, the more excitement grows towards AVs, the more concerns about their risks and unintended consequences also rise [17]. From research [27], to popular media [13–15, 47, 51], an opposing narrative revolving around themes of safety and feasibility has been steadily growing [23].

> Tesla's autopilot could save millions of lives. How many people will it kill first?" [1]

As effectively captured by a cover of Bloomberg Businessweek [1], the positive narrative of AVs as 'salvation' is counteracted by a pessimistic narrative that revolves around the idea of undesirable drawbacks. Increasingly more voices are warning about the potential risks and costs related to the adoption of partially automated vehicles in the ambition to reach actual AVs. According to the critiques, the claimed benefits of these technologies will be valid only when (all) vehicles will be able to drive completely autonomously

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[47]. Such a scenario, deemed unrealistic by some [63, 78], at the very least requires intermediate steps to happen [4, 62] where the human driver will only be partially relieved from the driving task, such as in traded control driving solutions where either the algorithm or the human controls the vehicle [2]. As testified by a growing occurrence of accidents involving partially automated driving systems [30, 66], intermediate solutions will–and already do–bring novel problems, such as loss of situational awareness [2, 22]. And even in a remote scenario where vehicles would be able to drive completely autonomously, the car will never be 100% safe as it "will drive in the midst of unpredictable pedestrians, bicyclists, human drivers, animals and whatever else might appear in their paths" [63]. As such, an animated debate also is also questioning whether cars should be designed to kill (or better 'to choose who to kill') [6] or not [45]. To counter the dominant techno-optimist narrative, then, a pessimist faction emphasizes how *driving automation carries costs and unprecedented risks for safety* [58, 90] (a view also addressed under the notion of *'pitfalls of automation'* [23]). The concern of inherent risks is in turn challenged by the argument that driving automation technologies could indeed cause accidents and costs, but these would be an acceptable amount compared to the number of lives saved [23].

Public understanding of automated driving, then, is generally divided into two dominant and polarized views, one optimistic (self-driving cars as a solution) and one pessimistic (self-driving cars bring safety risks and other costs). This has a direct impact on the public acceptability of driving automation technologies [54] but also, and foremost, on the way strategic stakeholders understand and take decisions about its implementations and regulations [81]. Public governance, in fact, generally tends to rely on the dominant master narrative of progress and scientific breakthrough [54], which currently translates (in some, especially Western, countries) into national and municipal initiatives allowing or even incentivizing testing in real-life environments, making automated driving technologies integral part of overarching political agendas [19]. Although the pessimist counter-narrative warns about the inherent risks, both narratives tend to limit their discourse around the narrow idea of *driving automation as autonomous vehicles*, hindering the way to addressing driving automation as a complex problem, of which efficiency and safety are only two of the multitude of aspects to consider. Driving automation, in reality, comes in steps [4, 62] and its functioning is often bound to environments with specific conditions [62, 90]. There is no single line of progress [17]: it comprises a set of technologies [4] and unfolds into different types of devices [78] each bringing possibly competing trajectories and strategies [17]. Furthermore, the implications of driving automation extend way beyond safety and traffic efficiency. Several types of social drawbacks can emerge, depending on the context [61, 91].

In response to this issue a growing body of literature, especially stemming from the social sciences, is now looking into automated driving and its complexity, both as a technological, social and cultural phenomenon. Researchers are increasingly investigating how people form opinions and respond to automated driving technologies [34, 48, 62, 69, 71] as a way to challenge dominant narratives. Despite surfacing *stories of socio-technical complexity*, however, these works produce knowledge that hardly feeds popular discourses and mostly remains unaddressed by stakeholders in decision-making settings.

Thereafter, our work builds on this emerging body of work and adds a distinctively designerly perspective to explore *how might we enable stakeholders to confront dominant narratives* when discussing and taking decisions regarding automated driving technologies. We respond to the growing call for approaches in technology development and regulation, to help acknowledge the political role of narratives [21] and understand their contribution to shaping common-sense beliefs in technological fixes. We use contestational artifacts (designed objects that manifest aspects of a political condition and offer alternatives to dominant practices and agendas [25]) within the context of focus groups to engage stakeholders (experts involved in the design and decision-making around driving automation technologies) in discussions about driving automation. We investigate whether their argumentations map onto dominant narratives, whether an adversarial participatory practice can help confront dominant argumentations, and what role artifacts play in such a process. Our ultimate goal is to provide stakeholders with opportunities for confronting dominant narratives of driving automation, developing critical debate, and ideally help break free from the utilitarian and techno-determinist framings carried by the concept of the self-driving car [45].

2 NUANCING STORIES OF DRIVING AUTOMATION

In addition to previous experience with related products, the storytelling spread through advertisement, branding, policy documents, and media, shapes the way people understand and approach new technologies [8]. The narrative ways these are introduced to the market, even specific word choices [48], affect public perception and influence adoption [48] [7], and determine the way strategic stakeholders, such as scientists, designers, and decision-makers understand the values and implications of such technologies for lay people [39]. A narrative, in fact, is a conceptual tool that directs attention towards specific assumptions and stories about the world – and technologies in it– guiding the actions of individuals or collectives [88]. These are usually shaped around specific values (i.e., efficiency), and made up of promises, claims, and beliefs [88]. Together with its materiality, public images, visions, and stories contribute to shaping specific socio-technical imaginaries of technologies [9].

As mentioned in the introduction, driving automation is on the one hand accompanied by an optimistic narrative that relieves the automotive industry from its share of responsibilities up to a point of legitimizing and empowering it as 'fixers' of mobility problems [9], and on the other hand, by a pessimistic narrative focused problematizing optimistic views and emphasizing the inherent risks of automated driving technologies. In both these extreme views, as for other issues before (e.g., environmental sustainability [12]), statistical and logical links are used to support persuasive narratives –causal stories– where the 'user' is the problem and the one to blame and technologies come in as arbiters and/or saviors [12, 81]. There is, however, a wide range of factors, entities, and places where to potentially intervene, and the real challenge for our

decision-makers should be to properly locate moral and practical responsibility within a chain of actors and possible causes [81].

Thereafter, stories about the socio-technical complexity of automated driving are increasingly being investigated. Building on a long history of social science literature about mobility, authors are now striving to dismantle narrow assumptions around autonomous vehicles that are rooted in problematic conceptualizations of the car itself, such as the understanding and addressing of the car as a private conveyance and commodity choice which leaves out–or better relegate to the owner– wider social concerns and responsibilities for injuries [46]. In particular, arguments around (moral) responsibility in the case of accidents are now widely questioned because of their grounding in an ill-defined vision of what real-life ethical dilemmas would entail. For instance, Jafari-Naimi [45] problematizes common approaches to ethical debates around AVs where experimental ethics is often used to define what could be the moral principles that 'people would agree on or feel comfortable with if we are to bring self-driving cars to the masses' [45]. According to the author, approaches like the trolley experiments suggest a simplified version of reality where, by being placed outside the envisioned situation, we get a false sense of clarity about choices and outcomes and have the inappropriate feeling of being in control. Contrarily, the reality of ethically challenging situations that would involve AVs is uncertain, organic, and under constant development [45].

> Sophisticated and nuanced ethical analyses of what is at stake in the design and implementation of self-driving cars give us an opportunity to rethink mobility and the instrumental and cultural values we assign to cars" [45]

Some authors engage even more explicitly with narratives of driving automation by challenging myths and common argumentations about these technologies. Nikitas and colleagues [62], for instance, combine literature review and reflection on results from personal studies to distill lists of connected and autonomous vehicles' potential benefits and concerns for society, and to discuss and dismantle eleven of the most typical myths regarding the development and deployment of these vehicles (e.g., *'no driving, no problem'*). Relatedly, Fraedrich et al. [34] ground their work on a systemic view of automobility to envision how the transition towards automated driving could unfold. They discuss different scenarios of AVs with respect to their embedding in a sociotechnical context to comprehend possible alternative consequences for the future of personal mobility. As Cugurullo et al. [19] argue:

> there is a plethora of possible scenarios on the horizon' of how these technologies could be implemented and reshape the built environment. To properly account for this plurality, AVs should not be addressed only as a technological issue, but rather as a social and political challenge too [19]

Understanding public perception and attitude toward these technologies, then, has become a crucial endeavor. Several studies use surveys, interviews, focus groups, workshops, and other methods, to involve people and stakeholders, and to understand collectively held views and attitudes toward AVs [69, 71]. For instance, Kassens-Noor et al. [48] conducted a public investigation that shed a light on how the specific terminologies used to describe AVs impact people understanding of these technologies. Stayton and colleagues [77], instead, employed ethnographic approaches to investigate how changing notions of autonomy are experienced and expressed by users of (simulated) AVs.

More or less explicitly, these types of studies all answer to the growing demand for new metaphors and enriched narratives of driving automation and mobility at large [9]. The dominant positive arguments of safety, efficiency, sustainability, and inclusivity, counteracted by the rhetoric of novel risks and feasibility issues, get complemented with more nuanced discussions of emerging risks, and novel aspects, such as regulations, equity, and infrastructural change. These works generate new knowledge that potentially may help strategic stakeholders, i.e., industry and policymakers, to approach driving automation beyond its claims and promises. These contribute to an ongoing shift in contemporary understanding of mobility, from focusing on technological fixes to a transport society perspective [34]. Nevertheless, despite enriching narratives of driving automation, this body of expert knowledge does not necessarily end up confronting stakeholders with the assumptions they hold towards these technologies and the narratives promoting them. Stakeholders hold expectations about technologies and their future users that remain hardly expressed and, as consequence, rarely understood [39]. While design approaches dedicated to challenging stakeholders' assumptions and overarching narratives do exist, these can rarely be found within the development and decision-making around driving automation technologies.

2.1 Surfacing narrative alternatives through design

A growing body of literature, especially stemming from the social sciences, is now looking into automated driving and its complexity, both as a technological, social, and cultural phenomenon. Automated driving technologies, however, are only the latest addition to a long series of technological innovations that have been pushing expert communities to rethink the city from the modernist ideal of an *'all ordering blueprint'* to a contemporary vision of *'messy (multi-species) entanglement'* [35]. In particular, design, and HCI more broadly, has come to acknowledge the city as a complex socio-technical system, where the views and felt experiences of communities should be allowed to steer the technological innovation discourse [33]. In this regard, recent years have seen a proliferation of design research investigations aimed at enabling collective imagination and contestation of possible urban futures [18]. As Crivellaro and colleagues [18] argue, the HCI community is increasingly more interested in understanding the role of design and technologies to support socio-political action and the public to affect change in their everyday lives. Building on critical design discourses, researchers are more and more expressing concerns about the political role of design and revising traditional participatory design practices to include speculative components with the final aim of enabling collective imagination, contestation, and steering towards alternative urban futures [3, 18, 29, 32, 82].

A body of related approaches, such as Adversarial Design [25], Discursive Design [85], Design for Debate [59], and Contestational Design [43], specifically pushes forward the idea that 'design is

uniquely equipped to address audience views and attitudes towards technologies because of its ability to give vivid and graspable forms to imaginative and compelling, even if troubling, future possibilities' [68]. As for traditional design, these practices still develop artifacts as custom arrangements of parts, capacities, affordances, and concepts, but the underlying intention is to provoke rather than to solve problems [25]. Although with slight differences, all approaches intentionally deviate from familiar configurations. These alternative types of designs (that DiSalvo, [25] defines *contestational artifacts*) leverage ambiguity [25, 59, 85], achieved through unexpectedness, exaggeration, and non-conventional associations, to produce 'disjunction between expectations, the material artifact and the experience of it' [25]. By doing so, particular aspects of a political condition become graspable expressive manifestations [25] that can facilitate people to engage with a given issue. These practices can be seen as forms of social design as they can promote debate and foster collective intelligence [59].

Within the context of urban futures, and automated driving technologies more precisely, contestational artifacts and related participatory practices are also increasingly being used as mediums to surface questions and explore underlying issues that often remain excluded from popular discourses. In the *Driverless City* project, for instance, Forlano [31] uses speculative videos and artifacts to challenge techno-deterministic visions of how AV futures could be, opening venues for pluralistic futures. Relatedly, Lindgren and colleagues [53], combined the use of speculative scenarios with ethnographic investigations to understand families' commuting and driving routines, with the ultimate aim of challenging and redefining concepts of trust and sharing, dominant in the popular solutionist narrative of AVs. These are just two of the design investigations that are bringing fresh and unexpected views into mobility future discourses through participation and contestation. Yet these type of practices remains a minority [82] and do not directly address the challenge of enabling stakeholders to confront dominant narratives of driving automation. These works produce knowledge that, again, remains confined to academic debate and rarely is addressed by stakeholders in decision-making settings.

3 CONFRONTING NARRATIVES THROUGH CONTESTATIONAL ARTIFACTS

This work, positioned at the intersection of design research, critical studies, and human-computer interaction studies (HCI), focuses on *design-led confrontation as an opportunity for reflection on implicit assumptions and narratives* that stakeholders may refer to when making decisions or designing driving automation technologies. We design and employ contestational artifacts: designed objects that manifest aspects of a political condition and offer alternatives to dominant practices and agendas [25]. In our investigation, these function as inquisitive tools to understand if and how stakeholders' discussions map to dominant discourses surrounding driving automation, as well as to promote the emergence of more nuanced storylines. We leverage the possibility of these purposefully crafted artifacts to surface assumptions and beliefs characterizing narratives of driving automation which, we argue, need to be addressed at a decision-making level, thus becoming part of the political discourse surrounding mobility futures. We build upon and contribute to the growing work of the critical design research community that looks at the political role of design, which includes a body of related approaches, such as Adversarial Design [25], Discursive Design [85], Design for Debate [59], Contestational Design [43] and more. Like these, we engage with the idea that collectively imagining desirable mobility futures, as all democratic processes in general, need spaces for public confrontation and contestation in order to flourish [25]. Thus, as part of a larger multidisciplinary collaboration around responsible approaches for intelligent autonomous systems development, we crafted a series of contestational artifacts representing four driving automation alternatives and employed these in focus groups with potential stakeholders.

3.1 Crafting contestational artifacts

The first author (design researcher), with the occasional support of a professional 3D artist and an engineering researcher, crafted the artifacts as allegorical representations of alternative perspectives toward driving automation. Building on established critical and speculative design tactics, such as para-functionality [55], they combined a familiar object with unconventional details that would generate cognitive estrangement—the experience of empirical reality made strange (Csiscery-Ronay, 2003, as cited in [11])— and sustain ambiguity. Ambiguity, in fact, allows suggesting issues and perspectives for consideration without imposing solutions [36]. More specifically, each artifact builds on the emblematic element of the steering wheel and hints at a specific narrative through distinct design features. Table 1 provides an overview of the four embodiments and the related narrative perspectives suggested by the following characterizing features: *spikes, crutches, handcuffs, and table-like surface.*

Despite the differences, all artifacts suggest an underlying narrative of driving automation as an implicit trade-off between driving comfort and control–as if these were directly (or inversely) proportional to safety. This way, we engage with the predominant claim in support of autonomous vehicles–the promise of being much safer than regular cars [63]– and purposefully suggest the reductionist idea that comfort comes with costs for safety. In this, we also connect with an extensive body of social sciences literature that stresses how the socio-technical imaginary of automobility is contradictorily characterized by both a rhetoric of freedom and an extremely extensive number of regulations [46]. Our intention was to craft artifacts that would be explicitly controversial and, thereafter, provoke debate.

While initiated around the design intuitions of the first author (as often happens in critical and speculative design practices [86]), the development of the artifacts was not arbitrary. The process was iterative; it gave space to both increasingly detail the concepts and also, and foremost, to systematically question them. The outcomes of each crafting activity, such as sketches, low-fidelity prototypes, 3D renders, and 3D printed embodiments, were regularly discussed with the other members of the team who, due to their diverse backgrounds (cognitive robotics, computer science and philosophy of technology), brought significantly different interpretations and concerns. Nevertheless, as we all shared an interest in the topic of driving automation and were all familiar with the project and its scope, we also conducted two short surveys, aiming to bring an

Table 1: Set of alternative artifacts and related ideological perspectives

Alternative	Representation	Description	Feature and narrative perspective
(A) Full manual driving		"Full manual driving is the only way to ensure safety and liability in all road conditions. It requires attention and effort…but driving is a responsibility after all"	*Spikes.* These emphasize the inherent effort and danger that manual driving entails [20]. The concept builds on the idea of the car as 'dangerous instrumentality' [46], and ensures that no scapegoat scenarios [57] emerge between the human driver and the car since the whole responsibility is explicitly left to the driver.
(B) Shared control driving		"Driving systems that share control with you can increase safety in all road conditions. You need to be aware and active at all times…but driving is smooth and less tiring"	*Crutches.* Allegory of the supporting role that technology can have if driving is a shared task. This type of automation, referred to as shared control, is explored in research as a meaningful approach to driving automation [22] where technology helps cope with the limitations of the human driver without reducing agency over the car.
(C) Traded control driving		"Driving systems that trade control with you provide comfort and energy during and after your drive… you are still responsible if something happens, but driving is effortless"	*Handcuffs.* This manifests the bounding relationship that traded control driving implies without explicating it. This type of automation, referred to as traded control, still requires the driver to be attentive and reactive at all times [57], but the way it is presented to the public promotes the false belief that the car is able to operate fully autonomously, which results in misuse.
(D) Full autonomous driving		"Fully autonomous driving is the best way towards driving safety and traffic efficiency. You don't need to worry about anything…just enjoy the ride!"	*Table-like surface.* This stands for self-driving vehicles' capacity to solve mobility issues while liberating the human driver to engage in more meaningful tasks [77], such as enjoying free time or working. This artifact matches with scenarios presented in self-driving concept cars as we deem these already powerful rhetoric representations of how one can see driving automation.

external viewpoint to assess the effectiveness of the artifacts, in terms of evocativeness, ambiguity, and provocativeness.

3.1.1 Preliminary concepts' assessment. During the crafting process, we collected external feedback from selected design and engineering professionals and researchers, through two online surveys. At an early stage, after preliminary low-fidelity prototyping activities (see Figure 1 as an example) we conducted an online survey where we communicated the initial concepts using sketches and brief descriptions (see Figure 2) to 'test' the allegorical associations. Through the answers of 11 participants, we learned that the intended associations were overall clear and effective in eliciting the desired emotional response. For instance, the first embodiment was mostly associated with *"a prickly rose branch"* or a *"cactus"* and would make people think of an *"uncomfortable, dangerous but interesting"* driving experience, or the second embodiment that reminded people of *"prison"* and elicited conflicted feelings towards a driving experience that would be *"oppressive, but safe"* as *"I am locked or stuck to drive this wheel"*. At this stage, we also asked to associate each sketch with one of the possible four descriptions, to further understand how people would interpret each image. While embodiment D was almost always coupled with the fully autonomous driving description, as intended, the others were often confused. Such confusion was further confirmed in some of the comments left at the end of the survey. For instance, one participant explained their confusion especially around the steering wheel with

Figure 1: Low fidelity prototypes developed for initial concepts exploration

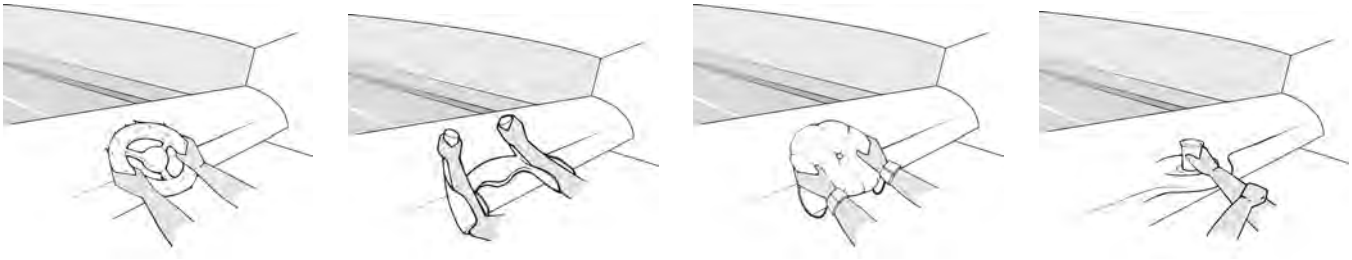

Figure 2: Sketches, based on the low-fidelity prototypes, used in the first survey for preliminary concepts assessment

spikes saying *"I don't know if you meant them to be interesting as well, but I could not relate them to something good, because to me it is clear that the spikes are bad because are unfriendly…"*.

In principle, one could consider confusion to be a problem but in this specific case, we looked at it as a sign of cognitive estrangement; a manifestation of positive ambiguity that can open up a space for meaning-making. Nevertheless, we also encountered undesirable interpretations and forms of confusion that could have hindered the way for one concept to be meaningfully discussed, thus needing intervention on the designs, especially regarding the concept C which was perceived as very uncomfortable and *"weird"*. Subsequently, at an intermediate stage of the artifact's development (when a relatively refined version of the 3D renderings of the four concepts was already developed), we conducted a second survey to assess again the appropriateness of the chosen representations. This assessment moment was motivated by disagreement among the team members about the actual effectiveness of the allegorical representations to elicit meaningful conversations about the driving scenarios. To address this issue, the first author developed an alternative set of four 3D renderings (Figure 4) each constituting a symbolic representation of different driving scenarios, as the previous set, but different in the descriptive rather than rhetorical approach to representation.

Through the answers of the 13 participants, we learned that the representations felt confusing for some (6 out of 13) and facilitated the understanding of the alternatives for others (4 out of 13). Despite the partial confusion, almost all participants correctly associated each description with the intended representation (option A 11/13; option B 13/13; option C 12/13; option D 11/13). Although the type of representation (3D rendering VS sketches) surely played a role in terms of clarity, based on these results we assumed that the new set of representations was more effective in describing the driving scenarios compared to the previous, which was also reaffirmed by some of the participants' final comments, such as *"It took a while to understand the visualizations, but once I did understand it, it made a lot of sense!"*.

Nevertheless, both looking at participants' answers and comments we considered this version not to be effective in triggering critical thinking toward driving automation. For instance, when asked if the representations would make them think of the implications of different driving automation scenarios, only two participants agreed. Relatedly, comments did not surface reflections on what the alternatives would imply for driving., but rather on the logic of the representations themselves, such as *"at first sight, only option C stands out. Then I see B, which seems as if there is no connection of the steering wheel to anything. Then, I start to see a second steering wheel in C, A, D, that with my background I can recognize it is supposed to signify the automation steering"*. Reflecting on the outcomes of both surveys, then, we became more conscious of how multiple alternative representations are possible and worth exploring, as each could surface different perspectives and effects. Yet, as the scope of our work is to understand how contestational artifacts could promote confrontation with dominant narratives and not to define what is the best way to represent the driving automation alternatives, we opted for further developing the allegorical representations, which was also coherent with the theoretical grounding of our methodological approach.

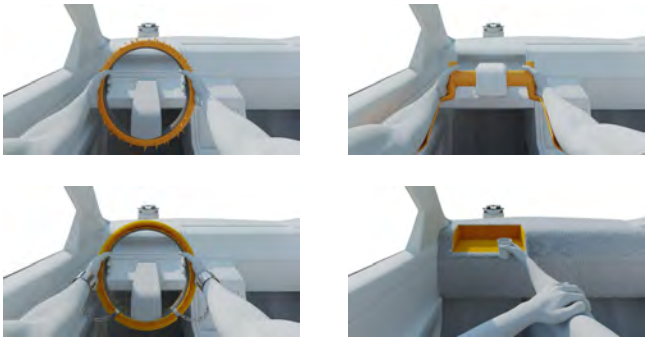

Figure 3: Early version of the four driving automation scenarios represented in 3D renderings

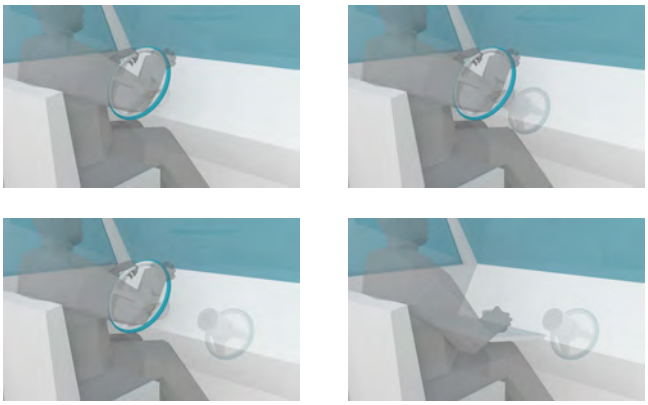

Figure 4: Alternative–non-rhetorical–version of the four driving automation scenarios represented in 3D renderings, used in the second survey for preliminary concepts assessment

3.1.2 Concepts refinement and artifacts' production. Learning from the preliminary surveys and discussing within the team, we iterated on the design of the four embodiments and their descriptions. On the one hand, we refined the embodiments by paying particular attention to aspects of credibility while also trying to maintain a productive level of ambiguity. On the other hand, we improved the descriptions by simplifying the language for a non-expert audience while also maintaining purposefully narrow views on aspects of safety and control.

Through the collaboration with a professional 3D artist and an engineering researcher experienced in prototyping, the process resulted in three sets of contestational artifacts: visual representations (Figure 5, top); tangible but non-experiential artifacts (Figure 5, center); and tangible experiential artifacts as add-ons on a driving simulator (Figure 5, bottom). The primary motivation for developing such alternatives was to adjust to the limitations imposed by the pandemic emergency on the possibility of conducting studies in person. Nevertheless, we embraced this also as an opportunity to explore if and how the material and experiential components of the artifacts would impact the reasoning about the artifacts and the related topics.

4 USING ARTIFACTS IN PARTICIPATORY RESEARCH

We used the contestational artifacts within the context of focus groups. Our aim was to understand stakeholders' reasoning about driving automation and whether and how this would be affected by being exposed to our artifacts. Focus groups, similar workshop settings that involve potential stakeholders, allow generating discussion around topics that requires collective views [64]. As such, these are often used by research and governmental institutions to investigate societal perspectives on a given topic (see various public consultation initiatives on driving automation in Europe [**? ?**]). In particular, these allow gathering a rich qualitative understanding of stakeholders' perspectives and open up a space for collaboration [62]. They are particularly suited for generating information on participants' beliefs, as well as collective views and the meaning that lies beyond those views [64].

Our exploration methodologically builds on existing narrative research approaches where argumentative resources are used as interpretative aids and boundary objects for argumentations [54], as well as on the growing body of research employing critical and speculative approaches to enable both strategic stakeholders and the public to take part in the political life of innovation (i.e., [16, 38, 73, 87]). More specifically, we build on DiSalvo's idea of Adversarial Design as a participatory practice where tools and methods are ideally crafted to promote debate and express dissent [25].

4.1 Procedure and materials

As shown in Table 2, we ran four focus groups, preceded by two trial sessions with design students. Each focus group lasted about 2 hours (as recommended in previous works [65]), and included around three activities:

- *Disclosing*. Participants are invited to share their first thoughts and overall attitude toward driving automation.
- *Sensitizing*. Participants are presented with the artifacts and challenged to associate them with descriptions (see 'Description' column in Table 1).
- *Deciding*. Participants are invited to agree on one scenario of automation to be implemented (in 6 months) and discuss its implications.

The preliminary sessions were crucial to determining the intuitiveness of the activities and the effectiveness of these in triggering nuanced discussions. In the first trial session (with 4 design students), we learned that presenting the artifacts already associated with their descriptions, and then asking for discussing the potential pros and cons of each was not sufficient to trigger debate and spontaneous exchange of opinions. This led us to think of a challenge for participants: matching each artifact with one description (*sensitizing*). In the following trial session (with 3 design students), we verified the effectiveness of the 'matching challenge' to trigger debate yet noticed little exchange of thoughts and convergence at the final stage. Thus, we also revised the final activity to be more provocative – an 'impossible challenge' where participants have to

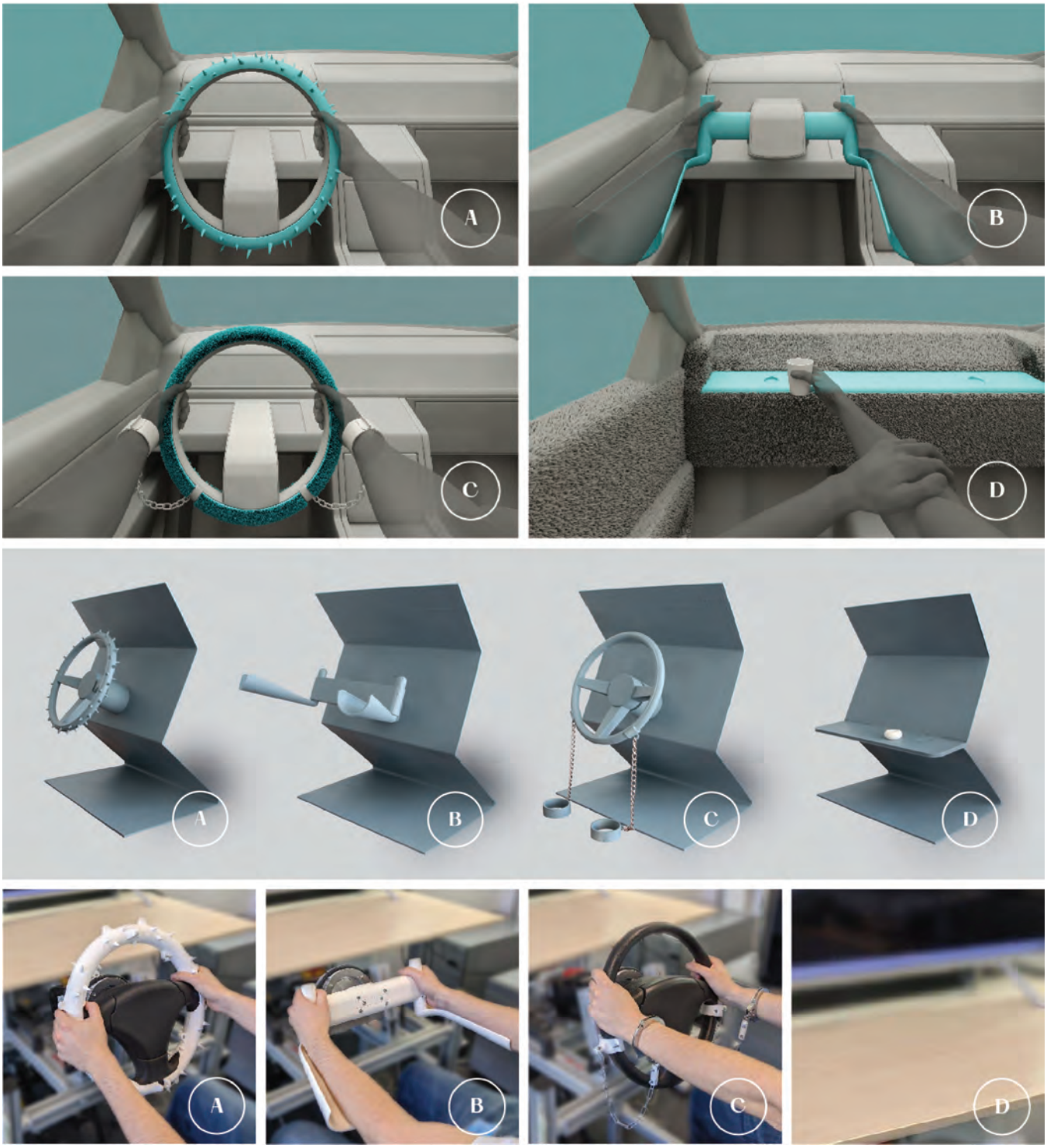

Figure 5: Three versions of contestational artifacts. Top: visual representations. Center: tangible, non-experiential, artifacts. Bottom: tangible and experiential artifacts applied as add-ons on a driving simulator.

agree on one single driving scenario to be implemented for a whole country in six months (*deciding*). Regarding the number of focus groups, besides the fact that two to three focus groups might be enough to discover about 80% of topics from discussions [41], we

deemed four sessions to be sufficient for the scope of our work (understanding if contestational artifacts could promote confrontation with narratives). These allowed us to both explore the use of the alternative sets of artifacts, as well as to involve a sufficient variety of stakeholders. The procedure was the same for each workshop, only the artifacts in use changed (see Figure 6) according to the restrictions in place at the time of the focus group, i.e., the first focus group employed only visual representations because physical gatherings were currently prohibited. For the same reason, each focus group procedure was individually submitted to and approved by the university ethics committee.

Table 2: Focus group settings and participants

Focus group	Artifacts type	Setup	Participants
1	visual representations	online	1 Innovation director from Design agency; 3 employees Municipality of Rotterdam, involved in innovation initiatives
2	tangible but non-experiential artifacts	in person	4 Engineering researchers
3	tangible and experiential artifacts applied as add-ons on a driving simulator	in person	1 Engineering researcher, 2 Design graduating master students
4	tangible but non-experiential artifacts	in person	3 Employees of Dutch road safety research and administration institutes

4.2 Participants

We involved a total of fourteen people (6 female and 8 male), which included both active stakeholders, experts of the mobility sector, and potential stakeholders–people with an explicit interest in future mobility and automation technologies and with technical expertise. Specifically, we selected a mix of researchers and graduating master students with engineering and design backgrounds; an innovation director of a digital design agency; three employees of the municipality of Rotterdam, involved in innovation initiatives; employees of Dutch road safety research and administration institutes. Students and researchers were recruited through an open call, shared via faculty mailing lists, while the representatives of agencies and institutions were invited via personal contacts. We distributed participants across focus groups according to the level of expertise, rather than mixing them, to avoid issues of dominance (a recurring problem in participatory processes [42]).

4.3 Data collection and analysis

With the written consent of participants, we video-recorded each focus group and took pictures of salient moments of the activities. The focus group recordings were transcribed and anonymized assigning each participant a pseudonym. Similar to the design for debate previous works [59], we analyzed and coded the transcripts following deductive thematic analysis and iteratively complemented with open coding. The coding book (table 3 in Appendix A) shows the themes used for coding, together with the key literature we extracted them from, as well as a set of themes we identified through the analysis. Building on [10] and [83], in fact, we familiarized ourselves with the data, defined a list of a-priori codes based on the themes emerging from literature; and then coded the transcripts both following a-priori codes and adding a-posteriori codes when needed. Finally, we iterated the coding of each focus group transcript with a-posteriori codes; and clustered the coded units. This decision was based on our research scope; more than looking for emerging themes, we aimed at answering the question of *if and how using contestational artifacts within participatory research can help confront stakeholders with the beliefs and arguments propagated by popular narratives*. Thus, we structured our analysis around three main hypotheses, that are:

- H.1. the themes discussed by stakeholders during the first part of the focus group (*disclosing*) match with–or to a large extent map to– the arguments perpetuated by popular narratives of driving automation.
- H.2. the focus group activity promotes more nuanced discussions about driving automation, manifested by a divergence between the initial (*disclosing*) and the final (*deciding*) argumentations.
- H.3. the critical design artifacts play a crucial role in enriching the discussion and confronting with taken-for-granted arguments, manifested by participants' reasoning about the artifacts (*sensitizing*).

We then visualized the coded arguments into plot diagrams to provide a bird-eye view of the results and facilitate analysis (Figure 9 in Appendix A shows the diagram from focus group 4 as an example). The discussions and arguments that emerged during the sensitizing phase were excluded from the visualizations as these do not necessarily reflect participants' views on driving automation, but rather their sense-making about the artifacts. Yet, in a second moment, we looked into this part of the discussion too as in the familiarization phase of the data analysis we noticed the emergence of a sub-theme focused on artifacts that we deemed interesting and worth discussion.

5 RESULTS

In this section, we provide an overview of how the discussions generated during the activities relate to and respond to the research hypotheses listed in the previous section.

5.1 (H1) Stakeholders' discussions (initially) map to popular narratives of driving automation

The themes emerging from the *disclosure* phase of all focus groups do largely map to popular arguments (see Figure 7). The diverse participant profiles and interests, however, translate into differences in overall attitude towards driving automation and selected themes. In both focus groups 1 and 4, the initial attitude was predominantly negative, focus group 3 had more in-between positions, and focus group 2 was slightly more positive than negative.

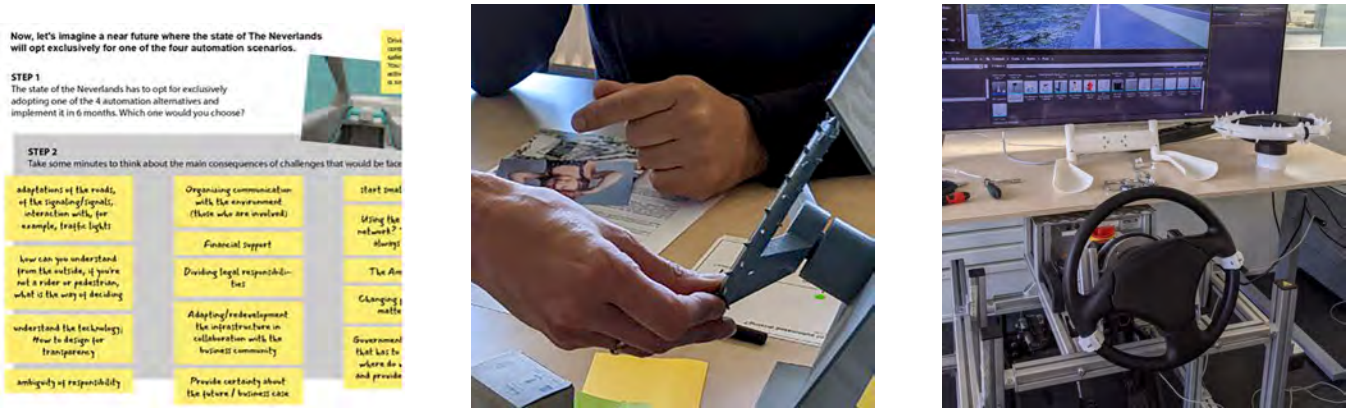

Figure 6: Left: a screenshot of the online collaborative whiteboard used to run the first remote focus group; the artifacts are introduced as visual representations. Center: tangible non-experiential artifacts in use during focus group 4. Right: testing setup with the driving simulator and the artifacts mounted as add-ons, in focus group 3.

On the positive side, all focus group discussions map on the theme of safety, and almost all to the idea of automation as a form of liberation (except from focus group 2). The discussions of potential benefits, however, also revolved around distinct themes in almost every focus group (except from 4): inclusivity (1), efficiency and sustainability (2), and efficiency and productivity (3).

On the opposite side, feasibility is addressed as a primary concern by almost all (focus groups 1, 3 and 4) except for focus group 2. Then, focus groups somewhat split regarding other concerns: focus groups 1, 2, and 3 focused more on safety; while focus group 4, which involved experts from mobility authorities and institutions, largely discussed aspects of acceptability, with a peculiar perspective. Their discussion of acceptability, in fact, did not focus on aspects of trust, i.e., how to make people trust self-driving cars, which is a common acceptability concern in popular narratives. They rather discussed beliefs and the need for accepting or rejecting them. In a participant's words *"someone last week [...] asked 'Do you believe? Do you believe that all cars can be autonomous and can drive everywhere? Like at some point' and this person was clearly thinking 'Yes, it is, it can be achieved'. And why? Because we should just adapt all the city streets"*. This manifests how, although mostly mapping to the main themes emerging from dominant narratives, the expert participants in focus group 4 were already capable of discussing them with nuances. Some instances of critical and nuanced perspectives, however, were also present in other workshops. For example, in focus group 2 potential sustainability gains are discussed together with counteracting arguments bringing up the complexity of the topic, such as *"I think in some circumstances and for some countries, [...] especially for countries where traffic is already quite well organized [...] maybe those countries (automated driving) it's worth, to add fuel efficiency to energy-saving policies"*.

5.2 (H2) Stakeholders' discussions diverge from polarized arguments towards nuanced perspectives

The plotted discussions (see Table 2 in Appendix A as an example) show signs of divergence from the *disclosing* to the *deciding* phases, together with an enriching of arguments. These are manifested by shifts toward different themes, by statements mapping to themes known in literature but excluded by popular storytelling, as well as by statements that map to multiple themes. For instance, both in focus groups 1 and 3, safety is first discussed as a benefit of AVs, but then problematized and addressed as a pain point, stressing how the feasibility of AVs depends on the possibility of having a context with specific (favorable) conditions. Similarly, focus group 4 unpacked and enriched the discussion of popular arguments over the course of the activity, but also surfaced unconventional views and topics, such as the role of misleading claims made by the mobility industry. We look at these shifts in perspectives as signs that the activity was able to promote divergence and complexity thinking in participants' discussions. But to better understand what the value of these richer discussions might be, we dived deeper into the arguments where we noticed complexity, interdependence of factors, and opposite views on the same theme. As a result, we identified the following three *narrative tensions*.

5.2.1 Global stories of somewhere technologies. The genericity of the AVs gains propagated by dominant narratives, especially efficiency and safety, clashes with the specificity of many feasibility concerns that are believed to hinder the way to the benefits of AVs. Some participants, for instance, emphasized the need for certain contextual conditions that would allow driving automation technologies to function, such as an environment where you don't have 'occluded things or bad weather, such as a *"desert where everything has a roof on top"* (P3 in FG2), a *"tunnel or an island"* (P4 in FG2). Relatedly, others expressed the belief that these technologies will eventually work only in certain countries, *"especially in the western countries"* (P4 in FG2). In places like Nepal and the South

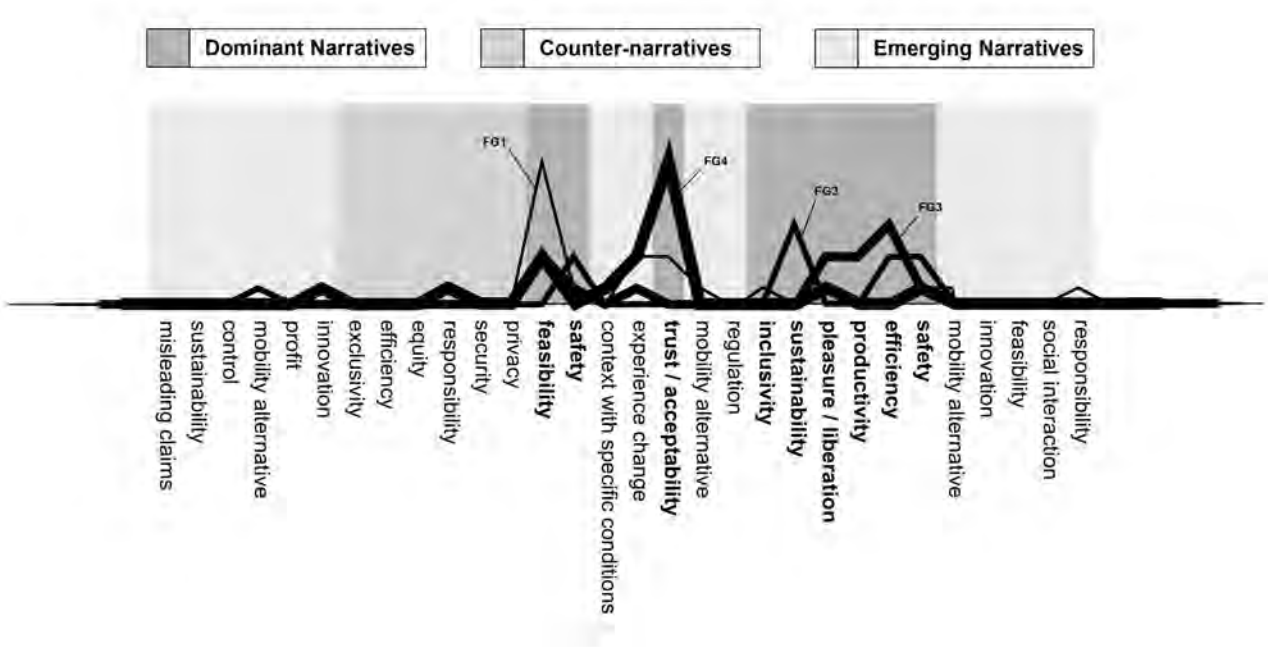

Figure 7: Arguments emerged in the disclosure phase of the four focus groups, distributed onto themes associated with dominant, counter, and emerging narratives

of Italy, the home countries of the two participants, it is deemed hard to imagine how such technologies could work, because of the complexity of the environment where there are narrow streets, hills, mountains, and less regulated driving. Driving automation technologies, then, delineate a geographical divide grounded on infrastructural differences that could only be exacerbated by technological advancements. Furthermore, the idea of city infrastructures fully arranged to enable AVs to function is not only hard but also disturbing to imagine: *"... it can be achieved. If you would remove humans from cities and replace them by cars..."* (P2 in FG4). This narrative tension, then, confronts us with how developing driving automation technologies, especially AVs, means *accepting the assumption that we can have an ideal place–an undefined somewhere–for these technologies to function.* Getting to such somewhere implies building infrastructures, changing regulations, and directing funding. Overall, a massive system adaptation that is carefully left out of the utopian storytelling of AVs.

5.2.2 Inclusive vehicles of exclusion. Inclusivity emerged as one of the most recurring arguments in favor of driving automation, across all focus groups. For participants, the idea that AVs will provide mobility opportunities to people that are currently excluded from driving is powerful and justifies interest and investments in these technologies. Even in the case of a specific participant (P3 in FG4) who started the discussion with *"why? I'm still looking for very strong arguments in favor of autonomous driving"*, inclusivity later comes as a sufficient justification. Driving automation technologies, however, also bring a radical change in the user experience of the car, as well as in its cost. As such, several participants raised the concern that AVs would in fact generate or exacerbate other forms of exclusion from driving, which can be due to the eventual raising costs of vehicles (P4 in FG1) or lack of technological literacy and confidence (P3 in FG2). Furthermore, in the hypothetical process of transitioning towards a fully automated mobility system, certain jobs, such as trucks and taxi drivers, would cease to exist. This second tension, then, confronts us with the dual potential of AVs to both increases as well as endanger access to individual mobility. By justifying the development of such technologies with claims of social benefits, like inclusivity, *we might neglect how answering social needs through a technological solution could also imply prioritizing the needs of some at the expense of others.* In short, arguments of inclusivity are prominent in the popular narratives, yet these are hardly presented together with their inherent trade-offs, and discussions of inclusion are often limited to matters of physical and cognitive inabilities.

5.2.3 Driverless connected mobility services that are not public transport. The third tension revolves around the theme of a mobility alternative. Many participants surfaced the idea that with driving automation you could increase public transport, car sharing, or ride-sharing *"because it's much easier to share"* (P1 in FG4); *"you are no longer dependent on the riding seat... now you have four people or eight people. Then you could drive 100 people..."* (P2 in FG1). This was discussed as a desirable perspective by several participants, as they saw it as an opportunity for reducing emissions, thus contributing to more sustainable mobility (P3 in FG2), improving efficiency by reducing the number of vehicles on the street (P4 and P1 in FG1), as an opportunity for novel forms of social interaction (P1 in FG1),

and as a solution to traffic safety and efficiency (P4 in FG2). This line of argumentation, however, was constantly contested and negotiated by participants, including the ones who started it. In fact, while some see AVs as an additional mobility alternative (P2 in FG4), others (P3 in FG1, and P3 in FG4, P3 in FG2) think of it in clear competition with public transport and even argue that *"we should invest more in public transport [...] getting away from cars"* (P3 in FG2). Underlying these arguments sits an undefined idea of what driving automation can be. Sometimes associated with cars, other times to shared vehicles, *driving automation technologies could actually be implemented in a multiplicity of ways and services*, all implying different types of investments, infrastructures, and experiences. Such a spectrum of possibilities, however, *hardly fits into the social dream of the AV*, where the vehicle is a personal space for playing, working, or sleeping, but rarely a shared space for commuting.

5.3 (H3) Stakeholders confront taken-for-granted arguments (partially) through artifacts

The discussions from all focus groups, except the last, ended up with a focus on shared control driving (option C) as a feasible and acceptable solution to implement in the short term. This is not a surprising result as the activity explicitly 'forced' participants to decide on a single automation scenario (among the four alternatives presented with the contestational artifacts) to be implemented within the limited timeframe of 6 months. In this regard, participants from focus group 3 explicitly mentioned that they would rather choose the full automation scenario if the timeframe was larger. The same reasoning motivated participants in focus group 4 to focus on the full automation scenario, explicitly putting aside the time constraint. Regardless of the final choice, all focus group discussions explored the various alternatives of driving automation, which shows how the activity was successful in letting stakeholders consider options beyond the sole idea of AV. As discussed in the previous section, the activity surfaced narrative tensions that are rarely addressed in popular discourses. But, *has this positive outcome resulted from the specific use of contestational artifacts?*

While we prefigured the contestational artifacts as a core part of our critical approach, the coded transcripts only partially show explicit links between these and the emerging themes and narrative tensions. In participants' arguments, we can see how the artifacts were helpful in shifting the attention towards shared and traded control driving alternatives that are seen as *'intermediate phases'* (P3 in FG1) of the path towards full automation; modalities that could allow the human driver and the vehicle to *'know each other better'* (P3 in FG1). Distinctive in this regard, is the case of focus group 4 where starting from the artifact's discussions, participants explicitly discussed how *"it's necessary that both the vehicle and the human are expressing their upcoming actions and intentions... It should be something like... in your face in your face [...] not making these spikes but something to make a very clear difference between what is assisted driving and what's automated driving"* (P2 in FG4). Some participants also surfaced specific concerns regarding the particular case of the shared control driving option, i.e., one participant (P3 in FG 2) argued that their grandma would feel intimidated by such technology; they would think that the car knows best, and therefore would feel reluctant to act. The 'grandma example' (and the underlying idea that automated vehicles could end up excluding people based on their technological fluency) is probably the only explicit example of arguments grounded on–or inspired by– the artifacts, that connect to the narrative tensions described in the previous section.

Nevertheless, aspects of the argumentations stemming from the artifacts' discussions, i.e., the idea of the human and the vehicle getting to know each other better, and needing to communicate their intentions to each other, suggest that participants tended to conceptualize the human-AV relationship differently from the dominant narratives. If in popular storytelling the human driver is a problem to be entirely replaced by a more competent–artificial–agent, here *the human driver and the vehicles are partners tackling a dangerous task*.

5.3.1 Bargaining partners in drive. To validate the intuition that participants were conceptualizing the human-AV interaction as a partnership and to further unpack this perspective, we have dived into the transcripts of the sensitizing phase of the activity, in which participants were introduced to the artifacts and challenged to match them with descriptions.

While almost all the artifacts generated some creative interpretation and reasoning, i.e., *"you could choose the handcuffs voluntarily because 'Hey, I want to push myself to just be attentive' even if it's just the car who controls"* (P3 in FG2), it was striking to see the discussions regarding the first artifact, embodying the full manual driving scenario (see one excerpt from focus group 4 in figure 8). The spikes, the characterizing element of this artifact, were intended to signify an inherent danger, a potential pain that manual driving implies. Participants, however, tried to understand their role in utilitarian terms, which led all (more or less explicitly) to surface the same alternative meaning: spikes are meant to communicate to the human driver the AV intentions. In the participant's words: *"the vehicle is the one driving itself, but you can control it. But the vehicle has spikes, so controlling it would be on purpose hard. And it's like, you can, but please don't"* (P3 in FG3). And then, *"if you cannot hold on to it anymore then maybe you should take a break from it"* (P3 in FG2). The same idea was further advanced by some participants who imagined the spikes as a dynamic feature of the steering wheel: when the car is in control, there are the spikes, and then when the human is in control the spikes disappear (P4 in FG 2, and P1 in FG4). Contrasting ideas about the same artifacts were also discussed, i.e., the spikes symbolizing the danger of driving, which makes you feel like the vehicle is doing everything for you, but actually, you are the person who should still be engaged (in the case of traded control) (P2 in FG4). However, the concept of spikes as a way for the vehicle to communicate intention resulted as the strongest and, especially in FG2 and FG4, participants enthusiastically indulged in imagining how this could transform into an actual design feature. In this regard, P3 in FG4 exclaimed: *"We are designing now!"*.

The discussions emerged during the sensitizing phase of the focus groups, then, confirmed the intuition that participants were conceptualizing *the human driver and the vehicles are partners tackling a dangerous task*. Even more so, it suggested that as part of such a partnership, the vehicle is envisioned as something that could negotiate, or even claim agency up to get full control. According

to this, we further refined this emerging concept of human-AV relationship as *'bargaining partners in drive'*.

6 DISCUSSION

In this section, we reflect on our proposition to look at *design-led confrontation as a meaningful way to create opportunities for reflection on implicit assumptions and narratives* that stakeholders may refer to when discussing and making decisions about driving automation technologies.

The results of our investigation show that the discussions of (potential) stakeholders tend to map onto the dominant arguments propagated by popular narratives, as well as that the focus group, our 'adversarial' participatory practice, helped to enrich the discussions with contrasting perspectives and nuanced interpretations of popular arguments. The emerging topics and perspectives (see Figure 1 in Appendix A), however, to a large extent match with knowledge existing in academic literature, which might suggest a shortcoming of the approach. The idea of a radical change in experience, for instance, is discussed by different authors (i.e., [52, 76, 80]), is implicitly contained in the theme of liberation, and inherent to corporate visions of driverless mobility futures (e.g., images of a passenger sleeping in the car). Similarly, the concept of mobility alternative is present in the literature that stems from the assumption that driving automation technologies could/will lead to a transition toward a new paradigm of shared mobility [40, 45, 49]. Nevertheless, we argue that the value of these emerging overarching themes lies in the way these relate to and confront popular narratives within the focus group discussions. These mostly emerged from participants problematizing taken-for-granted beliefs, such as the idea that driving automation will solve safety issues, or that AVs will be feasible. As such, these surface *narrative tensions* underlying popular argumentations, and confront participants with dominant beliefs and contradicting visions of future mobility. The first narrative tension, that we summarized as *'global stories of somewhere technologies'* invites us to question whether we–both as society and stakeholders–should be willing to embrace the systemic change that AVs might require, from massive infrastructuring, to revision of regulations, to the redirection of public fundings. It promotes reflections on how the choices that countries with already advanced traffic systems may impact the countries that are and will, for the envisioned future, remain excluded from such technological transition. It confronts us with the uncertainty of what would happen at the borders, and what is the geo-political landscape we refer to and, at the same time, are willing to shape in the process. Relatedly, the second narrative tension, *'inclusive vehicles of exclusion'*, brings up questions of who is involved and who is excluded from these types of innovation. It raises questions of whose access we are prioritizing and what solutions could increase inclusivity and equity for all, but also if and why we need a technological solution to social issues. Last, the narrative tension we summarized as *'driverless collective mobility services that are not public transport'* confronts stakeholders with the need to explicitly define what idea(s) and model(s) of automated mobility we are envisioning, and why. It surfaces questions on whether and how driving automation could facilitate sharing and collective mobility. And overall, it asks us to reflect on how a chosen mobility model would impact other existing mobility systems, i.e., public transport.

Similar to the three tensions, but distinctively designerly is the emerging concept of *'bargaining partners in drive'*. This constitutes both a narrative tension (emphasizing human-vehicle interaction over replacement) as well as a potential inspiration for future technology development (generating creative thinking into how bargaining of control could be best expressed and supported). The idea of negotiation between the human driver and the vehicle is somewhat present in automated driving visions, especially in the case of intermediate automation modalities, yet in our exploration, it emerged vividly as a site for reflection on the implications of delegating control. In particular, this invites us to reflect on the possibility for the vehicle to become a proactive agent – to engage in what we describe as a bargaining act, for emphasizing aspects of intentionality and 'will' [84]. The concept, we argue, powerfully challenges us to question the capabilities of both the human driver and the AV, and to further reflect on whether we could and should accept the vehicle explicitly telling us not to act, in a participant's words (P3 in FG3): *'you can drive, but please don't'*.

The emerging narrative tensions, then, introduce opportunities for stakeholders to engage and confront aspects of ethics, power, and justice that are present in literature (see the concept of mobility justice [75], or the topic of dangerous instrumentality [46]) but often remain unaddressed within the development and decision-making discourses around these technologies. These manifest how 'adversarial' participatory practices can be valuable discussion prompts in analogous workshop settings to promote critical reflections on driving automation technologies. As such, we suggest that the *narrative tensions represent a first contribution* of our work.

Also, and foremost, however, this work contributes to the growing body of critical design and HCI literature committed to promoting pluralistic views into mobility futures–and technological futures more broadly– through its methodological approach. Although our assumption of the central role of artifacts was only partially correct, through this investigation we built a rich understanding of the values and mechanisms that adversarial participatory practices can bring. We summarize these as a set of *methodological insights and design recommendations* that we generated reflecting on the process and the results.

6.1 Methodological insights and design recommendations

Reflecting on the role of the contestational artifacts within the activity, we observed that these were only partially responsible for the effects on participants' conversations and were limited to argumentations pertaining to aspects of human-AV interactions and relationships. This is not surprising as the artifacts did embody solely ideas of control, change of experience, and safety. However, this also suggests that nuanced perspectives that challenge dominant narratives can emerge independently from the use of contestational artifacts. As such, one could question whether this type of activity does qualify as an example of adversarial design [25], or even as a designerly intervention at all. As a matter of fact, focus groups are intended to broaden the understanding of a topic under investigation through a process that promotes critical

discussion of beliefs and meanings that lie behind collective views [64].

In response to this, we argue that *the structure of the activity can be a contestational artifact in itself.* The strategies used to both ask for personal views as well as for building a shared understanding of a topic can be inherently contestational. By presenting artifacts and their descriptions apart from each other and asking participants to collaboratively match them, we inherently opened a space for questioning and created a clash between the participant's rational thinking and the rhetorical nature of the artifacts. And by asking participants to make a non-realistic choice, deciding on one automation scenario to be implemented in six months, we pushed them to move a critique and problematize the processes to automate driving. Our work, then, extends Design and HCI existing knowledge on critical practices, specifically about how the debate must be regarded as an object of design in itself [89], further loosening the boundaries of what we define as a designed object rather than dissemination strategies [68].

While we argue that engagement strategies are artifacts in themselves, we also claim that more 'traditional' design artifacts–things embodying a thinking– bring a distinct value, which is generativity. As we illustrated in the results, general discussion can surface meaningful narrative tensions, however, the *discussions surrounding artifacts can generate novel interaction concepts and foster 'designerly thinking'.* As such, this work provides one example of how and for what purposes adversarial design–and critical design in general– can be employed in constructive research endeavors, which is often questioned [33, 74], but also shows how it can be generative, rather than merely contestational, another recurring critique to alternative design practices [89].

To our surprise, however, we learned that *the experiential component that embodied artifacts can enable does not necessarily help challenging beliefs and enriching discussions.* For instance, in focus group 3, where the artifacts were mounted on a driving simulator and participants experienced the alternative driving modalities, the discussions appeared considerably less rich and critical, especially compared to the ones that emerged in focus groups 2 and 4, where the tangible non-experiential artifacts were used. Thereafter, we suggest that *ambiguity is a crucial and powerful design strategy to trigger imagination and formulation of hypotheses.* As particularly evident in the discussions about embodiment A, the participants' incapacity of finding a convincing motivation for why a steering wheel would have spikes generated rich discussions and creative interpretations, that the research team itself did not anticipate. And, while ambiguity is known to be an engaging and thought-provoking quality of human interactions with interactive products [36], our work enriches this knowledge by providing further examples of how it can be purposefully crafted into contestational artifacts to enhance their capability of provoking critical and generative debate.

Based on these reflections we distilled five design recommendations for designers and researchers embarking on a similar journey, around narratives and contestation:

- *Define the scope, between confrontation and development, to decide on an artifact.* Although the two are not mutually exclusive, contributing to technology development distinctively benefits from the use of 'object' types of artifacts (over general activities), such as the steering wheel that helps grasp aspects of control and mutual understanding in automated driving scenarios.
- *Define the scale, between interaction and societal change (and everything in-between) to decide on an artifact.* The artifact we choose as a vehicle of contestation will influence the focus of the emerging debates. While a steering wheel may be well suited for discussing aspects of safety and control, it may be less so to address issues of social inequality and exclusion, for which a specially crafted map, a manual, or even a performance may be more effective.
- *Consider activities within the spectrum of possible artifacts to craft as an expression of contestation.* The same principles of unexpectedness, exaggeration, and non-conventional associations can be applied to activities, rather than material artifacts, and generate the estrangement effect desired to trigger debate and reflection.
- *Ponder whether to incorporate a computational dimension to the artifacts.* Although existing literature on adversarial design strongly emphasizes the coupling of computational intelligence and physicality [25], our experience suggests that providing stakeholders with an interactive experience of the artifacts may actually be counterproductive, as it removes from these the ambiguity.
- *Define design features that avoid confusion but maintain ambiguity.* Mere confusion is undesirable because it can promote irrelevant discussions and stall the debate. Yet, ambiguity is necessary to promote collective meaning-making. Fine-tuning a sufficient balance between clarity and ambiguity requires iterative efforts where artifacts are systematically crafted and questioned, within and outside a research team.

7 CONCLUSIONS

In this work, we problematized popular narratives of driving automation arguing that, whether positive or negative, these propagate simplistic assumptions about human abilities and reinforce technocratic approaches to mobility innovation. We built on narrative approaches to participatory research and adversarial design, to explore how design-led confrontation can create opportunities for reflection on implicit assumptions and narratives that stakeholders may refer to when developing and/or making decisions about automated driving technologies. Specifically, we developed a set of contestational artifacts– provocatory embodiments of steering wheels allegorically representing implications of four automated driving alternatives– and used them to spark discussions among stakeholders in focus group settings. Through the results of four focus groups, we showed how the discussions of the stakeholders tend to initially map to dominant narratives and diverge over the course of the activity. Discussions moved from dominant argumentations towards nuanced interpretations of popular themes, as well as novel ones. Based on these, we identified three narrative tensions. The enrichment of the discussions, however, was not exclusively determined by the use of contestational artifacts. The focus group process, with the explicit emphasis on disclosing personal views as well as taking decisions with others towards an unrealistic scenario, was itself able to foster critical discussions. Thereafter we suggest

that the structure of a participatory activity can be a contestational design artifact in itself. Distinctively, however, the discussions mediated by contestational artifacts add to such fostering of nuanced perspectives the capacity of promoting 'designerly thinking'–the emergence of novel interaction concepts. Interestingly, such generative thinking did not emerge because of the artifacts' capacity of manifesting technological capabilities, as one may expect, but rather because of the ambiguity crafted into the allegorical artifacts.

This work, then, contributes to a growing body of Design and HCI literature exploring critical approaches to computing and automation, by providing *narrative tensions* but also and foremost illustrating the value of adversarial participatory practices, and providing *methodological insights and design recommendations* for promoting confrontation with dominant narratives of technology through contestational design artifacts.

Our research, however, is not free from limitations. First, our analysis focuses only on the dynamics of the group discussions. Interesting and relevant nuances were raised by individual participants, yet these are not reflected in the results. For instance, almost in each focus group, there was one theme characterizing the discussions from the start to the end, which was introduced by one participant based on a personal need or experience, i.e., inclusivity as an answer to a personal health issue. For coherence and clarity, however, we decided not to address these individual perspectives in the current work. Relatedly, we also left out of the discussion researchers' small stories. Individual worldviews, disciplinary background, and social status (among other things), all contribute to shaping researchers' approach to research [44] and the ways technological narratives themselves are understood and contested. The project unfolded as a conversation among the disciplines that the research team brought together, which are critical design, cognitive robotics, and philosophy of technology. The researchers all live and work in The Netherlands but two come from other countries, Italy and Brazil, with relatively different social, economic, and political conditions. Yet, our work does not explicitly engage with the alternative views and values that our individual differences may carry and, as such, misses out on the opportunity to also critically reflect on whether and how personal standpoints translate into specific politics of artifacts [24]. We believe, however, that this inherently controversial space where personal standpoints and biases mingle with dominant narratives constitutes an interesting area worth investigating, on the relationship between the small and the big stories each participant and researcher carries and engages with [37].

Finally, the potential impact of our work is limited within the space of sessions like the ones we conducted and analogous activities. We purposefully limit our scope to promoting confrontation as to really dismantle dominant narratives would require a combination of long-term actions to eradicate assumptions rooted in a long history of mobility discourses, which is beyond our current capabilities. As Jain [46] argues, it is important to understand how the driver has become 'the problem', how potentially useful concepts like the one of dangerous instrumentality have been discarded, and how the dramatic simplified view of the complex object of the automobile has contributed neglecting the socio-technical complexity of mobility. In order to truly break free from dominant utilitarian framings, then, we will need to observe and understand where and how the controversial arguments characterizing dominant narratives of AVs originate and to deviate from those historically problematic trajectories [45]. Among the long-term actions that one could engage with in this direction could be to limit the roles and powers of the industry which is heavily responsible for defining the terms of mobility future discourses [45], which could happen by means of regulations and legal interventions (current legal investigations into deceptive advertisement could be seen as an example in this direction [79]). Although we do not engage yet with interventions at this scale, we believe our work, the methodological approach we propose, represents one of the possible entry points, a non-prescriptive instrument for pointing at the inherent tensions that need to be addressed if we truly aim for more just mobility futures. We show how adversarial participatory practices can provide a space for collectively asking *"what is the dot on the horizon we are aiming for"* (P2 in FG4) and question if we should even design certain technologies. As such, this work contributes to the Design and HCI disciplinary investigations into how we might open up opportunities for confrontation and contestation, as a way towards more democratic shaping of urban futures where technological interventions represent one in a multitude of possibilities.

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A APPENDIX

Table 3: Coding book. Under the "popular" category, we list the themes emerging from popular narratives. Under the "unpopular" category, we list the themes emerging from the literature that challenges dominant narratives in favor of nuanced stories of socio-technical complexity. Under the "emerging" category, we list the themes identified during the familiarization with the focus group data

Theme	Example argument	Sources	Category
SAFETY (+)	"Vehicle safety promises to be one of automation's biggest benefits. Higher levels of automation, referred to as automated driving systems, remove the human driver from the chain of events that can lead to a crash"	[62] [60] [90] [9][39]	Popular
EFFICIENCY (+)	"Reduced traffic congestion due to more efficient mobility and parking management"	[62] [60] [90] [9]	Popular
PRODUCTIVITY (+)	"Significant time saving - people can use in-vehicle time to be more productive"	[62] [60]	Popular
PLEASURE & LIBERATION (+)	"Smoother rides, more cabin space and more relaxed traveling"	[62] [60]	Popular
SUSTAINABILITY (+)	"Environmental benefits including less CO2 emissions due to CAVs eco-driving capacity"	[62] [60]	Popular
INCLUSIVITY (+)	"Fewer layer of social exclusion - less age, disability, and skill barriers in 'driving' a vehicle"	[62] [60]	Popular
TRUST & ACCEPTABILITY (0)	"User resistance to giving up control - loss of freedom and joy of driving and fear of unknown"	[62] [39] [90]	Popular
FEASIBILITY (-)	"Huge costs meaning to make road infrastructure compatible with CAVs"	[62] [9]	Popular
SAFETY (-)	"Loss of driving skills and situational awareness that might be critical in an emergency"	[62] [39] [90] [9]	Popular
PRIVACY (-)	"Privacy issues and loss of personal space"	[62]	Unpopular
SECURITY (-)	"Increased vulnerability to software and hardware flaws and cybersecurity threats"	[62]	Unpopular
EFFICIENCY (-)	"More car trips could be generated from more users and from unoccupied vehicles"	[62]	Unpopular
INCLUSIVITY (-)	"Equity issues in case CAVs end up being high-end products expensive for the average road user"	[62]	Unpopular
RESPONSIBILITY (-)	"Liability disputes for accidents and damage issues"	[62] [39] [90]	Unpopular
SOCIAL INTERACTIONS (+)	"Automation facilitates car sharing where people can experience new social interactions"	Focus group 1	Emerging
INNOVATION (+)	"Development automated driving technologies has a spin-off effect on related technologies"	Focus group 1	Emerging
INNOVATION (-)	"Self-driving vehicles are interesting and challenging to develop but not necessarily needed"	Focus group 4	Emerging
MOBILITY ALTERNATIVE (+)	"There will be less vehicles because people will not need to have their own vehicle anymore"	Focus group 1	Emerging
MOBILITY ALTERNATIVE (0)	"It is one of the possible means of transportation"	Focus group 4	Emerging
MOBILITY ALTERNATIVE (-)	"We should invest in public transport rather than autonomous vehicles"	Focus group 2	Emerging
REGULATION (-)	"Public institutions need to steer this transition towards a desirable perspective"	Focus group 4	Emerging
FEASIBILITY (+)	"Current investments in cars make possible to achieve automated driving technologies"	Focus group 3	Emerging
RESPONSIBILITY (+)	"Not driving, letting the car doing it, is a responsible choice you make"	Focus group 1	Emerging

Theme	Example argument	Sources	Category
SUSTAINABILITY (-)	"There are other things that we should focus on for the environment"	Focus group 2	Emerging
EXPERIENCE CHANGE (0)	"In a taxi it is funny to talk to the driver… that would change in an autonomous vehicle"	Focus group 3	Emerging
CONTEXT WITH SPECIFIC CONDITIONS (0)	"AVs need an environment like a desert where everything has a roof on top"	Focus group 2	Emerging
PROFIT (-)	"AVs provide new media space. Companies can sell movies and other things for the time you're in the car"	Focus group 1	Emerging
CONTROL (-)	"As in public transport, with shared AVs people have less control on choosing where and when to go"	Focus group 1	Emerging
MISLEADING COMMUNICATION (-)	"Safety, comfort and efficiency are benefits mentioned in every paper about AVs, but they are not supported with evidence"	Focus group 4	Emerging

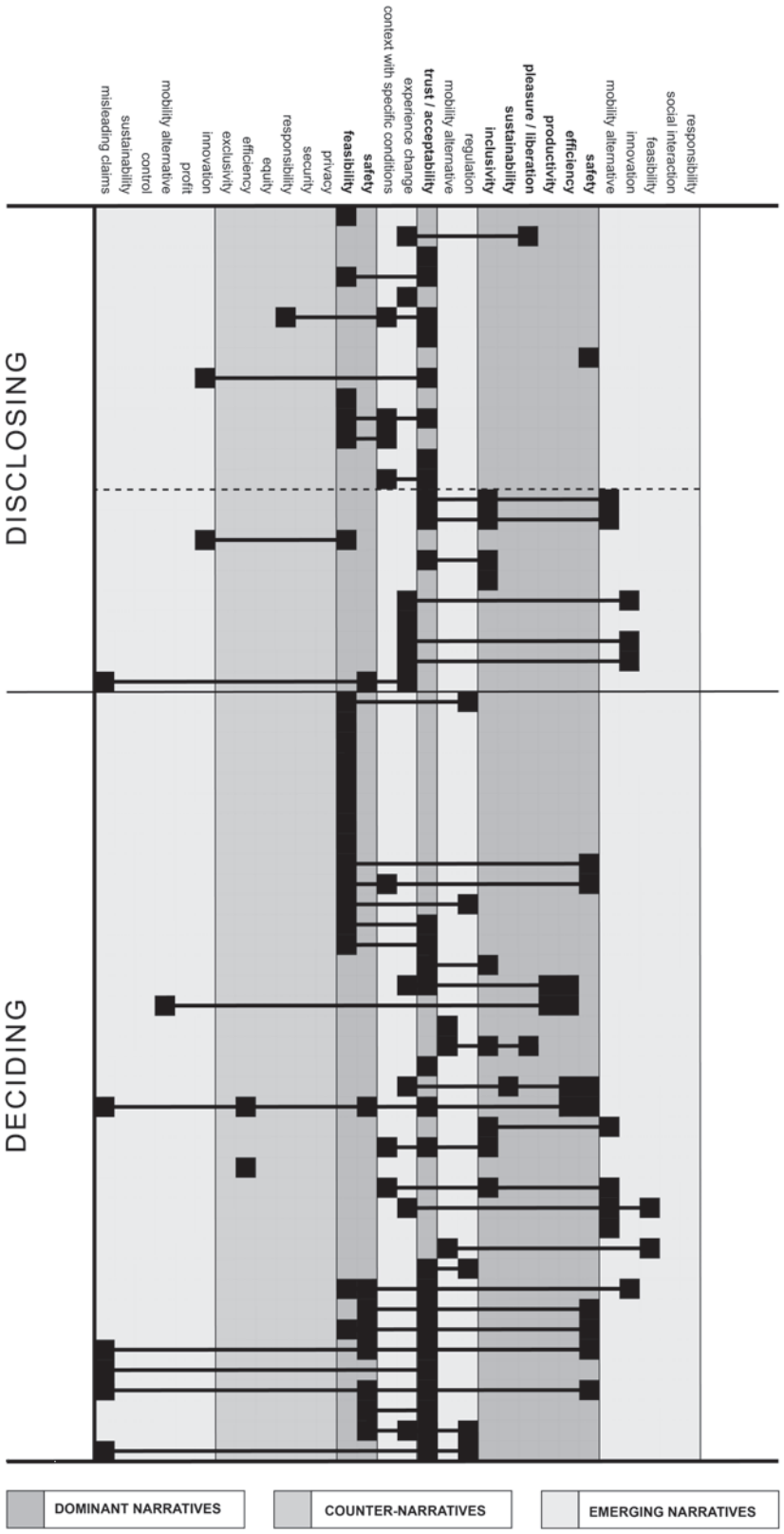

Figure 8: Plot table of arguments coded according to dominant, counter- and emerging narratives from focus group 4.