CONSTRUCTIVE CONTROVERSIES

DESIGNING FOR DEMOCRATIC DEBATE AND ETHICAL DELIBERATION IN THE SMART CITY

Anouk Geenen

Propositions accompanying the dissertation:

Constructive Controversies
Designing for democratic debate and ethical deliberation in the smart city

By Anouk Geenen
October 5th, 2023

1. Understanding socio-technical controversies as a resource rather than a burden enhances the democratic debate on smart cities. (This thesis)

2. The constructive use of socio-technical controversies by making value conflicts explicit and experiential through design, addresses the urgent need to re-enter public values into the democratic processes that surround emerging technologies. (This thesis)

3. Without friction no shine: The anticipation and application of Future Frictions shines light on value conflicts in the smart city. (This thesis)

4. To strengthen its role in transdisciplinary collaboration, design needs to further develop its roles as mediator and provocateur in multi-stakeholder settings. (This thesis)

5. To restore the disconnect between economic value and public value in efficiency-driven smart city visions, we must harmonize quantitative and qualitative experiences of the city.

6. To realign the academic system with the evolution of (transdisciplinary) research practices, there must be room to recognize different types of academic success.

7. Grappling with complexity is a challenge apparent in many fields of inquiry, ranging from theoretical physics to design research. No matter the means of inquiry, the race to address ever-increasing complexity is always run with a lap behind.

8. The list of learnings from a PhD journey is long, and those presented in the thesis barely comprise half of them.

9. PhD journeys are best captured by 'Geit t neet den boktj 't waal'.

10. Life is colored by the chaos of trouble.

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DISSERTATION

to obtain
the degree of doctor at the University of Twente,
on the authority of the rector magnificus,
prof. dr. ir. A. Veldkamp,
on account of the decision of the Doctorate Board
to be publicly defended
on Thursday 5 October 2023 at 16.45 hours

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Preface

Shakespeare allegedly said '*What is the city but the people?*' – a message that my colleague and amazing artist Julieta Matos Castaño has wonderfully depicted in the visuals that guide the thesis chapters. These drawings contain cities important to the PhD research or to me personally, namely Amersfoort, Amsterdam, Enschede, Cholula, Melbourne, New York, and Taipei. Each of these cities is characterized by its own charm, liveliness, and people – a character that cannot be captured in bits and bytes, but is part of the intangible urban fabric.

This thesis trades on many different subjects that conglomerate in the urban sphere, but that all boil down to the same basic notion: a city for the people, by the people.

Summary

From phones to the electricity grid to cities, the 'smartification' of society is all around us. This digital transition builds on the ubiquitous use of sensor networks, the collection of large data sets and the ability to analyze and apply the gathered data (close to) real-time. The smart city aims at creating a more smooth and efficient urban experience, with optimization of waste management, energy usage and mobility streams as central aims, in an attempt to create a higher quality of life for the citizens. Even though these goals are worth pursuing at first sight, the smart city is also contested for its tech-push vision, its emphasis on neoliberal ideals, and its lack of citizen participation.

In other words, the smart city is riddled with socio-technical controversies: conflicts that follow from the complex interaction between the social and technical aspects of society. The association with controversies is often negative, and they are rather avoided then celebrated. However, controversies reveal what is at stake when introducing technology in the urban sphere. In other words, controversies are places where politics 'happens': a plurality of perspectives comes together, values are negotiated and new social practices emerge, forming spaces of self-organized participation and value-assessment. In this thesis, therefore, I suggest to embrace controversies as entry points to a more democratic debate on smart cities. Moreover, I argue that controversies allow a re-entering of public values into this democratic debate. By understanding controversies as resource rather than a burden, I aim to enhance the democratic debate on smart cities with a stronger emphasis on the values at stake that ignite the issues of importance. Through operationalizing controversies, I seek to open up space for debate, where diverse perspectives and a plurality of values can co-exist and lead to creative yet critical resolutions. To achieve this, I propose design as a means to operationalize socio-technical controversies. By making issues visible and experiential, design helps to create agonistic public spaces that aim at constructively dealing with disagreements without necessarily resolving conflict.

This research concerns a societal need and scientific question in interaction with each other – discussing democratic participation in relation to the smart city raises research questions at the intersection of the ethics of technology, political theory and public debate, which are both theoretical and practical in nature. This type of research topic can then only be meaningfully addressed through a transdisciplinary approach, in which collaboration and knowledge exchange between academic and societal partners takes place. As a result, this thesis embodies the theoretical conceptualization of controversies, whilst incorporating their societal character and engaging input from stakeholder representing the quadruple helix: research, government, industry and civil society.

The main goal of this thesis is to explore and enable the constructive use of socio-technical controversies, by means of design approaches, in order to stimulate democratic debate and ethical deliberation about smart cities. In order to achieve this goal, I divide the research into three steps that correspond to three parts of the thesis.

To start, part A of this thesis deepens the theoretical understanding of controversies in. Chapter 2 starts with a theoretical exploration and literature study to further explore and substantiate the significance and potential of socio-technical controversies. I reflect on the historical and current theories and practices that aim to understand and utilize socio-technical controversies. As a result, I formulate a threefold potential of controversies to enhance ethical deliberation, civic engagement and alternative imaginations.

Chapter 3 offers a deeper analytical understanding of controversies and their anatomy. Through an exploratory workshop approach that builds on juxtaposing opposites - smart city dreams and nightmares specifically - I surface and empirically examine smart city controversies. This first study leveraged two different outcomes. Concretely, I identified four different smart city controversies, which were summarized in short vignettes. Conceptually, the study helped understand controversies as multi-dimensional value-expressions with micro (individual), meso (social) and macro (societal) level expressions, and conflicts both within and across these levels. This multi-dimensional nature of controversies makes them rich and insightful concepts to grapple with complexity often present in multi-stakeholder challenges and systemic design activities.

Part B of this thesis describes the Research-through-Design process and two resulting interventions to work with socio-technical controversies. These interventions provide the infrastructure to bring publics, issues and values together, and allow participants to meaningfully navigate and discuss the value conflicts that constitute controversies. This enables them to come together as publics and formulate their own issues and matter-of-concern, and as such provides a bottom-up, designerly approach to democratic participation in the smart city.

In Chapter 4, I combine scenario-based, participatory and systemic design techniques to unpack, navigate and address socio-technical controversies through what I call a 'Network of Conflicts'. This Network of Conflicts is a visual mapping of a controversy, and builds on the insights from Chapter 3 regarding the multi-dimensional value conflicts that shape controversies. By zooming in and out on the different conflicts that constitute a controversy, the Network of Conflicts approach provide a means to take in the bigger picture without getting lost in its complexity. The findings show that making controversies accessible by dissecting them into their formative elements and interconnections – values and value conflicts – helps to provide a setting where differences among multiple actors become explicit, and therefore, negotiable. By revealing and stimulating multiple perspectives to be expressed, this Network of Conflicts approach supports a setting where publics can identify and formulate their own issues, thereby providing a more emergent, bottom-up form of public engagement, that re-enters public values in the debate.

In Chapter 5, I present and evaluate the use of an interactive, design intervention, Future Frictions, to promote a discussion on public values and the societal impact of smart city technology. I build on speculative design and take inspiration from techno-moral scenarios to formulate three interactive scenarios. Through relatable future scenarios in the form of a neighborhood narrative and interactions with neighbors, Future Frictions makes participants become acquainted with multiple perspectives and various forms of societal impacts around urban technology. As a result, the experience allows for ambiguity and refrains from a deterministic view on urban technology. I show that Future Friction's three central features, 1) relatability, 2) plurality and 3) ambiguity, create the setting for audiences to empathize and engage with value conflicts, stimulate their imagination beyond externally formulated urban visions and formulate their own questions, issues, and matters-of-concern.

Part C presents the reflective part of this thesis. Throughout this transdisciplinary research, design takes a central position. In Chapter 6, I challenge and deepen this positioning in order to better clarify the contribution of design. Insights from literature, enhanced with reflections on the interventions of Chapters 4 (Network-of-Conflicts workshop) and 5 (Future Friction experience), led to the formulation of five roles for design in transdisciplinary collaborations: (1) generator; (2)

communicator; (3) facilitator; (4) mediator and (5) provocateur. I argue that the latter two roles, are the most recent and the most suitable roles in transdisciplinary settings, yet also the most challenging. I relate these roles to the design interventions presented in Chapters 4 and 5 and highlight how sensitivity to the ethics and politics of technology is key to further expand these roles.

Finally, Chapter 7 concludes how this thesis motivated, theorized, and operationalized socio-technical controversies as a constructive concept relevant for rethinking democratic debate and ethical deliberation in smart cities, and how it made the potential of controversies accessible through design approaches. This dissertation contributes to the study of socio-technical controversies by understanding them as multi-dimensional contestations about public values. This understanding enables the connection between the political concepts of issues and publics, with the ethical concept of values. As a result, this work centralizes *public's* values and value conflicts in the democratic debate. Consequently, this facilitates the integration of ethical deliberation into democratic ways of thinking about the future of the city. This integration is unequivocally made possible through means of design approaches that render visual and experiential representations of the values and conflicts at hand, thereby enable to 'make things public'. It is through design that the values and value conflicts become explicit, visible and experiential, and therefor available for public debate. The developed design interventions serve as Latourian things around which publics can gather to (re)negotiate public's values and identify the issues at stake in the smart city.

In conclusion, I have showed in this research that the combination of controversy-thinking and design techniques provides a valuable approach for rethinking democratic debate and ethical deliberation in the smart city.

Chapter 1
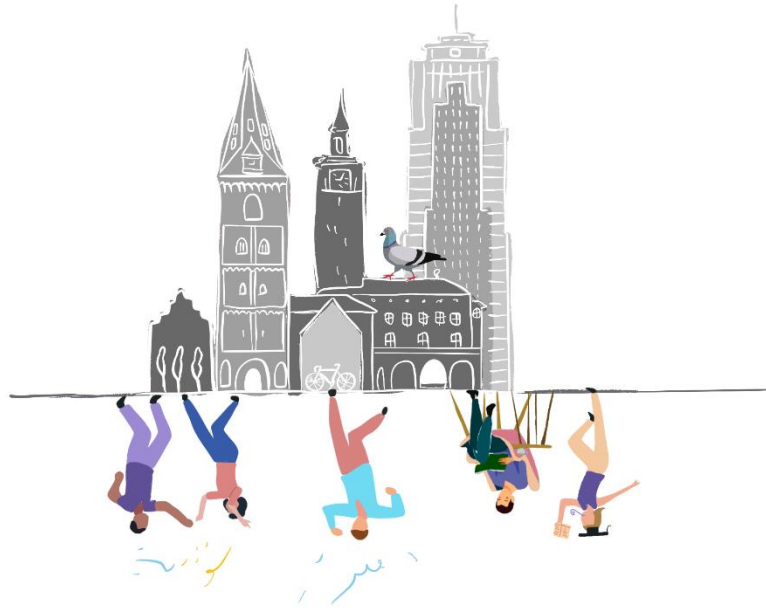
Introduction

1.1 Introduction

'Privacy watchdog imposes a 600.000 euro fine for Enschede due to WiFi tracking'

This headline dominated the news in the spring of 2021 (e.g. NOS, 2021; van Baars, 2021), and put the city of Enschede in a questionable spotlight: as a city that positioned itself as a citizen-centered smart city, the surveillance of citizens was surely not one of their desired flagpoles. Major Onno van Veldhuizen assured there was no case of surveilling citizens, but that WiFi tracking as a means to count passersby was necessary to measure efforts and effects on the livability and safety of the city (van Baars, 2021). The inner-city area, full of shops, restaurants and entrepreneurial activities, had been challenged by a declining number of visitors for several years. This forced many small-and medium enterprise owners to close their shops, with vacant buildings and decreasing economic activity as a consequence. With the ambition to stimulate a flourishing local economy, the local government employed WiFi tracking to understand how to attract more visitors to city again. After a citizen complaint however, the Authority on Personal Data (AP) revealed that this tracking was not privacy-proof, and it was possible to follow individual citizens through the technology. Even though this tracking was highly improbable (individual tracking could take place in the potential combination of WiFi tracking ánd camera surveillance, ónly in cases of being alone in the street for a longer period of time) and no actual abuse of data was established, the AP highlighted the theoretical possibility as enough reason to pose a fine and signal a warning. Despite the fact that no actual abuse was recorded, the case led to great controversy. Although employed since 2017, the municipality made no mention of their WiFi tracking activities in their outward appearance as a smart city – this lack of transparency led to distrust amongst citizens. At the same time, citizens still desired a more safe and economically thriving city center. Alternative techniques such as physical counting only revealed temporary snapshots, unlike the 24/7 insight that that WiFi tracking could provide. Moreover, WiFi tracking was not only practiced by the municipality: shops located in the city center used it as well, however these commercial activities fell out of the institutional control of the AP. This controversy revealed the need for all parties to come together and discuss the responsible use of technology to support urban flourishing. How to meaningfully debate the needs, effects and impacts of urban technology such as WiFi tracking? How to include a more democratic and ethically sound approach towards the smart cities?

WiFi tracking is one of the prominent examples of data collection and application in the smart city. The applications, opportunities and (legal) boundaries of the WiFi tracking of citizens, have been subjected to ongoing debate over the last years – although often behind closed doors and without the involvement of citizens. The case of WiFi tracking as highlighted above, is an illustration of the complex interaction between technology and society, and loudens the call for a better understanding of how to incorporate emerging technologies in a democratic society. As WiFi tracking example reveals, there were multiple issues at play in Enschede: the need for economic thriving, urban safety, entrepreneurial flourishing and citizen privacy all existed simultaneously. With the AP as only authority on the digital front, these debates often tend to gravitate towards discussions with privacy as the core concern. However, the picture is much more complex than protecting privacy alone: it regards the quality of public spaces and urban experiences. It concerns how to shape cities in the light of new technological opportunities and challenges, whilst upholding public values – including transparency, autonomy, serendipity, and many more. A sole focus on privacy risks losing track of a

nuanced discussion on what roles technology may play in future cities. The Enschede example showed how the debate on WiFi tracking is heavily layered and contains many different drivers and concerns. For example, there is an ill-defined need for technology (e.g. why does WiFi tracking or the counting of passerby's need to be 24/7), a lack of citizen involvement and democratic debate on the purposes of WiFi tracking (nor via media or promotional channels, nor via means of citizen participation), a multitude of actors involved whom each have different interests regarding WiFi tracking (e.g. municipality, local entrepreneurs, privacy-guards, technology companies, data stewards, citizens, visitors) and a competition of values to be safeguarded (e.g. privacy, safety, livability, transparency). All these elements are part of the complicated quest towards responsible smart cities, which cannot be handled by a legal or policy framework alone. There is a need for (more) democratic processes regarding the implementation and impact of smart city technology. How can controversies, such as the one surrounding WiFi tracking in Enschede, be leveraged to enhance democratic debate and ethical deliberation on the smart city?

This thesis aims to contribute to addressing this challenge through **stimulating democratic debate and ethical deliberation about smart cities by enabling the constructive use of socio-technical controversies by means of design approaches.** The remainder of this chapter will explain why this aim is seen as relevant and timely. Furthermore, it will introduce the research approach and questions as well as the outline of this thesis.

1.2 Smart cities

In 2017, the Dutch government developed a national Smart City Strategy to address complex urban challenges with digital technologies. Big data, sensor networks and AI are implemented to manage, monitor and control aspects of urban living; from real-time crowd management to monitor public safety, to tracking waste-levels in public bins to schedule waste collection moments and routes.

The 'smart city' is a continuously evolving concept; envisioned, emphasized and executed differently throughout the world (Hollands, 2008; Vanolo, 2014). Central in all instants of the smart city concept, however, is the employment of urban data and technology to enable optimized and improved city processes. Following the heavy promotion by IT-giant IBM since 2005, the smart city narrative seems to be the driving discourse in urban development (Wiig, 2015). In 2050, 70% of the world's population is expected to live in cities. In an attempt to adapt services to these increasing demographics, whilst navigating grand urban challenges such as climate change and growing socio-economic inequalities, the smart city employs digitization and datafication strategies to address these challenges. Equipped with apps and algorithms that are fed with data from urban sensors, smart cities bring a new level of insight regarding the urban environment. Data collected by urban sensors is used for the purposes of for example efficiency, safety and sustainability (Vanolo, 2016), building on what Kool et al. (2017) have coined the cybernetic loop: a continuous feedback-loop where data is being collected, analyzed an applied. The neoliberal promise of the digitized urban space is that more data combined with better algorithms, will render new insights on urban environments. These insights can then be used to control, predict and optimize city processes, in order to save energy, mitigate carbon emissions and enhance efficiency in for example mobility streams.

These smart city visions have received vehement criticism, however, regarding their modernist tendency for rationality and control, their a-political and technocratic nature, and their simplified

view of what cities are, i.e. taking a reductionist approach to urban life (Kitchin, 2014; Söderström et al., 2014). What is being left out when everything becomes measured and quantified? Such concerns arise when a technologically mediated view based on quantifiable indicators takes over and becomes the prime gateway to knowing about today's cities (de Lange, 2018). The underlying notion that a clean, computed and centrally controlled city is the means towards a better and happier urban experience, is strongly contested (Hollands, 2008). This idea of a 'techno-fix' to complex social, economic and environmental issues is heavily criticized, as it fails to acknowledge the impact of technology on daily life, and neglects citizens' needs and experiences of the city (Vanolo, 2016; Cardullo & Kitchin, 2019). Beyond concerns about privacy and cyber-security in a datafied city, worries exit on the lack of democracy, creativity and serendipity in a tech-driven urban space, that merely seems to focus on efficiency an economic profit (Hollands, 2015; Wiig; 2016, Grossi & Pianezzi, 2017), and fails to acknowledge the potential of technology to deepen social inequalities and marginalization (Hollands, 2008; Söderström et al., 2014; Grossi & Pianezzi, 2017).

In summary, smart city visions tend to understand technology as an anonymous and neutral carrier of progress that directly addresses the proposed target without any *collateral damage* or unintended societal effects. This instrumentalist understanding and application of technology as a solution to complex societal issues, deserves scientific and public scrutiny. This thesis is a step forward in that direction.

1.3 Embedding emerging technologies in democratic societies

1.3.1 Democracy and People: Publics

The call for a better understanding of how to incorporate emerging and disruptive technologies in democratic societies is getting louder every year. In 2021, former member of parliament Kathelijne Buitenweg, highlighted the need for stronger democratic processes regarding the impact of big data on society in her book 'Datamacht en Tegenkracht' (Datapower and Counterforce). Kees Verhoeven, another former member of parliament, echoed this call with his 2023 book 'De democratie crasht - Politieke onmacht in het digitale tijdperk' (Democracy crashes - Political impotence in the digital age), and likewise Maxim Februari, a Dutch philosopher and essayist, reaffirms the need to address this topic in his 2023 book 'Doe zelf normaal' (Act normal) – noting that many political decisions rely purely on data, and wondering how this relates to democratic processes. Also citizen-led initiatives emphasize this call for stronger democratic processes, such as de WAR in Amersfoort. Despite these repeated calls from multiple sides, the political and public debate on democracy and technology remains minimal. Although digitization has since risen on the political agenda, leading to a first state secretary (deputy minister) for Digital Affairs, the democratic debate on the digitizing society is still one that mostly takes place behind closed doors and within political institutions.

In other words, the smart city faces a democratic deficit: There is a need to include the public sphere in the debate on the need for and impact of urban technologies. Specifically, there is a need to involve citizens more actively in the smart city debate. Or as Engelbert (2019, 352) puts it: 'Many contemporary imaginations of the smart city, as well-intended as they might be, are still cultivating a top-down version of citizen participation and are excluding the interests and perspectives of citizens'. From parking apps that save searching time in busy streets, to scent-releasing sensors that calm "aggressive" visitors (Kanters, 2019), smart technology influences the city in many ways, that requires a democratic approach to deal with. The democratic process reaches beyond voting and

policy-making, and there is a need for more bottom-up and emergent activities regarding the impact of technology on society. Too often, citizens and other stakeholders are merely *informed* on the issues on the agenda, rather than actually *involved* in the formulation of these (Nesti & Graziano, 2020; Bastos et al., 2022; Vanolo, 2014).

1.3.2 Technology and Society: Issues

The 'smartification' of society – whether it be cities, farms or industries – is characterized by the amalgamation of the physical and digital world into 'smart' environments and applications that can constantly monitor, analyze and interfere in the world. These 'smart' applications are often presented as the ultimate and only solution to many complex challenges , given that they make it possible to automate decision-making, and intend to deliver services with higher cost-, time- and energy-efficiency. These developments, often labeled as 'disruptive', seem to go faster than current democratic processes can keep up with – oftentimes leading to undesirable social consequences. Think for example of the WiFi tracking example as highlighted earlier, or the continuous bias in AI applications (as was exemplified in the Dutch context with the far-reaching 'toeslagenaffaire'[1] and the missteps with SyRi in 2020[2]), the controversy around corporate power in smart city efforts in Toronto (Barth, 2020; Wylie, 2018) and the ongoing discussion on surveillance systems (cf. Zuboff, 2018).

These technological developments point to a need for more critical awareness regarding the impact of technology on the city. More specifically, a critical awareness that expands towards an understanding of both positive and negative consequences, and the potential interaction between those. The complexity and nuance of socio-technical issues, however, are rarely echoed in debate about smart cities. The future of the city is often depicted as either *dystopian* or *utopian* (Wiig, 2015; Vanolo, 2016; Valdez et al., 2018). On the one hand, there is an Orwellian fear of a Big Brother surveillance city, with dystopian views on the role of technology in human lives such as depicted in the Black Mirror series. In such scenarios, corporate companies and governments have the power over all collected data, and citizens become mere followers of urban algorithms. On the other hand, there is an optimistic understanding of a smart city that is able to solve all current and future challenges in an efficient and effective manner. This idealized smart city allows for ample bottom-up initiatives and public participation, because open-source data allows citizens to have a greater say in urban decision making. However, this binary opposition distracts from urban realities: the mundane everyday urban experiences are much more nuanced, layered and plural (Bina et al., 2020). Therefore, it is important to raise this plurality and support a democratic process regarding the implementation and impact of smart city technologies, in order to formulate alternative socio-technical imaginaries of the smart city (cf. Sadowski & Bendor, 2018).

1.3.3. Technology and People: Values

Additionally, there is a need to make public values a core part of the democratic practices regarding urban technology. Smart city technologies can challenge public values (e.g. Van Dijck et al., 2018). Currently, the focus on economic and governance values such as efficiency and convenience, often outshine attention to public values, such as autonomy and transparency. What societal effects do

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[1] An anti-fraud algorithm that turned out the be riddled with racial biases and financially bankrupted thousands Dutch families (Trouw, 2020).

[2] Systeem Riscio Indicatie – an anti-fraud algorithm that turned out to be at odds with international human rights (FD, 2020).

smart city technologies have beyond the supposed economic benefits and efficiency boosts? What public values should be protected and pursued in a smart city? Such values are the very stakes when moving towards a data-driven urban space. Technology ethics has increasingly gained traction in recent years, shifting the attention from privacy to a broader range of public values such as safety, fairness and accountability. In the Dutch context, the Rathenau Institute has been leading in this, with a call for recentralizing public values in the digital society in their report 'Urgent Upgrade' (Kool et al., 2017). And many Dutch cities, including Enschede, have recently put in effort to set up an 'ethical committee' that needs to assess any smart city policies (Kiel, 2021).

Although these efforts are noteworthy, the debate on public values again mostly takes place within institutions and between experts. There is a lack of citizen perspectives, of actual *publics'* values (van Zoonen, 2020). Therefore, there is a need to demystify the impact of technology on society, and make this discussion on values more available to a wider public. In other words, there is a need to embed ethical deliberation on technology more strongly in the political and public debate.

1.4 Theoretical Background: Issues, Publics, and Values

To address the need for more democratic practices in the smart city, I turn to the intersection of STS and political theory. In line with Latour (2005) and Marres (2007), who build on earlier work of Dewey (1927), this thesis adopts a pragmatist lens and approaches democracy as the interaction between publics and issues. Latour (2005) summarized this into the notion of 'ding-politik': a conception of democratic practice as the gathering of people around a 'ding' (thing), or something that is at stake for them, thereby inherently connecting the issues and the publics following the earlier work of Dewey on 'the public and it's problems' (1927). It is in through this gathering and the understanding of a 'thing' as a 'matter-of-concern' rather than a 'matter-of-fact', that people turn into publics, who come together to confront a shared issue.

In other words, when discussing democratic practices, I do not refer to democracy in terms of formal voting, institutionalized procedures and governmental bodies, but rather to adopt a pragmatist lens and understand democracy as a bottom-up activity, initiated and voiced by the public. In this regard, this thesis specifically takes an issue-oriented approach to democracy (Dewey, 1927; Latour, 2005; Marres, 2007). Issue formation is central to democratic practices, as democracy discusses the shared challenges and concerns that follow from the issues, or the 'things' at stake. An issue-oriented approach responds to the fact that many instances of citizen participation are not as 'democratic' as they claim to be: they limit the inclusion of citizen concerns by already formulating and framing the political object or issue in which participation is desired (e.g. Nesti & Graziano, 2020). Although there are many issues in the smart city, there is a missing public: the *demos* is lacking to uphold democratic practices. There is a need to make the issues available to publics and accessible for public debate.

This thesis translates the need to strengthen democratic practices in the smart city, to a need to form issue-publics. Secondly, this work translates the need to integrate ethics in this democratic practice, to a need to connect public(s) values to the concepts of publics and ethics. To achieve this, I add the notion of 'public(s) values', or values defined by the publics, as unremittingly tied to issues and public. I thus expand the binary relation to a threefold interdependency: the issues of concern and the people to whom they concern, cannot exist without the values that support these concerns. To achieve this, I build on a pragmatist understanding of publics, issues and values. Although these concepts are tightly coupled and hardly lend themselves for individual deconstruction, I will analyze

them separately below. Discussions of any one point carry the themes of the other two as I explore the connections and interdependencies.

Publics

Democracy firstly involves the *demos,* or the public. Following Dewey (1927), publics should be understood as a particular configuration of individuals bound by common cause in confronting a shared issue. Marres (2007, p. 773) updates this definition, and argues that publics do not need to have similar stakes or views, but can come together 'jointly and antagonistically' through partly exclusive associations to the issue. Publics thus consist of a plurality of voices and positions, and are called into being by issues – they form around an issue, to attend to its conditions and consequences (Dewey, 1927). Such a public does not need to consist of pre-existing communities and can be characterized as a community of strangers, bounded by the effect of the issue at hand. This means that there is no a priori, singular or generic public; as a public is associated by and through an issue, and takes distinct, dynamic and plural shapes (LeDantec & Disalvo, 2013).

Issues

Issues are central motivators in democratic theory, as they form the 'things' that matter, around which people come together to form a public. For Dewey, an issue is a condition of concern. Issues have consequences, and it is these consequences that create a community of 'affect' which turns into a public. Publics gather around these issues because there is something at stake to them. It is not the mere 'matter-of-facts' that drive them together, it is the understanding of these 'facts' as 'matters-of-concern' (cf. Latour, 2005). In other words, individuals must be able to perceive a condition as a matter-of-concern, to identify the issue and be moved to come together as democratic publics. This research understands these matters-of-concern as finding their origin in the values that members of the public wish to protect or pursue.

Public('s) values

According to McAuliffe and Rogers (2019, p.304), 'understanding the values that underpin political positions helps unveil the nature of plural politics'. In other words, values ignite political concerns, and are the basis for understanding the positions and associations of members of the public to the issue. Since values tend to be abstract concepts, they are often captured in lists to make them operational. Such lists however, give the illusion of being complete and definite; they invite to be 'checked of'. This does not align with a pragmatist approach to values, which underlines they should be understand as lived, interactive and dynamic (Boenink & Kudina, 2020, Fesmire, 2003). Pragmatist ethics provides an alternative to two dominant schools in ethics: consequentialist ethics (which evaluates actions based on their consequences) and deontological ethics (which evaluates actions according to one's duties). A pragmatist approach to ethics moves away from lists and rules, looks at the situated action and experience in order to negotiate value pluralism (Steen, 2013). Given their context dependency, there are no a priori blueprints for public values. The dynamic and contextual character of values requires their constant negotiation and (re)definition, calling for approaches that allow participants to collectively discover and express which values matter in specific contexts, and what they mean to them.

When taking the concepts of publics, issues and public('s) values as a point of departure, designing for responsible smart cities entails creating the conditions for people to formulate wishes and concerns around technology and data (their *issues*) which reflect their diverse *values* – and in this process, come together as *publics*. This dissertation proposes *socio-technical controversies* as

meaningful vehicles to bring issues, publics and public(s) values together, in order to enhance and enrich democratic practices in the smart city.

1.5 Controversies as sites of connection between Publics, Issues, and Values

Over the last decades, various endeavors from different academic disciplines have put emphasis on the democratization of technological developments (e.g. Schot & Rip, 1997; Durant, 1999; Genus, 2006; Kaplan et al., 2021; Lehoux et al., 2021; Ozkaramanli et al., 2022). The vast amount of these practices has one thing in common: they tend to ignore areas of conflict and strive for areas of consensus. In this thesis, I understand socio-technical controversies as constructive sites where publics, issues and values connect, enabling democratic and ethical deliberation on the impact of smart city technologies.

Socio-technical controversies are public conflicts that are shaped by the introduction of technology in society (Callon et al., 2009). They find their origin in a range of economic, political and ethical concerns (Nelkin, 1995), and represent the collision of multiple perspectives and values regarding technology. Declaring an issue as purely technical, effectively removes it from the influence of public debate, which is exactly what happens in some 'techno-fix' smart city visions. Approaches like actor-network-theory (Latour, 2005) demonstrate that social and technical components of socio-technical controversies cannot be separated. As a result, in this thesis, I specifically underline the constructive aspect of controversies and highlight the richness that they carry, as opposing points of view on any technology are inevitable in a pluralistic society, and can be seen as part of the normal democratic process (Mouffe, 1999).

The study of controversies as meaningful interactions between science and society, traces back many decades. Controversies have been a subject of study since the second half of the 20th century and has mainly attracted academic interest in the STS community (Pinch & Leuenberger, 2006). Already in the 1980's, Rip (1986) introduced them as means of informal technology assessment. He describes controversies as early warning signals, as they show the promises and concerns that surround the introduction of a given technology in society. As Rip argues, such informal assessments in which the public lays out its hopes and fears, are useful for technology developers and for what is now known as responsible innovation: by probing the societal implications of a given technology, its design becomes more reflective and informed, and hence better fit for future purposes. This line of thinking is continued in other work in the field, which described societal controversies around technoscientific issues as important sites for the enactment of democracy (e.g. Bijker, 1995; Sclove, 1995).

In the spirit of Latour (2005) and Marres (2007), I understand controversies as places where politics 'happens', exactly because of the disagreement at hand. Through controversies, a plurality of perspectives comes together, values are negotiated and new social practices emerge. In an agonistic manner (cf. Mouffe, 1999; DiSalvo, 2012), this work aims to embrace conflict and contestation, in order to open up space for debate, where diverse perspectives and a plurality of values can co-exist. As Cuppen (2018) formulates it, controversies are places of self-organized participation and value-assessment. This suggests a dynamic understanding of public(s) values, for which therefore *a priori* blueprints that can be 'ticked' do not exist. 'Unblackboxing' public values requires dynamic processes through which values are continuously (re)defined towards shaping responsible practices in smart

cities. By taking controversies as a starting point, I suggest a more emergent, bottom-up understanding of public values can be established.

Encouraging public debates around issues requires making matters-of-concern, or public values, accessible. Schoffelen et al., (2015), like Latour (2005), emphasize the importance of making things visible to encourage public debates concerning issues. In particular, opening up the formation of issues entails making differences among multiple actors explicit, revealing and stimulating multiple perspectives to be expressed and negotiated. To manifest these discussions, bring together multiple perspectives, and surface different issues, this research turns to design approaches.

1.6 Rethinking smart city democracy through design

Design[3] as a mode of democratic inquiry and practice (cf. DiSalvo, 2022) has become increasingly salient in recent years (e.g. DiSalvo, 2012, 2022; Björgvinsson et al. 2010; Ehn et al, 2014; Ozkaramanli et al., 2022). Design's creative impetus, generative qualities and ability to create a level-playing field among different stakeholders through the use of boundary objects such as mock-ups, prototypes and scenarios, have been positioned as meaningful, if not necessary, in addressing today's wicked problems (Buchanan, 1992). Design's unique positioning relates to its focus on 'making and doing', thereby developing new insights through 'the conception and realization of new things' (Cross, 1982, p. 221). In other words, design promotes a way of 'making things public' (cf. Latour, 2005).

To explore this relation between democracy and design in order to operationalize socio-technical controversies in the context of the smart city, I particularly build on insights and methods from Participatory Design (PD). Democracy is at the core of PD because of its active inclusion of participants: through methods of co-design, it recognizes participants as experts in their experience and enables them to be active contributors to the design outcome (Sanders & Stappers, 2008; Ehn, 2008). Moreover, PD aligns with the pragmatist approach sketched out in Section 1.3, as it focuses on people's concrete practices and personal experiences, with the aim to enable and empower publics (Steen, 2013). PD's tools and techniques support the emergence of values as well as help deal with conflicting values (Iversen et al., 2012), which can contribute to exploring controversies.

Over the last decades, several PD scholars (e.g. Björgvinsson et al., 2012a, 2012b; Ehn et al., 2014; Disalvo, 2010, 2015, 2022; Hillgren et al., 2016; Sawney & Tran, 2020) have incorporated the notion of democratic engagement through controversies, conflict and agonism in order to 'address controversial issues and allow a polyphony of voices rather than aiming at consensus' (Hernberg & Mazé, 2018, 1). PD activities can support the incorporation a diversity of actors, and the articulation of multiple perspectives around technological impacts in smart cities (Matos-Castaño et al., 2020), creating the conditions for agonistic public spaces that aim at constructively dealing with disagreements without necessarily solving conflict (Björgvinsson et al., 2012b).

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[3] This research does not involve the design of smart city technology, but concerns the design of democratic engagement in the smart city context. As such, it presents a form of political design (cf. DiSalvo, 2012), meaning that it evokes and engages political issues. This is not to be confused with design for politics which focuses on optimizing mechanisms of public governance within existing institutional structures.

Particularly relevant to this research is the Scandinavian approach to PD (e.g. Ehn et al., 2014), which relates to Latour's notion of 'ding-politik' (2005) in an effort to create design 'things', around which publics can gather. These 'things' take the shape of socio-material assemblies, rather than design objects, and are shaped through modes of 'infrastructuring' (LeDantec & Disalvo, 2013; Björgvinsson et al. 2010) to enable emergent spaces for self-organized participation. This is contrary to the currently applied method in urban planning, in which spaces for participation are created and participants are invited at specific moments and for specific input. Infrastructuring entails the "processes and strategies of aligning contexts and their representatives, where differences between current issues and how the future can unfold can be made visible, performed and debated as a kind of 'agonism'" (Björgvinsson et al., 2012b, 127-128). LeDantec and DiSalvo (2013) highlighted how the concept of infrastructuring within PD relates to the formation of 'publics', as design helps to make the issues visible and experiential.

Summarizing, design can contribute to operationalizing socio-technical controversies as it supports the formation of publics through the articulation of issues, while nurturing the discovery and redefinition of emergent public values, in the context of smart cities.

1.7 Objective and research questions

This thesis investigates how to generate spaces for democratic debate and ethical deliberation in the context of the smart city. For this, I use design approaches to create opportunities for the formulation of public values and issues around the impacts technology in society. This research concerns a societal need and scientific question in interaction with each other – discussing democratic participation in relation to the smart city raises research questions at the intersection of the ethics of technology, political theory and public debate, which are both theoretical and practical in nature. Therefore, this research requires a transdisciplinary approach, in which collaboration and knowledge exchange between academic and societal partners takes place which represent the quadruple helix: research, government, industry and civil society. Academically, this work builds on interdisciplinary insights coming from STS, Political theory, Ethics of technology and Design research.

The main goal of this thesis is to explore and enable the constructive use of socio-technical controversies, by means of design approaches, in order to stimulate democratic debate and ethical deliberation about smart cities. In order to achieve this goal, I divide the research into three steps that correspond to three parts of the thesis.

First, there is a need to **conceptualize controversies as constructive concepts for addressing socio-technical challenges (part A).** This part presents the theoretical underpinnings of working with socio-technical controversies. It deepens the argument *why* controversies are conflicts to embrace and utilize when working towards responsible smart cities, and helps us understand *what* controversies consist of. This first part is guided by the following research questions:

RQ 1   *What is the productive potential of socio-technical controversies for responsible smart city developments?*

RQ 2   *How to conceptualize and analyze socio-technical controversies as sites of value discussion?*

Next, the second part of this thesis moves from theory to action. It builds on the insights generated in part A, and continues with the challenge *how* to operationalize the potential of controversies. **Part**

B focuses on the development of design approaches to stimulate the constructive use of controversies as sites where publics, issues and values connect, in order to enable democratic debate and ethical deliberation on the smart city. Through the development of these design approaches, it aims to understand how the conditions can be created to generate issue-publics around value conflicts. For this, Part B presents two design interventions that are distinct in nature, but build on the same results that follow from part A, and have the goal to connect the concepts of publics, issues and values through operationalizing controversies.

RQ 3   What are the qualities of a setting that make controversies accessible to, and actionable by, publics?

RQ 4   How can (speculative) design stimulate ethical deliberation by making the value conflicts in controversies accessible and actionable?

Finally, since design approaches play a central role in this transdisciplinary research, I aim to **understand and reflect on the role of design in transdisciplinary collaboration in part C.** This reflective part of the thesis addresses reflections on two different levels: firstly it reflects on the position of design in this transdisciplinary research and the challenges involved with that, as captured by RQ5, and secondly it reflects on the contributions and limitations of the work presented in this dissertation.

RQ 5   How to understand design's contribution in transdisciplinary collaborations?

Figure 1.1 represents the conceptual map that guide this research. It shows the main concepts and methods that drive this investigation, and places them within the four clusters that this transdisciplinary research connects: democracy, ethics, design research and society, and shows how these four spheres are related and connected through a central role for publics. Throughout this research, I aim to follow the meandering crossings of these clusters and find synergy between.

Figure 1.1. Conceptual map.

1.8 Research approach

1.8.1 Research approach

To address the research questions that guide this work, I take an transdisciplinary approach and apply a number of research methods, mostly rooted in design research. Most prominently, this work builds on human-centered and participatory design methods, meaning that it centralizes the human experience of the smart city and focuses on eliciting and incorporating stakeholder needs, values, and wishes. To achieve this, I apply typical human-centered design techniques such as scenarios, roleplay and participatory settings, that emphasize empathy and help elicit stakeholder needs, values, and wishes. I combine this with a spirit of 'infrastructuring' (cf. Björgvinsson et al., 2010): an organic participatory approach that facilitates the emergence of possibilities along the way, but with a specific focus on democratizing innovation. It continuously interweaves contexts, processes, material engagements and diverse groups of people. Like the work of Björgvinsson et al. (2012a), this research focuses on the design of 'Things' (socio-material assemblies that deal with 'matters-of-concern') as opposed to things (design objects), in order to create agonistic public spaces where plurality is celebrated. I explore how these techniques can help operationalize controversies in a Research-through-Design (RtD) approach (Stappers & Giaccardi, 2017), which is an approach of scientific inquiry that aims to generate new insights through the process of making, discussing and reflecting on design. RtD bridges the production of knowledge with the creation of design interventions, and uses the design process as a research tool (Gaver, 2012).

Table 1.1 summarizes how this general approach translates to each chapter. Part A focuses on exploring and theorizing the concept of controversies to gain a better understanding of their relevance for democratic practices in the smart city. To address RQ 1, I theorize the threefold potential of controversies through study of (mainly STS) literature and compare this to global smart city examples. Next, I address RQ 2 by bridging theory and design through a design-based exploration

on the anatomy of controversies, and do so through a workshop that juxtaposes dreams and nightmares of the smart city. Working with dream and nightmare scenarios allows to access the values and wishes of participants regarding the smart city. The juxtaposition of these scenarios allows us to identify four smart city controversies, and to understand controversies as multi-dimensional value conflicts. This lays the groundwork for part B of the thesis, which actively works with smart city controversies in an effort to operationalize their potential for democratic practices in the smart city. Through a RtD process, I develop two distinct interventions: the Network-of-Conflicts (in response to RQ 3), and Future Frictions (in response to RQ 4). Both interventions employ the multi-dimensional nature of controversies and exemplify the controversies as resulted from RQ 2. Additionally, both interventions take the shape of 'design things' around which public can gather to discuss smart city issues (cf. Björgvinsson et al., 2012a). The RtD process of these designs took place between fall of 2020 and summer of 2022, and consisted of seven and six iterations respectively. To address RQ 3, I present and reflect on the RtD process that resulted in the Network of Conflicts, whereas to address RQ 4, I present and evaluate Future Frictions as a design outcome resulting from an RtD process. The research in order to address RQ 2, 3, and 4 builds on empirical participant data that is collected through thoroughly prepared evaluation forms that reflect on the design workshop or intervention at hand. This participant data, together with research notes, is analyzed through qualitative analysis (Bryman, 2014). Part C moves to the reflective chapters of this dissertation. To address RQ 5, I gather insights from literature and enhance them with project reflections. This allows to formulate five roles for design in transdisciplinary collaborations, and exemplify how these roles came to life during the implementations of the Network of Conflicts and Future Frictions (RQ 3 and RQ 4, respectively).

Table 1.1. Summary of the research questions, approach and main outcomes per chapter.

	Chapter	RQ	Research approach	Key outcome
Part A	**2**	What is the productive potential of socio-technical controversies for responsible smart city developments?	Theoretical exploration through literature study.	Suggesting a threefold potential for socio-technical controversies to enrich 1) civic engagement 2) ethical deliberation and 3) alternative imaginaries on the introduction of technology in cities.
	3	How to conceptualize and analyze socio-technical controversies as sites of value discussions?	Workshop approach based on contrasting utopian and dystopian scenarios to tease out controversies.	Anatomy of a socio-technical controversy can be understood as consisting of value expressions on the micro (individual), meso (social) and macro (societal) level, and value conflicts within (intra-level conflict) and across (inter-level conflict) these levels; 4 controversies that illustrate this framework.
Part B	**4**	What are the qualities of a setting that make controversies accessible to, and actionable by, publics?	Research-through-design approach based on systemic design techniques; evaluation of 4 iterations (Network-of-Conflicts workshop).	Explicating, visualizing and collectively navigating value conflicts through systemic design techniques, are key steps to make issues available and shape publics; Network-of-Conflicts workshop protocol.
	5	How can (speculative) design stimulate ethical deliberation by making the value conflicts in controversies accessible and actionable?	Research-through-design approach based on speculative design; evaluation of end-result with (Future Frictions) with 50 BSc students.	Mobilizing ambiguity, plurality and relatability in a speculative design intervention creates the setting for publics to engage with value conflicts and identify their own issues and matters-of-concern; Future Frictions.
Part C	**6**	What is the contribution of design to transdisciplinary collaboration?	Literature study and project evaluation, enhanced by reflections with consortium partners.	Introducing 5 preliminary roles for design: generator, communicator, facilitator, mediator and provocateur.
	7	How can design methods enable the constructive use of socio-technical controversies in order to stimulate democratic debate and ethical deliberation about smart cities?	Reflection and discussion on transdisciplinary potential of designing for controversies.	Evaluating the design interventions and providing a summary of the transdisciplinary research contributions of this thesis.

1.8.2 Transdisciplinary nature of this research

The need to improve the democratic dialogue on the impact of urban technology with an explicit account of public values can be characterized as a 'wicked problem' (Buchanan, 1992) that spans a wide range of scientific disciplines, professional domains and societal settings. Such real-world challenges cannot be addressed through academic research alone, but need input and expertise from other actors that are closely and directly involved in the challenge at hand. They thus require transdisciplinary approaches, that move beyond disciplinary and institutional silos, and combine insights, concepts and tools from multiple knowledge domains (Repko & Szostak, 2017; van der Bijl-Brouwer et al., 2021).

The research presented in this thesis takes place in the context of the NWO-funded project 'Designing for Controversies in Responsible Smart Cities'. This project is a collaboration between two Dutch universities and five project partners – a mix between governmental and industrial parties. A description of the consortium can be found in Table 1.2. The consortium context provides the foundation for this transdisciplinary research.

Table 1.2. Composition of the consortium

Consortium member	Involvement in project	Expertise
Municipality of Amersfoort	Smart city context, supplier and organiser real-life case	Smart city governance
Marxman advocaten	Consultancy on privacy issues and other legal affairs	Legal, especially ownership & privacy
AeroVision	User needs elicitation; consultancy on geo-information	Big & open data
Design Innovation Group	Preparation & facilitation of co-creation sessions & consultancy on knowledge and experiences gained through human technology practices	Strategic design interventions
Kennislab voor Urbanisme	Co-organising User Sessions & adding to dissemination by writing popular articles and organizing events	Events, communication, smart cities

Transdisciplinary work integrates disciplinary insights with contextualized and experiential knowledge. It is defined as 'a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge' (Lang et al., 2012, p 26). Transdisciplinary research consists of three core components: 1) it is an effort to transcend disciplinary boundaries, 2) it supplements academic knowledge with non-academic knowledge domains such as local and experiential knowledge and cultural values, and 3) it aims to address complex, real-world problems, thereby enhancing scientific insights for the good of society (e.g. Lang et al., 2012; Nicolescu, 2014).
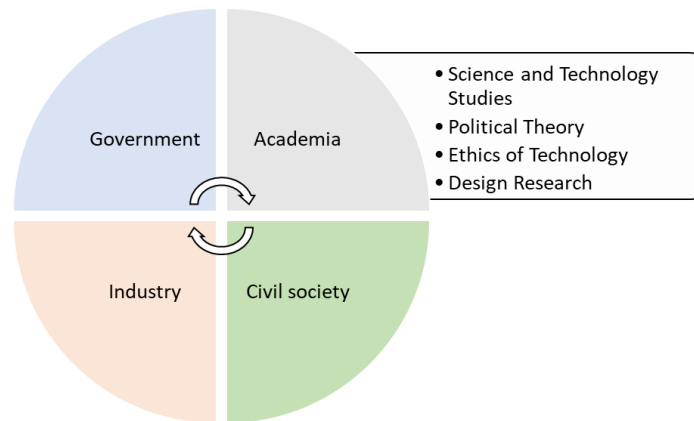
Figure 1.2. Quadruple helix collaboration.

This thesis transcends disciplinary boundaries as it combines insights, concepts and methods from science and technology studies, political theory, ethics of technology and design research (e.g. Latour, 2005; Marres, 2007; Boenink & Kudina, 2020; Ehn et al., 2014). It integrally connect the concept of controversies to democratic practices in the smart city, and aims to enhance these democratic practices with both a restored focus on public values, as well as a renewed approach through material engagement as provided by design. To achieve this, and given the urban context of this research, it combines knowledge, expertise and experience from all four strands of the quadruple helix[4] (Arnkil, 2010): research, government, industry and civil society (Figure 1.2).

1.8.3 The positioning of design in this research

It is worth to note that the field of design takes a special positioning in this transdisciplinary research. Although this thesis promotes a highly transdisciplinary perspective and aim to follow the meandering transdisciplinary borders, this thesis is most strongly positioned within design research. I explain this by relating design research to the three components of transdisciplinarity. Firstly, design research is a core disciplinary field from which I apply insights and techniques to support this transdisciplinary endeavor. It leverages insights on how to access tacit knowledge, how to meaningfully involve stakeholders and how to stimulate collective creative thinking and sensemaking (e.g. Cross,1982; Sanders & Stappers; 2008, Ehn et al., 2014). I build on human-centered and participatory design, and understand design as process of inquiry that is specifically sensitive to needs, wishes and values of those involved and affected by the design. Secondly, design also plays a key role in the transdisciplinary element of this research when connecting science to society. One of the most prominent challenges of transdisciplinary working is bridging the different languages used within disciplinary, sectoral and organizational boundaries (Sellberg et al., 2021). Design is an often used approach to bridge science and society, and considered to be a 'binding glue' (cf. Kelley & VanPatter, 2005), as it offers a common language through making ideas tangible, thereby moving the interaction beyond formal jargon or disciplinary language. In doing so, design allows different stakeholders to participate in the process and provides a promising way to navigate complex

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[4] Within the domain of technological innovation, the triple helix is a well-known concept: it denotes the connection and collaboration between industry, government and research institutes. A core partner is missing here however: the citizens, those who use and experience, whether positively or negatively, the technologies that flow from innovation labs. The quadruple helix therefor expands the triple helix, by incorporating civil society in the collaborative efforts. It thereby aims to stimulate and sustain public dialogue.

collaboration (van de Bijl-Brouwer, 2022; Gonera & Pabst, 2019). Some well-established practices and principles have contributed to the success of design in this context, such as problem framing and reframing (Dorst, 2011), human-centered design (van der Bijl-Brouwer & Dorst, 2017), and participatory design (Sanders & Stappers, 2008). Thirdly, when it comes to enhancing scientific insights for societal good, design offers a bridge from academic discussion to real world problem solving (Dorst, 2011). The complex, open-ended, ambiguous and networked nature of societal challenges invites space for design and its creative impetus to bring in its expertise in empathizing with multiple disciplinary paradigms and stakeholder perspectives (Buchanan, 1992; Dorst, 2015).

1.9 Thesis outline

The structure of this thesis is visualized in Figure 1.3. As this figure shows, the research is organized in three parts related to the three steps as discussed in Section 1.7, and each chapter addresses one of the specific research questions as outlined in Table 1.2.

Part A: Controversies to address socio-technical challenges

This first part presents the theoretical underpinnings of working with socio-technical controversies. Chapter 2 theorizes a threefold productive potential of socio-technical controversies to enrich civic engagement, ethical deliberation and alternative imaginaries on the introduction of technology in cities. Although these three potentials are intricately linked and hard to separate, the following chapters will specifically focus on the potential for ethical deliberation, by making the values and value conflicts that controversies contain, explicit. Furthermore, Chapter 2 provides a first understanding of the role of design in embracing and operationalizing controversies.

Chapter 3 further explores controversies as a constellation of value conflicts in the public realm. It provides a conceptualization of a controversy's constituent parts in terms of a micro-meso-macro architecture. Through an exploratory workshop approach, I surface and empirically examine four smart city controversies. I highlight multi-dimensional value-expressions that exist on the micro (individual), meso (social) and macro (societal) level, and reveal how a controversies consist of value conflicts within (inter-level conflict) and across these levels (intra-level conflict). This understanding of the anatomy of controversies provides a fruitful base to develop design approaches that allow to operationalize controversies.

Part B: Design approaches to operationalize controversies

Part B presents two distinct design interventions that operationalize the theoretical understanding gained in part A in order to enable the constructive use of technologies. These design interventions also provide the empirical grounding for part C of this thesis.

Chapter 4 presents a Research-through-Design approach, resulting in a workshop that combines scenario-based, participatory and systemic design techniques to operationalize socio-technical controversies. It does so by unpacking, navigating and addressing a so-called 'Network of Conflicts'. This Network of Conflicts is a visual mapping of a controversy, and builds on the insights from Chapter 3 regarding the multi-dimensional value conflicts that shape controversies. System design techniques such as mapping, leverage analysis and zooming in-and-out, provide a means to visualize and navigate the value conflicts present in controversies. Making these value conflicts explicit, and therefore, negotiable, is a key step to make issues available and shape publics, and provides the base for ethical deliberation on smart city technologies.

Chapter 5 presents and evaluates an interactive, speculative design intervention called 'Future Frictions' that aims to promote a discussion on public values and the societal impact of smart city technologies. This chapter again relates to the multi-dimensional understanding of controversies from Chapter 3. Through relatable future scenarios in the form of a neighborhood narrative and interactions with neighbors, Future Frictions familiarizes participants with multiple perspectives and various forms of societal impacts around urban technologies. I formulate and evaluate the principles of ambiguity, plurality and relatability as key elements when it comes to engaging publics with controversies and value conflicts through means of speculative design.

Part C: Design research and transdisciplinary collaboration

The last part of this thesis consists of reflections on two different levels: reflections on the position of design in this transdisciplinary research and the challenges involved with that, and reflections on the contributions and limitations of the work presented in this dissertation.

Throughout this transdisciplinary research, design takes a central position. In Chapter 6, I challenge and deepen this positioning in order to better clarify the contribution of design. Insights from literature, enhanced with reflections on the interventions of Chapters 3 (Network of Conflicts) and 4 (Future Frictions), allowed us to formulate five roles for design in transdisciplinary collaborations: (1) generator; (2) communicator; (3) facilitator; (4) mediator and (5) provocateur. I argue that the latter two roles, are the most recent roles in transdisciplinary settings, yet also the most challenging.

As a closing chapter, Chapter 7 reflects on the insights generated throughout this research. Here, I integrate and discuss the findings from the previous chapters, and highlight the unique contributions of this dissertation. I summarize the implications and limitations of working with controversies, and indicate future research opportunities to continue and expand this line of work.

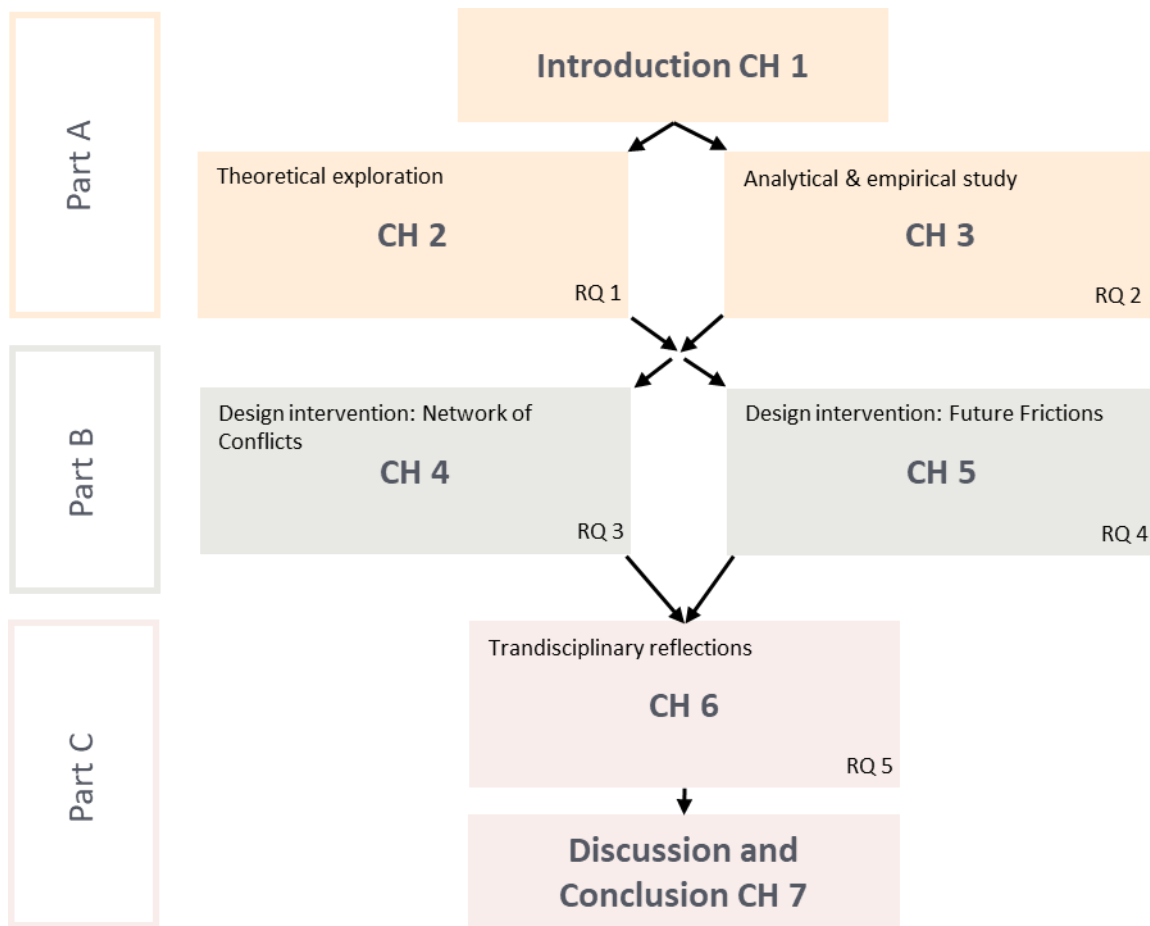| Part A | **Introduction CH 1** | |
	Theoretical exploration **CH 2** RQ 1	Analytical & empirical study **CH 3** RQ 2
Part B	Design intervention: Network of Conflicts **CH 4** RQ 3	Design intervention: Future Frictions **CH 5** RQ 4
Part C	Trandisciplinary reflections **CH 6** RQ 5	
	Discussion and Conclusion CH 7	

Figure 1.3. Thesis outline

Part A
Controversies to address socio-technical challenges

Part A of this thesis consists of two chapters and presents a theoretical exploration of socio-technical controversies to define the concept and substantiate *why* they can be seen as constructive conflicts when working towards responsible smart cities.

Chapter 2 theorizes a threefold potential of socio-technical controversies to enrich civic engagement, ethical deliberation and alternative imagination when smart technologies are introduced to cities. Although we understand these three potentials as intricately linked and hard to separate – e.g. part of ethical deliberation is asking 'what if' and thereby going into alternative imagination –, the rest of the thesis focuses on the potential for *ethical deliberation* specifically, by explicating the values and value conflicts that controversies contain. Furthermore, Chapter 2 provides a first understanding of the role of design in embracing and operationalizing controversies. Before arriving at this design part however, we first needed a deeper analytical understanding of controversies, to better grasp *what* we are working with.

Chapter 3 conceptually and empirically presents controversies as multidimensional value conflicts. It does so by providing an understanding of the micro, meso and macro levels of values, and the inter-level and intra-level conflicts between and within these levels, that build a controversy. The value conflicts that shape a controversy, reveal the underlying needs and wishes of the publics involved. Explicating them makes the issues more accessible. Chapter 3 provides both a conceptual understanding of controversies (through the micro-mese-macro structure), as well as a contextual understanding on the thematic issues that govern smart city controversies specifically (through four examples of controversies). Unpacking the multidimensionality of controversies triggers ethical deliberation, as it provides rich insight into the value conflicts that shape the issue at hand. Moreover, this understanding of the anatomy of controversies provides a fruitful base to develop design approaches that allow to operationalize controversies in Part B of this thesis.

'Marco Polo describes a bridge, stone by stone. "But which is the stone that supports the bridge?" Kublai asks. "The bridge is not supported by one stone or another," Marco answers, "but by the line of the arch that they form." Kublai Khan remains silent, reflecting. Then he adds: 'Why do you speak to me of the stones? It is only the arch that matters to me." Polo answers: without stones there is no arch."'

Italo Calvino - Invisible cities

Chapter 2

The potential of smart city controversies to foster civic engagement, ethical deliberation and alternative imagination

Abstract

In this chapter, we argue that socio-technical controversies are conflicts to embrace and utilize, rather than smoothen out or avoid. Building on theoretical insights from Science and Technology Studies and Philosophy of Engineering, and contextualizing these in the smart city, we highlight a threefold potential of smart city controversies to work towards more responsible development of future cities. We argue that socio-technical controversies are promising entry points for civic engagement, ethical deliberation and alternative imagination on the introduction of technology in cities. We support this threefold potential with examples from global smart city projects. Next, to activate this potential, we build on existing design approaches that embrace conflicts in a constructive manner, and suggest to work towards a 'Designing for Controversies' approach to engage with controversies.

Some adaptations have been made include and align the published work in the dissertation, and to keep terminology consistent with the rest of the thesis (i.e. 'alternative imaginaries' to 'alternative imagination' and 'ethical reflection' to 'ethical deliberation'). We emphasize the public rather than individual setting of this ethical inquiry. Reflection entails thinking through certain options and reasons, whereas deliberation includes the active weighing and examining of options and reasons, thus including a mature form of reflection.

2.1 Introduction

The development of smart city projects and their accompanying discourse have led to responses of both optimism and opposition. In this chapter, we understand the smart city as a general paradigm of innovation activities that aim to improve urban life through means of data and technology. Many different projects are pursued under this umbrella, ranging from measuring air quality to optimizing parking. Smart city projects are gaining foothold worldwide as they intend to optimize urban processes and enhance the quality of city life. Through apps, algorithms, and artificial intelligence, smart cities aim to prevent crime, resolve waste-issues, relieve congestion and improve public services (Komninos, 2008; Su, Li & Fu, 2011, Caragliu et al., 2011). At least, that is the promise of the smart city.

Many criticize this narrative, however, for being ill-defined and too tech-driven (e.g. Kitchin, 2014; Söderström et al., 2014; Valdez et al., 2018). As such, smart city projects generate socio-technical controversies: social conflicts that emerge from the coexistence of conflicting viewpoints due to the introduction and use of technology in society (Callon et al, 2009). Smart city controversies exist in relation to the general smart city paradigm and the desirability of a data-driven urban pace, which is for example voiced in the concern on tech-drivenness (Kitchin, 2014). However, controversies also occur regarding specific smart city projects and technologies. A recent example of controversies linked to a specific technology is the debate around the covid-19 tracking app: rather than the often-portrayed binary framing which contrasts privacy concerns with usefulness concerns, this debate has involved a broader scope of societal values such as public health, autonomy, privacy and freedom (Lucivero et al., 2021).

The impact of (urban) technology is often a contested subject: benefits, risks and uncertainties are put on the table, experts are asked to shed their light on it and the concerned citizenry voices their opinions. Socio-technical controversies represent the complexity of concerns, formulated by various stakeholders – ranging from engineers to policy makers to citizens. Actors involved in smart city projects, however, often ignore areas of conflict by seeking for consensus, avoiding disagreement or introducing a technological solution to solve issues at hand.

This chapter elaborates on smart city controversies as promising concepts for further study: controversies highlight friction between values and perspectives and as such reveal what is at stake. They allow space to move beyond univocal, corporate-driven visions of the smart city, and include multiple perspectives on the smart city and its impact on urban life. As a result, we propose that controversies create opportunities for civic engagement, ethical deliberation, and alternative imagination on the introduction of technology in the urban sphere. By nurturing these instances of conflict and harvesting the insights they contain, it is possible to work towards more responsible practices of engineering and design for the smart city.

The insights presented in this chapter follow from the research project 'Designing for Controversies in Responsible Smart Cities'[5], in which controversies are a point of departure to work towards more responsible development of smart city projects. The 'designing for controversies' approach entails creating responsible smarter cities that strike an optimal chord between civic engagement and

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[5] For more information, please visit www.responsiblecities.nl

technological innovations, while supporting the needs of a diverse group of stakeholders. This chapter outlines the motivations for taking controversies as meaningful points of departure.

To understand the potential of socio-technical controversies, we start our inquiry by reflecting on the contested nature of the smart city. Following this, we place the plea to utilize the potential of socio-technical controversies in a broader tradition within Philosophy of Engineering and Science and Technology Studies literature. These insights support our suggestion to embrace controversies as profound opportunities for further exploration, and bring us to presenting the threefold potential of controversies as sources for civic engagement, ethical deliberation and alternative imagination. Finally, we suggest several design approaches that provide promising avenues to actualize the identified threefold potential.

2.2 The contested smart city

The 'smart city' is a continuously evolving concept; envisioned, emphasized, and executed differently throughout the world (Albino, Berardi & Dangelico, 2015). From seemingly innocent parking apps that direct cars more easily to empty parking places, to more intrusive applications such as facial recognition in public squares to quickly identify offenders of law – in some cases directed towards hard criminals and in others towards jaywalking citizens, the implementation of smart city technology takes many forms.

Central in all these instances of the smart city concept is the employment of urban data and technology to optimize and improve city processes such as (amongst others) mobility, sustainability, energy and safety (Vanolo, 2014). Building on what is known as the cybernetic loop – a continuous feedback-loop where data is being collected, analyzed an applied – the city can benefit from real-time insight and intervention to enhance the urban experience. This idea of 'techno-fix' to complex social, economic and environmental issues is debated and criticized for its technological solutionism and reductionist approach to urban life, and its focus on efficiency as ultimate goal (Kitchin, 2014; Söderström et al., 2014, Valdez et al., 2018). Moreover, it perpetuates the idea that technology is neutral, whereas in reality, many instances exist of data-driven policies and uses of technologies that deepen social inequalities or negatively affect already marginalized groups.

As with any other socio-technological development, smart city technology has the potential to empower or disempower, include or exclude different perspectives and support or suffocate certain voices, leading to friction (Kitchin, 2014; Valdez et al., 2018). These points of friction appear due to differing ideologies and ideas on what the urban space means, for whom or what it should be designed and the role of technology in this context. Recent examples are the hand sanitizers as a response to the global Covid pandemic. These are placed in the public space, but sometimes fail to recognize hands of non-white people, thereby catering only a fragment of users of public space. In the Dutch context specifically there has been a major controversy on data-driven policy aimed to detect fraud in tax allowances, but the system was biased towards citizens with a foreign or double nationality (Henley, 2021). These instances highlight that technology is not neutral but heavily value-laden and deeply political, and highlight the contested nature of smart city technology.

Moreover, the impact of technology is not univocal: it can be framed from multiple perspectives. For example, a surveillance camera can represent safety to one, but exemplify Big Brother government and the invasion of citizens' privacy to the other. When these perspectives conflict, controversies

arise. Controversies are 'situations where actors disagree (or better, agree on their disagreement)' (Venturini, 2010), being issues at stake sufficiently important not to be ignored.

2.3 Understanding socio-technical controversies

Socio-technical controversies are public disputes that arise through the introduction of disrupting technologies in society (Callon et al., 2009), that find their origin in a range of economic, political and ethical concerns (Nelkin, 1995). Socio-technical controversies 'represent a reaction against technocracy in the search for a more human-centred world' (Touraine, in Nelkin, 1995). They are public issues, both mediated and mediatized, and characterized by incomplete knowledge, uncertainties and disagreements (Marres, 2007).

Controversies are complex phenomena; they do not reduce or resolve to clear-cut either/or cases. Instead of opposing ends of a binary, such as for example the privacy vs. safety debate is often depicted when discussing surveillance technology, controversies should rather be seen as polyhedrons, in which each plane represents a different frame to the issue. Going back to the example of the introduction of the covid-19 tracking app, there was more to the debate than (data) privacy and concerns on public safety in terms of public health (Lucivero et al., 2021). Lucivero et al.'s qualitative study showed that concerns on autonomy and freedom, as well as social stigmatization and digital literacy, were a central part of the public debate as well.

2.3.1 Controversies and democracy

Approaches like actor-network-theory (Latour, 2005) demonstrate that social and technical components of socio-technical controversies cannot be separated. Declaring an issue as purely *technical* effectively removes it from the influence of public debate, which is exactly what happens in some 'techno-fix' smart city projects. With the case of the covid-19 tracking app, merely introducing a more privacy-friendly tracking technique such as Bluetooth, does not resolve the concerns at hand. On the contrary, it intensifies potential pain points that originate from the tension among different societal values, as the tensions remain unacknowledged and unaddressed. To work towards responsible technology use in cities, it helps to understand how these controversies can be sources of added value, instead of avoiding them.

Controversies are right at the core of our democracy: it is through contestation and interaction between perspectives, that the 'matters-of-concern' (Latour, 2005) that deserve (political) attention become known. Following the works of Latour (2005) and Marres (2007), we understand controversies as instances where politics 'happens': a diversity of actors and plurality of perspectives come together, leading to self-organized participation and value-assessment (Cuppen, 2018). As a result, actors negotiate values, evaluate pathways for action, and new social practices emerge.

Controversies are relevant in the smart city context because they concern situations where something is at stake: actors gather because something is important to them ranging from, for example, air quality to social justice. Sustained, visible controversy over technologies may reflect serious debate over political and social goals (Jasper, 1988). These sources of tension function as expressions of conflict and negotiation, where 'actors are unremittingly engaged in tying and untying relations, arguing categories and identities, revealing the fabric of collective existence' (Venturini, 2012; 796). Venturini (2010; 264) compares controversies to the social at is magmatic state: they exemplify the melting and forging of collective life, continuously transforming between solid and

liquid state. Controversies are no static, but rather dynamic markers of social process: new action groups emerge, and issues are highlighted differently over time (Cuppen et al., 2020). As such, controversies are seen as the best settings to observe the construction of social life (Latour, 2005; Venturini, 2010).

Already in 1986, Rip acknowledged controversies as sources of informal technology assessment: through controversies, the impacts of actual or proposed projects are articulated and consolidated (Rip, 1986). Due to their public nature, controversies are relevant for gaining insight on stakeholders' perceptions and evaluations of new technology. By fostering these conflicts as early warning signals for unexpected risks or unintended social impacts, the societal and economic costs of developing technology through trial and error can go down considerably. Following this, Todt (1997) argued that including actively managed controversies in the design process can lead to more socially acceptable solutions. This idea has been carefully applied in, for example, energy innovation, where social opposition is quite common (Kolloch & Dellerman, 2018; Cuppen, 2018). Opposition to specific innovations and emerging technologies stems from a diversity of values and goals within society that are conflicting with some of the values expressed in the innovation design. These opposing interests can be a source for creative synthesis and shaper of innovation (Kolloch and Dellerman, 2018). Consciously embracing controversies allows the design process to open up and bring a diversity of actors and viewpoints into the design of a new technical system such as the smart city.

2.4 The threefold potential of working with socio-technical controversies

Acknowledging and embracing smart city controversies is essential to engage stakeholders to act on complex collective problems, and on shared issues of concern (De Lange and de Waal, 2017). Socio-technical controversies serve to point out problems, clarify definitions and generate alternatives with regards to the technology that is being implemented and its societal impact. They surface various perspectives, values and visions, thereby opening a wider view of the possibilities and limits of a technology. Conflicting views on (the impact of) technology are inevitable in a pluralistic society, and can be seen as part of the democratic process (Todt, 1997). These public controversies form the tangents of social life where reflections and dilemmas regarding ethical and political issues can become both debatable and actionable. Controversies can foster debates about issues that used to be taken for granted; they help to identify what the issues are, and articulate avenues to act on them.

Against this theoretical background, and within the context of responsible smart city making, we propose a threefold productive potential of socio-technical controversies to enrich the design and implementation of smart city projects. When embraced constructively, controversies enable:

a) Civic engagement – *to involve those affected by smart city projects*
b) Ethical deliberation – *to discuss the societal impact, direction and desirability of smart city projects*
c) Alternative imagination – *to allow room for different views and visions on the future of the city*

Within the previously described context of smart cities and their criticized tech-driven, univocal and top-down nature, these three opportunities arise as the most prominent and most valuable to address the lack of democratic debate on smart cities and their impact.

2.4.1 Civic engagement

One of the major points of critique of the smart city is that it perpetuates a top-down, corporate driven vision of urban space, and neglects citizen's experience and perspective of the city (Vanolo, 2016). In response to this critique, some projects make efforts to shift towards a more bottom-up and people-centric approach (Trencher, 2019). The challenge, however, is how to truly engage and include citizens, and work towards a process of collaboration and co-creation, rather than relying on mere citizen consultation.

We suggest that smart city controversies are natural spaces for civic engagement and should be fostered as means to democratize the smart city. Relating this to Latour's notion of *ding-politik* (2005), a controversy functions as a 'public thing': an occasion where various actors can meet and debate different issues that are of importance to the community. The issue at stake (the controversy) involves both facts about the world and concerns about their implications. People's engagement with the issues at stake are the basis for coming together (becoming a 'public') to develop accounts of what is the case and why this is important. Such a hybrid forum (Callon et al., 2009) offers space for negotiation on conflicting interests, expectations or values; whether it be ethical concerns or technical details.

A key aspect of democratization of the smart city is to open up pathways for participation in issue formation (Marres, 2007). This allows citizens to have a more active role in the politicization of technology. Controversies consist of both matters-of-fact and matters-of-concern, and are thereby not mere rational conflicts but also affective. They highlight what is at stake, what brings about strong feelings and what is of public value. Their intertwinement with public values (which we will elaborate on in the next paragraph), is a core part of how and why controversies drive civic engagement.

An example where contestation and controversy drove civic engagement in the smart city is that of Toronto's Sidewalk Labs. The project promised to turn Toronto's Waterfront area into an ultra-connected and smart city, containing autonomous cars, heated streets, and smart waste collectors. However, strong criticism arose from citizens and privacy campaigners against the ill-defined plans for data-collection and privacy, especially with Google being one of the project leads. Longstanding contestation led to delays, alterations and eventually even ending the planned project, with new plans being made that support non-digital means to support sustainability and the development of a citizen-centric city.

2.4.2 Ethical deliberation

Smart city controversies reveal what is at stake when discussing the nexus of urban technology. They highlight what issues and values are of concern and urge us to evaluate our actions and negotiate ways on how to move forward. Socio-technical controversies require us to not see urban challenges as solely technical problems that need a 'fix', but force us to understand the social, political and ethical questions that they raise. As such, controversies create opportunities for an ethical dialogue on the desired direction of technological developments. They help us to make sure critical questions

about the societal and ethical desirability of technology are incorporated in the development of smart city projects.

Therefore, we propose controversies as entry points for ethical inquiry and debate. The need for such an ethical dialogue on technology is widely recognized, amongst philosophers and engineers alike. Controversies also show the need to move ethical debate beyond much raised issues on privacy and cybersecurity. Albeit key concerns to address, society has been confronted with multiple and diverse unintended effects of the widespread application of data and algorithms, such as racial discrimination in facial recognition software or gender-discrepancies in voice recognition tools. Both examples highlight the value of inclusion as key in the design, development and programming or new technologies, additional to privacy and security concerns.

We thus understand controversies as a means to elicit ethical inquiry and access the values that are of public concern. These values are relevant input for engineers, so that they can translate them to actual norms and design requirements (van de Poel, 2013). The value tensions that are part of a controversy reveal the underlying needs and wishes of the publics involved. As such, controversies are a means to do bottom-up ethics, where we understand values as lived experiences that need to be understood in context, instead of elements of a top-down list of values that rely on discursive and abstract definitions only. Prior means to engage engineers and ethics more closely such as Value Sensitive Design (Friedman et al., 2013), offer such a fixed set of values as a means of 'checklist' when designing and implementing new technologies. Albeit a helpful and highly applied approach, it is much criticized for its use of a predefined list of values. Working with a list privileges certain values from the start, thus being less open to encounter values through a process of discovery within the local context (Le Dantec et al., 2009). This reduces the ethical and political conversation to a design requirement that must be checked off the list. It neglects that values are situated, contextual and mediated by technology (Boenink & Kudina, 2020), entailing that their relevance and meaning can change over time and space. Controversies offer a means for value discovery (Le Dantec et al., 2009), and their contextual character helps to directly engage with the local expressions of values, and prompts a commitment to respond to local context of design.

Moreover, through value discovery and the surfacing of values that are of concern, opportunity opens for aspirational ethics amongst engineers. Much of ethics in engineering focuses on preventive ethics: checking the mandatory rules that promote a safe society and prevent harm. Aspirational ethics however focuses on promoting human well-being and social good, and thus takes a more holistic approach to what a 'safe society' might mean. Whereas preventive ethics is a more negative interpretation of ethics (highlighting what should be prevented), aspirational ethics allows for a more positive interpretation (highlighting what should be fostered and promoted) (Harris, 2013). This approach to ethics fits well with, and follows more naturally from, a process of value discovery, as it is through understanding values in context that engineers can better grasp what values entail and how to promote them through their technological design (Harris, 2013).

The Responsible Sensing Lab in Amsterdam is an example of how controversial issues and the values they raise, can inspire new ways of design and engineering. Following the ongoing debate around surveillance cameras and their intrusion on citizens' privacy, they have developed the 'shuttercam': an experimental camera that can be covered by a cap, thus giving transparency on when it is recording and when not. By incorporating the values and concerns that are raised, and finding

innovative ways to integrate abstract values such as privacy into the design, this lab embeds public values in their practices, and is working towards more responsible sensors to support the smart city.

2.4.3 Alternative imagination

By bringing together various perspectives and revealing the values of concern, controversies open pathways for alternative socio-technical imaginaries of the smart city. It is through these critical questions about societal impact and desirability, that the public's dream and doom scenarios for urban futures become known. By understanding which values the public would like to protect or pursue, it becomes possible to create new imaginaries of the future that incorporate these values. These imaginaries can move well beyond the corporate-fed ideal of an efficient and optimized city, and can include new visions on, for example, healthy urban living or a smart city focused on supporting social interactions. When thinking about the kind of values to nurture, people engage their imagination, helping them to shape new ideals, or come up with standards to make urban futures more relatable and enjoyable.

Smart city controversies thus serve as much-needed opportunities for opening democratic discussions about urban futures. It might feel that controversies are divisive in nature, but when embraced, they can help to identify and shape more inclusive futures. They allow us to involve a diversity of perspectives and work towards a collective, alternative imagination on the smart city. This allows us to re-appropriate smart city futures and move beyond the merely corporate view urban space.

The current discourse is dominated by the utopian narrative of technological salvation as a response to the many global and urban crises the world is facing (Sadowski & Bendor, 2019). This reductionist, technocratic and top-down view on urban technology restricts stakeholders' imagination and limits the creation of new pathways to address the existing and future urban challenges (Vanolo, 2014; Valdez et al., 2018). It crowds out alternative visions on corresponding arguments on smart urbanism (Sawdowksi & Bendor, 2019). Current imaginaries of the urban future mostly reflect and reinforce the existing socio-political system, rather than opening space of alternative perspectives and futures. There is a need for means to move beyond one comprehensive, corporate view and allow different ideas and initiatives on smart urbanism to exist side by side.

Rather than abiding by these uni-directional visions on what the smart city entails, controversies enable us to create counter-narratives: new stories about futures that incorporate different values and perspectives than the dominant discourse of technological utopia. They allow to build new imaginaries from a collective perspective, incorporating multiple needs and visions. These types of alternative visions can be created through contestation and debate. Exploring multiple perspectives and meanings associated with technological artefacts allows for dialogue and understanding different application contexts. Similar to the approach of object theatre (Fritzsche, 2021), the aim is not to integrate different visions on a technology, but to represent alternative imaginaries by combining different narratives and voices. At the moment, such debate is lacking. Through embracing controversies and fostering these space of contestation and debate, we can cultivate space for alternative values, visions and futures. Controversies show that there are many futures ahead, and help to reflect on the anticipated outcome of societal choices. They are thus breeding grounds for alternative imaginaries of urban life.

Several examples of alternative visions to what a smart city could entail exist. The city of Barcelona is a great and rare example of a city that fostered new urban imaginaries by introducing a 'city data commons' and various platforms for civic participation in the smart city, thereby taking a different direction from the initial plans of corporate tech-giant Cisco. The city of Paris is a frontrunner of adapting the '15-minute city premise' (Moreno et al., 2021), that moves away from car-centric urban planning to emphasize values of accessibility, sustainability and local communities. This alternative imaginary ('communities should have access to their needs within a 15-min reach' and commuting is not necessary) impacts how the city can evolve and the role that technology can play in that process. Other efforts include innovative ideas of urban social justice, such as digitizing and mapping slums, or efforts on mental health and urban stress (McFarlane and Söderström, 2017).

2.5 Design approaches to realize the potential of controversies[6]

Although the potential of controversies has been recognized decades ago, ways to effectively exploit this potential are scarce. Moving beyond their theoretical analysis, we now turn to the innately more practically oriented fields of engineering and design to realize the identified opportunities that controversies bring. Following the theorized threefold potential, we suggest that a design approach to engage with controversies requires engaging in techniques that bring together the diversity of perspectives that are core to controversies, and should emphasize the following:

(1) *Empathy building and perspective taking*. To grasp the complexity and nuance that builds up a controversy, it is important to be aware of the diversity of perspectives that coexist in the socio-technical context of engineering projects – ranging from the technical to the civic perspective. Moreover, different stakeholders in society may have different goals and aspirations, that go beyond the pure use of the technology at hand. Greater empathy with the envisioned user will support engineering practices to view the 'user' as a more holistic 'human', and also incorporate 'society' in their practices.

(2) *Modes of critical and creative thinking.* The process of value discovery and ethical deliberation that happens through controversies, requires a critical mindset towards the design and impact of technology: what effects does it bring about and how does that influence our daily lives? At the same time, a creative attitude comes into play: how to mitigate unintended or undesired effects? What other futures could be envisioned? Key here is that these modes of thinking come jointly when addressing controversies constructively: merely resting on criticality won't allow us to harvest the potential to bring about new and better technologies that do include the values of concern. At the same time, merely relying on creativity will not allow us to truly understand the issues at stake, potentially running the risk of neglecting values of societal relevance.

To further develop this 'Designing for Controversies' approach, we must understand how to develop and support empathy among stakeholders with diverse, and potentially conflicting perspectives, and how to foster modes of both creative and critical thinking. In the field of design research, we find some inspiring examples of how to go about this. Systemic Design (van der Bijl-Brouwer & Malcolm,

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[6] Since this PhD project is part of a larger consortium project, this thesis does not specifically focus on empathy building and perspective taking.

2020) integrates systems-thinking with human-centred design and provides promising means to address the complexity that controversies carry, because of the multiple perspectives and values that collate. Speculative and Critical Design (Dunne & Raby, 2013) uses design as a medium to explore the societal implications of future technologies, and invites imagination and critique by being explicitly provocative. Below we highlight two compelling approaches that specifically centralize friction:

The Scandinavian participatory design approach (e.g. Ehn, 2014) is highly aligned with our exploration, as it combines theoretical insights from Latour (2005) and Mouffe (1999) into their design practices. Within this school of thought, controversies are taken as starting point of the participatory design processes. By employing 'agonistic public spaces' (cf. Mouffe, 1999), rather than consensual decision making, they foster the incongruent concerns and take them as a point of departure. 'Infrastructuring' is a move away from short-lived design project, towards a more open-ended space and long-term process where stakeholder can come together and co-create innovations.

Another source of inspiration is dilemma-driven design (Ozkaramanli, 2017), that shows how dilemmas and conflicts can serve as the breeding ground for design solutions, by highlighting the actual needs of the user. Dilemma-driven design helps to generate empathy for people's goals and values, and uses the creative potential of conflict to stimulate innovation. A similar attitude can be taken on when discussing smarty city controversies: these socio-technical controversies highlight the value tensions that new urban technologies bring about, and as such surface 'user' needs and potential pathways for addressing them – the user being a variety of stakeholders in the urban sphere here.

2.6 Conclusion

Smart city technologies tend to be sources of friction and debate, as multiple perspectives and expectations on urban futures come together and collide. In this chapter, we have argued that acknowledging and embracing these socio-technical controversies can be of added value to the design and development of smart city projects. We understand controversies as instances where politics 'happens': a diversity of actors and plurality of perspectives come together, values are negotiated, pathways for action are evaluated and alternative urban imaginaries emerge. We have described the productive potential of controversies to enhance and enrich the smart city debate, and theorized a threefold potential: to stimulate civic engagement, encourage ethical deliberation and envision alternative imaginaries. Next steps in urban policy and engineering practices should focus on harvesting the inherent value contained in smart city controversies by bringing these theoretical insights to practice. We suggest to build on existing design approaches that embrace conflict and value tensions, in order to enhance the engineering practice and work towards more responsible smart city projects. To engage in such practices however, it is important to first better understand how controversies are constructed.

Chapter 3

Curious Controversies: a systemic design lens to understand value conflicts in the smart city

Abstract

This paper explores socio-technical controversies in the smart city context, and proposes that controversies are valuable concepts for systemic design research and practice due to their multidimensional nature. Smart city visions and initiatives tend to be sources of friction and debate: multiple perspectives and expectations come together, leading to value tensions. In our work, we conceptualize controversies as a constellation of value tensions in the public realm. In this work, we stress the importance of embracing controversies and explore how to stimulate ethical deliberation regarding the soft impact of technologies in smart cities. Using an exploratory workshop approach, we empirically examine smart city controversies and propose that such controversies consist of conflicting concerns and value tensions at the micro-, meso- and macro-levels of system analysis. Our findings indicate that value tensions can arise within (inter-level conflict) or across these levels (intra-level conflict). Controversies can contain both type of conflicts. This analysis highlights the complex nature of socio-technical controversies, and how a better understanding of controversies may eventually help grapple with complexity in systemic design research and practice. Moreover, dissecting a controversy in this way into its formative elements allows triggering ethical deliberation on smart city practices, as it reveals pressing value tensions.

3.1 Introduction

From newspaper headlines to academic conference themes and paper titles, it is impossible to escape the abundance of socio-technical challenges, crises and conflicts that society is currently facing. Especially the concept of conflict, and how to work *with* it, rather than *against* it (i.e. by resolving or ignoring it), has recently gained more academic attention within design research (e.g. Ozkaramanli, 2021; Matic & Matic, 2021; Tromp & Hekkert, 2018; Matos-Castaño et al., 2017) and other fields such as Science and Technology Studies (STS) (Marres, 2007) and sustainability studies (Cuppen, 2018). This was also implied by the 2021 RSD conference theme 'playing with tensions', which highlighted value tensions and multistakeholder conflicts as key challenges at the forefront of systemic design practice and research. Systemic design often deals with tensions and conflicting requirements that they seek to change or intend to address (e.g. Dorst, 2019; van der Bijl-Brouwer & Malcolm, 2020). How to embrace these tensions and conflicts as valuable societal feedback?

To address this challenge, we introduce the notion of socio-technical controversies as a promising new concept to grapple complexity in multistakeholder settings in systemic design research and practice. Building on Li (2012), who introduced a micro-meso-macro structure for the social context of engineering, we propose that controversies contain a micro-meso-macro structure of value expressions that are entangled through tensions within and across these dimensions. We argue that adopting a systemic perspective means to understand and address such tensions in relation to each other, instead of dealing with them within the confines of a singular system level or reducing them to singular oppositions.

Controversies have been a subject of study since the second half of the 20th century and has mainly attracted academic interest in the STS community (Pinch & Leuenberger, 2006). Controversies are defined as 'situations where actors disagree' (Venturini 2010; 261), signalling issues at stake that are sufficiently important not to be ignored. Building on Latour's notion of ding-politik (2005) and Marres' issue-oriented understanding of public involvement in politics (2007), we understand controversies as places where politics 'happens': A diversity of actors and plurality of perspectives come together, values are negotiated, pathways for action are evaluated and new social practices emerge.

Since controversies highlight friction between values and as such reveal what is at stake, they are promising, holistic concepts when discussing tensions in a multistakeholder setting. Although the potential of controversies has been recognized decades ago (e.g. Rip, 1987), ways to effectively exploit this potential are scarce. Based on the aforementioned definition of controversies, socio-technical controversies may have a mediating role for revealing the diversity of values in multistakeholder collaboration. As opposing interests can be a source of creative synthesis and a shaper of innovation (Kolloch & Dellerman, 2018), we suggest that consciously embracing controversies and the value tensions they reveal, can trigger ethical deliberation and support more responsible practices in socio-technical contexts (Geenen et al., 2023). Our contribution, therefore, addresses the following question: How can socio-technical controversies be conceptualized to support ethical deliberation in smart city projects? To answer this question, we adopt an analytical perspective on controversies through examining four smart city controversies that were identified in two exploratory workshop sessions as part of a transdisciplinary research project on smart cities.

In what follows, we first introduce a theoretical understanding of controversies in the smart city context. For this, we bring in insights both from smart city discourse and Science and Technology Studies to underline the link between controversies and complexity. We conclude our theoretical analysis with the assumption that controversies can be understood as multidimensional value conflicts, with value expressions on the micro, meso and macro system levels. Next, to further substantiate this theoretical hunch, we explore the multidimensional nature of controversies in a workshop using utopian and dystopian smart city imaginaries with quadruple-helix stakeholders. Through four identified smart city controversies, we empirically argue how values are expressed at the micro, meso, and macro level, and how controversies are built from conflicts between (inter) and within (intra) these levels. Our findings highlight the complex nature of socio-technical controversies that exist within the smart city discourse, and support an understanding of controversies as multidimensional value conflicts. We end with a reflection on how this insight can help to support ethical deliberation in systemic design practices.

3.2 Smart cities

Smart city developments have been met with optimism and opposition in their aim to optimize city life, and have led to socio-technical controversies around for example smart surveillance and datafied urban space. Smart city visions hold the promise to improve city life through real-time insight into the datafied and digitized urban environment, that will allow to analyse, predict and optimize city processes. This clean, computed and centrally controlled version of a city implies a 'techno-fix' to complex social, economic and environmental issues. The smart city paradigm is heavily debated and criticized for its technological solutionism and reductionist approach to urban life (Kitchin, 2014; Söderström et al., 2014), focus on efficiency and economic profit (Hollands, 2015; Wiig, 2016, Grossi & Pianezzi, 2017), illusion of political neutrality (Kitchin, 2014; Söderström et al., 2014), potential to deepen social inequalities and marginalization (Hollands, 2008; Söderström et al., 2014; Grossi & Pianezzi, 2017) and neglect of citizen's experience and perspective of the city (Vanolo, 2016; Cardullo & Kitchin, 2019). Following this critique, recent developments have shown a shift of smart city projects from top-down, corporate-driven, techno-centric activities to a more bottom-up, citizen-inclusive, and people-centric approach, thereby moving away from its initial technological premise and emphasizing the smart city as a social endeavour (Trencher, 2019; Joss et al., 2019). Yet, the smart city remains a contested form of public space.

3.3 Controversies and complexity

Socio-technical controversies are public disputes that arise through the introduction and use of technology in society (Callon et al., 2009). We argue that controversies are important to embrace rather than ignore, as they concern situations where values are at stake: Actors gather because something is important to them. They are examples of wicked problems that are constituted of ethical issues (Sweeting, 2018). Moreover, These sources of tension form the foundation for conflict and negotiation, where 'actors are unremittingly engaged in tying and untying relations, arguing categories and identities, revealing the fabric of collective existence' (Venturini, 2012; 796).

The relation between controversies and complexity is further detailed in Venturini's work (2010), from which we recognize five main characteristics that make controversies relevant for systemic design: (1) they involve a diversity of actors, (2) they consist of unpredictable social

interdependencies, (3) they are irreducible, (4) debated and (5) signify conflicts. We elaborate on these characteristics by conceptualizing them in smart cities:

(1) Diversity of actors: Controversies involve a diversity of actors including humans and non-humans (i.e. technologies (Venturini, 2010)). Working with quadruple-helix stakeholders that represent governmental, corporate, research and civic interests, is becoming a more common practice to bring diverse (human) stakeholders together (Arnkil et al., 2010). Moreover, due to its active role in shaping urban interactions – for example, surveillance cameras in streets modifies the behaviour of citizens in the public space – technology becomes an additional active actor in smart city scenarios.

(2) Unpredictable social interdependencies: Controversies consist of unpredictable social interdependencies that evolve over time, creating new nodes and connections that could not be foreseen before. Controversies are not static, but rather dynamic places of social processes: new action groups emerge and issues are highlighted differently over time (Cuppen et al., 2020). For example, controversies about smart policing trigger discussions related to the connection between technology and discrimination.

(3) Irreducible: Controversies cannot be reduced to single questions that require an answer. Asking "how to make cities smarter?" will lead to additional questions about what 'smart' means, according to whom, whether technology is needed and whether 'smarter' is a desirable objective. The challenge and beauty of dealing with controversies lies in agreeing on both what the questions and the viable responses are.

(4) Debated: Controversies generate debates about issues that used to be taken for granted, creating dynamics between matters-of-fact and matters-of-concern (Latour, 2005). For instance, a few decades ago, there was no public debate about privacy issues in the city. Nowadays, with the introduction of sensors in cities to measure human activity, society has become aware of the implications of these technologies for us, making privacy a priority issue at the social sphere.

(5) Conflicts: Controversies are made up of conflicting values (i.e. value tensions). Given the diversity of frames of references involved in controversies, they result in disagreement and are often disputed (Callon et al., 2009). For example, surveillance cameras in the smart city can be viewed as contributing to urban safety, but can also be perceived as invading the right to privacy and anonymity in the city.

3.3.1 A multidimensional understanding of controversies

Complementing earlier work by Ozkaramanli (2021), we introduce a macro-meso-micro architecture (e.g. Li, 2012) to understand controversies as multidimensional value conflicts. Translating this to the smart city context, this entails value expressions on the micro level (regarding the individual lived experiences of the city), the meso level (regarding the social and relational experiences of the city) and macro level (regarding the societal and political experiences of the city). We propose that controversies exist of multiple conflicts within and across these levels. Instead of opposing ends of a binary, such as the *privacy vs. safety* debate that is often depicted when discussing surveillance cameras in the smart city, we argue that controversies might better be understood as multidimensional concepts, as an interplay of multiple conflicting concerns and value tensions (where we understand *concerns* as *expressions of values*).

When looking at some well-known socio-technical controversies, such as the debate about abortion, smart camera surveillance, or very recently the Corona-app, we argue that what makes these debates so complex and controversial, is their multidimensionality. They cannot be reduced to a simple yes/no question, a mere pro/con perspective, or a sole issue of concern. Consider, for instance, the debate on abortion. Van den Nieuwenhuizen (2022) explores the various nuances, grey areas, arguments, doubts and conflicting value expressions that build this controversy and provide it with its richness in her recent (Dutch only) work: Leven en laten leven (*Live and let live,* 2022). The abortion debate highlights that multiple concerns are at play simultaneously. Individual preferences, social critique, and political prolificacy exist next to, and often in tension with, each other. As such, a controversy represents an intricate web of concerns and value conflicts, that cannot be easily navigated or solved. In order to utilize the potential of controversies to act on complex collective problems, it seems key to understand the elements and the interdependencies present in this complex web of concerns.

To further substantiate this theoretical hunch, we explore the multidimensional nature of controversies in a workshop setting that uses utopian and dystopian smart city imaginaries to surface controversies. This workshop is aimed at including all four strands of the quadruple-helix stakeholders: government, industry, academia and civil society (see Figure 3.1) (Arnkil et al., 2010).
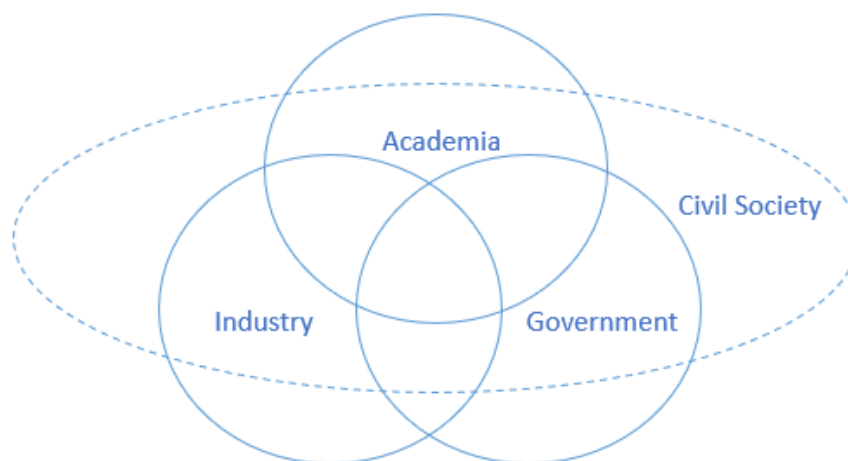

Figure 3.1. The quadruple helix.

3.4 Method: An exploratory workshop to explore multidimensional controversies

This section describes a workshop approach[7] to surface and explore smart city controversies. We proceed by explaining the process of data-analysis, that led to insights on value tensions present in controversies.

In order to surface and explore the socio-technical controversies related to smart cities, we developed a workshop approach, in which participants were asked to imagine utopian and dystopian scenarios of the future city (Matos-Castaño et al., 2022). Such imaginaries ground the values and beliefs people have on the city (Bina et al., 2020). The process of framing and reframing when

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[7] Developed in collaboration with Design Innovation Group as part of the (partly) NWO-funded project 'Designing for Controversies in Responsible Smart Cities' (project number CISC.CC.012).

moving from dream to nightmare scenario, triggered the formulation of value tensions and conflicting concerns, and supports the surfacing of controversies (Figure 3.2). By making these utopian and dystopian imaginaries explicit and contrasting them, we could make the controversies come to light and analyse the value tensions present in them. The workshop approach was supported by thoroughly prepared templates to capture participants' input for data analysis. These templates were fully anonymous and not retraceable to participants.
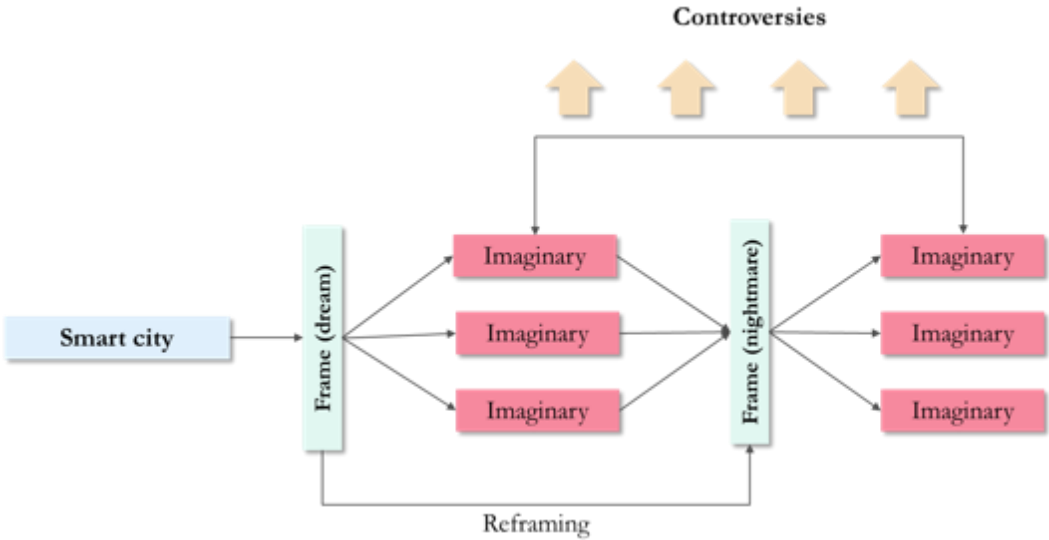

Figure 3.2. Making controversies come to light through exploring dream and nightmare scenarios for the smart city. This framing and reframing of imaginaries allows key concerns, values and value tensions to surface.

We implemented this workshop approach in two sessions (spring 2019). In total, 61 participants contributed, with 41 participants in the first event and 20 in the second. The participants came from diverse backgrounds and represented different strands of the quadruple helix stakeholders (Figure 3.1), such as local and regional government officials, real estate developers, technology developers, researchers and students, with civil society being the least represented stakeholder. All workshops were held in the native language of participants (Dutch), to ensure that the participants could fully and freely express themselves. During the workshop, participants were divided in smaller groups of 6-9 people to stimulate focused, shared discussions.

3.4.1 Workshop approach

The workshop approach consisted of five steps that took place over a 90 minute session. First, participants reviewed a visual of a certain city area that highlighted what type of data is being collected in public space by public and private organizations. This allowed participants to create a shared understanding of technological possibilities in the smart city, and probed them for the next step. Next, participants were asked to create their 'dream scenario' for a smart city. To prevent them from immediately thinking about potential risks, we provided three preconditions that would facilitate thinking about 'dream scenarios': (1) all data can be available, (2) people involved in smart city developments have good intentions, and (3) everything that needs to be properly secured is secured. Moreover, to broaden participant's visions about these scenarios, they received additional technology-cards that explained possible applications of smart city technology. We provided the participants with short prompts (e.g. "In a smart city, it would be wonderful…") and templates to facilitate systematic data collection and analysis. After discussing the identified dream scenarios with

each other, participants created a top-3 of their shared dream scenarios through voting. With the help of the facilitator, the group could narrow down the amount of scenarios as input for the next step. This step concerned the nightmare scenarios, to be formulated as potential risks and downsides of the top-3 dream scenarios. Finally, participants contrasted dream and nightmare scenarios, to surface value tensions and identify controversies. A more detailed version of the protocol can be found in Appendix A.

3.4.2 Data analysis

The collected data consisted of (1) notes and templates filled out by the participants during the workshops and (2) notes taken by the facilitators during the workshops. To analyse the date, we used a qualitative, interpretative approach; which aligns with the exploratory nature of this research (Verschuren, et al., 2010). We used open, emergent coding, to distil main themes (formulated as abstract values such as democracy, sustainability or autonomy). A visual representation of the data-analysis process can be found in Figure 3.3.
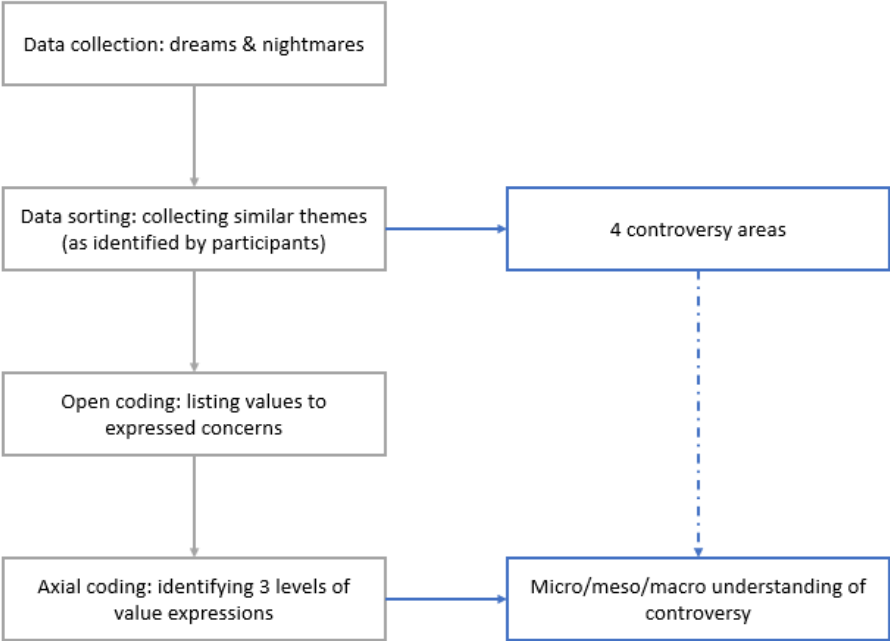

Figure 3.3. Flow-chart representation of the data-analysis process.

We translated and transcribed the dreams and nightmares that participants formulated during the workshop, which all contained less than 100 words as they were collected on prompted sticky-notes. We followed the categories and labels as provided by the participants during the session. Next, we conducted open coding (Bryman, 2015) to connect the concerns to values. We define concerns as *individual expressions* of abstract values voiced directly by the participants. To connect concerns to values, we read through the data multiple times and identified tentative categories for chunks of data, which revealed the underlying values of the dream and nightmare scenarios. For example, when participants' imaginaries focused on saving time in the city, we allocated the code "efficiency", or when they focused on the ability to make your own choices, we allocated the code "autonomy". We then grouped concerns as micro, meso or macro level concerns (Li, 2010) according to the scheme in Table 3.1. Following the work of Boenink & Kudina (2020), we note that values are situated entities that must be understood in context. Therefore, we interpreted values at multiple

levels, depending on the associated concern. For example, privacy could be expressed as a matter of *personal* privacy (i.e. not wanting to be followed and being able to move anonymously through the city), thus an individual concern, or it could be expressed as *public* value (i.e. the human right to privacy and the fear for a Big Brother State) and thus a societal concern. This is core to our analysis, as we are not looking for a list of pure values, but are aiming to understand the values *in context* and their associated concerns voiced in the participants answers.

Contrasting the utopian and dystopian scenarios provided a breeding ground for surfacing controversies, through which we identified four controversy areas from participants' literal quotes and comments (Appendix B). We recognized two main types of conflicts when identifying the controversies: intra- and inter-level conflicts. Intra-level conflicts represent the value tensions that exist *within* a (micro/meso/macro) level, thus for example, a micro-level concern conflicting with another micro-level concern. Herein, we recognize two different types of conflicting concerns: (1) within the same value theme and (2) between different value themes at the same level. Inter-level conflicts represent tensions that exist between value themes that are expressed on different levels: for example a micro-level concern conflicts with a meso- or macro-level concern.

Table 3.1. Coding scheme for micro-meso-macro architecture. Each level contains one example from the dream scenarios, and one example from the nightmare scenarios.

Level	Expression of values (concerns)
Micro	the personal perspective and individual experience of the city *'I can always find a seat in a sunny terrace'* *'I have the right to struggle'*
Meso	the social interaction, relational aspect and community-life of the city *'Technology contributes to the happiness of people, facilitating contact between them'* *'There is less understanding of other groups'*
Macro	the global, societal and political elements in a city *'With better insights of data to accelerate the energy transition'* *'Tech companies have too much control of technology'*

By comparing these levels of value expressions with the themes that followed from the contrasting dream and nightmare scenarios, we could discern the values and value tensions that contributed to the controversy. This process was conducted by two researchers (first and second authors) independently. Both researchers analysed the full data of the two workshops, and outcomes were discussed to settle any differences or disagreements.

3.5 Findings

We first present the macro-, meso- and micro-levels and their associated concerns and values. Next, we elaborate on the inter- and intra-level conflicts. Figure 3.4 illustrates how these inter- and intra-level conflicts may shape a controversy.
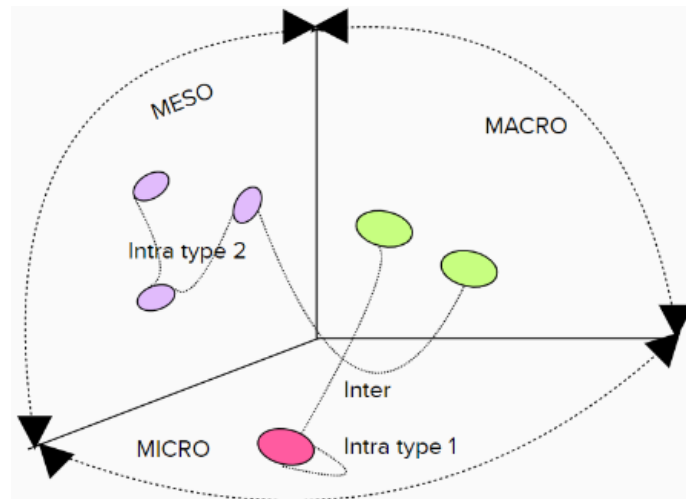
Figure 3.4. Visualization of the relations between the levels of concern that conflict with each other in a controversy.

3.5.1 Macro-level concerns

The macro-level consists of global, societal and political concerns: Participants either dreamed of a city that supports global goals such as sustainability or democracy; or feared the impact of technology that might reach beyond the borders of the city (e.g. the loss of autonomy in a world increasingly steered by algorithms). Macro-level concerns revealed the following thematic values: *democracy, autonomy, humanity, sustainability, efficiency, justice* and *quality of life*. For example, regarding sustainability, workshop participants identified the opportunity of '*better insights of data to accelerate the energy transition with smart grids'.* Concerns regarding efficiency were voiced mostly in the realm of interoperability and standardization of urban technology. Participants indicated the opportunity of the combination of real-time data and ubiquitous IoT to '*synchronize systems, like transport and school opening hours*'. This interoperability on a systems level would lead to higher efficiency in urban traffic and transport. This concern for interoperability was also voiced in relation to sustainability: '*with real-time management, we can block roads for polluting cars, when sensors notice high levels of air pollution'.*

Noteworthily, participants expressed more concerns on the macro level than on the meso and micro levels. We saw this both in terms of quantity of concerns, as the diversity of concerns: the macro level contained a higher variety of concerns compared to the other levels, where two or three key concerns clearly came forward, as we elaborate in the next sections.

3.5.2 Meso-level concerns

On the meso level we recognize concerns that relate to community-life and social practices in the city. The thematic values that were highlighted here were *social interaction, inclusion, serendipity* and *human touch*. Recurring concerns here relate to the importance of having connection with other citizens; in order to build friendships, but to also able to communicate authentically with those that have different views and values. Participants shared the fear of growing polarization, such as '*staying in your own bubble*', and only interacting with like-minded people due to algorithmically produced filter-bubbles online and in the urban context. Furthermore, at the meso level, we see the desire to implement technology to enhance community-building and shared living, where people look out and care for one another. For example, dream scenarios suggested to use real-time information management to '*help and provide services immediately for those in need'.* Or even more straightforward: '*technology contributes to the happiness of people, facilitating the contact between*

them', by for example *'creating coincidences'*. The unexpected and serendipitous encounter of new people and places was expressed as a key value for urban life.

3.5.3 Micro-level concerns

The micro-level encompasses concerns that relate to individual lives and personal experiences. Two key thematic values were expressed in this level: *freedom* and *personalization.* With regards to personalization, the main concern here relates to the development of technologies that fit the different competences and needs of individuals. When it comes to freedom, the micro-level contains concerns on the freedom to make mistakes: participants worry that ubiquitous and data-driven technologies will lead to *'losing the right to be imperfect'*. Participants highlighted that optimization and personalization are not always desirable, as *'humans have the right to struggle'*. It is through struggle that you learn and grow: by choosing the wrong route, you enhance your knowledge of the city map; or by ordering unhealthy food, you learn what is good and not for your body. Moreover, freedom also relates to the freedom to choose: being able to choose whether or not to use a certain technology, accommodate to algorithmic decisions or deviate from them. Participants shared a desire for *'an option to opt-out'.* Freedom is also voiced in the concern of privacy, which is translated by participants in the need for freedom of identity and freedom of action: *'you can be yourself, have freedom and remain anonymous'*.

3.5.4 Intra-level conflicts

Regarding the first type of intra-level conflict, we highlight an example from the macro-level value of *democracy.* One respondent wished that *'citizens have insight into their living environment because it helps forming an opinion on what is necessary, desirable or undesirable'*, whereas another respondent noted *'what you don't know, doesn't harm you'*. Another participant worried about to whom all this knowledge, aimed for democratization and participation of citizens, might be available by questioning *'will there also be foresight for criminals?'* These quotes highlight that also within levels, values might be viewed differently from different perspectives. We interpret these quotes as being driven by a *concern for democracy* at the macro-level, and they connect to *controversy area 3: The democratic city* (Appendix B). Although these concerns relate to the same value, they express different interpretations of this value, showing different stances toward how citizens should participate in decision-making about smart city technologies and the amount of information they need to be able to participate.

Regarding the second type of intra-level conflict, take an example from *controversy area 2: The scripted city* (Appendix B), where we recognized the desire for a more personalized perspective and optimized experience in cities: *'I am never in a traffic jam and I always find the most efficient route from A to B. I can always find a seat in a sunny terrace'*. However, simultaneously, we recognized a desire to live a free live that is uninterrupted by algorithms and is open to serendipity: *'Nothing can just happen to you'* in a highly personalized and optimized city. Albeit both being desirable values, the strive for one value might put pressure on the other, and thus, create value tensions at the same, in this case micro, level.

3.5.5 Inter-level conflicts

Going back to the desire for a more personalized perspective and optimized experience as expressed in the quotes: *'based on your data, the city would be personalized to you'*, and *'In a smart city, I can*

meet like-minded people and only do things that I am interested in', we see tension here with the micro-level value of *personalization* and the meso-level value of *social interaction*: '*You stay too much in your comfort zone, with too little contact with other people',* and '*you don't get exposed to new things, only whatever you like. This leads to segregation and polarization, and less understanding of other social groups'.* This conflict relates to *controversy area 4: Bubbled and isolated citizens* (Appendix B). It highlights tensions between various values, all worth pursuing but not always all achievable simultaneously, leads to controversies. Going back to *controversy area 3: The democratic city*, we find another example in the macro-level value of *democracy* and its expression through '*citizens give their opinion about policy decisions',* that exists in tension with the meso-level value of *inclusion,* where participants indicated worries about the '*exclusion of minority groups since their voices are less loud'*, especially with majority voices being amplified by technology and algorithms.

3.6 Discussion

In this contribution we have introduced the notion of socio-technical controversies as a promising new concept to grapple complexity in multistakeholder settings in systemic design. Our findings show that a controversy consists of multiple tensions within and across concerns on the macro-, meso- and micro level. Analysing and dissecting a controversy into its formative elements is the first step to understand the complexity inherent to controversies, as we have attempted in this contribution. This way of unpacking controversies has implications for ethical deliberation, which is a necessary component of democratic practices on socio-technical challenges with potentially far-reaching societal impact, such as the smart city. In the following discussion, we first reflect on the insights gained from the workshop results. We then propose controversies as meaningful entry points for ethical deliberation following our understanding of them as multidimensional value tensions. Finally, we suggest next steps to further the application of controversies in systemic design activities.

3.6.1 Reflection on results

Not all levels of concern were expressed equally: participants expressed more concerns on the societal (macro) level, than on the social (meso) or individual (micro) level. This difference could be related to the workshop approach: we explored generic smart city scenarios. A focus on personas and individual experiences within such a smart city scenario, could potentially peel out more concerns on the meso-and micro level, and is worth investigating in further research. Another explanation lays in the fact that macro concerns are also more strongly portrayed and present in the media: for example concerns on surveillance, sustainability and privacy have made headlines several times, whereas social concerns and citizen's needs tend to get way less attention, to the critique of many (e.g. Vanolo, 2016; Cardullo & Kitchin, 2019). This underlines the importance of teasing out controversies and understand the multiple concerns and value conflicts that exists simultaneously and at different levels, beyond those most prominently portrayed in the media.

Furthermore, the current analysis does not distinguish between concerns from, or tensions between, different stakeholders form the quadruple helix, as our focus was on understanding the nature of value conflicts in a controversy. It would be meaningful to add this layer of stakeholder-analysis in next iterations and further detail the multidimensional and multistakeholder understanding over controversies, as well as include civil society more strongly in the participants to ensure a fair representation of concerns.

3.6.2 Implications

From a systemic perspective, the expression of values and value tensions at multiple levels highlights the complex and rich nature of controversies. Socio-technical reality cannot be reduced to a binary opposition (Venturini, 2010), to pro or con, to 1 or 0: the existing challenges and following debates are more nuanced and rich than nowadays often portrayed in the (social) media and political landscape. Linking micro, meso and macro value expressions, and the inter- and intra-level conflicts that follow, offers an opportunity to explore this nuance and richness.

We suggest that embraced tension and controversy serves as valuable societal feedback in our path towards more just, responsible and sustainable futures. Given that controversies are carriers of value tensions and reveal which values are pressured and prioritized, we suggest the potential of controversies as meaningful entry points for ethical deliberation, as they provide immediate access to the issues and values at stake (or in Latourian terms, to the matters-of-concern (Latour, 2005)). The need for such ethical deliberation on technology is widely recognized, both in- and outside academia. Methods like Value Sensitive Design (Friedman & Hendry, 2019), which offer a fixed set of values as a means of 'checklist' when designing and implementing new technologies, have been developed as a reply to this need. Albeit a helpful and highly applied approach, it is much criticized for its use of a fixed list of values (e.g. Le Dantec et al., 2009). This reduces the ethical and political conversation to a design requirement that has to be checked off the list, and neglects the fact that values are situated, contextual and mediated by technology (Boenink & Kudina, 2020). Working with controversies provides a response to this, as they offer a means for value discovery (Le Dantec et al., 2009), whereby values are recognized lived experiences that need to be understood in context and in relation to each other. Controversies allow access to the situated values that are of public concern, and thereby controversies function as meaningful entry points to elicit ethical inquiry. To turn this inquiry into actionable steps, we suggest mapping the value tensions present in controversies, as a means to inform the design process e.g. Matos-Castaño et al., 2020; Geenen et al., 2022). Following Kolloch & Dellerman (2018), we understand these value tensions as a source of creative synthesis. Examples of this can be found in recent work of Baibarac-Duignan et al. (2022), where value tensions between stakeholders in the smart city form the basis for a design intervention in the form of a virtual experience, that stimulates ethical reflection on the smart city with citizens.

Furthermore, we anticipate that the inter- and intra-level conflicts require a different means of approaching them, as these conflicts have different qualities and add different things to the discussion. The micro-level concerns for example relate more to personal emotions, whereas the macro-level concerns relate more to politics. Regarding the inter-level concerns on the micro level, dilemma-driven design (Ozkaramanli, 2017) offers a meaningful approach to deal with these types of conflicts. Inter-level conflicts on the meso-level can be approached through theories from organizational studies or more broadly sociology, and inter-level conflicts on the macro level are part of the realm of , for example, political theory or conflict studies. Addressing intra-level conflicts is a new endeavour however, which requires more research in order to understand how to address this particular type of conflict and meaningfully leverage the tensions in it.

3.6.3 Next steps

Future research is needed to explore how the analytical framework proposed in this paper can be transformed into a generative one to utilize controversies in creating responsible smart cities. An important balance to maintain whilst exploring controversies in a designerly manner, is to keep

controversies manageable and actionable without reducing or simplifying their complexity and richness. A systemic design lens can help to keep the nuance and richness that socio-technical controversies carry, as it helps to acknowledge and incorporate the multidimensionality of controversies.

The lens of controversies outlined in this paper offers a theoretical contribution to the work on dilemma-driven design (Ozkaramanli, 2017) and dilemma thinking in systemic design (Ozkaramanli, 2021). Dilemmas and controversies are both conflict-driven concepts that may complement each other. However, this complementarity needs further research that bridges two different fields of design, namely human-centred design and systemic design. Dilemma-driven design, as proposed by Ozkaramanli (2017), relies on a phenomenological understanding of dilemmas and strictly focuses on individual dilemmas as fruitful starting points to create innovative products and services. Despite being valuable in human-centred design, solely focusing on the experiences of citizens would not suffice in systemic design. In this paper, we situate individual dilemmas (micro-level conflicts, also see Ozkaramanli, 2021) as part of a constellation of conflicts that make up controversies. In this way, we connect human-centred design and systemic design, and contribute to expanding dilemma-driven design through the lens of controversies. Future research is be needed to further explore the possibility for expanding the dilemma-driven design framework to encompass the complexity present in socio-technical controversies.

3.7 Conclusion

In this work we have explored the composition of socio-technical controversies, and we suggest them as meaningful concepts to navigate complexity present in the challenges faced by systemic design researchers and practitioners. Through an exploratory workshop approach, we surfaced and empirically examined socio-technical controversies in the smart city context. Our findings show that a controversy consists of multiple tensions within and across concerns on the macro-, meso- and micro level. The multidimensional nature of controversies make them rich and insightful concepts to grapple with complexity often present in systemic design activities. Moreover, unpacking this multidimensionality triggers ethical deliberation as it provides a rich insight into the conflicting concerns and situated value tensions in the socio-technical context.

Appendix A. Workshop protocol

The workshop approach consisted of 5 steps that took place in an approximately 90 minute session. A detailed summary of the workshop protocol is summarized in Table A1. More information on this workshop approach can be found in Matos-Castaño et al. (2022).

Table A1. A detailed summary of the five-step workshop protocol to elicit smart city controversies.

Step	Duration	Goal	Process
1. Setting the Scene	15 min	A shared understanding of the smart city	Participants receive a visual of a certain city area, this can be either a residential street or a central city square (example in Figure A1). This visual gives participants insights into current data collection points in the city and makes evident what type of data is collected in public space by either public or privacy organizations. Participants are probed with the following questions to create a shared understand of the smart city: (1) what is the first thing you notice?, (2) what is the most surprising element of the visual? and (3) any other additional comments?
2. Formulating dreams	20 min	Three smart city dreams per participant	Participants create 3 smart city dreams each, For this, they receive an 'ideal city' template with the following prompts on post-its: "In a smart city, it would be wonderful…" "In a smart city…" "In a smart city, I would use technology and data to…" To support free thinking without immediately imagining the risks and constrictions, participants receive the following preconditions: (1) all data can be available, (2) people involved in smart city development have good intentions, and (3) everything that needs to be properly secured is secured. To stimulate their thinking process and broaden their vision about smart cities, participants receive additional technology-cards that explain possible applications of smart city technology. An example of these cards is given in Figure A2. Lastly, participants explain their dreams to each other.
3. Voting	5 min	Narrowing down the top three shared dreams	Participants each receive three stickers and individually vote on their preferred dream scenarios. This leads to an aggregated top three dream scenarios.
4. Formulating nightmares	20 min	Three nightmare scenarios per identified shared dream	Participants think about the possible risks and downsides of the top three dream scenarios. To this end, they receive a template to reflect on the undesirable consequences of each dream scenario.
5. Identify controversies	20 min	Discussion on the most prevalent tensions	Participants discuss and reflect on the identified scenarios and value tensions that were surfaced, originating from the use of data and technology in the smart city.

Figure A1. Example of visual used in workshop sessions displaying a central city square.

Figure A2. Example of technology cards used to broaden participants' vision on the possible smart city applications. The cards describe both fictional and real smart city technologies.

Het zou geweldig zijn als je in een slimme stad...

Drie ideeën voor jouw ideale slimme stad!

In een slimme stad...

Voor een slimme stad, zou ik technologie en gegevens willen gebruiken om...

Bij deze opdracht ligt de nadruk op kansen en dromen. Daarom mag je van de volgende rand-voorwaarden uitgaan:
- gegevens zijn beschikbaar,
- betrokkenen hebben goede intenties,
- alles wat goed beveiligd moet zijn is goed beveiligd.

TIP
Op de poster staan voorbeelden van wat je kan meten in een stad, en op tafel liggen kaarten met voorbeelden van toepassingen.

"Houston, we have a problem"
Bij deze opdracht denken we na over de mogelijke risico's of onwenselijke gevolgen van de droom scenario's.

Idee/Scenario 1: _____

Onwenselijke gevolgen of risico's:

Idee/Scenario 2: _____

Onwenselijke gevolgen of risico's:

Idee/Scenario 3: _____

Onwenselijke gevolgen of risico's:

Figure A3. Example of data-collection templates regarding smart city dreams and nightmares.

Appendix B. Smart city controversies

Contrasting utopian and dystopian scenarios provided a breeding ground to achieve our goal of letting controversies come to light. During the workshops, participants discovered four main controversy areas:

1. Passivity and opacity

Technology offers opportunities to improve citizens' urban experience by providing targeted services and activities. No more waiting on the bus or standing in line for a restaurant table: technology will accommodate for your comfort and manage your route according to your preferences. However, outsourcing the provision of joyful and pleasant activities to technology takes the decision power and autonomy away from citizens. Whoever is controlling technology, whether it is corporates or the government, has the power of nudging citizens in any direction. As a result, people become passive spectators of what happens behind the smart city scenes.

2. The scripted city

Massive data collection and the use of predictive algorithms to improve efficiency turns the city into a predictable play. Technology becomes the writer that scripts the activities of what people should be doing in the city. As a result, people's behaviour and whereabouts become predictable. This reduces serendipity, or the changes of something interesting or pleasant happening by change. The prediction fever to increase efficiency neglects the importance of unexpected city encounters which is, in the end, one of the main reasons for people to live in cities in the first place.

3. The democratic city

In a democratic smart city, citizens can take part in policy making processes, voicing their concerns and wishes. Policy decisions are made transparent, and smart city data is accessible to everyone to guarantee equal insight and knowledge. Ensuring that everybody has digital literacy can contribute to a more flexible and hands-on democracy. However, is there a way to opt-out for those who don't want to participate? Will the neighbour with a dissonant voice still fit in? What about marginalized voices? There is a danger for peer pressure as full transparency will allow anybody to have insight on what others think.

4. Bubbled and isolated citizens

Technology filters citizens' experiences and interactions and allows them to meet like-minded people. This relieves anxiety and helps citizens to live within their comfort-zone. However, using technology to get targeted experiences could lead to a society where one only encounters what they already enjoy, without getting exposed to new things or people. People remain in their bubble and disconnect from other people and experiences, leading to polarization and isolation. There is a risk for a reduced city that does not represent the richness of multiple interacting perspectives and activities.

Part B
Design approaches to operationalize controversies

Part A theorized the threefold potential of potential of socio-technical controversies to enrich civic engagement, ethical deliberation and alternative imaginaries on the introduction of technology in cities. Additionally, it provided an analytical understanding of controversies by revealing the multi-dimensional nature of value conflicts that shape a controversy.

Part B turns to design research to operationalize our theoretical and analytical understanding of controversies. Design's generative, tangible and experiential qualities allow to 'make things public' through artefacts and interventions. Through a human-centered design approach, we pay explicit attention to human needs and values, in order to recentralize the citizen perspective in smart city narratives. Additionally, participatory design's innate democratizing nature resonates with the notion of bringing publics and issues together.

Part B consist of two chapters, each presenting a distinct design intervention and providing the empirical grounding for part C. Both chapters depart from the common aim to develop and evaluate a controversy-driven, participatory design intervention with a focus on ethical deliberation. Chapter 4 enables the articulation of issues by using a systemic design techniques to map value conflicts, and Chapter 5 enables ethical deliberation by using speculative design to make value conflicts experiential. The interventions are quite distinct in nature, yet build on the same assumptions and goals: They both rely on the multidimensional nature of controversies as identified in Chapter 3, and aim to connect publics, issues and values through operationalizing controversies.

Chapter 4 presents a Research-through-Design approach, resulting in a workshop that combines scenario-based, participatory and systemic design techniques to manage socio-technical controversies. It does so by unpacking, navigating and addressing a so-called 'Network of Conflicts', which represents a visual map of a controversy. System design techniques such as mapping, leverage analysis and zooming in-and-out, provide a means to visualize and navigate value conflicts in controversies. Making these value conflicts explicit, and therefore, negotiable, is a key step to make issues available and shape publics, and provides the base for ethical deliberation on smart city technologies.

Chapter 5 presents and evaluates an interactive, speculative design intervention called 'Future Frictions' that aims to promote a discussion on public values and the societal impact of smart city technologies. Future Frictions does this through relatable yet ambiguous future scenarios in the form of a fictional neighborhood. As a result, the experience allows for ambiguity and refrains from a deterministic view on urban technology. Future Frictions three central features, 1) relatability, 2) plurality and 3) ambiguity, are core when it comes to embracing speculative design to engage publics to actively engage with value conflicts.

'Convinced that every innovation in the city influences the sky's pattern, before taking any decision they calculate the risks and advantages for themselves and for the city and for all worlds.'

Italo Calvino - Invisible cities

Chapter 4
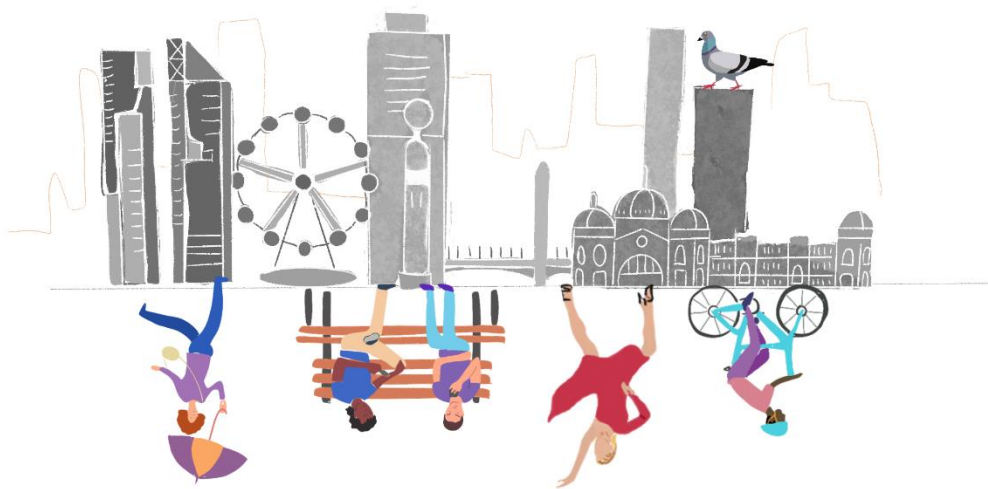
Putting controversies to practice: A design approach to unpack, navigate and address the Network of Conflicts

Abstract

This paper presents a Research-through-Design process, resulting in a workshop approach to constructively work with socio-technical controversies in the smart city context. We argue that operationalizing controversies supports the democratic debate on smart cities, as it can make issues more accessible and tangible, and therefore support publics to shape around these issues. Controversies are relevant because they are a core characteristic of democratic practice: it is through contestation and interaction between perspectives, that we learn what are the 'matters-of-concern' that deserve (political) attention. This work investigates what the qualities of a setting would be to effectively operationalize socio-technical controversies, and generate issue-publics. Our point of departure is to understand controversies as multi-stakeholder, multi-dimensional value conflicts. We combine scenario-based, participatory and systemic design techniques to unpack, navigate and address socio-technical controversies through what we call the 'Network of Conflicts'. Making controversies accessible by dissecting them in their formative elements and interconnections – values and value conflicts – provides a setting where differences among multiple actors become explicit, revealing and stimulating multiple perspectives to be expressed, therefore supporting a setting where publics can identify and formulate their own issues. Moreover, zooming in-and-out allows to focus on specific conflicts whilst taking insights from the full network into account, in order to leverage action towards more responsible smart city practices.

4.1 Introduction

Visions of the smart city are abundant and revolve around the introduction of data-driven technology in the urban sphere in order to optimize city processes such as traffic, waste disposal or energy usage (e.g. Angelidou, 2015, Zhao et al., 2021). The introduction of these technologies often follows from a top-down approach with little public consultation on which urban issues should be addressed. The smart city is critiqued for applying tech-fixes, rather than understanding and addressing the urban challenges and issues as perceived by citizens (e.g. Kitchin, 2014, Vanolo, 2016, Tompson, 2017). As such, the introduction of smart city technology often leads to controversy. We argue that the introduction of technologies in society should follow a more democratic process. After all, technology significantly affects the way we experience and act. We suggest to enhance the democratic debate on technology, by leveraging the STS concept of socio-technical controversies. In this paper, we wish to operationalize socio-technical controversies, and do so by applying design research techniques. Design methods help to bring various disciplines and stakeholders together to respond to challenges in transdisciplinary contexts such as smart cities (Cooper, 2019), and enhance the democratic development of technology by adding an experiential dimension (Ozkaramanli et al., 2022).

Socio-technical controversies often arise in contexts that involve multiple stakeholders around issues that are too important to be ignored. Controversies are public discussions about issues that people disagree about (Venturini, 2010, 261) – it is where perspectives clash and value tensions emerge. More specifically, controversies consist of conflicting values and concerns at different levels, from the individual and social to societal scales (Geenen et al., 2022). Moreover, controversies are right at the heart of our democracy: it is through contestation and interaction between multiple perspectives, that we learn what are the 'matters-of-concern' (Latour, 2005) that deserve (political) attention. Building on Latour's notion of ding-politik (2005) and Marres' issue-oriented understanding of public involvement in politics (2007), we understand controversies as places where politics 'happens': a plurality of perspectives comes together, values are negotiated and new social practices emerge. Controversies form spaces of self-organized participation and value-assessment (Cuppen, 2018). Since controversies highlight friction between values and as such reveal what is at stake, they provide a richness and nuance to democratic debate, which we find relevant for addressing socio-technical challenges.

At the same time, dealing with controversies is a delicate matter. They present multiple perspectives and sensitive choices that trigger intra- and inter-stakeholder dilemmas and require trade-offs with uncertain consequences. Seen in this way, controversies are examples of wicked problems that are constituted of ethical issues (Sweeting, 2018). They may even give stakeholders a feeling of paralysis, if not managed productively. Although they are often perceived as a source of impasse, controversies bring *publics* together around *issues,* because *values* are at stake. We are interested in facilitating this publics-issues-values formation through design. How can we make the democratic promise of controversies experientable when addressing complex socio-technological challenges? In this paper, we explore the experiential qualities that design methods and techniques bring to operationalizing controversies. For this, we build on earlier work of DiSalvo (2009) regarding design for publics, and explore how to organize a collaborative process such that publics can shape around an issue, to not only discuss, but also act on, the value conflicts that sustain the issue. In line with this proposition,

our main research question is: What are the qualities of a setting that makes controversies accessible to and actionable by publics (citizens and other relevant stakeholders)?

In order to answer our research question, we apply a Research-through-Design (RtD) approach (Stappers & Giaccardi, 2017). RtD is an approach to design research that involves the investigation of research questions through the development of a design intervention. It aims to generate new insights through the process of making, discussing and reflecting on design (Luria et al., 2021). We venture into an interdisciplinary RtD process, as we build on well-established methods and techniques from STS (such as cartography of controversies, cf. Venturini, 2010; Venturini & Munk, 2021) and participatory design (such as designing 'Things' or socio-material assemblies, cf. Bjögvinsson et al., 2012) and expand these approaches where appropriate and relevant for operationalizing controversies.

The paper is structured as follows. We start by deepening our understanding of socio-technical controversies, to position why they are meaningful concepts when addressing complex societal issues. Next, we turn to the RtD process to explore how to operationalize the theoretical concept of controversies into an actionable approach. We contextualize our approach in smart cities, since smart city initiatives entail complex human-technology relations and involve multiple stakeholders. This makes them a relevant socio-technical context to explore the potential of embracing controversies constructively. We present what design requirements informed to RtD process, elaborate on the insights gained during seven iterations, and explain the final workshop in full. Lastly, we reflect on the implications, benefits and challenges of the proposed workshop approach to reveal insights into how it can be applied in contexts other than smart cities.

4.2 Understanding socio-technical controversies

Socio-technical controversies are public disputes that arise through the introduction of technologies in society (Callon et al., 2009), and find their origin in a range of economic, political and ethical concerns (Nelkin, 1995). We argue that controversies are important to embrace, rather than ignore, as they concern situations where values are at stake: actors gather because something is important to them. Socio-technical controversies have a mediating role for revealing the diversity of values in multi-stakeholder collaboration. Their intertwinement with public values, is a core part of how and why controversies drive democratic practices. Particularly, the value tensions that are part of a controversy, reveal the underlying needs and wishes of the publics involved. As such, controversies offer means to elicit ethical inquiry and access the values[8] that are of public concern, or in the words of Le Dantec et al. (2009), they offer a means for value discovery. The contextual character of controversies helps to directly engage with the local expressions of values, and prompts a commitment to respond to local context of an issue.

Relating this to Latour's notion of *ding-politik* (2005) and Marres work on issues (2007), who both build on the earlier work of Dewey regarding democracy (1927), a controversy functions as a 'public thing': an occasion where various actors can meet and debate different issues that are of importance to the community. We define publics as 'a particular configuration of individuals bound by a common cause in confronting a shared issue' (Le Dantec & DiSalvo, 2013). Publics are called into being by issues—they form around an issue, to attend to it conditions and consequences. The issue at stake

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[8] Building on Boenink & Kudina (2020), we understand values as lived experiences that need to be understood in context, instead of elements of a top-down list of values that rely on discursive and abstract definitions only.

involves both facts about the world and concerns about their implications. It is not the mere facts however, that drives a public together, it is the understanding of these facts as issues that are of concern. A public bounded by an issue requires the transgression of the boundaries of social communities, into communities of 'affect': members are diverse due to the spread of effects related to an issue. Encouraging public debates around issues, requires making matters-of-concern accessible. Schoffelen et al., (2015), like Latour (2005), emphasize the importance of making things visible to encourage public debates concerning issues. In particular, the formation of issues entails making differences among multiple actors explicit, revealing and stimulating multiple perspectives to be expressed so they don't remain hidden.

Controversies often comprise a multiplicity of factors, actors, consequences and their relations. Rather than binary conflicts that can be formulated in pro or con, yes or no, controversies help us to see issues from a more plural, agonistic perspective, with multiple different perspectives to the issue existing side-by-side. Complementing earlier work by Ozkaramanli (2021), and Geenen et al. (2022), which both consider a micro-meso-macro framework to address conflicts, we understand controversies as multi-dimensional conflicts that consist of individual, organizational and societal values, and conflicts between or within these levels. This plurality makes controversies rich and nuanced concept, with a lot of depth to explore and operationalize.

In this work we specifically focus on smart city controversies in order to operationalize the concept of controversies. The smart city discourse centres a highly datafied and digitized city in order to optimize the urban experience (e.g. Angelidou, 2015, Zhao et al., 2021). Critics argue however, that the smart city follows a corporate agenda that applies techno-fixes to complex urban challenges, thereby neglecting citizens' needs and lacking to incorporate the societal impact of these technologies (e.g. Kitchin, 2014, Vanolo, 2016, Tompson, 2017). As such, the smart city is highly contested and filled with controversies. Smart city controversies reveal what is at stake when discussing the nexus of urban technology: they highlight what issues and values are of concern, and urge us to evaluate our actions and negotiate ways on how to move urban futures forward. They bring actors together because something is important to them, ranging from, for example, privacy to air quality to social justice (e.g. Barth, 2020; Mahajan et al., 2020; Masucci et al., 2020). They require us to not see urban challenges as solely technical problems that need a 'fix', but force us to understand the social, political and ethical questions that they raise. As such, controversies help us to make sure critical questions about the societal and ethical desirability of technology are incorporated in the development of smart city projects.

4.3 Design approach to access controversies

The goal of the work presented in this paper is twofold. Our research goal concerns understanding how to make controversies more accessible to support the formation of issue-publics in addressing socio-technical challenges. Next, our design goal relates to the creation of an intervention that operationalizes controversies in order to access and address the value conflicts that characterize in socio-technical challenges. In order to address both these goals, we employ a Research-through-Design (RtD) approach. RtD is a research approach that aims to generate new insights through the process of making, discussing and reflecting on design practices (Luria et al., 2021; Stappers & Giaccardi, 2017). It thus allows us to learn while doing, and the flexibility this research approach offers is needed for unexplored fields such as working with controversies. In RtD, the design process both delivers a design outcome, as functions as a research tool itself (Stappers & Giaccardi, 2017).

During the creation of our intervention to operationalize controversies, we opted for adopting a participatory setting, an agonistic approach, and a fictive and controlled setup. We bring these elements together through bringing together interdisciplinary insights and techniques.

Participatory setting: To start, we consider controversies as multidimensional and multi-stakeholder value conflicts, hence any setting must represent this multi-stakeholder nature. We incorporated this in our intervention by opting for a participatory setting in which stakeholders can interact. A workshop allows to bring various stakeholders together in a facilitated and guided manner, support mutual learning and collective sensemaking (Ørngreen & Levinsen, 2017; Matos-Castaño et al., 2020).

Agonistic approach: Next, to embrace controversies, we adopted an agonistic approach, meaning that conflicts and different perspectives are respected, or even celebrated, rather than smoothened out or solved (cf. Mouffe, 2005). For this we build on conflict-driven approaches such as dilemma-driven design (Ozkaramanli et al., 2016) and multi-functional problems (Matos-Castaño et al., 2017).

Fictive and controlled setup: Finally, we opted for a hypothetical setting in the form of future scenarios and roleplaying exercises, which allows gaining insights on how to access and act on controversies in a controlled environment, without the real-life struggles such as time pressure and power dynamics of an actual smart-city initiative. Scenarios and roleplay are often used techniques in both design research and conflict studies (e.g. Svanaes & Seland, 2004; Simsarian, 2003; Bartels et al., 2013). They help to increase empathy with the system at large and multiple perspectives present in it (e.g. Sustar & Mattelmäki, 2017; Talgorn & Hendriks, 2021), and allow to explore effects of different choices in a low-risk environment, which is particularly relevant with something as sensitive as conflict (e.g. Bartels et al., 2013). Together, these design choices led to the development of a participatory, conflict-driven, scenario-based workshop protocol.

Interdisciplinary insights and techniques: Content-wise, we were inspired by Björgvinsson et al. (2012) in our wish to design 'Things' (socio-material assemblies), rather than 'things' (design objects). Next, our workshop activities are informed by interdisciplinary insights and techniques. For example, we depart from STS insights regarding mapping or cartographing of controversies (cf. Venturini, 2010; Venturini & Munk, 2021), apply the co-design methods and mindset from participatory design (e.g. Sanders & Stappers, 2008; Björgvinsson et al., 2012), and later add common techniques in systemic design such as (value-)mapping, leverage analysis (cf. Jones, 2014; Ruecker et al., 2020; Murphy & Jones, 2020). From this foundation, we develop specific workshop activities and techniques appropriate and relevant for operationalizing controversies, and constantly refine these activities based on insights gained during the RtD process.

4.3.1 Workshop protocol

The foundations of the workshop approach consisted of the fictional city of Nevertire, which was expressed through a scenario and five stakeholder roles, and of a 'Network of Conflicts' (NoC) as a visual representation of the controversy. We will elaborate on both below. Additionally, the basic design or pilot workshop consisted of 1) warming up exercises to immerse in the scenario and stakeholder roles, 2) a mapping exercise in which participants unpack the NoC that represents the controversy as present in the scenario, and 3) a design exercise in which we encouraged participants to develop a prototype that responds to the identified NoC. Finally, to wrap-up the workshop, we inserted a debriefing activity. This helped participants to step out of the hypothetical scenarios and

shift back into their own individual personas, and also allowed us collect additional reflections as input for our RtD process.

Scenario and personas: The city of Nevertire

To access controversies in the smart city context, we developed a scenario called 'The Scripted City and Social Bubbles'. This scenario is based on previous research results and inspired by existing studies on controversies in the datafied city (Geenen et al., 2021; Kitchin, 2014). It describes a short narrative about the fictional city of Nevertire in 2030, where the municipality plans to collaborate with several technology companies to make urban processes more data-driven and to provide tailored city experiences to citizens. We provide a short section of this scenario below, and the full scenario is included in Appendix A.

> *The municipality plans to collaborate with companies to make urban processes efficient, provide tailored experiences to citizens. Nevertire will work towards becoming an ultra-smart city. On December 4th, 2030, these plans become real and the mayor announces that the smart city policy has been approved. Since technology governs every urban activity, life in Nevertire may increasingly feel like living in a 'bubbled society'.*

Figure 4.1. A snapshot of the Nevertire scenario (above) and the five accompanying personas (below).

The scenario is accompanied by five fictional personas (see Figure 4.1) which are worked out into five narratives (Appendix B). These personas allow to connect the socio-political context presented in the

scenario to individual experiences and interpersonal relations. We designed the different stakeholders based on three main criteria:

1. The stakeholders should represent a various perspectives namely private sector, government, and citizen positions.
2. Stakeholders should encounter individual dilemmas, namely a mismatch between personal goals, or between personal goals and those of the organizations they are associated with.
3. The position of stakeholders should be clear but nuanced enough to identify conflicts within stakeholder groups and between stakeholder groups.

Based on these criteria, we developed 5 stakeholder roles, representative of citizens, private and public organizations. Each stakeholder worked or was associated to a specific organization holding different values. Table 4.1 provides an overview of the stakeholders, their associated institutions, and their respective predominant values.

Table 4.1. A summary of the stakeholders, their associated institutions, and their respective predominant values.

Stakeholder	Individual predominant values	Associated institution	Institutional predominant values
#1- Tourist (citizen)	Serendipity Novelty Convenience	Online community to share urban experiences	Community Serendipity Sharing
#2- Employee tech company (private organization)	Success Innovation Convenience	Technology company developing and deploying sensors	Progress Innovation Efficiency
#3- Municipality worker (government)	Public good Privacy Collaboration	Urban planning department	Efficiency Public good Sustainability
#4- Journalist (citizen)	Autonomy Freedom Popularity	Magazine about technology	Information Innovation Personalization
#5- Data analyst (private organization)	Public good Success Knowledge	Data analytics company	Collaboration Progress Public good

Through a roleplaying exercise using the five stakeholder narratives, we explore the impact of smart city projects in Nevertire and what value conflicts inform the controversy at hand.

The Network of Conflicts

Due to our understanding of controversies as multidimensional value conflicts (Geenen et al., 2021), we centralize values as driving forces in controversies. Specifically, we understand controversies as representing conflicts between values that are expressed on the individual, social and societal leave. We translate this understanding into a 'Network of Conflicts' (NoC) that represents the value conflicts within, and between, these levels (Matos-Castaño et al., 2020; Geenen et al., 2021). To achieve our goal of operationalizing controversies in order to support the formation of issue-publics, we aim to access and address the underlying value conflicts that compose them, or to say, we aim to unpack and address the NoC that constitutes controversies. To do so, we coupled the notion of the NoC to a mapping activity that builds on insights from controversy mapping (cf. Venturini, 2010; Venturini & Munk, 2021), and value-mapping (cf. Ruecker et al., 2020). This also entails that the NoC will function as the primary means of inquiry that guides or RtD process (Stappers & Giaccardi, 2017).

4.4 Research through design

Table 4.2 summarizes the characteristics, research goals and insights gained per RtD iteration. We first provide a description of the basic design of the workshop. Next, we describe the four steps of our RtD process, which took place over a total of 7 workshop sessions. We summarize sessions that had similar settings and leveraged similar insights. Per step, we describe setting, aim and execution of the iteration, reflections hereon supported by collected observations and participant's quotes, the main insights gained and the redesign steps based on these insights. We gathered participant data through recordings of the sessions, as well as reflection forms which were part of the debriefing discussion at the end of each workshop.

Table 4.2. Summary of Research-through-Design process and main insights gained.

Iteration	Characteristics	Research goals	Activities	Insights
1.1 Summer 2020 Pilot session	Online 1,5h 5 participants academics with background in design and conflict studies	• Test scenario and roleplay exercise; • Test NoC exercise (analysing the controversy); • Test prototyping exercise (addressing the controversy).	• Provision of scenario and stakeholder roles; • Guidance through NoC activity; • Organization of activity to address the given controversy; • Pilot facilitation through digital collaboration platform mural.co.	*Scenario setting:* The scenario setting allows for an emotional distance to the value conflicts, which helps to engage and empathize with different perspectives. *Visual map:* The NoC helps to represent and understand multi-dimensional value-tensions present in a controversy, as the NoC provides a visual map which functions as a boundary object for deliberation. *Issue identification*: Collaboratively unpacking the NoC stimulates collective sensemaking and allows participants to identify issues within the controversial setting. *Addressing the controversy:* Working with controversies benefits from cognitive and temporal space to process insights on multi-dimensional nature and shift attitudes from analysing to addressing the NoC.
1.2 Summer 2020 Workshop during DRS conference	Online 1h 10 participants academic design-affiliated audience			
1.3 Winter 2021 Workshop during Speculative Futures event	Online 1,5h 4 participants non-academic design-affiliated audience			
2.0 Fall 2020 Workshop during lecture Trans-disciplinary Master Insert	Online 3.5h 6 participants MSc level students with diverse study backgrounds	• Test facilitation and guiding needs; • Test creativity & criticality drivers for identifying leverage points to access and address the NoC; • Test metaphors to identify alternatives to address the given controversy	Same activities as during the pilot with the following iterations: • Limited number of elements and nodes in network to function as boundary conditions of network; • Guided navigation to reflect on conflicts sparking new ideas (creativity) and new insights (criticality); • Collaborative collage-making to brainstorm how to address the controversy.	*Boundary conditions:* Boundary conditions are necessary to grapple the complex NoC and meaningfully navigate it. *Leverage analysis:* Leverage analysis helps to navigate the NoC and transition between analysing and addressing it.
3.1	Online			

Summer 2021 Workshop with Digicampus	2x2h 5 participants practitioners in the field of digital governance	• Explore how to move from reflection to action	• Addition of separate second part to address the controversy – test zooming in-and-out exercise	*Zooming in-and-out:* Zooming in-and-out helps to define more concrete interventions, and allows to leverage the plurality of values and value conflicts present in the NoC.
3.2 Summer 2022- Workshop at DesignLab	Offline 5h 7 participants MSc level design students			
4.0 Fall 2021 Workshop during RSD conference	Online 2h 10 participants academic design-affiliated audience	• Pilot pregiven NoC	• Present pregiven NoC • Apply zooming in-and-out exercise to pregiven NoC	*Addressing the controversy:* The process of addressing the NoC cannot be decoupled from the processes of analysing the NoC, as unpacking the NoC is an essential step for collective sensemaking of the controversy with all its different elements and interconnections.

4.4.1 First iteration

We summarize three sub-iterations[9] (Table 4.2), as these all had a similar setting (4-10 participants, 1-1,5h online) and research goal, namely focusing on the basic design of the workshop. Throughout the iterations, we did not change the goals or content of the unpacking and navigating exercises, but being a guided activity, we did update the explanation and facilitation of these exercises to make them more clear and concise[10]. Given the start of this process in 2020, the global circumstances required us to have a fully digital workshop.

These early iterations showed that the scenario provided enough provocation, relatability and input for participants to engage with and immerse themselves in the fictional city of Nevertire, and thus be able to meaningfully move through the workshop exercise. For example, we observed participants act out imaginary friendships and supporting each other based on shared values. Moreover, it helped participants to more easily express themselves: '*Although I was completely aware that the city of NeverTire represents a real-world challenge, by presenting it in this way, I did not feel pressured to come with sophisticated answers. It really helps in just brainstorming about the controversy'.* Finally, it helped participants to empathize with various perspectives: '*Having someone play a role and advocating different arguments and perspectives is a good way to develop a good, detailed overall view of the problem instead of only your own perspective'.* We noticed that the fictional environment allowed for an emotional distance to the conflict, which helps participants to more easily engage and empathize with different perspectives.

Next, participants signified that the mapping itself proved to be meaningful and insightful: '*Mapping out the conflicts helped with putting things in perspective', 'It made the process more visible and the thoughts of others sparked new ideas to reflect on'.* Collaboratively unpacking the NoC stimulated collective sensemaking and helped to create a shared understanding of the conflict at hand, which allowed participants to identify issues within the controversial setting. The resulting map of the controversy, or the NoC, (see Figure 4.2) was perceived as '*A handy tool to quickly inventory the values and main goals that produce conflicting interests or dilemmas'.* The unpacked NoC made the plurality of perspectives and conflicts that are part of a controversy, explicit and, importantly, debatable. It is a meaningful tool to represent and understand multi-dimensional value-tensions present in a controversy, as the NoC provides a visual map which function as a boundary object for deliberation. The network demonstrates the nuanced and complex nature of controversies, while making individual values and perspectives traceable. This is a key step for participants to identify issues and become issue-publics.

Finally, we learned that after unpacking the network, the step towards addressing the NoC proved to be very challenging for several reasons. Firstly, the constraints for this prototyping exercise were very open and left participants with discomfort and confusion on what to do. Secondly, the exercise felt pressured in the available time. It forced participants to switch mindsets, without proper guidance to do so. Participants noticed that this step felt '*too rushed*'. We underestimated the difficulty to move from the unpacking the network to actually working with it. Analysing and addressing the NoC, requires two very different mindsets: a critical, reflective attitude vs. an open-minded, generative

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[9] Although the iteration 1.3 was chronically later than iteration 2.0, the practical constraints did not allow us to expand our research goal beyond that of iteration 1.1 and 1.2. Hence that we group these iterations.

[10] For example, the visual format was updated to a color-coded environment.

attitude. Moving from analysing to addressing the NoC requires sufficient temporal and cognitive space to switch between these two activities.
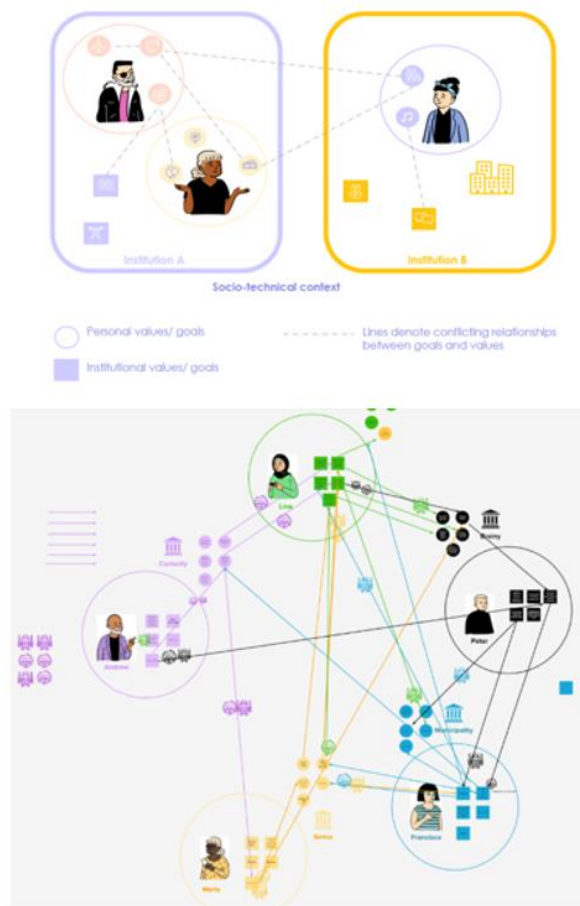

Figure 4.2. Above: Illustration of the Network of Conflicts, consisting of different stakeholders, values, and conflicts between them. Below: Network-of-Conflicts resulting from one of the workshop iterations.

In the following iterations, we focused on the second part of the workshop: addressing the NoC. This proved to be difficult as the NoC resulting from the unpacking exercise turned out to be complex and overwhelming to take in. Therefore, we introduced 'boundary conditions' to frame the controversy (cf. Sevaldson, 2011) and limited the network by imposing a maximum of values (sticky notes) and conflicts (lines) build the NoC (see Figure 4.2). Next, in order to address the NoC, the complex network needs to be navigated and made manageable somehow. For this, we introduced an exercise build on the systemic design technique of 'leverage analysis' (Murphy & Jones, 2020), meaning that one identifies nodes in the system that provide the most meaningful access point to the system. In our case, most meaningful meant that conflicts sparked both critical and creative modes of thinking. We opted for this, as we wished to encourage both creative action and ethical reflection (Nilsson & Jahnke, 2018). We invited participants to use icons to identify conflicts that sparked new ideas and creative thinking, or that that highlighted new perspectives and fuelled critical thinking. We expected that, through identifying leverage points and collectively choosing one of these points to focus on and address, i.e. create a design intervention for, the step to bridge analysing and addressing the NoC would be more feasible. Lastly, in order to address the NoC, we invited participants to create a digital prototype in response to a specific conflict, which was elected through the navigation exercise. This prototyping took shape through a collage-making exercise, for which we provided

participants with a digital library of visuals that were subtracted from a wide variety of famous paintings. We anticipated that the collaging exercise was a creative aid to help lo-fi prototyping in a digital environment, and supported this activity with guiding questions that can inform the development of interventions, such as 'when will the prototype be used' 'by whom' etc.

4.4.2 Second Iteration

The second iteration took place with a group of six master students from diverse study backgrounds, but all enrolled in a transdisciplinary specialty program. To ensure enough temporal space to bridge the analysis and addressing of the NoC, this iteration took 3,5h. The aim of this iteration was to combine all elements of unpacking, navigating and addressing the NoC according the redesign as described above, and test collage-making as a way to address the NoC.

The navigating activity proved to be a key step to summarize and leverage the information present in the controversy. It allowed to define an entry point to the system from which activities could be explored, and avoided people getting lost in the complexity of the network. It helped participants to make sense of the plurality of values and perspectives, aided them in understanding the potential of conflicts, and bridged the step from analysing to addressing the NoC: '*I found that controversies can become a source of ideas and don't have to be a barrier in cooperation between people'.*

After successfully moving through the mapping and navigating exercise, addressing the NoC again turned out to be challenging. Firstly, the design brief was perceived as too open and confusing, which resulted in abstract conversations and high-level interventions. When assigned with the task to create an prototype, many times the participants actually described mini-visions or aspirations, as opposed to a more concrete intervention. Simultaneously, the collaging exercise led to metaphorical thinking, which also kept interventions at the abstract level: '*for me at least, I think this had to do with the highly metaphorical nature of the exercise. My mind had an internal conflict between attributing relevant interpretations to the abstract images, and bringing this message across to others. So I felt conflicted about whether my thoughts about the [prototype] would also be understood by others. In a sense, this was somewhat a cognitive overload'.* Lastly, participants had difficulties translating the insights gained form analysing the NoC, to a concrete design intervention: '*I am not sure whether I transferred this knowledge on the granularity of coexisting dilemmas in the controversy to the [prototyping] exercise. I think the reflections were mostly retained at the mapping exercise itself'.* Addressing the NoC thus requires a concrete activity in order to manage the cognitive load needed to take in the information present in the network.

For the following iterations, we reformulated second part of the workshop to provide more guidance and structure when addressing the complexity presented by the NoC. The core exercise consisted of addressing the NoC by zooming in ánd out on the network. Zooming in entailed focusing on one conflict to work with. This singular conflict was formulated through the identification of leverage points. After coming up with a first lo-fi prototype, we invited participants to zoom out, place the intervention into the larger network, and reflect how the intervention affected the network. Did it raise any new conflicts, or address more conflicts than intended? How would each stakeholder feel about this intervention? What new insights can be used to redesign the intervention? Finally, based on the insights gained from zooming out and reflecting on 'the big picture', participants are asked to iterate and redesign their intervention. By iteratively zoom in-and-out on the NoC, we explicitly take the whole NoC into account when addressing it.

4.4.3 Third iteration

We again summarize two iterations due to their similar setting[11] (5-7 participants, 4-5h, with distinct slots for the activities of analysing and addressing the NoC, separated by a break, in order to generate cognitive and temporal space). The aim of this intervention was to test the newly formulated part to address the NoC, and gain more insight how the zooming in and out affected the design intervention: both in terms of process as output.

The zooming in-and-out exercise proved meaningful to get to more concrete interventions: '*it helps understanding better what that conflict is really about. And I think selecting one is a necessary step to get to solutions.'* These iterations again highlighted the paradoxical need to limit the network in order to meaningfully manage it – by zooming in on, and addressing a singular conflict from the larger network of conflicts, participants gained the cognitive space to create an intervention. Participants underlined the added value of addressing the NoC through zooming in on a singular conflict and designing an intervention for this conflict, and then zooming out on the full network again to gain additional insights on the consequences of this intervention to other values and conflicts. '*Zooming out personally helped a lot to make a "reality check". Without the zooming out after creating the intervention, it was a mere idea. (…) setting it into a larger context gave shape to the goals of our intervention.'* The zooming out exercise specifically led to new insights and ideas: '*When we zoomed out it become clear that our interventions were also addressing other conflicts, but also raising new challenges.'* As one participants shared: '*I think this was a valuable exercise, because it was based on previously established connections and allowed for reflecting from different stakeholders' perspectives.'* The activity of zooming in-and-out on the NoC in order to (re)design an intervention, represented a process of practicing both reflective and generative thinking – zooming out to reflect on the consequences in the network, and zooming in to generate new ideas or mitigate unwanted effects.

4.4.4 Fourth iteration

The fourth[12] iteration took place during the Relating Systems Thinking and Design Symposium (RSD10) and thus with a design-affiliated audience. We had 10 participants in total. Given the time-constrains of this iteration (2h, online), and the fact that we had saturated the first part of the workshop, we wished to gain more insight on the effects of the zooming exercise, and decided to only focus on the second part during this iteration.

In order to use all available time to focus on the second part of the workshop and iterate the zooming exercise, we presented participants with a summarized network based on the outcomes of a previous workshop. We still introduced the workshop with a roleplay exercise, but this time invited participants to explore the presented NoC, rather than unpack it themselves. After becoming acquainted with their role and the pregiven NoC, we moved to the zooming exercise. This exercise remained unchanged compared to the previous intervention. Being presented with a pregiven NoC,

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[11] Iteration 3.2 was the only iteration that took place in an offline, face-to-face setting. Albeit interesting, we do not dive into the effects of online vs. offline interactions on the workshop dynamics and outcomes, as this is out of scope for this research. Moreover, the presented workshop exercises did not change and were straightforwardly transferred from digital to physical context – digital sticky notes became physical ones, and the brainstorming canvas was replaced by a physical canvas in the shape of a flip-over.

[12] Chronically, iteration 4 fell between iterations 3.1 and 3.2. We summarize it separately however, due to its distinctly different setting and goal, namely only focusing on addressing the NoC. Whereas iteration 3.1 and 3.2 both focus on the full approach, including analyzing and addressing the NoC.

however, led to confusion and detachment among participants, as these conflicts did not directly resonate with the participants and their interpretation of the scenarios and persona. This made it particularly challenging to move forward through the planned exercises. Moreover, it led to an overwhelming amount of information that was hard to process when simply received, rather than generated by the participants themselves. One participant shared that the pregiven NoC '*did help to understand the roles and values of different stakeholders and how they together built Nevertire. However, there were a lot of values to be considered.*' This iteration proved very challenging yet very insightful. It showed that unpacking the NoC is an essential step for collective sensemaking of the controversy and all its different elements and interconnections. Merely presenting the final network does yield the same insights among participants. The process of addressing the NoC can thus not be decoupled from the processes of unpacking or analysing the NoC.

After successfully iterating the second part of the workshop, we achieved our design goal and gained sufficient insights regarding our research goal, and therefor concluded the RtD process.

4.5 Final design

This section briefly summarizes the final design that resulted from the RtD process. The RtD process allowed us to both gain insight on working with controversies to generate issue-public around value conflicts, as well as develop a refined workshop protocol as a design output. Below, we highlight the core activities of the workshop. An extensive description of the protocol can be found in the appendix C, for the interested reader who wishes to reproduce this workshop.
In order to make constructive use of controversies, our approach helps to systematically unpack, navigate and address the *Network of Conflicts* that shape controversies. Working with this NoC facilitates dialogue about public values among quadruple helix stakeholders.

The core activities of the workshop are divided in two parts:
0. *Roleplay*
1. Forming a NoC to map the controversy (*unpack, part 1*)
2. Identifying conflicts as leverage points to access the NoC (*navigate, part 1*)
3. Iteratively zooming in-and-out on the NoC to formulate interventions (*address, part 2*)
4. *Debrief*

Part 1: Forming the Network of Conflicts

In the first part, participants unpack the controversy present in the scenario, to achieve a deeper understanding of the issue at hand (the scripted city and social bubbles) and the conflicting values within and among various stakeholders. To start, participants familiarize themselves with Nevertire and the stakeholder roles. Through roleplay, participants generate insights into the individual dilemmas, inter- and intra-stakeholder conflicts. This allows them to deconstruct the controversy into its building blocks and create the NoC. Using sticky notes to represent values, and lines between them to represent the different types of conflict, the participants form a NoC that demonstrates the multi-dimensional and nuanced nature of controversies, while making individual values traceable. Next, participants identify conflicts that raise creative and/or critical attitudes, and thereby provide meaningful leverage points for intervention. By creative attitude we mean that the conflict sparked new ideas, and by critical attitude, we mean that the conflict inspired new insights.

In the second part, participants collaboratively reflect on how they can use the identified NoC to come up with interventions to address those conflicts, while also critically reflecting on those interventions from a value perspective. We assumed that conflicts that stimulate creativity but also raise critical questions might be the best starting points. To this end, participants first zoom in on a specific conflict that is chosen as a leverage point to access the NoC, and prototype an intervention to address it. Next, they zoom out to focus on the wider network again, to evaluate how this intervention may affect other values, and how it may mitigate or perpetuate other conflicts in the larger system. They thus reflect on the consequences of their proposed intervention, in order to anticipate any desirable or undesirable effects, and enhance their intervention with these reflections in a next iteration as they zoom in on the original conflict again. This iterative process of zooming in-and-out and redesigning of the intervention, allows participants to utilize the creative potential of each conflict while also benefiting from the larger NoC for ethical reflection. The final step is a debrief in which participants are expected to step out of their role and reflect on the experience and gained insights from their individual perspectives.

4.6 Reflecting on the RtD process

In this section we reflect on the insights gathered throughout the RtD process, which are materialized in the final workshop design. We identify 4 main insights regarding operationalizing controversies in order to generate issue-publics:

1. **Explicating the value conflicts is a key step to access issues and to shape publics**

By positioning value conflicts as a thinking tool to probe the controversy, we are explicating something that normally remains unseen, neglected or ignored. As one of the participants shared: '*Focusing on differences is a thing that most people intend to not do. Instead of ignoring or avoiding them, it's a good idea to really focus on them and try to make interventions on it.*' The framework of multi-dimensional value conflicts acts as an analytical tool to unpack the experiential components of a socio-technical controversy. Explicating the often implicit value conflicts acted as a first step in responding to them and helped to unravel difficult conversations. In this way, the participants could get to the core of the trade-offs that needed to be addressed as the relation between serendipity, convenience and control of technology in a scripted city. As such, they can be a catalyst for initiating discussions and pronouncing plural values and perspectives, rather than representing opposing viewpoints in a binary manner. Additionally, looking at conflicts from a values perspective enables empathy for the different perspectives at hand, as one of the participants mentioned: '*You start to understand the 'why' of other stakeholders better and can start a discussion on a level deeper than 'your word against mine'.*

2. **Collectively unpacking the Network-of-Conflicts is a way to 'make things public'**

Through mapping or unpacking the NoC, participants a) analyse the controversy at hand, and b) create a visual representation of this controversy and the value conflicts it conceals. Collectively analysing and visualizing the value conflicts that build a socio-technical controversy into a map, supports visualizing and collective sensemaking, which are key steps to make issues available and thereby shape publics. Mapping the NoC is a means to model, represent and communicate the richness present in socio-technical controversies, and highlights that controversies cannot be reduced to a simple yes-or-no question. The NoC proved a viable tool for analysis, because of the

way it organizes, visualizes and reveals information. It visually represents the problems space, and thereby, it serves as a boundary object for participants to navigate this problem space. '[the NoC] *yields salient information. In this case, most of the insights which were novel to me were uncovered during the mapping activity. This upgraded understanding helped me to diversify my value-centric view on Smart City Controversies'.*

3. **Addressing socio-technical controversies can be facilitated by understanding them as systems of values and value conflicts**

Throughout the first iterations, participants experienced challenges in moving from unpacking the NoC, to addressing it. The resulting NoC repeatedly turned out to be full of nodes and components, making it difficult for participants to maintain oversight of all the information it contained. Moreover, it made it hard to find a way to enter and process this information. Understanding controversies, or the unpacked Network of Conflicts, as a system of values and value conflicts that required systemic design techniques to manage, helped to address this challenge. Common systemic design techniques such as boundary conditions – which helped to manage the size and complexity of the network –, leverage analysis – which helped to find entry points to the network –, and zooming in-and-out – which helped to leverage the information present in the network – , provided meaningful for participants to actively engage with the NoC and use the controversy in a constructive manner.

4. **Analysing and addressing socio-technical controversies are separate yet intrinsically related activities**

Throughout our RtD process, we learned that analysing and addressing socio-technical controversies are distinct activities that require temporal and cognitive distance. Even though the analysing and addressing the NoC are therefore separated in two distinct parts of the final workshop protocol, our findings highlight that these activities are innately linked and cannot be executed separately. Collective sensemaking of the controversy through the creating the NoC, is a required step before any action regarding the controversy can take place. Merely being presented with the final network does not foster the same empathy with, and sensemaking of, the NoC, that is needed to shape publics. As such, the issue remains unclear and the public undefined. This then leaves no foundation for collective action. Moreover, a pregiven network only leads to detachment and confusion, which shows that the reciprocal relationships between interconnected elements (values and value conflicts) should be experienced rather than examined.

4.7 Discussion

In this work we have operationalized controversies through a design approach, in order to enhance the current democratic debate on smart cities. Smart city controversies reveal what issues and values are of concern. They require us to understand the social, political and ethical questions that smart cities raise. Although the potential of controversies has been recognized decades ago, ways to effectively exploit this potential are scarce. We therefore explored what the qualities of a setting are, that makes controversies accessible to, and actionable by, publics. We have done so through a RtD process which resulted in a workshop approach that helps to unpack, navigate and address the NoC that makes up controversies. The workshop simulates a participatory setting where publics can form around issues to discuss values and value conflicts.

4.7.1 Making controversies accessible and actionable

One of the core steps of operationalizing controversies is making them actionable, i.e. finding meaningful ways to actively work with them and concretely incorporate them in multi-stakeholder collaborations. To achieve that, we must first understand the multifaceted value conflicts they encompass. In other words, we must first make them accessible. In our approach we therefor start with an analysis of the controversy, which takes place through unpacking the NoC[13]. Unpacking the NoC helped to discuss the abstract values and value conflicts that build a controversy in a visual and dialectical manner. Explicating value conflicts contributes to the identification of issues, as it makes differences among multiple actors explicit, which is necessary to make the matters-of-concern available (DiSalvo, 2009). Moreover, it helped participants to build empathy and understanding for each other's perspectives. Embracing controversies means acknowledging and empathizing with different perspectives. In this process, empathy is an important enabler when working in transdisciplinary and conflict-riddled settings (Sustar & Mattelmäki, 2017), as it allows to develop a deeper and nuanced understanding of the multiple perspectives that come together a controversy.

The process of mapping the NoC facilitates a shared, in-depth understanding of the controversy at hand, and thereby supports collective sensemaking (cf. Weick et al, 2005). It is through this process of collective sensemaking, that a public is shaped. The visual character of the NoC and the mapping exercise, helped to make matters-of-concern accessible and encourage public debates concerning issues (Schoffelen et al., 2015). This contributed to facilitating the collective sensemaking of the controversy at hand, which is a precursor to shape publics that identify actions which acknowledge and might address the controversy. Although creating awareness of the existence of conflicts is relevant to support multi-stakeholder collaboration (Matos-Castaño et al., 2017), moving from awareness to actively incorporating those conflicts in multi-stakeholder collaboration calls for different activities that move from exploration and reflection to action.

The analysis and action phase required different mindsets and attitudes. Or as Schön (1986, 278) already pointed out, the 'stance appropriate to reflection is incompatible with the stance appropriate to action'. By introducing a navigation step between the analysis and action phase, we have attempted to bridge these distinct activities. This proved to be a key step to define an entry point from which activities could be explored, and prevented participants from becoming entangled in the plural interdependencies present in the NoC. Next, zooming in-and-out was a key step to address the controversy, being a form of *projecting* (DiSalvo, 2009): it allowed to make the conditions and

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[13] Where one could also argue that analysis is a form of action.

consequences of an issue known, allowing for a debate around desirable and undesirable smart city futures, such that a public may form. The zooming exercise allowed to balance concrete entry points to the system with a continuous awareness of the scope of the system. We saw, in line with findings by Boenink et al. (2018, 191), that participants can handle a "plurality of perspectives" about socio-technical challenges and are "quite capable" of identifying and acknowledging their "ambivalences and complexities". Zooming in helped to stimulate creativity and address a specific conflict through a prototyping exercise, whereas zooming out helped to stimulate criticality and assess the consequences of the prototype within the wider network. This allowed participants to develop reflexive awareness and enriched viewpoints regarding the smart city controversy (Stemerding et al., 2018).

4.7.2 Working with the Network of Conflicts

The NoC provides a map of the controversy at hand, and is a means to model, represent and communicate the value conflicts that shape the controversy. The visual vocabulary of mapping finds a home in STS (with controversy mapping (Venturini, 2010; Venturini & Munk, 2021), ethics of technology (value mapping (Friedman et al., 2013), and systemic design (with systems mapping and GIGA mapping (Jones, 2014; Ruecker et al., 2020; Murphy & Jones, 2020)). We developed the 'Network of Conflicts' as a specific technique to map the structure of the system under consideration (i.e. smart city controversy). Rather than simply applying one or the other approach to our transdisciplinary understanding of controversies, we have adapted existing practices and added a new lens: mapping controversies as multi-dimensional value-conflicts, where the values are the system nodes and the value-conflicts are the system interdependencies.

Although we initially aimed to use mainly participatory and scenario-based design methods in the workshop, systemic design methods and techniques such as 1) mapping, 2) boundary conditions, 3) leverage analysis and 4) zooming-in-and-out, proved to be useful additions to our understanding of socio-technical controversies as systems of values and value conflicts. According to Meadows' (2008) description of a system as an interconnected set of elements that is coherently organized, we understand controversies as systems consisting of values (nodes) and value conflicts (interconnections). Firstly, mapping is a means to visualize the system, and allowed us to unpack the controversy into a NoC, as elaborated in the preceding paragraph. Secondly, boundary conditions help to frame a system, as it is both implausible and uncritical to boundary judgements to address everything (Sevaldson, 2011). Thirdly, leverage analysis offers a mean to enter the system, because it highlights the most relevant information related to the research or design goal at hand (Murphy & Jones, 2020). We applied a qualitative measure, namely whether a conflict raised any critical or creative thinking on the identified values and conflicts (Nilsson & Jahnke, 2008). Lastly, zooming in-and-out on different levels of the NoC facilitates empathy with the system (Sustar & Mattelmäki, 2017), and brings more nuance to the developed interventions. Zooming in-and-out represents a shift from a linear to a systemic mindset, and urges us to design *evolutions* instead of *solutions* (vd Bijl-Brouwer et al., 2021). Typical design projects focus on developing one solution to a singular problem, thereby excluding any contextual factors and reducing any complexity.

Through iteratively zooming in-and-out, participants are encouraged to move between various levels of conflict as they discuss ways to intervene or address the conflict. In line with Rip's (1986) idea of controversies as sources of informal technology assessment, zooming in-and-out stimulates participants to reflect on potential consequences of their proposed intervention in relation to the

wider network, in order to anticipate and address any desirable or undesirable effects, and enhance their intervention with these reflections in a next iteration. Because of this, they gain a deeper understanding of the context in which they operate. Participants learn how to relate the values, conflicts and consequences of possible interventions to each other, in order to utilize conflicts constructively.

By explicitly deliberating on the potential consequences and value trade-offs, this approaches provides a form of concrete and actionable ethical deliberation, and could be seen as a form of guidance ethics (cf. Verbeek & Tijink, 2020) through navigating conflict. Through the set-up of the exercise, the zooming and prototyping allowed for a positive approach to ethics. Rather than focusing on restricting norms, the map stimulated a more positive account to what was desired in Nevertire. Through zooming out and reflecting on a) any potential undesired consequences and b) other values that are relevant for the personas, each iteration focused on how to enhance the intervention with a focus on values, rather than be limited by ethical constraints.

Embracing controversies entails that we move from binary to plurality when it comes to our framing of conflicts, and requires us to reflect on the impacts of our choices in the socio-technical context they are taking place. In that sense, it links to other approaches such a systemic and transition design (e.g. Jones, 2014; Irwin, 2015), that stimulate contextual thinking. Placing controversies at the centre of participatory processes through unpacking the NoC, provides a breeding ground for perspective-taking, and through that, catalyses the shaping of publics. The NoC serves as a boundary object for participants to navigate the controversy, and provides an infrastructure to mediate democratic practices by making value conflicts explicit. As such, we can understand the map or NoC as a Latourian 'thing' around which publics gather. Additionally, the circular shape of the NoC represents circular shapes of parliaments, emphasizing the 'gathering' of a public 'around' an issue.

4.7.3 Reflections on the method

In this work we applied RtD as our research method. RtD breaks the seemingly paradoxical relationship between research and design (Stappers & Giaccardi, 2017), and generates knowledge whilst providing tangible outcomes. In our case, we have learned how to make controversies accessible and actionable, whilst also creating a structured workshop protocol that can be applied in future work. The RtD approach is an explicit method choice, because of the flexibility it provides: it allows room to experiment with, and learn from, different design possibilities. This is particularly meaningful when exploring new and complex concepts such as socio-technical controversies. However, RtD also has its limits, for example the fact that RtD does not adhere to the same rigor of traditional scientific method as found in the social or natural sciences. We have attempted to mitigate this limitation and insert rigor in our RtD process by a) departing from the theoretically sound concept of socio-technical controversies, b) building on existing methods and techniques from STS, participatory and systemic design (cf. Venturini, 2010; Björgvinsson et al., 2012; Jones, 2014), and c) including a total of seven well-documented iterations.

Next, we used a workshop approach to embed our RtD process. Workshops as methodological tool both provide relevant research data, as well as a relevant learning experience for the participants (Ørngreen & Levinsen, 2017). From a research perspective, it is important to collectively reflect on this learning experience and evaluate the presented intervention. In this moment, participants move from their role of workshop participant, with a priority for their own individual development, to research participant, with a priority for research advancement. From a participant perspective it is

equally important to collectively reflect on the learning experience, as this offers a necessary moment to move from the role of participant, back to the role of the individual. When using workshops as a research tool, the debrief is an important part of the workshop. This allows to 1) process any emotions and share experiences, and 2) translate these into concrete learnings, guidelines or next steps. In our case, the debrief always consisted of a shared discussion and individual form, which allowed participants to reflect on the experience itself, the value of controversies, and how their experience could translate to their daily practices.

4.7.4 Future research

The scenario-based setting in the fictional city of NeverTire, together with the stakeholder roles, helped to frame the challenge to be confronted during the exercise, and establish the setting in which this challenge occurs. Although participants throughout the various iterations underlined that the scripted, hypothetical environment helped them to navigate the controversial space, as it made the encountered conflicts less personal and affective, it would be interesting for future research to test the presented approach within an ongoing, lived controversy, to understand how personal and more affective conflicts affect the notion of operationalizing controversies. This would allow to include new elements and sensitivities to acknowledge the complex character of a controversy that is directly felt by the participants. In addition, the multidimensional nature of controversies imposes a challenge in finding courses of action or design interventions which clearly follows from the prior analyses. Controversies provide a solid framework to extensively dissect the problem into sub-dilemmas and conflicts. However, converging from here is quite challenging. From our experience, further research should explore how to constructively use all the interdependencies illustrated in the NoC, to identify a course of action. We encourage further explorations to understand how to move to a design intervention which reflects the necessity of the extensive problem space exploration, without oversimplifying the yielded nuances and interdependencies.

Appendix A: Scenario

Below you may find the full scenario as provided to participants of our workshops.

Scripted City and Social Bubbles- Welcome to Nevertire!

Nevertire is a large town on the edge of a beautiful estuary. This city is well known for its vibrant nightlife, friendly people and traditional gastronomy. The mayor has been in power for the last two terms, and she is determined to improve the economy of Nevertire as well as the quality of life of the Netertirans. Believing in the wonders of technology and following the strong political agenda pushed by the mayor, the municipality of Nevertire is planning to turn this city into the smartest city in the world by 2040. Following the example of the neighboring town 'Los Lagos', the mayor of Nevertire is planning to install an omnipresent network of sensors that will generate data about every aspect of the city.

The expectation is that, having so many active sensors installed in streets, traffic lights or even in garbage bins, Nevertire will become an entity of its own. The city will be able to interact with citizens and make suggestions based on the personalized data they incessantly acquire. The network of sensors will connect with personal devices and identify the citizens' preferences. For example, once Nevertire turns into an ultra-smart city, when somebody gets hungry while walking in the street, they will get a message in your device helping you to find the closest restaurant to your liking.

To achieve this technological feat, the municipality is closely collaborating with Sensa, a tech company responsible for the development and maintenance of the sensors. Sensa worked on the smart city pilot in Los Lagos, and the results have been satisfactory. Thanks to the abundant data, municipalities can significantly improve the city's quality of life in many areas: mobility, crime reduction, health. By being part of this initiative, Sensa plans to invest in research and development to fight future health crises for which they are collaborating with Brainy, its data analytics partner. Knowing so many parameters, Sensa and Brainy will be able not only to improve mobility or provide targeted experiences, but also to model, predict, and give advice to prevent pandemics as the last two crises that humanity experienced a few years ago. This will put Sensa and Brainy at the forefront of innovation and social responsibility.

After a preliminary survey, the citizens of Nevertire seem enthusiastic about the changes Nevertire will experience in the near future. Who wouldn't want to live in a city where life will be tailor-made and adapted to your needs?

Today, 4 December of 2030, the smart-city policy of Nevertire has been approved, confirming the collaboration of Nevertire, Sensa and Brainy. The mayor announces the news with great enthusiasm, convinced that this initiative will increase the quality of life of the citizens of Nevertire.

By launching this smart city initiative, we are working towards making Nevertire the happiest city on earth. We will achieve this goal by implementing an ambitious network of sensors and making Nevertire a seamless, safe, efficient and personalized city experience for all inhabitants and visitors.

Figure A1. Nevertire scenario.

Appendix B: Stakeholder narratives

Below you may find an example of one of the stakeholders narratives that forms the starting point for the roleplay exercise. In total, five of these stakeholder narratives exist.

Stakeholder perspective

Andrew- Tourist

Andrew is about to book a very welldeserved holiday in Nevertire. He is excited about the wonderful stories of wide promenades, a fantastic nightlife, and fun people. This trip will be the second one he experiences in that region.

The first one was to Los Lagos, only 50 km far away from Nevertire. He still remembers every detail of that travel. That was an interesting one. Compared to his hometown, Los Lagos looked like a city out of a science fiction book all full of sensors, shining lights, flying drones and technology connected to your personal devices. As a visitor, it was amazing to walk around without any traffic jams (and pollution!). Clean. Efficient.

'Such an example of progress'- Andrew thinks.

In Los Lagos, Andrew's most striking experience was to use the Personal Local Guide that the municipality offered to visitors. Based on your online activity, the Personal Local Guide recommended restaurants, musea, activities, likeminded people to meet. Without any doubt, that was the most 'productive' holiday he ever had. Everything was planned and predictable.

While booking his holidays, Andrew sees a new message from Curio-city, the online community he founded to bring people together and share unexpected experiences during trips. Andrew loves experiencing novel experiences.

The subject popsup: 'You won't believe the antique shop I encountered while wandering in Brisbane'.

'Oh, interesting!'- While Andrew opens the message, the radio announces that Nevertire has just approved a policy to implement the same network of sensors that Los Lagos has. Perhaps he will get the same experience he enjoyed in Los Lagos...

Institutional profile linked to Andew

Curio-city

We envision a world where travel is better by connection and sharing urban experiences. Curiocitizens share stories about the unexpected treasures they find when they visit new places.

'Our main goal is to make cities spontaneous places where we can experience the wonders of surprise'.

When you join Curiocity, you have access to routes in the city that are full of surprises. Then, you can share how you felt and compare your feelings to what other fellow travellers experienced.

Curio-city is a global community of 20 million people in more than 50000 cities who share their stories,

Stay curious
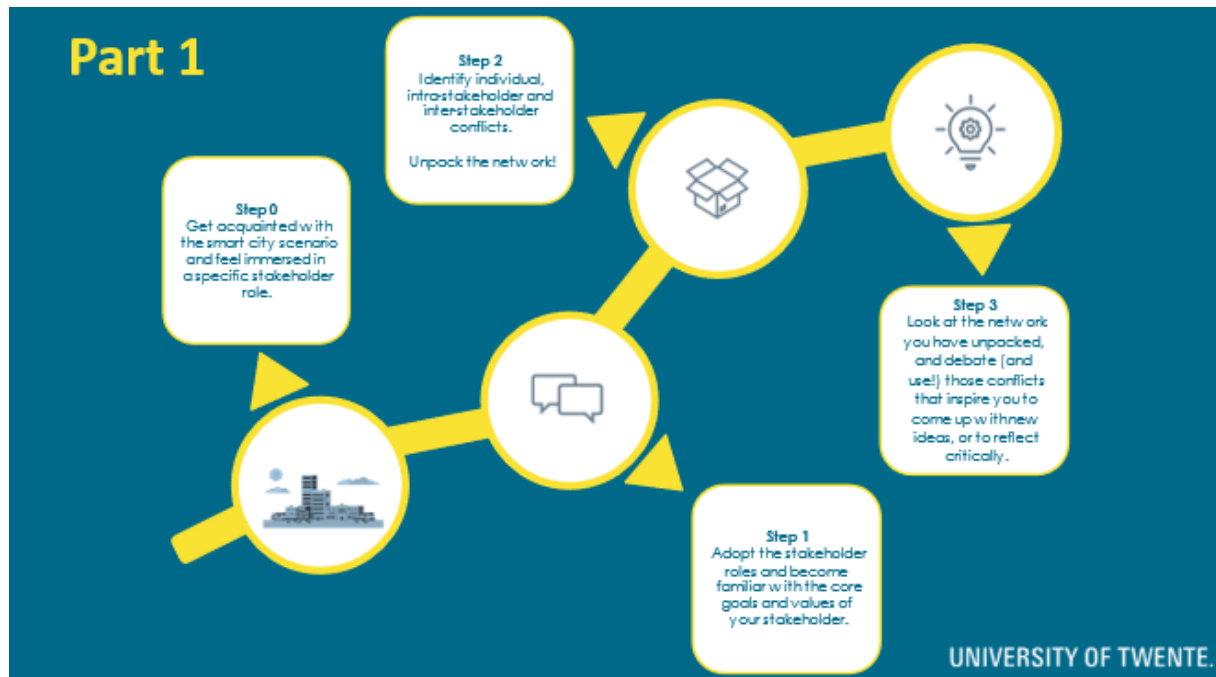
Experience novelty

Share your stories

Figure A2. Example stakeholder narrative.

Appendix C: Workshop protocol

Below you may find the a summary of the final workshop protocol.

Figure A3. Workshop protocol part 1.

Figure A4. Workshop protocol part 2.

Chapter 5

Future Frictions: Exploring value conflicts and public engagement in the smart city through an interactive intervention

Abstract

This paper explores and evaluates the use of a speculative and interactive design intervention, Future Frictions (FF), to promote ethical deliberation on the impact of smart city technology. By ethical deliberation, we understand a process of negotiating values conflicts, empathizing with multiple perspectives and weighing different future options. Our design intervention operationalizes the theoretical concept of socio-technical controversies, to make value conflicts more accessible and debatable for publics to engage with, in order for them to articulate their own matters-of-concern. Through relatable future scenarios in the form of a neighborhood narrative and interactions with virtual neighbors, FF makes participants aware of multiple perspectives and values regarding urban technology. As a result, the experience allows for ambiguity and refrains from a deterministic view on urban technology. We describe the design and evaluation of this controversy-infused intervention, and show that FF's three central features, 1) relatability, 2) plurality and 3) ambiguity, create the setting for publics to actively engage with value conflicts. FF highlights the politics of smart city technologies, moving away from homogenous perspectives around technological impacts and sparking a public into being.

5.1 Introduction

Data-collecting technologies are increasingly being implemented in various contexts, ranging from industry to the agricultural sector and our urban environments. The prefix 'smart' signals the 'innovative' future vision that stools on the application of data-driven technologies. This widespread introduction of technology has sparked local and global debate regarding for example 'surveillance capitalism' (cf. Zuboff, 2019) and skewed power distributions (e.g. Datta & Oldenhaal, 2019; Krivý, 2018). Smart technology has potentially far-reaching consequences and can challenge our public values (e.g. Van Dijck et al., 2018), leading to socio-technical controversies. Such socio-technical controversies are fueled by (public) contestations, conflicting perspectives, and multi-dimensional value tensions (Geenen et al., 2021). These controversies signal the need for more democratic debate on the direction of data-driven society. Moreover, controversies amplify an increasingly loud call to anticipate, assess and evaluate the societal impact of data-driven technologies. They thus simultaneously signal the need to explicitly take into account ethics and public values in the development and evaluation of new technologies. This paper aims to bridge and address these two needs by investigating how we can employ controversies as sites of democratic participation and ethical deliberation. We do so by developing and evaluating a controversy-inspired speculative design intervention.

To situate our work, we specifically focus on smart city controversies. The smart city has received vehement criticism for pursuing a top-down, neo-liberal, corporate vision, rather than generating bottom-up, participatory and human-centered expressions of the urban future (e.g. Martin et al., 2018; Sadowski & Bendor, 2019; Andreani et al., 2019). Following this critique, the discourse evolved towards the so-called 'smart city 2.0' (cf. Trencher, 2019), which takes a people-centric approach and employs smart technologies to address social issues and foster participation. However, these issues of social concern and participation sites are often formulated and framed by external stakeholders, such as governing bodies and technology developers, rather than by the people living in the city and interacting with the technology (Rettberg, 2020). Notably, the citizen is the expert in the experience of the city, yet missing in the conversation on smart city issues. Current conversations on smart cities mostly resonate with academic, corporate, and governmental audiences. At best, current participatory practices rally citizens around predefined issues as objects of debate, rather than let them identify and debate their own issues (Engelbert, 2019; Nesti & Graziano, 2020). However, in the words of Marres (2005) 'no issue, no public' – explaining the democratic deficit in the smart city discourse. The inclusion of citizens or 'the public' is not only a requirement for democratic policy making, but also a crucial factor when exploring desirable urban futures to shape actions in the present. We argue that in order to make smart city issues more accessible to the public, or rather, let the public define their own issues and matters-of-concern (cf. Latour, 2005), we need to operationalize *value conflicts* that smart city controversies conceal. It is through revealing and debating these conflicts, that issues become available for public debate.

To make the value conflicts that characterize these controversies accessible and actionable, we turn to speculative design, building on its power to encourage debate around socio-technical developments (e.g. Forlano and Matthew 2014). Additionally, our design is inspired by the prospective scenario-based approach of Boenink et al. (2010) and Lehoux et al. (2020), who apply scenario-based methods to stimulate meaningful public engagement and (moral) imagination – meaning that participants are enabled to relate the presented scenarios to ethical dilemmas in past or present global developments (Fesmire, 2003). In contrast to conventional, highly descriptive and

analytical approaches, design's tangible nature offers a focus on active and constructive interventions (e.g. Dorst, 2019). Design allows to make possible smart city issues tangible, debatable, and accessible for public engagement and ethical deliberation. Speculative design in particular can stimulate public debate about smart cities, given its ethical mission that it carries at heart: to challenge the status-quo, uncover unconventional perspectives and provoke thoughts about alternative futures (Dunne & Raby, 2013; Auger, 2014; Light, 2021). Our research is guided by the question: how can speculative design stimulate ethical deliberation by making the value conflicts controversies accessible and actionable?

The paper is structured as follows: we first elaborate on the relevance of socio-technical controversies and their relation to ethical deliberation and democratic debate. Next, we describe why a speculative design approach fits our challenge, and distill three 'principles' from speculative design literature that guide our design, namely ambiguity, plurality and relatability. We argue that these three principles stimulate participants to make sense of the smart city controversies in order to identify their own issues, as they help to make value conflicts more tangible and debatable. We then present a speculative design intervention called Future Frictions (FF), to operationalize the theoretical concept of socio-technical controversies, stimulate ethical deliberation on smart city technology, and allow participants to articulate their own issues and matters-of-concern. FF is an interactive intervention that immerses participants in a speculative urban environment, and presents them with various controversial scenarios and choices concerning the future smart city. Through the experiences of 50 BSc students, we evaluate how the three speculative design principles (ambiguity, plurality, and relatability) manifest in actual interactions with FF. Moreover, we reflect on the capacity of the intervention to make typically abstract value conflicts in the smart city tangible and debatable, and help organize a place for publics to identify their own issues. In doing so, we offer methodological insights into the way speculative design can help operationalize controversies to stimulate public debate on public values. Consequently, this intervention allows us to bridge two debates: the need for a stronger emphasis and embedding of public values in the debate on smart cities, and the need to make this debate inclusive for, and resonant with, citizens.

5.2 Theoretical background

5.2.1 Socio-technical controversies and value conflicts

A pressing challenge for smart cities today is how to include and safeguard 'public values' in their design and governance (Kitchin, 2016; Chang, 2021). Cities have to make sure that the implementation of smart technologies and infrastructures benefits the interests of the public instead of narrowly benefiting public administration, corporations, or institutional gatekeepers of expert knowledge. We see socio-technical controversies as meaningful entry points to discuss abstract concepts at the intersection of (smart) technologies, public values, and democratic practices. Working with controversies centers around value plurality (Geenen et al., 2022, Baibarac-Duignan & de Lange, 2020). We therefore propose to explore controversies for their productive capacity to highlight the coexistence of conflicting values. In an agonistic fashion (cf. Mouffe, 1999; DiSalvo, 2010), we emphasize the relevance of articulating points of contestation and conflict, that require active recognition and acceptance of divergent interests and competing values, rather than establishing consensus .

To make these controversies and the value conflicts they carry more accessible, we build on Binder et al.'s (2015) idea of democratic design experiments, which 'work by making issues experientially available to such an extent that 'the possible' becomes tangible, formable, and within reach of engaged yet diverse citizens" (163). According to Lehoux et al. (2020) the public's "struggle to visualize" the tangible effects of emerging technology, hinders publics to form around an issue. This speaks the perspective of pragmatist John Dewey (1927), who emphasized the importance of making the conditions and the consequences of an issue apparent and known, such that a public may form. With respect to supporting the creation of publics, DiSalvo (2009) argues that design can support projecting: the representation of a possible set of future consequences associated with an issue. The purpose of a projection is to make the consequences of an issue apparent, allowing for a debate around desirable and undesirable futures. We turn to the practice of speculative design to create these democratic design experiments for ethical deliberation, as speculative design helps to position new technological developments within imaginary yet believable everyday situations, thereby allowing to debate the implications of different technological futures before they take place (Dunne & Raby, 2013).

In this work, we base our understanding of ethical deliberation on the pragmatist work of Dewey by 1) understanding values as lived, dynamic and contextual, thereby refraining from the analysis of normative theories or application of lists of values, but rather aim to explore and debate values in context (Kudina & Boenink, 2020), 2) engaging a form of moral imagination, which involves an empathetic projection in order to consider interests and worries of other perspectives than one's own (Fesmire, 2003), and 3) involving a 'dramatic rehearsal' in which different future outcomes and alternative imaginaries are explored to test potential outcomes (Fesmire, 2003). In short, we understand ethical deliberation as consisting of recognizing and negotiating ethical concerns and (conflicting) values in context, whilst empathizing with diverse viewpoints and weighing alternative imaginaries for future situations.

5.2.2 Speculative design
We follow Banu's (2015) interpretation of speculative design as a material practice of ethical-creative co-existence, meaning that ethical provocation is materialized through creative speculation about alternative, future arrangements, translated to tangible or experiential design interventions. The potential of speculative design lies in its ability to engage with the political. It does so by envisioning possible consequences of current trends and challenging assumptions about the way things are or should be. Speculative design diverges from mainstream design practices, in that it does not apply design to solve a problem, but rather applies design to ignite a response (e.g. Auger, 2013; Light, 2021). This provocative character illuminates the power of the language of design to question, challenge and inspire new societal practices. It invites the audience to critically reflect, by providing ambiguous, non-prescriptive situations, with more than one interpretation possible (Auger, 2014). As such, it challenges our understanding of a given situation, and forces us to think and make sense of the situation for ourselves.

Speculative design is closely related to future practices such as design fiction and experiential futures. Design fiction relates to the development of fictional future products, so-called diegetic prototypes, that function as central provocative objects in future explorations (e.g. Bleecker, 2009; Kirby, 2010). Instead of designing objects or artifacts, experiential futures engage people with experiences or immersive situations that bring the worlds of tomorrow into the present in tangible

and concrete ways (Candy, 2010; Candy & Dunagan, 2017). Common across all three strategies is the designerly means to express futuring techniques in compelling, often provocative ways, intended to engage audiences. Through the creation of hypothetical scenarios and the visualization of potential futures, speculative design can help stakeholders better understand the potential consequences of different choices and actions (Lehoux et al., 2020). By incorporating plural perspectives, the audience can empathize with, and critically reflect on, the fact that consequences are not uniform but manifest distinctly for different perspectives. This enhanced understanding can help to explore the social, political, and ethical issues that are at the heart of socio-technical controversies. It allows to explore concrete manifestations of potential futures to instigate debate and gain insights about current actions in the present that could be taken to avoid or achieve them. Important here, is the notion of a 'perceptual bridge' as coined by Auger (2013): to make speculations accessible and legible, there should be a bridge between the audience's current world and the presented fictional world. It is important to root imagined futures in present-day, familiar objects or trends, to provide some level of familiarity and speak to people's everyday experiences. Speculative design sees 'everydayness' as a core quality to make futures relatable (Candy 2010, Kuzmanovic & Gaffney, 2017, Gaziulusoy, 2021). This relatability helps to make the intervention more accessible and understandable, and allows the imagined futures to be anchored in the present.

5.2.3 Distilling design principles
As no fixed speculative design method or framework exists, we formulated three main design principles based on the previous summary of speculative design, to guide the design of our intervention.

Ambiguity
Speculative design provokes reflection and debate by providing ambiguous, non-prescriptive situations, with more than one interpretation possible (Auger, 2014). Ambiguity impels people to interpret situations for themselves, which leads to deeper and more personal relations with the meanings offered by the design intervention. Ambiguity comes into existence when the artefact or situation sets the scene for meaning-making, but does not prescribe the result (Gaver et al., 2003). This interpretative quality makes ambiguity an appealing tool to stimulate debate and provoke responses (Blythe & Encinas, 2016). Because ambiguity does not merely invite, but requires participants to participate in meaning-making, its application shows deep respect for participants and their understanding, and makes it an excellent quality for participatory settings.

Plurality
By providing multiple, heterogenous perspectives, speculative design moves beyond homogenous visions of the future to depict a diverse unfolding of potential urban futures, bring in divergent and conflicting views, challenge dominant claims, and tap into value pluralism (Howell et al., 2021). The inclusion and (re)presentation of plural perspectives and futures, encourages intersubjectivity amongst multiple perspectives and thus ignites the release of multiple perspectives amongst participants, emphasizing the provocative character of speculative design. Plurality distinctly makes room for marginalized voices, alternative stories and perspectives that exist outside of the dominant narrative. It acknowledges that it matters through which eyes you are viewing an issue, and to be aware of who's story is being told, and who's perhaps is not being told. From a democratic perspective, the inclusion of diverse perspectives or 'unusual suspects' is important to counter the well-documented tendency of high-educated and wealthy citizens to participate disproportionately

in deliberative opportunities, and to identify points of view and conflicting interests that might otherwise go untapped.

Relatability

Relatability concerns the empathizing capacities of a speculative design, that make different perspectives and experiences accessible and easy to feel connected to, by for example providing similarities to one's own experience (Auger, 2013). When embarking on a speculative design journey, the reality of the design is not the core point of attention. The relatability of the design, however, is. Through relatable and recognizable events, people feel emphatically connected to the presented situation, which positively impacts engagement (Gaziulusoy, 2021). Moreover, relatability is key to avoid the speculative intervention to be shrugged off as 'not real thus not relevant' (cf. Kozubaev, 2020). Rather than focusing on highly extraordinary situations, speculative design and experiential futures explicitly bring in this focus on the mundane and lived experience (e.g. Candy, 2010, Gaziulusoy, 2021).

5.3 Designing Future Frictions

In this section, we present the design and evaluation of our intervention 'Future Frictions' (FF) using the aforementioned three main speculative design principles. FF stimulates participants to reflect upon a future city where technology is introduced, and lets participants experience and explore smart city controversies related to questions on data-collection, -ownership, and -sharing. The iterative co-creation of this intervention took place with the consortium partners and collaborators of our research project. This co-creation process took place between the fall of 2020 and the summer of 2022, and was continuously informed by multiple iterations and user tests (e.g. Baibarac-Duignan et al., 2023). A summary of these iterations and their insights can be found in Appendix A.

We designed a scenario-based, interactive, digital intervention to mobilize the principles of ambiguity, plurality, and relatability. Scenarios originate from the question 'What if?' – or in Dunne & Raby's (2013) words: 'Why not?' – and are commonly used to capture future possibilities and discuss ethical dilemmas of emerging technologies with a wider audience (e.g. Dorrestijn et al., 2014; Boenink et al., 2018; Lehoux et al., 2020). In line with Luria & Candy (2022), we attempted to balance immersion and provocation to stimulate ethical exploration. We situated our scenarios in a neighborhood narrative that presents participants with value conflicts and ethical dilemmas surrounding speculative smart city technologies, in which they carefully have to weigh their choices, and are aided in this decision by various neighbors' perspectives. By adding an element of interaction, where the next scenario depends on the participant's choice of action, the scenario becomes more immersive and experiential as the audience is urged to directly engage and become co-author of the scenario. Such game-like expressions of speculative design have been successfully used to stimulate civic imagination (e.g. Vervoort et al., 2010; Mangnus et al., 2022). To create this immersive and interactive intervention, and present the visual and tangible elements to make the scenario come to life, we developed a digital 3D experience with *Unity*, a software most commonly used for games. Through a collage-aesthetic where we place 2D visuals in a 3D world, we created an urban environment modeled after a neighborhood in the Dutch city of Amersfoort, in which participants need to navigate and interact with different elements. Both the collage-aesthetic and neighborhood setting were consciously chosen to move away from distant and futuristic images that often represent smart cities, but allow for a more realistic and playful depiction of the city. Figure 5.1

captures part of the iterative co-creation process, from scenario formulation to design of the 3D environment and its visual elements.
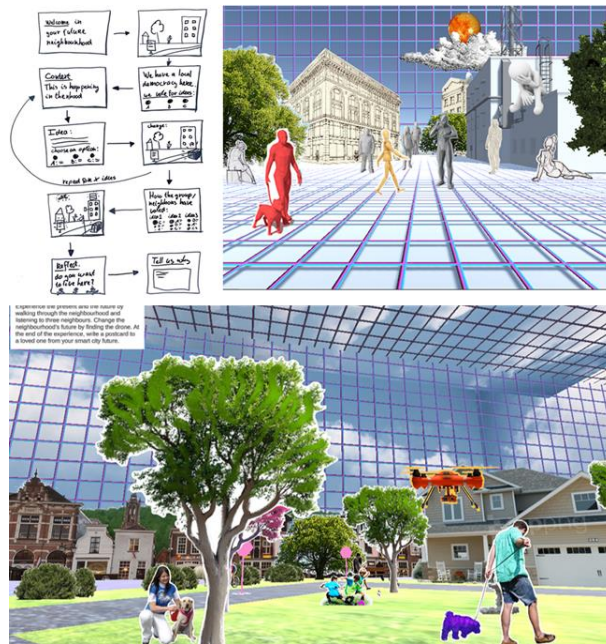
Figure 5.4. Examples of the various activities of the co-creation process. Top left we see the first sketches of the scenario; top right we see the development of the 3D-environment in Unity; below we see a snap-shot of the final 3D-environment.

5.3.1 Final design

FF engages participants with societal impacts of urban datafication through interactions with speculative smart city technology. FF immerses participants in a digital, 3D urban environment, where they can walk around the neighborhood and meet various neighbors (i.e. a teenage girl, a health worker and a local entrepreneur). On three occasions, they encounter speculative smart city technologies that the mayor of the fictive city of 'NeverTire' wants to introduce. The presented speculative technologies include a guardian-angel drone that continuously makes pictures of the city, an AI-cat that visits citizens depending on their measured loneliness, and a sensing pigeon that tracks the amount of waste each citizen produces. All of these technologies are fictional and slightly playful by intent. They relate to real-life issues (urban safety, loneliness, and waste disposal), but present a provocative and playful twist to the issue at hand. Participants then need to decide between three options of how the smart technologies and the data they collect, should be implemented. These options are deliberately provocative and expose potential tensions around corporate, community, and government control of data. Following their decision, participants both observe how the urban environment has changed based on the implemented choice (i.e. social protests, an increase of police presence), as well as learn how the experiences and perspectives of the neighbors are affected. Figure 5.2 presents this flow of the FF experience. In Table 5.1, we show the technology options and neighbors' interactions for one of the scenarios. FF is available in a short (10 min) and long (20+ min) version[14], and is designed such that it is self-explanatory and can be used independently.

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[14] During our Research-through-Design process we learned that interactions in public space require a different interaction time compared to for example workshop settings. To accommodate this insight, we decided to

Figure 5.2. Snapshots of the first scenario, including initial neighbor interaction (top left); introduction of technology and the three implementation choices (top right); a second neighbor interaction and visual changes to the neighborhood based on the choice ma

Table 5.1. Example of the interaction possibilities of the scenario regarding the Emotional support AI cat. Per scenario, we formulated three implementation options, three neighbor perspectives, and different responses per neighbor, depending on the choice made.

Scenario	Introduction	Option A	Option B	Option C
	Emotional support AI cats that can sense when someone feels lonely will become available in the city. The cats are programmed to visit all the lonely people that they sense. What powers should the AI cats have? Choose one of the three options:	The AI cats forget all about their visits by the next day.	The AI cats' visits are recorded in a neighborhood database to help neighbors connect and support each other.	The AI cats' visits are stored in the city's health records. Based on the data, health workers are sent to those registered as 'lonely'.
Neighbor 1 (Parent)	Hey there! I'm Max and this is Casper. I usually take my son and our dog for a walk to the park nearby after school. It's great when I don't meet too many neighbors and I can check my phone while the kid is playing.	Since this cat has arrived in the neighborhood, I seem to never have peace going for a walk! It might look like I'm lonely but I have a very busy and social work life, so I'm very happy to be left alone in my own neighborhood.	After being pestered by the AI cats for a while, I decided to complain to the public administration. Now, the neighborhood controls the loneliness data so the cats finally visit only those people in need!	What do you know: the AI cats are back. Now, if I'm feeling a bit low, usually because I'm so tired, I get a cat sniffing at me straight away. Not only that, but her visits go into my health record, so my health insurance is getting ever more expensive! I want them gone!
Neighbor 2 (Policy maker)	Good afternoon! I don't live here so I travel by car to the office every day. I love my job though, making sure that we deliver excellent quality of life for our citizens.	We found that people in this neighborhood were experiencing high levels of loneliness. The AI cats have been doing a great job in my city in improving happiness levels. However, we had to respect individuals' privacy, so it's not possible to find out who is really in need of help. Let's hope the cats will figure that out by themselves!	As the AI cats didn't seem to improve the neighborhood's happiness levels, we decided to give control of the loneliness data to the residents' board. They should know how best to deploy the cats! Plus, we are not responsible for the privacy issues anymore.	We are so happy with the AI cats now! After our local health professionals expressed their worries regarding people being left behind by the cats, we regained control of the data. We have even received a prize from the mayor for our efficient and cost-effective health system!
Neighbor 3 (Health worker)	Hello! My name is Nina and I am the neighborhood's nurse on	In the beginning, I was very happy to hear about the AI cats as we need more help in	It's strange to see that some people are becoming happier and some others	I love these AI cats! Finally, I have time to visit those patients who really

create two versions of FF, with the short version being more appropriate for engagements in publics events and the long version more appropriate for workshop settings.

| | duty. There are quite a few elderly people living in this area, and I like paying visits to their homes and drinking a cup of tea with them as often as my other duties allow. | this neighborhood. But now they've really become a nuisance! They are creating even more work for us nurses. Instead of visiting those people who really need our help, we are sent to people who are doing perfectly fine! | are becoming sadder. My elderly patients are doing much better now, but I see younger ones needing my visits. Yet, the AI cats don't seem to see them... | need me. The cats send the data to our central records, which allows me to plan my day much more efficiently! |

As a result, in a series of three scenarios, participants interact with in total nine neighbors and three fictional technologies – three different neighbors per technology, see Figure 5.3. To wrap up and reflect on the experience, participants are invited to write a postcard from this future neighborhood to a loved one. The postcard impels users to reflect on the controversy-fueled experience, and stimulates imagination about alternative urban futures.
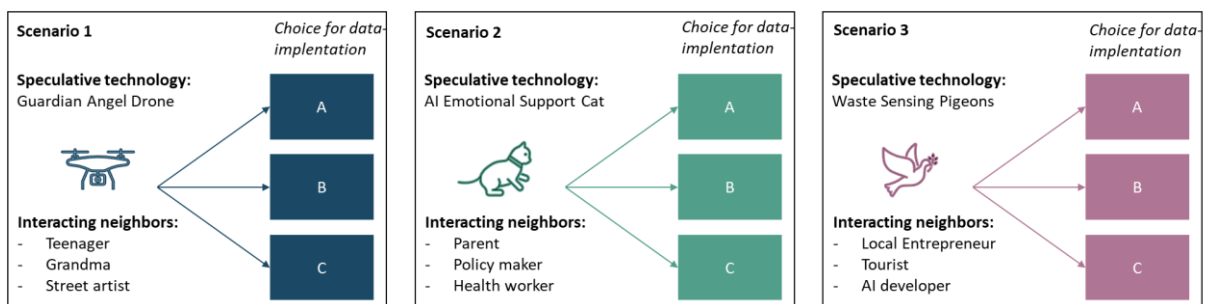
Figure 5.5. Summary of the presented technologies and neighbor perspectives. For each scenario, the options for data-implementation roughly correspond to individual (A), governmental (B) or corporate (C) control of data.

5.3.2 Translation of design principles

In the following we elaborate in what ways the three speculative design principles are embedded in the design of FF. A summary can be found in Table 5.2.

Table 5.2. Description of the three principles of Ambiguity, Plurality and Relatability, and the way these principles were translated into Future Frictions.

Speculative Design Principle	Translation to Future Frictions
Ambiguity Presenting in non-prescriptive manner, leave open for interpretation	- Containing positive and negative aspects of technology through neighbour's experience - Description of technology and implementation options are open
Plurality Including multiple and divergent perspectives, experiences, values	- Representing marginalized voices and unusual suspects - Representing a diversity of values through technology implementation options - Including plural social outcomes and experiences of urban technology
Relatability Connecting future and fiction to everyday experiences	- Providing recognizable environment through neighbourhood setting - Including relatable neighbour perspectives - Presenting fictional technology that connects to current trends and technological developments

Ambiguity

Working with the ambiguity principle required a balance between familiarity and fantasy: too straightforward scenarios leave no room for interpretation, yet too anomalous scenarios make it difficult to engage with the topic. To achieve this balance, we employ the conflicting values and multiple perspectives present in smart city controversies. In the options for implementation and neighbor experiences presented per fictional technology, we sought to provide concrete details, introduce positive and negative aspects and leave the dilemmas open so that participants could make sense of them themselves (cf. Gaver et al., 2003; Boenink et al., 2018). We deliberately embedded positive and negative elements of urban technology, to highlight the social, political, and ethical complexity of smart cities. The speculative technologies build on current-day technological trends, yet include a fictional functionality. The plausibility of these technologies adds to the ambiguous character of the scenarios as participants are invited to imagine and consider the potential impact of the technologies. Moreover, the three speculative technologies carry a brief description of what they aim to do, but leave ample space for interpretation on the specifics of implementation and the actual abilities or limitations of the technology. Lastly, the combination of speculative technologies, varying neighbors' perspectives, and the visual cues highlighting the contextual changes, stimulate participants to unfold their own reflections and interpretations of what is going on and how they themselves would experience the scenario. The experience of FF invites them to make their own assessment of certain societal impacts and value conflicts related to smart city technology.

Plurality

Plurality was applied both through providing technology implementation options that represent a diversity of values and lead to different societal outcomes, and by including multiple neighbors' perspectives regarding the impact of smart technologies. Next, the neighbors' perspectives emphasize the different meanings that one can give to technology and its societal impact. With neighbors highlighting pro's, con's and in-between's of the technology and selected choice for implementation, participants remain in a non-prescriptive environment that provides them a multiplicity of perspectives and insights. We focus on including and representing multiple, also marginalized or unexpected, perspectives in the usual smart city discourse by introducing for example a teenager, street artist, and tourist (Figure 5.3). These perspectives are normally not included in smart city futures. This plurality of perspectives helps to engage imaginations that depict a diverse unfolding of potential futures (Howell et al., 2021). Plurality is thus represented in the different storytellers and viewpoints, but also through the plural futures that are embedded in the intervention, and the plural values and value conflicts they represent.

Relatability

Relatability is inserted in several ways. Firstly, by providing the urban context of a neighborhood, including recognizable squares and buildings (vs. a sleek depiction of imagined techno-futures that only includes highways and skyscrapers). Presenting this narrative through the perspective of neighbors in an urban neighborhood, allowed us to move away from the corporate-driven urban visions (e.g. Sadowski & Bendor, 2019), and create a storyline that resonates with the everyday experiences of participants. Secondly, by inserting a diversity of neighbor experiences that present recognizable perspectives and allow participants to empathetically relate to the narrative. Thirdly, by situating the narrative in everyday conversations that regard teenage school kids, local entrepreneurs, and caretakers – perspectives often neglected in smart city visions, yet core to urban

communities. Lastly, the presented fictional technologies function as diegetic prototypes (Bleecker, 2009; Kirby, 2010), that relate to current trends and developments, and thus balancing design, science fact, and science fiction (Lindley & Potts, 2014). Together, these elements help to provide a perceptual bridge (Auger, 2003) between the recognizable urban context on the one hand, and the provocative aspects of future smart cities on the other hand.

5.4 Evaluating Future Frictions

We evaluated FF to evaluate 1) whether and how the three speculative design principles shaped participants' experience of FF, and 2) how the experience of FF helped to enhance ethical deliberation and ignite issue-publics.

5.4.1 Data collection

We have evaluated the short version of FF[15] with 50 second-year Bachelor students enrolled in the 'Advanced Technology' program. The students independently experienced FF in groups of five, meaning that they had to negotiate each decision made through a group discussion. After the shared experience of FF, the students discussed several reflective questions in their respective groups, for example 'What positive and negative impacts of technology does Future Frictions make you think of?'. The list of reflective questions can be found in Appendix B. Both discussions were audio-recorded with the participants' permission. These recordings provided us insight into how participants experienced FF, how they responded to the choices and consequences presented in FF, and what type of discussion FF stirred. In addition, we organized a follow-up, facilitated conversation with six students. This allowed us to collect more in-depth insights into the type of discussion that FF stirs. These conversations were again audio-recorded with the participants' consent.

5.4.1 Data analysis

The anonymized transcripts of the audio recordings were analyzed using blended coding, meaning a combination of deductive (theory-driven) and inductive (data-driven) coding (Bryman, 2015). For both research goals, we first used deductive coding by creating a coding scheme consisting of descriptions and indicators for each goal (Appendix C). We defined an initial description of ethical deliberation as presented in Section 2.1, and of the three principles we wish to evaluate (ambiguity, plurality, relatability) based on Section 2.3. After reading through the transcripts and familiarizing themselves with the data, the first author formulated additional codes in an inductive manner, by assigning (sub)indicators to the pre-defined themes. For example, we describe the experience of relatability as 'recognizing elements from everyday life in FF'. Based on an initial reading of the text, this experience is further specified by the actions of 'comparing to personal experience' or 'comparing to global examples'. This resulted in a hierarchical coding scheme for both research goals. Additionally, we coded for feedback on the intervention, as the research was part of an ongoing Research-through-Design project. This resulted in the coding scheme as presented in Appendix C, from which we synthesized our findings.

The first author was the primary coder, after creating a coding scheme in consultation with authors two and three. The second author, who attended the sessions and was actively involved in the data

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[15] The final design is available in two versions, that both can be accessed online or applied in the physical installation: 1) Shortened app experience, ~10 min, https://future-frictions-app.apps.utwente.nl/; 2) Extended 3D experience, ~20 min https://future-frictions.apps.utwente.nl/ .

collection, collaboratively discussed, reviewed, and added any additional codes and the overall analysis.

5.5 Findings

Our analysis identified (1) how participants experienced the design principles of ambiguity, plurality, and relatability, and (2) how this ignited ethical deliberation took place.

5.5.1 Experiences of the three principles

Ambiguity

The many questions that were brought up as students jointly experienced FF, such as '*When will pigeons follow humans?*' or '*Do long-term neighbors automatically have a higher score?*', reflected the ambiguity that we incorporated, which required participants to interpret the scenario for themselves. The fictional technologies provided enough information to be clear on their goal, but left room for interpretation of details. Furthermore, ambiguity was reflected in the presented options, which were deliberatively provocative and formulated such that such neither of them were clearly preferable: '*None of them are ideal*' and '*There have to be other options possible*'. Participants often voiced the wish for a fourth option, when noting that '*choices have consequences for everyone, positive as well as negative*', and '*All of our choices make some people feel more convenient or happy, while others feel more burdensome*'. One participant noted that '*you cannot make anything perfect and be able to satisfy everyone*'. This resonates the intention of FF to not decipher the perfect decision, but to help participants become aware of the fact that technology impacts different people in different ways.

Plurality

According to the participants, elements of FF that were based on the plurality principle (such as the diverse citizen perspectives and values) helped them to '*Consider as many different groups of people as possible*' and '*Consider other, alternative perspectives like the painter*'. Moreover, plurality also ignited the release of multiple perspectives among participants, stimulating debate and deliberation amongst them by expressing sometimes conflicting opinions and feelings. This was voiced for example in the following interaction: Participant A: '*[sharing the loneliness data with the] neighborhood would be utopian version*'. Participant B '*to me it's the baddest one; this is the person I don't want to inform. The government is not closely related to you. The neighborhood is too close, they can really make use of your privacy*'. Now the aim of FF is not to come to a consensus on this, but indeed to become aware of these different perspectives, in order to better navigate and address them whilst creating smart city technologies and policies.

Relatability

Participants shared that '*[FF] is realistic on the future, it does make me think about it, it makes me think about the amount of data we collect*' – indicating that the scenarios provided a perceptive bridge between the future and present-day. Furthermore, participants expressed the relatability of the scenarios by indicating connections to, and comparing the scenarios with, their personal experiences, current-day situations, or global examples. For instance, several times comparisons were made to Orwell's 1984, '*Big Brother is watching you*', or China's social credit system, for the choices that related to governmental data collection. For example, whilst negotiating the options related to the waste-sensing pigeons, participants noted: '*Pigeon introduces barrier to public services... wow, isn't that what is happening in China right now, that people who misbehave cannot*

travel by train and such. That is really rude when it would concern healthcare!'. Closer to home, participants saw resemblance in the guardian angel drone and the current situation in the local student bar, where you can real-time check who is there: '*It's like the Vestingbar-Cam, you can check online if there are people in the Vestingbar.'*

5.5.2 Ethical deliberation

The mobilization of the three principles of ambiguity, plurality, and relatability allowed participants to engage in ethical deliberation, which was expressed through: 1) Debating value conflicts, 2) Empathizing with different perspectives, and 3) Coming up with alternative imaginaries.

While engaging with FF, participants identified and debated value conflicts and empathized with different perspectives. This was reciprocal: discussing value conflicts allowed for the recognition of various perspectives, and empathizing with different perspectives facilitated the identification of value conflicts, leading to further debates. This interaction fostered discussions around alternative, often more desirable, imaginaries discussing smart city futures in which technology was used in desirable ways for participants involved with FF.

Debating value conflicts & empathizing with different perspectives

Participants engaged in questions on why certain situations might allow X, whilst other situations don't, and why. For example: It led to discussions on how different technologies with similar forms of data collection and application lead to different decisions, and reflect on the reasons for that. One participant noted that '*I don't know, with drones I'm fine with recording, but with cats… is it sound recording? I don't want it to do that without consent'*. The plural perspectives and urban futures helped them to understand the impact of technology from different viewpoints. This helped the participants to reflect on their own stances, argue and make their decisions in more informed ways: their choices were motivated by '*weighing the gains & losses'* and '*looking at the consequences of the options: how would we ourselves feel in such a situation, what would be the consequences for others, who can abuse it, what could be the positive sides'.*

The third scenario particularly (waste-sensing pigeon) led to debates on control of technology: limiting access to public services was unacceptable to many, although the idea of more strict enforcement on specific waste behaviors seemed appealing and acceptable to many: '*With the way we are going right now, the world really needs more sustainable behavior, it is a really simple thing to do. If you don't do it, you deserve to maybe have some limits. Not to this extent, but some punishment: a fine or something like that. (….) It might not be ideal, but if the healthcare part was not there, it would be okay to implement this'.* Several groups had similar discussions, suggesting an official warning or fine, rather than limited access to health services. This led to debates on where the limit of access to services could be: was it purely health services? What about limiting access to public transport then? What would need to change to make an option with a focus on public control desirable? Finally, participants suggested moving from a penalty to an incentive system, '*so that people who actually participate, get something back - rather than punishing, it is more about rewarding'.* As this summary of the participants' discussion highlights, their conversations explicitly centered on which public values might be affected and need to be safeguarded. While engaging in value debates around value tensions and empathizing with and enabling different perspectives, we observed that participants actively engage with the options and start to imagine improvements, extensions, and alternatives.

Coming up with alternative imaginaries

As participants repeatedly raised, there was no preferable option available in FF. The ambiguity present in FF led to debates on desirability of the options, weighing and negotiating the benefits and costs of each option in order to choose one of the options. However, because no perfect option was present in FF, the ambiguity served as a prompt to discuss alternatives to, and extensions of, the scenarios presented in the experience. Participants naturally engaged in a discussion on what would make an option more desirable or what needed to change in the scenario in order for it to be more acceptable. The elements of relatability and plurality helped shape their discussions, as they for example included comparisons to the real world to strengthen their argument. They related the presented scenarios to past or present global developments, and used this moral imagination when deliberating alternatives or extensions to the presented options. For example, for the second scenario (AI emotional support cat), many groups shared that, at the very least, for any of the options to be acceptable, consent to the data collection, storage, and application is necessary: '*I think it is fine that it is stored, if people consent to it. Just like you can do with donating organs. You shouldn't force it on people. If there is no way to consent to it individually, we should not use it collectively*'. Participants actively imagined alternative options with the introduced technology and started thinking of consequences beyond those portrayed in the intervention. In the scenario of the waste-sensing pigeons for example, participants suggested that '*this will lead to a market for pigeon traps*' and '*it will become a tourist attraction and people will catch those pigeons and take them to other cities, I can really see that happen*'. This indicates that FF actively immerses participants in an alternative future and stimulates them to think from within this context.

5.6 Discussion

In this paper we presented the design and evaluation of a speculative design intervention that helps to make socio-technical controversies more accessible and actionable. FF is an example of how speculative design can operationalize controversies and as such addresses the need to surface ethical concerns and stimulate democratic engagement regarding smart cities. FF shows how socio-technical controversies can become mediators in processes of (democratizing) ethical deliberation. We showed that speculative design can help to illuminate the complex social and ethical issues that underlie sociotechnical controversies. In this section, we will reflect on our RQ: how can speculative design respond to value conflicts in a way that makes controversies accessible and actionable?

5.6.1 Controversies and speculative design

FF is what Luria & Candy (2022) would call a hybrid design/futures intervention, but adds to that a specific connection to debates on democracy, as it is instilled in discussions on controversies, issues, and publics. In line with Luria & Candy (2022), we underlie the potential of speculative design methods to provide a wide audience with opportunities to grapple with potential ethical dilemmas early on, and as such provide them the opportunity to define own issues and matters-of-concern (cf. Latour, 2005). Our contribution is a step towards a more designerly approach of democracy (cf. Ozkaramanli, 2022). FF highlights the politics existing in smart cities, moving away from homogenous perspectives around technological impacts and sparking a public into being.

FF helps to make abstract topics such as value conflicts more experiential and accessible by presenting them in the recognizable context of a neighborhood narrative. As a result, FF functions as a boundary object through which researchers, citizens, and other stakeholders can come together to discuss complex socio-technical challenges. We see FF as a Latourian 'thing' through which tensions

around smart city technology can be explored, made explicit, and negotiated (Binder et al., 2015). Our intervention supports the practice of *projecting* to support the creation of publics (cf. DiSalvo, 2009), meaning that we make the conditions and consequences of an issue apparent and known, such that a public may form. According to Lehoux et al. (2020), public's 'struggle to visualize' the tangible effects of emerging technology, hinders publics to form around an issue. FF's digital interface responds to this challenge, by making the abstract dimensions of a controversy tangible and experiential, thereby supporting 'visibilising' desirable smart city futures (e.g. Matos-Castaño et al., 2020). Visibilising, in Latourian terms, entails 'making things public' by revealing and stimulating multiple perspectives to be expressed (Latour, 2005).

5.6.2 Mobilizing ambiguity, plurality, and relatability principles

This research contributes to the current speculative design discourse by identifying and implementing three principles to guide a speculative design project to stimulate ethical deliberation. The mobilization of constructive ambiguity, plural perspectives, and a relatable urban experience, is a distinct feature of FF, that enables participants to identify, navigate and prioritize conflicting values. *Ambiguity* through fictional yet plausible technologies that rendered both positive and negative societal consequences, required participants to make sense of the presented scenarios and enabled them to identify and formulate their own issues and concerns. *Plurality* was included through multiple neighbor perspectives, and enabled participants to empathically relate to multiple experiences of the same scenario. As such, plurality triggers participants to share their own, sometimes conflicting, perspectives. *Relatability* was included by providing the urban context of a neighborhood, by situating the narrative in everyday conversations that regard for example teenagers, and by fictional technologies that balance science fact and science fiction. This allowed participants to recognize and empathize with the presented scenarios. Moreover, it helped to recontextualize abstract controversies in recognizable settings, move beyond mere utopian and dystopian depictions of the urban future, and bring the scenario closer to our everyday experiences that are filled with nuance.

Together, these three principles create the setting for audiences to empathize and engage with value conflicts, stimulate their imagination beyond externally formulated urban visions and formulate their own questions, issues, and matters-of-concern. The deliberately ambiguous context encouraged participants to discuss and reflect upon the value conflicts that were represented, how they themselves would prioritize certain values and why. Through this process, they engaged in ethical deliberation as they started to share viewpoints on real-life examples, and related this back to smart city futures. Too often, citizen deliberations focus on decisions already made and issues already picked out (Engelbert, 2019; Nesti & Graziano, 2020). This refrains publics from the opportunity to define their own issues and engage on topics they identify as matters-of-concern. Through a series of interactive experiences of speculative urban futures, FF brings to the surface social interactions and value conflicts that smart city technology may trigger. FF widens the current technology-driven smart city discourse to include the everyday urban experience, which is often missing in smart city scenarios (Vanolo, 2016). It challenges singular visions of techno-oriented urban futures by an explicit focus on plurality, and moves beyond normative and prescriptive images of urban futures by embedding ambiguity in the scenarios. As such, FF does not steer participants to gather around externally formulated futures or issues, but rather engages around multiple futures in order to let participants define their own issues.

Moreover, these three principles help counter common speculative design critique in our intervention. Oftentimes, speculative design takes the shape of polished artefacts, presented in gallery-like settings. As such, it is perceived as elitist and distant from the realities of a wider audience (Forlano and Matthew, 2014; Kozubaev et al., 2020), centralizing the experience of the designer and not following the critical and democratic ideals that initiated the field (e.g. Gerber, 2018; Wong, 2018; Light, 2021). Additionally, speculative design is known for carrying a political flare and sparking provocation, yet those qualities can backfire in their aim to engage audiences, when they become too radical or too politically pronounced. FF counters both these critiques. By emphasizing relatability through the everyday setting of the neighborhood, including recognizable urban elements and neighbor perspectives, we bring speculations about urban futures closer to people's everyday experience and move away from the elitist-critique to create a more inclusive design. Moreover, we deliberately use a collage aesthetic, rather than a sleek and polished design, to make the intervention more inviting and less daunting to participate. Next, plurality allows us to explicitly incorporate multiple perspectives, different than our own. Through a co-creation process, we formulated diverse values, personas, and experiences. This helped us to de-centralize the designer's view, and explicitly include different voices and views, thereby contributing to the 'participatory turn' in speculative design (Farias et al., 2022). Lastly, it can be hard to hide your politics and assumptions as designers. Although we aim to repoliticize the smart city debate with FF, we have refrained from expressing explicit political preference, by inserting *ambiguity* in the intervention, and by not allowing for any preferred situation to exist in the experience. It is here that we also see the critical potential for ethical deliberation: by not presenting any preferred outcome, the experience automatically raises the question 'What then?', and puts the responsibility of answering this with the participants.

5.6.3 Transdisciplinary contribution

Our work illustrates the benefits of speculative design for democratic debate on technology, and offers an avenue to expand current RRI and TA approaches. Scholars from various disciplinary backgrounds are searching for more effective means to engage and empower citizens to actively participate in the conversation on our technological futures (e.g. Gaziulusoy, 2021; Steen et al., 2021). Genus & Stirling (2018, 67) share our urge to develop "more concrete and assertive frameworks for enabling practice of critical citizen engagement and participatory deliberation". We argue that design methods can act as mediators that connect people and issues of concern because of their experiential qualities. For example, scenario-based approaches are frequently applied to anticipate and explore potential future impacts of technology, and resonate with many related disciplinary fields, ranging from product design to moral imagination to anticipatory governance and technology assessment (e.g. Dorrestijn et al., 2014; Boenink et al., 2010; Lehoux et al., 2020). However, as Lehoux et al. (2020) notice, such scenarios are often presented at a high level of abstraction, and often ignore the daily experiences of humans living and interacting with technology.

Although recognizing that the public, or 'non-experts' and 'lay-persons', can bring in valuable experiential knowledge, Boenink et al. (2018) argue that they lack the in their scope of imagination of the future. This is exactly where we recognize a pressing need for interdisciplinary collaboration and the introduction of design methods to the democratic debate and ethical evaluation of (smart city) technology. Firstly, design refrains from using the terms 'non-experts' and 'lay-persons', as it recognizes the public, in our case citizens, as experts of their own experience (of the city, in our case), and approaches them as such. This means: meeting them within their comfort zone and

knowledge space, rather than within that of the researcher. This entails as well that specific spaces should be considered and created for the public to release and extend their scope of imagination, and become conversant with futures-in-the-making (Light, 2021), rather than suggesting their imagination does not suffice. Furthermore, speculative design sees 'everydayness' as a core quality to make futures relatable (*Candy 2010, Kuzmanovic & Gaffney, 2017,* Gaziulusoy, 2021*) and thus accessible for a wider audience to actively engage with*. It situates speculation in a way that makes it open and available for negotiation. As an interactive, immersive intervention, FF extends the typical text-based, descriptive approaches to scenarios for public engagement, and provides a combination of aesthetic and conceptual qualities that can help people to engage with typically abstract value conflicts. Our experience with FF shows the value of material and embodied engagement that speculative design offers, in order to involve a wider audience with socio-technical controversies. It also illustrates the potential of expanding disciplinary approaches and generates interdisciplinary methodological insights on the use of speculative design for ethical deliberation and public engagement, thereby presenting new ways to include publics in the discussion on smart city futures.

5.6.4 Limitations

Although FF shows the power of speculative design to make abstract ethical issues that are present in controversies more accessible and debatable to a wider variety of stakeholders, we acknowledge that FF mainly brings together participants who are already interested in such topics and willing to jointly debate controversies. To actually challenge and change current practices, we need to reach the 'unusual suspects' and find ways how interactive experiences such as FF and the debates they trigger, can influence decision-making. As the co-creation phase of FF largely coincided with the Covid pandemic and therefor closing of public space, we were limited to digital interactions which made it more challenging to reach citizens (e.g. Kishimoto & Kobori, 2021), and therefore led to a lesser degree of citizen involvement than desired. However, to create stronger foundations with regard to inclusive design and co-creation, and adhere to the rationale of bringing speculation out of the ivory tower, next iterations of the scenarios are currently being developed in more close collaboration with civil society. Furthermore, our research did not regard the organizational or procedural side of public ethical deliberation, but brings attention to how speculative design can be leveraged to make abstract ethical debates more experiential and stimulate the forming of publics around self-identified issues. We see this latter as a key prerequisite to democratize smart city processes and underline the importance of the process by itself, but equally underline the importance that the outputs of such processes are incorporated or institutionalized into the democratic process.

Future research

Responding to the often shared response of participants that a fourth 'choice' was missing, we are currently working on ways to allow participants to formulate and visualize such an additional option themselves within the FF environment. This will add another layer of interactivity, and nudge participants even more to reflect, imagine and negotiate on what they would find desirable and which values to prioritize when it comes to smart city technologies. Additionally, we see the mindset and method behind FF as a promising avenue to be applied in other socio-technical contexts than the current smart city context. The rationale behind FF (making controversies more accessible and actionable) and the three design principles (ambiguity, plurality, and relatability) could be applied to various socio-technical challenges that include multiple stakeholders, complex issues, and value conflicts, such as climate change, genetic engineering or the ubiquitous application of AI. The

abundance of socio-technical challenges not only requires actions, but more so, an alternative imagination of what the future could be.

5.7 Conclusion

This paper presented the design and evaluation of FF as a controversy-fueled speculative design intervention to elicit reflections on the value conflicts that arise with the implementation of smart city technology. FF makes socio-technical controversies more accessible and actionable by engaging participants around otherwise abstract and intangible issues of datafication and ethics in the smart city. By formulating, applying, and evaluating the principles of ambiguity, plurality, and relatability, we offer methodological insights into the way speculative design can help operationalize controversies and stimulate ethical deliberation, in order to provide more responsible and democratic ways to develop smart city technology. This research provides an instructive example of using speculative design to stimulate ethical deliberation amongst diverse publics, and serves as an invitation for more transdisciplinary research that includes the power of design in complex socio-technical challenges.

Appendix A: Iterations & Improvements

Fall 2020 – Spring 2021
Prototype development

The idea conception, formulation of scenarios and coding the 3D-environment took place in co-creation with DIG, Creative Coding Utrecht and Katpatat.
The prototype consisted of a singular scenario and a first design of the digital environment.

June 2021 – User test 1

The first user test took place during the Media Architecture Bienale. We tested if the set-up had the intended effect, and learned that the joint experience of scenario and digital environment led to interesting individual reflections and collective deliberations. However, the interface needed to improve to ensure ease of interaction with the digital environment.

Oct 2021 – User test 2

The second user test took place during the Dutch Design Week. The new protype consisted of 3 scenarios with in total 3 speculative technologies and 9 interacting neighbours. We learned that the time needed to navigate the digital environment and experience the intervention on full, led to a lesser degree of engagement. Therefor, we decided to create two versions of the experience: the full immersive version which allows you to nagivate the digital environment, or a shorter version which directly presents the choices to be made and neighbors' responses, without any need to find these in the digital environment.

May 2021 – Jan 2022 – User test 3

During the online meetings with the consortium project, we evaluated the user-experience of the intervention. Through screen-sharing, we could observe how users navigate the online environment and evaluate which elements were unclear and needed refinement. We learned that the participants' assignment needed a clarification and reformulation, and made the full experience bi-lingual by making it available in both English as Dutch.

Nov 2021 – May 2022 – User test 4

Through various engagements with students during lectures, we tested both the short and long version of the intervention, which allowed us to learn the conditions in which either of both formats of the intervention flourish. To stimulate more deliberation, we updated the final dashboard to accommodate the sharing of longer reflections.

June 2022 – Final evaluation

The final evaluation took place with 50 BSc students enrolled in the 'Advanced Technology' program. In groups of 5, students navigated FF and collectively reflected on the experience. We evaluated how the guiding design principles of Ambiguity, Plurality and Relatability were experienced, and how they influed the the goal of ethical deliberation and formation of issue-publics.

Figure A1. Summary of Research-through-Design process.

Appendix B: Reflective questions to guide independent group discussion

Work in groups and discuss the following questions:

1. While experiencing FF (≈ 25min)

> What motivated your choices in each of the scenarios?

> How do your choices shape futures in FF and with what implications?

> What positive and negative impacts of technology does FF make you think of? Please elaborate.

> Which neighbor's perspective surprised you most and why?

> What (public) values did FF make you think of? *(examples of (public)values are: autonomy, care, community, convenience, privacy, transparency, safety, serendipity, and more.)*

> What kinds of controversies do you perceive in FF?

2. In relation to your STF project (≈ 15min)

> How are the perspectives and questions raised in FF relevant in your own city or own course project?

> What are the lessons from experiencing FF that you would like to bring to your own project and why?

> For your project, which perspective(s) does FF make you think about that you did not consider before and why?

> What do you expect to be a possible controversy in your project?

Appendix C: Coding scheme

Table A1. Coding scheme

Theme	Description	Indicators	Sub-indicators
Ambiguity	Interpreting and making sense of the presented scenarios	Making assumptions about the capability of speculative technologies Making assumption about the extent of implementation options	n/a
Plurality	Acknowledging the plural perspectives and values	Recognizing the diverse neighbor perspectives Recognizing the diverse values portrayed by the technology options	n/a
Relatability	Recognizing elements from everyday life in FF	Comparing to personal experience Comparing to global examples	n/a
Ethical deliberation	Recognizing and negotiating ethical concerns and (conflicting) values in context, whilst empathizing with diverse viewpoints and weighing alternative imaginaries for future situations.	Mobilizing alternative imaginaries Highlighting (conflicting) value in context	Suggesting alternative consequences beyond the presented ones Proposing alternative options beyond the presented ones Expressing thoughts on desirability of options Weighing value trade-offs
Evaluation of tool	Sharing feedback on experience of FF	Feedback on interface design Feedback on staging the intervention	n/a

PART C
Design research and transdisciplinary collaboration

Part A theorized the threefold potential of potential of socio-technical controversies to enrich civic engagement, ethical deliberation and alternative imaginaries on the introduction of technology in cities. Additionally, it provided an analytical understanding of controversies by revealing the multi-dimensional nature of value conflicts that shape a controversy.

Part B presented two different design interventions, the Network of Conflicts and Future Frictions, to operationalize controversies. It demonstrated the value of making value conflicts explicit, visible and experiential through means of design.

Part C brings us to the reflective part of this thesis, and consists of reflections on two different levels: reflections on the central position of design in this transdisciplinary research and the challenges involved with that, and reflections on the contributions and limitations of the work presented in this dissertation.

Throughout this transdisciplinary research, design takes a central position. **Chapter 6** challenges and deepens this positioning in order to better clarify the contribution of design. Insights from literature, enhanced with reflections on the interventions of Chapters 3 (Network-of-Conflicts workshop) and 4 (Future Friction experience), allowed us to formulate five roles for design in transdisciplinary collaborations: (1) generator; (2) communicator; (3) facilitator; (4) mediator and (5) provocateur. We argue that the latter two roles, are the most recent and the most suitable roles in transdisciplinary settings, yet also the most challenging.

Chapter 7 is the general discussion of the dissertation, thus evaluating and reflecting on the research insights in full, connecting and integrating the various elements and learnings of this thesis. It provides reflections on the main contributions as well as some limitations of the work presented in this thesis. Overall it reflects on the fact that the combination of controversy-thinking and design approaches provides a valuable approach for rethinking democratic debate and ethical deliberation in the smart city, and delivers an innovative point of departure where new ideas on democracy could emerge from.

'And yet I have constructed in my mind a model of a city from which all possible cities can be deduced, Kublai said. It contains everything corresponding to the norm. Since the cites that exist diverse in varying degree from the norm, I need only foresee the exceptions to the norm and calculate the most probably combinations.

I have also thought of a model city from which I deduce all the others, Marco answered. It is a city made only of exceptions, exclusions, incongruities, contradictions. If such a city is the most improbable, by reducing the number of abnormal elements, we increase the probability that the city really exists. So I have only to subtract exceptions from my model, and in whatever direction I proceed, I will arrive at one of the cities which, always as an exception, exists. But I cannot force my operation beyond a certain limit: I would achieve cities too probable to be real.'

Italo Calvino - Invisible cities

Chapter 6

Positioning Design in Transdisciplinary Collaborations

Abstract

This chapter sets out to explore and explicate the contribution and positioning of design research in transdisciplinary collaborations. Design is increasingly positioned as a promising way of working in complex, multi-stakeholder collaboration – as is also true for the research presented in this thesis. In this chapter, we want to deepen and challenge this positioning in order to better clarify the contribution of design. Building on literature and experiences from the research project, we conceptualize five preliminary roles that design adopts in collaborative settings: (1) generator; (2) communicator; (3) facilitator; (4) mediator and (5) provocateur. We argue that the latter two roles, namely the mediator and provocateur, are the most recent and the most suitable roles in transdisciplinary settings. To fully encompass these new roles, however, design must keep evolving itself and ground its practices with more sensitivity to the ethics and politics of technology. We argue that deepening and expanding these roles will eventually strengthen the position of design when addressing socio-technical challenges, and reflect how this continuous evolution of design can be sustained.

Some adaptations have been made to include and align the published work in the dissertation, and to keep and to keep terminology consistent with the rest of the thesis (i.e. 'controversy workshop' to 'Network of Conflicts workshop'). Subsections 3, 4 and 5 are extended to include reflections on Future Frictions as an intervention.

6.1 Introduction

Design is a growing and continuously evolving field of practice and research. Over the last decades, we have seen design research activities move into new fields and topics, most prominently and often critiqued is Design Thinking entering management and innovation sciences (Kimbell, 2011). Another recent shift is that of design approaches such as systemic design (van der Bijl-Brouwer & Malcolm, 2020) to address societal challenges through transdisciplinary collaborations. Major societal challenges such as climate change, growing inequalities, and digitalization, require collaboration between academic and societal stakeholders in order to encompass and address the complexity of these challenges (Tejedor et al., 2017). The promise of transdisciplinary collaboration is to bring together academic and situated knowledge to create interventions through benefitting from multiple perspectives (Lang et al., 2012).

Design is often positioned as a promising way of working for bringing multiple disciplines and stakeholders together. However, it is not always clear how it does this. In this paper, we want to deepen and challenge this positioning in order to clarify the contribution of design to transdisciplinary settings. We wonder: how can and should design position itself? Is design 'the solution in itself' (cf. Dorst, 2019) or is its contribution more nuanced and humble than often claimed?

To build our argument, we zoom in on the promise of design to enhance transdisciplinary collaboration in the context of socio-technical challenges: where technological advances and societal transitions intertwine. Design is most well-known for its generative capacities, resulting in its ability to create aesthetic products and smooth services. However, in the last years, we see a stronger interest in the societal, political and ethical implications of design. Approaches such as speculative design (Dunny & Raby, 2013), adversarial design (DiSalvo, 2012) and value-sensitive design (Friedman et al., 2013; 2019) highlight these developments. These approaches use design as a medium to explore the societal and political implications of new technologies, and offer forms of materialized critique and provocation. Such critically-oriented design approaches allow for design to take on new roles with increased political and ethical sensitivity. Moreover, these approaches connect strongly to insights from Science and Technology Studies, Philosophy of Technology and Political Theory and reflect on design's role in public debate. For example, the work of DiSalvo (2010, 2012, 2022) relates to Mouffe's theory of agonistic pluralism (1999). The concept of agonism runs counter to tacit consensus, highlighting inherent disagreements and confrontations that may lead to productive deliberations, resistance or contestation. The growing attention towards the opportunity of design to support public contestation and provocation is highlighted by a recent special issue of the journal Design Issues (Hansson et al., 2018). In our work, we aim to provide more attention to understanding these new and different roles of design, specifically in a transdisciplinary context.

The main contribution of this paper is twofold: firstly, it generates insights into the position of design in transdisciplinary collaborations by proposing a preliminary typology of five roles that design can take in such collaborations, thereby aiming to clarify design's contribution and strengthening its positioning and possibilities for future research. Secondly, we argue that, to fully encompass the new roles that design takes in transdisciplinary settings, the discipline needs to keep evolving and better ground its practices with more sensitivity to the ethics and politics of technology, when it moves towards addressing socio-technical challenges.

This article is structured as follows. We first briefly visit the evolution of design as a discipline, and link its progress to core activities and 'requirements' posed by transdisciplinary collaborations. This helps argue why design and transdisciplinary collaboration seem complementary and compatible in practice. Second, we introduce an ongoing consortium-type research project and two design interventions in the context of smart cities, from which the presented work emerged. We then propose five preliminary roles design can take in collaborative settings, which we formulated based on experiences in this research project, and building on previous literature (e.g. van der Voort et al., 2016, Hansson et al., 2018). We finish with a reflection on how these roles are related and build on each other. Finally, we offer suggestions on how to sustain the evolution within design so that it can better position itself in transdisciplinary projects.

6.2 Design and Transdisciplinary Collaboration

Design is evolving and expanding its scope to address the complexity apparent in societal issues, and is often positioned as a promising way of working for bringing multiple disciplines and stakeholders together. Initially, the discipline's focus was on creating a specific product and/or service for a specific audience, with the designer as the central figure that carried creativity and followed all steps of the design process. Although this initial product focus still exists, and is the core of many design schools and studios, we have seen a significant shift from product to process (or service)-oriented design. This shift entails a changing object of design, from tangible products to non-tangible outputs like interactions, experiences, and most recently, services (Kimbell, 2009; Bürdek, 2005). Another significant shift is seen in the subject of design: the designer as central figure made room for greater involvement of end-users in the design process, recognizing them as experts in experiential knowledge (Sanders & Stappers, 2008). This evolved in parallel to, and with great inspiration from, the Scandinavian design tradition (e.g. Ehn et al., 2014) into participatory and co-design, where end-users, citizens and laymen, who were previously regarded as non-experts, are now recognized as experts in their own regard and are involved in the design process from start to end (Cooley, 2000; Sanders & Stappers, 2008). Where the aforementioned approaches still require a trained designer, the launch of several toolkits, such as the famous IDEO toolkit or convivial toolbox (Sanders & Stappers, 2012), made design knowledge and methods accessible to the non-designers. Throughout these developments, we also recognize an evolution in the context in which design is applied. Advancing from being highly driven by technological and economic forces, design is increasingly taking into consideration cultural, socio-political, environmental and ethical issues that preoccupy modern society (e.g. Leblanc, 2007, Mok & Hyysalo, 2018).

Meanwhile, the increasing complexity of scientific and societal challenges has led to a growing number of inter- and transdisciplinary collaborations. Topics like climate change, global migration or digitization – also characterized as 'wicked problems' (Buchanan, 1992) – span a wide range of scientific disciplines, professional domains and cultural contexts, which requires an holistic approach to adequately deal with the complexity and multi-dimensionality at hand. Transdisciplinary collaboration aims to be such an holistic approach. Lang et al. defined transdisciplinary as "is a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge" (Lang et al., 2012, p 26). In this definition, core elements of transdisciplinary collaboration are the focus on societal challenges and

the inclusion of various non-academic actors in scientific endeavours, such as government, industry and civil society – also known as quadruple helix collaboration (Arnkil, 2010).

We recognize why design is positioned as a promising companion in transdisciplinary collaboration. The complex, open-ended, ambiguous and networked nature of societal challenges invites space for design and its creative impetus to bring in its expertise in empathizing with multiple disciplinary paradigms and stakeholder perspectives (Buchanan, 1992; Dorst, 2015; Meija et al., 2018). Moreover, the complexity present in societal challenges requires tolerance for ambiguity, solution-driven mindsets and comfort in framing and reframing of the problem, all core qualities of design (Dorst, 2015, Meija et al, 2018).

An example of a societal, or rather a socio-technical challenge that could benefit from transdisciplinary collaboration and design insights, is the case of smart cities. Smart city visions have gained foothold over the last years, promising to improve urban services and increase quality of living through ICTs and supporting infrastructures (e.g. sensors, IoT) (Hollands, 2008). Such smart cities however render complex interactions between technology and urban life, with different concerns for government, private (tech) sector and citizens. Navigating the diverse needs, values and perspectives that all stakeholders bring in, whilst taking into account the context of smart technology and urban life, is a challenge fit for transdisciplinary collaboration.

6.3 The case of Smart City Controversies

The analysis presented in this paper follows from our ongoing research activities in NWO-funded project 'Designing for Controversies in Responsible Smart Cities'. This project aims to contribute to more responsible smart city practices and is a collaboration between two universities and five non-academic project partners. The consortium is a mix between governmental and industrial parties. The main goal of this project is to empower stakeholders with new, research-based design methods and tools for multi-stakeholder collaboration, when engaging with the complex socio-technical challenges, whilst gaining more insights into the ethical and political consequences of emerging smart city technologies. In other words, the project proposes a *design approach* as a source of mediation in the inherently transdisciplinary context of the quadruple helix stakeholders (Arnkil et al., 2010).

6.3.1 The concept of controversies

The contested nature of smart cities (i.e. top-down nature, technocratic nature, simplified understanding of cities and city life, and lacking attention for citizens, politics and ethics (e.g Greenfield 2013; Hollands, 2008; De Lange and De Waal 2013) leads them to be a breeding ground for *socio-technical controversies*. In this project, we define controversies as public disputes that find their origin in the complex entanglement of the social and the technical realm (Callon et al, 2009). Controversies arise in complex socio-technical contexts that involve multiple stakeholders and societal issues that are too important to be ignored – it is where perspectives clash and value tensions emerge (Venturini, 2010). Although often perceived as a source of impasse, controversies help to reflect on technical, social and ethical aspects of socio-technical challenges.

In our project, we take controversies as a starting point to envision responsible smart city futures, encourage ethical deliberation and stimulate civic engagement (Geenen et al., 2023). As part of this project, we developed several design interventions that centralize controversies and the value

conflicts they are made up of (Matos Castaño et al., 2022). To reflect on the role of design in transdisciplinary collaborations, we focus on two approaches in particular: the Network of Conflicts workshop and Future Frictions. We have implemented both approaches in multiple workshops with practitioners, students and project partners. In this paper we will not focus on the outcomes of these interventions, but rather on the role of design (as a discipline and practice) in these approaches, and the opportunities and challenges we encountered as design researchers.

6.3.2 Exploring smart city controversies – Network of Conflicts workshop

The Network of Conflicts workshop is an approach that unpacks, maps, and navigates the 'Network of Conflicts' that makes up controversies to facilitate dialogue among quadruple helix stakeholders (Geenen et al., 2021). We have embedded this approach in a workshop protocol that draws from scenario-based design (e.g. Anggreeni & van der Voort, 2007), dilemma-driven design (Ozkaramanli et al., 2016; Matos Castaño et al., 2017) and systemic design (e.g. van der Bijl-Brouwer & Malcolm, 2020). The core assumption in this workshop approach is to understand controversies as networks of four levels of conflicts (Matos Castaño et al., 2020): (1) inter-stakeholder conflicts (between stakeholder groups), (2) intra-stakeholder conflicts (within stakeholder groups), (3) personal dilemmas (within individuals), and (4) interdependencies among these conflicts and dilemmas that make up the full network.

To situate our approach in the smart city context, we formulated a scenario called 'The Scripted City and Social Bubbles', accompanied by five hypothetical stakeholder narratives (civil servant, data analyst, journalist, tourist and tech worker) (see Figure 6.1). This scenario describes a short narrative about the fictional city of Nevertire in 2030, where the municipality plans to collaborate with several tech companies to make urban processes more data-driven and to provide tailored city experiences to citizens. Through a roleplaying exercise using the five stakeholder narratives, we explore the impact of smart city projects in Nevertire.

Figure 6.1. The Nevertire scenario and five accompanying personas.

More specifically, our workshop approach consists of two parts, executed in two, half-day workshop-style sessions:

Forming a Network of Conflicts

In the first part, participants familiarize themselves with Nevertire and the stakeholder roles. Since the stakeholder narratives are deliberately ambiguous, the roles are open to interpretation, allowing participants to truly embrace these roles. By adopting these roles, participants generate insights into

the individual dilemmas, inter- and intra-stakeholder conflicts. This deeper understanding of the relationships within and among relevant stakeholders allows them to create the Network of Conflicts (Figure 6.2) and thereby deconstruct the existing controversy into its building blocks. The resulting network demonstrates the nuanced and complex nature of controversies, while making individual values and perspectives traceable.
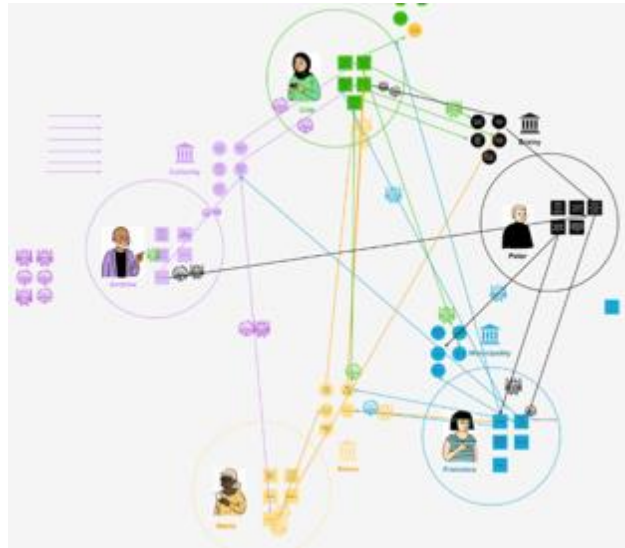

Figure 6.2. The Network of Conflicts that resulted from first part of the workshop approach.

Zooming in-and-out on the Network of Conflicts

In the second part, participants collaboratively reflect on how they can use the Network of Conflicts to come up with creative interventions. To this end, participants are first encouraged to zoom in on a specific conflict and to create an intervention to address this specific conflict. Next, they zoom out by positioning their ideas for an intervention in the Network of Conflicts to uncover whether and how this intervention influences other values and/or perpetuates other conflicts in the larger system. Finally, participants are asked to iterate and redesign their intervention. In this way, our approach allows participants to utilize the creative potential of each conflict while also benefiting from the complexity of the larger Network of Conflicts in ethical deliberation.

6.3.3 Exploring smart city controversies – Future Frictions

The second approach developed to explore smart city controversies and their potential to foster ethical deliberation, is Future Frictions. Future Frictions is a virtual, game-like experience, that builds on ideas of speculative design (Forlano and Matthew 2014; Dunne & Raby, 2013), and scenario-based (design) approaches (e.g. Anggreeni & van der Voort, 2007; Boenink et al., 2010; Lehoux et al., 2020). We again understand controversies as multi-dimensional, multi-stakeholder value-conflicts. But rather than unpacking a specific controversy, this approach 1) unravels the multi-dimensional nature of controversies by presenting various value conflicts and expressions through the eyes of citizens, and 2) lets participants explore and formulate their own issues, based on experiences in the game. Future Frictions can be experienced as a standalone intervention, without intervention by the design/research team, but it can also be embedded in a workshop or discussion setting as a conversation starter or focused intervention.

Experiencing Future Frictions

When playing Future Frictions, participants enter a digital, 3D urban neighbourhood, modelled after

the Dutch city of Amersfoort. They are presented with a quest to explore the neighbourhood and decide how smart city technology will be implemented in it. In a series of three scenarios, participants interact with nine neighbours in total, and encounter three fictional smart city technologies (Figure 6.3). We have purposefully chosen a diverse mix of perspectives to situate the smart city developments in actual urban roles, such as for example a teenage girl, tourist and street artist, amongst others. Each of the smart technologies is accompanied by an explanation of what it entails, and three options regarding the data collection, storage and application of the this technology. Each of these three options exposes potential tensions around commercial, community, and government control of the data. Participants need to decide how these smart technologies should be implemented. The outcomes of this decision are then experienced through observing changes in the environment, and listening to what some of the residents have to say about the effects of the technology on their daily lives.

Figure 6.3. Snapshots from Future Frictions. Left: the urban environment in Future Frictions and interactions with the neighbours. Right: An example of a speculative technology and the options for implementation.

While the three implementation options may initially appear as straightforward, the visualized impact on the neighbourhood (e.g. social protests, an increase of police, banners and signs) as well as narrated impact through the neighbours' perspectives, intentionally introduce ambiguity, inviting the participants to give their own meaning to the situation at hand. Through this, we aim to create opportunity for ethical deliberation, and introduce more nuance and depth in discussions about the benefits and challenges of smart city technology, without being prescriptive. Eventually, participants are prompted to write a postcard from the future neighbourhood, to stimulate reflection on the explored value conflicts and the overall experience of Future Frictions (Figure 6.4).

Figure 6.4. The invitation for reflection in the Future Frictions environment.

6.4 The five roles of design

Inspired by Sanders & Stappers' (2008) analysis of design's evolution and the growing role of co-creation design praxis, and building forward on a prior DRS conversation led by one of our co-authors (van der Voort et al., 2016), we noticed various distinct roles that design has played in our research activities related to controversies. In this section, we present a preliminary typology that identifies five roles: (1) generator; (2) communicator; (3) facilitator; (4) mediator and (5) provocateur. We argue that this preliminary typology is mostly discursive, as the roles cannot be strictly separated or siloed. There is a natural exchange between the roles as they build on each other, with potential overlaps, similarities and differences between them. At the same time, this preliminary typology helps to be more explicit about the contribution of design in transdisciplinary collaboration, allowing for a stronger positioning, and possibilities for future research. In the following, we define and exemplify each role, by first presenting the characteristics of each role, followed by indicating how we recognized them in both the Network of Conflicts workshop and Future Frictions.

6.4.1 Generator

Perhaps the most traditional role of design is that of the generator: being able to generate new ideas, imagine alternative future situations and create innovative products, services or interactions that did not exist before. Building on Simon (1988), design as the generator is concerned with constructing the artificial – either in tangible or intangible formats. As Cross puts it: "the central concern of Design is 'the conception and realization of new things'" (1982, p 221). More than thinking, analysing and modelling *before* making, design as the generator is about learning through making, failing and remaking.

Design as generator was most noticeable in our project when creating the scenarios, stakeholder narratives, and workshop activities as tools to structure the Network of Conflicts workshop. Creating comprehensive, grounded, nuanced, yet compact and actionable tools that could do justice to the complexity of smart city controversies was an inspiring design challenge. To tackle this, we required at least a basic understanding of the smart city discourse. In addition, the workshop activities evolved and improved through several iterations of repeating the workshop in educational and professional venues.

The idea to create a experiential, game-like, digital tool where smart city controversies could be explored, experienced and reflected upon through speculative and alternative urban futures, was where design presented itself in its generator role. Similar to the Network of Conflicts workshop, the creation of Future Frictions required grounded, nuanced, yet compact and actionable scenarios and stakeholder narratives, as well as knowledge of the smart city discourse, in order to do justice to the complexity of smart city controversies. The creation of the Future Frictions storyline and digital environment was an iterative exercise, where new elements, narrative layers and stakeholder perspectives were generated as the digital tool progressed.

6.4.2 Communicator

Because of its capacity to envision and create, design finds itself often in the role of a communicator. By employing visual communication principles, design is able to make abstract concrete, and create a shared form of communication that does not involve professional jargon or disciplinary paradigms. We recognize two layers in this role: outbound and inbound. When design takes the role of an outbound communicator, it uses visual skills (e.g. graphic design) to disperse information that is

often related to post-project communication and promotion (Barnard, 2013; Agrawala, Li & Berthouzos, 2011). Design as the inbound communicator focuses less on promotion and more on smoothening collaboration through translation of perspectives and knowledge into a visual or tangible form of common language (vs. textual format). Tangible artefacts, mock-ups and prototypes support collaboration spanning disciplinary boundaries, as they embody, integrate, create and transfer knowledge (Mason, 2015; Lim, Stolterman, and Tenenberg, 2008, Müller & Thoring, 2011). Design thus serves the role of communicator to facilitate interaction and shape the possibilities for interaction (Aakhus, 2007). This is where we recognize the transition to the following role of facilitator.

The communicator role of design can be recognized in multiple ways in the Network of Conflict workshop. Firstly, the textual scenarios were supported by adequate visualizations: recognizable and returning personas help to build the scenario and stimulate the roleplay exercise (referring back to Figure 6.1 for an example). Secondly, the use of Mural.co as an interaction platform with sticky notes and visualization opportunities, to support the interaction in an online setting. Thirdly, and perhaps most importantly, creating a visual Network of Conflicts helps visualize and better understand complexity. Several iterations were needed to create the appropriate tools to help create network: using different colours and different shapes of sticky notes to indicate separate elements that jointly build up the complex network (see Figure 6.2).

To create the experiential setting we envisioned, design as communicator was very important, as we needed a combination of audio-visual and interactive elements to deliver the experience. The communicative value of design was then present in multiple ways throughout the creation of FF. Firstly, the use of Unity as the appropriate software to express our ideas and create a 3D urban environment. Secondly, the shaping of that urban environment through a collage containing visual representations of various elements to create a neighbourhood. For example a public square, trees, neighbours, and specifically for the context of Future Frictions, speculative smart city technologies. On top of that, the placement of these elements within the urban landscape mattered. To allow participants to really experience this neighbourhood, interactive elements needed to be placed in different parts on the map, so that it would require participants to walk around, explore and learn. Similar again to the Network of Conflicts workshop, recognizable and returning stakeholders helped to build the full scenario. Thirdly, the translation of certain stakeholder perspectives into recognizable yet inclusive visual representation, and the use of graphic skills in order to make collage images more attractive and inviting. Lastly, the visual elements of change that were introduced after a participants makes a decision regarding a smart city technology. This decision not only affects the neighbours narratives, but also their visual representation as well the neighbourhood itself, by adding certain elements such as police, protests or signs (see an example in Figure 6.5). This visual representation of the effects of their decision helped to communicate the potential impact of smart city technology. All in all, design as communicator played a great role in making Future Frictions experiential, from the placement of elements to the movement through the urban square and the visual cues of changes in the neighbourhood.

Figure 6.5. Example of visual changes in Future Frictions. Protests appear on the general square, as a visual representation of the impact of the decisions made regarding the presented speculative technology.

6.4.3 Facilitator

As different stakeholders enter design processes, the need to guide them in these processes has increased (Sanders & Stappers, 2008). *Design as facilitator* is concerned with designing participatory tools and techniques to equip participants with appropriate tools to express their experiences, expertise and to share knowledge. Another important element of the facilitator role is the structuring of these tools and techniques in such a way that it stimulates engagement and enables creativity and social learning. The order in which certain activities and tools are being set up affect communication, collaboration and performance in multi-stakeholder projects (Chiu, 2002).

Design as facilitator was a core part of the Network of Conflicts workshop. Design skills were needed to create a logical process flow, with warm-up and debriefing exercises, shared time between individual and collective thinking and debate. For this, we developed new tools and techniques as well as adopting and adapting existing tools and techniques from literature (eg. Anggreeni & van der Voort, 2007). Yet, our goal was not primarily about smoothing stakeholder dialogue. We needed to create a smooth dialogue to bring across a message that was new to the stakeholders: using controversies as a starting point to explore and create responsible smart city initiatives. This brings us to the next two roles of design as mediator and provocateur.

Exactly because of its standalone capacity, Future Frictions required a lot of knowledge from design in its facilitator capabilities. After all, the structuring of the experience – from storyline to interaction possibilities – are all forms of facilitating the interaction such that it achieves the desired impact. For a standalone design, this weighs heavier as there is no possibility for the design researcher to intervene and clarify if needed. We thus needed to carefully reflect on the independence and understandability of the work and the intended message. In this case, the facilitator and communicator role were closely related, as part of the intended message was presented both through visual cues as well as logical structuring of the various elements of the experiential exercise. A logical flow was intended by starting the experience with a quest, to explain to participants what their assignment was when using the digital tool. By ending the experience with a reflection exercise in the form of a postcard, we ensured both a debrief for the participants, as a moment to collect qualitative data for the research team.

6.4.4 Mediator

Design as mediator emerges in complex multi-stakeholder projects that necessitate not only the balancing of stakeholder goals, but also the navigation and negotiation of those goals in relation to societal needs (Allen & Queen, 2018; van der Bijl-Brouwer & Malcolm, 2020). By moving from facilitation to mediation, opportunities open for design to create bridges between users and authorities and to prompt informed and prolonged discussions that stimulate reflection and reaction to social, political and economic forces that shape the context of design (Allen & Queen, 2018). The mediator role recognizes the need for deep and prolonged engagement with design as an iterative and continuous process that requires reflection-in-action (Schön, 1983). Moreover, it requires a broad range of knowledge across technical, social and societal domains, with a sensitivity to societal stakes, global forces and future trends (Shidende & Mörtberg, 2014). By the same token, *design as mediator* challenges assumptions about what is visible and invisible, and what is fixed and negotiable. Mapping exercises are examples of iterative and performative activities for *design as mediator* to interrogate relationships and contexts (Allen & Queen, 2008).

In our Network of Conflicts workshop, mapping was indeed a core part of design's mediating contribution. We see visualization — specifically mapping as was done with the Network of Conflicts (Figure 6.2) — as a particularly powerful mediation tool not only because of the tangible nature of the map, but also the process of creating the map. Thinking of values and value conflicts, and discovering their inherent connection to a place, is an analytical, synthetic and formative process that is essential to translate data into critical visualizations and propositional tools. Moreover, these benefits are not just for the viewer of the map (i.e. receiver of the workshop outputs), but also, and perhaps even more so, for the creator of the map (i.e. workshop participants) as they engage in alternating between the activity of encoding and decoding; constructing and deconstructing the map (Allen & Queen, 2018). Additionally, sensitivity to the context of smart city conflicts was a critical quality to support this mapping process and a core element of the design's mediating role.

Design's mediating role was present in Future Frictions through the multi-stakeholder context, where we deliberatively chose to include unexpected and less represented citizen perspectives, which are seldom present in regular smart city imaginaries (Vanolo, 2016). By presenting the perspectives and needs of for example children, careworkers and entrepreneurs, we intended to prompt a different discussion on the smart city technology, opening the space to reflect on societal impact, and introducing sensitivity for social stakes. This enabled participants to interrogate social relations, and negotiate stakeholder goals in relation to societal needs. Additionally, we challenged participant's assumptions on what smart city technology could or should achieve – thereby moving towards design as provocateur.

6.4.5 Provocateur

Design as provocateur is one of the most recent roles. In 2018, a full issue of the journal Design Issues was devoted to design as provocation: rather than taming or resolving wicked problems, design as provocation aims to fuel important issues, highlight problematic situations and sometimes even further complicate them, and show a deeper appreciation for what is at stake (Brown et al., 2018). Instead of design being the end result of a discussion, it uses design and the design process to start a discussion, critique social and political norms and suggest alternative interpretations (Hansson et al., 2018). *Design as provocateur* re-establishes the ability of design to question and challenge contemporary conventions and convictions that shape our world and advances participatory design

approaches that bring different people and perspective together (Brown et al, 2018). Some examples of approaches that embrace this role are Adversarial Design (DiSalvo, 2012), Speculative Design (Dunne & Raby, 2013), Critical Making (Ratto, 2011) and Design Fiction (Blyth et all, 2016). These approaches allow room for divergence and alternative perspectives and aim to create meaningful and collective action around a societal cause (Brown et al., 2018, p1).

Design as provocateur is almost innate to the topic of the Network of Conflicts workshop: conflicts that make up controversies are experienced as provocative in and by themselves. In the controversy project, we are inspired the most by DiSalvo's Adversarial Design, because this approach distinctly links itself to input from other fields that concern themselves with reflective thinking and societal critique, such as Science and Technology Studies and Philosophy of Technology, but manages to turn these engaged forms of thinking into engaged forms of practice (DiSalvo, 2012). Building upon the ideas of thinging, infrastructuring and connecting publics and issues, we recognize our workshop as a socio-material collective that accommodates conflicts and handles controversies, thereby advancing the idea of participatory design as creating spaces solely for deliberative processes, to creating spaces for agonistic pluralism where political issues can be renegotiated (Binder et al., 2015; Marres, 2007). The Network of Conflicts workshop allowed for a process of inquiry to make the multi-dimensional and complex aspects of smart city controversies known and sense-able, and thereby more easily addressed and acted upon (DiSalvo, 2012).

The tools title, Future *Frictions*, already underlines its provocative nature. Similar to the Network of Conflicts workshop, Future Frictions adopts a controversies lens, which are experienced as provocative in and by themselves. Also in Future Frictions, we aim to turn reflective thinking and societal critique to a more engaged practice in material form. We understand Future Frictions as a Latourian *thing* around which a public could gather to unpack and discuss issues, and recognize its ability to support agonistic pluralism. Moreover, the use of speculative smart technology such as sensing pigeons helped to provoke alternative images of the urban future and the direction of smart technology. Future Frictions stimulates a process of inquiry: both in the experience itself as it puts participants on a quest with three decisions to make, as well as beyond the experience as it triggers reflection on the state and impact of smart city technology. Similar to the Network of Conflicts workshop, Future Frictions allowed for a process of inquiry to explore the multi-dimensional and complex aspects of smart city controversies.

6.5 Discussion and Conclusion
The main aim of this paper was to uncover the complementary yet distinct roles that design can play in complex, multi-stakeholder settings. These are (1) generator; (2) communicator; (3) facilitator; (4) mediator and (5) provocateur. We formulated these roles based on experiences in a transdisciplinary research project and literature research. We envision that they will help discussing the role of design more explicitly, clarifying its strengths, revealing its weakness, and opening room for future research. In this section, we first reflect on the roles and next discuss ideas for future research to further strengthen the contribution of design to transdisciplinary collaboration.

6.5.1 Reflection on the five preliminary roles
The five preliminary roles are not strictly distinct categories. They build on each other and evolve with the complexity of the problem at hand. For instance, we recognize how the generator and facilitator roles intertwine because using scenarios and personas is a method to create smoother

collaboration, especially when discussing complex or sensitive topics like controversies. Here, role-playing using scenarios and personas helps participants to depersonalize the topic and become more open to other perspectives.

Although certain design interventions might emphasize on or the other role more, we argue that these roles do not happen independently or separately of each other, but actually build on each other's capabilities. For example, The Network of Conflicts workshop has a strong mediating character, however is only able to achieve this by employing the 'previous' roles of design as well: design as a generator was needed to create the scenario-based setting and formulate the five personas, design as a communicator helped to visualize the Network of Conflicts, and design as a facilitator was needed to manage the process and interactions within the workshop. All of these roles of design enabled the most prominent role of mediator, where controversies could be unpacked in a guided setting through the use of visual tools and personas. A similar line of reasoning can be applied to Future Frictions, which most prominently presented design as provocateur, however relied on the other four roles to achieve this. For both approaches, we could thus see all roles were represented throughout the design process, and that more 'evolved' roles are dependent on the skills of earlier roles. This highlights design's unique capabilities and character. By no means do we intend to say by this that design is the only one providing salvation in transdisciplinary settings; we understand design's role in transdisciplinary collaboration as another piece of the puzzle (van der Bijl-Brouwer, 2022). However, explicating these roles and understanding how the relate to, and build on, one another, helps to better position designs contribution in transdisciplinary projects and argue its unique contribution.

As the most recent roles, design as mediator and provocateur are less established and developed, and need further research to strengthen their theoretical grounding while also making them actionable in practice. We argue that they are also the most challenging roles: firstly because they require the skills and knowledge build up in the preceding roles as elaborated on above. Secondly, because they build on sensitivity to the context in which they operate, i.e. these roles do not deliver disconnect design solutions, but aim to meaningfully address the context. In this case, that entailed an understanding of the smart city discourse and its complex controversies. Additionally, these roles demand an understanding of the socio-political context in which they operate. Mediating cannot be achieved without an awareness and appreciation of the multiple perspectives at stake. Similarly, provocation requires a sharpness of critique that can only be achieved through deep understanding of the situation at hand, and the ability to zoom out and place that situation in a broader societal context. This awareness and understanding can be gathered through extensive research in the form of expert interviews, context mapping and co-creation with users – the known strategies to design research. However, given the growing complexity of the challenges which design researchers are faced with, specifically in transdisciplinary settings and the socio-technical context, we argue that design research and practices need to become more acquainted with, and attuned to, the political and ethical arguments and insights that follow from fields such as Science and Technology Studies and Philosophy of Technology. In our case, a thorough understanding of the relations between issue-publics, democratic practices and controversies as value conflicts, helped us to formulate the design interventions into their mediating and provocative characters. Not engaging with theories coming from the social, ethical and political realm would render a disconnected form of design, going back to delivering quick, finite solutions (Blyth et al., 2016). We acknowledge several practices that already exist within this realm, and are inspired by critically-oriented design approaches such as adversarial

design, speculative design and their potential for participatory settings. DiSalvo's recent work (2022) makes room for design in civic engagement, strengthening the link between design and democracy. Furthermore, we recognize the increasing popularity of value-sensitive design as a comprehensive method for including ethical sensitivity in design projects. However, we align with the critique of Le Dantec et al. (2009) that working with a pre-determined list of values runs the risk of neglecting local values, and limits the understanding of values in context. It is important to identify values with stakeholders and within the local context.

In order to move closer to political and ethical debates, and to align the democratizing aim of transdisciplinary design, we see great potential for incorporating the concept of agonism in design activities (Mouffe, 1999). Agonistic pluralism allows room for disagreement, contestation and confrontation in order to stimulate productive deliberation. DiSalvo (2010, 2012) extends agonism as a radical practice among designers to embed political values and implications into provocative or conflicting objects and design things. Notably, provocation and criticality remains at the designer's side in these approaches. We want to stimulate participants to take this role as well, to support a more democratic space for contestation. Recent work of Sawhney and Tran (2020) examined how various forms of contestation and agonism in collective social contexts, challenge and transform Participatory Design. They demonstrate how contestation in participatory design is transformed by different 'ecologies' inherent in the socio-cultural conditions, power relations, design constraints, and intrinsic values of practitioners. This work provides interesting starting points for further research on how to optimize space for contestation by participants, by for example mitigating existing power hierarchies or releasing design constraints.

6.5.2 Present challenges and future research

Although design has many merits that indeed make it a promising partner in transdisciplinary collaboration, it also has its limits. Its focus on finite 'solutions' to complex multi-faceted problems is yet to prove sufficient in dealing with system change, and as a result, design is more often than not disconnected from the context in which it has to operate (Lopes, Fam & Williams, 2012). The mediator and provocateur roles promise solace here. However, compared to the other roles, they are the most challenging ones to adopt. This is partially because they are historically not as mature as the other roles. The need to explore the wider political, societal and ethical context in which design operates, which can also be referred to as 'macro-level' or 'systemic' thinking is a relatively recent development in design research (e.g. van der Bijl-Brouwer & Malcolm, 2020). In addition, ethical and political sensitivity require time and suggest for a longer-term engagement (vs. short-term workshop format). For instance, the controversy project is grounded in the humanities through Latour (2005) and Marres (2007), thereby closely connecting to political theories on publics and issues. This shaped our perspective on engagement and the value-laden context of smart city technology. However bringing these insights to practice in a workshop setting for participants to embrace as well, proved challenging. As a result, we encourage further research into the roles of mediator and provocateur, to understand the most appropriate theoretical grounding and practical conditions for them to flourish in transdisciplinary contexts.

Following Sanders and Stappers (2008), we recognize the continuous evolution of design and the need for new tools and methods to address increasing complexity in design (research) projects. We argue that design should focus on developing more sensitivity to, and awareness of societal, political and economic factors that influence transdisciplinary collaboration. We suggest connecting more

strongly to the humanities and recommend the works of DiSalvo (2012, 2022) and Sawney and Tran (2020) as valuable examples, that engage in a conversation between design and theories on democracy and power relations. In line with Malazita (2018), we argue that critically-oriented design approaches can be leveraged in educational settings to help students from both design and engineering schools, to engage with social and political theory through their work. Following Findelli (2001), who traces this proposition back to the Bauhaus movement (p 56), we see a need to extend the knowledge base of, and in, design. Innovative educational and research programs such as the Transdisciplinary School at the University of Sydney, or Transdisciplinary Master Insert 'Shaping Responsible Futures' at the University of Twente, provide young designers and design researchers a broader palette to build from. These programs offer training by experts from different disciplines and stimulate the evolution of new approaches that support transdisciplinary working and stimulate designers to engage in debate with societal stakeholders. Simultaneously, we argue that other disciplines must gain greater awareness of the strengths of design, to release it from the sphere of 'pretty things' and 'post-its' (Hocking, 2010). Currently, design is often under-recognized in its capabilities and contributions (Lopes, Fam & Williams, 2012) and not widely accepted yet as having a significant, legitimate and valid role to offer in societal transitions (Hocking, 2010). We hope that the explication of the roles and strengths of design in this paper can help to make design's contribution more explicit.

Chapter 7

Discussion and Conclusion

7.1 Overview of research findings

The goal of this thesis was to enable the constructive use of socio-technical controversies, by means of design approaches, in order to stimulate democratic debate and ethical deliberation about smart cities. To achieve this goal, I divided the research into three steps or parts, that cover five research questions (Figure 7.1). The following section highlights the main findings of this thesis with respect to each part and research question.

Part A: Controversies to address socio-technical challenges

RQ 1   What is the productive potential of socio-technical controversies for responsible smart city developments? (Chapter 1)

RQ 2   How to conceptualize and analyze socio-technical controversies as sites of value discussion? (Chapter 2)

Part B: Design approaches to operationalize controversies

RQ 3   What are the qualities of a setting that make controversies accessible to, and actionable by, publics? (Chapter 3)

RQ 4   How can (speculative) design stimulate ethical deliberation by making the value conflicts in controversies accessible and actionable? (Chapter 4)

Part C: Design research and transdisciplinary collaboration

RQ 5   How to conceptualize design's contribution in transdisciplinary collaborations? (Chapter 5)

Figure 7.1. Overview of research questions.

Part A: Controversies to address socio-technical challenges

Part A of this thesis included the theoretical exploration of socio-technical controversies. It positioned *why* controversies can be seen as constructive concepts to address socio-technical challenges, and deepened the argument how controversies can contribute to enhancing the democratic debate with ethical deliberation.

To address RQ 1, Chapter 2 started with a theoretical exploration to formulate the productive potential of smart city controversies. To this end, I harvested knowledge trough a literature study, and linked insights from STS literature to examples from the global smart city discourse. I highlighted how controversies are instances where politics 'happens': a diversity of actors and plurality of perspectives come together, values are negotiated, pathways for action are evaluated and alternative urban imaginaries emerge. This understanding led to the formulation of a threefold potential of smart city controversies to enhance and enrich the smart city debate, as they foster (1) civic engagement (to involve those affected by smart city projects), (2) ethical deliberation (to discuss the societal impact, direction and desirability of smart city projects), and (3) alternative imagination

(to allow room for different views and visions on the future of the city) on the introduction of technologies in urban environments. These three potentials are interconnected and hard to strictly separate – e.g. part of ethical deliberation is asking 'what if?', and thereby going into alternative imagination, or navigating and negotiating different perspectives. The importance of this chapter lies in establishing an understanding of how controversies can be understood as constructive conflicts for democratic practice, and creating the foundation to focus on the potential to enable ethical deliberation in the next research steps.

Having a better grasp of *why* controversies can be understood as constructive concepts, I moved into understanding *what* controversies are made up of in RQ 2 (Chapter 3). Following a conceptual and empirical exploration of the anatomy of controversies , I demonstrated that controversies contain a micro-meso-macro structure of value expressions that are entangled through conflicts within and across these dimensions. Translating this to the smart city context, this entails value expressions on the micro level (regarding the individual lived experiences of the city), the meso level (regarding the social and relational experiences of the city) and macro level (regarding the societal and political experiences of the city). I argued that unpacking the multidimensionality of controversies triggers ethical deliberation, as it provides rich insight into the value conflicts that shape the issue at hand. The main contribution of this chapter lies in providing a conceptual understanding of socio-technical controversies as multi-dimensional conflicts, as well as a contextual understanding on the value conflicts and thematic issues that govern smart city controversies specifically, through four controversial scenarios that were surfaced during the workshop approach. The multi-dimensional understanding of controversies allows to dissect them in their formative elements, values and value conflicts, thereby helping to make controversies more accessible – both for publics to negotiate them, as for the further research and design activities of this thesis.

Part B: Design approaches to operationalize controversies

Part B of this thesis continued the investigation of controversies in a designerly fashion, meaning that I used the visual, tangible and experiential qualities of design to create 'design things' that represent socio-technical assemblies around which publics can gather. Equipped with the multi-dimensional understanding of controversies, I took a Research-through-Design approach and developed two ready-to-use controversy-driven, participatory design interventions with a focus on ethical deliberation (the Network-of-Conflicts (Chapter 4) and Future Frictions (Chapter 5). Additionally, I gathered insights on how to generate issue-publics around the value conflicts present in smart city controversies.

To address RQ 3, Chapter 4 presented the Research-through-Design process that resulted in a conflict-driven workshop format with a focus on value conflicts. I combined scenario-based, participatory and systemic design techniques to unpack, navigate and address socio-technical controversies through what the so-called 'Network of Conflicts'. The Network of Conflicts proved a viable tool, because of the way it organizes, visualizes and reveals value conflicts. Common systemic design techniques such as boundary conditions – which helped to manage the size and complexity of the network –, leverage analysis – which helped to find entry points to the network –, and zooming in-and-out – which helped to leverage the information present in the network – , provided meaningful for participants to actively engage with the Network of Conflicts and use the controversy in a constructive manner. Explicating value conflicts through unpacking the Network of Conflicts, made differences among multiple actors explicit, and therefor, negotiable, which provided the base

for ethical deliberation. Moreover, the process of mapping the NoC facilitates a shared, in-depth understanding of the controversy at hand, and thereby supports collective sensemaking. This stimulated multiple perspectives to be expressed, therefore supporting a setting where publics can form and formulate their own issues, and providing a more emergent, bottom-up form of public engagement, that re-enters public values in the debate.

RQ 4 was addressed through the development and evaluation of an interactive, speculative design intervention called Future Frictions (Chapter 5). I showed how the principles of ambiguity, relatability and plurality create the setting for audiences to empathize and engage with value conflicts, resulting in ethical deliberation. The mobilization of constructive ambiguity, relatable urban experience*,* and plural perspectives is a distinct feature of FF, that enables participants to identify, navigate and prioritize conflicting values. *Ambiguity* requires participants to make sense of the presented scenarios and enables them to identify and formulate their own issues and concerns. *Relatability* allows participants to recognize and empathize with the presented scenarios, whilst it helps us to recontextualize abstract controversies in recognizable settings, move beyond mere utopian and dystopian depictions of the urban future, and bring the scenario closer to our everyday experiences that are filled with nuance. *Plurality* ensures that multiple perspectives are represented in the scenario, and participants can empathically relate to multiple experiences of the same scenario. Together, these three principles create the setting for audiences to empathize and engage with value conflicts, stimulate their imagination beyond externally formulated urban visions and formulate their own questions, issues, and matters-of-concern. FF is an example of how speculative design can help illuminate the complex social and ethical issues that underlie sociotechnical controversies, by making abstract topics such as value conflicts, experiential and therefore accessible for debate.

Summarizing the insights from both interventions, I distill the following qualities of a setting to generate issue-publics through controversies:

1) *Makes values and value conflicts explicit*

Explicating the multi-dimensional value conflicts that shape controversies, is a form of 'making things public' that reveals the complex interaction between actors, technologies and values. It highlights marginalized perspectives and public values at stake in the socio-technical context, thereby negating the alleged neutrality of technology and repoliticizing the smart city debate. As such, smart city technology can be represented as 'thing', rather than an indisputable fact. It provides participants the knowledge and opportunity to interact and contest, to identify the matters-of-concern, and come together as a public around an issue. Making values and value conflicts explicit helps to make the issues transparent. This can be achieved through visual, tangible or experiential formats. The Network of Conflicts emphasized values conflicts in a visual manner through a map, whereas Future Frictions provided a more experiential approach encapsulated in an interactive, game-like intervention.

2) *Invites interaction and stimulates collective sensemaking*

By creating a joint setting to collectively understand, navigate and discuss the controversy at hand, publics can shape through collective sensemaking of the values and value conflicts present in the controversy. This requires access points for interaction in the intervention, to provide participants the opportunity to share their own perspective of the controversy, and allowing them to *contribute*

to the explication of value conflicts and thereby the formulation of the issue. Or in Disalvo's words, providing an 'open space of contestation' (DiSalvo, 2012). The Network of Conflicts invited interaction quite directly through its participatory workshop format, and further sensemaking was stimulated through the multiple perspectives present in the scenario, and the collaborative mapping of the Network of Conflicts. Future Frictions also required interaction quite directly as it required participant input to move through the scenarios and reflect in the final step, and the ambiguity present in the scenarios stimulated sensemaking of the controversy at hand. The experiences of Chapter 4 showed that the qualities of interaction and sensemaking are coupled, because it is through the interaction with the intervention, that people are encouraged to reflect on their own perspectives, share with and learn from one another, and as such, make sense of the issue at hand. For example, merely presenting a final Network of Conflicts without any opportunity to interact with it or add to it, does not foster the same sensemaking of the controversy, and leaves the issue unclear and public undefined.

3) Presents relatable scenarios

Through relatable scenarios, participants can translate the applicability, effect and impact of the controversy to their own experience. Relatability concerns the empathizing capacities of a design, that make different perspectives and experiences accessible and easy to feel connected to, by for example providing similarities to one's own experience. Through relatable and recognizable events, people feel emphatically connected to the presented challenge, which positively impacts engagement (Gaziulusoy, 2021). Although both design interventions worked with a fictive and future scenarios of the smart city, both narratives were grounded in the mundane, lived experience of the city. Relatable personas such as a tourist, government employee, or teenage girl – perspectives often neglected in smart city visions, yet core to urban communities – bring the smart city narrative in conversation with the experience of everyday life. Presenting the smart city narrative through these perspectives allowed to move away from the corporate-driven urban visions and create a storyline that resonates with the everyday experiences of participants. As a result, participants could engage in new ways with the challenges of the smart city.

Part C: Design research and transdisciplinary collaboration

Part C presented the reflective part of this thesis. To address RQ 5, Chapter 6 provided a reflection on the contribution and positioning of design research in transdisciplinary collaborations. Insights from literature, enhanced with reflections on the interventions of part B led to the formulation of five roles that design adopts in transdisciplinary settings: (1) generator; (2) communicator; (3) facilitator; (4) mediator and (5) provocateur. Although certain design interventions might emphasize on or the other role more, I showed that these roles do not happen independently or separately of each other, but actually build on each other's capabilities. The roles of mediator and provocateur are the most recent and also the most challenging roles, as they require the skills and knowledge build up in the preceding roles, but also require ethico-political sensitivity to the context in which they operate. To further develop and strengthen these two roles, design research should additionally become more acquainted with, and attuned to, political and ethical arguments from the social science and humanities. Not engaging with theories coming from the social, ethical and political realm would render a disconnected form of design. The main contribution of this chapter is the formulation of the five roles that design can take in transdisciplinary collaborations, thereby clarifying design's contribution and strengthening its position.

7.2 Contributions

This thesis aimed to enable the constructive use of socio-technical controversies, by means of design approaches, in order to stimulate democratic debate and ethical deliberation about smart cities. To achieve this, it navigated the transdisciplinary boundaries of STS, Political theory, Ethics of technology, Design research, and the societal sphere of the smart city. Specifically, it traversed the spheres of democracy, ethics, and design research (as visualized in Figure 7.2), and did so through a focus on the concept of socio-technical controversies. To structure the contributions that this research rendered, I first highlight them with respect to each of these themes, that is to the spheres of Democracy, Ethics, and Design, as well as to the concept of socio-technical controversies. Next, I stress that the main contribution of this work is at the meandering of crossings between these different knowledge domains. It is the synergy between these various elements that enables the constructive use of controversies.
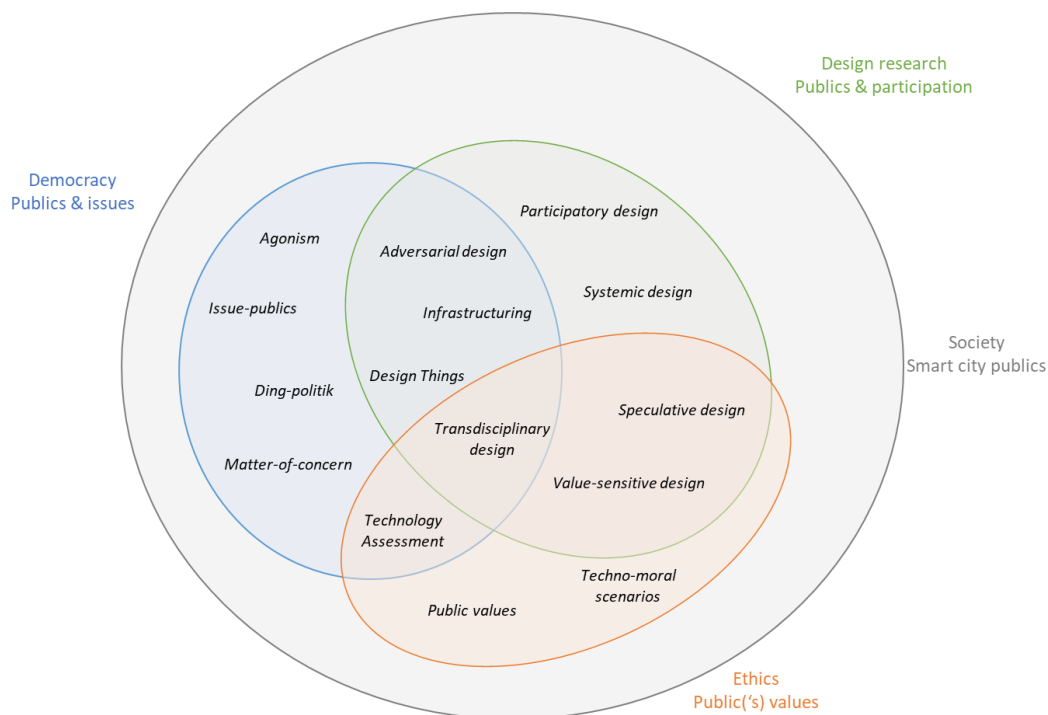
Figure 7.2. Conceptual map as presented in Chapter 1.

Understanding socio-technical controversies as contestations about public values

The contribution of this thesis to the study of socio-technical controversies is to consider them as multidimensional contestations about public values (Chapter 3). Smart city technologies can challenge public values (e.g. Van Dijck et al., 2018). This thesis elaborated how these contestations of public values play out on the micro, meso and macro levels, and how the conflicts between and amongst these levels shape a controversy. The framework of multi-dimensional value conflicts provides an analytical tool to examine and unpack socio-technical controversies. Rather than aiming to resolve controversies, this work follows Marres (2007) in making the issues available for public debate, and let multiple perspectives exist side by side in an agonistic fashion. Looking at conflicts from a values perspective enables empathy for the different perspectives at hand. Explorative design studies (Chapters 4 and 5) indicated that approaching controversies through unpacking values helped

participants to understand the 'why' of other stakeholders and enabled them to engage in a more meaningful conversation.

Rethinking democratic engagement through conflict

This thesis addressed the democratic deficit in the development of smart cities through a new conceptual lens: The lens of socio-technical controversies. Rather than seeing controversies as an obstacle, this thesis showed how controversies can function as catalyzers for democratic debate by employing an agonistic (cf. Mouffe, 2005) understanding of controversies. As a result, it embraced conflict and contestation in order to open up space for debate, where diverse perspectives and a plurality of values can co-exist. The focus on controversies is a Deweyan act, in the sense that it aims to make issues available, accessible and actionable for publics. Through the development of the Network of Conflicts (Chapter 4) and Future Frictions (Chapter 5), this research created the conditions for people to formulate wishes and concerns around smart city technologies (their *issues*) which reflect their diverse *values* – and in this process, come together as *publics*. Controversies provide a means to recenter the 'things' or matters-of-concern in public debate (Latour, 2005), and contribute to an issue-oriented, bottom-up understanding of democracy, beyond its institutional setting.

Enabling a bottom-up approach to ethics

Embracing controversies promotes a re-entering of public values into the debate on smart cities. In doing so, this research advanced current methods of democratic debate and public engagement to include an ethical component. Through its understanding of controversies as contestations about values, this work established an emergent understanding of public values. As such, this work opened up space for a bottom-up approach to ethics, i.e. re-affirming public's values rather than examining external criteria and frameworks. Instead of working with an a priori defined list of values (e.g. Value Sensitive Design, Friedman & Hendry, 2019) or fixed definition of values (e.g. privacy-by-design), controversies allow to work with a situated understanding of values, contribute a means of value discovery in context (cf. LeDantec et al., 2009), and thereby function as meaningful entry points to elicit ethical inquiry (Chapter 3). Both the Network of Conflicts (Chapter 4) and Future Frictions (Chapter 5) facilitated the formation of publics that can come together to (re)define values as *public's* values. These interventions support the democratic formulation of ethical issues and concerns originating from smart city technologies, or to say: provide a means to define public's values resourced by the public. As a result, it aims to empower citizens to raise ethical concerns, moving beyond the hegemony of the top-down considerations of experts.

Design as democratic practice and inquiry

This thesis applied participatory design techniques such as infrastructuring and thinging to operationalize controversies, and included a new element through its focus on contestations of values. As such, this work adds to the existing works that connect design and democracy (e.g. Latour 2005; Björgvinsson et al., 2010, Ehn et al., 2014; DiSalvo, 2022; Ozkaramanli et al, 2022) through a specific focus on public values. Moreover, this research expanded participatory design approaches from mini-publics and specific issues, to democratic engagements in the smart city context. Design's visual and experiential qualities (Matos-Castaño et al., 2020; Ozkaramanli et al., 2022) enable the transition from abstract and complex concepts to concrete experiences. As a result, design helps to 'make things public' (cf. Latour, 2005) and responds to the public's 'struggle to visualize' (Lehoux et al., 2020) the effects of smart city technologies. The visual character of the Network of Conflicts

(Chapter 4) and experiential character of Future Frictions (Chapter 5) both related to *projecting* (Disalvo, 2009): making the conditions and consequences of an issue known, in order for a debate around desirable and undesirable smart city futures, such that a public may form.

Synergy: Constructive controversies

This research has contributed to the topics as summarized above, but the main contribution and added value is in the synergy between the described elements. The contribution to one theme inevitably seeps through to other themes. The constructive use of socio-technical controversies can only be achieved through cross-pollination and weaving together of the aforementioned interdisciplinary concepts.

Primarily, this thesis demonstrated the constructive use of controversies by 'unblackboxing' the formation of issues, supporting the construction of publics, and (re)defining public values as interrelated processes. This research specifically contributed to integrating a focus on values in the process of issue-formation, by explication the value conflicts that shape a controversy. This conceptual connection between publics, issues and values has been made possible through design. Both design interventions make the value conflicts visible (Network of Conflicts) and experiential (Future Frictions), and thereby available for negotiation and public debate. As a result, the design interventions provide a means to move issue-formation to arenas beyond the institutional setting. In line with Schoffelen et al., (2015) and Latour (2005), this work emphasizes the importance of making issues accessible to encourage public debate. In particular, unblackboxing the formation of issues entails making differences among multiple actors explicit, revealing and stimulating multiple perspectives to be expressed so they don't remain hidden. The understanding of controversies as contestations about public values, mediated through a design infrastructure, allows to facilitate democratic debate with ethical deliberation. In Deweyan terms, it connects the notion of 'public(s) values', or values defined by the publics, as unremittingly tied to issues and public: the issues of concern and the people to whom they concern, cannot exist without the values that ignite these concerns.

From a methodological perspective, this thesis sheds light on how to make constructive use of controversies through design. This entails that they become less contentious and more approachable, so that they become open for public debate, rather than remain obscured. This research demonstrated the power of design in doing so, through two design interventions. The Network of Conflicts and Future Frictions provide an infrastructure for people to engage with controversies, identify values and value conflicts, formulate issues and come together as a public around their own issues, rather than respond to external, pre-identified issues – such as the privacy debate. In other words, these interventions function as Latourian things, allowing publics to gather and discuss the issues at stake. Through this thing, tensions can be explored, made explicit, and negotiated by convening around it. Both design interventions represent the value conflicts that shape a controversy (through a visual map or through neighborhood scenarios), to enable publics to identify their own matters-of-concern. This *representation* aspect is key, i.e. design approaches add a visual, material, and experiential character to this representation, thereby 'making things publics' (cf. Latour, 2005) through artefacts and interventions.

Together, the connection between publics, issues and values, and the design things, enabled the integration of ethical deliberation into democratic ways of thinking about the future of the city, by means of design. Design is a crucial factor in making this connection between ethics and democracy

possible, as design allows to make ethical deliberation experientable by publics (Ozkaramanli et al., 2022), leading to new forms of public engagment with smart city issues. The design interventions provide the infrastructure to bring publics, issues and values together, and allow participants to meaningfully navigate and discuss the value conflicts that constitute controversies. This enables them to come together as publics and formulate their own issues and matter-of-concern, and as such provides a bottom-up, designerly approach to democratic debate and ethical deliberation in the smart city.

The materiality, methods and mindset from Design Research (e.g. Dorst, 2019), allowed us to move beyond descriptive, analytical frameworks that organize concepts, to active, generative techniques and design interventions. STS, Political theory and Ethics of technology provide meaningful tools for analysis and understanding of controversies, but offer little to no insight about action, change and *how* to 'make things public'. They represent verbal traditions with focus a on theories, critiques and insights expressed in words, taking a spectator position to the challenge at hand. Design, on the other hand, is an embodied making tradition, where both process and outcome happen with and through design materials (Bardzell et al., 2012). As such, design takes an activator position. This thesis does not argue for a hierarchy between these approaches, but emphasizes the synergy between them. This synergy is embedded in the interventions, but also suggested for the two newest roles of design in transdisciplinary collaboration (mediator and provocateur, Chapter 6).

In summary, enabling the constructive use of socio-technical controversies through design contributes to the content and shape of democratic debate in the smart city. Controversies offer a means to (re)negotiate public values and insert a focus on values in the formation of issues, thereby loading the democratic debate with ethics. Design approaches offer a means to make controversies available and accessible for publics, enabling the formulation of issues and formation of publics, thereby adding a designerly dimension to democratic engagements.

7.3 Reflections on the research

In this thesis, I enabled the constructive use of socio-technical controversies, by means of design approaches, in order to stimulate democratic debate and ethical deliberation about smart cities. This section discusses reflects on the research in three parts: on the connection between democracy and ethics, on the research approach, and lastly on the transdisciplinary setting and the consortium project in which this research was embedded.

7.3.1 Reflections on democracy and ethics

This thesis discussed how to load democratic engagement with discussions on public values, and as such connected aspects of politics and ethics. Politics and ethics meet in the interactional space where visions, values and tensions are negotiated. The negotiation of value conflicts is both an ethical as well as a political act. It requires reflection on what is desired and prioritized, which are questions of ethical concern. Simultaneously it requires to ask how, and by whom, this negotiation is happening, and to what actions it leads. These are political questions. The two meet when identifying public or local expressions of values, and when centralizing value conflicts, -plurality and -trade-offs in our discussions. Simply inserting the outcomes of these discussions into engineering and design activities (such as for example Value Sensitive Design or Privacy-by-Design) is a simplification of the messy reality that ethics and politics represent: they require a continuous conversation, and represent an unremitting balancing between plural perspectives and situated values. This thesis

positioned design as an approach to organize this interaction and conversation, and foster a democratization of ethics. Rather than addressing an issue from normative theory, working with controversies allows to address normative issues from everyday experience, centralizing actual public's values.

This thesis highlights the importance of democracy and ethics in relation to the smart city. When discussing ethics, I move beyond the idea of ethics in terms of good or bad, yay or nay, accepting or rejecting certain technologies, but rather encourage a more nuanced attitude to ethics that offers room for plurality and nuance of values. To address the challenges that new technologies or socio-technical systems like the smart city impose, we need a wider ethical discourse than 'just' safeguarding and protecting people against the impact of technology. There must also be room for a more positive approach to ethics; that focuses on what is desired, rather than what must be avoided. To achieve this, it is important to start thinking from the vantage point of values, instead of from norms and restrictions. The Network of Conflicts in Chapter 4 provides an example of this. Through iteratively zooming in-and-out and prototyping, participants were stimulated to take a more positive account of working with values and consider what was desired, rather than focus on restricting norms. Through zooming out and reflecting on a) any potential undesired consequences and b) other values that are relevant for the personas, each iteration focused on how to enhance the intervention with a focus on values, rather than be limited by ethical constraints. By explicitly deliberating on the potential consequences and value conflicts, this approach provides a form of concrete and actionable ethical deliberation, and could be seen as a form of guidance ethics (cf. Verbeek & Tijink, 2020) through navigating conflict.

7.3.2 Reflections on the research approach

Human-centered design

This thesis has followed a human-centered design approach to explore how to constructively use socio-technical controversies. I applied typical human-centered design techniques such as scenarios, roleplay and participatory settings (Simsarian, 2003; Anggreeni & van der Voort, 2007; Sanders & Stappers, 2008; Ehn et al., 2014) to help elicit these values, needs and wishes. I understand human-centered design not in an anthropocentric sense in that it neglects other actors such as the environment or technologies, but embrace it to center the human experience in a broader sense than it has been done so far in smart city scenarios. Most of the current smart city scenarios do not contain citizen perspectives, and even if they do so, the view of the human is that of a homo economicus, basing life arrangements on rational reasoning alone (Vanolo, 2016). This research adopted a more holistic view on the human, acknowledging that non-rational reasoning such as emotional needs, moral values or personal preferences also play a role in shaping life. Chapters 4 and 5 centered the human experience in a broader sense, by including a diversity of perspectives and providing counter narratives of what a 'smart citizen' looks like. To allow for a broader understanding of the smart city to be included in the design intervention, a variety of stakeholders (e.g. project partners, students, workshop participants) were involved in the various research and design steps, such as formulating the scenarios or choreographing the interaction.

Research-through-Design

The work presented in this thesis builds on Research-through-Design (RtD) (Stappers & Giaccardi, 2017; Zimmerman, 2010) and infrastructuring (Björgvinsson et al., 2010; LeDantec & DiSalvo, 2013). Both are organic approaches that are characterized by a continuous, flexible, open-ended process

and allow the emergence of possibilities along the way. RtD signifies that the design activity itself, or the construction of artifacts, becomes a central research activity. Infrastructuring relates specifically to mechanisms for constituting and supporting a public, and focuses on participation in designing Things (socio-material assemblies). The RtD process relied on qualitative and interpretative research techniques, and did not aim to provide replicable results. RtD as a research approach was an explicit method choice, as it allowed the necessary flexibility to navigate this transdisciplinary research, and fitted well with its emergent and situated character. RtD provides a systemic and structured approach, yet also provides (theoretical) flexibility to adjust to circumstances and new learnings when needed. It is an iterative process that samples a set of design choices that allow to reflect on the topic of interest, rather than systemically evaluate all design opportunities (Gaver, 2012). As such it allowed us room to experiment with, and learn from, various design possibilities, as exemplified in the inventions presented in Chapters 4 and 5.

Workshop as research tool

Participatory design traditionally involves a staged, workshop setting in which participants move through a structured choreography of interaction. This thesis as well relied in several instances on workshops as a means to explore theory in practice and collect relevant data. Workshops as methodological tool are often used in participatory design (Schoffelen et al., 2015; Sanders & Stappers, 2008) since they provide both relevant research data, as well as a relevant learning experience for the participants. Workshops provide a collaborative and immersive environment to explore and experiment, whilst advancing meaning negotiation between both participants themselves, as well as between researchers and participants. This makes them very well fitted for a transdisciplinary research approach, where knowledge is co-created with quadruple helix stakeholders. Also fitting with the transdisciplinary approach and context of the smart city, is the application of participatory design outside these staged settings, in public space (Schoffelen et al., 2015). Future Frictions (Chapter 5) has been used in various public settings, ranging from libraries to exhibitions and events, and is an example of how participatory design is becoming active outside the staged setting of the workshop. To achieve this, we designed Future Frictions such that the interactive intervention could be experienced without further interpersonal facilitation: the experience itself contained a clear provocation and assignment, guiding participants stepwise through a carefully curated quest. In public places however, there is no pre-defined public, and the challenge is to engage publics. For example, through the experiences with Future Frictions in public space, we learned that interactions in public space require a different interaction since publics are on-the-go, compared to for example workshop settings where publics have scheduled time for the engagement. To accommodate this insight, it was decided to create two versions of FF, with the short version being more appropriate for engagements in publics events and public space, and the long version more appropriate for workshop settings.

7.3.3 Reflections on transdisciplinarity

The presented work was shaped by transdisciplinary research approach and took place within the NWO-funded project consortium 'Designing for Controversies in Responsible Smart Cities'. This transdisciplinary approach implies a need that simultaneously provides a challenge, namely to include different forms of knowledge, and engage a wide range of societal actors in the scientific process in a meaningful way (Sellberg et al., 2021). In the following section, I summarize two transdisciplinary challenges encountered during my research. These challenges do not exist isolated

from each other but are rather interconnected, which makes them particularly challenging to navigate.

Managing process and collaboration

Given the emphasis on stakeholder involvement in this transdisciplinary research, the collaboration process was one of the key challenges. To maintain extended periods of engagement with partners and participants requires adequate relationship and expectations management (Bulten et al., 2021; Pohl & Hadorn, 2007). Especially since the timelines of academic projects tended to be longer than in non-academic environments, and this can lead to a mismatch in expectations on deliverables. Furthermore, it requires extensive project management skills in order to reconcile the values and preferences of the various actors involved, and create ownership for the identified problems as well as the formulated solutions (Sellberg et al, 2021; Lang et al. 2012; Roux et al. 2017). In my case, the presented research took place in the setting of a consortium project, with a total of seven different academic and societal partners involved. Navigating the different expectations and stakes in such a setting makes for a not so straightforward research path. Through bi-annual consortium meetings, the project team ensured there were regularly moments to navigate the different perspectives and the different stages of the research, from defining a shared research goal to disseminating the final results. Additionally, the team had several one-on-one meetings with each stakeholder to keep the flow of the collaboration going and source specific expertise when and where needed. There are two reflections to be made here: Although managing these different stakes was challenging, working in the consortium context did provide the direct quadruple helix context that supported (part of) the co-creation activities that were part of this research. Additionally, part of the process management when working in a transdisciplinary setting is being flexible and adapting to changing situations or stakes. The dynamic societal context of transdisciplinary research is both a strength as a challenge. This research was for example faced with a new city council that implemented budget cuts regarding smart city projects, and the Covid pandemic that led to the closing of the public space. As such, it required flexibility to manage and adapt to these changing circumstances.

Balancing scientific rigor and societal relevance

Another challenge related to the balancing of scientific rigor and societal relevance – which is related to managing different expectations and preferences amongst the consortium partners. One of the key qualities yet challenges of transdisciplinary research, is the integration of diverse forms of academic and non-academic knowledge to address societal issues and to create new scientific insights (Seidl et al., 2013; Scholz & Steiner, 2015; Sellberg et al., 2021). To do so, transdisciplinary research requires new concepts and approaches. There is currently only a small, albeit growing, availability of methodological resources for transdisciplinary research. According to Dorst (2019), when disciplinary practices are employed in other fields of activity, they cannot simply be adopted without substantial change, but require adaptation in order to meet the needs of the target field. The mapping exercise that contributes to unpacking the Network of Conflicts (Chapter 4) is an example of that. I developed the Network of Conflicts as a specific technique to map the structure of socio-technical controversies. Rather than simply applying one or the other approach to my transdisciplinary understanding of controversies, I have adapted existing practices (e.g. systems mapping (Jones, 2014), controversy mapping (Venturini & Munk, 2021), value mapping (Ruecker et al., 2020) and added a new lens: mapping controversies as multi-dimensional value-conflicts, where the values are the system nodes and the value-conflicts are the system interdependencies. Not only was the Network of Conflicts a new technique and thus relevant in a scientific sense, it also allowed

stakeholders to navigate conflicts in a meaningful and insightful manner, thereby providing societal relevance and new insights to non-academic audiences as well. An important reflection here is that to achieve this latter point and ensure societal relevance, it is crucial to remove any academic jargon to make insights and interventions accessible to wider audiences. Design plays a central role in this, at it offers a common language through making and doing (Cross, 1982), thereby moving the interaction beyond formal jargon or disciplinary language. In the case of the Network of Conflicts, this was achieved through the visual vocabulary of the map. As a result, design allows different stakeholders to participate in the process and provides a promising way to navigate complex collaboration (Van de Bijl-Brouwer, 2022; Gonera & Pabst, 2019).

Consequently, transdisciplinary research delivers a different type of output than traditional disciplinary work. The generated knowledge is not only translated in academic outputs such as journal papers or conference contributions, but also translated into knowledge sharing activities, which in the context of this research took the shape of blogs, workshops, exhibitions, and more. Although not always recognized as such within traditional academic frameworks, I stress that these diverse forms of output are relevant research project output, as they help to build the collaboration and partnership, share and co-create knowledge, and continuously merge the knowledge from the academic and societal sphere. After all, transdisciplinary research is a two-way street: its aim is not only to incorporate knowledge *from* societal stakeholders, but also deliver knowledge *to* societal stakeholders, and contribute to a societal challenge.

The need for an evolving academic system

I conclude this section with a reflection on whether the traditional academic frameworks still function in the relatively new context of transdisciplinary research. Placing the challenges next to the importance of transdisciplinary research, there is a need for change within the current academic system in order to better accommodate transdisciplinary research. How can the academic system adapt to this changing context in which research takes place, and the practice of how it takes place? How can the academic system adapt the way it evaluates academic output and research careers? In times of discussions on open science, open access and gateways to knowledge, it seems unfit to keep evaluating the knowledge distribution in channels that do not distribute widely, but only reach and resonate in a room with academic peers. To truly stimulate transdisciplinary practice, I see the need to broaden the scope of what is considered academic practice, with the suggestion to evaluate research output and the researcher's career not purely on academic impact, but on multiple forms of impact (e.g. qualities like leadership or societal engagement). In this regard, I would like to highlight the ongoing developments in the Dutch academic movement of Rewarding and Recognition, who argue for a new a new way of assessing, evaluating and acknowledging academic progress, beyond scientific impact alone. These ideas were first published by the VSNU as a whitepaper in November 2019 and are currently implemented as part of the Shaping 2030 and people-first vision of the University of Twente.

Next, with transdisciplinary research having its own distinct and well described challenges, such as for example longer exploratory phases (Nasch, 2008) as more fields of knowledge need to be combined, or difficulties adapting to and combining practices and requirements from different departments, it deserves questioning how institutions can accommodate these transdisciplinary practices in a more supportive manner. How to rethink existing frameworks and faculties to adapt to more permeable disciplinary boundaries? How to break the silos and work in ecosystems? The

institutional landing of transdisciplinary work deserves attention. Faculties and existing disciplinary platforms provide a 'boxed' environment that can be seem uninviting for transdisciplinary research. There is a need for more open and permeable environments that allow for a swift and supported exchange of knowledge, that recognize various cultures and traditions of knowledge. This requires research institutes to rethink the way organizational units are set-up and how they can allow inter- and transdisciplinary knowledge exchange to happen with less hurdles, and support transdisciplinary collaboration also on the organizational level. Several promising examples exist in this regard, such as the Athena Institute of the Vrije Universiteit Amsterdam, or the DesignLab here at the University of Twente. These institutes approach research and education activities from an innovative perspective and take a distinct inter- and transdisciplinary frame.

7.4 Research limitations

After highlighting the academic and societal relevance of this study, I now critically discuss its limitations. These limitations help to understand the reach and implications of the presented work, and to define concrete opportunities for furthering this research in future efforts.

The first limitation regards the participants of the research activities. Alongside several 'regular' citizens, the participants predominantly consisted of consortium partners, conference attendants and novice designers (e.g. design students). Given the strong democratic character of this work, the research and co-creation activities could have benefited from a larger amount of participants representing civil society specifically. Although all participants were citizens themselves, and therefore able to share their perspectives as citizens, most simultaneously represented the stakeholder role related to their professional environment. In line with the transdisciplinary nature and the smart city context of this research, several design interventions were planned to take place in public space, such as for example on city squares, to interact directly with citizens. However, the Covid pandemic provided strong restrictions in this regard and affected the data collection between March 2020 and April 2022. The urban sphere, which provided the lab-area of this research, remained restricted due the Covid regulations for the majority of the research time, hindering the collection of data as originally planned. I adapted to the continued constraints and the uncertainty of this situation, by redesigning the interventions to make them fit for digital or hybrid formats. Both the Network-of-Conflicts workshop (Chapter 4) and Future Frictions (Chapter 5), are available for digital interaction.

Although the research team continued to find means to interact digitally with various stakeholders, and returned to offline interactions as soon as allowed (the Network-of-Conflicts workshop and Future Frictions were both evaluated in online as well as offline interactions), I found that the digital context in which much of this research took place, provided a barrier for citizen engagement. While online participation carries the benefit of lower costs and lower time-investment (due to the ability to join from home rather than travel to location), empirical studies show one should be cautious about the comparative advantages of online participation (e.g. Bobbio, 2019; Friess & Eilders, 2015). There are several reasons for this. Online interactions make it more challenging to reach certain audiences, most prominently due to limitations in accessibility and inclusivity (e.g. Warner-Mackintosh, 2020): digital interaction requires access to online environments and a level of digital literacy. Moreover, online events, unlike public square encounters, mostly require a predetermined sign-up to participate, thereby attracting an audience that is already to some extent interested in the topic. Additionally, research by Kishimoto and Kobori (2021) confirms that the number of citizen

participants decreased significantly during Covid's online interaction period. This could be caused by an absence of social factors motivating to participate (Maund et al., 2020), a changed participatory interest (e.g. focus on Covid apps), or by online fatigue. However, despite the adverse circumstances, I also perceived the unexpected change of interaction from in-person to online, to provide an opportunity, because this has allowed to reach a wider international community, and Future Frictions is for example used in lectures at Cleveland State University in the United States. It would be interesting for future research to more directly engage with citizens, and compare the different results of online and offline interaction.

Another limitation is that the research output and its practical application have yet to be evaluated in an ongoing smart city project with ongoing, lived controversies. Case studies have a rich history for exploring the space between the world of theory and the experience of practice, and are meaningful activities in design research (Breslin & Buchanan, 2008). For example, working with an ongoing case could allow for more context-specific issues, insights and interventions. Additionally, although this thesis reveals the potential of working with controversies when understanding them as value conflicts, it is fair to assume several reasons exist to avoid controversies in real-life settings, such as work relations, tense interactions, affective and time costs, and more. Working with controversies could therefor also defer stakeholders to engage with the issue at hand. Consistently applying and adapting the provided insights and interventions to an ongoing and coherent case would provide knowledge on the desirability of working with controversies in practice, and how to reformulate or redesign the current insights to best contribute to the complexity of practice context.

Despite the initial intention to embed and evaluate this research in an ongoing smart city case provided by the consortium project, the research team unfortunately had no access to such a long-term, coherent case that could be used as a living lab. This directly links to the one of the opportunities of transdisciplinary research that is simultaneously one of its greatest challenges: working in a societal context. Collaborating with multiple partners, sectors, institutes and disciplines over a longer period of time requires not only a great amount of project management, but also flexibility and adaptability when research accommodations change – leading to moments of bricolage (e.g. Hargreaves, 2021). When working in the societal context, situations can always change (e.g. Covid, political developments, new city council and governance plan). As such, no long-term case was available for this research. Alternatively, I worked in small, disconnected cases that directly related to societal partners. The Network-of-Conflicts workshop, for example, has been tested with, and promoted by, Digicampus, a network organization that contributes to the Dutch digital governance ecosystem.

7.5 Future research

This thesis enabled the constructive use of socio-technical controversies, by means of design approaches, in order to stimulate democratic debate and ethical deliberation about smart cities. The topics covered, the design explorations conducted, and the findings yielded, lay the groundwork for new research avenues. I perceive many exciting opportunities to continue and expand the work presented in this thesis, and hope it will contribute to continued and strengthened transdisciplinary interaction between STS, Political theory, Ethics of technology and Design Research. The following section provides suggestions for such future research, based on the limitations of the study and inspired by the insights gathered throughout this thesis. It first reflects how the specific insights and design interventions that were part of this research, could be iterated and transferred in future work.

Next, it reflects more broadly how the presented concepts and thinking can be expanded in future research.

7.5.1 Transferability of the research insights and interventions

This research was developed in the context of smart cities, yet is envisioned to be applicable to a wide variety of socio-technical controversies. The smart city provided the socio-technical context and enabled to distill thematic issues and empirical examples of controversies in order to contextualize the design interventions. However, I believe that the insights presented are relevant outside the smart city context as well, and can resonate with many different socio-technical controversies. Specifically the generated insights regarding the threefold potential (Chapter 2) and multi-dimensional nature of controversies (Chapter 3), as well as the qualities of a setting to generate issues-publics (part B) can easily be extended to other domains where socio-technical controversies reside, as they are not specific to smart cities. The developed interventions, namely the Network-of-Conflicts workshop (Chapter 4) and Future Frictions (Chapter 5), do relate to the smart city context through their scenarios, but they could readily be adopted to other contexts. Both interventions are directly available for future use as they are licensed under creative commons or open source software, and are accessible for next researchers who wish to use or expand them. When moving towards other socio-technical context, it would be particularly interesting how the insights form this thesis could be meaningfully applied in debates that relate to sustainability, digitization, and ecosystems that include non-human actors more explicitly.

7.5.2 Expanding the research insights and interventions

Beyond human-centeredness

This dissertation has been innovative in its transdisciplinary approach, and the distinct role that design research took in it to support democratic practices. This lays the ground for future design research to further extend its evolution from a production and consumption-based paradigm to a value-creating paradigm, where value is understood in the public rather than financial sense. There is great potential for connecting this work on controversies to conversations on de-growth, decolonization and more-than-human, post-capitalist and feminist futures, when it comes to smart city visions and other socio-technical futures. Post-capitalism is becoming an urgent area of inquiry, in academic and public arenas alike, raising questions like: How can smart city visions align with visons on universal basic income, the donut economy and workers right in the platform economy (cf. Lowrey, 2019; Raworth, 2017)? How to move beyond human-centeredness, to represent and involve non-human actors, and evolve from quadruple to quintuple helix interaction (i.e. include the natural environment and steer towards socio-ecological transitions) (cf. Choi et al., 2023)? How to adapt a feminist perspective on urban space and explore power dynamics in social relations, in concert with the built environment (Schalk et al., 2017)? How to move to a 'digital welfare state' (cf. Huws, 2020)? These questions require an approach that understand the human in concert with its environment, and acknowledges nature and technology as equal actors.

Smart city

The current undertaking does remark, yet does not dive into, the political economy of capitalism and neoliberal ideology in which the smart city vision is developed, nor in the economic stakes related to the smart city discourse. These are great determinant factors in society, however. Connecting the quest for responsible smart city design not only to politics and democracy, but also to current governing economic structures, would provide heightened insight into the issues at stake and the

complex entanglements between them. Additionally, such post-capitalistic explorations of alternative socio-technical imaginaries carry their own controversies, issues, and value conflicts. The current research has been a first step both topic- and method-wise in the quest for responsible smart cities, and future research should dive into more expanse questions to further develop the lens of controversies.

A new research avenue: connecting systemic and speculative design

Questions like those raised in the previous paragraphs, require alternative imaginations and explorations of futures. Simultaneously, in order to explore how to change the status quo and address the systemic challenges, an understanding of the system under scrutiny is needed. For this, I see great potential in both systemic and speculative design, and particularly finding the synergy between them. These fields are not often brought together, and their connections and interactions remain largely underexplored. This dissertation applied techniques and insights from both systemic design and speculative design, as both disciplines offered great promise to work constructively with controversies. I understand them as related and complementary, yet separate approaches, and have used them independently from one another in my research (Chapter 4 applies techniques from systemic design, whereas Chapter 5 relates to speculative design).

Systemic design allows for a holistic perspective and stimulates a transdisciplinary framing, with specific attention to connections between stakeholders, values and issues (e.g. Jones, 2014; van der Bijl-Brouwer & Malcolm, 2020). Speculative design allows for a deliberation on desirable futures, with specific attention to societal and ethical reflection through materialized imagination (e.g. Dunne & Raby, 2013; Auger, 2013). Both adhere to the goal to address complex societal challenges. Roughly put, the one is provides an analytic perspective whereas the other generates alternative future constellations. I see great potential for both approaches to enhance each other to deliver a unique approach towards societal challenges. Systemic approaches for understanding, analysis and participation can inform and enhance speculative design's critical and relational thinking, as well as introduce a stronger emphasis on co-creation with multiple stakeholders to make speculative design more inclusive and user-friendly. Speculative and critical future explorations can complement systemic design's holistic approach of the problem space. Combining a systemic analysis with a speculative exploration, could lead to more informed, sustained and critical alternative imaginaries, addressing the challenges of today. It would help to ground speculation in systemic understanding, and expand a systemic analysis with speculative explorations. When brought together in synergy, they can help to challenge the system, engage imagination and trigger social change.

7.6 Concluding remarks

This thesis motivated, theorized and operationalized socio-technical controversies as a concept relevant for rethinking democratic debate and ethical deliberation in smart cities, and has enabled the constructive use of socio-technical controversies accessible by means of design approaches. I have argued why, and demonstrated how, working with controversies enables to re-enter discussion on public values in the democratic debate, and what the indispensable role of design is in this. The abundance of current socio-technical challenges and controversies underline the compelling nature of this work. Yet I believe that there is no singular right way to respond to the socio-technical challenges presented by smart cities in particular, or the introduction of emerging technology in society in a broader sense, and encourage the work presented in this thesis to be part of an ecology

of conversations, theories and methods that form a dynamic dialogue. Aligning different discourses and practices is key to provide the necessary synergy to address today's complex challenges.

I hope this work encourages and inspires other researchers to become attuned to the potential of socio-technical controversies, to address socio-technical challenges by means of design approaches, and to elicit richer conversations into the democratic, ethical and design space of smart technologies.

Going back to the example of Enschede that we started out with – this thesis provided an alternative to the top-down, institutional approach that focuses on safeguarding a singular public value, and demonstrated how a purposeful examination and explication of the controversy at hand through means of design, promotes a bottom-up, democratic approach that emphasizes the diversity and nuance of public's values.

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Acknowledgements

A PhD trajectory is an individual journey, yet shared by many. It is both a research journey, as a researcher journey. Research-wise, I have learned a lot. Being trained in a completely different field, it has been a very inspiring, exciting and rewarding journey to embark in this – to me – new field of design research. Researcher-wise, I might have learned even more. Life happens whilst doing a PhD, and persevering through hardships is only learned by experience. Now, neither of these journeys could have been completed without the continuous and kind support of many. A PhD is celebrated as an individual achievement, but cannot be completed without a community of support. They say it takes a village to raise a child; I'd say it takes a (smart) city to support a PhD candidate. I am extremely grateful for the community of supervision, support and encouragement I am surrounded with, and pleased to put the spotlight on all the kind people that are part of that community.

Firstly and foremostly, I am grateful to Mascha and Peter-Paul for giving me the opportunity to start my PhD and for trusting my capabilities in a new environment, in terms of location and academic disciplines. Mascha, thank you for taking on the challenge of inviting a physicist in a design team, and guiding me all the way to being a real design researcher. Peter-Paul, thank you for our pleasant conversations and for your support on the diversity art project – without your support this artwork would have not been there. You both have allowed me the space to learn and work independently, and provided encouragement throughout this adventurous PhD process. Aside from specialists in your field, I have gotten to known you as genuine and warmhearted professors, and inspiring role models in your profession. I surely hope our paths will cross again in future endeavors.

Then, there are two special people without whom I would have not been able to present this final dissertation: Deger Ozkaramanli and Julieta Matos-Castaño. Deger and Julieta, a warm thank you to you: it is because of your academic support and friendship, that I was able to finish this PhD journey. You pulled me through challenging periods with confidence and a smile, and I learned a lot from both of you.

Deger, I am very grateful that you entered the supervisory team and shared the remaining steps of the PhD journey with me. You entering the thesis team has been a pivotal moment: you helped me set the sails in the right direction to allow this PhD ship to sail, whilst remaining my navigator high on the deck. Our many conversations have enriched my thinking and writing, as well as enhanced my joy and confidence in the process. Your always sharp feedback, daring questions, and mostly, your trust in my work, inspired and empowered me to keep going and explore tentative findings and ideas. I always left our meetings feeling more light, inspired, confident and excited about the challenge ahead, which is very rare superpower for a supervisor. I look forward to follow your future endeavors and stay connected on the personal and professional front.

Julieta, working alongside you has been an absolute inspiration and pleasure. I want to express my appreciation and gratitude for your relentless support, words of wisdom and encouragement, never-ending optimism and can-do mentality. And on top of that, a big thank you for your wonderful illustrations that guide this thesis. We have had an easy and enjoyable collaboration from day one, which even resulted in us co-founding the Speculative Futures chapter in The Hague. You have been a true companion throughout this PhD journey, showing up with messages and actions of support, or sharing Tony pictures and a good joke. We shared lots of reflections on research, career paths and life, in which your advice was always sound and motivating. But most importantly, we shared many

laughs: from DDW travels to Google translations or train borrels. I look forward to our continuous collaboration through Speculative Futures and beyond (see you at the UN office in NYC one day!).

Then, there are many more collaborators and colleagues that were part of this PhD journey.

Corelia, I am very happy you joined the smart city project, first from the UU and later the UT legions. I admire your mind and pen sharp as a razor, and your never-ending optimism and flexibility, always finding and going for new opportunities. I hope to catch more train borrels with you!

Michiel, I most certainly hope you will join this borrel! Although we only had few opportunities to exchange ideas, I always appreciated your critical and positive presence in the project, and I continue to be inspired by your work.

A word of thanks also goes out to the consortium partners of the NWO project in which this PhD research is embedded: Jan-Willem, Wendolijn and Zoë from Future City Foundation; Sebastiaan and Joris from Marxman Advocaten; Leon and Tamme from Areovision; Jos and Janette from the Gemeente Amersfoort, and Marieke, Geert and Lianne from the Design Innovation Group. Thank you for your collaboration and support in the NWO project. It was an informative and inspiring experience to do research in this consortium. Additionally, I am grateful for Digicampus and the various students and other participants that joined the workshops and helped to make the researcher possible.

During my research I had the opportunity to guide several students in their graduation assignments. Thank you to Anne-Joke, Eeuwe, and Chen for the inspiration you provided both in content and process – supervising you was a little bit of supervising myself at the same time.

Thank you as well to my (former and new) HCD colleagues, Arie Paul, Cristina, Deger, Evgeni, Francesca, Jelle, Julieta, Mascha, Niels, Renan, Robert-Jan, Thijs, and Young-Suk, a wonderful group of inspirational researchers. It was a pleasure to work in an environment with such engaged scientists and fun people. A special shoutout goes out to Robert-Jan, who has been my office mate for most of the past years, and with whom I have happily exchanged many thoughts on (PhD) life. Thank you for being my paranymph during this special day!

Then, my dear PhD colleagues, Channmi, Benedetta, Tina, Lara, Tamara, Gisela, Nina, Merishna, we have shared many struggles and smiles during our PhD journeys, which provided comfort throughout. I warmly look back our shared time at the UT office, at DDW, at the first DPM writing week, at the DRS conference in Bilbao (I will never be able to take a picture again without reconsidering my pose!) or simply over dinner and drinks. I hope our paths will cross again, in academia or elsewhere.

Aside from working on my PhD research, I spent my time at the UT on initiating and executing two Diversity and Inclusion initiatives, namely a special edition of the UToday magazine and a diversity artwork. Engaged scholarship is expressed in more than research alone, and I am proud to have contributed to this theme at the UT. This was only possible because of the support from Linda, Sterre, Mieke, Michelle, UToday and the CAAC. Thank you for your enthusiasm and collaboration, which made these projects possible.

Outside the academic walls, I have found great joy, distraction and support in various communities, which each helped to keep my sanity and allowed me to express different sides of myself. I am

grateful for the experiences with the Speculative Futures community that Julieta and I initiated, and look forward to our next collaborations. Next, I am thankful for my bookclub-buddies, that provided a very safe physics-nest and helped me to also save some time for non-academic literature and reflections on life. And let's not forget the always wonderful snacks! Thank you also to the girls of my dance team, specifically Sheruela and Dagmar, for being festival buddies, sharing the stage and even sharing the PhD journey! Dancing academics, we got this! Additionally, I am grateful for the Tenerife ladies – strangely enough this cognitive-driven scientist found comfort and motivation in your special card session (and of course you kind encouragements) when finalizing this research. Lastly, thank you to VillaVibes and the fantastic groups I was able to take to the Ardennes and Portugal, for making one of my long-term goals come true and supporting my first steps as an international travel guide.

Some heavy counting leads to the insight that over these past PhD years I have packed boxes, drilled or plastered walls, and moved my stuff for a whopping eight times, and I have lived with 17 different housemates. To my Roosevelt roomies, particularly Jaap and Rick as consistent members of the team, I enjoyed our early morning swims followed by coffee and convo, late night joint laptop (or puzzle!) sessions, and cozy evenings on the couch. Thanks for providing me with some lunch when I went into my writing cave, for sharing nights of dancing and always being ready with a hug when needed.

To my friends in Limburg whom I've seen far too little: I look forward to catch-up and share new adventures together. Monique, we go back to kindergarten, and I am happy that our friendships has survived the many years and many kilometers of distance. Daniek, Selma, Lotte, Lindy, I fondly look back at our catch-ups, concerts nights, zoo-visits, and as a latest addition to the activities: puzzle weekend! Lotte, Ellen, Milou, Katja, Imke, Anouk: a girlsday with you is always fun and I hope to enjoy many more in the future.

Marieke, I always look forward to our borrels, whether it is to discuss life, RTL boulevard, global politics, the Songfestival or other random things. You always provide a sharp and humorous account. I am super happy with our bookclub discussions and very grateful for your support and friendship along the past years.

Jeroen, thank you for our inspiring talks on design and design research, which made me realize I knew both more and less about design then I thought, and thus made me feel like a real researcher. I enjoy our shared cynicism and curiosity for the world.

To my girlgang, Sammie, Sanne, Hanneke, Kiki, Vikki, Tania: I am incredibly lucky and grateful to have met each and every one of you, and I feel proud and happy to be part of such an amazing group of friends. It is inspiring and humbling to be surrounded by your intelligence, compassion, humor, and great dose of energy and craziness. In this global friendships it takes a rare moment to find us all in the same country, yet you always make me laugh and feel at home. Thank you for sharing the challenges and celebrations of this PhD journey with me. Sanne, I appreciate your unending optimism. From desert-trips in Colombia where we ended up at the most random places, to roadtrips to France with the most hilarious water gym experience, I fondly look back at the shared adventures and hope to make many more. Hanneke, I am in awe of your relentless energy and sportive mindset, and look forward to cheer you on during the final lap of your PhD journey or the many laps of triathlons. Kiki, your always bubbly and positive presence is contagious, as is your drive to make the world a better and more sustainable place. And let's not forget your incredibly contagious laugh!

Vikki, you have been an anchor in difficult times, not only to me during this PhD journey but to many around you – traversing the world to do so. Thank you for coming in with daily celebrations, balloons and what not when I was stressing over deadlines. Tania, whilst life's road brought some unpredicted curves, it is inspiring to see how you navigate them, flow along and adapt to new circumstances whilst remaining true to yourself. Sammie, as fellow PhD's, even fellow transdisciplinary researchers, éven interested in the same field of emerging technology and ethics, we have supported each other throughout our PhD journeys. I appreciate our daily check-ins and regular work-at-home collabs, where we share progress, frustration, words of wisdom and your cat Indi as an extra bonus. You jumped in with support when needed, and celebrated every milestone, small or big. I hope to be able to reciprocate the same support during the following two years of your PhD, and look forward to celebrating every milestone in your journey as well. You got this! I am very glad to have you as a paranymph by my side.

Ria, Ben, Oma Toos, thank you for your support and patience throughout these years whilst wondering what I was actually doing, when I was graduating, or why I didn't 'just finish', and for always being there with a glass of wine or a puzzle for support and relaxation. I also wish to remember and acknowledge my Oma Nellie, who herself was not allowed to finish elementary school due to caring duties, and who has been an inspirational force for me during my educational and research activities.

Lenny, I am truly delighted to have shared our weekly worksessions in your home in Utrecht, and even more delighted to have experienced your wonderful cooking skills each time.

Mom and Dad, thank you for always supporting me to study and explore my interests, however random they might be. I admire and appreciate you. It is from you that I learned 'Geit neet, besteit neet' and 'Geit 't neet, den boktj 't waal', which turned out to be leading wisdoms in this PhD. You both nurture my drive and commitment. Mom, I gladly take my mind off work with you and share an interest for dogs, sewing and puzzling. Dad, thank you for navigating the stormy and sunny days of this PhD journey with me. And for always doing so with patience, understanding and support - whether calls would extend from Haelen to Amsterdam, or from Mexico to Dubai and beyond.

Daniel, you changed the whole narrative. Who would've ever guessed this bubbly city-girl wanted to camp on a mountain in the cold, and would actually enjoy the peace and quietness. You must be something really special. You've made the last leg of this PhD journey one full of smiles and sunshine, despite the many obstacles we faced along the way (dare I list the sickness, accidents and fresh scars, doctor visits and veterinarian visits, broken, missing and robbed stuff, phone issues beyond imagination, and a dose of visa trouble to top it off). You keep calm when life (or I) gives you chaos. I am excited to explore many more mountain views together. A muchos aventuros mas.

About the author

Anouk Geenen (1992) was born in Weert, The Netherlands. She studied at the University of Amsterdam, where she obtained a BSc in Liberal Arts & Sciences, and a MSc in Theoretical Physics. As part of her studies, Anouk had the opportunity to spent a semesters abroad in Melbourne (University of Melbourne), and New York City (Stevens Institute of Technology). She gained professional experience as a teacher, teaching physics to high-school students and university undergraduates (2012-2018), and as a consultant working on sustainability (2014-2016) and public-private partnerships (2017-2018). Intrigued by the role of technology in society, Anouk chose to extend her academic background by pursuing an internship at renowned Rathenau Institute, where she did research on public values in relation to the smart grid. Her curiosity on socio-technical challenges was sparked, which led her to pursue a PhD in socio-technical controversies at the University of Twente.

As part of her transdisciplinary PhD research, Anouk applied design research to explore the constructive potential of socio-technical controversies to bring stakeholders together, to stimulate democratic participation and ethical deliberation on smart urban technologies. The work of Anouk and her colleagues has been regularly featured at Dutch Design Week over the last years. She received the David Hakken Grant (2020) for her work in participatory design and interdisciplinary thought leadership, and received the EuroDIG scholarship (2022) to participate in the European Dialogue on Internet Governance and share insights on the value of design research for multi-stakeholder collaborations.

Anouk underlines the importance of engaged scholarship, which she expressed amongst others through her active contribution to ongoing DEI debates at both the UvA and the UT. She was granted the UT Incentive fund twice, for two distinct, university-wide projects to promote diversity and inclusion at the UT. As part of the PhD committee, she initiated the first PhD writing week with the DPM department. Moreover, she is co-founder of the Speculative Futures chapter in The Hague and aims to bring creative futures-thinking to a wider audience.

Anouk truly beliefs there is great power in combining analytical and critical skills with creative and generative approaches, in order to make the complexity of current and future socio-technical challenges more accessible for both decision-makers as the wider public. She is eager to continue her research within her current position as design researcher within the Societal Impact Design group at Hogeschool Inholland, whilst having a great curiosity for what other paths life may offer.

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