

Einar Sneve Martinussen

POCKETS AND CITIES

Investigating and revealing the networked city through interaction design

Einar Sneve Martinussen

Pockets and Cities

Investigating and revealing the networked city through interaction design



Arkitektur- og designhøgskolen i Oslo
The Oslo School of Architecture and Design

© Einar Sneve Martinussen, 2015

ISSN 1502-217x

ISBN 978-82-547-0278-9

CON-TEXT 74

Pockets and Cities

A doctoral thesis submitted to:

The Oslo School of Architecture and Design

PUBLISHER:

The Oslo School of Architecture and Design

COVER ILLUSTRATION:

Einar Sneve Martinussen, Timo Arnall and Jørn Knutsen

FIGURES AND ILLUSTRATIONS:

Unless otherwise noted, all figures and illustrations are credited to the author.

PRINTED BY:

Akademika Publishing

DESIGN:

Einar Sneve Martinussen

Contents

Acknowledgements	1
Abstract	3
1. Introduction	7
1.1 Background and context	9
1.1.1 Research questions	14
1.2 Design research practice	15
1.2.1 Practice and production	16
1.2.2 Summary of publications	17
1.2.3 Arguments and contributions	21
1.3 Structure and form of the thesis	22
2. Context and background	24
2.1 Situating the project	25
2.2 Interaction design	27
2.2.1 Perspectives on interaction design	27
2.2.2 Technology as material for interaction design	30
2.2.3 Culture, interaction design and technology	33
2.2.4 Critical approaches to design	38
2.2.5 Ubicomp	40
2.3 The networked city	42
2.3.1 The Smart City	45
2.3.2 Critical perspectives on the networked city	48
2.4 Everyday life	50
2.4.1 Everyday life and technological change	52
2.4.2 Everyday urban life and the ‘production of space’	54
2.4.3 A cultural perspective on everyday life	55
2.4.4 Culture as a ‘whole way of life’	56
2.4.5 Production and circulation of meaning	57
2.5 Reflections on context and background	61
3. Practice and methods	64
3.1 Practice-led design research	64

3.2 Discursive design	66
3.3 Practice	69
3.3.1 The <i>Immaterials</i> project	69
3.3.2 <i>Immaterials: Ghost in the Field</i> (2009)	71
3.3.3 <i>Immaterials: Light Painting WiFi</i> (2011)	80
3.3.4 <i>Immaterials: Satellite Lamps</i> (2014)	87
3.5 The work in the world	94
Anecdote 1: Watching the numbers	95
Anecdote 2: Across and beyond the web	96
Anecdote 3: Inspiring visual language and techniques	97
Anecdote 4: Education	100
Anecdote 5: Exhibitions	102
Anecdote 6: Opinions and public debate	102
Anecdote 7: Re-enactment	104
Anecdote 8: The unexpected	106
3.5.1 Reflections on cultural circulation	108
3.6 Methodological themes	111
Interdisciplinary connections	111
Observation and interpretation	111
Collaborative and creative generative production	114
Exploration and experimentation	117
Material explorations of technology	119
Exploring visual techniques	124
Documentation	124
Communication and dissemination	125
3.6.1 Limitations and challenges	128
3.7 Reflexive mixing of methods	130
4. Methodological reflections	133
4.1 Design research practice as cultural engagement	133
4.1.1 Material practice	134
4.1.2 Popular practice	137
4.1.3 Critical practice	142
5. Analytical themes	146

5.1 An analytical position on the networked city and interaction design	146
5.1.1 The networked city as material and spatial	149
5.1.2 The pasts, presents and futures of the networked city	152
5.1.3 Invisibility and the technological imagination of the networked city	157
5.1.4 Cultural materials of networked city life	161
5.1.5 Across networked city life	166
6. Conclusions	171
References	177
Article 1-4	193
Appendix A-D	265

Acknowledgements

Thanks to my supervisor Andrew Morrison for his dedicated, generous, and inspirational support. This thesis comes out of a collaborative, project-based practice that would not have been possible without my colleagues and friends Jørn Knutsen and Timo Arnall. I am grateful to the Institute of Design at the Oslo School of Architecture and Design (AHO) for supporting this explorative, and often experimental, research project. In particular I want to thank my institute leaders Rachel K. B. Troye and Jonathan Romm, my teaching and research colleagues, and our students.

This project is connected to the research project YOUrban, founded by the Norwegian Research Council, and Verdikt. I'm thankful for the support and inspiration from my colleagues within the YOUrban project, including Jonny Aspen from AHO's Institute of Urbanism and Landscape and Even Westvang from the design studio Bengler. Thanks to Espen Sommer Eide for the music, and to my friends across the Internet for inspiration and motivation. I'm grateful to Taina Bucher for reading the first draft of this thesis, and to Aylish Wood, Guy Julier and Tim Anstey for their evaluations.

This thesis is dedicated to my wife Ida Rein, my daughters Anna, Kajsa, and Ellinor, and my parents Ranvei Sneve and Dagfinn Martinussen.

Einar Sneve Martinussen
Oslo, April 2015

Abstract

This thesis is about investigating and revealing the networked city through interaction design. The ‘networked city’ describes the interweaving of digital, networked technologies with the urban landscape and everyday city life. The networked city has become a prominent topic in recent years across academia and industry, and is making its mark on daily life. Networked city life is enacted through wireless networks, satellite navigation, and ever-more sophisticated mobile devices, while the discourses of emerging technologies in cities are dominated by technology-led visions of the ‘smart city’ (Greenfield, 2013). In this thesis I address these issues through practice-led interaction design research that seeks to explore, visualise, and communicate the technological and cultural invisibilities of the networked city.

This project comes out of a collaborative project- and design-based practice. It is a ‘research-by-design’ project that draws together an interdisciplinary frame spanning interaction design, urbanism, and theories of everyday life and culture. In this project I pursue an explorative, reflexive design research practice that seeks to visualise and communicate emerging technologies in cities. The thesis addresses two connected research questions: first, how can the often invisible, technical structures of networked city life be investigated and made visible through interaction design? And how might practices of explorative and communicative interaction design contribute to new perspectives on the emergent networked city? These questions are further part of the research challenge of developing an analytical position on the networked city and interaction design situated in everyday life and culture.

The design, development, and dissemination of a film series titled *Immaterials* plays a central part in the research practice of this thesis. The *Immaterials* series was produced by myself and a small team of interaction design researchers. In this series of online films we investigate and visualise three common, yet invisible, urban technologies: RFID, WiFi, and GPS. With the *Immaterials* films, tools and approaches from interaction design were used for doing technical, material investigations of technology, and further turning these investigations into communicative and discursive artefacts for engaging with the popular cultural understanding of technologies. The films and artefacts produced in this thesis therefore have a dual analytical and methodological function; they are a means for revealing the networked city, and

catalysts for a wider cultural discussion of the role of emerging technologies in urban life.

Through the practice of this thesis I illustrate and argue for an expanded view of interaction design that is not limited to issues of technology and use, but that explores how technologies are understood culturally. Interaction design is here approached in a discursive and cultural frame, where the tools and methods of the discipline are put to use for navigating, translating, and engaging between and across technology, materials, and media. We have termed this a 'discursive design' approach that uses the languages and techniques of design to explore and communicate complex technological issues, and to promote discourse, critique, and invention.

In this project, analysis is threaded through a reflective design research practice. Alongside the body of the design work, I have identified and developed a set of themes for analysing the relationships between interaction design and the networked city. These are informed by the practice-led interaction design research, alongside interdisciplinary analysis that draws together concepts from interaction design and networked urbanism with theories of everyday life and culture studies. Together, the thematics work towards developing an analytical position on the networked city and interaction design. This analytical positioning situates these fields in relation to both everyday life and to the cultural materials and expressions that accompany new technologies into daily practices. This is further connected to how design can contribute to these cultural materials through discursive, mediated artefacts such as online films.

With this thesis, I make contributions on three main levels. I develop analytical themes and discussions that investigate the relationships between the networked city, interaction design, and daily urban life. Through the practice-led research, I also develop examples of how interaction design can be used for contributing to, and stirring, popular cultural discourses of technology. Finally, through this project I have created and communicated a body of design work that in itself contributes to the imagery of networked city life.

Chapter 1

Introduction

The urban landscape is changing in ways that can't always be seen. As digital, networked technologies become a part of daily urban life, the invisible terrain of the networked city is taking shape. The 'networked city' describes an emergent urban condition where computation and wireless, digital communication is an integral part of the urban fabric, and where digital technologies are increasingly important across planning, governance, and everyday urban life. The emergence of networked city life can be glimpsed in the glow of millions of high-resolution touchscreens. Its presence is indicated by chirping phones, vibrating pockets, online maps navigated by satellites, and social media practices that change as quickly as fashion. Wireless networks keep our devices tethered through fleeting signals; delicate touchscreen finger gestures translate into casual interactions with the vast complexities of the web.

Networked city life is taking place in cafés, streets, and across popular culture, yet the technological phenomena it is built upon remains invisible. The wireless landscape of the networked city is largely unseen by the naked eye. This 'electromagnetic terrain', as Mitchell (2004) observed, is intricate, invisible, and only hinted at by the presence of antennas (p. 55). This thesis is about investigating and revealing the networked city through interaction design. Through practice-led design research, I visualise and communicate its invisible technologies, and question how the networked city can be conceptualised and understood in a cultural context.

Over the last decade, interactions with digital, networked technologies have become a largely naturalised part of urban life. Online maps, electronic ticketing, games, social media, and ever-more sophisticated mobile devices are bringing together urban and online practices. In 2002, Amin and Thrift (2002) suggested that code and software would be increasingly responsible for the future of cities, and that 'nearly every urban practice is becoming mediated by code' (p. 125). Today, digital structures are not only involved in how cities are planned and governed; they are interwoven with urban life as interactions with mobile devices and networked services that are simply taken for granted. Graham (2004) observed how 'new media technologies are being woven so completely into the fabric of everyday urban, social and economic

life that they, in turn, are becoming more and more ignored in cultural and media discourse' (p. 23).

Similarly, Mackenzie (2010) discussed how mobile devices and wireless networks increasingly are becoming a part of the backdrop of daily life. Mackenzie observed how this 'wirelessness' affects 'how people arrive, depart, and inhabit spaces, how they relate to others, and indeed, how they embody change' (ibid, p. 5). As everyday urban life increasingly becomes enacted with and through networked technologies, the networked city is manifested in the interactions with these products and systems; this leads to new ways of using, experiencing, and understanding the city.

In the emerging cultural and technological landscape of the networked city lies new challenges, and unknown problems and potentials for new ways of researching and designing within urban life. The main research questions I address are: how can the invisible structures of networked city life be investigated and made visible through interaction design? And how might practices of explorative and communicative interaction design contribute to new perspectives on the emergent networked city? These questions are part of the overarching research challenge of developing an analytical position on the networked city and interaction design situated within everyday life and culture. Together, these questions address how the networked city can be explored and analysed through an interdisciplinary approach, and further, how interaction design research can be used to gather insights and to create meaning at the meeting point between new technologies and everyday urban life. Analytically, the point of departure is how interaction design research can contribute to the field of the networked city and, in turn, how investigating and visualising the networked city might challenge interaction design, both as research and as practice.

I take up these research questions through an explorative, practice-based design research project where critical reflection on technology is brought together with hands-on material investigation of the phenomena of the networked city. I do this alongside a culturally oriented interaction design practice directed towards communication and mediation. I make contributions on three main levels. Analytically, I identify and develop interdisciplinary themes and perspectives on the relationships between networked city life and interaction design. Methodologically, through practice-led research, I develop a set of examples and discussions of how interaction design can be used for

engaging with popular cultural discourses of technology. As design outcomes, I have created and communicated a series of visualisations and films that investigate common, invisible technologies. Through online dissemination and cultural circulation, this body of design work contributes to the imagery and ‘technological imagination’ (Balsamo, 2011) of networked city life.

In this Introduction I first briefly situate the thesis by outlining the context for the project. Second, I elaborate on the research questions, concepts, and issues that the thesis addresses. I then describe the central design works and publications this project has produced, as well as some of the approaches that have been taken. Finally, I outline the structure and form of the thesis.

1.1 Background and context

I have taken an interdisciplinary approach to the networked city and interaction design, analytically, methodologically, and conceptually. I bring together three main fields of research: interaction design, research on the networked city, and everyday life and culture. These fields of study overlap thematically, but their relations are rarely considered analytically or methodologically. One of the contributions of the thesis is to explore and analyse theoretical crossovers between these fields in order to discuss relationships between interaction design and networked city life (see Chapter 5).

Since the 1980s, digital, networked technologies in cities have been addressed across multiple fields of research, including computer science and human-computer interaction (HCI) (e.g., Paulos & Jenkins, 2005; Foth et al., 2009), urbanism and geography (e.g., Graham et al., 2004; Amin & Thrift, 2002; McCullough, 2004; Mitchell, 2004), cultural and social studies (e.g., Crang et al., 2007; Galloway, 2004, 2008), and artistic research (e.g., Benford et al., 2004). Research areas range from urban planning and surveillance to locative (i.e. location-related) social media, artistic experimentation, ethnographic studies of technology use, and civic participation.

A number of different concepts and terms have been used across these fields to describe the interweaving of the urban and the digital, such as ‘urban computing’ (e.g., Kindberg et al., 2007), ‘urban informatics’ (Foth et al., 2009), and the ‘smart city’ (e.g., Townsend, 2014). In this thesis I have chosen to adopt the term ‘networked city’, because it places the emphasis on

networks and communication (Mitchell, 1999; 2004), rather than disciplines and specific agendas or visions. The term the 'networked city' is also open to a number of interpretations and can be understood on various scales. I therefore see it as a fitting starting point for interdisciplinary research.

On a consumer scale, networked city life is closely connected to the industries surrounding software, hardware, and content for smartphones and mobile devices; some of the more prominent companies are Apple, Google, and Amazon. A central characteristic of the emergence of the networked city is that developments and changes of both technologies and their use are happening rapidly. Just in the last five years these have included the global propagation of smartphones and tablets, new wireless infrastructures, and mobile online maps, new business models for selling wireless data-traffic, and electronic ticketing systems for public transport. We have also witnessed the coming and going of social media trends, many of which are connected to locative technologies and situated use (such as Foursquare and Instagram).

On an industrial and commercial scale, the field of urban technology is dominated by companies that work with the research and development of computational systems and infrastructures for cities, such as IBM, Siemens, and Cisco. Over the last decade this industry has developed and promoted the concept of the 'smart city' as the dominant vision for near-future urban technology (Townsend, 2013; Deakin & Waer, 2012). The smart city discourse is largely driven by technology companies with a background in informatics systems; ones that have moved towards developing and promoting ICT-based solutions for the management of cities. Proposed smart city systems typically involve infrastructure for collecting urban data using embedded sensors, and using this data to optimise the allocation of resources and for security operations and control. Different smart city systems are currently being implemented by municipalities in cities around the world, while others are in the planning and marketing stages.

It is important to note that the conceptual and theoretical space of the networked city is contested. Central to the discourses of the networked city are competing visions of how, and by whom, the future of networked urbanism should be developed. The vision of the smart city has been met by critiques that question what impact these forms of pervasive, networked technologies will have on everyday urban life. Researchers such as Greenfield (2013) and Townsend (2013) further suggest that the possibilities and challenges for



Figure 1.1. Networked city life takes place across everyday urban practices. Smartphones have made the web mobile and locative, bringing the networked city into our pockets and purses.

networked city life should be developed within and across social and public contexts of urban and civic life.

Research on the networked city rarely takes up issues of interaction design, but in this thesis I see these two fields as closely connected. Networked city life is made possible by fibre-optic cables, wireless networks, satellites, and data centres. In daily urban life, however, the networked city is manifested through interactions with devices and interfaces that, more often than not, are found in our pockets (see Dourish & Bell, 2007; Martinussen, 2013). I have titled this thesis *Pockets and Cities* to reflect this, and to establish a point of departure: namely, interaction design situated across everyday life and culture (Figure 1.1).

Interaction design can be broadly defined as the design of how technological systems are used and experienced (Hallnäs & Redström, 2006). As a field with roots in computer science and HCI, interaction design has typically been associated with use- and user-oriented design of computer-based products and systems (ibid), but these notions have been expanded to more widely consider how to design across the activities and contexts that digital technologies are a part of (see Dourish, 2001; Buchanan, 2001).

As networked, digital systems and devices have become an increasingly important part of society (as exemplified by the emergence of the networked city), researchers such as McCullough (2013) and Balsamo (2011) have argued that the discipline of interaction design is of growing cultural relevance. Here, interaction design is not just seen as the shaping of use and functions, but as a practice that mediates and establishes cultural meaning between new technologies and everyday life. Interaction design research and practice have both begun to develop approaches that take up these issues, including ‘critical design’ (Dunne & Raby, 2013) and ‘discursive design’ (Morrison et al., 2011). In a critical or discursive frame, interaction design is not only related to how computational products are used and experienced, but also to how technology is culturally mediated and made meaningful across different contexts. In this thesis, a cultural approach to interaction design offers a way to address the relations between the everyday use of the technologies of the networked city, and the cultural expressions and representations that these are connected to and embedded within.

Interaction design, it should be stressed, has a legacy of working with emerging technologies and the near-future, as well as of dealing with the minutia of technology use. I suggest that bringing interaction design together with research on the networked city can bring out current meeting-points between citizens, urban experience, and popular expressions of technology, but it can also uncover possibilities for future inventions. In this thesis I therefore see interaction design as potentially having a unique position in the overlap between technological developments and everyday life, which enables both conceptual and practical means for negotiating and engaging with the emergence of the networked city.

Although the networked city is increasingly present in everyday life, through interactions, media, and products, the technological phenomena of the networked city are largely invisible. The technology is either physically unseen,



Figure 1.2. The ‘electromagnetic terrain’ of the networked city takes many forms, and is often a complex intertwining of old and emerging infrastructures. Credit: Jørn Knutsen.

such as radio waves, satellites, or software, or, following Latour (1999), deeply ‘black-boxed’ as data-centres, communication protocols, transoceanic cables or antennas (Figure 1.2) (Callon & Latour, 1981; Star, 1999). The invisible nature of the technological foundations of the networked city is crucial to how it functions, and to how it gets embedded in daily life.

As well as being technologically unseen, our everyday interactions with the networked city are becoming something to be taken for granted. Within cultural studies of technology and design, Highmore (2009) observed that everyday life witnesses ‘the path technologies take when they become ordinary’ (p.5). When new technological artefacts, such as digital, networked interactions and smartphones, become embedded in everyday practices, they

'fade from view' (ibid) and take on a form of cultural invisibility. As it is taking shape, the networked city is thereby fast becoming both technically and culturally invisible. Investigating and revealing relationships between these various forms of cultural and technological invisibility, and the tensions and biases these give rise to (Feenberg, 2010), is one of the central topics of this thesis.

This thesis, then, is a reading and interpretation of the networked city founded in interaction design and stretching across everyday life. I am primarily interested in the cultural dimensions of the emergence of the networked city, and how it is taking shape in everyday life and culture through interactions, representation and imagination. My main focus is not on technological systems, infrastructures and visions in themselves, but in how they become a part of popular imagination and cultural understanding, and further, how interaction design research can engage and contribute to this cultural landscape.

1.1.1 Research questions

In this thesis I approach the emergence of the networked city by addressing two connected research questions: first, how can the invisible landscape of the networked city be investigated and revealed through interaction design? By this I mean, how can analytical and generative approaches from practice-led interaction design research be used to develop ways for visualising and communicating the technological phenomena of networked city life? At one level I want to access and analyse the material aspects of the unseen technologies of networked city life. In addition, I want to find ways for situating the discourses of the networked city within the realities of contemporary urban environments.

The first research question leads to the second: How can interaction design be used to generate, or discover, new perspectives on the networked city? I am interested in two aspects. First, how can visualising and communicating about networked cities through design be used to articulate (or re-articulate) networked city life culturally? Second, what form of interaction design research could this practice point towards? And how might interaction design be used in creating meaning in the meeting-point between new technologies and everyday culture?

The two research questions are connected, and while the first is directly responded to within the design research practice and outcomes (see Chapter 3), the second question is discussed in connection to these outcomes in Chapters 4 and 5. Across these two questions I address the overarching research challenge of developing an analytical position on the networked city and interaction design situated within everyday life and culture. This is addressed in Chapter 5 through identifying and discussing four interdisciplinary, analytical themes on the relationships between networked city and interaction design.

1.2 Design research practice

This project comes out of, and was developed through, a purposefully broad and varied design research practice. I take a ‘research by design’ approach (see Morrison & Sevaldson, 2010), where experimental, reflexive design practice is used as a mode for exploring and developing knowledge and reflection. Further, the research comes out of what we have called ‘discursive design’ (see Article 1 and Chapter 3). Put simply, discursive design can be described as an approach to interaction design where the tools and methods of the discipline, rather than being focussed on use and interfaces, are put towards communicative use in contributing to discourse. Here, interaction design is not seen as a practice for problem-solving and innovation, but is used for investigating and communicating about emerging technologies in a cultural, discursive frame. In taking a discursive design approach, the focus has been on how interaction design might be used to engage with how technologies are discussed and understood culturally.

Throughout this research process I have used a medley of design competencies and research methods through mixing reflexive, analytical and generative design research practice situated across technology and culture (see Chapter 3). Central to this practice is the iterative overlapping between explorative and communicative design, and academic reflection and cultural observation and interpretation. In analytic terms, the research brings together concepts from the networked city, interaction design and theories of culture and everyday life to discuss and reflect on characteristics, potentials and challenges of emerging networked city life.

1.2.1 Practice and production

The most visible output of this thesis is the *Immaterials* project, with its series of visualisations and films: *Immaterials: Ghost in the Field* (Figure 1.3), *Immaterials: Light Painting WiFi* (Figure 1.4) and *Immaterials: Satellite Lamps* (Figure 1.5). These films explore and visualise, in turn, radio frequency identification (RFID), wireless networks (WiFi) and the Global Positioning System (GPS). These technologies are crucial to today's networked city life, yet are poorly understood outside technical fields. In the *Immaterials* films we show the development of instruments and techniques for mapping and visualising these invisible technologies as spatial, urban phenomena. The production of these films has been a collaborative process involving a small team of interaction designers and researchers connected to the research projects Touch and YOUrban at the Oslo School of Architecture and Design (both funded through the Norwegian Research Council).

The *Immaterials* films are research outcomes, highly expressive designs and active engagements into popular culture. In the four publications included in this thesis, the films, their background and the process of making them are discussed from several perspectives. As such, they also act as vehicles for analysing the relationships between networked urban life and interaction design, and for developing an argument for how interaction design might be used for engaging with networked technology in a cultural frame.

This thesis has a specific focus on communication, which is visible in how the films were produced and distributed towards popular online media. Our motivation was to use our explorations and visualisations to make the invisible landscape of the networked city accessible to a wider public, including designers, researchers and ordinary citizens. The broad popular uptake of the films in news media, exhibitions, magazines, teaching, books and across the Internet is therefore an important part of this project (see Chapter 3.5). With its popular propagation, I argue, the project moves from exploration and communication of technology through design, towards a form of cultural engagement with how these technologies are articulated, understood and imagined.

In this thesis I develop layered discussions about networked technologies in cities, media and design. These discussions are informed by practice and reflections on technology rooted in interaction design making and analytical reflection. This, then, is not a thesis where a set of design cases have been developed, to then be analysed. The practices and outcomes are analytical

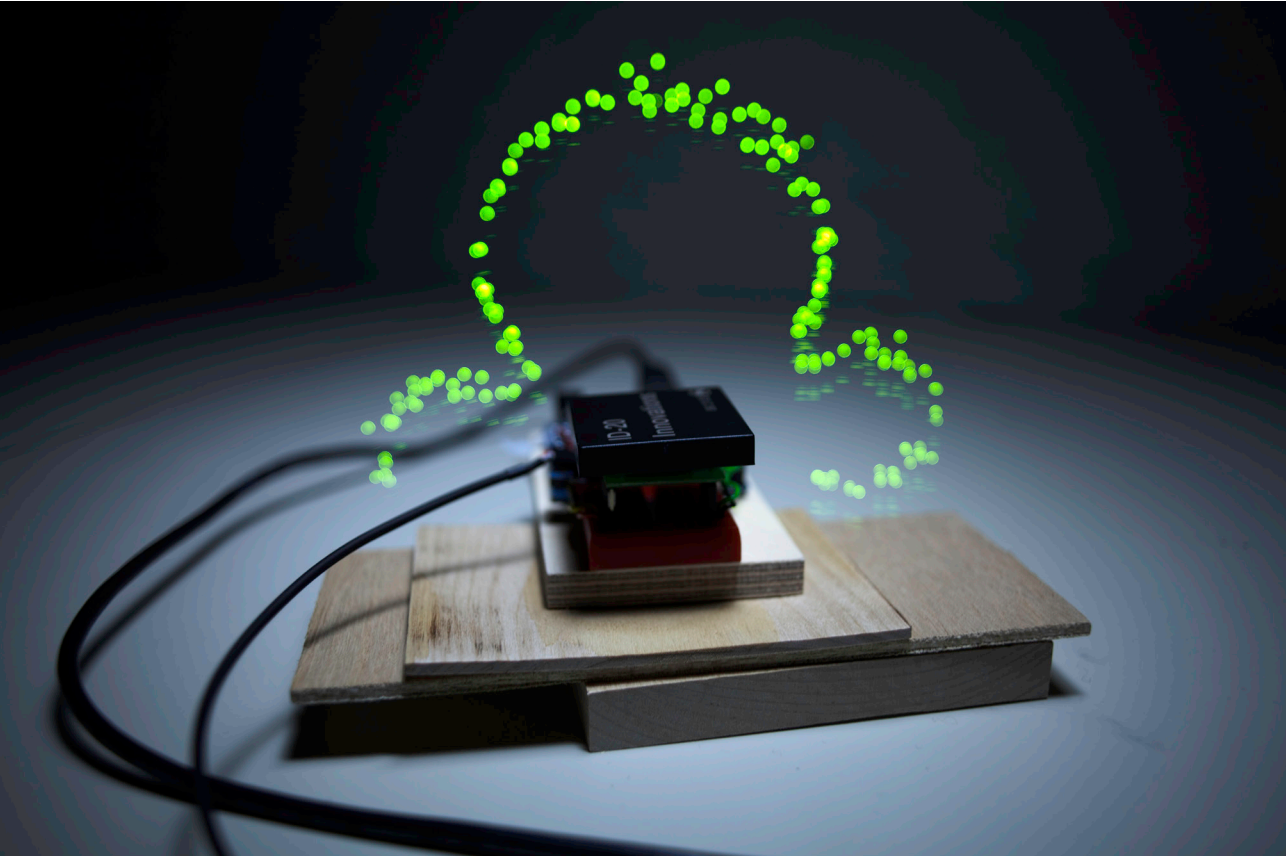


Figure 1.3. Still from *Immaterials: Ghost in the Field* (2009):
<http://www.nearfield.org/2009/10/immaterials-the-ghost-in-the-field>

in themselves as a form of discursive design. The analysis is also integrated in how the design practice and outcomes interpret the networked city. The object of analysis, in both the writing and in the films, is the conceptualisation of the networked city through interaction design, and the cultural potential this might entail.

1.2.2 Summary of publications

Alongside the design-oriented outcomes of the project (the *Immaterials* films, the artefacts and the communicational practice), the thesis consists of four publications. The first, 'Depth of Field: Discursive Design Research through Film' (Arnall & Martinussen, 2010), published in the journal *FORMakad-*

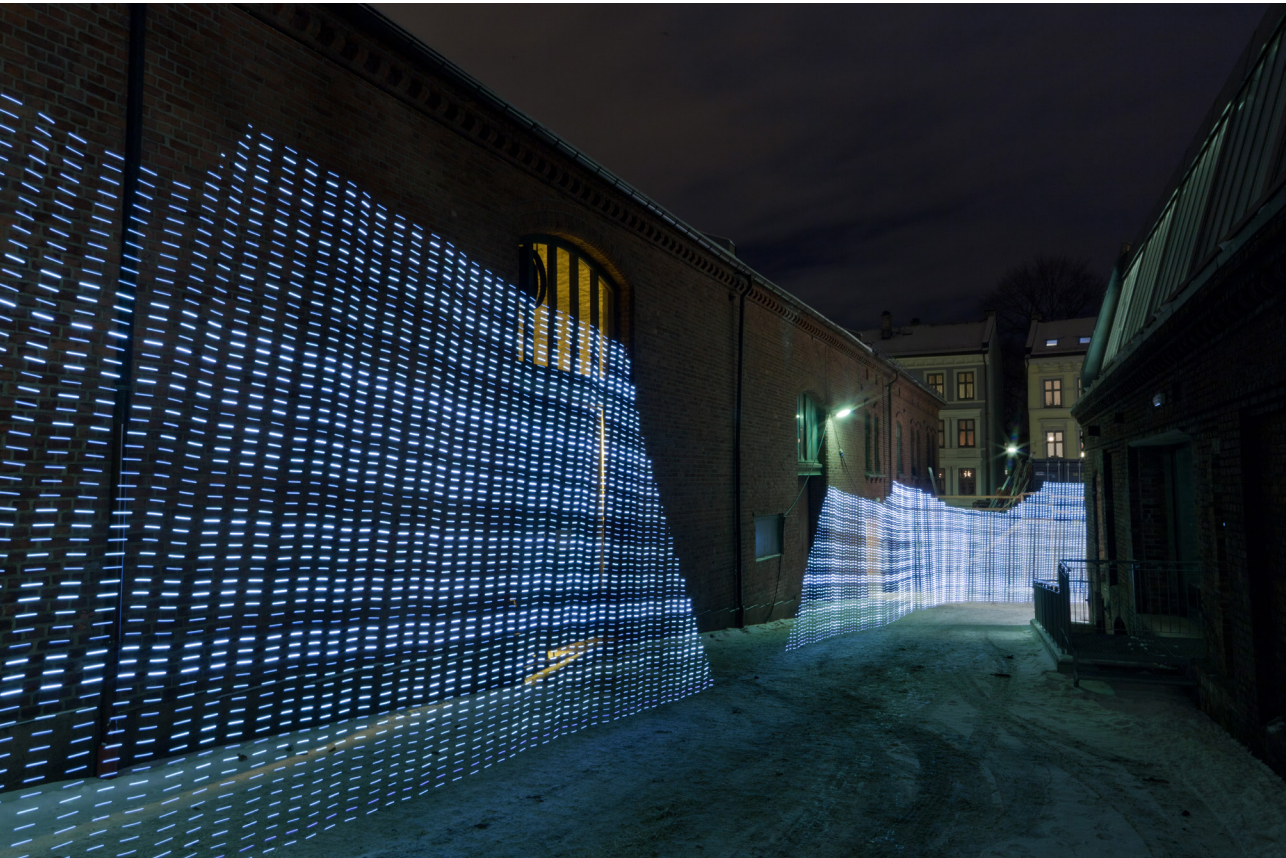


Figure 1.4. Still from *Immaterials: Light Painting WiFi* (2011):
<http://yourban.no/2011/02/22/immaterials-light-painting-wifi/>

emisk, is about combining interaction design research with the production of online film to find new ways of exploring and communicating about technology. This article gives an account of how film has played an intricate role in our design research practice, from revealing the materiality of invisible wireless technology, to explaining complex technical prototypes, to communicating to a broad audience through online mediation. In this article we also discuss how the use of film as a reflexive and communicative medium ‘allows for design research to operate within a social and cultural frame’ (Arnall & Martinussen, 2010, p. 100).

‘Depth of Field’ was published as an online article with a collection of embedded films, including *Immaterials: Ghost in the Field*. ‘Depth of field’ is



Figure 1.5. Still from *Immaterials: Satellite Lamps* (2014):
<http://kairos.techorhetoric.net/19.1/inventio/martinussen-et-al/>

not a publication that specifically addresses the networked city, but its topic, RFID, has come to be an important aspect of networked city life. The article forms the foundation of the methodological analysis and production of this thesis by covering the development of the discursive design research approach that this thesis comes out of.

The second publication is a book chapter titled ‘Making Material of the Networked City’ (Martinussen, 2012) published in the edited book *Design Innovation for the Built Environment* (Hensel, 2012). In this publication I describe and analyse the development and design of our visualisations of wireless WiFi networks, as shown in the film *Immaterials: Light Painting WiFi*. In this publication, the focus is on the WiFi visualisations as imagery, and how

these might act in contextualising the invisible, technical phenomena of the networked city as a material and spatial part of the urban landscape. The publication reflects on what these visualisations can tell us about the material aspects of wireless networks in cities; it concludes by elaborating on how this project relates to the discourses of networked city research.

The third publication, 'Pockets and Cities: Interaction Design and Popular Imagination in the Networked City' (Martinussen, 2013), published in the journal *Design and Culture*, looks at the film *Immaterials: Light Painting WiFi* and its propagation through popular media. In this publication I also analyse the role of media representations in how networked city life is conceptualised culturally. I bring together concepts from the networked city with theories of everyday life to illustrate and problematise relations between interaction design, popular imagination and technological change. Finally, I situate the WiFi-film within the context of online culture and mediation, and propose that the film can be seen as an example for how interaction design research can be directed towards designing for popular imagination.

The final publication, titled 'Satellite Lamps' (Martinussen et al., 2014), is an experimental online research article about the production of the film *Immaterials: Satellite Lamps*, and was published in the journal *Kairos—A Journal of Rhetoric, Technology, and Pedagogy*. This film is about visualising how the urban landscape affects the accuracy of GPS signals. In the 'Satellite Lamps' publication we give a detailed and media-rich account of the design process and research practice of the project.

Given the format of the online journal *Kairos*, we had the opportunity to purposefully design an online article for communicating the heterogeneous and layered nature of our design and research practice. We showed not only the polished outcomes, but the whole process, including failures, ongoing reflections, iterations, refinement and the multiple approaches and techniques involved in exploring the networked city through design. This publication was based on the collected documentation of the project, including sketches, photographs, diary entries and prototypes, and as such reflected the status of the research as communicative, reflexive, analytical and generative. The publication has a wide scope, and alongside an account of the design research practice, it also includes a selected cultural history of GPS and reflections on the emergence of the networked city.

‘Satellite Lamps’ plays multiple roles in this thesis: first, it offers a thorough description of, and reflection on, the discursive interaction design practice developed through the *Immaterials* project. Second, the design of the online form of the publication is an exploration of how this research can be disseminated, and how interaction design can be used in research communication. Finally, through its detailed accounts of practice, this publication also enables a meta-reflection around which form of design research the project constitutes.

1.2.3 Arguments and contributions

This is a multi-layered project, both in terms of practice and analysis. The inquiry is developed through both practice-led design research and interdisciplinary, analytical reflection. There were multiple routes for how this research could have been drawn together as arguments and contributions spanning the publications and design outcomes. I have chosen to follow up the research questions along two connected lines.

First, through exploring and investigating the relationships between the networked city and interaction design technologically, culturally and analytically. Through the *Immaterials* films and their dissemination I have worked towards making the networked city culturally visible. Through this project we have created and communicated a body of design work that in itself contributes to the imagery of networked urban life. With this discursive design practice, I argue for re-articulating discourses of emerging technology. Through these design-explorations and outcomes, insights and knowledge about interaction design and the networked city are generated and uncovered.

The design practice investigates the networked city and interaction design on a technological and cultural level. Through this thesis I also develop an analytical investigation of these relations and work towards an interdisciplinary, analytical positioning. This is developed in Chapter 5 through identifying and discussing four interdisciplinary, analytical themes that examine characteristics of networked city life: networked city life as *material*, *temporal*, *invisible* and *cultural*. As an analytical contribution, the themes propose a positioning for conceptualising and contextualising the networked city in relation to interaction design, everyday life and culture.

The second line of inquiry is concerned with analysing the interaction design research practice itself (see Chapter 4). I propose seeing this form of

culturally situated and communicative interaction design research as a way to design for and within the popular imagination. I reflect on this as a possible direction for engaging with everyday culture through interaction design. I argue for a stance on interaction design as a discursive practice that might navigate, translate and engage between and across technology, materials and media. As a methodological contribution, I develop a set of examples and discussions of practice-led interaction design research as an approach to popular cultural engagement through the production and dissemination of discursive design artefacts.

1.3 Structure and form of the thesis

The thesis is made up of various forms of media, including films, images, opinion articles, websites, and different forms of research publications. Some of these are included in this document, such as the four main research publications, a selection of online articles (see Appendix A-D) and a selection of images; others are referenced and included as links. The exegesis is structured as three parts: 1. Context and background (Chapter 2), 2. Practice and methods (Chapter 3) and 3. Discussions, reflections and conclusions (Chapters 4–6).

The first part consists of ‘Chapter 2: Context and background’, where I situate the thesis in a wider research context and draw up a background for the project. First, I locate my perspective on interaction design and elaborate on perspectives that I see as fruitful in the context of this project, including a selection of themes and topics that go beyond the traditional HCI framing. Second, I present the concept of the networked city, trace its histories, discuss the dominant visions and myths that surround it, and bring forward critical perspectives from different disciplines. Third, I look to theories of everyday life and culture for perspectives on how technologies find their way into daily life. Central topics here are the cultural invisibility of the ordinary, the ‘production of space’ (Léfebvre, 1991) and technoscience in daily life. I end the chapter with reflections on the issues this framing brings to the fore in relation to the research questions.

In ‘Chapter 3: Practice and methods’ I give an overview of design research methods, focussing on practice-based design research and discursive approaches to design research. Furthermore, I give an account of the design research practice that forms the basis of the thesis. I look at the *Immaterials*

project and films, the process of making them and their dissemination. I also discuss the cultural circulation of the films and how they have travelled, including popular online media, education and public discourse. I end the chapter with outlining the central methodological themes of the research.

In the final part of the thesis, consisting of Chapters 4–6, I discuss and reflect on how the design research practice and publications respond to the research questions and problematics raised in the thesis. ‘Chapter 4: Methodological reflections’ is a discussion of the design research practice of the thesis, and how this can be characterised as material, popular and critical. I develop an argument for seeing interaction design directed towards popular imagination as a mode for engaging with new technologies in everyday life. In ‘Chapter 5: Analytical themes’ I analyse characteristics and relationships of the networked city and interaction design, especially focussing on the interplay and tension between interaction, networked technology and daily life. In this chapter I identify and discuss four interdisciplinary themes that collectively work towards an analytical position on the networked city and interaction design. ‘Chapter 6: Conclusions’ includes reflections on the project as a whole and how it contributes directions and ideas towards the networked city and interaction design.

Chapter 2

Context and background

This is an interdisciplinary research project that involves and spans multiple fields of inquiry and practice. In this chapter I outline the context and background for the thesis and position the project towards relevant concepts. This establishes the background for the discussions and analysis that follow later in the thesis (see Chapter 4 and 5) and provides a context in which to situate the practice, the outcomes and the publications (see Chapter 3 and 4).

My research comes out of interaction design, and is set within the analytically emergent frame of the networked city. The networked city, and its relations with everyday urban life and interaction design, is a complex research context. I suggest that this necessitates an interdisciplinary perspective. As with other complex and emerging issues, these cannot be addressed within any single, existing disciplinary framework (Repko, 2012). In this thesis, interdisciplinarity is taken up analytically, drawing on concepts from design, urbanism, technology and culture studies, as well as methodologically, through practice-led interaction design research involving approaches from across the design disciplines, engineering, communication and filmmaking.

Interaction design has itself been defined as an inherently interdisciplinary field, drawing on a collection of methods and approaches from both traditional design areas and art, engineering and behavioural sciences (Hallnäs & Redström, 2006, p.126). Hallnäs and Redström (ibid) suggest that ‘as we search for a sound foundation for interaction design as it develops beyond initial fascination of new design opportunities, the question of how practice relate to theoretical foundations become increasingly important’ (p. 126). Addressing complex interdisciplinary contexts has been an important approach for extending the theoretical foundations of interaction design research. This can be illustrated by projects that specifically use interaction design practice as a means for working in interdisciplinary contexts. For example, Ward and Wilkie (2009) have brought interaction design education together with science and technology studies (STS) for examining how design can approach technoscience using sociologically inspired research techniques. Here, they draw on STS research into relations between scientific research and social, political and cultural values, to address interaction

design's relationships to technology development. Similarly, Kerridge (2009) has brought STS together with speculative design to explore potentials for public engagement with biotechnology.

The research presented in this thesis takes a related approach to interdisciplinary design research, bringing interaction design practice together with research from multiple domains. The design research activities have also been supported by a purposefully broad reading of research across several fields; popular writings from design, technology and more; evolving online discourses; as well as the interpretation of popular media. This has led to a rich and widespread enquiry that cultivates relational, and often tangential, insights that are brought together through the design research practice and its outcomes. The analytical and conceptual construction of this interdisciplinary framework is thereby also a central part of the contribution of this research.

2.1 Situating the project

In this chapter I bring to the foreground research from within three main fields: research and practice within interaction design, developments and critiques of the networked city, and studies of everyday life and culture:

The field of interaction design is the starting point for the thesis and serves two complimentary functions: as a theoretical context and as a generative practice. First, as a theoretical field, interaction design research has spurred influential conceptualisations for how we interact with technologies, including the notion of 'ubiquitous computing' (Weiser, 1991) and material approaches to technology (e.g., Vallgård & Redström, 2007; Blanchette, 2011). Interaction design research has also developed critical approaches to design and technology, such as 'critical design' (e.g., Dunne & Raby, 2013) where the tools and languages of design are used to question technological innovations. Interaction design research has also begun to turn towards cultural perspectives on design and technology (e.g., Balsamo, 2011), even though these primarily are confined to use- and user-centred issues (Hallnäs & Redström, 2006).

Interaction design also offers approaches and methods that are central to the practice-led research of this thesis. In this chapter I will give an overview of

theoretical aspects for locating the research, while in the following chapter I will focus on practice and methods (see Chapter 3).

The networked city is the overarching thematic that the project is situated within. The emergence of the networked city as part of contemporary urban life has been a research subject within urbanism over the last few decades (e.g., Graham et al., 2004). Today, research on networked cities is dominated by commercial development and discourses around 'smart cities' that primarily come out of technology- or planning-led initiatives (Townsend, 2013). In locating my perspective on the networked city, I draw on a growing body of critical discussions of the potentials and challenges of networked, interactive technologies in everyday urban life (e.g., Greenfield, 2013; Galloway, 2004, Bell & Dourish, 2007). Furthermore, in this thesis the emergence of the networked city is seen in relation to an intertwining of technology and culture (see Slack & Wise, 2005) through everyday life, cultural expressions and interaction design.

The third part of this thesis' background is everyday life and culture. Studies and theories of everyday life have been central in urbanism and cultural geography, but are rarely taken up in research and development of networked cities. Perspectives on everyday life and culture are similarly lacking in the dominant technology-centric discourses of HCI. In this project I bring perspectives on everyday life and culture into discussions and reflections on the relationships between the networked city and interaction design. I take up everyday life and technological change (e.g., Michael, 2006; Highmore; 2002; Slack & Wise, 2005), urban life and the 'production of space' (Léfévre, 1991; Moran, 2005), as well as perspectives on everyday culture (Williams, 2002; 2013) and the production and circulation of cultural meaning (e.g., du Gay et al., 2013; Hall et al., 1997).

In structuring this chapter I start with interaction design, followed by the networked city, and end with everyday life and culture. At the end of the chapter I elaborate and discuss the research issues and questions of the thesis within the context and background drawn together here.

2.2 Interaction design

In broad terms, interaction design concerns the shaping of our use and experience of technological systems, including, but not limited to, digital interfaces, online services and products where digital technology plays an important role. Interaction design is an interdisciplinary field that has its roots within computer science and HCI. Today the discipline has developed far beyond its technology-centred origins to include aspects such as product design, visual communication, electronics, web design and information visualisation, as well as artistic and critical practices (e.g., Dunne & Raby, 2005; Benford et al., 2004).

As interactions with computational systems have moved from workplaces and desktops towards mobile and social contexts, the discipline of interaction design has expanded from designing self-contained interfaces, to facilitating and shaping activities across software, products and environments. Interaction design currently involves both designing the detailed behaviour and experience of products and services, as well as addressing more widely how ‘contexts shape actions’ (McCullough, 2004, p. 47). This shift in the discipline is also reflected within interaction design research, which today encompasses a broad set of approaches to emerging technologies; media and communication design; and concepts surrounding ubiquitous computing, user-centred design, and tangible and embodied interaction (Bagnara & Crampton-Smith, 2006).

2.2.1 Perspectives on interaction design

In my research and design practice, I have adopted a purposefully broad definition of what interaction design is and what it entails. Included within my scope is the design of how digital technologies are used, understood, and experienced; it involves both the shaping and conceptualisation of technology into use and understanding, as well its relations through the communicative and cultural (Balsamo, 2011). Interaction design, in this frame, represents granular insights into the shaping of technology, alongside concepts and perspectives on the use and experience of technological systems across different contexts. In this section I briefly situate my framing of interaction design by drawing up relevant perspectives on practice and research, going back to its technological origins within computer science and up to the current multi-faceted status of the field.

Dourish (2001) traces the origins of HCI as a parallel to the history of computing. Early mainframe computers relied on specialised ‘electrical’ or ‘symbolic’ interaction, where the operator programmed the computer using circuit-building or patch-cables, and later punch-card systems. These systems were followed by ‘textual’ interaction with the introduction of command-line interfaces, where interaction with the computer was done by writing code. The most significant transition in the history of computer interfaces, according to Dourish, was the following move from text-based to ‘graphical’ interfaces. Graphical user interfaces, alongside important input inventions such as Englebart’s mouse (1968), are still the central paradigms for computer interfaces.

With the transitions from one interface paradigm to the next, Dourish argues, interaction with computers gradually incorporated ‘a wider range of human skills and abilities’ (ibid, p. 14). Dourish uses this trajectory to emphasise the importance of HCI in the history of computing. Dourish argues that the development of interfaces from highly technical and specialised tools to interfaces that rely more on general human skills and abilities ‘allows computation to be made ever more widely accessible to people without requiring extensive training, and to be more easily integrated into our daily lives by reducing the complexity of those interactions’ (ibid, p. 14). This trajectory is interesting because it specifically connects the design of interactions with the increasing use and importance of computers across society. But it also indicates how HCI comes out of technology-led disciplines. Although the origins of HCI within computer science and engineering offers great technical possibilities, this legacy also brings with it a perspective on interaction design that typically focusses on usability, functionality, and problem solving.

In parallel with the increased use of computers and digital devices across daily life beginning in the 1980s, interaction design grew into a design discipline unto itself. In doing so it brought HCI together with traditional design disciplines such as industrial and graphic design (Bagnara & Crampton Smith, 2006). Hallnäs and Redström (2006) discuss definitions of interaction design from the last few decades and identify a shift of focus away from use- and user-oriented design of computational interfaces towards a more general design process, involving material exploration, expression, and invention. Bagnara and Crampton Smith (2006) argue that as daily life gets increasingly involved with complex interactive systems, interaction design research and practice is also getting more complex and diverse:

In a more comprehensive perspective, interaction design takes into consideration that any interactive system also develops and transforms the dynamics of human behaviour, changes experiences and the way people make experiences. So interaction design, like most other kinds of design, is often a conscious and explicit endeavour to imagine and design human behaviours, in this case behaviours in the digital world, by creatively exploiting the potential of digital technologies. (Bagnara & Crampton Smith, 2006, pp. xxv)

Interaction design, these researchers argue, is no longer just about designing computational operations, but takes place within the broader context of daily life, inventing new activities and new ways of living (*ibid*). Reflecting this, they argue, research in interaction design is going beyond the technologically centred frames of engineering and problem solving inherited from HCI and computer science, bringing together theoretical and practical frameworks for approaching complex relations between materials, interactions, services, technology, and culture (*ibid*).

In addressing the widespread implications of digital technologies, interaction design research has both developed and adopted a number of concepts and directions for reflecting on and theorising how new technologies can be interpreted and explored through design, including those of ‘experience design’, which addresses the holistic, experiential aspects of digital interaction (e.g., Buxton, 2007); ‘critical design’, which approaches the technological and societal issues through the use of design for speculations and critique (e.g., Dunne & Raby, 2001; Maze & Redström, 2009); and ‘reflective design’, which brings critical technological practice together with HCI (Sengers et al., 2005). In commercial settings, interaction design has also expanded from its former role of solving interface-related problems to exploring potentials of new technologies and directions for technological innovation (Moggridge, 2007).

Alongside the conceptual expansion of interaction design research, interaction design practice has also undergone an extensive disciplinary diversification. Interaction design has come to involve a number of disparate design fields, including graphic design, media and communication design, product-development, and electrical engineering. But interaction design is also developing its own disciplinary tools, insights, and sets of knowledge, thus becoming, as Murray (2013) argues, a medium for making cultural and social meaning of complex, techno-social systems.

Interaction design represents a central part of daily networked life. As the use of computers has moved from work contexts to everyday life, the implications and relevance of interaction design, both as a discipline and as a field of research, has expanded. Following this, the scope has expanded far beyond the efficiency and optimisation of specific use-cases (which has traditionally dominated computer science and HCI) to the broader scope of everyday life and culture. Interaction design today encompasses the expressiveness of interfaces, aesthetics of networked products, and awareness of social dynamics, as well as material interpretation and the minutia of crafting technologies into designed interactions (Saffer, 2013).

In this broader sense of the field, interaction design cannot be defined as simply interactions between humans and computers; the field includes the social and cultural activities facilitated by these interactions. Importantly, interaction design today is a rich, layered, and heterogeneous discipline. The boundaries of the field are shifting along with the digitisation of society; it is within this ongoing 're-demarcation' of interaction design that I situate this thesis, specifically bringing together material knowledge, cultural perspectives, and a critical stance. In the following sections I will take up four themes that I have identified as starting points for my practice and analysis: 1) material explorations of technology; 2) cultural perspectives on interaction design; 3) critical approaches to design and technology; and 4) the concept of ubiquitous computing.

2.2.2 Technology as material for interaction design

Within the current interaction design research there is a growing body of research that focusses on conceptualising and developing the material aspects of technologies. This is closely linked to an understanding of technologies as malleable materials for design, which have their own affordances, constraints, and possibilities. Schön (1983) describes how, in a design process, the practitioner goes through a physical conversation with materials. The direct shaping of the materials, and how materials 'talk back', is a central part of this dialogue. This dialogical approach to materials, Schön says, forms and informs the development of the design process and is a part of what he defines as 'reflection-in-action' (ibid). Digital and networked technologies have introduced new complexities into this relationship between materials and practice. These include temporal aspects, multi-dimensional interactive relations, distributed social action across networks, and other highly complex

and often invisible components that may be difficult to comprehend or grasp for both designers and users.

Hallnäs and Redström (2006) write that one of the characteristics of interaction design, both as academic subject and as design practice, is ‘the combination of design with a view of computational technology as a new expressive design material’ (p. 25). Furthermore, Löwgren and Stolterman (2004) argue that working with rapidly developing technologies also introduces particular challenges for interaction design:

One of the most challenging aspects is that interaction design is concerned with *digital* artifacts. The technology constituting our design material is changing so rapidly that there never seems to be time for reflection or for a more thoughtful approach. (pp. 2-3; emphasis original)

Interaction design researchers have approached ‘technology as material’ from both theoretical perspectives, offering analyses of the role of digital technologies in the physical world, as well as from practical perspectives, developing tools and insights for design and development.

In 1995, in his influential book *Being Digital*, Nicholas Negroponte (1995) proposed that with the advent of the digital, global information network, information would be liberated from matter, moving ‘from atoms to bits’. While the Industrial Age was about the laborious production and movement of physical goods, Negroponte argued, ‘the information superhighway is about the global movement of weightless bits at the speed of light’ (ibid, p. 12). Blanchett (2011) writes that these kinds of discussions have worked to establish the popular myth that digital technologies are immaterial and abstract. Blanchett problematises this notion, arguing instead for the importance of understanding and analysing the physical materiality of computing systems, and how they are ‘suffused through and through with the constraints of their materiality’ (Blanchett, 2011, p.2). ‘Without a basic understanding of the material constraints under which computing systems operate’, Blanchett writes, the ‘essential dynamics that animate the built environment of the virtual will remain invisible and unaccounted for’ (ibid, p. 26). Following Blanchett, conceptualising digital technologies as material realities is important for understanding their constraints and possibilities, as well as the politics and economics they are a part of. As discussed in Chapter 5, I argue that this perspective is central to understanding and critiquing the networked city.

Digital technologies as materials for design have also been addressed from practical perspectives. Drawing on technical insights from HCI, researchers have addressed the spatial and physical properties of technologies such as sensors and actuators, and how these have had implications for their use (e.g., Reeves et al., 2006). Vallgård and Redström (2007) explored how the characteristics of networked computing alongside physical materials might create new properties. From this, Vallgård and her colleagues further proposed a material strategy for HCI, where design would be guided by combining physical and digital traits into what they call ‘computational composites’ (ibid). Nordby (2011) suggests seeing technologies as the basis for ‘conceptual materials’ in the early phases of design processes, where the creative work of the designer is closely linked with interpreting material possibilities. Nordby argues that there is a need for understanding technologies as design materials for the purpose of inspiring new solutions or concepts (ibid).

Across practice-based research into materials, ‘material exploration’ has been a central approach (e.g., Vallgård, 2009; Knutsen, 2014). Fernaeus and Sundström (2012) argue that:

The dynamic nature of our design materials, especially when making design explorations at the latest forefront of technology, imposes an explicit need for material exploration within design process, as well as challenges in terms of how to document these practices of research. (ibid p. 489)

Furthermore, the researchers here point to the need for developing methods for material explorations, as well as methods for communicating material properties and possibilities.

In my own research practice, I have engaged with technologies as materials for design along two connected routes: first, as research on material qualities of new technologies in a practical sense, similar to what was argued for by Fernaeus and Sundström (2012). Here, explorations, visualisations, and the design of illustrative products are used for developing and communicating material insights for informing design practice (see Martinussen & Arnall, 2009). The second route is research that works towards contextualising technologies through visualisations. This approach might resonate with Blanchett’s (2011) argument for understanding digital materiality on a conceptual level. Here, a material perspective on technology is not used to inform the

design of new products, but to communicate about common, invisible technologies towards broad audience and across different cultural contexts. In this thesis the main focus is on the latter approach, and how this might be a way of engaging with popular culture, but both aspects will be picked up and elaborated on.

Interaction design represents a granular insight into the materiality of technology and brings together analytical and creative perspectives. The networked city is made up of new materials, with new possibilities and challenges for design and research. To take these on we need to develop conceptual as well as practical understanding of materiality of these technologies, both for the purpose of fostering a critical reflection on networked urban life and for facilitating invention and innovation.

2.2.3 Culture, interaction design and technology

A central perspective in this thesis is to place interaction design in a cultural frame. By this I mean how interaction design takes part in, and contributes to, cultural understandings of technology. The thesis further explores how interaction design is part of the cultural landscape of the networked city: both directly, through shaping use and everyday interfaces, and conceptually, through influencing the popular expectations of new technologies. To address this I draw together social, cultural and technical approaches and frames from different fields, and apply these to both the practice-based inquiry, and the interdisciplinary analysis developed in Chapter 5. In this section I present cultural approaches to interaction design and design in general, as well as outlining the ‘technocultural’ perspectives my research specifically draws upon.

Across different areas of design research a broader range of cultural perspectives has been taken up. These include a growing body of research on studies of design, design culture, and design history. Julier (2013) developed a critical discussion of design in society, using the concept of ‘design culture’ to examine relationships between design processes, objects, production, and the role of design in contemporary life. Julier describes how ‘design culture’:

... lies at the interface between object and individual user, but also extends into more complex systems of exchange. It describes the normative actions, values, resources and languages available to designers,

design managers and policy-makers as well as the wider publics that engage with design. (ibid, p. xiii)

Julier argues that through researching design cultures, 'new territories, objects, social practices, economic arrangements and connective tissue between them may be revealed' (ibid, p. 252). The role of design in contemporary society, and the potential for researching design, has also been taken up in cultural studies of everyday life (e.g., Highmore, 2009) and within design history (e.g., Spark, 2013). Highmore (2009) writes that:

What makes design culture such a productive case for general social and cultural research is that it can supply the objects that demonstrate the thoroughly entangled nature of our interactions in the material world, the way in which bodies, emotions, world trade and aesthetics, for instance, interweave at the most everyday level. (p. 2)

Similarly, a broad range of issues concerning the relationships between culture and design has also been addressed in the journal *Design and Culture*. Cultural and social perspectives on design have also been taken up across multiple practice-led research projects. These include projects that deal with socially responsive design, such as the 'Design Against Crime' research centre at Central Saint Martins College of Art and Design (designagainstcrime.com), or initiatives where strategic design processes are involved in policymaking, such as the Helsinki Design Lab (Hill, 2012). In the context of the emerging networked city, the civic engagement projects of the UK studio Proboscis are of particular interest. With their 'Urban Tapestries' in 2002–2004 they made an early, pre-smartphone platform for using mobile phones for community-based participatory mapping, what they called 'public authoring'. Similar approaches, where digital tools are designed for allowing citizens, architects, and planners to collaborate on multimedia urban mapping, have also been taken up in urbanism recently (e.g., Morrison et al., 2012).

These different approaches to design and culture inform this study, but here I'm specifically interested in the relations between culture, interaction design, and technology. Interaction design research's background in engineering and computer science has been important in developing technical know-how and an operational understanding of technology, but this also often leaves out cultural and social perspectives.

Design researchers have also addressed cultural approaches to interaction design specifically, often discussing interaction design by drawing on cultural and social perspectives from other fields. These follow different research agendas, but share a concern for developing and expanding cultural framings for interaction design. In addressing the complexities of multimodal, digital communication, Morrison (2010a) argue for a ‘sociocultural’ approach that includes design, production-based inquiry, situated use and transdisciplinary analysis (ibid, p. 11). This transdisciplinary analysis draws on aspects of Activity Theory, learning research and social semiotics, but also lifts interactivity, articulation and communication.

Morrison (2010b) writes that ‘a sociocultural perspective asserts that design, learning, transformation, meaning and communication are realized through social relations and mediated activity that take place in developmental processes and situated contexts’ (p. 44). Morrison further suggests that a sociocultural approach to communication design and mediated action also ‘includes the processes and realizations embodied in design, as well as those articulated through situated use and refined through reflection on action’ (p. 45). For interaction design research it is interesting to note how sociocultural approaches have been used to bring together transdisciplinary analysis with practice-based inquiry; for example through the analysis and design of software, digital media and interfaces (i.e. Eikenes, 2010).

Another influential direction has focussed on developing new approaches to user research, drawing on action research, anthropology and ethnography. Here, methods have been developed for going beyond the typical testing of usability in labs, and focussing on everyday use with approaches such as ‘cultural probes’ (Gaver et al., 1999; Gaver et al., 2004). The use of cultural probes involves designing artefacts that are given to users for the purpose of gathering insights from the user’s perspective. Such probes have included cameras, instructions, notebooks, questionnaires, and digital devices. Cultural probes have also been taken into the contexts of the networked city, where Paulos and Jenkins (2005) have developed ‘urban probes’ as designed interventions into urban life. These ethnography-inspired approaches, however, usually limit their scope to a particular set of users and uses design to study their activities and contexts.

Interaction design and culture have also been addressed in a broader sense through bringing research on technology and culture into design. Balsamo

(2011) argues for considering cultural issues throughout design processes, both through how designers interpret cultural materials and how design contributes to cultural meaning. In this thesis I draw specifically on Balsamo's discussions of the role of design in shaping cultural understandings by lifting two concepts: *technoculture* and *technological imagination*.

At the centre of Balsamo's argument is addressing what she calls 'the blind spot' between culture and technology that has been created by technological and cultural determinism (ibid, loc. 185). Balsamo draws on Slack and Wise (2005), who observe that in the dominant perception of the relationship between culture and technology, these are seen as separate domains of human life. Balsamo argues that keeping the technological separate from the cultural is particularly problematic within design. This, she explains, makes the probable consequences of technological innovation unthinkable, but it also limits the imaginative space for design and narrows the possibilities for technology that is under development (Balsamo, 2011, loc. 192; 195). Following Slack and Wise (2005), Balsamo suggests avoiding creating an opposition between the terms 'technology' and 'culture', and instead proposes the term 'technoculture' as a concept that 'formulates technology and culture as a specific unity' (ibid, loc. 212).

Designing with technology, according to Balsamo, is about designing within technoculture, bringing together material knowledge of the technological and exercising the 'technological imagination'. Balsamo, drawing on, among others, Heller (2005) and Ihde (2008), describes technological imagination as the mindset that enables people to think with technology, and to transform 'what is known into what is possible' (ibid): 'It is through the exercise of their technological imaginations that people engage with the materiality of the world, creating the conditions for future world-making' (ibid, loc. 240). From a humanist perspective, Balsamo extends the assertion from STS that every technology is a socio-technical construction (e.g., Bijker & Law, 1992), and stresses that every technology also involves the expressions of cultural understandings, including narratives, myths, values, and truth claims (loc. 282). The technological imagination is shaped by (and shapes) these expressions of cultural understanding. Cultivating and challenging the technological imagination, Balsamo argues, is therefore a 'cultural imperative of the highest order' (loc. 247).

Balsamo's notion of technological imagination has similarities with what Feng and Feenberg (2008) call the 'technical heritage'. These researchers defined 'technical heritage' as 'taken-for-granted assumptions about the forms and meanings of specific technologies' (p. 117). This, they argue, makes up the historical and cultural background that design processes are influenced by. This background, they suggest, takes two forms: 'beliefs and practices of the everyday lifeworld, and culturally biased knowledge sedimented in technical disciplines shaped by a history of technical choices' (p. 112). This 'technical heritage', Feng and Feenberg argue, shapes the possibilities and outcomes of design processes through unconsidered assumptions of what is possible and appropriate design choices for particular technologies.

Feng and Feenberg's discussions of the 'technical heritage' extends Feenberg's (2010) critiques of technology towards design, in particular drawing on Feenberg's 'instrumentalization theory', which 'understands technology as designed to conform not just to the interests or plans of actors, but also to the cultural background of the society' (Feng & Feenberg, 2008, p. 112). Feenberg argues that in order to develop a critical perspective of technology, it is necessary to examine and question the biases and tensions between the functional bases and the cultural meanings of technologies.

The spread of networked technology across society makes interaction design culturally relevant beyond the individual uses of devices. McCullough (2013) suggests that as digital interfaces increasingly become a part of the world, interaction design becomes more like architecture: a discipline that shapes the environments we live in. Cultural perspectives on technology, as Balsamo (2011) argues, thus should be of particular interest both in the context of technological innovation, and for knowledge-building across the field of interaction design research. In this thesis I argue that a technocultural approach is valuable for both addressing the emergence of networked city life, and for situating interaction design across technology, culture and daily life.

Following Balsamo's lead, we could describe interaction design's engagement with technoculture as both cultural reproduction, in the sense of interpreting and conceptualising technoculture, and as cultural invention and contribution, through the design of new interactions, products, and expressions. 'Culture', Balsamo writes, 'is both a resource for, and an outcome of, the designing process' (ibid, Loc. 326). This suggests a space for interaction design research that is interpretive, as well as propositional. In this thesis

I suggest that interaction design research can take part in the emerging technoculture of the networked city through both material interpretations and explorations, and through designing and communicating new conceptualisations of technology.

2.2.4 Critical approaches to design

In seeing interaction design research in a cultural frame, the work done within 'critical design' is an important point of reference. Critical design can be defined as an approach where the tools and processes of design practice are used not to solve or resolve problems, but to critically rethink the parameters of the problem area itself (Mazé & Redström, 2009). Critical design has typically used design to question, challenge, or speculate about technological change in culture and society (Dunne & Raby, 2013). Critical design places its focus outside commercial, technological innovation and instead proposes alternative perspectives on emerging technologies in everyday life through designing speculative products or interactions (Malpass, 2013).

The term *critical design* was coined in the mid-1990s by Dunne and Raby (Seago & Dunne, 1999; Dunne, 2005; Dunne & Raby, 2001) to describe a design practice that 'uses speculative design proposals to challenge narrow assumptions, preconceptions, and givens about the role products play in everyday life' (Dunne & Raby, 2013, p. 34). Dunne and Raby, through their own practice, writings, and teaching at the Design Interactions Programme at the Royal College of Art (RCA) in London, have been influential in establishing a particular approach to critical design that draws on conceptual art and is situated in opposition to commercial design. Dunne and Raby describe their take on critical use of design practice as a position rather than a methodology, where the intent is to place design in a cultural, social, and political context:

It is about thinking through design rather than through words and using the language and structure of design to engage people. It is an expression or manifestation of our sceptical fascination with technology, a way of unpicking the different hopes, fears, promises, delusions, and nightmares of technological development and change, especially how scientific discoveries move from the laboratory into everyday life through the marketplace. (ibid, p. 35)

Different perspectives on critical design are found across interaction design research. Mazé and Redström (2007) draw on Dunne and Raby to argue for a critical practice in design research where ‘a pragmatic conception of reflection is extended as a critical modality—to question and transform rather than only describe and affirm’ (ibid, p. 10). Similarly, Bowen (2009) proposes a ‘critical artefact methodology’ where artefacts produced through a form of critical design are used to communicate between designers and various stakeholders. Within HCI, Sengers et al. (2005), drawing on critical design approaches and critical technical practice (Agre, 1997), suggest ‘reflective design’ as an approach to HCI, where devices and technologies are developed with the intention of questioning the values embodied in computational systems.

Ratto (2011), taking a similar critical approach to computing technologies, suggests ‘critical making’ as a strategy for research and pedagogy, where conceptual understandings of technology are explored through making. For Ratto, the focus is not on the artefacts or products, but on the collaborative processes of making and exploring technological artefacts. He sees this ‘critical making’ as a possible direction for both critique and innovation. Of particular interest in Ratto’s work on critical making is how it joins approaches from critical design with material-exploration, as discussed above.

Critical design and related approaches offer an interesting position towards using design for exploring, conceptualising, and communicating emerging technologies. It is interesting to note that the relevance and impact of these approaches also have been the subject of critique. Malpass (2013) questions the lack of wider theorisation and intellectual stance of critical design, specifically the form associated with Dunne and Raby at the RCA:

More and more, the danger is that critical practice becomes overly self-reflexive and introverted, sustained, practiced, and exchanged in a closed community. By operating in this way, its usefulness as part of a larger disciplinary project is undermined. (ibid, p. 334)

This points to the broader question of what the audience and the discursive frames of critical design approaches are. When critical design attempts to challenge narrow assumptions about technology in everyday life, who is being challenged and to whom is the work being communicated? The typical contexts for most critical design projects are art settings with galleries and niche publications, or inside design research projects in the form of

user-studies and research articles. If the goal of critical design is to use design as a way to challenge the role of technology in everyday life, then we could question how, and to whom, it is being communicated. How could critical design address everyday, popular culture and bring the work into a wider context? These questions will be taken up in relation to the discussions of our own practice as ‘discursive design’ in Chapters 3-4.

2.2.5 Ubicomp

Above I have presented specific perspectives on interaction design that I position my research in relation to. But in situating this research project I also draw on more general conceptualisations of technology from across the interaction design field. One of the most influential concepts to come out of HCI and interaction design research is Weiser’s notion of ‘ubiquitous computing’, or ubicomp (Weiser, 1991). The concept of ubicomp has been important for establishing directions for interaction design and technology development, and specifically for visions of the ‘smart city’. The concept has its origins in the late 1980s, as a vision for how information processing could be integrated into everyday objects and activities. Weiser (*ibid*) writes:

Ubiquitous computing names the third wave in computing, just now beginning. First were mainframes, each shared by lots of people. Now we are in the personal computing era, person and machine staring uneasily at each other across the desktop. Next comes ubiquitous computing, or the age of calm technology, when technology recedes into the background of our lives. (p. 1)

According to Weiser, interactions with computers should ‘take into account the natural human environment and allow the computers themselves to vanish into the background’ (*ibid*). Since the 1990s, the concept of ubicomp has been important in establishing research agendas across computing and interaction design (see Galloway, 2004; 2008). The dominant discourses have been concerned with the possibilities of miniaturisation, invisibility, and the ‘disappearance’ of the computer (Norman, 1999).

Ubicomp is particularly interesting because of the sub-themes and concepts it has inspired. These have emerged around different forms of technologies and research agendas, including interaction design, where the ‘invisible computer’ (Norman, 1999), ‘tangible interactions’ (Shaer & Hornecker, 2009), and

‘embodied interaction’ (Dourish, 2001) address the interactive potential of ubicomp. ‘Pervasive computing’, as used by the journal *IEEE Pervasive Computing* (e.g., Satyanarayanan, 2002), takes up issues of technology development and computing research. Further, the term ‘urban computing’ (Paulos et al., 2005; Greenfield & Shepard, 2007) has been introduced to specifically discuss the potential of ubicomp in cities.

Ubicomp represent a conceptualisation of technology and interaction design that have been influential across academia and industry. The central premiss is typically that computing technology, in the near future, *can*, and *should*, be invisibly embedded in everyday environments to seamlessly support human activities. This dominant vision of ubicomp has also been the subject of critique. Bell and Dourish (2007) discuss the relationship between ubicomp and contemporary everyday life, questioning ubicomp’s persistent focus on the near-future. These researchers observe how many elements of the visions of ubiquitous computing that have been described, such as mobile computing, wireless networks, and embedded sensors, are currently a part of the contemporary reality of everyday, networked life. Bell and Dourish (2007) argue that by placing its goals and visions in a ‘proximate future’ that is always just out of reach, ubicomp fails to engage with the messiness of daily, urban life. Similarly, Chalmers and Galani (2004) examined ubicomp’s striving for ‘seamless’ systems, and argued that ‘seamlessness’ might be a utopian and unfruitful ideal. These researchers argue, instead, for designing ‘seamful’ interactions where attention is given to how seams in systems are perceived.

Galloway (2004) makes the argument that ubicomp research, because it is increasingly technology-driven, misses the cultural and social perspectives that Weiser originally argued for (see also Galloway, 2008; Araya, 1995). Similarly, Greenfield (2006) addresses societal and political aspects of ubiquitous, pervasive computing technologies. Kinsley (2002) discusses how the visions and agendas of ubicomp are produced through corporate, promotional media and ‘vision videos’. Kinsley examines how the concepts of ubicomp, when mediated through online media, works towards shaping the popular imagination of our technological future.

The concept of ubicomp plays an important role in the emergence of the networked city, particularly in the research and development of what has come to be known as the ‘smart city’. Here, the vision of seamless, pervasive technological systems is extended to the scale of cities and urban planning.

However, issues of interaction design, or how technologies are experienced and understood, are rarely addressed. There are many similarities between ubicomp's conceptualisations and the discourses of the smart city. I therefore see the critical perspectives on ubicomp as particularly valuable in contextualising and questioning the networked city. I will focus on this later in this chapter.

2.3 The networked city

The second main theme of this thesis is the networked city. In this section I first look at some of the history and background of the networked city, as well as its current implications across academia and industry. I will further present a set of critical perspectives on networked cities that together contribute to framing my reading of this field.

The role of computing and digital infrastructures in cities has been a reoccurring theme across various fields of urban research and computer science for decades. Topics have included the spatial implications of telecommunications infrastructure (Graham & Marvin, 1996), the geography of cyberspace (Kitchin, 1998), and architecture and digital technologies (Kolarevic, 2013). Research on the networked city has been addressed within multiple fields, including computing and technology development (e.g., Caragliu, 2011), urban studies and cultural geography (Cragg et al., 2007), and STS (Latour et al., 2004). Such research, however, rarely goes across or between the issues of applied technical development and the cultural and social perspectives.

Before I go further, I will briefly reflect on some of the terminology used to navigate this field to outline the scope taken in this thesis. Just as the landscape of the networked city is multilayered and complex, and shaped by economics, politics, technology, and media, so too is its language and nomenclature. As is typical within research, development, and promotion of emerging technologies, the networked city has given rise to numerous terms, buzzwords, and concepts.

The terminology surrounding the networked city reflects some of the disciplinary boundaries found between the research fields involved, such as urban studies and computer science. The terminology originating within computer sciences often follows the lead of ubicomp, with terms such as 'urban computing' (Paulos & Jenkins, 2005; Kindberg, Chalmers & Paulos,

2007; Greenfield & Shepard, 2007, Galloway, 2008), ‘urban informatics’ (Foth et al., 2009), and the ‘smart city’ (Townsend, 2013; Greenfield, 2013; Deakin, 2014). While urbanism and urban studies have coined ‘cybercities’ (e.g., Graham, 2004a), the ‘sentient city’ (Graham & Marvin, 2007), the ‘informational city’ (Castells, 1989), ‘digital ground’ (McCullough, 2004), ‘technocities’ (McGuigan & Downey, 1999), and the ‘city of bits’ (Mitchell, 1999; 2004; 2005). These terms and concepts come out of specific research agendas, commercial visions, and disciplinary concerns, and therefore take on different approaches to the digital development of cities.

The widespread coining of terms over the last two decades suggests that this field of research territory is both dynamic and often-contested, and a field that remains largely undefined. This also indicates that there is a potential space here for new research and new conceptualisations. The ongoing coining of terms also points to how the research language of the networked city changes over time at a relatively fast rate, becoming temporally sensitive. Terminology continuously becomes outdated, such as the late 1990s term ‘cybercities’ (see Graham, 2004), which makes interesting elements of research seem unconnected. In this thesis I have purposefully used the relatively uninvested position of interaction design research within this space to navigate freely across disciplines and concepts, looking both backwards and sideways.

As described in the Introduction, I have chosen to adopt the term ‘networked city’ to describe the interweaving of networked technology and city life. I’ve chosen to use this term because it places the emphasis on networks and communication, rather than on disciplines or visions. The term can be understood at various scales, and has been subject to a number of interpretations. Mitchell (1999; 2004) used the term to frame his arguments and speculations about near-future developments of urban technologies towards a ‘city of bits’. Mitchell contextualised the networked city of digital communication by focussing on networks as an important element of the history of cities, from canals and railroads to telegraph cables and electricity. Mitchell goes on to argue that ‘like their pipe-and-wire predecessors, however, digital telecommunications networks will not create entirely new urban patterns from the ground up; they will begin by morphing existing ones’ (ibid, p. 15). A key point here is that the networked city of digital communication is not seen as a radical transformation, as was often the case in early literature on urban information and communications technology (ICT) (Crang et al., 2007;

Thrift, 2004), but as a part of the continuity of urban history, where technologies and urban life co-evolve through multiple and diverging processes.

Mitchell places the focus on urban life and the scale of the city, while Castells (1989) sees the networked city as operating on a global scale. For Castells the networked city is an 'informational city', a part of the flows of information in a globalised networked society (Castells, 2004). Castells argues that there is a growing tension between the 'space of flows' (the space of global information networks) and the 'space of places' (the local urban spaces). 'Cities', Castells writes, 'are structured, and destructured simultaneously by the competing logics of the space of flows and the space of places' (ibid, p.85). For Castells, the networked city is the city of the information age, 'an age marked by the growing gap between splintering networks of instrumentality and segregated places of singular meaning' (ibid, p.92).

Castells' framing of the networked city has also been subject to critique. Thrift (2004) argues that Castell, alongside Virilio (1993) and Harvey (1989), is putting forward a myth of how information networks are changing our apprehension of space, time, and subjectivity (Thrift, 2004). This myth, Thrift writes, is 'based in a technological determinism which unproblematically reads off the characteristics of the technologies involved onto society' (ibid, p. 99). Instead, Thrift suggests that 'cities cannot be seen as places which are leaking away into a space of flows', and that 'this is to fundamentally misunderstand the way in which new information technologies have normally acted as a supplement to human communication rather than a replacement' (ibid, p. 100). Similarly, Graham and Marvin (2001) advocate for a critical focus on networked infrastructure and how, in the relations between its construction and use, networked urbanism emerges as a complex and dynamic sociotechnical process. Graham (2004b) critiques the generalised discourses of the 'impact' of information technologies on cities, and, drawing on sociologists Wellman and Haythornthwaite (2002) and their early studies on the Internet in everyday life, argues for looking in rich empirical detail at 'the complex ways in which new media technologies are being used in real ways, in real places' (Graham, 2004b, p.18).

The networked city, then, encompasses a wide scope for research and design. Some of these directions I will follow up with below, while others are not addressed in this thesis. In establishing a framing I want to point out the distinction between Castell's 'networked city of the information age'—the

city as a part of a global networked society—and Mitchell’s notion of the networked city as a city where an ‘electromagnetic terrain’ is a part of the urban landscape of daily life. As the focus of this thesis is on interaction design, culture, and the everyday, I mostly align with the latter framing. My key interest here is not the high-level concepts of networked urbanism, but the designs, media, and cultural expressions of networked city life. In extending a technocultural approach to interaction design to the networked city, my focus is on how networked cities are experienced, understood and made culturally meaningful. Further, in emphasising *networked city life*, I situate my research in relation to the notion that networked, urban technology is situated, cultural, and a part of the rich and layered contexts of the city.

2.3.1 The Smart City

While networked cities over the last ten to fifteen years have become a prominent theme within different fields of research, the networked city has also grown into a significant area of commercial development. Driven by large technology corporations like IBM, Cisco, and Siemens, the concept of the ‘smart city’ has become a central narrative for the development, marketing, and envisioning of networked technologies in cities. The smart city describes an urban future where digital networks, embedded sensors, algorithms, and data gathering make cities more efficient, more secure, and better-maintained. Smart city initiatives are typically funded and pursued by technology corporations that produce software and infrastructure. The smart city, as envisioned by this industry, can be described as a technology-centred approach to urbanism that promotes an instrumental, and largely top-down, perspective on how networked cities ought to function (Greenfield, 2013). The rhetoric and conceptualisations of smart cities, however, are not just confined to corporate promotional discourse; they have also been prominent across urban technology and planning research (e.g., Hatzelhoffer et al., 2012).

In situating research and design within networked city life, the vision of the smart city is important for a number of reasons. First, it represents an influential commercial and technological force in the development and planning of digital, urban societies. The smart city has become a profitable industry, and is seen as an important next direction for technology corporations (Townsend, 2013). Second, the narratives promoted by the smart city shape discourses and establish visions and expectations in technology development, politics, and media (as discussed in Article 3). Finally, the concept of the

smart city also brings a set of tensions into the field of networked city research. As I will discuss below, the often hyperbolic visions of the smart city illustrate the importance of developing a critical perspective of what networked technology can, or should, mean for urban life.

The smart city industry first became prominent in the early 2000s, and has since followed multiple directions towards both envisioning and implementation of its systems. I will outline three tendencies that will indicate the scope of this field: first, the development of new smart cities from the ground up; second, proposals for implementing smart city infrastructure and software in existing cities; and third, smart city rhetoric taken up in urban technology and planning research.

First, many of the most well-known, and often controversial, smart city projects have been initiatives for planning and developing completely new cities where ‘smart’ technologies are integrated from the ground up. These include the South Korean u-City projects, such as New Songdo, a new city built on reclaimed land outside Seoul. Started in 2003, New Songdo was supposed to be a city where ubiquitous computing was the key driver (Hwang, 2009; O’Connell, 2005; Lee & Oh, 2008). The u-City projects have since run into various financial and technological problems, and their future is currently uncertain (Greenfield, 2013).

Other new smart cities built from the ground up include Masdar City in the United Arab Emirates, and PlanIT Valley in Portugal (ibid). Of particular interest here is also the ‘CITE’ project (the Center for Innovation, Testing and Evaluation) by Pegasus Holdings (Lindsay, 2011). CITE is a test-town under construction in the New Mexico (USA) desert with infrastructures, buildings, and roads to support a town of 35,000 people—but with no intended inhabitants. The town is meant as a laboratory for large-scale testing of urban technology, including traffic management, power grids, surveillance, and sensor systems. According to Pegasus Holding, the intended clients for this test-town are governments and corporations that want to do large-scale testing and research on future smart city systems.

Second, these new smart cities are unique in that they take place outside existing urban contexts, but similar systems and approaches are also being implemented by corporations and municipalities in cities around the world. A much-publicised example is IBM Smarter Cities group’s ‘Intelligent Oper-



Figure 2.1. A promotional image of IBM's 'Intelligent Operations Center' for Rio de Janeiro. Credit: IBM.

ations Center' for Rio de Janeiro (Figure 2.1). This is a collaboration between the technology corporation IBM and the city of Rio de Janeiro, and is meant to create a model for data-driven city management (Singer, 2012). The system consists of sensors, cameras, and networks that are placed throughout many of Rio's poorer neighbourhoods. These send data and footage to an 'Intelligent Operations Center', as shown in Figure 2.1, where operators can observe ongoing situations and deploy emergency services or maintenance operations as needed.

Third, outside the corporate context, the concept of smart cities is also being taken up in other areas of urban research and developments. Topics here include upgrading existing infrastructures, energy conservation, data-driven

planning, and urban regeneration, as discussed in, for instance, the *Journal of Urban Technology* (see Allwinkle & Cruickshank, 2011). Here, ideas of the smart city are part of larger initiatives for urban and regional developments. This is interesting because of how the persistent rhetoric of the commercial smart city discourses are being appropriated within government- or municipality-led urban development projects to describe the potentials for networked, digital technologies.

2.3.2 Critical perspectives on the networked city

The ideas and visions behind the smart city have been the subject of critical discussions across urban studies, computer science, architecture, and interaction design. Here, I will present a few critical perspectives on technology and cities found both within current discussions around the smart city, and from the last decades' discussions of networked technology and ubiquitous computing.

Greenfield (2013) critiques the urban ideals and political positions of the smart city industry. Through de-constructing and analysing corporate promotional discourses alongside early attempts at implementations, Greenfield questions the values, politics, and the understanding of urban life promoted by the smart city industry. Greenfield argues that the smart city should be understood as being closely connected to neo-liberal political economy, and is predicated on the privatisation of public services and increased control of public space. Similarly, Sennet (2012) questions the public, urban qualities of projects like New Masdar and what these offer, or perhaps do not offer, to city dwellers. Both of these researchers question how the politics of the smart city affect the relationship between public and private urban space and services.

Drawing on urban theory—specifically Jacobs' (2006) arguments against the functionalist urban ideal and Scott's (1998) critiques of modernism, planning, and power—Greenfield (2013) further argues that the possibilities and challenges of the networked city must be understood and discussed across politics, economics, and urban life. Townsend (2013) discusses recent developments of smart city systems, reflecting on the practical realities and weaknesses of these initiatives as commercial, technology-driven ventures. Townsend instead argues for working towards strengthening a civic understanding of what networked cities might become. These perspectives all point out how the smart city is entangled with power-relations, values, and

interpretations of urban life, and raise the important question of who the smart city is intended for.

As these critiques indicate, the visions put forward by the smart city industry are built on a specific way of understanding what cities are and what they should be. The smart city is built on a perspective of urbanism grounded in a 'belief that cities should, and could, be controlled and optimised through technology' (Martinussen 2013, p. 293). Projects like IBM's 'Intelligent Operation Center' for Rio de Janeiro prompts the question of who the smart city primarily is valuable for: its operators and planners, or its citizens? And further, what forms of interactions and designs are possible within these visions of the networked city? At an overarching level, this suggests that there is an epistemological position embedded within the smart city discourse that rests on the questionable assumption that cities are going to be better and more efficient through operationalising extensive monitoring and data-gathering systems.

From the fields of both urban geography and computer science, the notion of the smart city, and the research discourses it comes out of, have been criticised for promoting hyperbolic expectations of the networked city of the future. Graham (2004a) writes about the industry of urban ICT and its perspectives on urban technology:

Such so-called 'technological determinism'—the reading of the universal effects of technologies from their intrinsic properties—is attractive. It makes good copy for the media and creates glamorous notions of a new electronic 'frontier' awaiting colonisation by those hardy pioneers that are up to the task. (p. 10)

Similarly, Crang et al. (2007) suggest that 'the remediation of everyday urban life through ICTs involves subtle shifts in the spatial, temporal, scalar, and material processes which together help constitute urban change' (p. 2405). Using ethnographic studies of everyday use of existing networked services, including instant messaging, online grocery shopping, and daily logistics, these researchers demonstrate how 'ICT-based urban change involves layering, tangling, and imbrication of new practices and new possibilities alongside old ways and enduring demands' (ibid, p. 2407). These critiques of the focus on perpetual newness, or revolutionary transformation, are particularly relevant in addressing the discourses that currently surround smart cities and similar developments of networked technology.

These critical perspectives on the networked city have similarities to critiques of ubicomp from within the fields of computer science and HCI. For example, studies of interactive technologies in urban contexts have similarly been used to question the envisioned ‘seamlessness’ of ubicomp (see Galloway, 2004; Bell & Dourish, 2004; 2007; Dourish & Bell, 2007). In discussing the dominant, future-oriented visions of ubicomp, Bell and Dourish (2007) argue that a central weakness of these visions is the focus on the ‘proximate future’. By placing the potential developments of urban interaction design in imaginary future use-contexts, research and development, across ubicomp and the smart city, gets removed from the implication and potentials of contemporary daily life. Instead, Bell and Dourish argue for ‘developing a ubiquitous computing of the present which takes the messiness of everyday life as a central theme’ (Bell & Dourish, 2007, p. 143).

Even though these discussions and critiques come out of, or are related to, HCI, they do not address issues of interaction design at the level of designing. What would it mean to design for the messiness of everyday life? How can interaction design be used to situate the networked city in the present? Issues of interaction design for the networked city are rarely addressed, neither by the dominant narratives of the smart city nor by its critics. The potential for exploring the cultural expressions and inventions that the emergence of the networked city also entails is also rarely addressed.

2.4 Everyday life

The final theme in setting up the context for this thesis is everyday life. Studies and critiques of everyday life occur across urban and cultural studies, sociology, and geography, and take up a range of issues, including macro-structures of power, gender, and politics, as well as detailed studies of mundane practices (Gardiner 2000; Sheringham 2006). Notions of everyday life, influenced by Léfèbvre (1991) and de Certeau (1984), prevail as being socially and culturally situated; they are layered, embodied, and potentially transgressive. In studies of technoscience and everyday life (see Michael, 2006), these concepts are applied to interactions with technology and provide interesting insights for questioning the relationships between design, technological developments, daily life, and popular culture.

Theories and studies of the everyday represent a source of concepts and insights that is rarely taken into account in technology development, or in the dominant discourses of the smart city. Many of the critiques of the smart city and the visions of ubicomp, however, such as those presented above, share a common concern for everyday life in the face of technological development. In problematising the smart city industry, Greenfield (2013) uses Jacobs' (2006) observations and discussions of life on the street to shift the focus from a top-down, technology-driven perspective on the city, towards addressing the daily, networked lives of citizens. Crang et al. (2007) and Bell & Dourish (2007) use ethnographic studies of everyday technology use in cities to locate and discuss the potentials and challenges of the contemporary networked city, while Galloway (2004) makes use of cultural and social theories of everyday life to discuss Weiser's writings on ubicomp in light of contemporary technology development. In interaction design, studies of the everyday are rarely taken up explicitly, but are often manifested in the background of design practices and research. Here, the everyday is typically seen as the context of use, where the focus is on usability, ergonomics, or user-centred aspects of products and interfaces (e.g., Norman, 1999).

Taking up everyday life as a theme should be seen in relation to the technological perspectives on interaction design presented above. I suggest that theories and studies of everyday life can extend and supplement these perspectives, and be valuable for researching the networked city and interaction design. My motivation for taking up everyday life as a thematic is both analytical and conceptual, and can be broadly summarised on three levels: first, theories of everyday life offer perspectives for grounding the often technology-driven discourses of the networked city and interaction design in daily practices and culture. Second, taking up everyday life in research on emerging technology is also a way to establish a perspective on technological change. Conceptually, daily life offers a viewpoint on technology and design that puts the social and cultural life of citizens, rather than technological innovation itself, in the foreground (see Highmore, 2002). Third, emerging technologies in everyday life are made meaningful both through use, and through how they are represented culturally. Engaging with the everyday through design, can therefore also involve analysing and designing cultural representations of networked city life. This latter perspective is particularly important, as the focus of this thesis is not on ethnographic studies of technology in use, but on using interaction design for exploring and commu-

nicating everyday technologies towards popular culture, and work towards re-articulating technocultural discourses.

Relations between theories of everyday life, interaction design, and the networked city are discussed in detail in Chapter 5. Here, I will take up three overarching topics for contextualising the research: first, everyday life and technological change; second, the notion of production of urban spaces as social and cultural; and third, cultural perspectives on daily life, taking up culture as ‘ordinary’ and the production and circulation of cultural meaning.

2.4.1 Everyday life and technological change

As discussed by Graham (2004b), technology development and everyday life were seen as separate domains in much early urban technology research. Graham, drawing on the work of Haythornthwaite and Wellman (2002), argues for seeing the networked city as being embedded in everyday life:

Rather than being seen as technologies to be adopted and shaped within the fine-grained practices of everyday urban life, new media were cast thus in this dominant discourse as a ‘dazzling light’, ‘shining above everyday concerns’ (Haythornthwaite and Wellman, 2002: 4, quoted in Graham, 2004b, p.17)

Michael (2006) observes how the absorption of emerging technologies in everyday life involves overlapping processes of change and mundanity:

... everyday life is characterised simultaneously by the promise of exotic technoscientific artefacts, the actual arrival of new technoscientific products and the mundane uses of existing technoscientific products—that is, by rapid change and quotidian repetition. (ibid, p. 2)

Similarly, Highmore (2002) discusses how the success of technological innovations is indicated by how much they get absorbed into a ‘landscape of the mundane’ (ibid, p. 2). Emerging technologies get naturalised through everyday use, but, as Amin and Thrift (2002) observe, urban life also gets ordered in new ways by increasingly complex and ‘black-boxed’ technological structures. Following Akrich (1992), the design of technical objects work toward ‘scripting’ the relations and activities these objects are a part of. As networked city life becomes a part of ‘producing the ordinary’ (Amin & Thrift, 2002),

it gets normalised and overlooked as a part of what Thrift (2004a; 2004b), drawing on Clough (2000), describes as the ‘technological unconscious’.

Thrift suggests that the increasing technical background to human activity, in the form of cables, software, wireless signals, etc., can best be understood as a ‘technological unconscious’ whose ‘content is the bending of bodies-with-environments to a specific set of addresses without the benefit of any cognitive inputs, a prepersonal substrate of guaranteed correlations, assured encounters, and therefore unconsidered anticipations’ (Thrift, 2004a, p. 117).

In the context of the networked city, Amin and Thrift (2002) discuss how the largely unknown and unseen technical structures of the city influence the ‘spaces of anticipation’ in everyday urban life. Similarly, Bucher (2012) discusses how the software platforms and automated algorithms of social media (Facebook, for example) can also be seen as a ‘technological unconscious’ that shapes everyday social, networked life:

This form of unconsciousness can be understood as the powerful operations of software putting its mark on the conditions of existence, where living and nonliving processes are increasingly being programmatically addressed, correlated, and anticipated in unseen and unknowable ways. This unconsciousness is however not to be understood as imaginary, but rather in terms of the actual computational processes that run in the background, beneath and beyond what is perceivable to users via the interfaces of the computer. (ibid, 12)

Slack and Wise (2005) discuss the problems of following both cultural and technological deterministic approaches to technology in everyday life. In critiquing technological and cultural determinism, they examine the concept of ‘intended’ and ‘unintended’ consequences of technology, arguing that to differentiate between foreseen and unforeseen effects is to suggest that ‘intended’ or ‘primary’ effects are somehow more real. They further suggest that intended effects and side-effects overlap in unforeseen ways, and argue that this illustrates how everyday life is not simply shaped or scripted by technological innovations. Rather, technological change in everyday life is a heterogeneous and ‘multistable’ process where different relations come together across social and cultural contexts and at different points in time. In the context of the networked city, everyday life not only illustrates how

technological innovation plays out in daily use, but also how technologies take place within the messiness and friction of city life.

2.4.2 Everyday urban life and the ‘production of space’

Conceptualisations of urban life is prominently taken up in Henri Lefebvre’s writings on everyday life and cities. Lefebvre’s writings on everyday life span over fifty years and numerous topics. Central to his philosophy is a critical examination of the relationships between capitalist society and daily life. Lefebvre focusses both on the repressive forces of capitalism on everyday practices, and on the festive, revolutionary potential found in everyday life itself (Merrifield, 2000). In the context of this thesis, however, I’m chiefly interested in Lefebvre’s writings on the ‘production of space’ and the powers and relations that shape urban life (Lefebvre, 1991).

For Lefebvre, urban space is actively produced through processes of social change, tensions, ideology, and power. Lefebvre suggests that the production of space can be understood as a ‘spatial triad’: a three-way relationship between ‘spatial practices’, ‘representations of space’, and ‘representational space’ (Lefebvre, 1991). Put simply, Lefebvre argues for seeing urban space as a process where planned functions, urban life, and representations of space all play connected roles with how the city is understood and imagined. ‘Spatial practices’ describes how spaces are perceived through daily realities (including private life, routines, and leisure) and urban realities (including the routes, functions, and environments of the city). ‘Representations of space’ describes how spaces are conceived or conceptualised, for example through planning, policy, architectural visions, and artistic practices.

Representations of space, Lefebvre writes, are one of the dominant forces in how space is produced. Lefebvre describes these representations of space as embedded with knowledge, understanding, and ideology, and at the same time they are ‘always relative and in the process of change’ (Lefebvre, 1991, p. 41). Representations of space may be abstract, Lefebvre states, but they ‘play a part in social and political practice’ and establish relations between objects and people (Lefebvre, 1991, p. 41). While representations of space often have direct practical impact, as with architecture or infrastructures, ‘representational space’, or lived space, describes ‘space as directly lived through its associated images and symbols’ (ibid, p. 39). Representational space overlays physical space, and describes how the experiences of daily urban life are also

changed or appropriated by imagination and the ways in which we understand the city.

Léfebvre's writings on the production of space resonate with contemporary studies of everyday life. Moran (2005), writing about everyday life, modernism, and historical change, discusses the role of media and political discourse in creating attitudes, ideas, and popular understandings. While Léfebvre in the early 1970s focussed on high-level representations of urban space, such as legislations, blueprints, planning, and the history of artistic techniques, Moran shifts the focus to daily life in general and how mundane representations in cinema, sitcoms, advertising, and tabloid newspapers shape the public discourse and opinions on everyday issues such as traffic, working conditions, commuting, and welfare. Drawing on Léfebvre, Moran argues that 'lived, social space is inextricably linked to represented, imagined space' (Moran, 2005, p. 19), and that both are central to an understanding of everyday life.

In contextualising interaction design, technology, and networked city life, I draw out two central points from the notion of 'production of space': first, daily life and everyday urban space are not stable, but, as Léfebvre argues, socially and culturally produced. Second, how the everyday city is represented, and how it is imagined, play a part in shaping the understanding of everyday life and establish parameters for public debate and popular culture. The question I then pose is, how can design act in the construction of the representations and interactions that shape the understanding of the networked city? As discussed in the following chapters, I address this question both through analysis and through the creation of new cultural materials that work towards shifting conceptualisations of the networked city.

2.4.3 A cultural perspective on everyday life

One of the key motivations for this thesis is to investigate and explore how interaction design might contribute to making meaning in the intersections between everyday life and emerging technologies. Here, cultural representations and expressions are central:

The growth of the mass media, new global information systems and flows, and new visual forms of communication have had—and continue to have—a profound impact on the ways our lives are organised

and on the ways in which we comprehend and relate to one another and to ourselves. (du Gay et al., 2013, p. xxviii)

To situate how a interaction design practices might work towards and within cultural processes, there is a need to establish an initial cultural perspective in relation to everyday life. I discuss two related ways of defining and examining culture: first, Williams' (1989, 2013) notion of lived, everyday culture as both 'ordinary' and a 'whole way of life'; and second, I complement Williams' notions of lived culture with perspectives that more specifically take up culture as 'the production and circulation of meaning' (e.g., Hall et al., 1997; du Gay et al., 2013).

2.4.4 Culture as a 'whole way of life'

Williams (2013) discusses how *culture* is a complex term that can be defined and analysed in multiple ways, and that these should be seen in relation to each other. He argues that 'the variations of meaning and reference, in the use of the term culture, must be seen not simply as a disadvantage, which prevents any kind of neat and exclusive definition, but as a genuine complexity, corresponding to real elements in experience' (ibid, loc. 1262). In emphasising culture as complex, Williams suggests that an important aspect of defining culture is what he describes as a 'social' definition of culture:

... in which culture is a description of a particular way of life which expresses certain meanings and values not only in art and learning but also in institutions and ordinary behaviours. The analysis of culture, from such a definition, is the clarification of the meanings and values implicit and explicit in particular ways of life, a particular 'culture'. (Williams, 2013, loc. 1233)

From this follows two connected perspectives on culture: first, the centrality of lived, everyday culture—culture as 'a whole way of life'. Second, the notion that from the viewpoint of everyday life, culture is 'ordinary' (Williams, 1989). Williams sees culture as two interrelated processes: first, traditions, as known meanings and directions which we are trained to; and second, as processes of creative observations and reconfigurations where new meanings are created and offered. For Williams, these processes of sharing, finding, and creating common meanings are central to the making of society. For looking at interaction design and the emergence of the networked city,

there are important insights to draw from Williams' definition of culture. First, to see culture as both 'ordinary' and 'a whole way of life' is to acknowledge that cultural processes take place within and across everyday life. Second, as suggested by Slack and Wise (2005), this definition is also valuable in analysing technology, culture, and daily life. Slack and Wise argue that 'from the perspective of culture as a whole way of life, technologies are integral to culture, not separate from it' (ibid, p. 4).

Within practices of everyday, lived culture, technological artefacts and devices are part of a whole range of activities 'within which people make meanings in their lives: from everyday expressions and practices such as conversation over dinner or checking e-mail, to institutional structures and activities such as the structures of educations and the practice of designing a technology for public consumption' (ibid, p. 4). Culture as a 'whole way of life' is a valuable perspective for engaging with the networked city because it allows for bringing technology fully into the concept of culture through representations and everyday practices. Slack and Wise define this integral view on technology and culture as 'technological culture', where instead of focussing on the oppositional relationships between the technical and the cultural, these fields are seen as integrated within culture. This argument is further validity of what Balsamo (2011) draws on in her discussions of 'technoculture'.

2.4.5 Production and circulation of meaning

The second perspective on culture that I bring up retains Williams' emphasis on the centrality to culture in 'the giving and taking of meaning, of communication and language' (du Gay et al., 2013, p. 6), but extends these to examining and questioning more specifically *how* meaning is produced and circulated.

Hall et al. (1997) discuss how culture, in the context of cultural studies and sociology of culture, has primarily been seen as the 'production and exchange of meanings—"the giving and taking of meaning"—between members of a society or group' (ibid, p. 2). Here, culture is not seen so much as a set of *things*—novels and paintings or TV programmes and comics—but as a process or a set of practices through which these things are interpreted and made meaningful by the culture's participants. An important point is that, in 'any culture, there is always a great diversity of meanings about any topic, and more than one way of interpreting and representing it' (ibid). Hall (1980) argues that interpretation, and often multiple interpretations, therefore

becomes an essential aspect of how meaning is given and taken. In the production of meaning the interpretation, or decoding, is as important as the writing, or encoding, of meaning (ibid).

Further, Hall et al. argue that cultural meanings are important in understanding society and everyday life because they are not only ‘in the head’, but because they ‘organise and regulate social practices, influence our conduct and consequently have real, practical effects’ (Hall et al., 1997, p. 3). Cultural practices are therefore central because ‘it is by our use of things, and what we say, think and feel about them—how we represent them—that we *give them meaning*’ (ibid, p. 3; emphasis original). Hall et al. observe that we give objects, people, and events meaning through how we integrate them into everyday practices, the frameworks of interpretation we bring to them, and, it is important to note, how we represent them (see below). As such, culture:

is involved in all those practices which are not genetically programmed into us—like the jerk of a knee when tapped—but which carry meaning and value for us, which needs to be *meaningfully interpreted* by others, or which *depend on meaning* for their effective operation. (ibid, p. 3; emphasis original)

Hall et al. (1997) and du Gay et al. (2013) extend these notions of culture by examining and questioning how meaning is produced and circulated. These researchers suggest the concept of the ‘circuit of culture’ as a heuristic device for framing and analysing contemporary cultural artefacts. In introducing this model in 1997, these researchers used it specifically to analyse the ‘story’ of the Sony Walkman, while in a recent re-issue this analysis was juxtaposed with the Apple iPhone. The ‘circuit of culture’ is a model for analysing cultural artefacts that does not focus on isolated events or processes, such as how an artefact is produced or marketed, but rather on the interplay between key processes where meanings are made and circulated. The ‘circuit of culture’ suggests that ‘meanings are produced at several different sites and circulated through several different processes or practices’ (Hall et al., 1997, p. 3). In the circuit of culture, these researchers identify a set of key cultural processes: representation, identity, production, consumption, and regulation. This model emphasises both the interplay between different practices and how these processes are part of a circuit that continuously establishes, distributes, and re-configures meaning.

‘Representation’ is one of the central processes identified in the circuit of culture, and one that is of particular interest to the design production and analysis of this thesis. Hall (1997) describes how representation, as a signifying practice, involves:

... making meaning by forging links between three different orders of things: what we might broadly call the world of things, people, events and experiences; the conceptual world—the mental concepts we carry around in our heads; and the signs, arranged into languages, which ‘stand for’ or communicate these concepts. (p. 61)

Hall writes how producing meaning through representations, such as visual imagery or film, further depends on practices of interpretation for the representations to be meaningful. Through the related cultural processes of a ‘circuit of culture’, representations are interpreted and re-interpreted, and their meanings shift and evolve across different contexts and discourses. I suggest that it might be valuable to see these cultural perspectives on representation and circulation of meaning in relation to Léfèbvre’s urban perspectives on representations of space and representational space. The cultural representations of the networked city are central to how it is made meaningful in everyday life. Furthermore, these meanings shift and slide as new media, technologies, interactions, and imagery co-evolve with public discourse and everyday practices.

Central to the notion of the circuit of culture is the concept of ‘articulation’, which refers to the process of connecting disparate elements, and to how these connections are made. Hall (2005) writes that an articulation is ‘the form of the connection that can make a unity of two different elements, under certain conditions. It is a linkage which is not necessary, determined, absolute and essential for all time’ (ibid, p. 141).

The notion of articulation draws attention to how cultural processes involve ‘the contingent relations among practices, representations, and experiences that make up the world’ (Slack & Wise, 2005, p. 126). Slack and Wise suggest that in examining and discussing technological culture, it is valuable to think about ‘technologies in terms of articulations among the physical arrangements of matter, typically labeled technologies, and a range of contingently related practices, representations, experiences, and affects’ (ibid, p. 128). Seeing the networked city as processes of articulations therefore would involve

considering how concepts, institutions, representations, and lived culture are connected, and how these connections are made and can be re-made. A valuable insight that is brought to the foreground by the notion of articulation is that cultural meaning in daily life is not stable and not linear, and it can be re-articulated when new connections are made or when old ones are questioned. Hall (2005) writes that:

the so-called ‘unity’ of a discourse is really the articulation of different, distinct elements which can be rearticulated in different ways because they have no necessary ‘belongingness’. The ‘unity’ which matters is a linkage between that articulated discourse and the social forces with which it can, under certain historical conditions, but need not necessarily, be connected. (ibid, p. 141)

Because networked city life is an emergent, the technologies, the everyday experiences of them, and the discourses they are surrounded by are shifting. The concept of articulation offers a perspective to look at how institutions, technologies, legislation, interactions, and representations are brought together. It also draws attention to how everyday life and concepts of technological innovation, such as ‘smartness’ and ‘seamlessness’, are articulated through how these are represented and interpreted. An important point, from the perspective of interaction design research, is how the concept of articulation also could offer a mode for engaging with networked city life. In this thesis I suggest that interaction design research, through a communicative, culturally oriented practice, can work towards re-articulating discourses of the networked city by designing and mediating new forms of cultural representations. Engaging with the technocultural discourses of the networked city is further seen as a valuable route for engaging with how meaning is created in the meeting between everyday life and emerging technologies.

I see the concept of the ‘circuit of culture’, alongside those of representation and articulation, as valuable for investigating the relationships between the networked city and interaction design for a number of reasons. First, it highlights the centrality of meaning and cultural practices in the intersection of emerging technologies and everyday life. Everyday life is made up by habits and practices, but these are also accompanied by cultural expressions. Second, it emphasises that the cultural meanings of concepts such as the networked city, and the devices and technologies associated with it, are created and circulated through the interrelations between multiple processes, such as

everyday interactions, visual representations, advertising, product- design, and public debate. Third, the cultural meanings of the networked city are not singular or stable, but are interpreted and evolving through the continuous interplay of different cultural practices. As such, the ‘circuit of culture’ is not understood here as a formulaic model for analysis, but as a viewpoint for interpretation and design.

2.5 Reflections on context and background

The fields and theories presented in this chapter make up the context that this thesis works within. They establish issues and conceptual frames and are the background for the content matter that I address. This background is also the starting point for approaching the research questions that I introduced in the Introduction.

The first research question is how the invisible landscape of the networked city might be investigated and revealed through interaction design. This brings together material, critical, and cultural perspectives on interaction design with research on networked cities. Although this question is addressed specifically through the design research practice discussed in the following chapter, it also raises questions about the ontological status of the networked city. Is the networked city something that can be revealed? Is it something pre-existing that the researcher can simply investigate and make visible? To clarify what I mean by ‘revealing through design’, it might be valuable to again turn to theories of everyday life. Van Loon (2002) argues that ‘we will not understand anything about everyday life as long as we seek to reduce it to epiphenomena of hidden and secret “structures”’ (p. 94). Everyday life is heterogeneous and layered, and so too is the networked city. In proposing that the networked city might be revealed through interaction design, I simply suggest that aspects of its technical, unseen infrastructures might be investigated, visualised and made culturally accessible.

Galloway (2004), drawing on van Loon, argues that social and cultural theorists, as well as designers of ubiquitous computing, need to ‘find new ways of looking at the roles of technology in everyday life’ (p. 405). By ‘revealing’ the technological phenomena of networked city life, the motivation is to contribute to how these technologies can be made accessible. To ‘reveal the networked city’ is not to be understood as an agenda for uncovering and

explaining pre-existing technical systems. Rather, this form of ‘revealing’ is about designing expressions that propose ways of looking at and imagining the emergence of networked city life.

The second research question is how interaction design might be used to generate, or discover, new perspectives on the networked city. This is addressed through bringing together design practice and interdisciplinary analytical discussions. Through designing new ways of visualising and communicating technology, the motivation is, following Hall (1997), to re-articulate technological discourses of the networked city. By creating new links between unseen technological phenomena and the city, I attempt to contribute to the technological imagination (Balsamo, 2011) of everyday life and perhaps stir or challenge the technical and cultural biases of the ‘technological heritage’ (Feng and Feenberg, 2008). But the question of developing new perspectives on the networked city is not only addressed through the design practice and its outcomes, but also within the analytical work of bridging and bringing together theories and concepts from different fields to make up new conceptual formations. This is done in response to the research challenge of developing an analytical, interdisciplinary position on the networked city and interaction design situated within everyday life and culture. To illustrate this I suggest addressing three underdeveloped disciplinary connections:

First, in the current research there is a gap between the dominant approaches to the networked city, as illustrated by the smart city, and those found within interaction design. Second, the networked city, and the urban and cultural issues this might entail, are rarely addressed in interaction design and HCI research. This two-way gap is reinforced by the difference of scale that the fields work within. The smart city, both within commercial development and research, places the emphasis on infrastructure and systems, governance, economics or planning strategies (e.g., Caragliu et al., 2011; Hatzelhoff et al., 2012), while interaction design research typically address topics at the scale of interfaces, devices, and use- and user-centred approaches.

Third, the cultural and the everyday are largely under-developed within both research on interaction design and networked cities. Interaction design research is still largely influenced by technology-centred HCI and methodologies originating within informatics and cognitive psychology (see Galloway, 2004; Balsamo, 2011; Dourish & Bell, 2011; Murray, 2013), while research on the networked city is dominated by the largely technology-determinist smart

city discourse (see Townsend, 2013; Greenfield, 2013) and macro-perspectives on technologies in urban development within planning and geography (see Graham, 2004b). By being confined to these technology-specific domains, the cultural and the everyday are rarely considered in research on the networked city and interaction design. Neither are the theoretical and practical opportunities that might be found in the overlap between interaction design and the networked city. Exploring and developing new interdisciplinary frames and positions could therefore be valuable across these disciplines, enriching both practice and analysis on multiple levels.

I suggest that these underdeveloped disciplinary connections represent a potential that could be addressed by taking up the research challenge of developing an analytical position on the networked city and interaction design, and further situating this within everyday life and culture. This is further connected to the research question of how we might investigate and reveal the networked city through interaction design. And how might practices of explorative and communicative interaction design research contribute to new perspectives on the emergent networked city? The specific research questions are taken up in Chapters 3 and 4, while the challenge of developing an analytical position is taken up in Chapter 5.

Chapter 3

Practice and methods

In this chapter I discuss the methods and approaches of the design research practice that sits at the centre of this thesis. This practice draws on mixed methods that span the making, communication, and engagement with how the design outcomes ‘travel’ into and across culture. In this chapter I first give an overview of ‘research by design’ and ‘discursive design’ as overarching approaches. Second, I give an account of the *Immaterials* films and their place in the trajectory of the research, focussing on the practice of production and dissemination. I also reflect on the cultural spread of the films and visualisations as discursive artefacts. Finally, I outline and summarise the main methodological themes of the design research practice.

3.1 Practice-led design research

This thesis was developed through practice-led design research that borrows approaches and directions from ‘research by design’. This approach sees designs practice as a mode for inquiry, exploration and knowledge-building (Morrison & Sevaldson, 2010). This mode of knowledge-building, for example, uses design activities to explore a particular domain, where the research is conducted through practical design experiments, interpretations, and explorations. Koskinen et al. (2008) note that ‘a growing number of design researchers pursue integrated approaches where design work and research is interwoven. Accordingly, design work becomes inseparable from research’ (p. 46). In different variants, research by design approaches has been used across areas of design and architecture (see Sevaldson, 2010; Hensel, 2012).

Sevaldson (2010) describes processes of research by design as connected to ‘practice through research’, where the design practice is seen as a theory-building activity. Here, design practitioners engage in generative design activities where ‘investigations are conducted within a first person perspective combined with a reflexive mode making design knowledge explicit’ (ibid, p. 2). As research inquiry, practice-led research by design opens up possibilities for generative, explorative, and innovative approaches, implying that ‘the design practices by themselves have an inherent element of investigation,

innovation and knowledge generation' (ibid, p. 11). This view draws upon Schön, both in the formulation of 'reflection in action' (Schön, 1983) and in the ability to generate knowledge in explorative investigations of material. This form of practice-led research by design, Sevaldson writes, is distinct from the kind of knowledge-building found in 'traditional' sciences, in that the research inquiry is not about hypotheses, problems, and problem-solving. Instead, it is oriented towards exploration and moves towards generative discovery and critical exploration.

Koskinen et al. (2011) suggest a constructive approach to research by design that seeks inspiration from engineering and social sciences, but that investigates design-specific means and methods for research. These researchers refer to the experimental science laboratory, the field of social research, and the showroom as sites or directions for constructive design research. While they see these sites as important foundations and starting points for developing methods and theories in research by design, they also argue for moving beyond these settings and research approaches.

In challenging and expanding the notions of research by design, Mainsah and Morrison (2013) examine the importance of 'inter-disciplinary and inter-methodological experimentation as a mode of knowledge building' (ibid, p. 153). These researchers argue for examining and developing relations between how 'design research may benefit from investigations, explorations and innovations in the means of conducting and of conveying design research from qualitative methods in the social sciences' (ibid) alongside 'the production of knowledge by designing and via the acts of constructing design artefacts' (ibid). Further, they see methodological experimentation as being needed 'as a continual feature of design research in the wider project of reflexive knowledge building' (p. 160) and argue for 'the importance of methodological innovation that allows design research to look into its practices, academically, productively and through situated application' (ibid, p. 161).

I suggest that the research presented in this thesis should be seen in relation to this prompt for inter-disciplinary and inter-methodological experimentation, through academic inquiry across disciplinary fields, experimenting with modes of online research dissemination (see Article 4), popular communication, and through a rich and multifaceted design research practice.

Mainsah and Morrison suggest that ‘a diversity of design techniques drawn from design practice can usefully inform ways design research is conducted experimentally’ (ibid, p. 160), forming a methodological and dialogical mix of ‘differently situated and generated approaches’ (ibid, p. 153). They further argue that ‘this mix itself needs to be seen as a mode of experimenting with knowledge production relating to design’ (ibid). I would extend this argument by suggesting that if knowledge production is embedded within the methodological mix of design research practice, then the outcome of this knowledge production is deeply dependent upon the qualities and characteristics of the design practice in question. In practice-led design research inquiry, the themes and approaches, alongside the motivations, talents, and competencies of the designers involved, are central to the forms of knowledge and insight that can be generated. In this chapter I therefore focus on providing an overview of the specificities of the design research practice of this thesis. These aspects are also taken up in detail in the publications (see Article 4), and are discussed further in Chapter 4.

3.2 Discursive design

While approaches from research by design inform this project as a knowledge-building activity, the motivations and directions of the project can be described by what I and others have termed ‘discursive design’ (see Arnall & Martinussen, 2010; Morrison et al., 2011; Arnall, 2013c; Knutsen, 2014). Discursive design uses the languages and methods of design to investigate ‘relations between the meditational and the technical and that ... [connect] communication, context and culture’ (Morrison & Arnall, 2011, p. 2).

In exploring and developing the notion of discursive design, we extend on practices and concepts from ‘critical design’ (Dunne, 2001; Dunne & Raby, 2013). The concept of critical design opens up for a reflective, critical position on technology and design research. Seago and Dunne (1999) describe the key methodological factor in critical design research as:

... using the process of invention as a mode of ‘discourse’, a poetic invention that, by stretching established conventions, whether physical, social, or political, rather than simply affirming them, takes on a radical critical function, a material critical theory, or what Dunne terms a ‘parafunctionality’. (p. 17)

In the context of ubiquitous technology, this ‘radical critical function’ of design can be described as ‘a critical medium for reflecting on the cultural, social, and ethical impact of technology’ (Dunne, 2005: xii). Drawing on critical design, DiSalvo (2012) has proposed ‘adversarial design’, which uses design to take adversarial, and often radical, political positions. DiSalvo argues that design practice could be used both for providing the means for taking action towards social and political issues, and for bringing awareness to these kinds of issues by making them apparent and known (DiSalvo, 2009).

Our discursive design approach builds on the legacy of critical design, but whereas critical design approaches are concerned with speculation and art-centred contexts, discursive design emphasises ‘the communicative and rhetorical abilities inhabited by objects and the processes that go into shaping them’ (Knutsen, 2014, p. 127). And whereas DiSalvo’s approach to adversarial design is directed towards raising and critiquing specific social and political issues, we do not argue that this discursive design process is necessarily provocative, subversive, or ‘critical’ in the way that critical design and adversarial design typically are. The important similarity to critical design is the use of design artefacts and communication to challenge the assumptions and preconditions of emerging technologies, and using the processes and tools of interaction design to critically rethink the opportunities and challenges of the technology.

As discussed in Chapter 2, critical design has been critiqued for being overly self-reflexive and for limiting its communicative scope to art-related contexts (Malpass, 2014). With discursive design, our motivation is to put conceptualisation and communication of technology into a wider cultural frame. This is realised through a design practice where the processes, tools, and languages of interaction design are combined with rhetoric and visual means to investigate and communicate new relationships between technology and culture. Here, the design of discursive artefacts, like online films, is understood as a cultural production that contributes to circulation of meaning. Further, seeing discursive design in the context of everyday life also involves stepping beyond studies of use to include the cultural materials and expressions that accompany new technologies into daily life (Michael, 2006). Therefore, in developing a discursive, culturally situated approach to design research, we have taken a strong mediational focus and emphasise communication. Discursive design embodies the notion that the communication of ideas, concepts, and arguments through mediated design artefacts can be essential to both creating

effective interactive products, and to 'provoking discourse in and around technology-centric research' (Arnall & Martinussen, 2010, p. 119).

In Article 1 we suggest that one way of conceptualising the outcomes of discursive design is by seeing these communicative artefacts as 'boundary objects' (Star & Griesemer, 1989). Star and Griesemer introduced the concept of boundary objects to describe objects that can be used to translate between fields or contexts and that are 'both adaptable to different viewpoints and robust enough to maintain identity across them' (p. 1). When design research is mediated through online social media, online film may be seen as a boundary object that can inscribe complex and difficult aspects of design research in a broad public discourse. As these media artefacts act in an online social media context, they are embedded into diverse mediational forms such as news, blogs, and discussions forums, where they are used to support and discuss many perspectives and viewpoints. As designed boundary objects, online media artefacts may have the potential to initiate and contribute to discourses around emerging technology.

Morrison et al. (2010) suggest that in analysing this mode of design as discursive practice, it needs to be understood as a communicative whole that brings together 'a complex of design knowledges and practices and their articulation through media and products' (ibid, p. 3). This further needs to be seen more widely in terms of addressivity and articulation and through highlighting the rhetorical in design (ibid). Drawing on Bakhtin (1986), Morrison et al. write that the notion of addressivity is central to how discursive design is 'realised', in that it acknowledges that all discourse is socially shared and draws on a 'dialogical interplay with other voices and social, cultural and schematic conventions and emergent practices' (ibid).

In investigating and revealing the networked city through discursive design, it is therefore important not to simply design visualisations, but to also involve the creation and circulation of cultural meaning. This approach to design research emphasises the potential for design practice to both explore and communicate what is technically and culturally obscured.

3.3 Practice

The methodological approaches outlined above came together in multiple ways, through a collection of collaborative design research projects. The motivation driving the practice has been to find ways for using interaction design to take part in and work towards re-articulating discourses of emerging technologies, both within design and towards broader cultural contexts. This is reflected in the research question of investigating and revealing the invisible structures of networked city life through interaction design, and has provided a frame for both analysis and approach.

The design research that this thesis comes out of was developed by a small team of interaction design researchers at the Oslo School of Architecture and Design (AHO). The central members included Jørn Knutsen, Timo Arnall, and myself, alongside a wider network of international designers and researchers providing input and reflections on work as it progressed. Key among these were Jack Schulze and his colleagues at the London-based design studio BERG, Even Westvang at Bengler in Oslo, as well as Professor Andrew Morrison and our colleagues at AHO. Our collaborative practice is founded on the broad set of backgrounds and competencies found within the core team, including industrial- and graphic- design, music, filmmaking, photography, electronics, and programming, as well as architecture and urbanism. Alongside the research projects presented here, the team has been involved in teaching interaction design at the master's level at AHO and lecturing internationally at academic and popular events, as well as taking part in other creative design projects within both research and commercial contexts.

The work presented in this thesis started in 2007 as a part of the research project Touch (see Arnall, 2013a), which focussed on exploring interactive potentials with RFID. From 2009 onwards it continued through the research project YOUrban, exploring and analysing networked cities, social media, and design. Over the next sections I will look more closely at the body of work that we have called the *Immaterials* project.

3.3.1 The *Immaterials* project

The *Immaterials* project consists of a collection of films, images, artefacts, and written materials created in the process of exploring, conceptualising, and communicating the complex and often invisible technological phenomena that

networked, interactive products and services are made up of. To introduce the project I will briefly look at the origin and application of the term ‘immaterials’ itself. The term was first used in discussions within the design research team (the AHO group together with designers from BERG) as a shorthand for describing the material qualities we discovered while exploring visualisations of RFID in the Touch project. The term was later taken up across our research and within BERG’s commercial design practice, where it was used for communicating the complexities of what the BERG designers called ‘connected products’ (products that are intrinsically connected to the web, such as BERG’s ‘Little Printer’ [see bergcloud.com]). Schulze (2009) writes:

The products we design now are made with new stuffs. Service layers, video, animation, subscription models, customisation, interface, software, behaviours, places, radio, data, APIs [application programme interfaces] and connectivity are amongst the *immaterials* for modern products. (online)

BERG designer Matt Jones has further summarised and discussed the concept of immaterials using sociality, data, radio, and time as key examples (Jones, 2009). In our research practice at AHO we have taken up the concept of immaterials with a different emphasis, shifting the focus from developing products and interactions towards conceptualising and communicating the material and spatial qualities of the immaterials themselves, specifically by extending the notion of immaterials towards investigating and revealing the phenomena of the networked city. It has been fruitful to see the technical phenomena of the networked city as forms of immaterials to emphasise how radio, wireless communication, data, and positioning technologies are a fundamental part of the construction of networked cities (Martinussen, 2012).

The term *immaterials* emerged early in the process as a means for description and discussion through explorative, collaborative design practice, and was later put to use for framing and communicating in terms of popular online culture. But the term *immaterials* also has some specific limitations or weaknesses, in relation to the research questions the visualisations came out of. The term *immaterial* suggests that the technological phenomena of the networked city is somehow immaterial or intangible, while the visualisations, on the contrary, show how these phenomena, even if they are invisible, are highly tangible as material and spatial structures. Across our research we therefore see ‘immaterials’ not so much as a descriptive term, but as an

evocative way of naming and drawing attention to the overlooked and often unseen technical structures of urban life.

The first part of the *Immaterials* project was launched in 2009 with the film *Immaterials: Ghost in the Field* (Arnall, Schulze & Martinussen, 2009), and was followed by *Immaterials: Light Painting WiFi* (Arnall, Martinussen & Knutsen, 2011) in 2011; the latest instalment was the film and online research publication *Immaterials: Satellite Lamps* (Martinussen, Knutsen & Arnall, 2014). This film series brought together visualisations of technology with documentary elements showing the production of the visualisations. In this thesis I have chosen to emphasise these three main *Immaterials* films as visualisation and communication projects. However, the production and dissemination of these three films is only part of the practice that made up the overall *Immaterials* project. This is illustrated by the 2013 exhibition *Immaterials*, curated by Honor Hargar (2013) for Lightroom in Brighton (UK), where a range of different artefacts and films from the project were collected. Including both early experiments, such as the *RFID Pen* (shown in Article 1 as part of the visuals experiments section [Arnall & Martinussen, 2010, p. 116]) and *Robot Readable World* (Arnall, 2013b), an experimental film by Timo Arnall made up of found footage of computer vision interfaces and demonstrations.

My strand of the *Immaterials* project is concerned with the networked city and how it can be conceptualised. I have therefore chosen to focus on the three main *Immaterials* films and how they visualised and communicated RFID, WiFi, and GPS in the context of the networked city. In the following sections I give an account of each of these films, addressing their position within the design research practice, the motivation behind them, the process they came out of, and their general dissemination and reception.

3.3.2 *Immaterials: Ghost in the Field* (2009)

Immaterials: Ghost in the Field is a film about visualising RFID. RFID, or ‘Radio Frequency Identification’, is a technology commonly found in electronic ticketing systems, logistics systems, and access cards. The technology allows for the wireless interaction between two objects that are placed in close proximity to each other; a reader and a tag (e.g., one embedded within a plastic metro card like London’s Oyster system [Figure 3.1]). An RFID reader has an antenna that sends out an electromagnetic field. An RFID tag consists of a smaller antenna and a computer chip. When an RFID tag gets



Figure 3.1. A London Oyster card RFID reader in context. Credit: Timo Arnall.

within the field of the reader, it receives a charge through electromagnetic induction. This turns the chip on and initiates a small bit of communication between the reader and the tag; a typical case is the updating of travel credit on an electronic metro card. *Immaterials: Ghost in the Field* is a four-minute-long documentary that explains the operation and use of RFID by showing visualisations of the ‘readable volume’ between an RFID reader and tag. The film also shows the technique and process invented for creating these visualisations (Figure 3.2) and discusses how RFID can be understood as a spatial and material phenomenon.

In the context of the networked city and interaction design, RFID is an interesting technology. Over the last decade, with the introduction of elec-

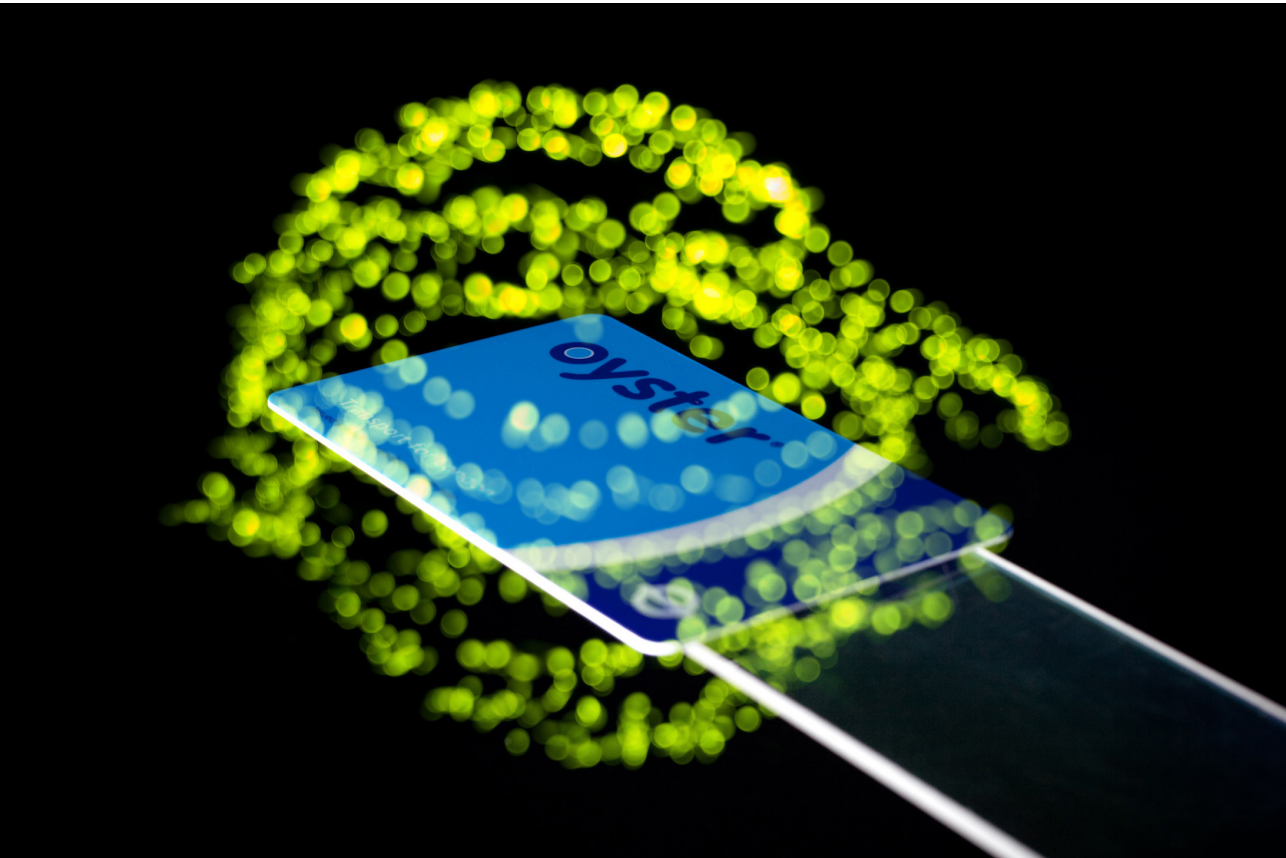


Figure 3.2. Still from the film *Immaterials: Ghost in the Field* showing a visualisation of the readable volume around the RFID tag inside an Oyster travel card.

tronic ticketing, RFID has become commonplace in everyday life in many cities. An electronic ticketing system, like London's Oyster card, works by having a network of readers on buses and tube stations. For the individual user the swift 'tap and beep' interaction of electronic travel cards has become one of the ways in which the networked city gets enacted, while at an urban level, the digital traces created by each of these individual interactions together make up detailed, aggregated data-sets of how public transport is used. These data-sets have many potential uses. In London, researchers at University College London have used these data-sets to create visualisations of how people move through the city (Roth et al., 2011). While in urban planning the datasets have been used for transport planning (Eltis, 2013), the same datasets have also been re-contextualised by the design studio Mudlark

through the game ‘Chromaroma’ (chromaroma.com). Here, Oyster card interactions were used as the input for a city-wide urban game where players collected points through commuting. As these examples illustrate, in the context of the networked city, RFID is interesting both because of its ubiquitous, everyday use, and also because it points towards possibilities for how both playful and utilitarian interactions and systems for the networked city might be developed.

Motivation

Around the years 2006–2009, when the Touch project was initiated, RFID was becoming a part of industry, daily life, and aspects of public debate. In corporate research across logistics systems and computing industries, RFID was discussed as a building block for a much-anticipated ‘Internet of Things’ (IoT) (EPoSS, 2008). In parallel, RFID-based ticketing and access systems were becoming embedded in daily urban life, replacing paper tickets and keys. In popular culture, RFID has been represented as a powerful tracking technology (a much-used trope in crime shows like *C.S.I.* and action films like *Casino Royal* [2006]). Here, RFID is often wrongly connected with GPS to create an imaginary system that allows for tracking RFID tags with satellites.

The public debates about RFID during those years were concerned with issues surrounding tracking and privacy. In the United States, religious and anti-government activists rallied against RFID, using the term ‘spychips’ (Albrecht & McIntyre, 2005) to describe RFID as a technology that allowed for governments and corporations to track peoples’ movements and activities. With the Touch project, our motivation was to address RFID as a material for interaction design; we attempted to go against and beyond the industrial focus on infrastructure and logistics, as well as to examine and challenge myths about the technology (Arnall, 2013c).

Process

As discussed in Article 1, our initial approach to re-contextualising RFID was to use the design of interactive products to illustrate how its potential use could be shifted from industrial, utilitarian contexts to playful, domestic contexts (see also Martinussen et al., 2007; Johansson, 2009). This involved inventing a series of prototype products that were communicated through online film, including the media player *Skål* (Figure 3.3). Alongside these experiments in product-development and communication, we developed research and teaching materials for doing interaction design with RFID.



Figure 3.3. *Skål* is a token-based media player for children, where RFID tags embedded in toys are used to control media content, such as films and pictures. With this product we wanted to re-imagine RFID aesthetically and contextually, thus getting away from utilitarian, industrial applications and moving towards playful, domestic settings emphasising materials, colours, and interactions (<http://www.skaal.no>).

Here, we focussed on using ‘product reviews’ of existing RFID products together with illustrations to attempt to communicate how to ‘design with RFID’ (Martinussen & Arnall, 2009).

This process of designing prototypical products was valuable in conceptualising particular use-cases for RFID and discussing potential product areas, but in our experience from teaching and following online discussions of the films, these products did not work towards conceptualising the material qualities of the technology itself. We therefore made a methodological shift in our

practice, from re-contextualising emerging technologies through products to conceptualising and explaining technological materials through visualisations.

As explained in the film *Immaterials: Ghost in the Field*, one of the central problems and possibilities of designing with RFID is that the interactive element (radio waves), which operate by proximity, are invisible. In the film we show the technique we developed for visualising the ‘readable volume’ of an RFID interaction using ‘light painting’. Light painting is a technique where a moving light source in a dark environment is captured with long-exposure photography, creating traces of the light’s movement in the resulting image.

In our visualisations, inspiration is drawn from the history of using light painting for making visible phenomena that we cannot normally see, such as movement. In the early 1900s, Frank and Lillian Gilbreth used light painting to study the movement of factory workers, with the purpose of simplifying work-patterns (see Article 4, ‘Visual Exploration’). In the 1940s and 1950s, Gjon Mili used light painting in a similar way, but with a more expressive purpose. Most famous are Mili’s *LIFE* magazine photographs of Picasso ‘painting’ in the air with a torchlight (Baldassari et al., 1997). Here, however, we were more interested in his photographs of figure skater Carol Lynne, where light sources on her skates are used to capture traces of her swirls, making her movements visible (Figure 3.4).

In the context of comics, McCloud (1994) writes and draws about visual languages for expressing invisible phenomena. McCloud emphasises how making the invisible visible through illustrations or images involves abstraction and highlighting, as well as relating to established visual codes. In comics, this has evolved into tropes such as motion lines for showing moment or action, ‘Kirby krackle’ (named for comic book artist Jack Kirby) for showing invisible energy fields, and dotted lines for showing something that is hidden (ibid; Kirby Museum, 2011). In developing our visualisations, we drew inspiration and guiding principles from how abstraction and visual codes are used in illustration and comics. In finding ways for explaining and expressing the technical, material qualities of RFID (and later WiFi and GPS) as visualisations, central questions were, therefore, which characteristics to bring to the foreground, how these could be abstracted and communicated, and how we might use existing visual codes in expressing these characteristics.



Figure 3.4. One of Gjon Mili's 'light painting' photographs of figure skater Carol Lynne (1945). Here this photographic technique is used to overlay the patterns of her movements with a static, mid-swirl image. Credit: Gjon Mili.

With RFID, we wanted to emphasise how the technology allows wireless interaction that works on proximity. In our interpretation, the central quality of RFID is where the tag can be read by the reader. To arrive at this we drew on experience from making interactive products and detailed technical explorations. Our visualisations therefore put the shape of the field in the foreground, abstracting the readable volume to only showing the edges as dotted lines and using animations of cross-sections to show the volume itself (see Figure 1.3). How this abstraction is expressed in the film is again connected to iterations and explorations of photographic technique (Figure 3.5), writing code, and building hardware (Figure 3.6).



Figure 3.5. The studio setup for shooting light paintings of the London Oyster card shown in Figure 3.2. The most important aspect of this setup was how lighting and exposure could be controlled to create good light painting photographs.

Inventing a technique for visualising RFID also involved developing a way of communicating these visualisations. In making the film, we combined the visualisations with elements of documentary filmmaking. The film shows the techniques and methods for making the images alongside the end results. As such, conceptualising RFID through visualisation works as a combination of explanation and expression. As a documentary, the film explains how the technology works by explaining the technique for visualising it. Showing the process of making the visualisation is thus also an important part of making the technology visible.



Figure 3.6. One of several versions of the RFID probes developed for creating the visualisations. This probe used a SonMicro RFID reader to detect the presence of an RFID tag. A piece of custom software turned this detection signal into a short flash of an LED.

Immaterials: Ghost in the Field marked the beginning of the *Immaterials* series. In our design research practice it represents a methodological shift away from interactive products and case studies in the HCI tradition, towards a cultural and communicative turn with an explicit focus on making materiality of invisible technologies accessible.

Dissemination and reception

Immaterials: Ghost in the Field was launched online in October 2009 as a film embedded inside a blog-post on the Touch project's website. The initial reception of the film was also documented and written about on the website:

In the two weeks since we launched our film *Immaterials* we've seen it spread across the Internet, going much further than we anticipated for such an esoteric exploration! So far it's been covered by Infosthetics, Slashdot, PSFK, Fast Company, Popular Science, io9, Wired, Gizmodo (FR, JP), Microsiervos, Make Magazine, Gizmologia, Influxinsights, WonderHowTo, Amal Graafstra, William Gibson and Warren Ellis amongst many others. (Arnall, 2009)

The film had been viewed online ca. 207,000 times (by 23 March 2015) and had been taken up across a broad range of contexts. The majority of activity around the film was in relation to design and technology: popular technology websites, engineering forums, interaction design magazines, electronic arts, DIY electronics, etc. Even though the film travelled far and was taken up in the design literature, education, and in exhibitions (see below), it did not enter the broader popular web culture and traditional media in the same way as the following *Immaterials* film did.

3.3.3 *Immaterials: Light Painting WiFi* (2011)

Immaterials: Light Painting WiFi is a 4:50-minutes-long film about visualising how wireless, digital communication networks are a part of the urban landscape. The film shows the development and use of a technique for visualising the signal strength of WiFi networks using urban photography and light painting. WiFi is a standard for small-scale wireless broadband communication that uses high-frequency radio to transfer data. WiFi networks from cafés, businesses, and peoples' homes often leak into streets and parks, bringing a form of fragmented connectivity into the city (see Article 2 for a detailed explanation of the technical aspects of WiFi in cities). In the opening of *Immaterials: Light Painting WiFi* we see the team building a WiFi measuring rod, which is an instrument for surveying the landscape of wireless networks (explained in the film and in Article 2). The operation of this instrument is explained with subtitles alongside footage of the rod being demonstrated (Figure 3.7). Over the remainder of the film we see the designers using this instrument to light paint cross-sections of WiFi networks in different urban environments.

WiFi has a number of characteristics in common with RFID in the context of the networked city: first, because it is based on radio waves it, too, is invisible. Second, WiFi has become a common, and often overlooked,



Figure 3.7. In this still from *Immaterials: Light Painting WiFi* we see the WiFi measuring rod being used. The rod consists of a four-metre-high column of LED lights and a WiFi receiver. The height of the light column is controlled by the strength of a chosen WiFi network. When the rod is moved through space and photographed using long exposure times, it draws a cross-section of the signal strength of the network.

part of everyday networked life in many cities. Third, WiFi has emerged rapidly as part of a conglomerate with other, more discussed technological developments, most notably mobile computing devices such as smartphones and tablets. In 2004, Graham wrote about the status of the contemporary networked city, noting that:

... the new 'Wi-Fi' services, which allow people with laptops to connect wirelessly to the Internet at fast speeds are, initially at least, only going to be available in airport lounges and selected chains of branded coffee shops and petrol stations. (Graham, 2004b, p. 20)



Figure 3.8. In this still we see a full version of the WiFi graph created by the process shown in Figure 3.7.

In 2010–2011, when this film was made, smartphones and laptops had recently become commonplace, as had WiFi networks. The activity of searching for and connecting to WiFi networks in cafés, at friends’ houses, or wherever a signal could be picked up across the city had become a part of networked city life. These interactions were, and still are, reliant on technically complex and often obscure interfaces that require the user to navigate lists of network names, Internet protocol (IP) addresses, and password encryption protocols. WiFi has also become a part of the visual urban landscape through markings and signage advertising its existence, for example, in cafés that offer WiFi to their customers (Morrison & Arnall, 2011). WiFi has not been a trope in popular entertainment in the same way as ‘RFID as tracking device’,

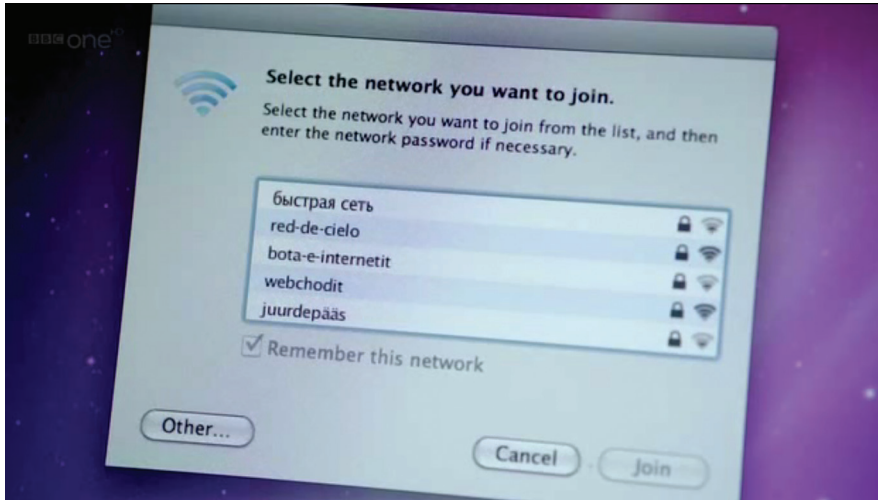


Figure 3.9. In a still from *Sherlock*, the BBC's modernisation of the Sherlock Holmes character (Thompson et al., 2012), the detective uses the network names (in several languages) that show up on the WiFi interface of his MacBook to deduce that assassins are in the neighbourhood. Here, the common experience of searching for WiFi networks is used as a humorous shorthand for placing Holmes in the contemporary networked city (Martinussen, 2012). Screenshot by the author.

but rather shows up in the narrative texture of shows that take place in the present, such as the BBC's modern-day series *Sherlock* (Figure 3.9).

Motivation

After making *Immaterials: Ghost in the Field*, we analysed and discussed what other immaterials of networked city life might be; from smartphone sensor data to GPS. We collaboratively sketched out how these might be explored, visualised, and communicated. With *Immaterials: Ghost in the Field* the focus was on the material, interactive qualities of the technology, but in going forward our motivation was to also focus on visualising urban and spatial characteristics of technologies of the networked city. We chose to pursue WiFi because this technology represents the foundational premise for networked city life: the network itself. While RFID points out what we are interacting with, wireless networks are what we are interacting through. As such, WiFi is one of the prototypical technologies of the networked city.

Immaterials: Light Painting WiFi was also motivated and inspired by research on the networked city and critical perspectives on ubicomp (as discussed in Chapter 2). We wanted to address Mitchell's evocative descriptions of the



Figure 3.10. Still from *Immaterials: Light Painting WiFi*. Here we see a university WiFi network spreading into a park. The dotted lines of the graph make it possible to see through it, thereby placing the visualisation in environment without obscuring the space behind it.

networked city as an ‘electromagnetic terrain’ by attempting to survey this landscape. Bell and Dourish (2007) argue against the dominant focus on the ‘proximate future’ in ubicomp and suggest that a ubicomp of the city is already here as a part of the messiness of everyday, networked life. By visualising WiFi, we wanted to take up this argument and to show the networked city as a present, everyday reality.

In examining the emergence of the networked city, Greenfield (2009) argues that ‘the complex technologies the networked city relies upon to produce its effects remain distressingly opaque, even to those exposed to them on a daily basis’ (online). This argument resonates with the motivation and direction

of *Immaterials: Light Painting WiFi* as a discursive design project and the methodological move of the *Immaterials* project towards visualising and communicating complex, everyday technical phenomena.

Process

The process of making the WiFi visualisations is shown in detail in the film itself as well as being discussed in Articles 2 and 3. Here, I will summarise a few aspects for situating the film within the trajectory of the project.

The RFID visualisations showed the technology in a dark studio, detached from the contexts in which it might be encountered in daily life. With WiFi our motivation was not just to create visualisations of the technology, but rather to show its place in the city, thereby using visualisations for contextualising the networked city in the city. We explored visualisation techniques and aesthetic qualities for highlighting wireless networks as urban phenomena that operate on the scale of architecture. This included elements such as the size and scale of the visualisations, the choice of locations, and the graphic qualities of the graphs (Figure 3.10). Urban photography was here used to show the phenomena of WiFi in the streets where it takes place, using urban spaces as a frame of reference (Figure 3.11 and Figure 3.12).

As with *Immaterials: Ghost in the Field*, this film also used documentary elements in contextualising invisible technology. The wireless networks were explicitly made visible in the visualisations, but also implicitly made visible by showing the process of creating these visualisations. Documentary film-making was used to show both the technique and the fieldwork, emphasising that this film was not only about visualising wireless networks, but also about exploring the networked city. By not using voice-over and interviews, as in the previous film, this film focussed on showing the process rather than explaining it. This was part of a deliberate choice to move beyond a pedagogical explanation of technology, towards a more open-ended way of articulating an expressive awareness of everyday technological phenomena.

Dissemination and reception

Immaterials: Light Painting WiFi was published in February 2011 as a film embedded in articles on the websites for the research projects YOUrban and Touch. The reception and propagation across different cultural contexts over the first year was later documented and discussed in a website article entitled 'Visualising WiFi for the Masses' (Martinussen, 2012):

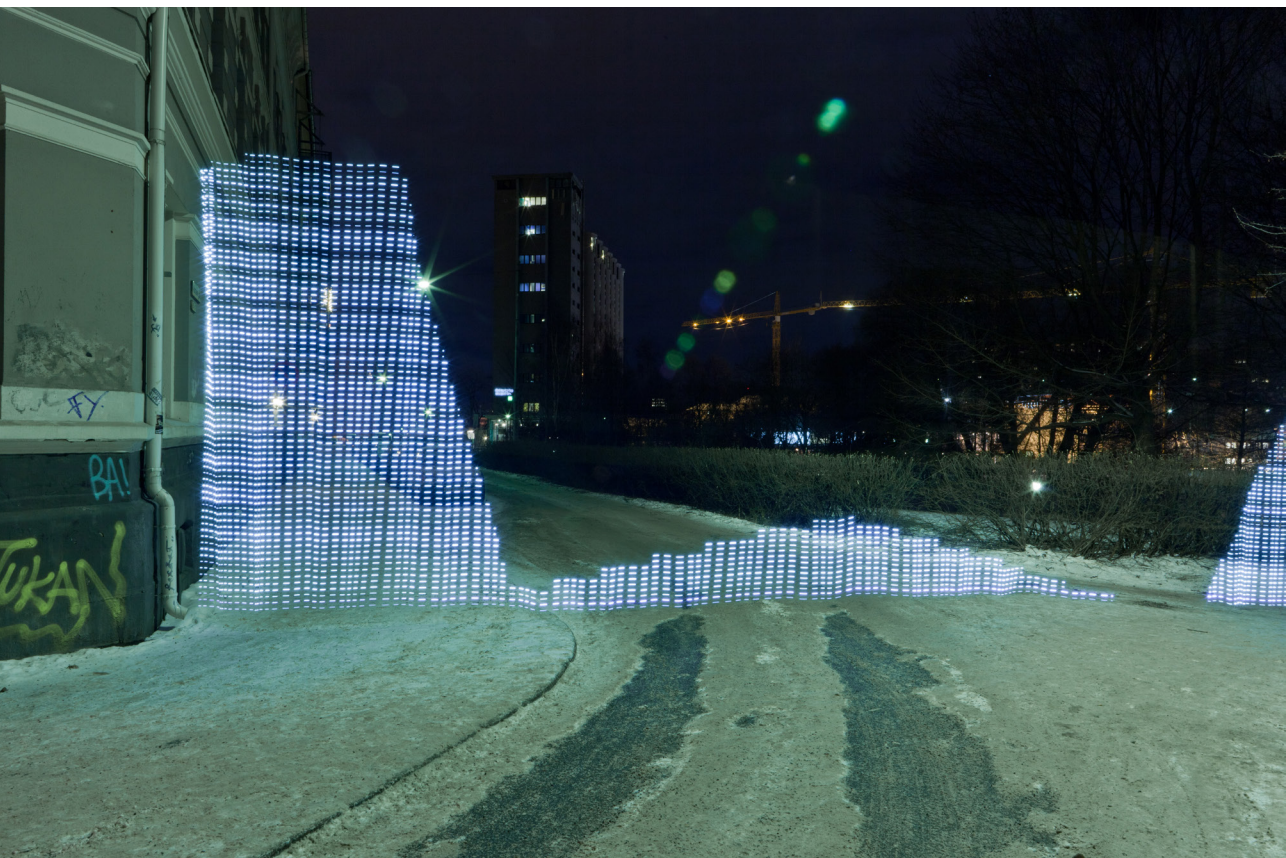


Figure 3.11. Cross-section of a WiFi network leaking out of an Oslo apartment building and into a snowy street. The shifts in signal-strength are most likely created by walls inside the apartment.

A year ago we released our film *Immaterials: Light Painting WiFi*. Since then the film has been viewed over a million times and spread far across the Internet, finding its way into many different contexts and taken up in various fields. It has received broad international coverage through traditional news media, design magazines, television, radio, popular science, exhibitions, awards, books, and research. It is still being discussed on blogs [and] websites and is still being reported and shared on social media. In many ways, the film has become a part of popular culture. (online)



Figure 3.12. A WiFi network along a busy road in Oslo.

As of 23 March 2015, the film had been viewed approximately 1.4 million times across the web. It has been taken up across both online and offline popular media, in education, exhibitions, social media, and in other research. The cultural spread of the film is elaborated upon in Chapter 3.5 and in Article 3.

3.4.4 Immaterials: *Satellite Lamps* (2014)

The *Satellite Lamps* project included two connected elements: first, it was a film about visualising how GPS is shaped by urban space. Second, it was an experimental online research publication that gave a detailed account of the production of the film, alongside a discussion of GPS as a technology with a rich and layered cultural history (see Article 4). The film showed a series of lamps that were designed to receive signals from GPS satellites, and to adjust



Figure 3.13. Still from *Immaterials: Satellite Lamps*. Here we see a single 'satellite lamp' placed along a road in a light-industrial neighbourhood of Oslo.

their brightness according to the quality of these signals. The lamps were placed in urban environments and photographed over time, using time-lapse photography. The resulting image-sequences showed the patterns of GPS accuracy flicker and shift as satellites moved across the sky and their radio-signals got blocked by buildings. As with *Immaterials: Light Painting WiFi* the film is a short documentary where we see a team of design researchers bringing a set of instruments (here, the satellite lamps) into the networked city to explore an aspect of its invisible landscape (Figure 3.13).

The *Satellite Lamps* publication presented the design research practice of exploring and developing visualisations of how GPS accuracy in cities shifts



Figure 3.14. In this still from *Immaterials: Satellite Lamps* we see a satellite lamp placed by a fjord, receiving a consistent and strong GPS signal. In the film we see the lamps in a sequence of environments that roughly corresponds to the history of GPS: from naval warfare (hence the fjord) , to car navigation, and finally to pedestrian use.

over time and space. This was a detailed and thoroughly documented account of aesthetic choices, technical tangles, and communicative concerns using a host of different media types, including images, drawings, and films. The publication also contained an essay outlining the history of satellite navigation from a military vision to everyday urban technology (Figure 3.14).

In Article 4, I go into detail about placing GPS in the context of the networked city and interaction design. Here, I will point to three aspects in the context of the *Immaterials* project. First, GPS operates on a different scale than both RFID and WiFi. GPS is a system that in theory can be used to locate anything, anywhere there is a view of the sky. It is fundamental to all

forms of locative technologies, upon which both implementations and visions of the networked city rest. Second, GPS is not a background phenomenon, but an interactive technology where a person, typically using a smartphone to navigate the city, is on one end, and a constellation of satellites is on the other end (see Article 4). When we use mobile, online maps, or locative social media like Foursquare, we interact with these satellites in real-time. Third, at the same time that GPS allows for playful, social smartphone interactions, it is a geopolitical, military technology created by the US government. The political and economic aspects of GPS are central to its history from the early 1960s to today. As such, GPS illustrates how the networked city is entangled with complex and often contested infrastructures, political agendas, and unpredictable socio-technical changes.

Motivation

When Apple introduced GPS into its iPhone in 2008, the discussions in our design research team centred around what this would mean for the networked city. Mobile devices with wireless connectivity had already brought the web into people's pockets and out into the city. The addition of GPS had the potential of connecting the web to our location in physical space, more deeply weaving together urban and digital life. In connecting mobile computing with physical space, GPS is therefore central to networked city life. But in cities, GPS is also prone to being unreliable and having unpredictable shifts in accuracy due to the presence of tall buildings. In critiquing the vision of 'seamlessness' within HCI, Chalmers and Galani (2004) discuss GPS shadows from buildings as one of the fundamental 'seams' of ubicomp.

We were intrigued by how GPS entails spatial interaction, yet the spatial formations of the city contradict the fundamental principle of GPS, which is line-of-sight to the sky. The landscape of GPS in the networked city is therefore a continuous negotiation between satellite geometry, the built environment, and our movements through the city.

Process

The process of creating *Immaterials: Satellite Lamps* is presented and discussed in Article 4. In placing *Satellite Lamps* in the research trajectory of the thesis, here I take up two aspects: first, the attempt to visualise GPS was a deliberate challenge for further exploring the *Immaterials* project as practice-led design research. Second, the design of the online publication itself was an exploration of potentials for both doing and communicating practice-led design research.



Figure 3.15. This image shows an early attempt to visualise GPS by light painting a heat map of accuracy along the ground. As discussed in Article 4, this technique proved to be unsuccessful because it did not account for the shifts in accuracy caused by the continuous movement of GPS satellites.

First, because of its scale and complexity, exploring and visualising GPS was challenging both on a practical and conceptual level. In taking up this challenge our intention was to push the *Immaterials* project further and to iterate on what we had learnt from designing and developing the previous films. But *Satellite Lamps* also represented a meta-challenge as practice-led design research. After two relatively successful visualisation projects, this was an attempt at ‘repeating the experiment’ in an explorative sense, and to see what we could do with the knowledge and insights built in the course of the previous projects. This means that *Satellite Lamps* was not just motivated by the prospect of making GPS visible, but also the opportunity to purposefully



Figure 3.16. This image shows satellite lamps being shot as a time-lapse sequence using a motorised, moving camera-rig.

observe, document, and reflect on the whole process of a discursive design research project.

Second, the *Satellite Lamps* project was an exploration of potential modes for both doing and communicating practice-led design research. In all the films there is an element of documentary that works in parallel with the visualisations. Showing how the visualisations are made is part of contextualising and explaining them. With the *Satellite Lamps* publication the intention was to experiment with how we could ‘make visible’ the whole design research process. In the *Satellite Lamps* publication the film is embedded within an online account of its making, taking practice and communication as the main focus and using extensive documentation and reflections of the whole process, from



Figure 3.17. A large part of the *Satellite Lamps* project consisted of location scouting and fieldwork; we used the lamps to explore how different urban environments shapes GPS signals.

research into the technicalities and histories of GPS, unsuccessful experiments (Figure 3.15), product design (Figure 3.16), and fieldwork (Figure 3.17).

Dissemination and reception

Satellite Lamps had just been published online as of the original writing of this thesis (August 2014) and the extent of its spread across the web is still uncertain. Initial responses suggest that *Satellite Lamps* have not reach the same kind of audiences as *Immaterials: Light Painting WiFi*, but has instead been shared and responded to within interaction design research and technology communities. The complexity of GPS, and of the project itself, could be the reason for the limited popular uptake. Yet, on a different level the project has been taken up as an example for practice-led research, presented and

discussed at conferences and events, as well as being exhibited internationally (see below). An interesting point is that the project has been included in the exhibition *DREAD* (see below) for offering a critical perspective on GPS, as well as recommended in a popular article on the official Facebook site for the Air Force Space Command; the US Department of Defence agency responsible for the operation of GPS.

3.5 The work in the world

In this section I will present a collection of different aspects of the cultural circulation of the films and their imagery. For reflecting on the ‘work in the world’ I draw on the relational model of the ‘circuit of culture’ discussed in Chapter 2. Du Gay et al. (2013) write that ‘... analysing the production of a cultural artefact in the present day involves not only understanding how that object is produced technically, but how that object is produced culturally; how it is made meaningful ...’ (p. xxxi). This, they observe, happens throughout the production and circulation of cultural artefacts in different processes. Further, Hall (1997) writes that cultural meaning is made through both encoding and decoding. Both interpretations and re-interpretations of the films across different disciplinary boundaries, discursive fields, and cultural contexts contribute to how the films become part of the cultural landscape of the networked city.

Throughout their circulation, the films and imagery have been engaged with by different groups in different ways, and have contributed to multiple discourses about networked cities. This circulation has further fed back into our own practice, where we have also engaged with the uptake of the films, and as such taken part in their circulation on different levels. This research project is not a study of cultural circulation and participation in particular, however. We have not performed online ethnography or similar methodologies that would allow for insights into how specific groups or audiences have responded to the films. To follow the circulation through different cultural contexts has instead been a part of situating and contributing to the design practice and reflection. As I discuss in this section, it allows for multiple perspectives on the work, as well as illustrating the discursive potential of online communication integrated into design research.

To present and reflect on the cultural circulation of the films, I have chosen to give brief accounts through a set of anecdotes. Following Michael (2012), ‘anecdote’, as a method, can allow for a ‘focused form of accounting’ where complex and layered processes can be presented as distinct fragments that together give an impression of the whole. With the anecdotes I have collected here, the intention is to give an overall impression of what the work has done in the world, while also showing specifics. This section is also accompanied by Appendices A-D, where more documentation and reflections about the project and its cultural circulation is written up as a series of web-articles published during the project.

Anecdote 1: *Watching the numbers*

In Berlin, on a Sunday morning in February in 2011, we first showed *Immaterials: Light Painting WiFi* to the world. We got ourselves a spot in an open track at a design and technology conference called *Cognitive Cities*. I talked for twenty minutes to an audience of about thirty people about our explorations of the networked city, and ended with a showing of the film. The night before we had uploaded and published a web article with the embedded film (Appendix A), and now we used the conference’s social media channels (Facebook and Twitter) to distribute the URL. We spent the rest of the day in a café outside the conference venue, following up the spread of the link across our social media networks and beyond through re-postings and sharing. First, the film got picked up by the conference audience, then it spread across social media within fields related to technology and design, and then quickly got written about on large technology and design websites like Gizmodo, Engadget, and Wired.

By the end of the first day, the number of people who had seen *Immaterials: Light Painting WiFi* had grown from the thirty or so people at my presentation to about four thousand online. The next morning, after the film had been shared and viewed across North America, the viewing figures had reached almost ninety thousand (Figure 3.18).

For weeks, the first thing we did every morning was to check the numbers, collect referrals and articles, and answer all sorts of emails. In total, all the films related to the *Immaterials* project have had upwards of 2.5 million plays (i.e. how many times the films have been watched in full) and more than 19.5 million page loads (meaning how many times webpages have showed the films’ title image). These numbers also only reflect how many times the films



Figure 3.18. Screenshot of the Vimeo statistics page for *Immaterials: Light Painting WiFi*, showing viewing figures for the first week after its release. Screenshot by the author.

have been shared through the formal sharing tools of the video-sharing service Vimeo. They do not reflect how many times the films and images have simply been copied and pasted into other sites, or the viewing figures of pirated versions of films. These are therefore far from exact numbers, but they give an indication of how many people have seen the imagery from the project.

Using online media to publish and spread discursive design artefacts allows us as researchers to obtain empirical data on how and where the work is viewed. This also gives us a glimpse into how the work circulates and is taken up, discussed and reappropriated on the websites that embed the films. Online media therefore not only gives us the possibility of reaching broad audiences, but also gives us the opportunity to observe and engage with those audiences.

Anecdote 2: Across and beyond the web

Late one March evening in 2011, after my family had gone to bed, I sat in the kitchen with my iPhone, attempting to explain the WiFi light paintings to the audience of a Canadian radio show. This was one of many examples of the films travelling both across, and beyond, the web. Both the RFID and

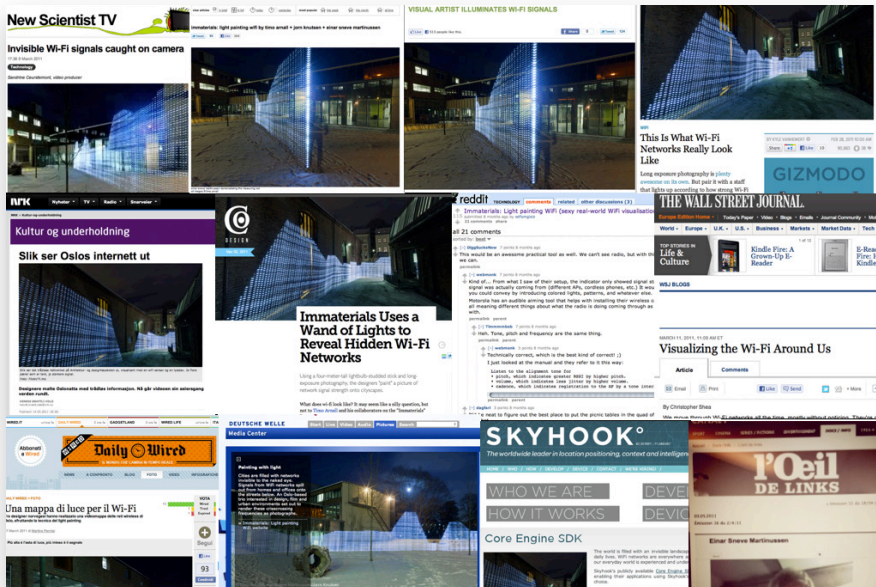


Figure 3.19. *Immaterials: Light Painting WiFi* spread far across the web, finding its way into multiple online contexts. Screenshots collected by the author.

WiFi visualisations got picked up and discussed in different online contexts: by design and technology sites, within networked city research, on technical forums, on news sites, within art, etc. (see Figure 3.19). We documented and wrote about this on our own websites (see Appendices D and E). But the films also spread from its initial online circulation and into various other ‘offline’ contexts, including radio, television (Figure 3.20), print magazines, and newspapers.

Today, years after the films were published, we still get requests to include the images in books (Figure 3.21) and magazines, or for showing the films at events and conferences. This allows us to reflect on how the cultural circulation and re-circulation of the films and images is continuous, without our interference. As such, we could argue that they have become a part of the popular cultural landscape of the networked city.

Anecdote 3: Inspiring visual language and techniques

The first non-media contacts about the WiFi light paintings came from industry and advertising. The American location-mapping company Skyhook

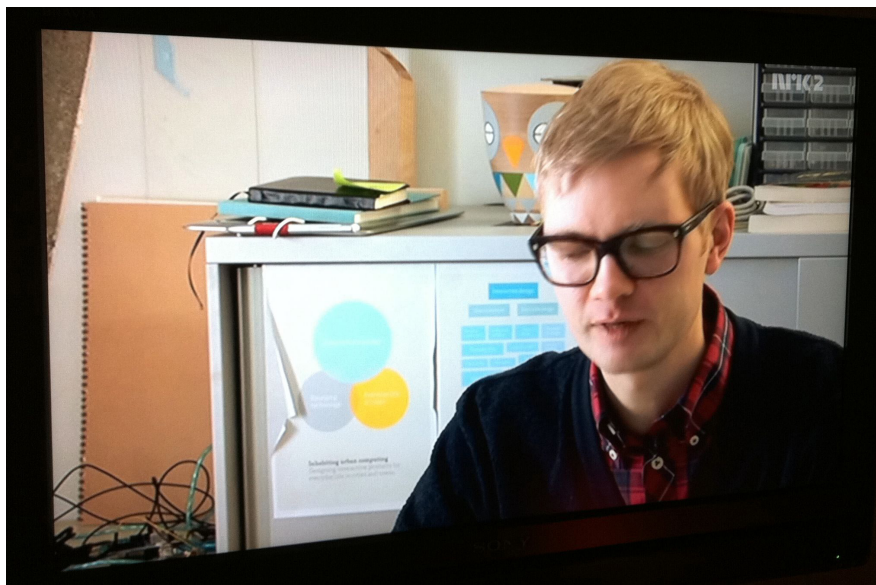


Figure 3.20. This image shows the author talking about the WiFi film on a segment on the NRK (Norwegian public broadcaster) art and culture show 'Nasjonalgalleriet'. Interestingly, national attention around the project came as a response to the broad international reception it had received. Also, even though this was national television, the viewing figures were much lower than the traffic generated by the story on popular websites such as Gizmodo.

wanted to use the images to illustrate its services. Skyhook maps WiFi networks to aid online maps when GPS reception is poor. The company is best known for having delivered urban location data for the iPhone's first non-GPS map application. The global engineering-firm ABB contacted us to find out if we might be able to do the same kind of visualisations for its radio-location systems for equipment in mines. This, the company hoped, would make it easier to communicate the system to its clients. A Norwegian advertising agency contacted us to see if it would be possible to use these visualisations to market WiFi hot-spots for a telecommunications provider. We responded by explaining that these visualisations would show the actual qualities of the network, with both its strengths and flaws. After this the agency did not follow up on the proposal.

In June 2011, British Telecom started airing a TV ad called *The BT Smart Wireless Home Hub*. This film opens with shots of city streets overlaid with glowing graphs, and a voice-over that says: 'Every city, every town, every home is filled with an invisible network of competing signals' (BT, 2011).



Figure 3.21. The WiFi visualisations have appeared in numerous coffee table-style books on graphic design, photography, and information visualisation. Here, the Gestalten book *Visual Storytelling—Inspiring a New Visual Language* (Klanten et al., 2011).

In this ad, we recognise the visual language of the WiFi film, as well as the conceptual premise of an invisible landscape of networks. These examples, in different ways, show how our visual language for invisible technology has been seen as useful across industrial, commercial, and communicative contexts. (See also Appendix D.)

Interestingly, the visual technique of using vertical rods for light paintings has been taken up extensively by designers and hobbyists. The technique has been used for aesthetic and technical explorations, leading to both online instructions for how to build ‘light painting wands’ (Figure 3.22) and commercially available products (see Appendix D.)

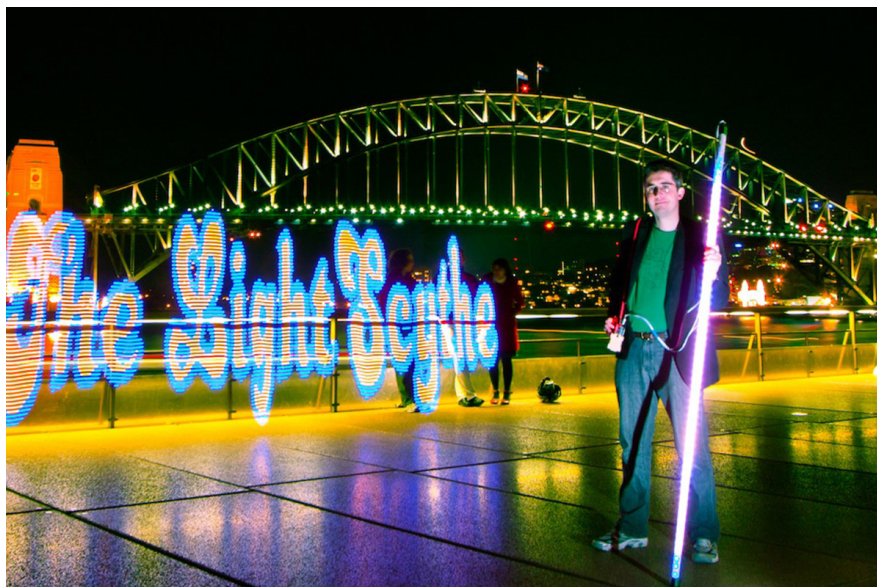


Figure 3.22. This image shows ‘LightScythe’, an open-source wand-based light painting tool inspired by *Immaterials: Light Painting WiFi*. The tool, and the instructions for how to make one, were created by a man who calls himself ‘The Mechatronics Guy’: <https://sites.google.com/site/mechatronicsguy/lightscythe>. Credit: ‘The Mechatronics Guy’.

These examples illustrate how the research may have contributed to expanding the visual language of the networked city in a number of direct and indirect ways. It also shows how design practice builds on, and is part of, a broad set of cultural resources for inspiration and invention.

Anecdote 4: Education

Every few months after we published *Immaterials: Ghost in the Field*, we got emails from interaction designers and design students struggling with RFID projects. Typical questions would be about the readable volume of particular tag-sizes, and questions about programming and sourcing of hardware. We responded by sending some of the educational materials we used in teaching our own students at AHO, as well as sharing and contributing to online code-example and software library websites.

In 2011, Tom Igoe published the second edition of his influential interaction design and technology textbook *Making Things Talk* (2011), which had become central in teaching about networked interactions since the publi-



Figure 3.23. Tom Igoe's book *Making Things Talk*, a textbook for designing interactive, networked products. Credit: Timo Arnall.

cation of the first edition in 2007 (Figure 3.23). Here, Igoe used our RFID visualisations alongside other work from the Touch project to explain and illustrate RFID for designers; *Immaterials: Ghost in the Field* was one of the few available reference points for designing with RFID.

Taking part in educational contexts has allowed us as design researchers to reflect on the challenges of building knowledge about the invisible materials of interaction design. It has also reinforced the challenges of communicating in ways that are both legible and constructive, as well as inspirational.

Anecdote 5: Exhibitions

Through various forms of online sharing and re-publishing, the work has been re-contextualised in different ways. This includes being included in technical, industrial, and artistic contexts. Some of the most specific re-contextualisations have happened through the curation of exhibitions. The films and the imagery have been included in a number of exhibitions as both large photographic prints and screenings of the films. Two interesting, and perhaps contrasting, examples are the 2011 New York Museum of Modern Art exhibition *Talk to Me: Design and the Communication between People and Objects* (curated by Paola Antonelli), which included *Immaterial: Ghost in the Field*, and the exhibition *DREAD—fear in the age of technological acceleration* at De Hallen Haarlem in Amsterdam (2013, curated by Juha van't Zelfde), where the *Satellite Lamps* were exhibited.

Both *Talk to Me* and *DREAD* work across design, technology, and art, but while the first is a playful collection of products and artefacts that address the communication between people and technology, the second takes on a critical perspective on contemporary technological issues like surveillance, privacy, drones, and the politics of the digital (Figure 3.24).

As the *Immaterials* project is brought into new configurations by others, it allows us as researchers to reflect on its status in new way. It also illustrates how the circulation of these discursive artefacts into new contexts changes how the work can be decoded or re-interpreted.

Anecdote 6: Opinions and public debate

One of the consequences of the broad international attention that *Immaterials: Light Painting WiFi* got was that it gave us access to national media and the possibility to engage with the public debate about networked cities in Norway. Following a television appearance on NRK, the Norwegian public broadcaster, and a feature interview in the newspaper *Aftenposten*, I was contacted by another national newspaper, *Dagbladet*, to write an opinion article on urban planning and technology. I used this opportunity to write a critical article about digital technologies and challenges in Norwegian urban planning discourses. This opinion article led to an invitation to a series of meetings with Statsbygg, the state agency responsible for all major public construction, planning, and property management in Norway. With Statsbygg, I discussed how networked cities could be addressed in national planning policies, and how these issues should be lifted across political and public debates about urban



Figure 3.24. *Satellite Lamps* at *DREAD—fear in the age of technological acceleration* at De Hallen Haarlem in Amsterdam (2013), next to Trevor Paglen’s *They watch the moon*, a photograph of a classified US ECHELON listening station for capturing communications and telemetry signals. Credit: Gert-Jan van Rooij.

development. After nearly three years of seminars and planning meetings, these discussions finally ended up with the international conference *Digitalt Byliv* (meaning ‘digital urban life’) in Oslo in 2013 (Figure 3.26).

We at the YOUrban project organised *Digitalt Byliv* in collaboration with Statsbygg, the Ministry of the Environment, the Foundation for Design and Architecture in Norway, and the Research Council of Norway. Here, we got mandate to organise an event with the expressed purpose of putting the networked city on the national agenda for urban planning, architecture, and design. With our programme for *Digitalt Byliv* we gathered national and



Figure 3.25. Opinion article in *Dagbladet* in 2011 titled ‘Et digitalt byliv’ (meaning ‘a digital urban life’). This opinion article was initiated by the visualisations, and in turn, the article initiated the collaboration with Statsbygg that became the *Digitalt Byliv* conference.

international researchers, activists, practitioners, and politicians, and focused on critical and civic perspectives on networked cities.

This example illustrates how using interaction design in a communicative, culturally oriented mode might give access to ways of engaging with public debate. Yet, as the three-year planning process indicates, to actually engage with public debate at the level of political and governmental institutions also requires many other forms of discursive work outside of those of discursive design. This points to both limitations and possibilities with this approach, as the design work on its own is limited to inspiring new ways of seeing the networked city. But if this design work achieves cultural momentum, it may, as was the case here, be an initial step towards gaining access to political and institutional discourses.

Anecdote 7: Re-enactment

Over the summer of 2012 we re-enacted the whole WiFi film with a TV crew from Discovery Canada. This re-enactment involved acting out the process of



Figure 3.26. The *Digitalt Byliv* conference in Oslo in 2013.

making the measuring rod, including fake soldering scenes, and creating new visualisations (Figure 3.27). The result was a short documentary with voice-over and interviews that aired throughout the Discovery network. This is an interesting example of how the project got re-contextualised, but still kept some of its communicative and conceptual robustness as a boundary object. It also raises the question of how robust these films, as boundary objects, are to re-contextualisations.

In the Discovery Channel segment, the tone, expression, and presentation of the work was transformed to follow particular conventions of fast-paced popular science entertainment. This was challenging, and potentially problematic, because it changed how the project was represented. Yet, the argument for seeing the networked city in new ways was still embedded in the



Figure 3.27. Re-enacting *Immaterials: Light Painting WiFi* in 2012 with the Discovery Channel.

visualisations and the technique, as well as being communicated through our interviews. Although this re-enactment was a drastic form of re-contextualisation that may have transform parts of the work, at the same time it also was part of the broad cultural circulation of the project's concepts and imagery.

Anecdote 8: *The unexpected*

When we launched the films into the world we initially expected them to be taken up within the fields of design, technology, and urbanism. With *Immaterials: Light Painting WiFi* we got a much broader response than we could have anticipated. One of the effects of this widespread circulation has been many forms of unexpected online encounters. Many of these have been from

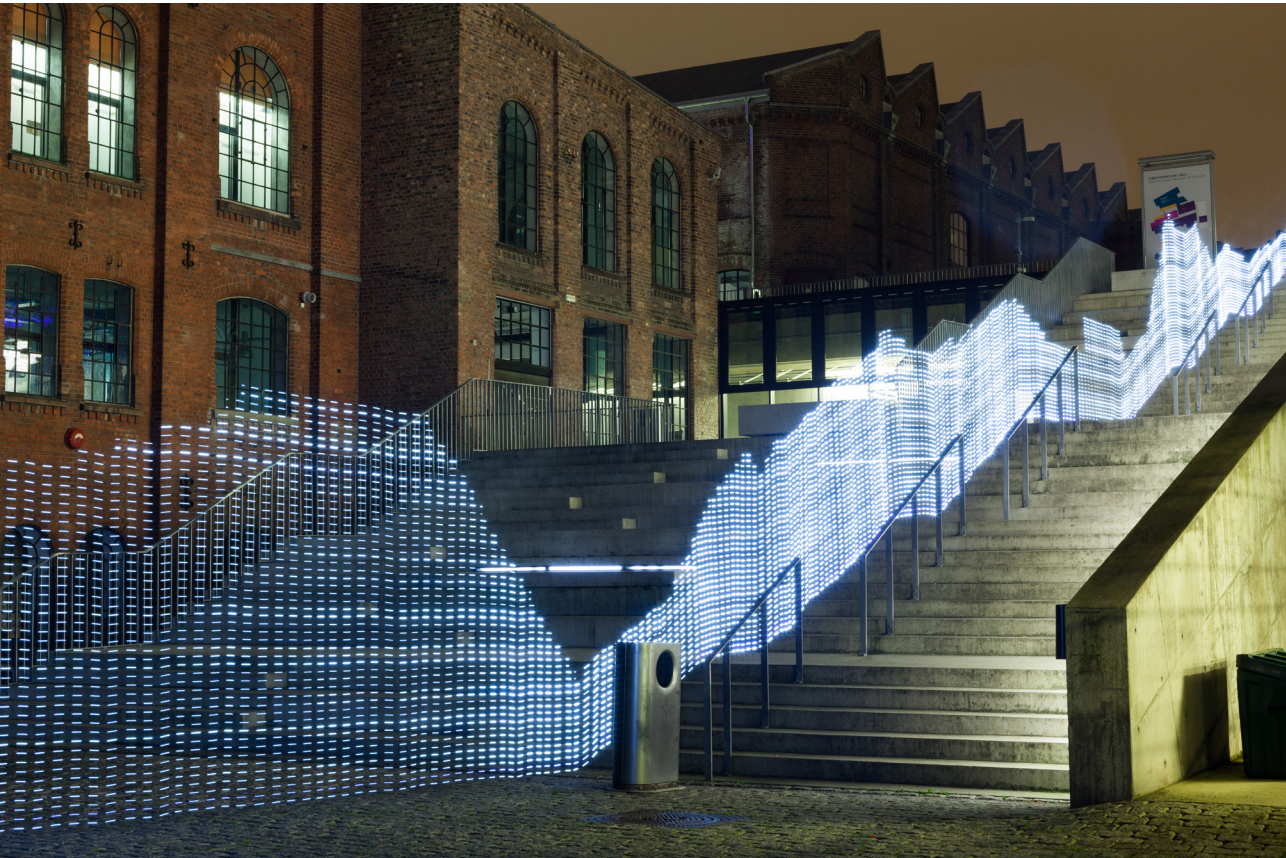


Figure 3.28. WiFi visualisations created for the Discovery Channel in the summer of 2012.

activists working against the propagation of electromagnetic radiation. Various groups have requested to use the images to illustrate what they perceive as ‘the dangers of electromagnetic poisoning’:

Perhaps you intended something else regarding this project, but many of us see something greater that can come out of your project. This can help people to visualize hidden dangers. Yes, it has beauty to it, but so does any wild creature, a tsunami before it hits, a volcano, tornado, etc. We still need to have a healthy fear/respect of things that can be beautiful as they can [kill] us. (Baxter family, 2013, email correspondence)

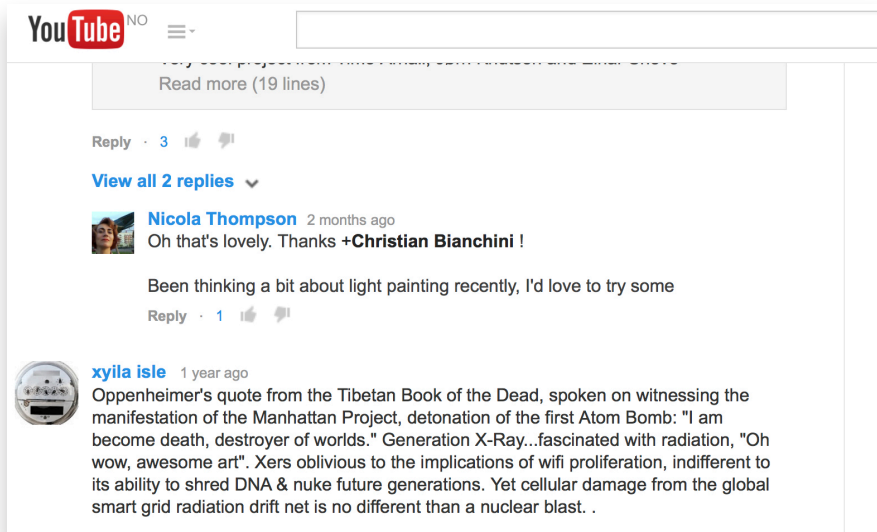


Figure 3.29. YouTube comment from user 'xyila isle', who is concerned about WiFi's ability to 'shred DNA and nuke future generations'. Screenshot by the author.

These perspectives on the films have also been argued for across forums and discussion groups, as well as in the YouTube comments for the films (see Figure 3.29). This shows another side of how emerging, wireless technologies are understood in different cultural contexts. These views are often dismissed in scientific discourse (e.g., Newman et al., 2012), but they do point out how invisible technologies are subject to people's myths and fears. The concerns of the Baxter family, as expressed in the email quote above, can be seen as another side of invisibilities of the networked city. These unexpected reactions to the films allow us to observe a much wider spectrum of cultural circulation than would be possible without the use of popular online media.

3.5.1 Reflections on cultural circulation

These anecdotes show some of the ways in which the films and the visualisations have become part of the cultural landscape of the networked city. They illustrate different aspects of the circulation of the films and images as discursive artefacts, as mediated representations, and as boundary objects. As cultural artefacts they are subject to different interpretations and contextualisations that establish, distribute, and re-articulate cultural meaning. Following Hall (1997) and du Gay et al. (2013), their meaning shifts and evolves as they

circulate from context to context: from commercial promotion, advertising, art, education, and folk-theories of technology. Across these fields, the films take part in different forms of articulations by being connected to various discourses and agendas. The films have travelled across multiple boundaries: between online and offline media, disciplinary domains, design practice, and popular entertainment, and from online popular culture to urban politics. We can also observe how the films, as boundary objects, have a certain robustness that directs how they are interpreted across fields. Here I would suggest that the argument for becoming aware of the networked city in new ways is a central point that travels across boundaries.

Kay (2000) uses the concept of the ‘technoscientific imaginary’ to describe shared representations and representational practices across both science and technology and across broader, popular culture. This resonates with Balsamo’s (2011) discussions of the ‘technological imagination’, but where the latter concept is connected to how technologies are understood in design processes, the ‘technoscientific imaginary’ involves the images and representations of technoscience that also travel through popular culture and media. We could argue that the films and visualisations of the *Immaterials* project, in a small way, have become part of both the technoscientific imaginary and the technological imagination of the networked city.

Viewing designed, mediated representations as contributions to the popular imagination is also interesting in relation to everyday life. As discussed in Chapter 2, the networked city makes its mark on the everyday through the habits and practices of daily life. But cultural meaning in daily life is also constructed by the representations and cultural materials that accompany daily practices. Following Williams (1989) and Moran (2005), I would argue that the popular imagination of technology is an important part of the ordinary, everyday culture. Contributing to the technoscientific imaginary of the networked city can therefore be a way to engage with networked daily life.

To follow the cultural circulation of the design work poses both challenges and possibilities for us as researchers, and for what kinds of insights and knowledge can be generated. Collecting and documenting how the films and visualisations have been brought into new contexts allows us to reflect on the work in new ways. Examining responses and discussions allows us to evaluate the status of the outputs and how these outputs communicate. This also reflects our motivation of engaging with broad, popular culture. In this

respect, I would argue that one of the strengths of the work is its open-endedness. Its central argument for seeing emerging technologies in new ways is not prescriptive or locked-down, but lends itself to a wide range of discourses and reflections.

There are also weaknesses and problems with this approach to doing research across and within culture. Designing towards popular imagination, while also examining the heterogeneous cultural circulation, is layered, unpredictable, and often tangential. How the work travels on its own is largely outside the control or planning of the researcher. How we choose to follow the cultural circulation, and which anecdotes we collect, are part of directing the reflections and analysis. In doing this work of selection, it is important to be aware of our agenda and our vested interests in the work. One approach to keeping this analysis open-ended has been to equally include the different directions the work has taken, for example by not just focussing on prestigious art exhibitions or design magazines, but to equally include popular media, advertising, DIY-interpretations, and the unexpected.

The cultural circulation of the work is a central part of our discursive design practice, and also raises questions about our role as researchers and cultural producers. Designing the films and visualisations can be seen as interventions towards popular online culture. These interventions are motivated explicitly by the possibilities of seeing the networked city in new ways, and implicitly by a critical perspective on smart cities and the neo-liberal urban discourses they come out of (see Greenfield, 2013). Seeing this practice as intervention also illustrates how we as researchers take part across and within the cultural contexts that the work travels through. We are not just designing and communicating these films to observe and document their impact, but as a way of actively taking part in articulating discourses of the networked city. These articulations are therefore also coloured by our motivations for exploring, visualizing, and critiquing the networked city.

Finally, as discursive design, the design practice involves both production and circulation. Following and taking part in the cultural circulation of the films feeds into the ongoing design practice and methodological reflection. How each film travels through culture is continuously woven into the production of new work, suggesting that discursive design is more about ongoing cultural engagement than cultural intervention. These issues are taken up further in Chapter 4.

3.6 Methodological themes

Over the remainder of this chapter I will outline what I have called the ‘methodological themes’ of the thesis. I identify themes that run through the research as methodological formations that are interwoven throughout the projects. These are a medley of research methods and design techniques that have been blended through a collaborative, explorative, and reflexive design research practice.

Interdisciplinary connections

The academic, technical, and cultural contexts that I address in this thesis are complex, multiple, and often emergent. In approaching these I have taken on a purposefully open-ended, and often eclectic, interdisciplinary cross-reading of research literature alongside technical and popular texts from across disciplines, sources, and mediational forms. This approach has similarities to what Michael (2006), in his analysis of technoscience and everyday life, describes as a ‘peripatetic’ approach: ‘a gentle meandering through, and more or less haphazard encounters in, a forest of intellectual traditions’ (Michael, 2006, p. 17). In a more experimental and expressive way, I have also drawn inspiration from Hollings’ cross-mediational juxtapositions of popular culture, science, and military research in examining fantasies of science in postwar American society (Hollings & James, 2006; Hollings, 2008).

In a practical sense, an interdisciplinary approach has included researching technical documentation, engineering literature, and design techniques. This have allowed us to generate design artefacts that both communicate and engage with the materiality of emerging technology. Interdisciplinary cross-reading is a theme that goes across the practice for both analytical and methodological framings. The relational and reflexive aspects of this interdisciplinarity came most clearly to the surface in the publication *Satellite Lamps*. Here, a detailed multi-mediational account of a design process was brought together with analytical perspectives on the networked city and the wide-spanning cultural, technical, and military history of GPS.

Observation and interpretation

Throughout the research process we have engaged in multiple forms of observation and interpretation of cultural expressions of technology, everyday life, products, and technological systems. The focus has been on how the concepts and technologies of the networked city are part of the cultural landscape

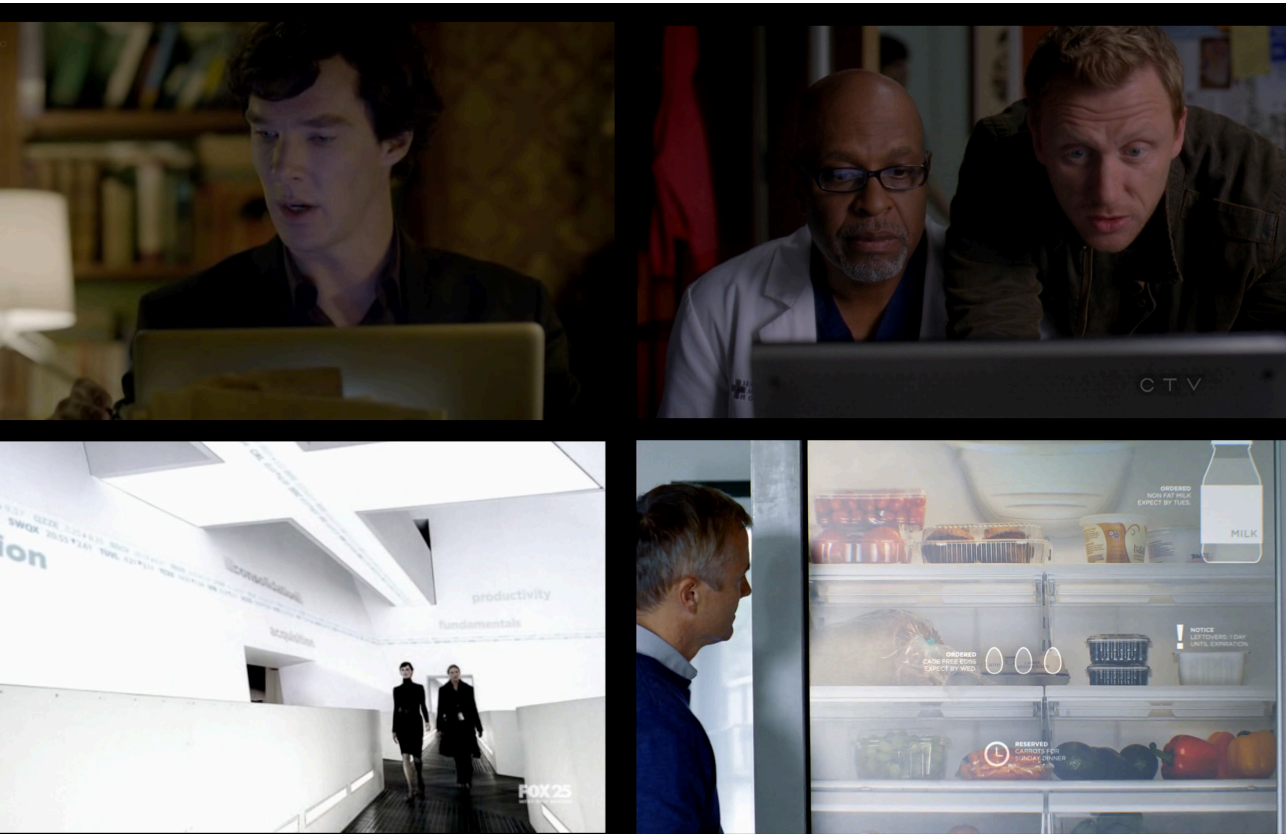


Figure 3.30. A selection of screenshots collected from popular TV and online media. Clockwise from top left: Sherlock Holmes uses WiFi to find assassins in *Sherlock* (Thompson et al., 2012); GPS is used to explain Twitter in *Grey's Anatomy* (Wilding & Kidd, 2011); a transparent refrigerator door screen from Microsoft's 'vision video' *Productivity Future Vision* (Microsoft, 2011); and situated, dynamic screens in *Fringe* (Abrams et al., 2008). In the first, technology is used in a humorous way as a shorthand for modernising Sherlock Holmes; in the second, an established technology, GPS, is used as a reference for explaining an emerging social media system; the last two are examples of the trope popular at the time of using Adobe After Effects to overlay screens and motion graphics in space.

through cultural expressions, representations, and practices, alongside how technologies are realised through products, interactions, and everyday use. This has included methods such as observational photography of artefacts and use (Arnall, 2014); collecting and interpreting scenes and screenshots from popular television, films, and websites (Figure 3.30); as well as analysing products (what we have called a 'product review' [Martinussen & Arnall, 2009]) and following the shifting discourses of emerging technology. Obser-



Figure 3.31. Collecting products and artefacts in the studio. Credit: Timo Arnall.

ventions have been collected through note-taking, photography, and collecting of products and artefacts (Figure 3.31; Figure 3.32). These have been discussed and analysed in a collaborative studio setting.

We have taken two connected approaches in our interpretations of these varied cultural artefacts. The first approach is through interpreting how these objects, practices, and media are expressed through design and mediated through film-making, visual communication, sound, typography, interactions, etc. Second, we have taken on what Morrison et al. (2013) call an exploratory and prospective hermeneutics. ‘Prospective hermeneutics’ can be defined as going beyond interpretations in a historical or contemporary frame, and towards engaging with how things might be in the future. A prospective hermeneutics of the networked city and interaction design may,



Figure 3.32. Reviewing interactive products involves not only analysing their interactions and product design, but also examining their technical solutions. This often involves dismantling products, such as the ‘Violet Mir:ror’ networked RFID reader, shown here. Credit: Timo Arnall.

for example, focus on interpreting how discourses of technology might be re-articulated through designed mediations.

Collaborative and creative generative production

Our research centres around studio-based collaborative design practice with a multi-competent team of professional designers/researchers. Sanders and Stappers (2012) describe general methods and tools used in creative, generative design research that centre around user involvement and collaboration with non-designers. In our practice we share some of these approaches, such as workshops, idea evaluation, communication, and sketching, but our research practice is specifically shaped around a team of professional designers



Figure 3.33. The design research process has been characterised by mixed, collaborative practice, here exemplified by an image from the shooting of *Immaterials: Light Painting WiFi*, where we see two of the team-members involved in on-the-fly programming whilst calibrating the WiFi measuring instrument. This illustrates the multi-sited nature of the process, spanning the studio, the city, and online platforms.

and their skills and experiences. This practice is characterised by being collaborative, creative, and generative, working from initial conceptualisations through to finished design productions (Figure 3.33).

There are many elements to this process, including sketching and concept development in studio settings, using both traditional pen-and-paper drawing techniques (Figure 3.34; 3.35) as well as experimenting with mock-ups through photography, visual experiments, code, and electronics: what Kunia-vsky (2006) has called ‘sketching in hardware’. These processes are framed by formal and informal studio discussions, the development and testing of ideas,



Figure 3.34. Multiple forms of sketching were used throughout the design research process. This image shows drawings in situ, and the use of notebooks and frequent sketching for developing ideas and concepts, and for exploring and documenting creative processes.

and ongoing presentations of individual work for critique and evaluation. Further, these forms of collaboration extend to the prototyping of technical instruments, the creation of concepts for visualisations, the refining of outcomes, and the writing of research publications.

In structuring the collaborative process we made use of the formulation and re-formulation of design briefs throughout the design processes (see Article 4). These briefs were short descriptions of directions, challenges, and constraints that were used to align the team, to evaluate directions, and to discuss concepts and initial ideas. Briefs were valuable in emphasising a discursive design approach, making sure that issues of communication, articulation,

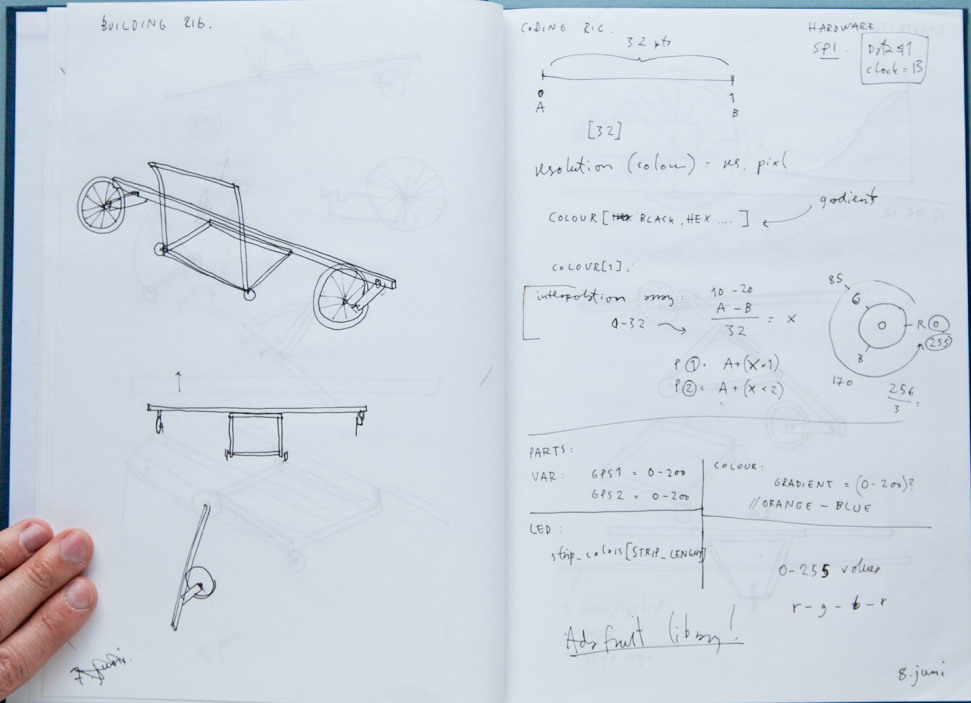


Figure 3.35. This image shows a typical page from a sketchbook used in the development of *Immaterials: Satellite Lamps*. This form of sketching and illustrating was used in a more formal way to address specific constructions and forms. Here we see drawings of a potential light painting rig alongside ideas for calculating colour-coding responses.

and addressivity were also taken up in experimental phases. Furthermore, the ongoing re-formulation of briefs were, following Schön (1983), a mode for moving between 'reflection in action' and 'reflection on action'.

Exploration and experimentation

Exploration and experimentation is an important part of our design research practice, both as technical exploration and visual and communicative experimentation and through experimenting with mixing methods for research and dissemination. As discussed in Chapter 2, experimental approaches have been used in HCI to explore and re-interpret interactive qualities of computational

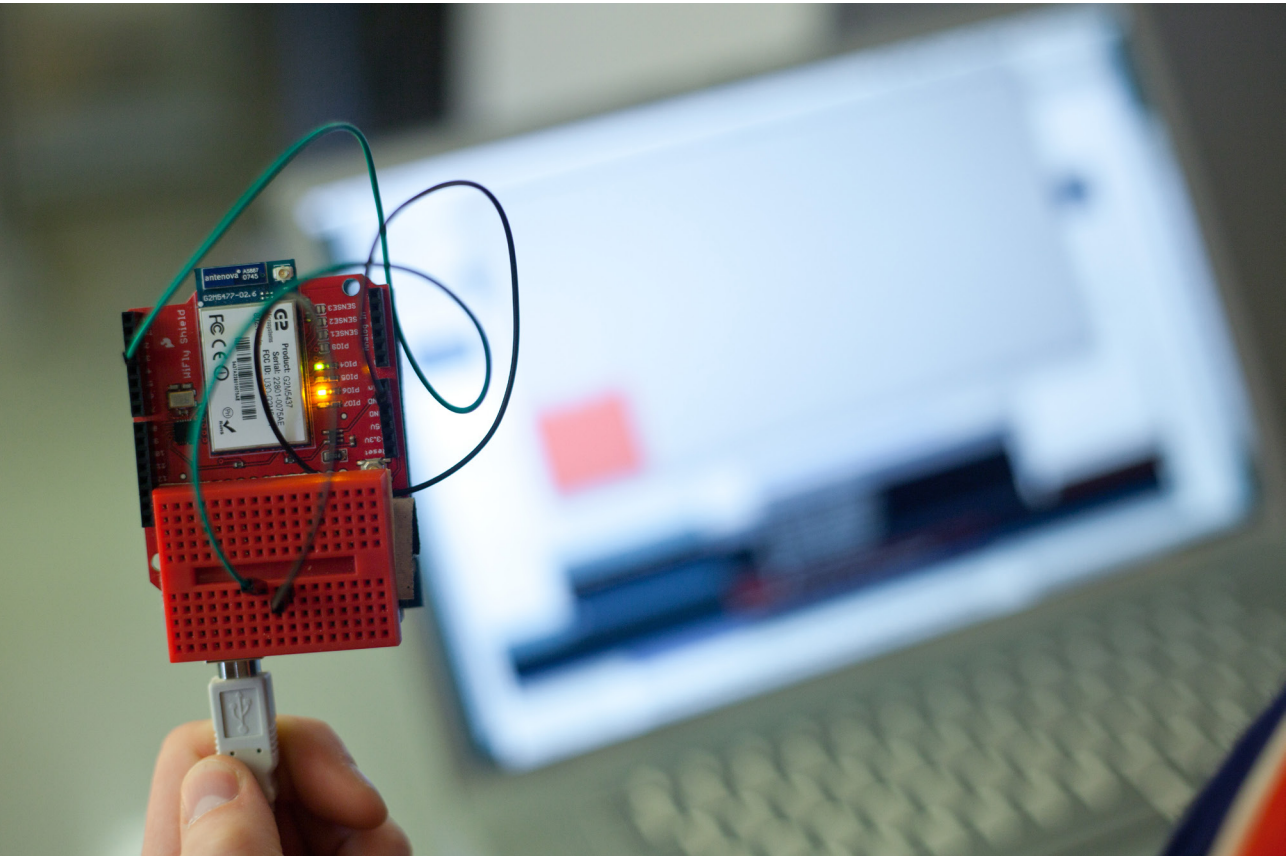


Figure 3.36. Early experimental probe for logging WiFi signals at high speeds. Here we have re-written the basic software of the WiFi component to continuously scan for networks, rather than attempt to connect to them.

technologies. Creative experimentation with technology is also found in new media research and electronic arts, such as is in the journal *Digital Creativity*.

Within social and cultural research, Last (2012) argues that experimentation should:

... push the limitations of current conventions of representation and knowledge-making. There is a desire to move away from what is considered 'safe', orderly and established, whether it is by searching for methods that meet the imperatives of new theories, existing complexities or desired accessibility. (p. 708)

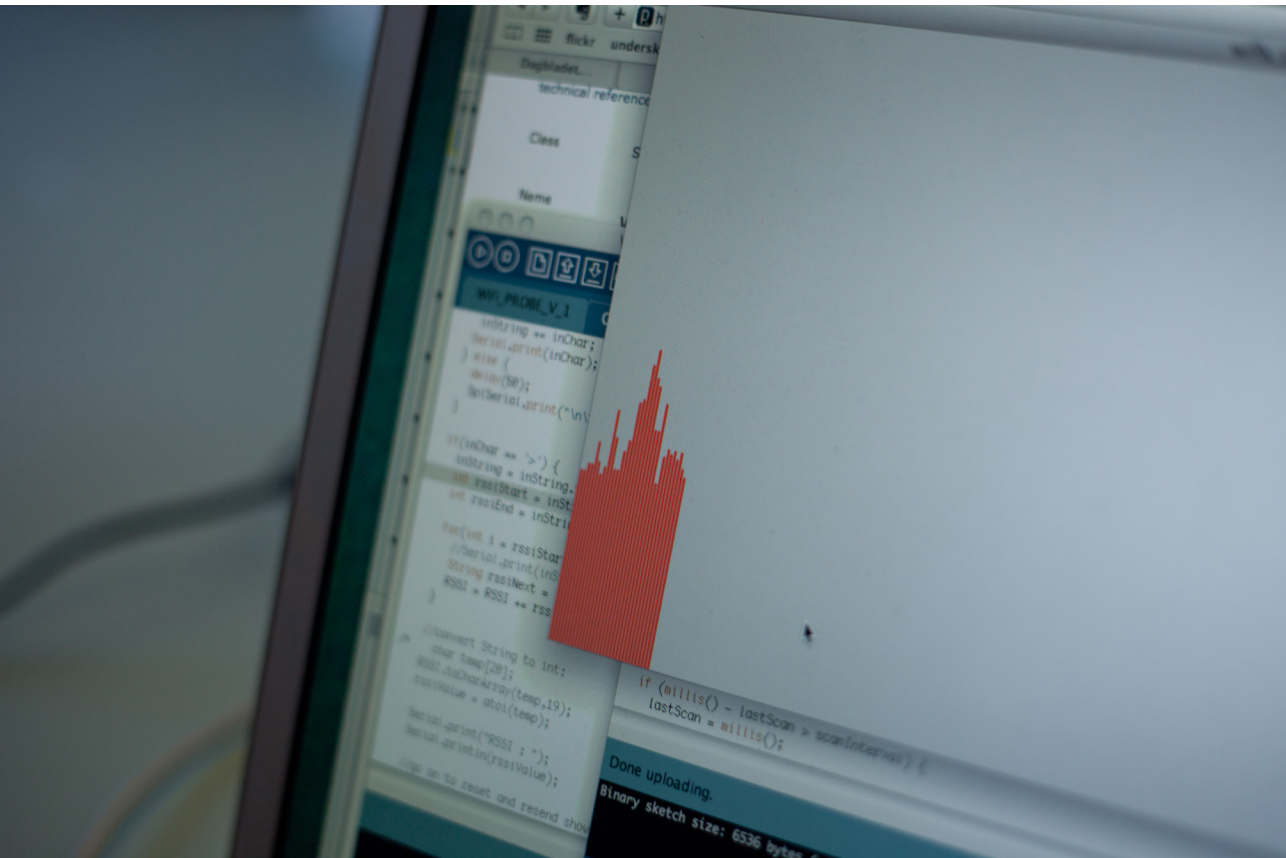


Figure 3.37. A piece of software written specifically to log in and graph rapid changes in WiFi signals received from the probe shown in Figure 3.36.

In our design research practice we have taken an experimental and explorative approach to interaction design and the networked city by specifically bringing together mediational and communicative experimentation with technical, material exploration (see below). It is important to note that this was also a process of learning and knowledge-building through experimentation with technologies, expressions, and communicative moves.

Material explorations of technology

As discussed in Chapter 2, material explorations of technology have been taken up across research and practice within HCI and interaction design. The motivation has typically been how material explorations may ‘spur and potentially direct, inspire, and allow for new user-centered innovations?’ (Fer-



Figure 3.38. This is a GPS probe built specifically for logging and graphing changes in different GPS variables in the field. The probe communicates with a custom piece of software that graphs out variables in real-time.

naeus & Sundström, 2012). In our research we have taken on an additional direction, focussing also on contextualising and communicating the material and spatial characteristics of technologies as phenomena of everyday urban life. Here, I outline three aspects of our material explorations of technology:

First, in getting at the basic characteristics of the technical phenomena of the networked city we used the method of repurposing industrial hardware. We used our expertise in coding and electronics to cut through the intended functionality of hardware components in order to explore specific, underlying characteristics of the components. There are examples of this approach across all of our visualisation projects. RFID, WiFi, and GPS components were re-appropriated to be able to ‘sense’ the phenomena they



Figure 3.39. This shows print-outs of twelve hours of GPS signals logged from a specific location. Here we could discuss and evaluate how GPS had changed over time (see Article 4).

rely on—radio-waves and satellites—rather than using it for communication or location (Figure 3.36). This hands-on, creative approach to technology can be associated with so-called ‘hardware hacking’ (Grand et al., 2004), where technical design competencies and tools are used to evaluate and expand the functionality of existing hardware.

Second, we used explorative data-visualisation in evaluating and sharing the data gathered from hardware components. Armitage (2009) writes about the material exploration of data, suggesting a method of building explorative tools in code to visually uncover qualities in data-sets. Such material exploration through visualisations can lead to ‘a better understanding of the data available: what there is, how to represent it, what the core concepts are’

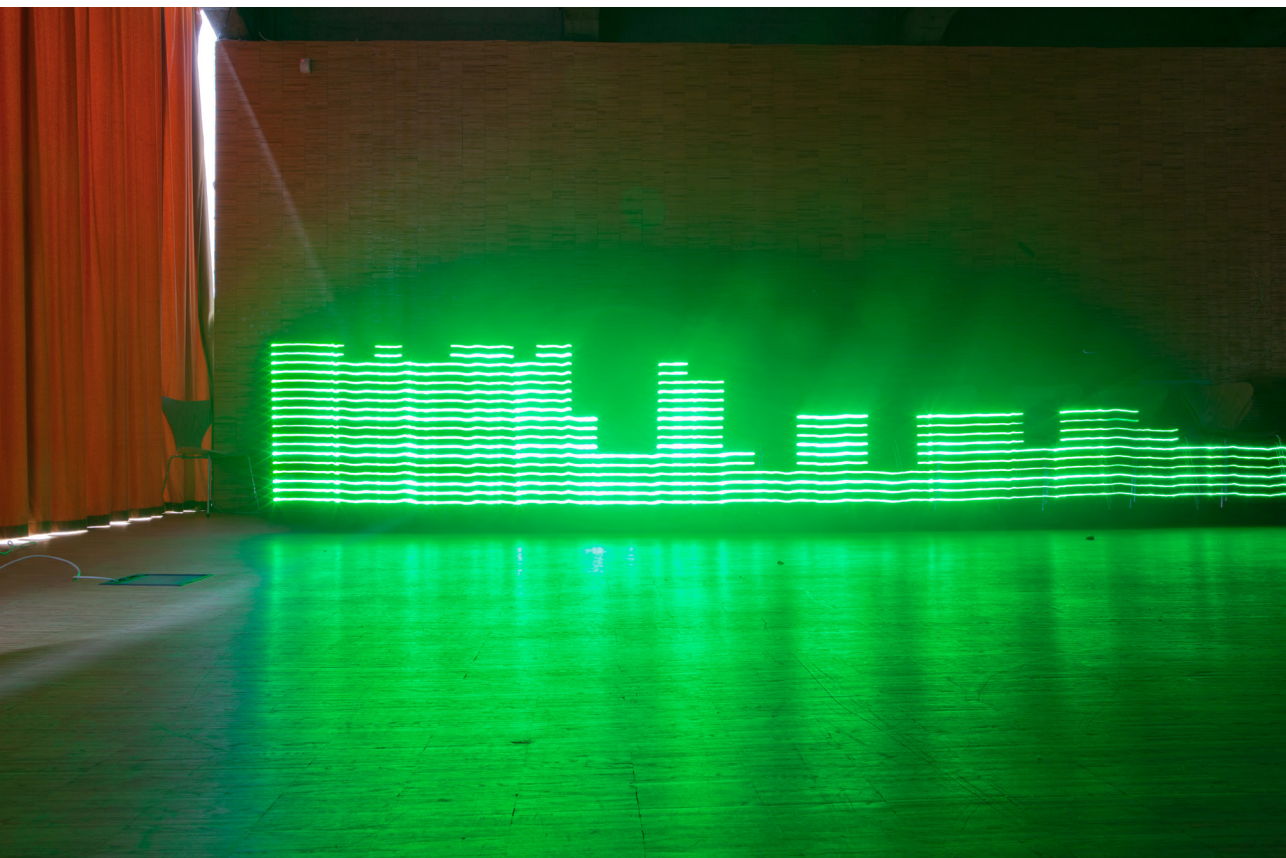


Figure 3.40. This is one of the first iterations of WiFi visualisations. The visualisation here is technically similar to the final results, but its expression is much more rudimentary: its luminescence is too bright to be able to see the space it is in, and the edges of the block-diagram are a by-product of the update-time of the hardware rather than an expression of the shifts in signal.

(*ibid.*) We took up these methods by building software tools for mapping and graphing properties and qualities of RFID, WiFi, and GPS in order to better understand them (Figure 3.37). We further turned these into field-tools with the ability to show us site-specific data of the networked city in real-time (Figure 3.38). Making these pieces of software and hardware for preliminary visualisations further allowed us to share and evaluate technical insights across the team (Figure 3.39).

Third, our technical explorations relied on engaging with open-source knowledge-building. Open-source knowledge-building spanning amateur hobbyists, education, and professional practice has in recent years been central in

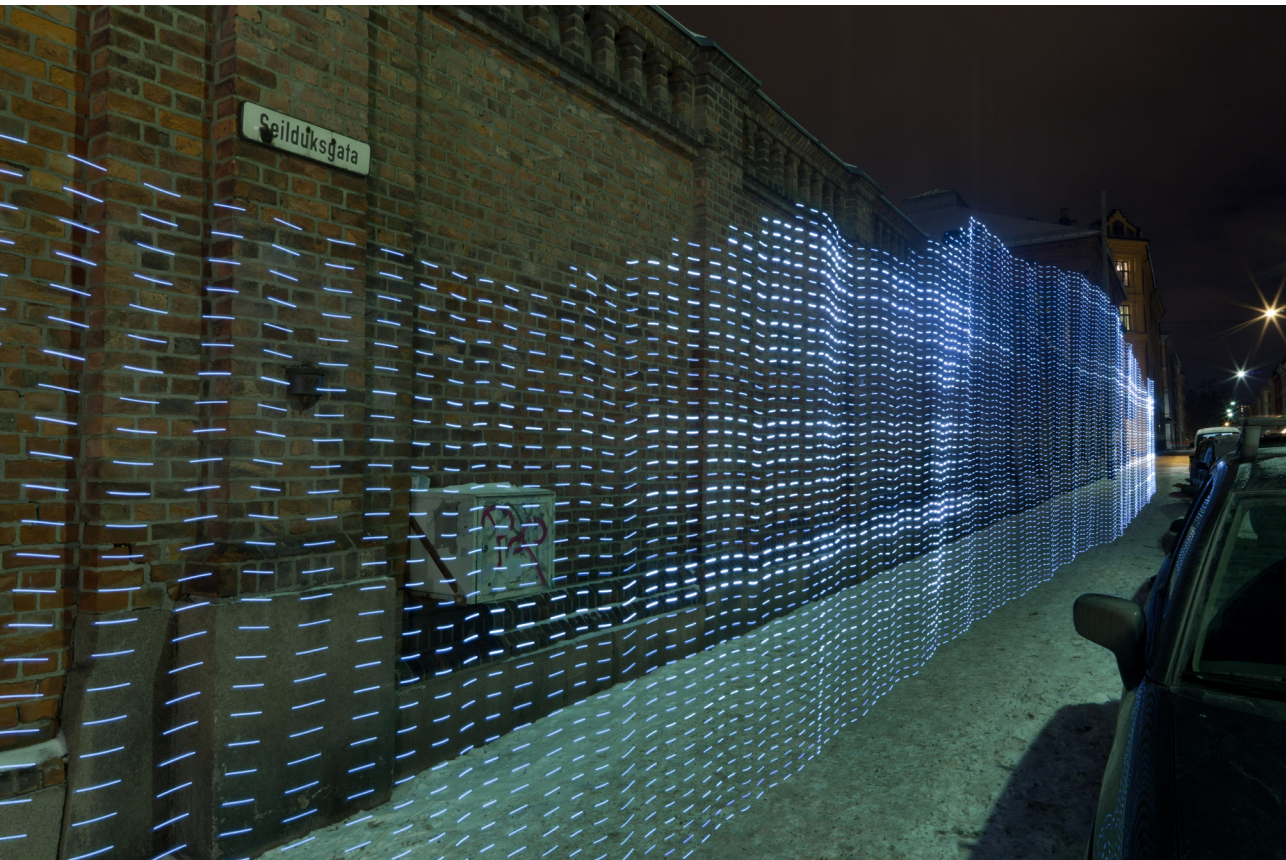


Figure 3.41. In the final iterations of the WiFi visualisations we chose to have graphs that were made up of white, dotted lines, which made it possible to see through them. The signal strength was expressed as a continuous line between shifts in signal, rather than as hard edges.

bringing digital technologies into design. Important here are communities for social online sharing of code resources (e.g., Github.com, Sparkfun.com, Adafruit.com), open development platforms (e.g., Arduino.cc), and a growing literature that bridges specialist technology fields with other disciplines, such as design and art (e.g., Igoe, 2005; 2007). This has made the route back and forth between design ideas and concept development, and prototyping and testing, much shorter. In our technical explorations we actively used and contributed to these forms of open-source resources.

Exploring visual techniques

In close connection with the technical explorations, the design research practice also included methods for exploring and inventing visual techniques and for developing visual language. This included photographic techniques such as light painting and time-lapse and urban photography, as well as approaches from graphic and information design. Research and design of information visualisations from graphic- and communication-design offer tools and practices that can abstract complex systems and phenomena into knowable, visual artefacts. There is a strong tradition in graphic design of making accessible visual representations of complex and multi-faceted information, as exemplified by the rich graphic histories presented by Tufte (1997).

Information visualisation also has a history of addressing abstract phenomena such as time (Davies, 2012), and has more recently been used to make visible the routines and habits of everyday life, as illustrated by the work of Feltron (feltron.com; daytum.com). In relation to these there is also a growing body of work in the visualisation of digital data (e.g., Klanten et al., 2008; 2010). In our work we brought together graphic qualities from information visualisation and photographic techniques by using light to overlay information into physical spaces.

Refinement through iterations is a central aspect of this practice. The visualisations are not just explorations of technological phenomena, but also experiments in communication. As discursive designs their mediational qualities and communicative refinement is central. One approach to this has been to internally evaluate the aesthetic qualities of the visualisations (Figure 3.40 & 3.41); a connected approach is to show 'work in progress' to a network of colleagues and students and at events. Through involving external viewpoints we developed the communicative qualities of the films through informal feedback and evaluation with people outside the team.

Documentation

Different forms of documentation were an integrated element in our research practice, including photography for documenting the practice (Figure 3.42), collecting sketches and artefacts from the design process, gathering statistics of the project's spread across the web, viewing data about the films and websites, and collecting media and projects that discussed the project in various ways (Arnall, 2009; Martinussen, 2012). Over parts of the project we also kept a daily logbook for keeping an account of the detailed reflections, design

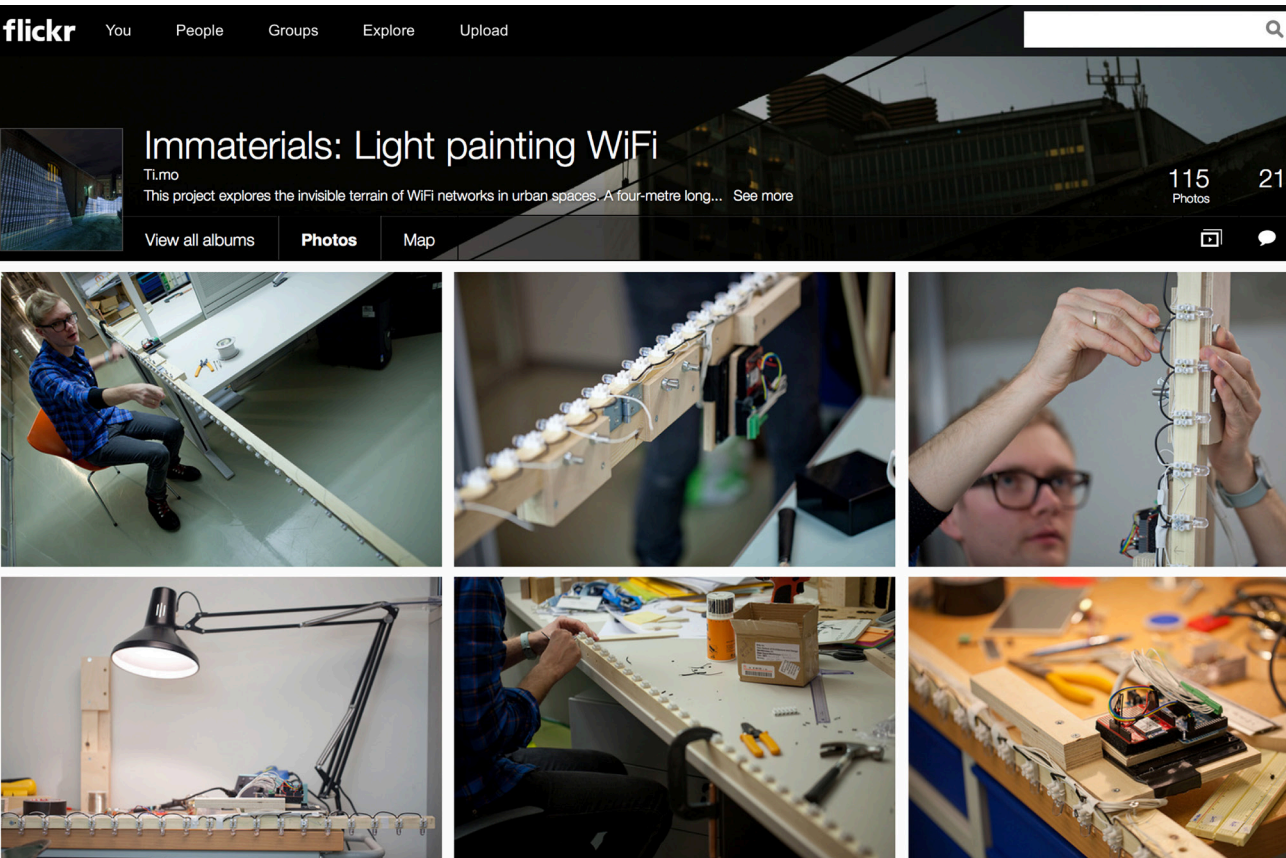


Figure 3.42. Screenshot from a Flickr album where the photographic documentation of making *Immaterials: Light Painting WiFi* was collected and made public.

choices, and discussions that made up the projects (Figure 3.43). This form of self-ethnography of the design research process both aided an ongoing ‘reflection on action’ and formed the basis for Article 4.

Communication and dissemination

In taking a discursive design approach, communication is important within the practice itself, in the design of the outcomes, and in how these are disseminated. There are multiple levels of communication across different activities and phases: internally within the team and its extended network of collaborators, in the production of visualisations and films, in how these are communicated online, in engaging with the cultural spread of the films, and

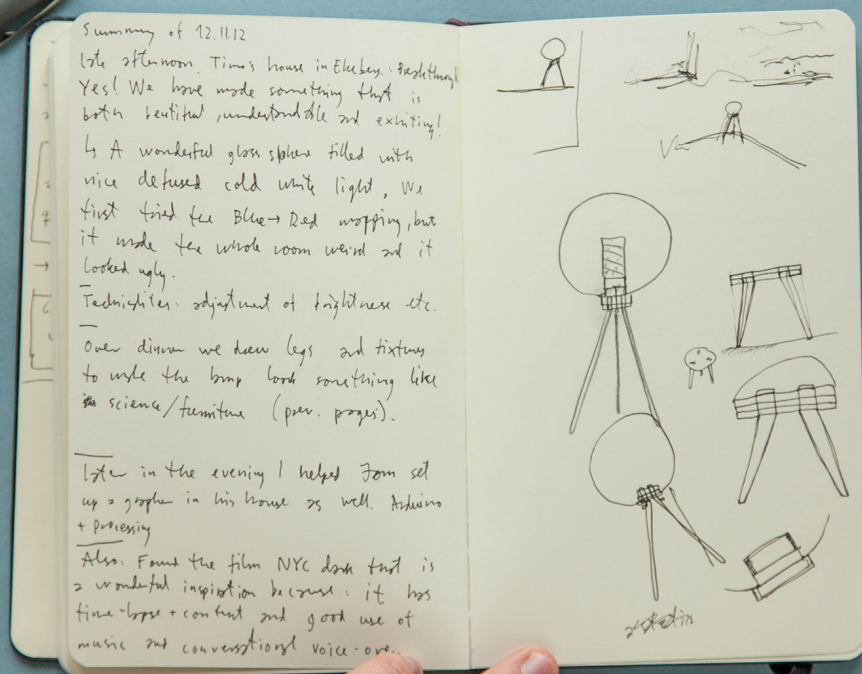


Figure 3.43. Logbook for 12 November 2012. On the left is a summary of how we made a breakthrough in the experimentation with forms of visualisation. On the right are some early sketches for what later became the satellite lamps.

finally as online research communication. I will here take up three aspects: production, dissemination, and online research communication.

The production of the films involved communicating the outcomes of the technical and visual experiments towards a broad, popular audience. In producing communicative design artefacts towards popular, online communication, we drew on the team's competencies and skills from film-making, including photography, editing, sound, motion graphics, and copywriting (Figure 3.4). In particular, this process also involved interpreting and exploring conventions, techniques, and mediational qualities of popular, online film. These interpretations informed production choices such as which video-sharing platforms to publish on, the length of the films, the complexity



Figure 3.44. Editing *Immaterials: Satellite Lamps*; working across film, sound, and text.

of the visualisation, and how to balance between explanation and evocative expression. In producing popular online films we wanted to maintain a high production value, while at the same time distancing the films from the slick, upbeat ‘vision videos’ of the likes of Microsoft’s or Apple’s advertising. This directly influenced production choices such as choice of music, the pace of editing, and the style of copywriting.

The films were disseminated through a multi-mediational and multi-sited approach. The films were simultaneously published through the online film-sharing site Vimeo (a design-oriented competitor of YouTube), as well as being embedded within website articles that situated and located them as research on the networked city and interaction design. Publication via Vimeo allowed for the films to be embedded by others on third-party sites in high

definition, as well as providing us with detailed statistics for viewing figures and the project's spread across the web. The Vimeo sites for the films also pointed back to our own websites, where the films were accompanied by text and photographs discussing and situating the films. The spread of the films across and beyond the web was further followed up on by engaging with traditional media, by writing press-releases and opinion articles, and organising interviews and events.

The experiences and insights from designing online communication were further developed towards disseminating design research as multi- mediational online scholarship (Ball, 2004). With *Satellite Lamps* we did novel explorations of drawing together web design, academic writing, photography, and film (see Article 4). This further illustrates the potential of integrating communication into design research at the practical, popular, and academic levels.

3.6.1 Limitations and challenges

Although the methodological themes outlined above illustrate some of the potentials and possibilities of the thesis' discursive design research approach, they also point to some of the challenges and limitations this practice might entail. I will here briefly discuss some of these challenges, and how I have addressed them.

First, the methodological and analytical interdisciplinarity of the research posed multiple challenges. Going across and between multiple fields and disciplines might lead to a superficial understanding of the complexities involved. Analytically, the research brings together theories and concepts from disparate fields and backgrounds. Weaving these together as a considered and productive inquiry is challenging. Similarly, the methodological challenges of doing practice-led research across design and technology involves acquiring background knowledge and complex tools from science, and using these for expressive, creative purposes. For example, the WiFi visualisations required specialised research into radio-transmission and communication protocols, while the GPS project involved studying the physics and mathematics of satellite navigation.

The challenges of interdisciplinarity were addressed on multiple levels. First, through acknowledging that because this is a hybrid research project that came together as practice-led design inquiry; the insights and knowledges that

we produced are therefore also hybrid and propositional (see Chapter 3.7). Second, the research has taken place inside the larger research project *YOURBAN*, which also involves designers, urbanists, media scholars, and programmers. This has provided an interdisciplinary arena for ongoing discussion, evaluation, and critique of the design outcomes and the analytical work.

The second methodological challenge I want to address is the practical and analytical issues that arise from explorative design research. Exploration is a valuable part of this project, but has also been demanding. Exploration can be time-consuming and can at times seem unfocused. Explorative design research might also lead to knowledge and insights that are relevant to the design team, but difficult to communicate externally. In our explorative work we continuously addressed these issues by focusing on communication. As such, the explorations are in part directed by the motivation of communicating these to wide audiences. This brings a certain focus and rigour to the explorative process. But this focus may also mean that interesting, but difficult, directions remain under-explored because they fall outside of what can be elegantly communicated.

The third challenge is the tension between critical and discursive approaches, and communication towards popular culture. With the films and visualisations, our motivation was to work towards contributing to discourses of emerging technology. By visualising and creating new images of the networked city, we constructed articulations that suggested seeing and understanding the networked city in new ways. But as the anecdotes earlier in this chapter indicate, the interpretations that happen through wide cultural circulation are unpredictable and open-ended. Many of the responses to the films suggest that they were interpreted as having a critical function, such as their inclusion in the exhibition *DREAD*. Other interpretations saw the films as popular science-style entertainment, as having commercial, promotional potential, or as material insight for interaction design innovation.

I would argue that reaching these broad and varied audiences was made possible through a combination of discursive design and popular communication. This included discovering engaging and relevant content matter, producing spectacular visualisations and films with high production values, and creating an online communication strategy. One challenge of this type of discursive, popular design practice is that the outputs might simply be interpreted as aestheticisation of technology. Although the aesthetic qualities

of the work are crucial, we went far in contextualising and situating the films in the wider discourse of the networked city. This strategy is exemplified by the documentary style of the films, where the visualisations were presented not just as spectacular images, but as investigations. The tensions between the popular and the critical is important for discussing the possibilities and challenges of a discursive design approach; these issues are addressed in detail in Chapter 4.

3.7 Reflexive mixing of methods

In this concluding section of this chapter, I will bring up for discussion the ways in which the themes described here overlap in a mixing of methods and techniques. Through a collaborative, explorative, and reflexive research practice, we combined analytical and generative methods, explorative and communicative techniques, and reflection and production. There was an important, ongoing overlapping between interpretation and analysis and creative production. Interpretation of popular culture is a part of designing communication, communicating is a part of exploration, and documentation contributes to evaluation. One of the ways in which this analytical/generative overlap was enacted was through reflective iterations. By this I mean going back and forth between making designs, and evaluating and analysing how these relate to a cultural, communicative context. This happened both within the individual sub-projects and across the practice as a whole. Each film in the *Immaterials* series is an iteration of both the techniques and processes developed in the previous films, and a response to how the previous films were disseminated and received as cultural artefacts.

Methodologically, the design research practice presented here can be characterised as a reflexive, generative research practice that is oriented towards popular culture. For Schön (1983), new designs are created in the dialogical reflection between the designer's creative explorations and the materials involved. In this practice we recognised Schön's notion of design practices as having the potential for reflection in and on action, but we also extended these notions to the broader technological and cultural contexts that the practice is part of. The design research was enacted through 'reflective conversation' with technologies as materials, but also through a reflexive approach to communicative forms, mediational qualities, and cultural contexts.

In discussing ‘research by design’ in a cultural and social frame, Mainsah and Morrison (2013) argue that a reflexive approach to design research involves ‘recognition of the researcher’s implication in the construction of spatio-temporal practices and interrelations as well as their amplifications and mobilization’ (p. 154), and further that:

Reflexivity involves understanding the assumptions, biases, and perspectives that constitute the basis of research. It includes epistemological questions and contextual conditions of understanding that are implicated [and] rooted in practices of collaboration, and in the choice of perspectives. (ibid)

With this practice I have shown how taking a reflexive design research approach to the networked city can involve questioning the assumptions and biases that make up the basis for its technology-driven research and development. Further, as I will elaborate and discuss in Chapter 4, this choice of perspective also opens the way for a methodological reflection on practices of interaction design research. The practice and methods presented in this chapter have given an overview of how I have engaged with relationships between the networked city, interaction design, and everyday life and culture through practice-led design research. I have tangled with interpreting culture and technology, experimenting with emerging technological materials, making and refining visual language, communicating through film-making, and disseminating through online media. Through this process I suggest that tacit knowledge from interaction design practice has been made explicit through re-purposing and re-contextualisation methods and techniques. This practice can be seen as an epistemology: as a way of building and exploring knowledge through reflexive, experimental, communicative design research. It is important to note, as my account of practice and methods suggests, that this epistemological orientation is not concerned with prescriptive outcomes, but rather suggestive, evocative, expressive, and relational ones.

In discussing artistic research and experimental geography, Kerr (2008) suggests that ‘to act/research is to be involved in change—experimental change’, and that we need to ‘recognise that acts of knowing are forms of change’ (p. 65). This notion could be extended to experimental and communicative interaction design research, where forms of knowing are enacted through exploration and generative design practice. Davies (2011) observes that in the frameworks of social sciences, experimentation is increasingly conceived

'less as what can be known through precisely controlled conditions, and more about creative forms of world-making' (Davies, 2011, p. 268). Last (2012), drawing on Latham (2003) and Latour (2004), suggests that the active participation in 'world-making' is reflected in the desire of many researchers to move 'beyond "mere critique" and to affect spaces and relations of concern through other means, which are hoped to be more effective in reaching relevant audiences' (Last, 2012, p. 709). As I have shown in this chapter, in a reflexive mixing of methods and techniques, practice-led interaction design research can work towards affecting spaces and relations of concern; following Latour (2004), practice-led interaction design research can thus move from 'matters of fact' to 'matters of concern' and, through designing, explore and visualise these concerns through expression and communication.

Chapter 4

Methodological reflections

In the previous chapter I presented the practice and design outcomes of this thesis. Over the next two chapters I shift the focus towards analysis and reflections. In this chapter, I collect insights from methodological reflections, while in Chapter 5 I address relationships between the networked city and interaction design at an interdisciplinary, theoretical level. In this chapter I reflect on how we have engaged with the networked city through culturally oriented interaction design. Based on this, I argue for exploring the methodological potential of interaction design for creating multiple forms of cultural meaning in the meeting between new technologies and everyday life. I discuss how the design research practice of the thesis illustrates a methodological potential of interaction design directed towards the popular imagination, and a route for engaging culturally with new or emergent technologies. I approach this through three main demarcations concerning an intersecting set of methodological practices. These are a) material practices, b) popular practices, and c) critical practices.

4.1 Design research practice as cultural engagement

The central methodological move made in this thesis is to use interaction design to *make the technically invisible culturally visible*. This means that interaction design is approached not as a discipline for shaping the use of technologies, but for addressing and engaging with how these technologies are understood and articulated culturally. I suggest that this methodological turn is made up of three connected, overarching aspects: first, the interpretation of technoculture, both as cultural expressions, products, and practices, and as a technological phenomenon, interpreting not only existing artefacts and conditions, but also, through ‘prospective hermeneutics’ (Morrison et al., 2013), addressing what these could be in the near future. Second, the generative, creative processes of producing new cultural artefacts in response to these technocultural interpretations. The use of online film to disseminate towards popular, online culture is here central in communicating across boundaries and discursive fields. Third, through the production and communication

of these online, discursive artefacts there is a potential for opening up for re-interpretations of technology. Through making technologies apparent in a cultural frame, we also make the technology accessible to others, making possible multiple interpretations and re-articulations. The design outcomes of the research are therefore not endpoints in themselves, but online media artefacts that, as described in Chapter 3.5, are designed to travel across disciplinary and cultural boundaries. Across the design research, aspects of interpretation, production and communication, and cultural circulation overlap and inform each other.

This research project has engaged with the networked city and interaction design through addressing and expressing technical, ‘black-boxed’ phenomena towards a popular, cultural frame, drawing attention to emerging technocultural conditions in daily life. This, I suggest, illustrates potentials for re-articulating discourses of technology through design. In reflecting on this potential, I examine three characteristics of the design research practice: first, as material practice, engaging with the granular technical structures of networked city life. Second, as popular practice, engaging with contextualising and disseminating material, technical insight for a broad audience. Third, discussing whether this practice could be seen as critical, and reflecting on its critical and/or discursive potential.

4.1.1 Material practice

Interaction design is involved in processes of shaping technological phenomena into products and services. In these processes, interaction designers make use of competencies, tools, and approaches for making sense of technical structures, and translate these into modes of creative, generative production. As such, interaction design instrumentalises material knowledge and insight to interpret technologies as malleable design materials. As discussed in Chapter 2, interaction design research has begun to develop approaches for understanding computational technologies as design materials (see Fernaeus & Sundström, 2012; Vallgård & Redström, 2007; Nordby, 2010). I argue that the invisible technologies of the networked city also need to be seen as materials that are, and can be, shaped through processes of interaction design. This includes pragmatic, granular insight into the material characteristics of technologies like GPS or RFID, and how they might be used to solve concrete problems in different contexts. It is important to clarify, though, that advocating a *design material approach* to the networked city would also

include how its material characteristics can be interpreted through creative exploration and expression. As such, the networked city represents material possibilities and challenges for interaction design on multiple levels.

In part, the material possibilities and challenges for interaction design within networked city life are constrained or, following Akrich (1992), 'scripted' by the choices inscribed into the construction of infrastructures and standards, meaning that what is possible or appropriate to design is directly influenced by the physics of technical materials, as well as being directed by software standards, guidelines, and regulations. In the context of designing for smartphones, this latter aspect of standards and software guidelines is particularly evident. Here, the design and development of applications and services is deeply entwined with development tools. A typical example is Apple's Software Development Kit for iPhone and iPad developers. This is a collection of code examples and pre-made elements like buttons and menus, alongside guidelines for what is required for making applications for sale through Apple's proprietary App Store (see developer.apple.com). These structures and standards are crucial in making it possible to design with complex technologies, but they shape the space of possibilities for designing. In this example the design practice could be said to work within the constraints and directions of the 'technical heritage' (Feng & Feenberg, 2008). On a conceptual level, however, interaction design practice is not just shaped by cultural and technical background, it also has an active engagement with it. As the practice of this thesis illustrates, interaction design can be directed towards interpreting and expanding material knowledge of technology on an explorative or expressive level.

It is important to note, as Nordby (2010) argues, that seeing technology as design materials also implies that they are a source of inspiration and conceptualisation. The technological, material possibilities and challenges of the networked city open a design space for curiosity and invention. For example, in the first year after GPS was included in the iPhone, and made accessible for designers through the CoreLocation API, popular applications included finding clean restrooms in New York, getting taxis, and finding bike routes in cities. Since then, thousands of GPS-based applications have been created, often using the technology for its original, intended purpose (i.e. navigation of online maps); many other applications have used the material possibilities of location awareness in unforeseen, inventive, and often elegant ways (see Article 4).

On a commercial level, the unpredictable and inventive interpretation of technological material is evident in the plethora of applications and services designed for networked city life. On a different level, the potential for material investigations and interpretations could also be illustrated by the explorative and communicative design research presented through our own projects.

One of the foundations in our inquiry is the use of material explorations to build hands-on knowledge and conceptual insights into emerging technologies. This involves the interpretation of how technologies are represented in culture (see Article 3), how they are described in technical documentation, and what the tools and platforms at our disposal allow us to do with them. Our inquiry also includes designing new instruments and products for testing out the material characteristics of technical systems. This practice involves developing an understanding of material constraints and conventions, as well as imaginative exploration and stretching of these constraints and characteristics.

There is a legacy within interaction design for working with emerging technologies and within contexts of technological innovation, where material exploration has been central in developing novel applications (Fernaes and Sundström, 2012). I suggest that there is an important distinction to be made between material exploration for the purpose of investigating potential for innovation, and the practice presented in this thesis. This design research practice, I argue, goes beyond exploring the potential for novelty by joining or layering material exploration with communication.

To illustrate this point, I will briefly elaborate on some of the ways in which this layering took place in *Immaterials: Ghost in the Field*. Our earliest motivations for visualising technological phenomena through and for design came from the need for making material sense of RFID in our design of interactive products and in our teaching (see Martinussen & Arnall, 2009; Arnall & Martinussen, 2010). In investigating the material qualities of RFID as an interactive technology, our explorations were closely connected to how these could be communicated through visualisation.

The communicative potential of these material visualisations proved to be valuable within the discipline of interaction design, as exemplified by the use of the visualisations in Igoe's influential textbook *Making Things Talk* (2011). Furthermore, the communicative potential travelled into the broader cultural context, as illustrated by the film's inclusion in the exhibition *Talk to Me* (2011)

at the New York Museum of Modern Art. These layers of material and communicative practice are iterative and often overlapping, going across different cultural contexts and making meaning of technology on a material level.

A material design research practice that is explorative and communicative has the potential to go beneath the ‘technological imagination’ or the technocultural assumptions of what design can or cannot do. Following Ihde (2008), this is also about challenging the perceived neutrality of the technical material through making or communicating new interpretations. While the material plasticity of technology is not neutral, it is also not static. To acquire material knowledge and insight through creative investigation has the potential for challenging or expanding the technological imagination.

Through the practice of this thesis, we have invented ways for turning the tools and methods of interaction design towards its technical materials. In this we repurposed the competencies and approaches of interaction design to reveal the phenomena that they are a part of. At the same time we developed knowledge of the detailed possibilities and constraints of these technologies far beyond the constricted perceptions built into the third-party development tools that interaction design typically relies on. Through popular, online communication we have further made these explorations accessible to others. I argue that through material exploration and communication, we have extended the agency of our interaction design research practice. By this I mean that we have challenged how we as interaction designers can approach the technical materiality the networked city, and used our material knowledge and competencies to make technological phenomena accessible for interpretation and discussion. I therefore suggest that material exploration and communication of technology through design is a central aspect for how interaction design research can engage with the technoculture of networked city life.

4.1.2 Popular practice

Our material explorations extend into communicative frames, which prompts the question of which cultural framings we communicate towards and within. By suggesting that this practice is a *popular practice*, I mean to emphasise that it is engaged with communicating within and across popular culture on multiple levels. Further, as a discursive design practice, this is important because it illustrates how the research works towards ‘taking up challenges of the

technical and shifting them into cultural, communicative planes' (Morrison et al., 2010, p. 10). This involves addressing widespread audiences across different discursive fields through the design and dissemination of discursive artefacts. It also entails the role of the popular within the design practice itself at the level of interpretation, production, and communication.

Popular cultural expressions are an important aspect of everyday life and culture, and are widely discussed within culture studies (see Chapter 2). In discussing our design research practice as related to 'the popular', I choose to use a wide, non-evaluative, descriptive definition of popular culture as simply expressions and practices that are widespread or 'widely favoured or well liked by many people' (Storey, 2012, p. 5). This means that we are interested in interpreting and designing within the broad cultural landscape of networked life, and not just designing artefacts for research journals, design magazines, and galleries. This could be seen as a direct response to the motivation for the design research to work towards challenging or expanding the cultural materials of networked city life. This prompts the question of who we are addressing, and through which communicative means we mediate. Further, it opens up the question of how we, following Hall (2005), can use design to engage with the articulations of networked city life.

Bazerman writes that new 'technologies emerge into the social configurations of their times and are represented through the contemporary communicative media' (Bazerman, 2002, p. 3). Understanding how to communicate within the discursive spaces of contemporary media is central in creating popular representations of emerging technologies. Today, emergent practices of online media are important in how expressions and interpretations of technologies reach broad audiences. Through exploration, experiments, and empirical observations of the spread of our films, I have suggested that online mediation can play a central role in the process of communicating technocultural concepts to a wide audience (Arnall & Martinussen, 2010). Further, I have argued that online film, as discursive design artefacts, can act as boundary objects (Star & Griesemer, 1989) with the potential to reveal, explain, and translate complex technologies within a popular cultural frame and, I hope, provoke reflection, discussion, and critique.

As boundary objects, online film can be used to translate between fields or contexts, such as news, art exhibitions, blogs, and discussions forums, through being 'both adaptable to different viewpoints and robust enough

to maintain identity across them' (ibid, p. 1). Following from the above, the adaptability and robustness of these discursive, online boundary objects comes down to how they are mediated through design and how these mediations make use of the possibilities and conventions offered by contemporary online media. This perspective brings forward the importance of the mediational qualities of how these artefacts are designed and communicated.

Immaterials: Light Painting WiFi is an interesting example of how our design research practice worked towards a popular frame. With this project, we reflected on and extended what we had learnt from the previous films (see Article 1) and specifically made an attempt to instrumentalise the notion of designing discursive boundary objects in online media. As discussed in Chapter 3 the film travelled far across the web and various forms of social media, and further across diverse discursive contexts such as traditional broadcast media, exhibitions, print magazines, and textbooks. Many aspects of this cultural circulation were unforeseen and beyond what we could have expected. But I suggest that they all came about as a consequence of how the visualisations, the film, and the processes of communicating were designed towards popular culture.

In conceptual terms, this involved the choice of content matter—visualising WiFi, a technology that is highly present in everyday life, yet poorly understood—and further, how these visualisations were produced through bringing together explanation and expression with the purpose of stirring popular imagination. In practical terms, this popular practice involved how the project was designed and communicated within the conventions and possibilities of contemporary online media, which included everything from the choice of duration, the level of production value, the technical possibility to be embedded in other online contexts, and the online media strategy behind spreading the film. The conceptual and practical aspects of *Immaterials: Light Painting WiFi* illustrate how design choices and qualities, as well as how the work is articulated, are important in designing towards popular culture.

A key point is that this is not a linear or singular process of designing films or artefacts and pushing these towards the cultural landscape through online media with the intent of a widespread uptake. Instead, this practice entails the overlap between analysing and interpreting popular discourses of technology across contemporary media context, and generating new popular cultural material on the basis of those insights. The discursive potential here lies in the

rapid shifts between the material making and the communicative production, and an informed, critical analysis of the discourses of technology alongside a productive interpretation of the potentials and conventions of online media.

To take on a popular practice is to see interaction design as cultural production, in that it produces artefacts—in the form of images, films, interfaces, and products—that on different levels take part in shared cultural meaning. These cultural materials are, further, part of everyday life and shape expectations and experiences. In reflecting on how interaction design research take part in technoculture, it is therefore important to note that interaction design is not only influenced by the cultural background in the form of a ‘technical heritage’ (Feng & Feenberg, 2008), but also takes part in *generating* the cultural landscape of networked city life. Balsamo (2011), following Bourdieu (1984), writes that designers ‘serve as cultural mediators by translating among languages, materials, and people, to produce—among other things—taste, meaning, desire, and coherence’ (loc. 323). Further, Balsamo suggests that ‘through the practices of designing, cultural beliefs are materially reproduced, identities are established, and social relations are codified’ (loc. 323).

The connection between cultural materials and everyday life is an important aspect of how interaction design practice can interpret and challenge conceptualisations of technology. I suggest that the *Immaterials* project relates to this connection between popular communication and the everyday in two connected ways: First, by visualising everyday technological phenomena within mundane urban environments—bus-stops, residential streets, parking-places, etc.— and using the spaces of the city as a point of reference for situating the networked city in the urban realities of the present. Second, the practice address the everyday by communicating through popular, contemporary media of daily life; specifically using social media and online film. The *Immaterials* project is not just making technology visible, but also making technological phenomena accessible in daily life through popular cultural communication. An important aspect of how technology is made accessible as cultural materials, is therefore how and where these are communicated, and how and by whom they can be accessed.

In Chapter 3 I presented accounts of the cultural circulation of the artefacts produced through this research project. These accounts illustrate some of the ways in which the project has been engaged with by others. They show both variation in responses and effects, and, as indicated by the viewing statistics,

broad reach. An important point, is how this cultural circulation feeds back into the practice. Popular communication was weaved into the design-practice both through observation and documentation of responses, and through direct engagement with individuals, groups and institutions (i.e. the *Digitalt Byliv* conference, the MoMA exhibition *Talk to Me*, the activists and artists behind the exhibition *DREAD*, email correspondences with interaction design students, or Igoe's textbook *Making Things Talk* [2011]). These forms of engagement were initiated, and made possible, by the popular communication of the films. Further, these varied forms of engagements also became embedded within the research practice itself.

Making everyday, popular media a central part of the discursive design practice has allowed for both interpreting and responding to technoculture. I argue, that one of the potentials for discursive design is to create meaning in the meeting-point between everyday life and emerging technologies through taking active part in stirring and expanding technoculture. The challenge then is how to design and communicate conceptualisations of technology that are accessible, and relevant, across popular, cultural contexts.

If popular cultural expressions can contribute to ways of understanding and re-articulating technology, we could then argue for using design to stir or complement these understandings by designing new forms of expressions. In pursuing this notion, it is important to be careful not to assume what Ihde (2008) describes as a 'designer fallacy': 'the notion that a designer can design into a technology its purposes and uses' (ibid, p. 51). In this context, this could be extended to the assumption that we can simply design new understandings by designing our intended perspectives into cultural materials, such as images, films, or interfaces.

In suggesting that interaction design can be a way to purposefully contribute to the popular cultural understanding of networked city life, it is therefore important to keep in mind that the outcome of this practice is subject to interpretation and not simply a mode of constructing 'understanding' through design. Rather, I see a culturally oriented interaction design practice as a potential for contributing to the layered and heterogeneous technocultural mesh of networked city life through exploring, investigating, and communicating in ways that stir popular imagination by suggesting new forms of images and interpretations.

4.1.3 Critical practice

I argue that the practice of this thesis also takes up a critical perspective on interaction design and networked city life. In this section I discuss how the practice as a whole points towards a form of *critical practice* and, further, the relations between the critical, the material, and the popular. Can a design research practice produce popular, high production-value online media while still maintaining a critical perspective?

I suggest that the criticality of this research project is closely connected to the flows and shifts of agency through the explorative and communicative aspects of the practice. As material practice, the agency of the designer is shifted from supporting technological innovation, to de-constructing technological systems and making these visible and accessible. As popular practice, the agency of the design team is put towards working the web as a communicative ecology of varied acts, activities, cultural contexts. Here mediational and communicative competencies are not used to promote products or visions, but to engage with technoculture through offering materialisations and conceptualisations of technology as popular, online, cultural expressions for others to unpack, refer to and respond to. Further, I also suggest that there is a form of criticality enacted through how design production and reflection, as agency, is extended towards interdisciplinary research.

In analysing this design research practice in a critical perspective, I draw on Feenberg's theoretical discussions of technology in a social and cultural frame. Feenberg argues for regarding technologies as an environment rather than as a collection of tools, and that 'we live today with and even within the technologies that organise our way of life' (Feenberg, 2008, Loc. 1068). With his 'instrumentalization theory', Feenberg distinguishes analytically between aspects of technology that stem from their functional relation to reality, which he calls the 'primary instrumentalization', and aspects that stem from their social involvements and implementation, which he calls 'secondary instrumentalization' (loc. 977).

Secondary instrumentalisation, Feenberg writes, establishes the social meaning of technological artefacts and how these are integrated to a social environment through, among many other processes, cultural expressions and design. Both primary and secondary instrumentalisation takes part in forming technical and discursive biases for how technology is used and understood socially and culturally. Feenberg argues that for a constructive criticism of technology,

it is central to ‘take aim at the deficiencies in the secondary instrumentalization because it is here that design receives its bias’ (Loc. 1038-1039). Following Feenberg, a critical practice of technology should question and uncover the cultural and discursive biases of technology. This could further contribute to ‘opening up technology for a wider range of interest and concerns’ that could ‘lead to its redesign for greater compatibility with human and natural limits and powers’ (loc. 1100).

I suggest that one of the ways in which the practice of this thesis is critical is through investigating and revealing some of the tensions or gaps between the ‘secondary instrumentalization’ of the networked city (its social and cultural meaning) and its ‘primary instrumentalization’ (its technical and functional basis). The criticality lies in showing the unseen structures of networked city life within popular cultural settings. Through the practice of *making visible*, it goes against the dominant narratives of the seamless smart city by showing emerging technologies as a part of the material, spatial, and often messy contexts of urban life. I argue that a critical perspective on technology is central exactly because we are engaging with emerging technologies that have yet to arrive at stable social and cultural meanings, and that this further requires us to ‘engage in shaping discourses in action that are not yet located in dominant practices and knowledge of such technologies’ (Morrison et al. 2010, p. 3).

As a critical approach to design, this practice shares some of the premises brought forward by ‘critical design’ (see Chapter 2). Critical design argues for using design’s processes for invention as a mode of discourse for ‘stretching established conventions, whether physical, social, or political, rather than simply affirming them’ (Seago & Dunne, 1999, p. 17). But whereas critical design speculates about the future, and challenges technological developments using the design of fictional products and systems (Dunne & Raby, 2013), our practice is about investigating and revealing the technologies of the present.

The practice presented in this thesis, as illustrated by the *Immaterials* films, does not speculate about the networked city of the future. Instead it situates the networked city within the spaces of contemporary urban life. It uncovers some of the technical and discursive biases of technology, and therefore offers a form of critical reflection on what the networked city is today. This critical reflection, I suggest, is multiple and layered, rather than singular and polemic. I argue that one of the strengths of the *Immaterials* project is that it

is both expressive and open-ended. Because the project explores an emergent, complex technocultural condition, it is important that the visualisations and conceptualisations it offers open up for both critique and innovation. A possible weakness of the *Immaterials* project is that its open-endedness could be seen as unfocussed and that this could limit its critical potential. One critique of the *Immaterials* visualisations are that they could be seen simply as aestheticisations of technology and that this could limit which kinds of interventions and arguments they can contribute to. I argue that the aesthetic, expressive qualities of the films are crucial for addressing the emergence of the networked city in general and for making its technologies culturally accessible. This approach is valuable on an overall, technocultural level, but for addressing more contentious issues of networked urbanism, such as surveillance, militarisation or the privatisation of public services, a more political form of discursive design towards activism or politics could be more appropriate. This is not the topic of this thesis, but have been addressed in other visualisations projects I have been involved in, and could be addressed as a future research direction (see Chapter 6).

The criticality of this practice is not about illustrating a specific argument, but is embedded in how the design outcomes work towards making new articulations and expressions. Its value as a critical reflection on technology lies in making the technology visible and accessible to many through cultural engagement. In the *Immaterials* project, this critical potential is developed through using the designers' agency over material and media to connecting material investigation with visualisation, and further through using popular, online communication to make these visualisations broadly accessible. This illustrates the potential for using discursive design to contribute to discourse by both creating and challenging conceptualisations of technology. These conceptualisations includes elements of celebration and wonder in showing us the spectacle of technologies that have come to be taken for granted. Yet, at the same time, they put forward a critique of how the creative and inventive potentials of these technological phenomena are rapidly narrowed by mundanity, invisibility, and the dominant conceptualisations of the smart city.

The criticality of the *Immaterials* project is embedded in how the invisible landscapes of the networked city have been made visible towards popular, online culture. But a critical perspective on technology is also evident within the design practice itself on both a material and a communicative, popular level. First, as a material practice the critical is present through questioning

and exploring technical materialities and challenging the agencies, tools and assumptions we design with and within. Second, on a communicative level the practice is critical in addressing popular culture, and in how it communicates towards this context. Because widespread assumptions and biases about technology take place within popular culture, it is therefore crucial for a critical practice to address these contexts; this is done through bringing together material explorations with popular, online mediation. This overlapping of investigating, making visible, and communicating through design is central to the discursive potential for interaction design as cultural engagement.

In going back to the methodological move outlined at the beginning of this chapter, the potential for discursive design engagement lies in the relationships between interpretation of culture and technology, the design of cultural artefacts, and the communication of these artefacts towards popular culture. In addressing technocultural change, this methodological overlapping offers ways of looking closely at the particular articulations, representations, and relations that are at work in the emergence of networked city life, and further to address these technological, historical, and cultural formations by attempting, at some level, to re-articulate discourses of technology through design and communication.

Chapter 5

Analytical themes

In the previous chapter, I reflected on the methodological characteristics of the practice of the thesis. In this chapter I shift focus and discuss characteristics of the networked city and interaction design on an analytical level. In doing so I draw specifically on the interdisciplinarity of the thesis. In Chapters 3 and 4, I addressed the research question of how we might investigate and reveal the networked city through interaction design, and how practices of explorative and communicative interaction design research might contribute to new perspectives on the emergent networked city. In this chapter, I take up the overarching research challenge of developing an analytical position on the networked city and interaction design. I explore and develop this analytical positioning by joining concepts and perspectives from across the disciplines and fields presented in Chapter 2: interaction design, the networked city, and everyday life and culture.

This chapter is structured as a series of four themes that uncover different aspects of the relationship between the networked city and interaction design. The themes are informed by the methodological reflections from Chapter 4, but the object of analysis is not the design outcomes or practice itself. Rather, the purpose of this chapter is to develop a rich, interdisciplinary discussion, informed by theory and practice, that challenges or expands the analytical space for networked cities and interaction design.

5.1 An analytical position on the networked city and interaction design

The emergence of networked city life is complex and contested on multiple levels. As was discussed in previous chapters, networked city life implies technical innovations and cultural changes and challenges, as well as economic and political tensions. The networked city is a significant site for technocultural change across urban life, media, the built environments, planning and policy. Many of these changes gets enacted through designed interactions, and the networked city is therefore an interesting and important context for interaction design research. Further, the networked city should

also be seen in relation to the emergence of an increasingly networked society and culture. The networked city is an interesting interdisciplinary analytical context for addressing technocultural change on multiple levels. Analysing the networked city and interaction design could therefore be valuable for questioning and framing networked life and our networked world in general.

On a cultural level, the ‘secondary instrumentation’ of the networked city—the social and cultural meaning of its technological artefacts (Feenberg, 2010)—takes multiple forms, and is far from stabilised. The technical and discursive biases that these secondary instrumentations give rise to, such as the concept of the smart city or the notion of seamless interactions, have implications across daily life and popular culture, as well as for research across interaction design, technology, and urbanism.

Through the practice of this thesis we have used interaction design to address some of the technocultural biases of the networked city through visualising and communicating common technological structures towards popular culture. As discussed in Chapter 4, this practice illustrates how culturally oriented interaction design, through creating discursive artefacts and online dissemination, can be used to create boundary objects that can travel across and between fields and contexts. As design research, the thesis has also gone across and between boundaries on a theoretical level. As I have argued, investigating the emergence of the networked city necessitates an interdisciplinary approach both through practice and through analysis. This is reflective of the overarching research challenge I put forward in the opening of the thesis: *to develop an analytical position on the networked city and interaction design situated within everyday life and culture*. In this chapter I work towards an interdisciplinary, analytical positioning by going across disciplinary boundaries and joining up concepts and perspectives from different fields of research.

In the conclusion of Chapter 2, I elaborated on the relevance of, and motivation behind, this research challenge by identifying three underdeveloped disciplinary connections. First, interaction design is rarely taken up in the research and development of networked cities or, specifically, smart cities. In general, the discourses of networked urbanism take place on the level of infrastructure and planning, and rarely address the design of interactions. Second, issues from urbanism, such as techno-social urban change, are similarly not addressed in a nuanced way in research on interaction design, where the general discourses take place on the level of interfaces and technological

innovations. Third, across research on both networked cities and interaction design, there is a potential for further taking up cultural and everyday theories and perspectives, such as the 'production of space' (Léfebvre, 1991), cultural circulation (e.g., Hall et al., 1997; du Gay et al., 2013), articulation (Hall, 2005), and discussions of technoculture (Slack & Wise, 2005; Balsamo, 2011).

In developing an analytical positioning across these fields, I bring together the interdisciplinary formation of the networked city, interaction design, and everyday life and culture. The central object of analysis is the web of relationships between these domains, and how they may give rise to new perspectives on the networked city and interaction design. Each might be highlighted in different ways throughout this chapter, but the underlying concern is with how relations between and across these fields of study might bring out tensions or possibilities in how they can be analysed. The purpose of this analytical positioning is therefore not to establish prescriptive guidelines or a set framework, but to develop arguments and raise questions that might offer directions and insights that will together contribute to how networked cities and interaction design might be analysed.

To reflect on and discuss the networked city and interaction design, I identify and discuss four themes informed by the practical design investigations alongside interdisciplinary theoretical discussions. Each theme is a starting-point for delving into and analysing a specific interdisciplinary characteristic. The themes are not endpoints or guidelines, but rather are abstractions for analysing and challenging the relationships between interaction design and the networked city, while at the same time enabling an overview of networked city life. Together these themes make up a layered framing for investigating the networked city and interaction design from multiple perspectives.

The themes take up the following issues: 1). Material and spatial aspects of networked technologies in cities. 2). Networked city life in a temporal context, meaning how it technically and culturally changes over time, and how this involves its past, present, and future. 3). The challenges and potentials of invisibility, on multiple levels, for how the networked city and interaction design can be analysed and critiqued. 4). How networked city life is entwined with processes of cultural production, representation, and articulation where meanings associated with everyday technologies and devices are produced, distributed, and interpreted. I conclude the chapter with a reflection on how

these arguments raise issues for networked city life as research, design, and popular discourse.

5.1.1 The networked city as material and spatial

The first theme I address is how networked city life may be understood as being material and spatial. Across practice and theory I have explored how a material approach can be valuable for the networked city and interaction design. In the previous chapter, I reflected on the design practice of the thesis as a joining of material investigation with communication. Approaching networked technologies as materials for design uncovered how these technological phenomena are both constrained and malleable, and that they, through design, can be subject to creative interpretation and expression. The insights from this methodological move can be extended to an analytical level, and prompt the question of how the networked city itself can be understood as being material and spatial. This is a broad topic, but here I will focus on two levels of materiality: at the level of infrastructure and power, and at the level of everyday urban environments.

At a macro-level, the networked city is part of an infrastructural materiality. Networked city life is made possible by, as well as bounded by, the materiality of complex technical infrastructures. ‘Study a city’, Star (1999) writes,

and neglect its sewers and power supplies (as many have) and you miss essential aspects of distributional justice and planning power.... Study an information system and neglect its standards, wires, and settings, and you miss equally essential aspects of aesthetics, justice, and change. (ibid, p. 379)

In the networked city, urban systems and information systems are brought together. As material constructs, these infrastructures are both global, with undersea cables, server farms, and satellite constellations, and local, with sensor-grids, traffic cameras, and WiFi networks. The networked city is therefore involved in multiple layers of politics, power, economics, and change. This ranges from the geopolitics of GPS and procurement policies in municipalities to local telecoms’ decisions of which neighbourhoods will get their broadband cables upgraded.

The economic foundations of the smart city industry is to develop, implement, and maintain the infrastructures of our networked urban future (Townsend, 2013). This entails the implementation and maintenance of the technological and material basis of the networked city: its software, cables, sensors, and servers. The clients for this industry are actors with planning power within urban politics: typically municipalities and private developers. The services and systems the smart city infrastructure propose are meant to serve these actors, which is why resource management, outdoor marketing, and surveillance are key use-cases. Greenfield (2013) argues that the urban ideal proposed by the smart city resembles that of post-war modernism: a rational, efficient city managed from above. Just as the urban planning practices of high-modernism have had long-lasting spatial consequences for cities around the world, so might the visions of the smart city. This illustrates how industry, politics, and economics are all built into the materiality of an emerging infrastructure. The urban ideals and epistemological models of an industry that largely comes out of computing is thereby shaping the future possibilities, and challenges, of networked city life.

Following Star (1999), I would argue that to take a material perspective on the infrastructures of the networked city means to highlight how standards, wires, and antennas are constructed and how these processes involve power, politics, and societal change. The infrastructure of the networked city could be seen as a part of the planned and functional spaces of the city. Following Léfèbvre (1991), these structures therefore contribute to how urban space is produced. This prompts the question of which organisations, corporations, and institutions have the power and the means to make decisions about the implementation of infrastructure, and how these choices further have implications for the possibilities and challenges in both networked city life and for design.

On a micro-level, the networked city is part of the urban materiality and spatiality of everyday life. Early urban ICT research made a clear distinction between the virtual realities of cyberspace and the physical realities of the city, suggesting that the tension between the virtual and the physical was key to understanding networked cities (Graham, 2004a). Contrary to this, recent researchers have argued that the networked city takes place within the materiality of urban life alongside the built environment and daily practices. Graham (2004a) writes that the ‘hard material basis for the “digital revolution” is neglected but crucial ... [T]he “information age”, or the “network society”, is not some immaterial or anti-geographical stampede online’ (ibid,

p.139). Rather, as Crang et al. (2007) observe, the networked city is part of 'the ordinary, taken-for-granted technostructural background for widening domains of everyday life' (ibid, p. 2406).

Central to these perspectives is how the networked city is a part of the local, material realities of urban environments. In Article 2, I discuss how the WiFi visualisations contextualise and situate the digital within the concrete spaces of the city, showing the intricate relations between radio waves and concrete, glass and steel. This illustrates and reinforces the argument that digital technology in urban life is as significant as architecture, even if this is not yet reflected in urban theory or planning.

A material and spatial perspective on networked city life emphasises that it is local and situated within the cities we already live in. It is not some seamless, generalised digital future, as proposed by the dominant narratives of the smart city and ubicomp, but another layer in the already dense and complex contexts of the city, taking place alongside the built environment, the political, and the everyday. Bell and Dourish (2004) argue that 'the spaces into which new technologies are deployed are not stable, not uniform, and not given. Technology can destabilise and transform these interactions, but will only ever be one part of the mix' (p. 2). An important point is that these heterogeneous spaces of the city that networked technology becomes part of are not just physical and spatial, but also social and cultural. Following William's (1961) notion that culture is a 'whole way of life', the technologies and products we routinely interact with in our everyday lives are embedded in the lived culture of the networked city. This also makes it necessary to see the materiality of technology from a cultural perspective (as will be taken up below).

An infrastructural perspective on materiality illustrates how the networked city is implicated in political processes and economic realities, and further how aspects of power and legislation are part of how networked urban space is produced. A perspective on everyday materialities allows for examining and situating the technological structures of the networked city in relation to the heterogeneity of contemporary urban spaces. It also suggests that the digital constructions of the networked city have to be understood on an architectural level, as forming environments that shape urban life. In connecting these perspectives to the methodological reflections in Chapter 4, I further suggest that addressing the materiality of the networked city at the level of design can also allow us to explore how the technological is malleable and

negotiable, and how we, through design, might take part in interpreting and translating between the domains of technology, everyday life, and culture.

On a material level, interaction design can be seen as a bridge between the networked city and the technocultures of everyday life. As illustrated by the practice of this thesis, I argue that interaction design offers ways of engaging with the material and spatial aspects of the networked city in a mode that is practical, inventive, and culturally oriented. In this sense it is a strong alternative to the discursive force of the smart city and thereby offers a situated, grounded view on everyday urban technology that acknowledges the balance between material possibilities and constraints, as well as offering possibilities for creative exploration, expression, and invention.

5.1.2 The pasts, presents and futures of the networked city

With this theme I address the question of how we may situate the networked city temporally, and how this might be a valuable perspective on networked city life and interaction design. It may be useful to emphasise relations between the pasts, presents, and futures for how interaction design and the networked city is part of social and cultural change. The central point here is to bring together research on technology and design from historical, contemporary, and future framings to situate networked city life within continuities, and discontinuities, of everyday change. In this section I first critique the dominant concept of impact from networked city research by connecting this to cultural histories of technology, then discuss everyday life as a site of change; finally, I ask how interaction design can interpret possible futures.

The motivation for addressing the temporal aspects of the networked city comes from experience and observations from working across interaction design and urbanism. Interaction design works within ongoing technological change on a detailed level. Platforms, devices, and software tools have fast update cycles and a longevity in the span of months to years. Interaction design practice is therefore continuously focussed on the latest technological possibilities. Urbanism follows the timeframes of urban planning processes and architecture, which typically take years and have a longevity of decades or even centuries. The networked city takes place across the tensions between these timeframes, including the rapid shift in networked technologies and consumer electronics, the hyperbole of the smart city, and traditional architecture and urban planning. Investigating these temporal aspects could

therefore be interesting for establishing a more nuanced view of the future possibilities of networked city life.

The ideal of progress and the concept of impact have long been central to expectations of technology development in Western cultures (Slack & Wise, 2005). This is especially prominent within discourses of the networked city. Graham (2004a) critiques the dominance of what he calls the ‘impact’ metaphor in research on urban ICT, where the focus is on the potential revolutionary transformations caused by technological innovations:

New media technologies and practices are often abstracted from their historical context and presented simplistically as meteoric impactors arriving as if from nowhere to revolutionise pre-existing places and mobility practices. (ibid, p. 35)

In the corporate narratives of the smart city, the ideal of progress is also connected to a technological determinist perspective on the urban, where cities are seen as systems that could, and should, be radically transformed and optimised by technological innovation. The tendency to see technological innovations as disruptive, Graham argues, tends to deny the temporal continuities of everyday urban life and glosses over the ‘subtle interrelations between old and new, non-mediated and mediated, that occur within the fine-grained fabric of cities and everyday life’ (ibid, p.35).

Across interaction design research there is also a tendency to focus on novelty, impact, and disruption. As discussed in Chapter 2, the dominant discourses of ubicomp describe interaction design innovations taking place in a ‘proximate future’ that is just out of reach (Bell & Dourish, 2007). By placing the goals and potential achievements in the proximate future, both the smart city and ubicomp remove their technologies and designs from the contemporary, cultural, and material contexts of the everyday. By being ahistorical and disconnected from contemporary culture, these visions and speculations obscure the cultural and social implications of technological development. I argue that the focus on the near future gets in the way of engaging culturally with the networked city of the present. I suggests that it is therefore valuable take a situated, temporal perspective of networked city life by acknowledging the relations between its cultural history, its everyday present, and its possible futures.

In writing about technology and social change in a historical perspective, Bijker and Law (1992) argue that 'technology does not spring, *ad initio* from some disinterested front of innovation. Rather it is born of the social, the economic, and technical relations that are already in place' (p. 11). In a similar fashion, the historian David Nye (1997) writes that 'every new technology is a social construction and the terms of its adaptation are culturally determined' (p. 381). In extending these perspectives beyond a cultural history of technology and towards the broader temporal continuities of the networked city, it is important, especially coming from the context of design, to ask how cultural and social relations continuously change, and are changed by, new technologies in everyday life, also after their initial adaptation. It is also important to ask how the technocultural changes accompanying technologies of the networked city, like RFID, WiFi, and GPS (Figure 5.1), also involve practices of design.

The temporal has also been central in studies of everyday life. The web of relationships between everyday life and historical change has been examined as a way of seeing the everyday as a dynamic process where the old and the new co-exist (e.g., Léfèbre, 1991; Moran, 2004; 2005; Highmore, 2001; 2002). Moran (2004) writes that the 'everyday offers a corrective to the spectacularizing discourse of modernity, its self-promoting emphasis on the latest design or technological innovation' (p. 54). The local, lived experiences of everyday life are described by Harootunian (2000) as a 'site of unevenness' (p. 56) where the old and the new, the local and the global takes place side by side. Seeing networked city life as a 'site of unevenness', where the old and the new overlap, is a valuable way of framing the possibilities and challenges of emerging technology. Further, the mundanities of the everyday can provide a counterbalance to the exaggerated 'newness' of deterministic visions of technological progress (Massey, 1992).

Theories of everyday life have also been used in analysing conceptualisations of the future of the networked city. Galloway (2010) examines how technological change in everyday life and social expectations shape how possible and partial futures continuously unfold. The socio-technical changes that the networked city are a part of, Galloway argues, 'involve persistent tensions between pasts, presents, and futures that make certain identities and objectives possible or probable, and others impossible or improbable' (ibid, p. 32). Situating networked city life within the continuities and tensions of the everyday can provide a critical grounding in the present as well as giving a connection

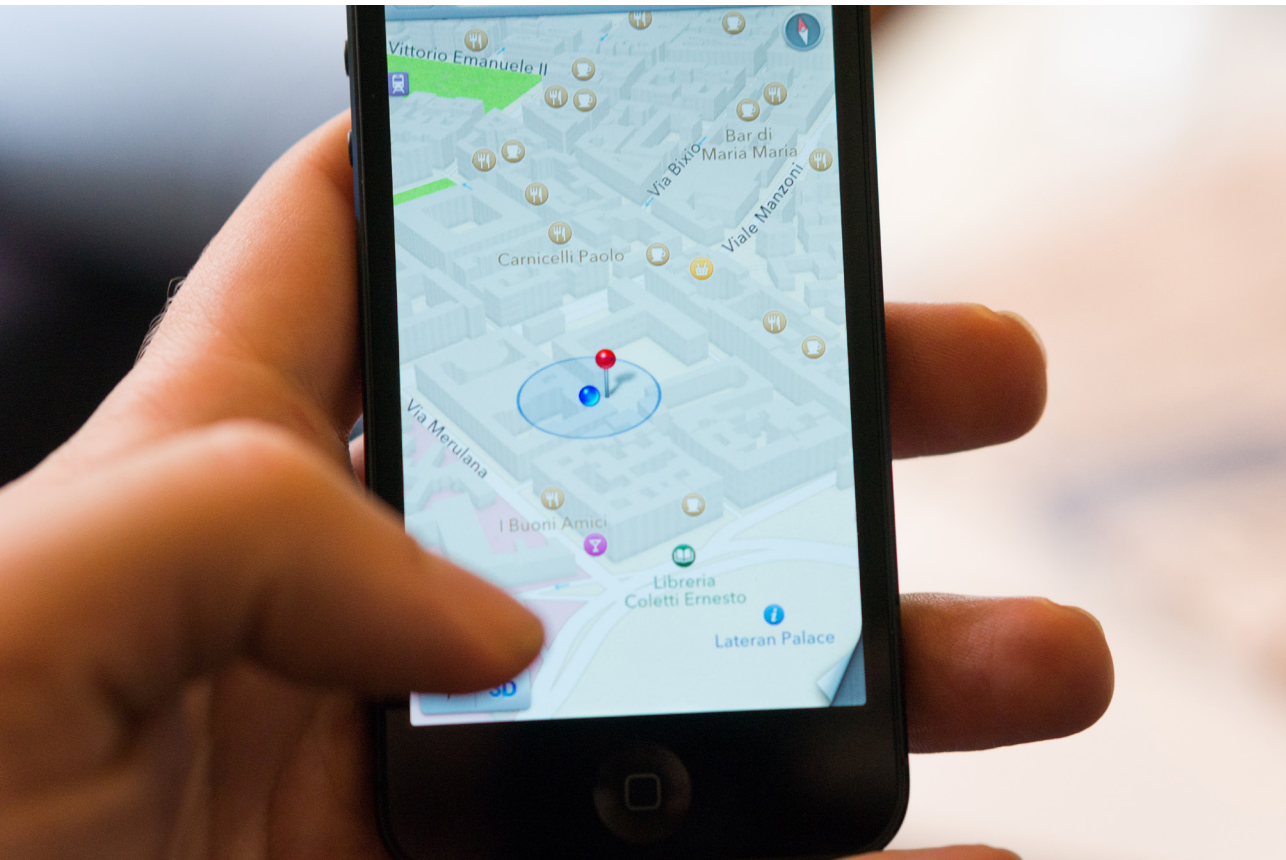


Figure 5.1. The ways in which GPS relates to social and cultural change today is only partially due to how and why the system was initially developed. Much more important, I argue, is the popular cultural practices and expressions that facilitate GPS in everyday use. By this I mean both the design of applications for anything from calorie-counting and dating to commuting to the media and narratives that surround these activities. The social and cultural technological changes in everyday life take place between interaction design, marketing, and business development, but not necessarily at the level of core technology development. Credit: Timo Arnall.

to the past. As an approach to the future of the networked city, this also opens up for questioning how and by whom these futures are being constructed, and further ‘who currently has the power to imagine and debate future scenarios, and who is excluded or absent from these activities?’ (ibid, p. 34).

From the perspective of interaction design and innovation, it could be argued that overemphasising the past and the mundanities of the present might lead to a conformist, or at least unimaginative, outlook on the potentials for

networked city life. It might be valuable to also reflect that the everyday can be seen as a site for transgression, resistance, and creativity. In de Certeau's (1984) critique of everyday life, one of his central insights is how everyday urban practices are not simply products of repression or shaped by 'strategies' imposed from above by political or economical structures. Instead, de Certeau argues that everyday urban life also consists of 'tactical' responses to imposed order, such as navigating the city on foot using shortcuts and improvised routes (Merryfield, 2000; Borden, 2001). Seeing the everyday as a space for 'tactical' uses and understandings of the city draws attention to the potential for creative interpretations within the everyday. Pointing towards how everyday life, alongside providing a corrective against deterministic conceptions of 'impact', also opens a space for creative and cultural interpretation and invention.

In a temporal framing, interaction design is interesting as a professional discipline, as a research topic, and, I would argue, as a conceptual viewpoint. As a generative practice, interaction design navigates the space between the everyday present and the possibilities of the future. The practice of designing mobile devices and interfaces involves anticipating, shaping, and sometimes disturbing near-future everyday practices. Interaction design is an engrained part of the temporal processes of networked city life through shaping what has recently become technically possible into the everyday experiences of the very near future.

Conceptually, interaction design can be seen as a practice of bridging the near past, the present, and the near future. The question we then should raise is, what kinds of possible futures can interaction design contribute to? Are we confined to increasing the usability of existing interfaces or finding ways to commodify technological innovations? Should we instead ask what kinds of conceptualisations of emerging technologies interactions design could take part in? A perspective on technocultural change would, I suggest, prompt the question of how interaction design practice can be extended beyond facilitating innovation to question or problematise, through design, how possible futures can unfold. These questions should be seen in relation to the methodological reflections in the previous chapter, but it is important to note how these perspectives also have implications for interaction design in general.

5.1.3 Invisibility and the technological imagination of the networked city

A third theme I suggest that is fruitful to explore is how networked city life is characterised by invisibility on multiple levels; herein lie challenges and potentials for both everyday life and interaction design. As discussed in previous chapters, the methodological move of the *Immaterials* project was to make invisible technical materials culturally visible. Through discursive design, we visualised and communicated technologies that were both technically invisible as well as culturally overlooked. The combination of cultural and technical invisibility is central to how the networked city can be perceived and explored.

Following Feenberg (2010), I suggest that invisibility is also engrained in biases found between interaction design and the networked city. On multiple levels, the concept of invisibility shapes relations across these fields. To unpack and illustrate this I will highlight some of the ways in which invisibility affects interaction design. I will focus on two related aspects; first, the practical implications of working with invisible, technical design materials, and second, how the concepts of invisibility and seamlessness have become part of the ‘technological imagination’ of the networked city (Balsamo, 2011).

Designing for networked city life involves interpreting and shaping complex and often invisible technological materials. Reflection through a ‘physical conversation’ with these technical materials, where the material ‘talks back’ (Schön, 1983), is often not possible in a direct way. Instead, interaction design practitioners approach the technological, material phenomena of networked city life through tools, platforms, and abstractions that allow them to access underlying technical possibilities. These include the tools used for developing software, such as APIs and programming environments, as well as design guidelines and rules for what is acceptable and appropriate for certain brands of devices. Designing with invisible materials therefore means working within constrictions placed by the tools and systems that are available for negotiating between technological materials and design practice. What forms of inventions and expressions that are likely to be created are not just bound by material possibilities, but are consequences of how these frameworks are constructed.

One of the characteristics of the networked city is that its technological materials are a part of the everyday urban landscape. The often messy spatiality

of networked city life is, as we have explored in the *Immaterials* project, not easily accessed or negotiated through available software tools. The fluctuations of GPS, the readable volumes of RFID tags, and the physical obstructions of WiFi are not accounted for through general development platforms, nor are the social and cultural uses of these technologies. Unintended use, inaccuracies, latencies, and fluctuations are local and social implications of the interweaving of digital technologies with practices and materialities of urban life. This illustrates that as digital technologies move into the world, they cannot be understood through software abstractions alone; there is a need for developing a different form of material knowledge for design. The challenge is to question both how platforms and tools shape the ways in which we can engage with invisible materials, and how to use the remarkable invisibilities of networked city life to invent and create new forms of expressions and experiences.

For interaction design, invisibility is not just a material characteristic, but is also part of the 'technological imagination' as an important vision or 'ideal' for how to interact with digital technologies. Balsamo (2011) uses the concept of 'technological imagination' to describe the 'mindset and a creative practice of those who analyse, design, and develop technologies' (ibid, loc. 657). As discussed in Chapter 2, Balsamo, drawing on Ihde (2008), defines the 'technological imagination' as not just a background assumption that steers the design, but as a culturally and historically shaped 'creative resource that is evoked in the design process' (loc. 3504). As such, the technological imagination shapes possibilities and expectations across the design and development of new interactive technologies. I argue that the technological imagination of the networked city is shaped by the legacy of 'invisible computing' and the vision of 'seamless interaction', and that this is problematic for an interdisciplinary view of networked city life.

With the conceptualisations of ubicomp in the early 1990s, Weiser and his colleagues argued for making 'computing an integral, invisible part of the way people live their lives' (Weiser, 1991, p. 1). According to Weiser, this new form of digital interaction would be built on computers that recede into the background to work towards 'invisibly enhancing the world' (ibid). In the decades since, the visions of ubicomp, and similar concepts from across commercial and academic fields, have been influential within both interaction design research and in the broader, cultural narratives of networked technology. This is specifically evident in the discourses of the smart city (see Article 3). Within design, Norman (1999) has been a central proponent for these



Figure 5.2. Seamlessness and seamless positioning technology is at the core of the majority of visions of both the smart city and of daily life in the near future, as seen here in Microsoft's *Productivity Future Vision*. In reality, these systems would most likely have to be built on the same material and technical principals as GPS, namely radio waves and triangulation. As we saw in Article 4, GPS is far from seamless, but is shaped by the material realities of everyday urban life. Screenshot by the author.

visions through his concept of the 'invisible computer'. Norman argues that design should work towards 'hiding the technology so that it disappears from sight, disappears from consciousness, letting us concentrate upon our activities' (p. viii). For Norman, technology should ideally work towards serving 'human needs invisibly, unobtrusively: the human-centred, customer-centred way' (p. ix).

These visions of 'invisible computing' from interaction design research resonate with how products and devices of networked city life are being portrayed in commercial discourses through product marketing and 'vision films' (see Kinsley, 2010, 2012). Here, the visions of invisibility that we recognise from ubicomp and Norman's 'invisible computer' are closely linked with ideals for seamlessness and efficiency. In marketing the iPad 3, Apple showed the iPad in multiple stages of everyday use, and stated that the company believed that its 'technology is at its very best when it is invisible' (Apple, 2012), while its rival Microsoft (2011) showed us a future where every device, from the kitchen to the city, is seamlessly synchronised (Figure 4.2) (see also Article 3).

The ideal of ‘seamlessness’ has been critiqued for not accounting for the messiness of everyday life and the often unpredictable implication of technological innovations (see MacColl et al. 2002; Chalmers & Galani, 2004; Galloway, 2004; Bell & Dourish, 2007, 2012). The vision of seamless, invisible systems does not align with the notion of the everyday as a ‘site of unevenness’ where local and global, new and old, efficient and the inefficient co-exist (Harootunian, 2000). As discussed by Highmore (2011), everyday life is not characterised by seamless interactions and invisible efficiency, but rather by shifts and overlaps between familiarity and friction, habits and the unexpected, and changes and continuities.

In the context of networked city life it is also important to note that to strive for seamless interactions and invisible technologies represents an epistemological problem. The myth of the ‘invisible computer’ leans on positivist and deterministic expectations of the possibilities of future technology and their relationships to everyday life. Norman (1999) writes that the aim of interaction design should be to ‘overcome complexity [and introduce simplicity]’ (p. 64). I would argue that this form of argumentation relies on the questionable assumption that the complexity of networked everyday life is something that *can* be, as Norman suggests, ‘overcome’ through design, and furthermore that invisible simplicity in everyday life is something that is both possible and desirable. As a response to this position, I would argue that exactly *because* networked technologies are embedded in everyday life, they take part in practices and contexts that are necessarily complex, heterogeneous, and situated.

In striving for seamlessness, ubicomp, the smart city, and contemporary interactive product design reduce the technological imagination of networked city life to a vision of efficient, invisible technological systems that work everywhere and all the time. This, I argue, is to overlook and obscure the diversity of urban life, and to underplay the multiple material, cultural, and social relations that constitute the networked city.

Balsamo (2011) argues that the ‘technological imagination’ is performative, and to exercise the technological imagination is to improvise within constraints to create something new (loc. 240). These constraints are influenced by cultural and social assumptions: what Feenberg (2010) calls the technical and discursive biases for how technologies are used and understood. As discussed in the previous chapter, Feenberg writes that to critique a technology, it is valuable to address the deficiencies in how its social and cultural

meanings, for example created through design, relate to its functional relation to reality.

The technological imagination operates on the level of technocultural meaning, but it also affects the tools and platforms used to access the functional basis of technologies. Above I discussed how software abstractions and APIs give designers access to technological possibilities. Through the *Immaterials* project we uncovered how the ideal of seamlessness and invisibility is reflected in these tools, and how the complex, material realities of networked city life are typically unaccounted for (see Article 4). This illustrates how both conceptual assumptions and bias, alongside technical, material properties, affect the relations between interaction design, daily life, and the networked city.

Different forms of technical and cultural invisibility are central to how networked city life is designed for, and how it is represented and understood. The tensions between invisible technological materials, the ordinariness of everyday use, and the ideals of invisibility together make it challenging to evaluate, discuss, and design for the possibilities and problematics of networked city life. I would argue that the technical and cultural invisibility of the networked city becomes problematic when the invisibility comes to be taken for granted; when it becomes a system of assumptions embedded within the technological imagination, which in turn influences the possibilities for discourse and design. Designing with, and analysing, technology is influenced and constrained by technocultural biases and assumptions, but, following Balsamo (2011), exercising the technological imagination can also challenge and develop new ways of imagining technology. The exploration and problematisation of the networked city, I argue, should therefore include questioning how invisibility shapes the technological imagination and, as addressed in the following section, how this in turn affects cultural meanings and expressions.

5.1.4 Cultural materials of networked city life

The final theme is how networked city life may also be understood as taking place through cultural materials. By this I mean to emphasise how the networked city is a part of everyday life through cultural expressions and practices. Here, I define *cultural materials* in a broad sense as encompassing both visual and textual representations in media, myths, and public debates, as well as interfaces, devices, and the corporate marketing and envisioning of

technology. Further, this could be seen in relation to the model of the 'circuit of culture' where cultural meaning is produced and circulated through different, related processes where cultural materials are produced, interpreted, represented, and regulated. Following Hall (1997) this prompts the question of how the technological, material aspects of the networked city are culturally represented, interpreted, and made meaningful, and how this affects how the networked city is understood and how it can be engaged with.

Cultural materials play an important role in forming experiences and assumptions in networked urban life. As was discussed in Chapter 2, Moran (2005), drawing on Léfèbvre's (1991) notion of 'production of space', argues that 'lived, social space is inextricably linked to represented, imagined space, and that both are central to an understanding of everyday life' (Moran, 2005, p. 19). Moran suggests that media representations, in their multiple and often mundane forms (such as marketing, sitcoms, and newspaper columns), are crucial in establishing the parameters of public debate, and suggests 'how much power, or little power, we have to change our everyday lives' (Moran, 2005, p. 168). Michael (2006) extends the role of cultural materials in everyday life to the relations between technoscience and the everyday: 'The discourses, and sometimes spectacles, that "accompany" technoscience into everyday life', he writes, 'serve in the reordering of the present in order to fashion a future everyday life' (Michael, 2006, p. 9).

I suggest that because of the invisibility of the technological materials of the networked city, its cultural materials are particularly important in how it can be understood. This happens in multiple and overlapping ways, but here I will look at two layers of how cultural materials and representations work to produce meaning in networked city life: first, the role of cultural materials in stabilising and reinforcing technological innovations in the present, and second, how cultural materials contribute to processes of anticipation through envisioning the near future.

The contemporary cultural materials of networked city life take many, and often fragmented, forms, such as advertisements for smartphones, 'apps', or broadband services; public debates about surveillance and security; the interfaces of mobile devices; and technical terminology in cinema and television. Highmore (2001; 2009) writes about how novel technical devices and possibilities become embedded within the everyday. Cultural representations play a central role in these processes of normalising technologies and in situ-

ating them in daily life. In discussing these processes in relation to interaction design, I suggest that it might be fruitful to look to Bazerman's (2002) concept of 'representational resting points' from research in rhetoric. Bazerman defines 'representational resting points' as accepted representations that have become established enough to be stable points of reference and the 'basis for common understanding' (ibid, p. 349). Bazerman examines the rhetoric surrounding emerging technologies in a historical perspective, analysing the discursive practices of Thomas Edison and his colleagues at Menlo Park during the development of the first system for distribution of electric light. The invention and implementation of this system cannot be fully understood, Bazerman argues, without seeing this in relation to how the technology was represented across different discursive contexts, including legal documents and patents, marketing, media, and public demonstrations.

Electric light, Bazerman states, had to 'find representational terms that could be comprehended before it could create its own new world of experience and meaning' (ibid, p. 320). It is these representations, Bazerman argues, 'that go between minds, creating meaning and accommodating novelties to existing sets of beliefs and social institutions' (ibid, p. 2). An important part of the stabilisation of the technology, then, is how representations become stable points of reference as 'representational resting points'. In order to become relevant, viable, and desirable, new technological developments, like those of the networked city, do not just rely on technological practices, but also on discursive practices through 'the development of symbols that will give presence, meaning, and value to a technological object or process within a discursive system' (ibid. p.335).

The connection between technical and discursive practices can be extended to how the networked city is emerging, and how cultural materials contribute to popular imaginations and anticipations of the near-future. Kirby (2011) examines the role of popular cinema in introducing and normalising new scientific and technological ideas, suggesting that representations of science and technology in cinema contribute to the 'technoscientific imaginary' (Kay, 2000) (see Chapter 3). Cinema, Kirby writes, is central to this technoscientific imaginary by being a powerful 'virtual witnessing' technology by creating 'visually and emotionally immersive environments' (p. 40). 'Virtual witnessing' can, following Kirby, be defined as 'any attempts to persuade others that they have witnessed a "natural" phenomena without the need for them to witness the phenomenon directly' (p. 26). Kirby argues that virtual witnessing of, for

example, interactions with envisioned devices through cinema works towards culturally situating potential or emerging technologies, fostering public attention by establishing the need for (and viability of) these technologies.

While Kirby examines the technoscientific imaginary in general, Kinsley (2010; 2012) investigates the use of corporate vision videos, specifically within the field of ubicomp. As discussed in Article 3, 'vision videos' are films produced by technology companies to communicate strategies and visions for the future. Vision videos do not necessarily promote specific products, but rather place the technological systems of companies in near-future scenarios. In Article 3, I argue that the typical scenarios communicated in these films are shaped by visions of seamlessness and efficiency, and that they rarely relate to realities of neither design or everyday life. Kinsley (2012) comes to similar conclusions as to how vision videos reproduce the dominant visions of ubicomp. Further, Kinsley suggests that as discursive formations, vision videos are 'situated in a discourse of anticipation that disciplines the way future orientation takes place in the living present' (Kinsley, 2010, p. 14). This 'politics of anticipation', Kinsley writes, plays out on multiple levels and in often subtle and unconscious relations to our embodied understandings of the world. These mediated visions, Kinsley argues, do not simply represent future goals that industry or society should be working towards, but rather 'act within and constitute a present' (ibid, p.29). As discursive artefacts, vision videos appeal to new modes of reading and anticipating the technocultural everyday through evocatively depicting 'potential modes of technological encounter in lucid detail, as if they are achievable in the present moment' (ibid, p. 18).

Which 'politics of anticipation' are reinforced, and in which way future technologies are portrayed, depends on how and by whom these cultural materials are produced. As Kirby and Kinsley write, representations and conceptualisations of emerging technologies, both in vision videos and popular cinema, are typically produced by parties that 'have vested interests in conveying to audiences that these fictional technologies *can* and *should* exist in the real world' (ibid, p. 196; original emphasis). It is important not to overemphasise the direct influence of corporate filmmaking and advertisement, however, but instead acknowledge that these cultural expressions of the networked city, whatever their intended purpose might have been, provide framings for how to discuss and respond to technological change.

Both established representational resting points and representations of prospective futures are part of the 'technical heritage' of the networked city as aspects of the 'broader cultural values and practices that surround a particular technology' (Feng & Feenberg, 2008, p. 111). In reflecting on this, I want to highlight two connected perspectives. First, as Bazerman (2002) argues, the relations between technical and discursive practices are important in understanding how emerging technological phenomena become culturally meaningful. This implies that to engage with the networked city requires an interdisciplinary approach, and that culturally oriented design can contribute alongside, or in opposition to, urban planning, engineering, and computer science. Second, following Hall (2005), the cultural materials of the networked city are part of articulations that create meaning by forming connections between technologies, concepts, visions, and agendas. These articulations include, for example, the influential connection between urban, networked technologies, and the concepts of seamlessness and the strive for optimisation and efficiency. Further, as Hall argues, seeing these processes as articulations also implies that their connections have the potential to be changed, or re-articulated. In the previous chapter, I discussed how the practice of this thesis can be seen as an attempt to re-articulate discourses of technology through discursive design. On an analytical level, however, we should ask: what do representational resting points and visions do to the popular imagination through the articulations they form (or are part of)?

As networked city life is an emerging phenomenon, it is limited as a cultural, creative resource for design, and in how it is articulated in popular culture. In relation to the previous theme, I argue that the cultural materials of the networked city are coloured by ideals of invisibility and seamlessness, and an underdeveloped understanding of everyday life. How the networked city is being portrayed across popular and technological discourse does not necessarily align with its material, everyday possibilities and problematics. This illustrates an important challenge for how we approach networked city life: namely, that while the networked city is technologically sophisticated, we do not have equally developed cultural materials for engaging with it. Exploring ways of engaging with the networked city is important exactly because these emerging technological systems and practices are part of social and cultural changes in everyday life.

Critiques of everyday life, such as those of Léfèbvre (1991), the Situationists (Sadler, 2001), and de Certeau (1981) (see also Gardiner, 2000), have argued

for the potential for change in everyday life. Following these views, Moran (2005) argues that the ‘cultural materials that have been representing our everyday lives over the last few decades have often served to deny or obscure this potential for change’ (p. 169). If we want to begin to transform our everyday lives for the better, Moran suggests, we need to ‘consider more closely how we think, talk about and represent them’ (ibid, p. 169). In this research project I have follow up this argument by asking not just how we can analyse the cultural materials of networked city life, but how we might design cultural material for thinking about it in new ways.

The *Immaterials* project made visible the contemporary technological structures of the networked city, showing that these structures are not seamless, but rather are part of the often messy material and spatial environments of our cities. This suggests a different form of articulation of the networked city than what is offered by the smart city industry or by corporate vision videos. Rather than connecting networked, urban technologies to ideals of an efficient and optimised near-future, *Immaterials* connected these technologies to everyday urban spaces of the present. *Immaterials* illustrated an approach to using the discursive potential of interaction design and online communication to make the technologies of the networked city culturally accessible, and for suggesting a way of looking at the networked city in new ways. For engaging with the emergence of the networked city, I argue that there is a need for expanding and developing how it can be understood culturally. The key point is that this means finding *multiple* ways of understanding, expressing, and representing networked city life.

5.1.5 Across networked city life

With the *Immaterials* project we represented and conceptualised the networked city in new ways. With the themes identified and discussed in this chapter, I have worked towards also re-contextualising the networked city and interaction design analytically. Together, these themes raise questions, concepts, and arguments that contribute to an analytical position on interaction design and networked city life. This positioning brings out tensions and possibilities across fields of research, and develops a layered analysis of networked city life and interaction design. In the closing section of this chapter I will discuss the analytical contributions offered by this positioning on an overarching level.

The analytical themes identify specific characteristics of the relationship between the networked city and interaction design. Identifying and developing these characteristics as four connected strands is both a rhetorical and analytical move. With each of the themes I have developed a specific perspective that contributes different arguments and connections. For example, the material perspective uses materiality to bring forward constraints and possibilities across both technology and infrastructural politics, as well as urban space and interaction design. The temporal perspective situates networked city life by discussing tensions between its past and present, and questions how possible futures are constructed. The discussions of invisibility connect implications of invisible, technical materials with invisibility as an ideal or bias within the technological imagination of the networked city. The cultural perspective both connects cultural materials with discourses of emerging technologies, and suggests that this is a potential space for re-articulation through design.

While each of these themes analyses specific characteristics, collectively they develop connections that work towards grounding, situating, and contextualising the networked city and interaction design. The analytical contribution is both identifying the characteristics themselves, and the connections, or articulations, that they collectively form. By following different routes and making different connections, the analysis also works towards putting the heterogeneity of networked city life in the foreground. Rhetorically, this analytical move is also an argument for exploring multiple ways of analysing, designing, and critiquing. The four themes I have identified should therefore imply that there are also many others to be taken up.

This analysis reinforces the importance of an interdisciplinary approach to emerging technologies in daily life. With these analytical themes, I have discussed characteristics by collecting and applying concepts from across disciplines. Each of the themes is a novel conceptual formation that crosses and expands the demarcations of the largely unconnected fields of interaction design, networked cities, and everyday life. Through joining up these formations, I should stress, the analysis works towards situating the networked city and interaction design in relation to daily life and culture. Through turning towards the everyday, this analysis has uncovered new ways of contextualising and conceptualising both the networked city and interaction design. Everyday life is important, conceptually, for developing a richer and more grounded analysis, but also for developing a stance towards technological change.

As networked cities become partial realities across the world, their effects manifest themselves in the daily lives of citizens. Everyday urban life in a networked city illustrates how technological culture involves a multiplicity of relations between and across technologies and people. Ihde (2008) writes that:

while it is clear that a new technology, when put to use, produces changes in practices ... these practices are not of any simple 'deterministic' pattern. The results are indeterminate but definite, but also multiple and diverse. Moreover, both intended results and unintended results are unpredictable in any simple way, and yet results are produced. (Ihde, 2008, p. 59)

From city to city, neighbourhood to neighbourhood, and from citizen to citizen, everyday life is different and has different challenges and possibilities. For each individual citizen, daily life is largely made up of routines, habits, and often taken-for-granted cultural practices. As new technologies become more or less successfully adopted, they eventually become embedded within these practices (Highmore, 2009). Taking an everyday perspective on the networked city implies that there is no single cultural context or narrative about networked city life, but multiple ways in which it becomes, and is embedded in, different contexts.

Everyday life is situated in the present, both materially and temporally. But the everyday is also a 'site of unevenness' (Harootunian, 2000) where residues of the past and hopes for the future overlap. I have argued that perspectives on daily life are underdeveloped in the dominant narratives and visions of ubicomp and the smart city. This does not mean that there is an opposition between daily life and networked urban technologies. Rather, it means that the multiplicities of the everyday rarely are addressed when future technologies are envisioned. As Crang et al. (2007) observe in their ethnographic studies, the remediation of everyday urban life through the technologies of the networked city 'involves subtle shifts in the spatial, temporal, scalar, and material processes which together help constitute urban change' (p. 2405). The key point is that this remediation is layered and tangled with cultural materials that also work towards shifting everyday experiences and the technological imagination.

Seeing everyday life as a site for technocultural change opens up the question of how these change processes can be understood, and how they can be

engaged with. Léfèbvre's (1991) concept of the 'production of space' can offer a valuable perspective on how change can be analysed, negotiated, and affected. Léfèbvre's dialectic model of spatial production argues that everyday urban space is socially and culturally produced in the relations and tensions between how the city is perceived in daily life; how it is technically, functionally, and economically conceived; and how the city is conceptualised and imagined through cultural materials.

Extending Léfèbvre's relational model to the networked city highlights how it is produced across everyday life, technology, design, and culture. The spatial practices of networked city life are constructed and constrained by the city's infrastructure, protocols, and technological materials. It is important to note that these spatial practices of the networked city are extensions or variants of existing practices, sharing the same possibilities and vagaries that daily life entails. How the networked city is represented or conceived, and how it is imagined, both take place across the city's cultural materials: both through its mediated visions and stabilised representational resting points. Léfèbvre's spatial triad brings out both the ways in which power and economics constrain daily urban life, and the potential for engaging with change in daily life, through daily practices and on a cultural, representational level. I argue that this is important because it offers an active perspective on technocultural changes, and suggests multiple ways in which we can engage with these.

Through the practice and analysis of this thesis I have argued that interaction design can actively take part in facilitating, negotiating, and questioning the emergence of networked city life. Central to this argument is a perspective on the technocultural realm as being a dynamic construction. This reflects the concept of the 'production of space', but extends this to the relations between the networked city and interaction design. Interfaces and devices are part of the spatial practices of networked city life. Here, interaction design contributes to how the technological structures of the networked city are used and experienced in daily life. As I have suggested, however, interaction design can also operate across representational spaces through articulating or making apparent ways of understanding or imagining of the networked. This suggests that daily life, as well as contextualising emerging technology, also opens the way for a discursive potential. As the *Immaterials* project illustrated, discursive design can explore this potential through creating and re-articulating cultural materials of networked city life.

Theories and critiques of everyday life provide perspectives for discussing, analysing, and engaging with the networked city and interaction design. Invoking the everyday as a topic can imply a focus on ordinariness, multiplicity, and popular cultural practices and expressions. But in urban studies taking up the everyday has also meant aligning with common citizens and with lived culture, 'to side with the dominated against those that would dominate' (Highmore, 2002, p. 1). In the 1950s and '60s, urbanists turned to the everyday to critique the dominant functionalist ideals of postwar urban developments. In 1961, Jane Jacobs (2006) used observations of city life to critique Le Corbusier's urban ideal of planned order, arguing for the value of street life for urban communities. Kevin Lynch (1960) turned to ordinary citizens' experiences of urban space in his radical urban mapping techniques. Léfèbvre (1991) critiqued the power of capitalism over social and cultural space, while the Situationists attempted to re-invent the city through artistic practices for re-imagining everyday life itself (Sandler, 2001).

In the same way that studies of the urban everyday brought cultural and citizen-centric perspectives into urbanism, we similarly need an everyday perspective on the networked city. The dominant smart city narrative promotes an understanding of urbanism that bears similarities to the mid-twentieth century high-modernist urban ideal of a city planned and managed from above (Greenfield, 2013). Positioning the networked city in relation to everyday life is to argue for counterbalancing the business-driven, technology-led perspective of the smart city. As such, the everyday can act as ballast for both challenging and inventing new conceptualisations of technology.

The analytical positioning developed in this chapter draws attention to relations between networked city life and interaction design. These positions open up questions of how to examine and how to design in the networked city, and how to conceptualise networked city life. An overarching issue is the misalignment between the technological phenomena of the networked city and its cultural materials. As discussed above, the networked city is technologically sophisticated, yet we do not have the equally developed cultural materials for engaging with it. Further, I suggest that networked city life does not just need better technologies, but rather better ways of understanding the technologies. The key point is that, considering the heterogeneity of the networked city, this would mean allowing for several ways of understanding networked city life, and for creatively questioning its spatial, material, and cultural possibilities and challenges.

Chapter 6

Conclusions

Through practice-led research, this thesis has taken up the question of how interaction design can engage with the networked city in an everyday cultural frame. In responding to this I have developed a purposefully broad perspective on the networked city to include the multiple ways in which digital, networked technologies are interwoven with the urban landscape, as infrastructures, cultural expressions, products, and daily practices. This broad, cultural perspective on technocultural change is important because it offers a contrasting alternative to the growing force of the technological and economical constructs of the smart city. An overall analytical contribution of the thesis lies in identifying and discussing characteristics of the networked city and interaction design, as well as in suggesting interdisciplinary cross-overs. Central here is the analytical move of bringing together research on the networked city and interaction design through everyday life. This move is important because it has lifted a cultural, everyday perspective into both interaction design practice and analysis of the networked city.

Within this framing I have investigated and revealed invisible technological materials of common urban technologies by using the tools and approaches of interaction design in new ways. Across this practice I have further addressed the question of how interaction design research may be used to generate or shift cultural perspectives on the networked city, and how this form of design inquiry can be situated against a broader understanding of technology, culture, and daily life. I have argued that interaction design can have the potential for wider technocultural engagement, where the material and communicative methods of the discipline are put to use for stirring or challenging the popular, technological imagination of the networked city. As I argue in Article 3, 'design can and should take on the role of negotiating and translating between popular culture and emerging technologies by creating alternative images and perspectives directed toward the popular imagination' (Martinussen, 2013, p. 307).

In analysing the relationships between interaction design and the networked city, I have asserted that the many emerging technological systems in cities are technologically sophisticated, but that we do not have equally developed

cultural materials for engaging with their implications. This, I have suggested, limits potential for discussion, critique, and invention. Through the *Immaterials* project I showed how interaction design has the disciplinary resources to contribute more than just useful interfaces, but also to contribute poetic, expressive, or challenging ways of seeing, and imagining, the networked city.

The practice as a whole—going across the material, the popular, and the critical—can be seen as a methodological move that may be described as *making the technically invisible culturally visible*. By this I mean approaching interaction design not as a practice of making technologies usable, but as a practice of engaging with how technologies are articulated and may be understood culturally. Everyday life is here seen as intertwined with the popular, cultural expressions that accompany daily practices. How these expressions and representations are designed and mediated is important for shaping everyday understandings of technology. Further, unpacking and conceptualising seemingly normalised or mundane technologies through design is a valuable way of addressing their status as everyday phenomena. In Article 3, I argue that:

Interaction design exists in the intersection between technology, infrastructures, services, and citizens. Through both practice and products, designed interactions embody how we interact with and live with technologies in daily life. As emerging forms of products and interactions solidify and become conventions, opportunities are lost and challenges are overlooked. The challenge now is not just to understand the networked city, but to find ways of reframing and re-imagining its concepts and consequences. Here, the agency of the designer may be shifted from supporting and confirming processes of technological development toward problematizing discourses around those processes and through using media to be both critical and propositional within popular culture. (Martinussen, 2013, p. 308)

By creating cultural expressions that make everyday technological, invisible phenomena accessible in a popular cultural frame, the disciplinary methods and competencies of interaction design have been employed to take part in the multi-level, technocultural discourses of the networked city. This involves an expansion of interaction design research beyond a typical focus on technology and use-cases. Instead, through this practice I advocate for interaction design to contribute to how technologies can be conceptualised and made accessible across culture. As shown in the discussions in Chapter 3 and 4, this

form of cultural production and popular communication has further allowed others to engage with the invisible technologies of urban life. Through online presence, social media and different forms of cultural circulation the *Immaterials* visualisation have been made available for multiple forms of engagement and interpretation. This illustrates the potential for using discursive interaction design research to bring the networked city out of the spaces of technological speculation, as exemplified by dominant smart city discourses, and into spaces of cultural meaning, articulation, and re-articulation.

This thesis makes contributions, and has implications, on different levels. The body of design work collectively contributes to the imagery and technological imagination of networked city life, while the design research practice offers a set of examples and discussions of how interaction design can be used for engaging with popular, cultural discourses of technology. This practice is also an exploration of the potential of a discursive design approach. In Chapter 3, I presented the notion of discursive design as a framing for using design to re-articulate or challenge technocultural discourses. A discursive design approach has been valuable for raising issues of culture, mediation and articulation across the across practice. In exploring the discursive and communicative potential of making technologies visible and accessible, I have interpreted and extended the notion of discursive design. In particular, I have suggested that discursive design could be developed towards creating and challenging conceptualisations of technology. Here I see both a challenge and potential for discursive design in how conceptualisations of technology can be designed in ways that are accessible, relevant, and expressive across different discursive fields and cultural contexts. If we are to design cultural materials that allow others to engage with emerging technocultural conditions, like the networked city, then the question is how these conceptualisations can be shaped in ways that allow for both invention, discourse and critique.

I have suggested that one of the strengths of the *Immaterials* project is that it is both expressive and open-ended. Further, I have argued that complex, emerging technocultural issues need to be conceptualised in ways that open up for both critique and innovation, and that allow for multiple articulations and re-articulations to be made. Yet, this approach also limits what kinds of arguments and discussion that can be designed for and explored. The *Immaterials* project embodies a general argument for seeing the networked city as situated in contemporary everyday life, but it does not address specific problematics of networked urbanism, such as privatisation or surveillance.

Addressing issues such as these would perhaps require an approach to discursive design that is less open-ended, and more explicitly critical or political. In taking discursive design forward it is important to address the balance between supporting broad technological invention and discussion, and advocating for critical perspectives. I argue that the challenge is find ways, through design, for creating and communicating conceptualisations that can foster both critical reflection, and creativity and invention. I argue that the value of discursive design lies in the connection between how discursive artefacts, like online films, are produced, and how they are communicated through popular online media. In developing and expanding discursive design further, the relation between design production and online dissemination is therefore central, and could offer a fruitful direction for further research.

This thesis also raises possibilities and challenges for a technocultural perspective on interaction design. I suggest that an important implication is to question how interaction design works, or can work, within and towards the production and circulation of cultural meaning. How interaction design navigates and contributes to technoculture also prompts the question of how technoculture can be analysed, explored, critiqued, and extended through interaction design. This opens multiple possibilities for further research, and following the characteristics of the practice identified and discussed in Chapter 4, I suggest three connected routes for further practice-based, culturally oriented interaction design research: material, popular and critical.

First, a practice-based and culturally framed approach to interaction design contrasts with attention to the technical and functional that prevails in much HCI research. Instead, through attention to a technocultural view, it would be valuable to develop explorative and communicative research that may generate material and technical knowledge across interaction design education and practice. As demonstrated by parts of the *Immaterials* project, there is a potential for further developing techniques and pedagogies for material exploration, such as sensor-based light painting, and thus allow others to address complex or invisible technologies on the level of expression, invention and creativity.

Second, the popular aspects of the practice could fruitfully be extended towards a further exploration of popular, online communication as an approach to discursive design. As our films illustrate, there is a potential for using online boundary objects to communicate across cultural contexts and

disciplinary demarcations. As explored with the ‘Satellite Lamps’ publication, there is further a potential for turning these insights towards the dissemination of design research. Here I suggest that it could be valuable take up the research question of how online communication and interaction design can communicate insights from research to both interdisciplinary fields and broad popular audiences.

Third, the critical aspects of the practice show that there is a potential for further developing approaches for critique of technology through design. I have argued that interaction design can, and should, create alternative conceptualisations of technology on a cultural level, and that these conceptualisations can be critical in themselves by stirring or expanding the technological imagination. I see a great potential for further research to move beyond the networked city and address other important issues in the emergence of networked society and culture. It is important to note that in expanding this critical perspective it is central to see the critical or discursive potential as connected to the material and popular aspects of the thesis, and that all three are important for re-articulating technocultural discourses.

Analytically, I have used a collaborative project- and design-based practice, alongside an interdisciplinary research framing, in order to examine and discuss relations between interaction design and the networked city. Through developing a set of analytical themes, I have worked towards an analytical position on the networked city and interaction design that is situated in everyday life and culture. The themes work as abstractions of characteristics of networked city life, while also being statements towards an argument for seeing the networked city and interaction design in a cultural and everyday perspective. As components of a wider framework, the themes prompt us to consider the multiple contexts and relations through which the networked city and interaction design take place.

Seeing interaction design in the context of urban life requires a shift in attention from the individual user and interface to the surrounding urban and cultural context. Viewing the networked city in relation to interaction design means that it, too, has to change its focus, but from the overarching technical and infrastructural issues to the everyday, networked interactions of citizens. Interaction design and the networked city can be bridged by perspectives on daily life. To introduce everyday life into these fields offers a means of addressing cultural perspectives, multiplicity, and friction, and may further provide a

grounding for the design and conceptualisation of emerging technologies in urban life. It places these technologies and their possibilities in our pockets and our streets, and suggests that the emergence of networked city life might, and should, lead to something more interesting and rewarding than invisible, efficient systems and the utopian seamlessness of the smart city.

Léfebvre argued that ‘the only genuine, profound human changes are those which cut into the substrate [of everyday life] and make their mark upon it’ (Léfebvre, 1991, p. 228). The networked city is making its mark on both daily urban life and on the cultural materials that accompany the everyday. The networked city offers great unexplored potential for daily life, and for design, but also entails unknown problems and unforeseen consequences. Yet, one of the current challenges of the networked city is that its potentials and issues become all too easily (and uncritically) obscured by technical and cultural invisibility, and the hyperbolic discourses and conceptualisations. Rather than becoming a subject for broad discussion, invention, and critique, networked city life is reduced to technology-driven corporate visions for the future, or interactions with mobile devices whose technological wonders we take for granted.

The networked city is more than glowing smartphone screens and a striving for infrastructural seamlessness. Using interaction design and online media to visualise and communicate its spectacular technical landscape has aided the discovery and analyse of the characteristics and biases of the networked city. More importantly, however, making these technical structures culturally visible draws attention to the networked city in and of itself. This illustrates the importance and value of exploring new ways of seeing and understanding the technologies of everyday life. In doing so, interaction design may contribute to and challenge practices and conceptualisations of the networked city by stirring the popular, technological imagination.

References

- Abrams, J. J. (Writer), Kurtzman, A. (Writer), Orci, R. (Writer), & Graves, (Director). (2008). Pilot [Television series episode]. In Abrams, J. J. (Executive producer), *Fringe*. United States: Fox Network.
- Agre, P. (1997). *Computation and human experience*. Cambridge, UK: Cambridge University Press.
- Akrich, M. (1992). The De-scription of technical objects. In W. Bijker & J. Law (Eds.), *Shaping technology/Building society: Studies in sociotechnical change* (205-225). Cambridge, MA: The MIT Press.
- Albrecht, K., & McIntyre, L. (2005). *Spychips: How major corporations and government plan to track your every move with RFID*. Nashville, TN: Nelson Current.
- Allwinkle, S., & Cruickshank, P. (2011). Creating smart-er cities: An overview. *Journal of Urban Technology*, 18(2) 1-16.
- Amin, A., & Thrift, N. (2002). *Cities: Reimagining the urban*. Cambridge, UK: Polity Press.
- Apple. (2012). *The new iPad*. Retrieved from <https://www.youtube.com/watch?v=K8ecN36Ffpc>
- Araya, A. A. (1995). Questioning ubiquitous computing. In *Proceedings of the 1995 Association for Computing Machinery (ACM)*.
- Arnall, T., Schulze, J., & Martinussen, E. (2009). *Immaterials: Ghost in the field*. Retrieved from <http://www.nearfield.org/2009/10/immaterials-the-ghost-in-the-field>
- Arnall, T., & Martinussen, E. S. (2010). Depth of field: Discursive design research through film. *FORMakademisk*, 3(1) 100-122.
- Arnall, T., Martinussen, E., & Knutsen, J. (2011). *Immaterials: Light painting WiFi*. Retrieved from <http://yourban.no/2011/02/22/immaterials-light-painting-wifi/>
- Arnall, T. (2013a). The *Immaterials* project. *elasticspace.com*. Retrieved 17 September 2013, from <http://www.elasticspace.com/2013/09/the-immaterials-project>
- Arnall, T. (2013b). *Robot readable world*. Retrieved from <https://vimeo.com/36239715>
- Arnall, T. (2013c). Exploring ‘immaterials’: Mediating design’s invisible materials. *International Journal of Design*, 7(3) 101-117.
- Arnall, T. (2014). *Making visible—Mediating the material of emerging technology* (Doctoral dissertation). Oslo School of Architecture and Design.

- Bagnara, S., & Crampton Smith, G. (2006). *Theories and practice in interaction design*. Interaction Design Institute, Ivrea, Italy: Lawrence Erlbaum Mahwah.
- Baldassari, A., Picasso, P., & Museum of Fine Arts, Houston. (1997). *Picasso and photography: The dark mirror*. Paris: Flammarion.
- Ball, C. (2004). Show, not tell: The value of new media scholarship. *Computers and Composition*, 21(2004) 403-425.
- Balsamo, A. (2011). *Designing culture: The technological imagination at work*. Durham, NC: Duke University Press. [Kindle version]. Retrieved from Amazon.com
- Bazerman, C. (2002). *The languages of Edison's light*. Cambridge, MA: The MIT Press.
- Bell, G., & Dourish, P. (2004). Getting out of the city: Meaning and structure in everyday encounters with space. *Workshop on Ubiquitous Computing on the Urban Frontier*, Ubicomp 2004, Nottingham, UK.
- Bell, G., & Dourish, P. (2007). Yesterday's tomorrows: Notes on ubiquitous computing's dominant vision. *Personal and Ubiquitous Computing*, 11(2) 133-43.
- Benford, S., Crabtree, A., Flintham, M., Drozd, A., Anastasi, R., Paxton, M., Tandavanitj, N., Adams, M., & Row-Farr, J. (2004). Can you see me now? *Transactions on Computer Human Interaction (TOCHI)*, 13(1) 100-133.
- Bijker, W. E., & Law, J. (1992). *Shaping technology/building society: Studies in sociotechnical change*. Cambridge, MA: The MIT Press.
- Blanchette, J.-F. (2011). A material history of bits. *Journal of the American Society for Information Science and Technology*, 62(6) 1042-1057.
- Borden, I. (2001). *Skateboarding, space and the city: Architecture, the body and performative critique*. Oxford, UK: Berg.
- Bourdieu, P. (1984). *Distinction: A social critique of the judgement of taste*. Trans. Richard Nice. Cambridge, MA: Harvard University Press.
- Bowen, S. (2009). *A critical artefact methodology: Using provocative conceptual designs to foster human-centred innovation* (Doctoral dissertation). Sheffield Hallam University, UK.
- Buchanan, R. (2001). Design research and the new learning. *Design Issues*, 17(4) 3-23.
- Bucher, T. (2012). A technicity of attention: How software 'makes sense'. *Culture Machine*, 13(2012) 1-13.
- Buxton, B. (2007). *Sketching user experiences: Getting the design right and the right design*. Amsterdam: Elsevier.

- Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, 18(2) 65-82.
- Castells, M. (1989). *The informational city: Information technology, economic restructuring, and the urban-regional process*. Oxford, UK: Blackwell.
- Castells, M. (2004). Space of flows, space of places: Materials for a theory of urbanism in the Information Age. In S. Graham (Ed.), *The cybercities reader* (82-94). London: Routledge.
- Chalmers, M., & MacColl, I. (2003). Seamful and seamless design in ubiquitous computing. *Workshop at the Crossroads: The Interaction of HCI and Systems Issues in UbiComp*, 17.
- Chalmers, M., & Galani, A. (2004). Seamful interweaving: Heterogeneity in the theory and design of interactive systems. In *Proceedings of the 2004 Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques*, 243-252. Cambridge, MA: ACM Press.
- Clough, P. (2000). *Autoaffection: Unconscious thought in the age of teletechnology*. Minneapolis: University of Minnesota Press.
- Crang, M., Crosbie, T., & Graham, S. (2007). Technology, time-space, and the remediation of neighbourhood life. *Environment and Planning A*, 39(10) 2405-2422.
- Davies, G. (2011). Molecular life. In V. Del Casino Jr., M. Thomas, P. Cloke, & R. Panelli (Eds.), *A companion to social geography*. Oxford, UK: Wiley-Blackwell, 257-274.
- Davis, S. B. (2012). History on the line: Time as dimension. *Design Issues*, 4(28) 4-17.
- Deakin, M., & Waer, A. (Eds.). (2012). *From intelligent to smart cities*. London: Routledge.
- de Certeau, M. (1984). *The practice of everyday life*. Berkeley: University of California Press.
- de Lauretis, T., Huyssen, A., & Woodward, K. (Eds.). (1980). *The technological imagination: Theories and fictions*. Madison, WI: Coda Press.
- DiSalvo, C. (2009). Design and the construction of publics. *Design Issues*, 25(1) 48-63.
- DiSalvo, C. (2012). *Adversarial design*. Cambridge, MA: The MIT Press.
- Dourish, P. (2001). *Where the action is: The foundations of embodied interaction*. Cambridge, MA: The MIT Press.
- Dourish, P. (2007). Seeing like an interface. *Proceedings of the 19th Australasian Conference on Computer-Human Interaction: Entertaining User Interfaces*. ACM.

- Dourish, P., & Bell, G. (2007). The infrastructure of experience and the experience of infrastructure: Meaning and structure in everyday encounters with space. *Environment and Planning B: Planning and Design*, 34(3) 414.
- Dourish, P., & Bell, G. (2011). *Divining a digital future: Mess and mythology in ubiquitous computing*. Cambridge, MA: The MIT Press.
- Du Guy, P., Hall, S., Janes, L., Madsen, A. K., McKay, H., & Negus, K. (2013). *Doing cultural studies: The story of the Sony Walkman* (2nd ed.). Los Angeles: SAGE.
- Dunne, A. (2005). *Hertzian tales: Electronic products, aesthetic experience, and critical design* (2th ed.). Cambridge, MA: The MIT Press.
- Dunne, A., & Raby, F. (2001). *Design noir: The secret life of electronic objects*. London: August.
- Dunne, A., & Raby, F. (2013). *Speculative everything: Design, fiction and social dreaming*. Cambridge, MA: The MIT Press.
- Eames, C., Eames, R., Demetrios, E., Demetrios, L. E., & Mills, S. (Writer) (2000). *The films of Charles & Ray Eames* [DVD]. Chatsworth, CA: Image Entertainment.
- Eikenes, J. (2010). *Navimation. A sociocultural exploration of kinetic interface design* (Doctoral dissertation). Oslo School of Architecture and Design.
- Eltis. (2013). *Ten years London Oyster card—Results and future developments (UK)*. Retrieved from http://eltis.org/index.php?id=13&study_id=4036
- Engelbart, D. (1968). 1968 demo. Retrieved 4 December 2009 from <http://sloan.stanford.edu/MouseSite/1968Demo.html>
- EPoSS & European Commission. (2008). Internet of Things in 2020—A roadmap to the future. Retrieved from http://www.smart-systems-integration.org/public/documents/publications/Internet-of-Things_in_2020_EC-EPoSS_Workshop_Report_2008_v3.pdf
- Feenberg, A. (2010). *Between reason and experience: Essays in technology and modernity*. Cambridge, MA: The MIT Press.
- Feng, P., & Feenberg, A. (2008). Thinking about design: Critical theory of technology and the design process. In P. E. Vermaas (Ed.), *Philosophy and design: From engineering to architecture* (105-119). Dordrecht, The Netherlands: Springer.
- Fernaes, Y., & Sundström, P. (2012). The material move how materials matter in interaction design research. In *Proceedings of the Designing*

- Interactive Systems Conference (DIS '12)*. ACM, New York, NY, USA, 486-495.
- Foth, M. (Ed.). (2009). *Handbook of research on urban informatics: The practice and promise of the real-time city*. Hershey, PA: Information Science Reference.
- Galloway, A. (2004). Intimations of everyday life: Ubiquitous computing and the city. *Cultural Studies*, 18(2-3) 384-408.
- Galloway, A. (2008). *A brief history of the future of urban computing and locative media* (Doctoral dissertation). Carleton University, Ontario, Canada.
- Galloway, A. (2010). Locating media futures in the present. *Aether: The Journal of Media Geography*, 5a: 27-36.
- Galloway, A. (2012). *The interface effect*. Cambridge, UK: Polity.
- Gardiner, M. (2000). *Critiques of everyday life*. London and New York, NY: Routledge.
- Gaver, B., Dunne, T., & Pacenti, E. (1999). Design: Cultural probes. *Interactions*, 6(1) 21-29.
- Gaver, W., Boucher, A., Pennington, S., & Walker, B. (2004). Cultural probes and the value of uncertainty. *Interactions* 11(5) 53-56.
- Graham, S., & Marvin, S. (1996). *Telecommunications and the city: Electronic spaces, urban places*. London: Routledge.
- Graham, S., & Marvin, S. (2001). *Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition*. London; New York, NY: Routledge.
- Graham, S. (Ed.). (2004a). *The cybercities reader*. London: Routledge.
- Graham, S. (2004b). Beyond the 'dazzling light': From dreams of transcendence to the 'remediation' of urban life: A research manifesto. *New Media & Society*, 6(1) 16-25.
- Graham, S., & Crang, M. (2007). Sentient cities. *Information, Communication & Society*, 10(6) 789-817.
- Grand, J., Russell, R., & Syngress Media, Inc. (2004). *Hardware hacking: Have fun while voiding your warranty*. Rockland, MA: Syngress Pub.
- Greenfield, A. (2006). *Everyware: The dawning age of ubiquitous computing*. Berkeley, CA: New Riders.
- Greenfield, A., Shepard, M., & Architectural League of New York. (2007). *Urban computing and its discontents*. New York, NY: Architectural League of New York.
- Greenfield, A. (2013). *Against the smart city* (1st ed.). Do projects. [Kindle edition]. Retrieved from Amazon.com.

- Hall, S. (1980). Encoding and decoding. In S. Hall, et al. (Eds.), *Culture, media, language: Working papers in cultural studies, 1972-79* (128-138). London: Hutchinson.
- Hall, S. (Ed.). (1997). *Representation: Cultural representations and signifying practices*. London: SAGE.
- Hall, S., & Grossberg, L. (2005). On postmodernism and articulation: An interview with Stuart Hall. In D. Morley & K.-H. Chen (Eds.), *Stuart Hall: Critical dialogues in cultural studies* (131-151). London: Taylor & Francis e-Library.
- Hallnäs, L., & Reström, J. (2006). *Interaction design, foundations, experiments*. The Swedish School of Textiles, University College of Borås.
- Harger, H. (Curator). (2013). *Immaterials* [Exhibition]. Brighton, UK: Lighthouse.
- Harootunian, H. (2000). *History's disquiet: Modernity, cultural practice and the question of everyday life*. New York, NY: Columbia University Press.
- Harvey, D. (1989). *The condition of postmodernity*. Oxford, UK: Blackwell.
- Hatzelhoff, L., & Kolar-Thompson, L. (2012). *Smart city in practice: Converting innovative ideas into reality: Evaluation of the T-City Friedrichshafen*. Berlin: Jovis.
- Heller, A. (2005). The three logics of modernity and the double blind of the modern imagination. *Thesis Eleven* 81(5) 63-79.
- Highmore, B. (Ed.). (2001). *The everyday life reader*. London: Routledge.
- Highmore, B. (2002). *Everyday life and cultural theory: An introduction*. London: Routledge.
- Highmore, B. (2009). *The design culture reader*. London: Routledge.
- Highmore, B. (2011). *Ordinary lives: Studies in the everyday*. London: Routledge.
- Hill, D. (2012). *Dark matter and Trojan horses: A strategic design vocabulary*. Strelka Press. [Kindle edition]. Retrieved from Amazon.com.
- Hollings, K., & James, S. (2006). *Welcome to Mars* [Audio podcast]. Retrieved from https://archive.org/details/Welcome_to_Mars
- Hollings, K. (2008). *Welcome to Mars: Fantasies of science in the American century, 1947-1959*. London: Strange Attractor.
- Hwang, J. (2009). u-City: The next paradigm of urban development. In M. Foth (Ed.), *Handbook of research on urban informatics: The practice and promise of the real-time city*, 367-78. Hershey, PA: Information Science Reference.

- Igoe, T. (2011). *Making things talk*. (2nd ed.). Sebastopol, CA: O'Reilly.
- Ihde, D. (2008). The designer fallacy and the technological imagination. In P. E. Vermaas (Ed.), *Philosophy and design: From engineering to architecture* (pp. 51-61). Dordrecht, The Netherlands: Springer.
- Jacobs, J. (2006). *The death and life of great American cities*. New York, NY: Modern Library.
- Johansson, S. (2009). Sniff: Designing characterful interaction in a tangible toy. In *Proceedings of the 8th International Conference on Interaction Design and Children, IDC 2009*, Como, Italy, June 03-05, 2009. ACM, New York, NY (186-189).
- Jones, M. (2009). *Immaterials* lecture at CAT London. Retrieved June 26, 2013, from <http://berglondon.com/talks/immaterials/>
- Julier, G. (2014). *The culture of design* (3rd ed.). Los Angeles: Sage.
- Kay, L. E. (2000). *Who wrote the book of life?: A history of the genetic code*. Stanford, CA: Stanford University Press.
- Kerr, I. (2008). Research and development: Participatory research: Geography: Experimental. In N. Thompson (Ed.), *Experimental geography*. New York, NY: Melville House.
- Kerridge, T. (2009). Does speculative design contribute to public engagement of science and technology? In *Multiple Ways to Design Research: Research Cases that Reshape the Design Discipline. Proceedings of the Swiss Design Network Symposium*. Lugano, Switzerland.
- Kindberg, T., Chalmers, M., & Paulos, E. (2007). Guest editors' introduction: Urban computing. *IEEE Pervasive Computing*, 6(3) 18-20.
- Kinsley, S. (2010). Representing things to come: Feeling the visions of future technologies. *Environment and Planning A*, 42(11) 2771-2790.
- Kinsley, S. (2012). Futures in the making: Practices to anticipate 'ubiquitous computing'. *Environment and Planning A*, 44(7) 1554-1569.
- Kirby, D. (2011). *Lab coats in Hollywood: Science, scientists, and cinema*. Cambridge, MA: The MIT Press.
- Kirby Museum (2011). *Evolution of the Kirby Krackle*. Retrieved on 5 August 2012, from <http://kirbymuseum.org/blogs/simonandkirby/archives/3997>
- Kitchin, R. (1998). *Cyberspace: The world in the wires*. Chichester, UK: J. Wiley.
- Kitchin, R., & Dodge, M. (2011). *Code, space: Software and everyday life*. Cambridge, MA: The MIT Press.

- Klanten, R. (Ed.). (2008). *Data flow: Visualising information in graphic design*. Berlin: Gestalten.
- Klanten, R. (Ed.). (2010). *Data flow 2: Visualizing information in graphic design*. Berlin: Gestalten.
- Klanten, R., Ehmann, S., Schulze, F., Losowsky, A., & Silus, R. (2011). *Visual storytelling: Inspiring a new visual language*. Berlin: Gestalten.
- Knutsen, J. (2014). Uprooting products of the networked city. *International Journal of Design*, 8(1) 127-142.
- Kolarevic, B. (2003). *Architecture in the digital age: Design and manufacturing*. New York, NY: Spon Press.
- Koskinen, I., Binder, T., & Redström, J. (2008). Lab, field, gallery, and beyond. *Artifact*, 2(1) 46-57.
- Koskinen, I., Zimmerman, J., Binder, T., Redström, J., & Wensveen, S. (2011). *Design research through practice: From the lab, field and showroom*. Waltham, MA: Elsevier/ Morgan Kaufmann.
- Kuniavsky, M. (2006). *Sketching in hardware*. Retrieved 7 December 2009 from <http://www.sketching06.com>
- Lane, G. (2003). Urban tapestries: Wireless networking, public authoring and social knowledge. *Personal and Ubiquitous Computing*, 7(3-4) 169-175. doi:10.1007/s00779-003-0229-8
- Latham, A. (2003). Research, performance, and doing human geography: Some reflections on the diary-photograph, diary-interview method. *Environment and Planning A*, 35(11) 1993-2017.
- Latour, B. (1999). *Pandora's hope: An essay on the reality of science studies*. Cambridge, MA: Harvard University Press.
- Latour, B., Hermant, E., & Reed, P. (2004). *Paris: Invisible city*. Retrieved from <http://www.bruno-latour.fr/node/343>
- Latour, B. (2004). Why has critique run out of steam? From matters of fact to matters of concern. *Critical Inquiry*, 30(2) 225-248.
- Lee, J., & Oh, J. (2008). *New Songdo City and the value of flexibility: A case study of implementations and analysis of a mega-scale project*. MS thesis, Massachusetts Institute of Technology, Cambridge, MA, USA.
- Léfèbvre, H. (1991). *The production of space*. London: Blackwell.
- Léfèbvre, H. (1991). *Critique of everyday life, Vol. 1: Introduction*. London: Verso.
- Lindsay, G. (2011). Not-so-smart cities. *New York Times* (24 September). Retrieved 10 May 2012 from <http://www.nytimes.com/2011/09/25/opinion/sunday/not-so-smart-cities.html>

- Löwgren, J., & Stolterman, E. (2004). *Thoughtful interaction design: A design perspective on information technology*. Cambridge, MA: The MIT Press.
- Lynch, K. (1960). *The image of the city*. Cambridge, MA: The MIT Press.
- MacColl, I., Chalmers, M., Rogers, I., & Smith, H. (2002). Seamless ubiquity: Beyond seamless integration, *Proceedings of the Ubicomp 2002 Workshop on Models and Concepts for Ubiquitous Computing*. Göteborg, Sweden: 29.10.2002–1.10.2002.
- Mackenzie, A. (2010). *Wirelessness: Radical empiricism in network cultures*. Cambridge, MA: The MIT Press.
- Mainsah, H., & Morrison, A. (2013). Towards a manifesto for methodological experimentation in design research. In *Proceedings of NORDES 2013. Experiments in Design Research: Expressions, Knowledge*, Critique. Copenhagen/Malmö.
- Malpass, M. (2013). Between wit and reason: Defining associative, speculative, and critical design in practice. *Design and Culture*, 5(3) 333-356.
- Martinussen, E., Knutsen, J., & Arnall, T. (2007). Bowl: Token-based media for children. In *Proceedings of the 2007 Conference on Designing For User Experiences* (Chicago, Illinois, November 05–07, 2007). DUX'07. ACM, New York, NY, 3-16.
- Martinussen, E., & Arnall, T. (2009). Designing with RFID. In *Proceedings of the 2009 Conference on Tangible and Embedded Interaction*. TEI '09. Cambridge, UK: 16.02.2009–18.02.2009. Available: <http://dl.acm.org/citation.cfm?id=1517734>
- Martinussen, E., Knutsen, J., & Arnall, T. (2014). Satellite lamps. *Kairos: A Journal of Rhetoric, Technology, and Pedagogy*, 19(1). Retrieved from <http://kairos.technorhetoric.net/19.1/inventio/martinussen-et-al/>
- Martinussen, E. (2012a). Making material of the networked city. In M. Hensel (Ed.), *Design innovation for the built environment* (235-247). London & New York, NY: Routledge.
- Martinussen, E. (2012b). *Sherlock and WiFi*. Retrieved from <http://www.voyoslo.com/2012/01/sherlock-and-wifi/>
- Martinussen, E. (2012c). *Visualising WiFi for the masses*. Retrieved from <http://yourban.no/2012/06/01/visualising-wifi-for-the-masses/>
- Martinussen, E. (2013). Pockets and cities: Interaction design and popular imagination in the networked city. *Design and Culture*, 5(3) 289-312.
- Mazé, R., & Redström, J. (2009). Difficult forms: Critical practices of design and research. *Research Design Journal*, 1(1) 28-39.

- McCloud, S. (1994). *Understanding comics: The invisible art*. New York, NY: HarperPerennial.
- McCullough, M. (2004). *Digital ground: Architecture, pervasive computing, and environmental knowing*. Cambridge, MA: The MIT Press.
- McCullough, M. (2006). On the urbanism of locative media [Media and the city]. *Places*, 18(2) 26-29.
- McCullough, M. (2013). *Ambient commons: Attention in the age of embodied information*. Cambridge, MA: The MIT Press.
- McGuigan, J., & Downey, J. (1999). *Technocities: The culture and political economy of the digital revolution*. London: SAGE Publications.
- Merrifield, A. (2000). Henri Lefebvre—A socialist in space. In M. Crang & N. Thrift (Eds.), *Thinking space* (167-182). London: Routledge.
- Michael, M. (2006). *Technoscience and everyday life: The complex simplicities of the mundane*. Maidenhead, UK: Open University Press.
- Michael, M. (2012). Anecdote. In C. Lury & N. Wakeford (Eds.), *Inventive methods: The happening of the social*. London: Routledge.
- Microsoft. (2011). Productivity future vision. Microsoft Office Videos, YouTube channel, 25 October. Accessed 10 May 2012 from <http://www.youtube.com/watch?v=a6cNdhOKwi0>
- Mitchell, W. J. (1999). *E-topia: Urban life, Jim—But as we know it*. Cambridge, MA; London: The MIT Press.
- Mitchell, W. J. (2004). *Me++: The cyborg self and the networked city*. Cambridge, MA; London: The MIT Press.
- Mitchell, W. J. (2005). *Placing words: Symbols, space, and the city*. Cambridge, MA: The MIT Press.
- Moggridge, B. (2007). *Designing interactions*. Cambridge, MA: The MIT Press.
- Moran, J. (2004). History, memory and the everyday. *Rethinking History*, 8(1) 51-68.
- Moran, J. (2005). *Reading the everyday*. London; New York, NY: Routledge.
- Morrison, A., & Sevaldson, B. (2010). 'Getting going'—Research by design. *FORMakademisk*, 3(1) 1-7.
- Morrison, A. (2010a). Views From the Inside Out. In A. Morrison (Ed.), *Inside Multimodal Composition* (3-26). Cresskill: Hampton Press.
- Morrison, A. (2010b). Scramble in a Conceptual Toolbox. In A. Morrison (Ed.), *Inside Multimodal Composition* (27-64). Cresskill: Hampton Press.
- Morrison, A., & Arnall, T. (2011). Visualizations of digital interaction in daily life. *Computers and Compositions*, 28(3) 224-234.

- Morrison, A., Arnall, T., Knutsen, J., Martinussen, E., & Nordby, K. (2011). Towards discursive design. In *Proceedings of IASDR2011, 4th World Conference on Design Research*. Delft, The Netherlands: 31.10.2011–04.11.2011.
- Morrison, A., Aspen, J., Hammersam, P., Sem, I., & Havnør, M. (2012). Designing experimental urban mapping with locative social media. In *Proceedings of Design Research Society 2012 Conference*. Chulalongkorn University, Bangkok, Thailand: 01.07.2012–04.11.2012.
- Morrison, A., Tronstad, R., & Martinussen, E. (2013). Design notes on a lonely drone. *Digital Creativity*, 24(1) 46-59.
- Murray, J. H. (2012). *Inventing the medium: Principles of interaction design as a cultural practice*. Cambridge, MA: The MIT Press.
- Negroponte, N. (1995). *Being digital*. New York, NY: Knopf.
- Newman, G., Duffy, C., Powell, A., Gray, R., & Locklin, J. (2012). *Position paper on electromagnetic hypersensitivity*. Retrieved from <http://www.badsciencewatch.ca/wp-content/uploads/2012/08/BSW-Anti-WiFi-2012-Position-Paper-UPDATED-Jan-27-2013.pdf>
- Nordby, K. (2011). *Between the tag and the screen* (Doctoral dissertation). Oslo School of Architecture and Design.
- Norman, D. (1999). *The design of everyday things* (Revised and expanded edition). New York, NY: Basic Books.
- Norman, D. (1999). *The invisible computer: Why good products can fail, the personal computer is so complex, and information appliances are the solution*. Cambridge, MA: The MIT Press.
- Nye, D. E. (1997). *Electrifying America: Social meanings of a new technology, 1880–1940*. Cambridge, MA: The MIT Press.
- O’Connell, P. (2005). Korea’s high-tech utopia, where everything is observed. *New York Times* (5 October). Retrieved 10 May 2012 from: <http://www.nytimes.com/2005/10/05/technology/techspecial/05oconnell.html?pagewanted=all>
- Paulos, E., Anderson, K., & Townsend, A. (2004). UbiComp in the urban frontier. *Human-Computer Interaction Institute*.
- Paulos, E., & Jenkins, T. (2005). Urban probes: Encountering our emerging urban atmospheres. In *Proceedings of the 2005 Conference on Computer Human Interaction (CHI)*, 341-350. Portland, Oregon, USA: 2.4.2005–7.4.2005.
- Ratto, M. (2011). Critical making: Conceptual and material studies in technology and social life. *The Information Society*, 27(4) 252-260.

- Reeves, S., Pridmore, T., Crabtree, A., Green, J., Benford, S., & O'Malley, C. (2006). The spatial character of sensor technology. In *Proceedings of the 6th Conference on Designing interactive Systems*. New York, NY: ACM. 31-40.
- Repko, A. F. (2012). *Interdisciplinary research: Process and theory* (2nd ed.). Los Angeles: SAGE.
- Roth, C., Kang, S., Batty, M., & Barthélemy, M. (2011). Structure of urban movements: Polycentric activity and entangled hierarchical flows. *PLoS ONE* 6(1) e15923. doi:10.1371/journal.pone.0015923
- Sadler, S. (2001). *The Situationist city*. Cambridge, MA: The MIT Press.
- Saffer, D. (2013). *Microinteractions*. Beijing: O'Reilly.
- Sanders, E. B.-N., & Stappers, P. J. (2012). *Convivial design toolbox: Generative research for the front end of design*. Amsterdam: BIS.
- Satyanarayanan, M. (2002). A catalyst for mobile and ubiquitous computing. *IEEE Pervasive Computing* 1(1) 2-5.
- Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York, NY: Basic Books.
- Schulze, J. (2009). The ghost in the field. *berglondon.com*. Retrieved from <http://berglondon.com/blog/2009/10/12/the-ghost-in-the-field/>
- Scott, J. C. (1998). *Seeing like a state: How certain schemes to improve the human condition have failed*. New Haven, CT: Yale University Press.
- Seago, A., & Dunne, A. (1999). New methodologies in art and design research: The object as discourse. *Design Issues*, 15(2) 11-17.
- Sengers, P., Boehner, K., David, S., & Kaye, J. (2005). Reflective design. In *Proceedings of the 4th Decennial Conference on Critical Computing: Between Sense and Sensibility*, 49-58. Aarhus, Denmark, 21.8.2005-25.8.2005.
- Sennet, R. (2012). The stupefying smart city. In R. Burdett & P. Rode (Eds.), *Urban age electric city* (16-18). London: LSE Cities.
- Sevaldson, B. (2010). Discussions & movements in design research. *FORMakademisk*, 3(1) 8-35.
- Shaer, O., & Hornecker, E. (2010). Tangible user interfaces: Past, present, and future directions. *Human-Computer Interaction vol. 3* (1-2).
- Sheringham, M. 2006. *Everyday life: Theories and practices from surrealism to the present*. Oxford, UK: Oxford University Press.
- Singer, N. (2012). Mission control, built for cities. *New York Times*. Retrieved 10 May 2012 from <http://www.nytimes.com/2012/03/04/business/ibm-takes-smarter-cities-concept-to-rio-de-janeiro.html?pagewanted=all>.

- Slack, J. D., & Wise, J. M. (2005). *Culture + technology: A primer*. New York, NY: Peter Lang.
- Sparke, P. (2013). *An introduction to design and culture in the twentieth century* (3rd ed.). London: Routledge.
- Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science*, 19(3) 387-420.
- Star, S. L. (1999). The ethnography of infrastructure. *American Behavioral Scientist*, 43(3) 377-391.
- Storey, J. (2012). *Cultural theory and popular culture: An introduction* (6th ed.). London & New York, NY: Routledge.
- Thompson, S. (Writer), & Haynes, T. (Director). (2012). The Reichenbach Fall [Television series episode]. In Gatiss, M. & Moffat, S. (Created by), *Sherlock*. London, UK: BBC.
- Thrift, N., & French, S. (2002). The automatic production of space. *Transactions of the Institute of British Geographers*, 27(3) 309-335.
- Thrift, N. (2004a). Remembering the technological unconscious by foregrounding knowledges of position. *Environment and Planning D: Society and Space* 22(1) 175-90.
- Thrift, N. (2004b). Cities without modernity, cities with magic. In S. Graham (Ed.), *The cybercities reader* (98-101). London: Routledge.
- Townsend, A. M. (2013). *Smart cities: Big data, civic hackers, and the quest for a new utopia*. New York, NY: W. W. Norton.
- Tufte, E. (1997). *Visual explanations: Images and quantities, evidence and narrative*. Cheshire, CT: Graphics Press.
- Vallgård, A., & Redström, J. (2007). Computational composites. *Proceedings from the Conference on Human Factors in Computing Systems*, San José, CA, USA.
- Vallgård, A. (2009). *Computational composites: Understanding the materiality of computational technology*. (Doctoral dissertation). IT University of Copenhagen.
- Van Loon, J. (2002). Social spatialization and everyday life. *Space and Culture*, 5(2) 88-95.
- Virilio, P. (1993). The third interval: A critical transition. In V. A. Conley (Ed.), *Rethinking technologies* (pp. 3-12). Minneapolis: University of Minnesota Press.
- Ward, M., & Wilkie, A. (2009). Made in criticalland: Designing matters of concern. *Networks of Design: Proceedings of the 2008 Annual*

- International Conference of the Design History Society (UK) University College Falmouth, 3-6 September, 118-123. Universal Publishers.*
- Weiser, M. (1991). The computer for the 21st century. *Scientific American* (Special Issue on Communications, Computers, and Networks).
- Wellman, B., & Haythornthwaite, C. A. (2002). *The Internet in everyday life*. Malden, MA: Blackwell.
- Wilding, M. (Writer), & McKidd, K. (Director). (2011). Don't deceive me (Please don't go) [Television series episode]. In Beers, B. (Executive producer), *Grey's anatomy*. New York, NY: American Broadcasting Company.
- Williams, R. (2013). *The long revolution*. New York, NY: Parthian Books. [Kindle edition]. Retrieved from Amazon.com
- Williams, R. (2002). Culture is ordinary. In B. Highmore (Ed.), *The everyday life reader* (91-99). London & New York, NY: Routledge.

Article 1

Article 1, 'Depth of Field: Discursive Design Research through Film' (Arnall & Martinussen, 2010), is published online as a pdf with embedded films in the journal *FORMakademisk* (formakademisk.org). All films in the article are clickable links to the online film-files.

The full digital version of the article can be accessed at:

<https://journals.hioa.no/index.php/formakademisk/article/view/189/185>

Timo Arnall & Einar Sneve Martinussen

Depth of Field

Discursive design research through film

Abstract

This article is about the role of film in interaction and product design research with technology, and the use of film in exploring and explaining emerging technologies in multiple contexts. We have engaged in a reflective design research process that uses graphical, audiovisual, and time-based media as a tool, a material and a communicative artefact that enables us to approach complex, obscure and often invisible emerging technologies. We give a discursive account of how film has played an intricate role in our design research practice, from revealing the materiality of invisible wireless technology, to explaining complex technical prototypes, to communicating to a public audience through online films that may fold broader social and cultural discourses back into our design research process. We conclude by elaborating on discursive design approaches to research that use film as a reflective and communicative medium that allows for design research to operate within a social and cultural frame.

Keywords: interaction design, product design, discursive design, emerging technologies, RFID, film, reflective, communication, mediation.

Introduction

In the last decade, interaction design has found itself in a rather unique position. As an interdisciplinary field, drawing upon many domains such as Human Computer Interaction (HCI), product and graphic design, informatics, art, engineering and critical practice, it has grown the potential to situate itself in a critical position between emerging technologies and culture. In particular, there are emerging modes of doing exploratory design research that result from the newfound relations between product, interaction and communications design.

In this article we discuss our design research activities that use film as a material for exploring, conceptualising and communicating with emerging technology. We analyse this through existing framings of audiovisual media in HCI, technology, and interaction design research. The central research question we address is how does audiovisual media enable new kinds of practice-based design research with emerging technology?

In posing this question several others also arise. How might designers use and shape audiovisual media to support processes of understanding and conceptualising with emerging technology as part of their practice? And what opportunities do audiovisual media open up for design in explanation and communication within a broader social and cultural context?

The article develops two main aspects: film as a material in communicating and conceptualising new technology and the role of film as a tool in the design research process. The concept of depth of field here opens up three things for us. First, we investigate the boundaries between the field of design research and the critical conceptualisation of technology. Secondly, in our design practice we use film to probe the depth and materiality of emerging and often invisible technologies. Third, depth of field is one of the cinematic qualities of film that is used here to both communicate about technology, and to help understand the role of audio-visual mediation in the design and development of technological products.

Film is a communication media that involves audiovisual representations that have immersive and experiential qualities, and that can be very selective in conveying and framing subject matter. By using film, we imply a mode of production and display that involves cinematic qualities such as genre, narrative and cinematography, not simply video as a tool

for documentation or analysis, but film as a purposeful, constructed, designed and directed experience.

Seven short films are included within this text. They have been produced over several years as an integrated part of our research. They are embedded in the article where they form topics and construct a path through the research as is argued for example in the field of visual rhetoric and through the genre of the visual essay or 'pictorial texts' (e.g. Mitchell, 1994).

The films are thus meant to be watched at critical points in the text where they act as both cases and arguments. We analyse these films through addressing their role in unpacking, conceptualising and visualising emerging technology, how the films themselves provide us with new design materials, and by looking at their role in communicating about technology on both an explanatory and experiential level.

Background

Research in interaction design builds knowledge around the concepts and practices involved in creating and using interfaces that mediate between people and computational systems. Interaction design research has drawn much from research in technology and informatics, but has expanded from its early technologically centred remit (e.g. Bagnara & Crampton-Smith, 2006) and developed approaches and theories such as those of critical design, user-centred design, reflective design and experience design. These are attempts to theorise around the rapid changes brought about by the emerging technological media in which design work takes place and in which designed interfaces are experienced (e.g. Redström, 2001). Today interaction design encompasses a broad set of approaches to technology and ubiquitous computing, user interfaces, tangible and embodied interaction, as well as media and communication design (e.g. Poggenpohl, 2006).

Our take on interaction design draws on a purposefully broad range of contexts and approaches from HCI, product, graphic design and visualisation, media, communication and also from particular approaches to prototyping and crafting with electronics and software. Our communicative design research methods are aimed at exploring emerging technologies that work from a design informed position with distinct qualities of hands-on making and form-giving, where tangible materials and prototypes are formed alongside visualisation and other mediating processes.

RFID and ubiquitous computing

This design research emerges from a project called Touch that investigated an emerging technology called Radio Frequency Identification (RFID). At its simplest RFID offers a wireless method for identifying objects at a distance, using small, battery-less RFID 'tags' that can be embedded inside products, objects and environments. RFID is rapidly emerging and is already implemented on a large scale in logistics and asset tracking, access control, security, and ticketing such as London's 'Oyster card'. The research discourse around RFID is often driven by powerful economic interests and focuses on utilitarian and industrial applications (eg. DeVries, 2008), the optimisation of tags, readers and infrastructures (eg. Dontharaju et al., 2009). Privacy and security are an important part of the public debate around RFID (e.g. Albrecht & McIntyre, 2005) and research is concerned with privacy and security policy (eg. Garfinkel & Rosenberg, 2005). The popular understanding of RFID is often coloured by fundamental misunderstandings largely created by mass-media representations that are very different from actual physical characteristics of the technology (Poole et al., 2008). The most common 'folk' theory about RFID is that tagged people or objects can be read from great distances, enabling governments and corporations to track people's everyday lives.

These dominant research and popular discourses around RFID rarely address the design of RFID interactions and products outside of utility and industrial contexts, or engage

with the public understanding of the technology. We position our research outside these dominant approaches to RFID. We do so in order to address a more nuanced view on the challenges and possibilities of RFID and this demands that we unpack the material of the technology, and that we re-frame it in a way that it can be designed, shaped and critiqued.

Already widely used in the world, it is important to understand how RFID is seen as a prototypical ubiquitous interface technology. It is located within a broader frame of research from 'ubiquitous computing' or ubicomp first developed by Mark Weiser at Xerox PARC in the late 1980s. Ubicomp describes a post-desktop computing paradigm where technologies 'weave themselves into the fabric of everyday life until they are indistinguishable from it' (Weiser, 1991: 1).

Contemporary ubicomp research includes alternative perspectives such as tangible and embodied interaction (Dourish, 2001), social and cultural issues (Galloway, 2004), user experience and society (Greenfield, 2006) and the concept of seamfulness which works towards active, engaged interaction rather than the dominant visions of seamless and ambient computing (Chalmers & Galani, 2004). An influential account of ubiquitous technology criticises the ever-shifting 'proximate future', where technologies are always 'just out of reach' despite the fact that many aspects of ubiquitous computing are already intertwined into society, culture and contemporary everyday practices (Bell & Dourish, 2007).

The dominant approach to ubicomp has been directed towards visions of a near-future of ambient, calm, invisible technology, with a discourse of miniaturisation, invisibility and 'disappearance' (Norman, 1999). Invisibility is a critically important issue for RFID, where it is not only conceptually obscure, but invisibly embedded inside products, and through interaction, generating obscure data in databases that are often outside user control. In our research, we address the issues of invisibility by focusing on visualising the tangible and spatial qualities of the technology itself and by contextualising it through embedding it in products and interactions where RFID offers opportunities for physical-world interaction embedded in everyday objects (Martinussen & Arnall, 2009). These multiple viewpoints reveal a complexity in the field and ubicomp represents an entirely new set of design materials, applications and implications that need to be explored.

Mediating technology

There is a need for design research to engage with emerging technologies like RFID in order to build knowledge that encompasses theoretical, critical, reflective and practical approaches to the technology. In addition, there is a need to understand the critical processes of translation between emerging technology and the popular cultural imagination. In a landscape dominated by powerful technology-push, is there a way for design to uncover and communicate the potential for human qualities, playfulness and sensitivity to materials and context?

Historically, film has been a central part of the communication of new technology with interfaces being mediated through film or video demonstrators. From televised events showing off household robotics at the 1939 New York World Fair to the invention of modern computing paradigms such as the mouse – in Engelbart's 'Mother of all demos' (Engelbart, 1968; Moggridge, 2007).

Products too are often initially experienced through cinematic forms, from lifestyle commercials for Sony televisions, to explanatory 'how to' informercials for the Apple iPhone, to user-generated 'unboxing' videos on YouTube. These forms include advertising and consumer marketing strategies, but also explanatory modes. The commercial film for the Polaroid SX-70 camera, directed by Charles and Ray Eames in 1972 (Eames Office, 2000), is a fine example from design practice of new technology explained to the masses through a product commercial, conveying technology and experience combined into one form. The

relations between scientific advance and cinema are extremely close. Kirby demonstrates how film establishes achievability of scientific and technical discourses, and ‘cinematic depictions of future technologies demonstrate to large public audiences a technology’s need, viability and benevolence’ (Kirby, 2010: 41).

In the Touch project we have attempted to meet these challenges and opportunities for interaction design research via a broad socio-cultural approach to technology. This approach sees technologies as part of a wider social and culturally situated perspective and how they are taken up, adapted and adopted in contexts of design, testing, use and revision. Important here for design research that involves digital materials, processes and communication is the concept of mediation (Vygotsky, 1978). Mediation helps us to frame activities that involve designers in inquiry with a subject-matter that are directly and indirectly related through an artefact or a tool. In a socio-cultural perspective on design, interaction and communication, mediation allows us to get at the interplay of cultural codes and symbolic significations and the tools and technologies within which they are realised. However, this is a two way process. Tools and technologies also influence how we design, work and communicate so that finding out about their properties, affordances and constraints is also revealed through the activities of designing and the design of emerging products and services. The artefacts we design in the context of emerging digital technologies also convey their compositional and communicative character as mediating artefacts. Wartofsky sorts artefacts at three levels: primary artefacts are tools used directly in human activities (Wartofsky, 1979). Secondary artefacts are ‘symbolic externalizations’ or ‘objectifications’ of primary artefacts. Tertiary artefacts are abstracted from the function of secondary artefacts. At this third level, mediating artefacts are abstract and conceptual: they are no longer concerned with plain representationality but move into the realm of imagination. Here artefacts become powerful forces for transformation, embodying vision and potential. In the context of our research, we can discuss our design practices and research perspectives through artefacts like prototypes and products, and through representational artefacts like films that are both able to articulate concepts, potentials and visions for emerging technologies.

The films we include are examples of this as artefacts that mediate complex intersecting activities (Engeström, 2010) and various layers of design and communication. The films also ‘speak’ from several positions. These filmic artefacts are conceptualised and communicated at the level of artefact as tool and sign, but they are also artefacts of mediation. They encompass different disciplinary knowledge of RFID as technology, as interactive material and as culturally resonant media. At the level of articulation in discourse, they also interlace different conventions and stylistics that are realised through our own varied expertise in film, advertising, graphic, interaction and product design. In summary, following Hahn and Gregory (2007) mediating artefacts are constructed and invested with meaning in complex relationships among other objects by conceptualizing and reorganizing particulars. In this project we have reframed RFID technology through the tools of interaction design with a communicative intent, and explored the limits and edges of what the technology lets us do in design.

Frameworks

Within the discourses of emerging ubiquitous technology, we adopt a research by design approach that draws on a number of conceptual and theoretical frameworks in designing, analysing and reflecting. Below we go through some of the concepts we use and situate the filmmaking activity within practice-based design research. The contexts for this work are numerous and inherently multi-layered, so in order to discuss the films we must bring together a network of theories to provide frameworks for analysis. We define existing frameworks that are useful for analysing our practice-based design work, our material

approaches, the experiential and exploratory prototyping, and the propositional, discursive design artefacts themselves.

Critical design

In conducting research with emerging technologies the practices and approaches within critical design define an important set of design tools and analytical means. The term 'critical design' was introduced in Anthony Dunne's book *Hertzian Tales* (Dunne, 2005) and describes a design process that use speculative design proposals to challenge assumptions, preconditions and givens in technological systems (Dunne & Raby, 2007). Critical design can be defined as a form of design that uses the processes, tools and languages of product and interaction design to not solve or resolve problems, but to critically rethink the parameters of the problem area itself (Mazé & Redström, 2007). Critical design is currently being contextualised and developed with a focus on critical practice in design research where 'a pragmatic conception of reflection is extended as a critical modality - to question and transform rather than only describe and affirm' (ibid: 10). Critical design, therefore, provides an analytical stance and design approaches for exploring, conceptualising and communicating around emerging technologies. Mediation through photography and film is central in critical design practice. Dunne writes about 'the design object as prop':

By abandoning the technical realism of the prototype and the visual realism of the traditional industrial design model, conceptual models in combination with other media, can refer to broader contexts of use and inhabitation. For instance, by using conceptual models as film props the viewer can be drawn into the conceptual space of the object in use rather than an appreciation of the thing in itself. (Dunne, 2005: 92).

Here we need to broaden the concept of 'design object' to include film props and other conceptual objects like traditional design models, working prototypes and technical probes, but also to consider the conceptual space of film as a design object in itself.

The concept of critical design is central to our process and position on technology and design research. Seago and Dunne describes the key methodological factor in critical design research as "using the process of invention as a mode of "discourse", a poetic invention that, by stretching established conventions, whether physical, social, or political, rather than simply affirming them, takes on a radical critical function, a material critical theory, or what Dunne terms a 'parafunctionality' (Seago & Dunne, 1999: 17). In the context of ubiquitous technology, this 'radical critical function' of design can be describes as "a critical medium for reflecting on the cultural, social, and ethical impact of technology" (Dunne, 2005: xii). Critical design in the field of RFID could address the conventions of the technology both on a instrumental and technical level by re-conceptualising the interactional and experiential possibilities of the technology, and on a social and cultural level by challenging and re-contextualising RFID in a broader public discourse. In this sense we have to see critical design in the bigger picture of technology, culture and media.

The research we report on takes place in the context of internet media where our work is mediated through online 'social' channels and connections (Shirky, 2008; Boyd, 2008). Much of the impetus for the research comes from the motivation to participate in public discourse, and the ability to use media as a way of conducting 'design probing' (Gaver et al. 1999) that uses various media forms to uncover and explore various latent perspectives and attitudes. This has been particularly important when working with a rapidly emerging technology as controversial and misunderstood as RFID. The dissemination of the research work through film has been part of the motivation for doing explorative design research in this area. When design research is mediated through online social media, online film can used as a 'boundary object' (Star & Griesemer, 1989) that can inscribe complex and difficult aspects of design research in a broad public discourse. Star and Griesemer (1989) introduced

the concept of boundary objects to describe objects that can be used to translate between fields or contexts and are 'both adaptable to different viewpoints and robust enough to maintain identity across them' (1989: 1). When designed media artefacts act in an online social media context, they are embedded into diverse mediational forms such as news, blogs and discussions forums, where they are used to support and discuss many perspectives and viewpoints.

Our overall approach uses film to mediate design artefacts and to build upon critical design approaches to problematise RFID. These films may then be put into a public domain to raise debate and with different participants/audiences. They have the potential to create and direct the discourses around emerging technology through the boundary objects of the films. These approaches from critical design contribute to a discursive mode of design research that connects to making and knowing, and to mediation and communication.

In our view, the mediating aspects of critical design are crucial, and must be explored beyond the art-centred forms of mediation that currently dominate critical design. We seek to do this by using film and online media as our central strategy in a discursive design take on research by design to communicate design research towards both technology and design communities, and a broader public. By emphasising the communicative activity of our design research, together with a reflective and explorative approaches of critical design, we seek to develop a practice of discursive design. This practice is also informed by reference to research into media and rhetorics of online discourse.

Research through interaction design

In interaction design the move towards computing that is embedded in everyday life has influenced new modes of embodied interaction that occupy a world of physical and social reality (Dourish, 2001:3). Interaction design has traditionally worked with situated forms such as wireframes, diagrams and screen-based prototypes (e.g. Landay & Myers, 2001), but when interfaces are ubiquitously spread across the physical world, we need new ways of sketching and visualising, that place greater emphasis on the body, time and space. Non-screen-based tangible interaction takes place outside of traditional confines of desktop computing and means that designers must work with complex networks of sensors, embedded computation and actuation (Igoe, 2007). In order to conduct these design explorations, we have needed to build knowledge around new technological materials, and develop new tools and techniques for practising design such as 'sketching in hardware' (Kuniavsky, 2006). However, design practice with tangible interactions is still relatively new, often requiring lengthy-development cycles that still rely heavily on technical knowledge of hardware and software that can be far removed from the design of user experiences (Klemmer et al., 2004). In order for designers to communicate about and through tangible interactions, there is a need for design research to develop new tools for sketching, rapid prototyping and visualisation that more fully account for the design of interactive experiences in these new contexts.

In our investigations into RFID, we situate ourselves in a process of research by design and practice through research as described by Sevaldson (2010). In research by design the design practice is a theory building activity: engaging ourselves as design practitioners in generative design activities where our 'investigations are conducted within a first person perspective combined with a reflexive mode making design knowledge explicit' (Sevaldson, 2010: 2). Here design engages in a research enquiry that opens up for generative, explorative and innovative approaches. This view draws upon both Schön in the formulation of reflection in action (Schön, 1983), and in the ability to generate knowledge in a bottom-up, explorative investigations of material and phenomena. In research by design we place ourselves as distinct from the kind of knowledge building found in 'traditional' sciences, in that our inquiry is not about hypotheses, problems and problem-solving. Instead, it is oriented

towards exploration and moves towards generative discovery, and towards desirable surprises (ibid). In practice through research we consider that our design practice - which is funded by research and has been practiced outside of commercial or client-based constraints - has been conducted in order to build abstracted or generalised knowledge of emerging technologies. This mode of knowledge building uses design activities to explore a particular domain, where the research is conducted through practical design experiments and explorations.

Design material

Design has a tradition of working closely with materials in shaping and constructing experiences. Schön (1983) describes design as a physical conversation with materials, and concentrates on the ways in which materials 'talk back' as part of this dialogue. But technology has introduced new complexity into this relationship, introducing time, multi-dimensional interactive relations and various highly complex and invisible components that are very hard to grasp for designers. Vallgård and Redström (2007) see technology as a set of 'composite' digital materials that are likened to physical materials in architecture and design, pointing towards the often overlooked and pressing need to address the actual fundamental physical and spatial aspects of ubiquitous technologies. The spatial characteristics of sensing systems have a direct impact on the qualities of the interaction and the physical form of digitally augmented products (eg. Reeves et al. 2006). Nordby (2010) sees technological material as an important element of early phase conceptual design, where conceptual designs are often developed in tandem with new materials, and where designers need to understand materials in order to inspire new solutions. As well as treating RFID as a new material, the Touch project has also used the new opportunities and constraints offered by audiovisual media within its' design practice.

There is also a need to understand film as a design material, and reflect on the ways in which the material/medium of film operates within design research. At one level, film inscribes a mode of representation that involves time, audiovisual media, and a form that requires attentive and immersive engagement from an audience. To produce film requires literacy in cinematic form, such as formal narrative and nonnarrative construction, film style, editing and characterisation that are often developed and adapted from or contrasted with the classical Hollywood model (Bordwell & Thompson, 2007). At an instrumental level, film production can involve scripting, dialogue, visualisation, storyboarding, shooting, animation, editing, compositing, layering, motion graphics and special effects (Katz, 1991; McClean, 2008). Cinematic materials may include props, lighting, sets, sound, grading or colour balance, film stock or video format, shutter speed, frame rate, depth of field, sharpness and resolution. Here film offers a compositional space, where for instance we might shoot physical props and environments that define the space on the screen as 'real'. Special effects technologies may then be used to increase the expressive and manipulatable space of film, allowing for 'real' spaces and representations of 'physical' objects to be manipulated through software in what Manovich calls a 'metamedium' (Manovich, 2007). These are all part of the manipulatable 'materials' in the repertoire of moving image tools.

Film in interaction design

Film has lent itself to being used in multiple ways within design processes. This ranges from low-fidelity documentation and reflection (Ylirisku & Buur, 2007), enactment through video such as Sketch-a-move by Jain & Klinker (in Buxton, 2007: 321) to high-level experience prototyping of pervasive computing experiences (Halskov & Nielsen, 2006).

The use of film and video has been well documented from interaction design and HCI research, where video is used as part of an interaction design 'toolbox' to capture, document and communicate user-studies as part of a user-centred design process. Film is also well

understood as a prototyping tool, where the techniques for audiovisual, time-based representation are instrumentally important in communicating the spatial, social, tangible, embodied and time-constrained nature of interactive systems.

Ylirisku and Buur (2007) see video as a critical component in user-centred design and innovation processes. They depict video as a documentation tool to edit events, enactments, activities and social interactions as well as a way of facilitating collaboration and 'meaning making' processes in design. In 'design documentaries' (Raijmakers et. al. 2007) the focus is on observation and compilation of activities in everyday life in the 'discovery research' phase of a design process. Bonanni and Ishii (2009) use stop-motion animation to foster 'collaboration, legibility and rapid iterative design' when prototyping tangible interactions, and find that the medium inherently highlights the constraints of the body, space and materials. Halskov and Nielsen (2006) explore the use of video production in the design process that they call 'virtual video prototyping'. This involves both live-action filmmaking and the use of virtual 3D sets as tools for prototyping and enacting proposed interfaces. They see that 'the strongest argument for using this medium has been that it has been able to create an illusion of an idea without having to go into technical detail' (Halskov & Nielsen, 2006: 225). For these designer-researchers 'the communicative power stems from the high degree of realistic presentation of concrete situations in a story-driven rather than a technology-driven way' (Halskov & Nielsen. 2006: 226). They also highlight the problems of lengthy post-production processes as one of the limiting factors of video prototypes.

The films below demonstrate some of these approaches to film in discovery, prototyping, experimentation and evaluation. But for us there are many perspectives on film in interaction design that are not necessarily about empirical investigations or documentary representations. Within a research by design process, film may also reveal and articulate complex subjects, through multiple genres, and for multiple audiences. In a discursive design approach, we may be able to explore emerging technologies through still applying critical design approaches that involve play, invention, imitation, parody and irony, in ways that may be able to reveal and translate across many socio-cultural contexts.

Interaction design has developed methods of conceptualising and representing user experience, in practices such as 'experience prototyping' (Buchenau & Suri, 2000) and 'experience design' (Shedroff, 2001) allow for the tangible enactments and communication of experiences as part of a design activity. The audiovisual, time-based material of film opens up for experiential representations where objects, actors (or users) are typically situated in 'natural' sets or environments which reinforces the constraints of time, space and the body. In design research these experiential representations open up potential for the mediation of designed user-experiences in ways that may not be possible through other static visual, textual or verbal forms.

Graphic and information design offer tools and practices that can abstract complex systems and phenomena into knowable, visual artefacts. As shown in the rich graphic histories presented by Tufte (1997), there is a strong tradition in graphic design of making accessible visual representations of complex and multi-faceted information. The repertoire of graphic and information design have recently broadened to include time and motion, which can be seen in the 'motion graphics' that have become commonplace in broadcast news (Krasner, 2008). Film opens up for kinds of explanatory modes of communication within interaction design. Just as the Eames' were able to explain the radical change in photography brought about by Polaroid technology, we are able to use film to reveal and explain the intricacies of interactive and ubiquitous technologies. As increasingly complex and 'invisible' technologies emerge into the world, we see the need for a greater understanding of ways that the visual, cinematic qualities of film can be used to communicate experiential and explanatory perspectives on technology.

Research in many domains is beginning to accept the move towards a multi-media culture. Within studies of culture and technology, new media and digital art in a 'technology-engaged' world is being examined (Murphie & Potts, 2003), while studies of visual digital culture explore the relationships between digital technologies and media is with a focus on new forms of spectatorship within mass culture and new digital visual forms (Darley, 2000).

There is also a small but growing section of research that involves multi-mediational forms as part of their research dissemination, such as the refereed online journal *Kairos*. The dominant form of research, however, is still textually logocentric. We are having to tread new ground, even as interaction designers, to be able to use video as part of this research argumentation and scholarly publication.

Design activities

The Touch project has consisted of a small team of design researchers with a broad set of skills collaborating in conceptual and practical processes of developing concepts and detailed design outputs. We have approached technology as designers, in a collaborative design studio setting that allows for exploration, divergent paths and iterations. The team's talents and backgrounds include interaction and product design, programming, film, advertising and media. In this process we have valued hands on making and material explorations in developing a design literacy with material. This brings together a varied set of skills and design-tools such as creative methods, sketching, the detailed design and fabrication of product and prototypes, development of electronics and software, graphic design, motion-graphics and film-making.

The designed objects presented in the films emerged from an iterative process of conceptual and practical designing, making and testing that draw on product and interaction design methods, but these objects and products are also created with a focus on how they are going to be presented through audiovisual media. The process of production helps in the forming of conceptual frameworks, as complex ideas need to be tuned and refined in order to communicate them. The films were made with attention to communication, style and genres through a process of scripting, set-building, lighting, and post-production processes of editing, motion-graphics and special effects. Some of the films have a focus on presenting products that have already been designed, while others are generated from scripts to present specific concepts.

Many of the issues raised above as frameworks for the research were condensed into a set of design briefs that were used to guide the inquiry. These briefs set up areas and possibilities for design research that included: 'properties of RFID as design material', 'playful RFID' and 'RFID in domestic contexts'. Importantly, this means that the project has not worked towards given problem statements, but from the position of using design briefs to generate materials, to uncover opportunities and constraints, and to work towards desirable surprises. This again frames our research perspectives and foregrounds a discursive design approach with a focus on communication and conceptualisation of the technology.

Films from Touch

The following selection of films has been made as part of the Touch project over a period of three years within the design activities described above. These films have played various roles in inventing, mediating, articulating, and communicating within our practice-based research. The films have been published and distributed online using video sharing tools, and here they have become the boundary objects through which we discuss and communicate about RFID technology to broader audiences.

The first films show a research approach that explores the materiality of RFID in experimental and highly aestheticised ways. These films emerged out of probing at the

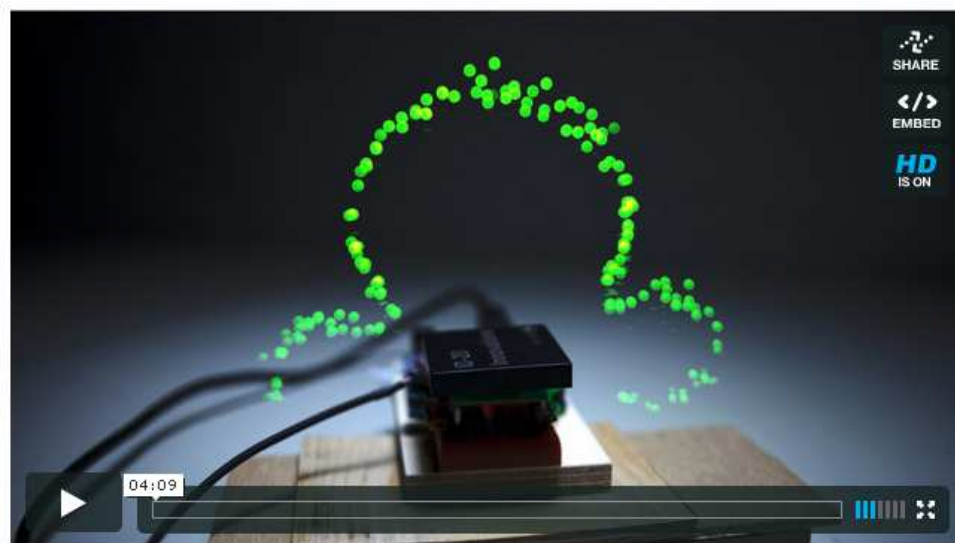
technology with the visual tools of photography and animation. Next, product-focused films articulate views on technology in context through specific experiential and explanatory moves, such as the use of motion diagrams. These films then set up a series of narrative 'vignettes' which convey experiences of actually using the technological products in specific contexts. In the latter films we embed critical framings of technology into culturally resonant forms which communicate to a broad audience, in what we are calling a discursive design approach.

Exploring materiality through film

As we have seen, RFID is a particularly immaterial technology, it is literally 'black boxed' into packaged components, and the qualities of its invisible radio fields are badly understood. The spatial and material aspects of RFID are important for design, in order to be able to create interactions and products that take advantage of the spatial and gestural properties of the technology.

These technological materials are in the first instance defined by engineers, scientists and researchers in domains very different from design, and often with different motivations. RFID for instance is framed as a technology that can track logistics in large infrastructural and economic systems. This means that the technology is often designed in a certain way, to support certain kinds of functions, contexts and activities. Designers must resort to manuals and data-sheets in order to understand the opportunities and constraints of the technology. Unfortunately, this translation of the 'raw' technology is more often than not biased towards particular kinds of application (such as scanning boxes of products on an RFID-enabled conveyor belt), often inaccurate in its' measured and theoretical limitations, and occasionally wilfully misleading for marketing or sales purposes. Building on the manner in which Nordby (2010) models short-range RFID as a 'conceptual material for conceptual designing', there is a need to physically model it as a material for product design too.

The following two films emerged from an exploratory design process that investigated the spatial qualities of RFID fields using technical probes. Very early on in the Touch project we realised that we had to better understand RFID as a physical, manipulable material. We designed electronic probes that could help us understand the physical relations between various RFID components. We see the concept of audio-visual media being used as a design material in a design process, where experimentation with visual techniques such as long-exposure photography, compositing and stop-frame animation lead to material discoveries that are then carried through into new design work.

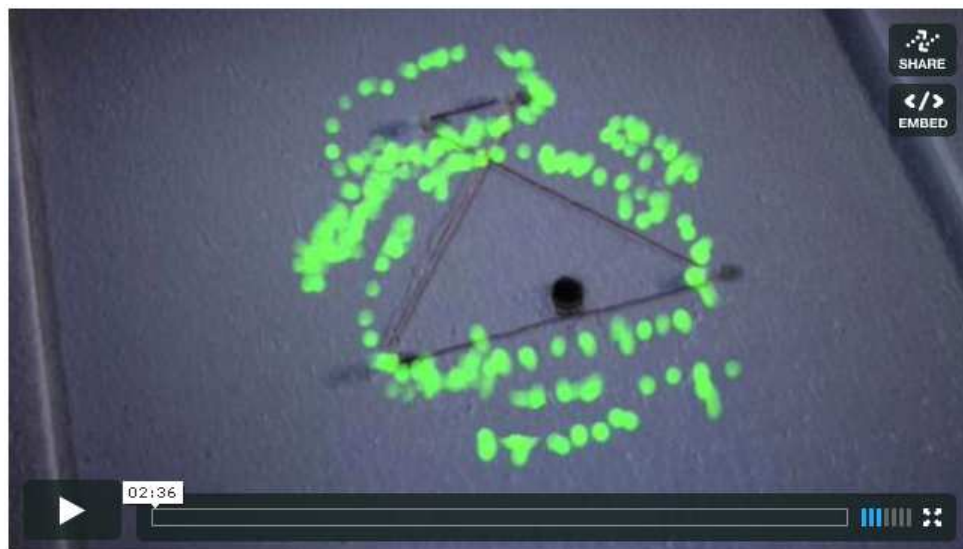


The resulting compositions - built out of many layers of imagery - accurately reflect the way in which RFID interactions inhabit physical space. The visualisation builds a detailed model of the spatial aspects of RFID, leading us to reflect on the tangible and embodied nature of the technology, where it almost feels like we could wave a hand through the field. Here we are making the invisible visible, constructing empirical evidence of the technology that then become foundational design materials in our practice. The materials here are more akin to physical materials of product design, not about digital behaviour, but about form, space, and surface quality. The visualisations reveal for us as designers how the spatial fields might be embedded inside products or environments, in order that they can be used gesturally.

These visualisations do not exist outside of the form of film, people can't go and experience our 'light fields' in an exhibition or through a demonstrator, the films are the only representational form. The use of layering over time through animation allows for particularly expressive modes of explanation, where the evidence can be laid out in sequences that don't overload one visual frame with information. This provides a visual and temporal layering that makes tangible, common sense: the visualisations occupy a 'real' space and are sequenced in a way that provides an immediately graspable view into the spatial qualities of RFID.

Communicatively, the visualisations are striking aesthetic artefacts that evoke connections to other forms of media like photographic lightpainting, holography and special effects. But they are presented in a documentary framing, including interviews intercut and overlaid with explanatory sequences that take the viewer through the process of constructing the visualisation itself. The simple narrative arc, introducing the problem of invisibility and then revealing the visualisations - when combined with the high production value of the visual material - resulted in the film being viewed and discussed widely online. We reflect on this online mediation below.

In this second immaterials film we go from revealing the boundaries of the 'readable volume' to exploring and manipulating the material substrate of RFID: the antenna.



Here the same techniques of probing, long-exposure photography, animation and compositing are used to reveal the relationship between the RFID field and the shape of an antenna. A new level of understanding is built about the way in which RFID fields surround coiled antennas. But critically we are creating, shaping and experimenting with the material of radio, the added layer of expression—literally drawing with radio—evidences an even more nuanced visual model for how radio behaves. There is a creative dimension to the work, where we as designers - through our visualisations - show that the technology is not static and constant, and can be fundamentally shaped through design. When taken together, these films are intended to build material knowledge of RFID, but also through their form, show how designers might begin to take some control over the technical materials, for aesthetic, interactional or functional purposes.

In this design activity there is no separation (temporally, spatially or conceptually) between the filmmaking and the design process. These films can be seen as design processes that work within the material of film. Unlike post-process 'documentation', these filmmaking processes have taken place within a design activity, where the analysis, reflection and action emerged through the film visualisation process. We see that the use of film closely inter-relates the tool, the process and the outcomes. As they are formed the films act as mediating artefacts within this multi-disciplinary design activity. They evidence, expose and uncover otherwise unseen aspects of the technical materials in ways that reframe them for designers.

Conceptually this creative deconstruction of RFID through film points towards what might call a discursive design approach. Drawing on methods from critical design that unpack and re-conceptualise the technological material, combined with narrative and communicative approaches, we may begin to challenge some of the expectations and dominant understandings of RFID. In ways that are explored in more detail below, these films have also acted as boundary objects that work between design, technology and other communities. The consideration towards these communicative aspects may enable design research to be taken up broadly in public discussions.

Communicating products and prototypes through film

Here we explore RFID products and prototypes and the ways in which they are communicated through film. The main aim of these products has been to explore RFID technology in new contexts, and to engage with the opportunities and constraints of the technology in various uses. Here the design process has involved physical product design, designing with embedded electronics and systems, visual and filmmaking activities, and cinematic enactments with non-working props.



As a product, Skål (Norwegian for Bowl) explores RFID interactions in a domestic media context, where it broadens the activity of television-based media consumption towards playful, physical engagement. In this project film is being used to communicate a functioning product prototype, while at the same time bringing forward playful and tangible perspectives. The film is explicitly diagrammatic in its opening section, where it explains the interaction and function. It then shows the product in use without going deeply into the technical background, but focusing on experiential qualities.

Using these explanatory and experiential representations in film open up for communicative modes of research. The films achieve a high level of believability in the product qualities in order to reflect on the opportunities and constraints of RFID technology in products. Using a persuasive cinematic language to represent these product qualities might be critiqued as obscuring the critical aims of the project. But critical design discourse is already '...blurring the boundaries between the everydayness of industrial production and the fictional world of ideas' and suggests 'a role for design objects as discourse where functionality can be used to criticize the limits that products impose on our actions' (Dunne, 2005: 43). In presenting the product in these ways we place emphasis on the discourse of the design object which lies in the playful and physical everyday activities in a domestic context.



Sniff tells a story about everyday experience with an RFID sniffing toy dog that was designed to explore tangible and social interaction through a children's toy. It presents the technology through a short moving diagram, where a layered compositional space explains the prototype through combinations of live-action footage, sound and motion graphics diagrams. We then introduce short sequences that show various activities around the product in use. To convey these experiences we invest meaning into the activities and contexts around the prototype being used, and offer the audience a glimpse of the daily lived experience.

In this film we see a specific quality of discursive design which involves the role of products and their presentations in re-conceptualising technology. In Sniff we see the potential for reframing technology through explanation and experiential representation of use and activities, and not by focusing on the technology itself. Here the use of cinematic qualities such as short depth-of-field and other stylistic devices such as quick-cut montages enable jumps in time and action that strongly reinforce the playful, exploratory perspectives on the technology.



The iPhone RFID film was created to engage with a critical mass of discourse around the iPhone and to provoke a subtle reframing of the discussion of RFID to include media, play and tangible manipulation. In this film, the iPhone RFID reader is a non-interactive prop that plays a sequence of clips that allowed us to enact a pre-prepared set of interactions between the phone and objects, which then seem to trigger media playback on the iPhone. This simulates the experience of using physical objects to play media and communicates a simple example of that experience. This rapid prototyping process through film allowed us to quickly experiment with product experiences without extensive technical development. The significant re-framing here was between the concept of an iPhone as a screen-centric device, and an iPhone that interacts directly with the physical world. The film is then a speculative object from which to see the possibilities for the rich, playful interaction between mobile devices and the world.

These three films offer experiential representations of RFID interaction that shift attention towards use and activity and away from technical specifications and features. Rather than the selection of relatively austere, gallery-based, and highly abstracted para-functional objects referenced by Dunne (2005: 50), these products are placed in everyday contexts, using highly communicative product presentations. However the intentions remain similar, to critique and reframe the discourse around technology through product design. Conceptually, they propose and speculate through cinematic enactments that tell stories about possible technological futures. They embody an activity of translation and re-framing, from a purely technical discourse towards design discourse that involves new contexts (domestic, media, entertainment), new users (children), new materials (natural materials, toys), and new activities (playful and exploratory).

Conceptualising proximity

The next film embeds a particular view of RFID and proximity interaction into a short sequence that playfully resonates with a history of the 'chain reaction' film genre. It is designed to reach beyond a research or design community in order to provoke discussion and to increase awareness of the technological implications. It does this by parodying an existing popular cultural form in a way that inherently embeds the technology into the narrative.



In our overall attempt to shift the discourse around RFID away from the systemic and infrastructural viewpoint and towards tangible and playful concepts, it has been important to find new framings of the technology. Nearness or proximity is one of the key aspects of RFID interaction, the radio field of an RFID tag is small, and thus objects need to be close in order to interact. The film condenses the wide-reaching and complex research from the Touch project into a physical moving diagram, a poetic invention that involves objects, relationships and physical movement. We are taken through multiple enactments of nearness, field interactions and various other physical relationships that involve proximity such as light, magnetism and air pressure.

The film fondly references a history of popular cultural and popular science forms such as Fischli and Weiss, Tinguely, Pythagoras Switch (2001), Heath Robinson and Rube Goldberg. Fischli and Weiss' film *The Way Things Go* (1987) is arguably the best known of the chain reaction films, which involve tangible chain reactions where one physical kinetic or chemical reaction leads to another, often in impossibly long sequences. In *Nearness* nothing touches. With sensing technologies like RFID, mere proximity is enough to trigger a chain reaction. In this way the film takes a cultural form and re-appropriates it in a way that embeds the research as part of the mediation.

Both the *Nearness* and *Immaterials* films act as boundary objects where the intention is to translate and align discourse around proximity and the interactive qualities of RFID. These films are self-contained design objects in their own right that act as 'online probes' that are able to provoke and catalyse a discussion around the themes of the research. For example *Nearness* was featured in the London newspaper *Metro* which is distributed to over 1.3 million readers on the London Underground alongside the Oyster-card ticket gates. The film ended up being mass-mediated in the very contexts that the technology is used every day, showing the potential for discursive design research in a public context.

Analytically *Nearness* can be seen as an approach to critical design that has a discursive and communicative focus. As a discursive design artefact it takes a critical design stance that highlights the assumptions and preconditions of RFID, using the processes and tools from interaction and product design to rethink the opportunities and challenges of RFID. It articulates a subtle but fundamental aspect of RFID interaction that is already widely used

in the world, and in doing so sensitises us to the ways in which ubiquitous sensing and tracking works in the physical sense. In its para-functionality it ‘attempts to go beyond conventional definitions of functionalism to include the poetic’ (Dunne 2005: 43). In doing so it broadens RFID discourse from utilitarian, industrial and privacy issues towards playful, aesthetic and reflexive consideration of proximity interaction.

Behind the scenes: design and reflection in film

This film, produced for this article, is a compilation of experimental footage and sequences that show design explorations and processes.



Here many of the beginnings of audiovisual concepts for Nearness and Immaterials can be seen. Many of these sequences use visual layering techniques to diagram elements of virtual interaction into the physical space of live-action film. There is an aspect of invention in these explorations; the creation of spaces, objects, movements and audiovisual techniques that map and visualise the interactive phenomena of RFID. Rather than investing time in creating complex software and hardware prototypes, the interactive experience – with many of its intricacies such as visual symbols, timing, sound and gestures – are quickly made inside film compositing applications. Objects are shown to change state, to connect to each other, to toggle back and forth in hierarchies, based on the interactions between fields. In a reflective activity of designing interactions, there is great value in having tools that offer efficient prototyping of interactions at an experiential level, that don't need to rely on complex electronics or physical design. There is also value in working within a medium that is not tied to a specific location or a unique demonstrator, and that is editable, reproducible and transmissible allowing it to be shared freely and widely amongst a research group.

Analytically film sequences have acted as mediating artefacts in our design process, particularly in the iterative loop between conceptual development and the practical making process. The film production process is highly reflective, where early experiments revealed new possibilities and led to new visualisations and material knowledge. A film sequence can gather and articulate a set of ideas in one place, providing a tangible outcome and further motivation for the design activity. In particular we see how audiovisual media may be used as an exploratory tool in design, where the processes of compositing and motion graphics

introduce yet more distance and consideration in communicating with and about emerging technology. The manipulated and composited space of the screen becomes a 'metamedium' from which to practice design approach.

Discussions

The overarching theme in our research is conceptualising, and re-conceptualising emerging technology through design. We have approached this through a discursive mode of interaction design research that draws on critical design approaches and uses film as a central part of its process and outcomes. As shown, film has been used as a tool and a medium to materialise and conceptualise with RFID technology. Specifically, we have addressed the role of film in exploring materiality, and the use of cinematic qualities in experiential and explanatory representations of the technology. Through this process we have reflected on the role of film in practice-based design research, and film in a broader public communication of RFID.

Film in the design research process

For practice-based design research, film offers a representational form that communicates about physical objects and their interactive, tangible behaviours over time. The time-based, audiovisual material of film can combine both the explanatory power of moving diagrams, with experiential and contextual sequences, and this opens up for complex objects and processes being externalised within a practice-based design research activity.

In our inquiry, film has been used for more than documentation of finished designed artefacts; the film-making process has been intricately woven into the designing and research activity. Film-making can be seen as a highly reflective activity: just as sketching has certain reflective and communicative qualities, film introduces new reflective and communicative properties into the design research process. It is a malleable metamedium that involves a highly reflective production process, and communicative outcomes. Film has enabled a loop of externalisation and internalisation that oscillates between practical and conceptual considerations within our internal design research process. However, unlike an experience prototype or demonstrator, films are unlikely to reveal usability issues or uncover new or unexpected user-behaviour outside of very constrained situations that are set up for the film-making process. Unless films are designed to elicit specific responses, they will generally not offer an audience the ability to experience the intricacies of interfaces, the knowledge that can only come from hands-on experience.

Film-making in design research can be seen as central in both reflection-in-action and reflection on action (Schön, 1983). Scripting and editing, in particular, allow for a highly granulated 'reflective conversation with the situation' (ibid: 76) where we reflect on both the situation of the concepts, contexts and applications of the technology, and on the designed objects and systems being created. In this, we shift stance from a hypothetical 'what if' to recognising implications, considerations of the total and moving from explorations towards proposals (ibid). However, in the process of film-making, we have also reflected back on our designs and the discourses around RFID. Through this we situate, articulate and discuss our own perspectives and the films become mediating artefacts with which to move our own practice and research forward, letting us collectively reflect on issues and technologies within our own inter-disciplinary design activities.

Conceptualising, contextualising and communicating

In conceptualising and communicating about technology we have approached the dominant discourses of RFID from a design informed position. The Touch project has attempted to weave its way through a broad set of complex and overlapping discourses of technology, design and culture. Film has played a key role in these activities: unpacking and visualising

the technology, reframing it, inventing with it, designing products and communicating about it to various audiences. Film has been used as a way of probing, externalising and unpacking conceptual frameworks about RFID technology within our own design research process. This is evident in the *Immaterials* films that were produced as a process of conceptually and practically unpacking RFID; the film acts as a tool for creating 'material evidence' of the technology. However, the films also act on a communicative level in creating models for thinking about the tangibility of radio fields. This proves to be useful both in the process of designing with RFID, but also in the broader discourse around RFID.

These films embody many kinds of concepts that attempt to reframe or rescript the dominant discourses around RFID. *Nearness* sets out to critique the dominant discourse of identification and shift the focus towards the tangible qualities of proximity. *iPhone RFID* shifts the focus away from logistics and tracking, to playful consumer-centric applications. *Skål* explores the opportunity for small, self-contained RFID products that work in domestic contexts, away from the privacy risks of RFID in public life. *Sniff* explores the experiential and playful aspects of RFID in everyday life. *Immaterials* uncovers and reveals the invisible materiality of RFID, and in doing so it offers a grounding for the discussion and debate of the controversial aspects of the technology. *Immaterials* also demonstrates a particular approach to technology shown by and through many of the films; this is an approach that does not take the technology as given, constant and pre-defined. Instead, it explores and uncovers the technology through probing, experimenting and re-contextualising in a way that offers new perspectives for design research and broader audiences.

The films – analysed as artefacts – might be described as design material, information visualisations, diagrams, mappings, models, explorations, explanations, arguments or articulations. Materialisation and visualisation are core concepts here. 'Immaterials' visualises the tangible, material and spatial qualities of RFID, and *Nearness* articulates the elegance and magic of proximity. By visualising these qualities of RFID in ways that are accessible to a wide audience, the films aim to help shape a wider understanding of the technology.

In addressing the discourse around RFID it has been important to contextualise RFID in ways that separate the technology from its use in utilitarian and industrial contexts. Film here has enabled ways of re-framing the technology through telling stories about products and applications that are both explanatory and experiential. With a wide range of narrative and explanatory styles, films can operate on multiple levels, and tell simple stories alongside explanations, visualisations and rich experiential framings. This is not a new form. The Eames' used a similar combination of aesthetic explanatory sequences alongside experiential narratives that mediated the Polaroid camera in use in rich contexts. Similarly, the process of re-contextualising RFID broadens the scope for discussion and further design with the technology. As an example, the *Skål*, *iPhone RFID* and *Sniff* films show visions of products in use in domestic contexts as part of family life. These films emphasise that the materiality and context of use strongly defines the character of the products and applications that can be built.

Through visualising and materialising the technology, showing potential use in everyday contexts, addressing the popular cultural imagination and proposing a gentle critique of the dominant discourses around RFID, we advocate for grounding the technology, and the visions of it, in the present. Bell and Dourish argue for 'developing an "ubicom of the present" that takes the messiness of everyday life as a central theme' (2006:1). Our research advocates strongly for the role of design in shaping near-future perspectives on technology that is closely intertwined with the present, where detailed, considered artefacts relate to current practices and culture, and films can be the substrate through which these artefacts are mediated.

Discursive design and online mediation

These films were created for many audiences: this includes ourselves as a research team, for our project collaborators, for the design research community and for a wider online audience. Film sharing online has become simple and popular; sites like YouTube and Vimeo allow for distribution of films to a potential mass audience. The films articulated our own research perspectives by being embedded into articles on the Touch weblog (Arnall, 2009a) where they were contextualised by the media response and feedback. They were also embedded widely across the web, on news sites, in discussion forums, weblogs and specialist publications.

The dissemination of research online through media such as film is an important potential resource for discursive design research. In the cases presented here, the films have acted as highly communicative objects that are designed for specific and multiple audiences. The *Immaterials* film for instance has been embedded into a wide range of public discussions, from engineers and scientists discussing the accuracy of the 'empirical evidence', to privacy advocates critiquing it as an 'inappropriate model' for invisibility (Arnall 2009b). Similarly, with *Nearness*, the highly aestheticised visualisations have resonated with a wide audience that engaged in discussing tangible perspectives on RFID technology.

These early experiments in online mediation became the means for articulation of new concepts to a wide audience, and point towards the possibilities for using films as a means of probing the socio-cultural aspects of emerging technology. Critically, the level of cinematic detail and production quality has resulted in boundary objects that are both robust and adaptable enough to be interpreted in many contexts. These boundary objects can then provoke discussion and critique at the same time as revealing, explaining and translating complex technologies within the popular cultural imagination.

By combining the conversational aspects of film in online mediation with the speculative and provocative methods of critical design, discursive design may offer new ways of doing design research in a social and cultural context.

Conclusions

As we have shown through the films, the analysis of them and in the discussions above, there are a number of perspectives on the role that film can play in conceptualising and communicating about emerging technology. This has been shown as a process of film production and cinematic enactment that works in practice-based design research. We have also pointed towards the use of film in discursive design approaches that together with online mediation can broaden the context of public technology discourse and interaction design research with technology.

The multi-disciplinary activities within interaction design that involve a high level of agency over technological materials, combined with a tradition of visualisation and communication, may hold a potentially important role in the translation and interpretation of new emerging technology for public discourse and understanding. We have shown how practice-based design research has the ability to create representations and communicative artefacts, as opposed to technological development or mass production. A communicative approach to interaction design is central to this research. It embodies the idea that the communication of ideas, concepts and arguments through mediated design artefacts is essential to both creating effective interactive products, and to provoking discourse in and around technology-centric research. The form of film – that embodies both a highly reflective design activity and communicative qualities – is an ideal medium for interaction design research, where it can coalesce knowledge around practices and processes and project towards potential futures. Film allows for a degree of probing, explanation and reflexive

understanding of emerging technologies, but through its communicative qualities, also opens up for participation in broad social and cultural discourses around technology.

The core motivation behind this research is contextualising, conceptualising and communicating RFID towards a broader public discourse and the popular cultural imagination. We build on approaches and positions from critical design, but we do not argue that this process is necessarily provocative, subversive or 'critical' in the sense that critical design typically is. Our design proposals can just as easily be used to bolster and reinforce current practice as it can be used to critique it. The important similarity to critical design is the use of design artefacts to challenge the assumptions and preconditions of RFID, and using the processes and tools of interaction and product design to critically rethink the opportunities and challenges of the technology. In our research we have arrived at an approach to critical design that has a strong mediational focus and emphasises communication, and this strong focus makes up what we can call a 'discursive design'.

In this process, we have shown how we have increased our own 'depth of field' in design knowledge of emerging technology, and how we have developed cinematic modes of doing design research. We see the potentials for a kind of discursive design practice, where the object of design and analysis is the discourse that is catalysed by new artefacts, and the emphasis of design research is on communication. Through this we envisage the potential for extending the field of interaction design research to also include critical and discursive approaches, communication of emerging technologies and audiovisual media.

Timo Arnall

Research Fellow

Oslo School of Architecture & Design, Institute of Design

Email address: Timo.Arnall@aho.no

Einar Sneve Martinussen

Research Fellow

Oslo School of Architecture & Design, Institute of Design

Email address: einar.snevemartinussen@aho.no

References

- Albrecht, K., & McIntyre, L. (2005). *Spychips: How Major Corporations and Government Plan to Track Your Every Move with RFID*. Nashville, Tenn.: Nelson Current.
- Arnall, T. (2009a, 12. October). *Immaterials: the ghost in the field*. Retrieved December 8, 2009, from <http://www.nearfield.org/2009/10/immaterials-the-ghost-in-the-field>
- Arnall, T. (2009b, 26. October). *Responses to 'Immaterials'*. Retrieved December 8, 2009, from <http://www.nearfield.org/2009/10/responses-to-immaterials>
- Bagnara, S., & Smith, G. C. (2006). *Theories and practice in interaction design*. Ivrea: Interaction Design Institute Ivrea.
- Bell, G. & Dourish, P. (2007). Yesterday's tomorrows: notes on ubiquitous computing's dominant vision. *Personal Ubiquitous Computing*, 11(2), 133-143.
- Bonanni, L. & Ishii, H. (2009). Stop-motion prototyping for tangible interfaces. In *Third International Conference on Tangible and Embedded Interaction. February 16-18, 2009 Cambridge, UK. Conference Proceedings*. New York: ACM, 315-316.
- Bordwell, D. & Thompson, K. (2007). *Film Art: An Introduction* (8th edition). Boston: McGraw Hill.
- Boyd, D. (2008). *Taken Out of Context: American Teen Sociality in Networked Publics*. PhD thesis University of California-Berkeley, School of Information. Retrieved December 8, 2009, from <http://www.danah.org/papers/TakenOutOfContext.pdf>

- Buchenau, M. & Suri, J.F. (2000). Designing Interactive Systems. In *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques*. New York: ACM. 424 – 433.
- Buxton, B. (2007). *Sketching User Experiences: Getting the Design Right and the Right Design*. Amsterdam: Elsevier.
- Chalmers, M. & Galani, A. (2004). Seamful interweaving: heterogeneity in the theory and design of interactive systems. In *Proceedings of the 2004 conference on Designing interactive systems: processes, practices, methods, and techniques*. Cambridge, MA: ACM Press, 243-252.
- Darley, A. (2000). *Visual Digital Culture: Surface Play and Spectacle in New Media Genres*. London: Routledge.
- DeVries, P. D. (2008). The state of RFID for effective baggage tracking in the airline industry. *International Journal of Mobile Communications.*, 6(2), 151-164.
- Dontharaju, S., Tung, S., Cain, J. T., Mats, L., Mickle, M. H., & Jones, A. K. (2009). A design automation and power estimation flow for RFID systems. *ACM Transactions on Design Automation of Electronic Systems*, 14(1), 1-31.
- Dourish, P. (2001). *Where the action is: the foundations of embodied interaction*. Cambridge MA: The MIT Press.
- Dunne, A. (2005). *Hertzian tales : electronic products, aesthetic experience, and critical design* (2th edition). Cambridge, MA: The MIT Press.
- Dunne, A. & Raby, F. (2007). Critical Design FAQ. Retrieved November 23, 2009 from <http://www.dunneandraby.co.uk/content/bydandr/13/0>
- Eames, C., Eames, R., Demetrios, E., Demetrios, L. E., & Mills, S. (Writer) (2000). The films of Charles & Ray Eames, Volume 4. DVD. Chatsworth, CA: Image Entertainment.
- Engelbart, D. (1968). 1968 Demo. Retrieved December 4, 2009, from <http://sloan.stanford.edu/MouseSite/1968Demo.html>
- Engeström, Y. & Sannino, A. (2010). Studies of expansive learning: Foundations, findings and future challenges. *Educational Research Review*, 5(1), 1-24.
- Fischli, P. & Weiss, D. (2002) [1987]. *The Way Things Go*. [New York]: First Run Features.
- Galloway, A. (2004). Intimations of everyday life: Ubiquitous computing and the city. *Cultural Studies*, 18(2-3), 384-408.
- Garfinkel, S. & Rosenberg, B. (Eds.) (2005). *RFID: Applications, Security, and Privacy*. Upper Saddle River, N.J.: Addison-Wesley.
- Gaver, B., Dunne, T. & Pacenti, E. (1999). Design: Cultural probes. *Interactions*, 6(1), 21-29.
- Greenfield, A. (2006). *Everyware: The dawning age of ubiquitous computing*. Berkeley, CA: New Riders.
- Halskov, K. & Nielsen, R. (2006). Virtual video prototyping. *Human-Computer Interaction*, 21(2), 199-233.
- Hahn, Y. & Gregory, J. (2007). *Abstractness of mediating artifacts as probes*. Paper presented at the Nordes Conference, Stockholm, May 27-30. Retrieved December 8, 2009, from <http://www.nordes.org/data/uploads/papers/120.pdf>
- Igoe, T. (2007). *Making things talk*. Beijing: O'Reilly Media.
- Katz, S. (1991). *Film Directing Shot by Shot: Visualizing from Concept to Screen*. Studio City, CA: M. Wiese.
- Kirby, D. (2010). The Future is Now: Diegetic Prototypes and the Role of Popular Films in Generating Real-world Technological Development. *Social Studies of Science*, 40(1), 41-70.
- Klemmer, S. R., Li, J., Lin, J., & Landay, J. A. (2004). Papier-Mache: toolkit support for tangible input. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Vienna, Austria, April 24 - 29*. New York, NY.: ACM, 399-406.
- Krasner, J. (2008). *Motion graphic design, Applied History and Aesthetics*. Amsterdam: Elsevier.
- Kuniavsky, M. (2006). *Sketching in hardware*. Retrieved December 7, 2009 from <http://www.sketching06.com>
- Landay, J. A. & Myers, B. A. (2001). Sketching Interfaces: Toward More Human Interface Design. *Computer* 34(3), 56-64.
- Manovich, L. (2007). After effects, or velvet revolution. *Artefact*, 1(2), 67-75.

- Martinussen, E. & Arnall, T. (2009). Designing with RFID. In *Third International Conference on Tangible and Embedded Interaction. February 16-18, 2009 Cambridge, UK. Conference Proceedings*. New York: ACM, 343-350.
- Mazé, R. & Redström, J. (2009). Difficult forms: Critical practices of design and research. *Research Design Journal*, 1(1), 28-39.
- McClean, S. (2008). *Digital Storytelling: The Narrative Power of Visual Effects in Film*. Cambridge, MA: The MIT Press.
- Mitchell, W. (1994). *Picture theory: essays on verbal and visual representation*. Chicago: University of Chicago Press.
- Moggridge, B. (2007). *Designing Interactions*. Cambridge, MA: The MIT Press.
- Murphie, A. & Potts, J. (2003). *Culture and Technology*. New York: Palgrave Macmillan.
- Nordby, K. (2010). Conceptual Designing and Technology: Short-Range RFID as Design Material. *International Journal of Design* [Online] 4:1. Retrieved May 7, 2010 from <http://www.ijdesign.org/ojs/index.php/IJDesign/article/view/625>
- Norman, D. A. (1999). *The Invisible Computer: Why Good Products Can Fail, the Personal Computer Is So Complex, and Information Appliances Are the Solution*. Cambridge, MA: The MIT Press.
- Poggenpohl, S. (2006). Interaction as an Ecology: Building a Framework. In Bagnara, S. & Crampton Smith, G. (Eds.) *Theories and practices in interaction design*. Mahwah NJ: Erlbaum, 287-299.
- Poole, E. S., Le Dantec, C. A., Eagan, J. R. & Edwards, W. K. (2008). Reflecting on the invisible: understanding end-user perceptions of ubiquitous computing. In *Proceedings of the 10th international Conference on Ubiquitous Computing*. New York: ACM, 192-201.
- Pythagora Switch. (2001). Retrieved December 7, 2009, from <http://en.wikipedia.org/wiki/PythagoraSwitch>
- Raijmakers, B., Gaver, W.W. & Bishay, J. (2006). Design documentaries: inspiring design research through documentary film. In *Proceedings of the 6th conference on Designing Interactive systems*. New York: ACM, 229-238.
- Redström, J. (2001). *Designing Everyday Computational Things*. PhD Dissertation. Göteborg University. Retrived from www.johan.redstrom.se/thesis/pdf/intropages.pdf
- Reeves, S., Pridmore, T., Crabtree, A., Green, J., Benford, S. & O'Malley, C. (2006). The spatial character of sensor technology. In *Proceedings of the 6th Conference on Designing interactive Systems*. New York: ACM, 31-40.
- Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think In Action*. New York: Basic Books.
- Seago, A. & Dunne, A. (1999). New Methodologies in Art and Design Research: The Object as Discourse. *Design Issues*, 15(2), 11-17.
- Sevaldson, B. (forthcoming 2010). *Being specific about practice research in design*.
- Shedroff, N. (2001). *Experience Design 1*. Indianapolis, Ind.: New Riders.
- Shirky, C. (2008). *Here Comes Everybody: The Power of Organizing Without Organizations*. New York: Penguin Press.
- Star, S. L. & Griesemer, J. R. (1989). Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science*, 19(3), 387-420.
- Tufte, E. (1997). *Visual Explanations: Images and Quantities, Evidence and Narrative*. Cheshire, Conn.: Graphics Press.
- Ylirisku, S. & Buur, J. (2007). *Designing with video*. London: Springer.
- Vallgård, A. & Redström, J. (2007). Computational composites. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. New York: ACM, 513-522.
- Vygotsky, L. (1978). *Mind in society: the development of 10 higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wartofsky, M. 1979. *Models: Representation in Scientific Understanding*. Dordrecht: D. Reidel Publishing Co.
- Weiser, M. (1991). The Computer for the 21st Century. *Scientific American* (Special Issue on Communications, Computers, and Networks).

Article 2

Article 2, 'Making Material of the Networked City' (Martinussen, 2012), is published in the edited book *Design Innovation for the Built Environment* (Hensel, 2012).

Chapter 16

Making material of the networked city

Einar Sneve Martinussen

16.1

A Wi-Fi network on a street in Oslo.



Figure 16.1 shows the strength and reach of a common Wi-Fi network on a street in Oslo. To create photographs like this we have developed a technique using long exposure photography and a specially designed measuring rod that visualises Wi-Fi signal strength as a bar of glowing lights. The height of the bar corresponds to the strength of a network in a specific location, and, when moved through space, the measuring rod displays the changes in the Wi-Fi signal. This is captured using long exposure photography and the narrow bar of light is stretched into a cross-section of the network that shows how it changes through the physical environment.

This chapter investigates and discusses phenomena of interacting with wireless networks in the city through practice-based design research. Using tools and methods from interaction and communication design, a small team of design researchers have developed instruments and techniques that can reveal qualities of

wireless networks that we cannot normally see. This allows us to get closer to some of the spatial, contextual and material aspects of everyday networked technologies, and how these may be used to unpack, communicate and discuss our interactions with devices and networks in the city.

Wireless networks in cities

Wireless networks and increasingly sophisticated mobile phones are becoming an interwoven part of daily life in many cities. Our interactions with personal technology are moving into urban contexts and starting to influence how we understand and experience our environments. These developments are taken up in a broad range of research fields and studied and discussed within and across multiple disciplines, including urban studies (e.g. Graham and Marvin 2001), architecture (e.g. Mitchell 2004; McCullough 2004), anthropology (e.g. Galloway 2009) and computer science (e.g. Paulos *et al.* 2004; Foth 2009). In this chapter I approach wireless technologies and network material in cities through practice-based design research. I focus on discussing and contextualising some of the phenomena that surround our interactions with network technologies, and explore their material qualities through visualisation.

Many of our activities based around network technologies are already becoming mundane, like using our mobile phones to take our online lives with us into the streets, cafés and buses, and finding our way around the city guided by online maps, GPS and real-time public transport updates. An increasing number of new services and applications are being designed and marketed around everyday urban activities such as shopping, commuting and socialising. Behind these novel products and activities are complex technologies and infrastructures that are only vaguely understood by common consumers and designers alike.

The design research presented in this chapter investigates and unpacks spatial, contextual and material qualities of one of the basic background phenomena of the networked city: the Wi-Fi network. Wi-Fi, or IEEE 802.11, is a standard form of wireless network that is typically used to distribute internet connection to laptops and mobile phones within a limited area (Wi-Fi Alliance 2011). Wi-Fi communication uses high-frequency radio waves to send and receive data between a base station and a mobile device. The base station shares an internet connection with mobile devices through setting up a radio field. This field is often called a wireless zone or hotspot, and is the space where a mobile device can detect the radio waves coming from the base station and create a two-way data connection. The size of a Wi-Fi zone depends on the strength of the base station and the antennas in the mobile devices; it can vary between 30 metres and 100 metres or more. The reach and shape of the wireless network also depends on how the physical environment absorbs and reflects the radio waves. This can have unforeseen effects and make Wi-Fi networks seem spatially unpredictable.

Wi-Fi networks have qualities that make them an interesting topic for this study. In several respects, Wi-Fi is a part of popular culture that stretches far beyond the technical basis of wireless communication standards. Wi-Fi base stations are inexpensive consumer products that allow people to create their own networks. This has made them almost ubiquitous (Mackenzie 2010). Wi-Fi networks

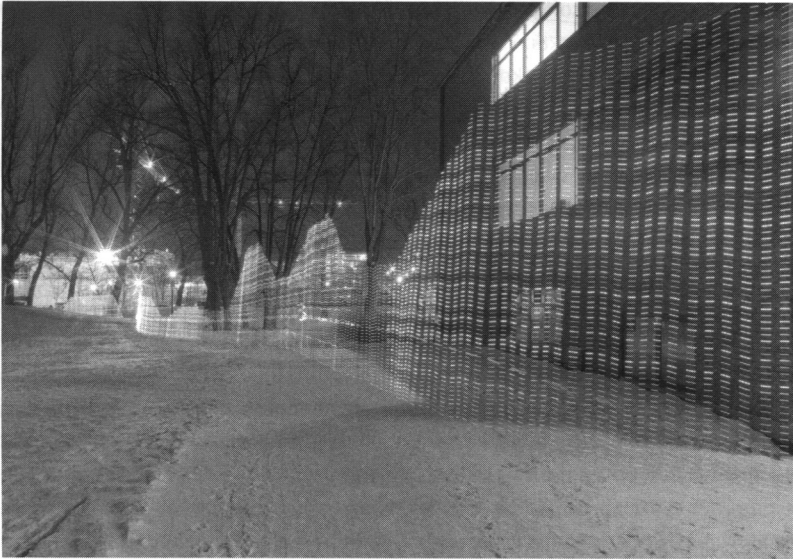
are popular in homes, offices, businesses and in institutions. They are especially numerous in urban contexts. The radio waves from all these networks reach out into the environment, which makes it possible to detect and identify any number of domestic and institutional networks in most urban settings. If you can find a network without password protection, or if you know the password, you can therefore connect to the network while sitting outside in a park, in a café or in your own apartment. This density of overlapping networks is occasionally experienced by most Wi-Fi users as a list of network names in the network settings of the phone or computer. Access to Wi-Fi networks has itself become a resource in the city, and this is especially true when it comes to cafés and coffee bars. For many the wireless internet is already a taken-for-granted aspect of cafés and the quality of the Wi-Fi influences where you choose to drink your coffee. Wi-Fi networks play an important role in contemporary urban life. Even if better technologies or new pricing models may make it obsolete in a few years, this technology is an interesting one of the first ways in which the Web is brought into the city.

Wi-Fi networks are just one example of how digital phenomena are becoming a part of the urban landscape. Our interactions with mobile devices, applications and services generate, and are surrounded by, invisible technical phenomena like data from embedded sensors, bluetooth connections, signals from GPS satellites, and numerous forms of wireless networks. The inner workings of these technologies are often opaque and black-boxed, but we use them and experience them in our daily life in ways that are already becoming mundane. Importantly for design research, we also design with and around these phenomena. We therefore find it especially interesting to develop techniques for bringing the invisible digital structures and the physical environment together in order to spatialise and contextualise some of the material aspects of the networked city.

Investigating wireless networks

Figure 16.2 shows how the Wi-Fi network of the Oslo School of Architecture and Design reaches through a neighbouring park making it possible for the students to bring their laptops outside when the weather allows. What we see here is a 100-metre-long cross-section from the corner of the campus (on the right), where the signal is relatively strong, diagonally across the park to where the signal disappears behind a small mound. The reason for the meandering curves of the cross-section is that the Wi-Fi measuring rod used to create the visualisation is 4 metres tall, and therefore has to avoid the low branches of the trees.

The measuring rod is reminiscent of the poles used by traditional land surveyors to map and describe the topography of physical landscapes. Similarly, our equipment and technique allows us to survey and visualise the immaterial landscapes that surround our interactions with mobile devices. Mitchell describes this landscape of digital networks as an 'electromagnetic terrain' that is both intricate and invisible, and only hinted at by the presence of antennas (Mitchell 2004: 55). Visualising and representing invisible technological phenomena have previously been explored at the intersections between design, art and studies of technology. Our design research is inspired and informed by work such as that of Dunne and Raby's 'Tuneable cities' (1994-97) and their discussions of 'hertzian space' (Dunne,



16.2
A university Wi-Fi network stretching across a park.

2005; Dunne and Raby, 2001), Jarman and Gerhardt's 'Magnetic Movie' (2007) and Chalmers and Galani's discussions of the physicality of wireless networks and their concept of 'seamful design' (2004). The investigations presented in this chapter are also grounded in our own research into visualising the material qualities of RFID – another ubiquitous and immaterial technology (Arnall and Martinussen 2010).

Our photographs of networks in urban contexts are the result of the interplay between the lights on the Wi-Fi measuring rod and the optics and exposure times of the camera (Figure 16.3). The rod has been specifically designed for creating the Wi-Fi visualisations through an iterative process of developing electronics and code, and taking photographs. For common Wi-Fi users the strength of a network is displayed on the screen of their device as a fan of 4 bars that indicate reception. Our rod measures the strength of a network in a similar way to a smartphone, but displays it with much more detail. The rod has 80 bright white LEDs that



16.3
Detecting a Wi-Fi signal indoors.

are connected in 40 pairs along a 4-metre-long wooden beam. This means that we can display the signal strength with a resolution of 40 levels, which allows us to make detailed graphs of the network reception in the environment on a scale of 0 to 4 metres. The reason for drawing out the graphs at this large scale is to show the architectural scale at which Wi-Fi operates.

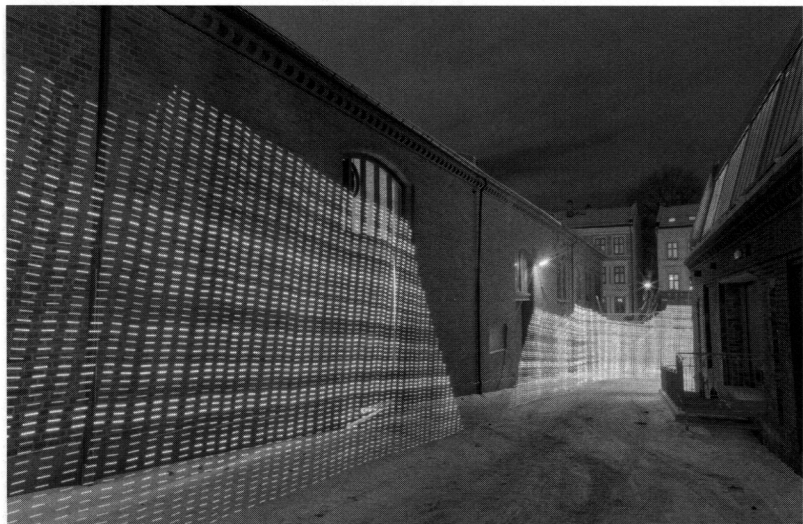
The Wi-Fi measuring rod is a stand-alone, battery-powered instrument that consists of three connected parts: a Wi-Fi module, a microcontroller and a row of LED lights. The Wi-Fi module is relatively small and similar to those found in smartphones. The microcontroller is called Arduino and made for prototyping and development, and allows us to write our own code in a lightweight programming language. The microcontroller is programmed to use the Wi-Fi module to scan the environment for a specific network identity and measure the signal strength of this network. The signal strength is then translated into how many of the 40 LED pairs to turn on (Figure 16.3).

Scanning for Wi-Fi networks does not give instant feedback, but depends on factors such as the number of available networks and the speed of the Wi-Fi module. We have programmed the measuring rod to scan for signal strength every three seconds and draw straight lines between each new scan-point (Figure 16.4). This means that if the rod is moved at a speed of 1 metre per three seconds over a chosen area, the Wi-Fi mapping gets a resolution of one reading per metre. The LEDs also flash on and off every 100 metres to create dashed lines rather than solid ones. This effect creates a texture that makes the cross-section semi-transparent. Consequently, it is possible to see through the graph and allows the visualisation to appear within the physical environment without covering the background scene (Figure 16.4).

When photographing the moving measuring rod we use a photographic technique called light painting. Light painting involves long exposure photographs of a dark environment and painting or drawing by moving a light source. Light painting

16.4

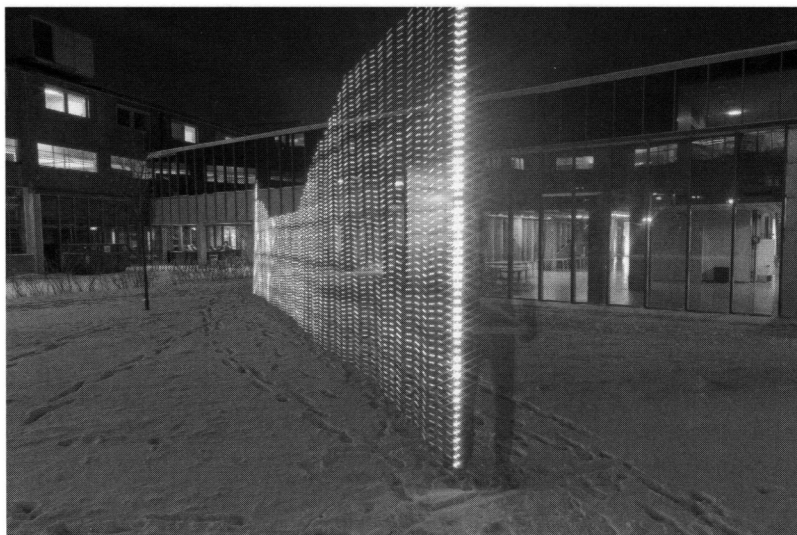
The texture of the cross-section is made of dashed lines and linear transitions.



has a background from photography and art, which includes early examples by Man Ray, and Mili and Picasso (Baldassari 1997). Light paintings were also used early as a technique for analysing movement, for example, the Gilbreths' studies of work processes (Marien 2006). Light-painting photography has several characteristics that make it an interesting technique for visualising invisible phenomena like Wi-Fi. First, it lets us photograph both the physical environment and the light-painted representation of the network in one picture. This means that the detailed qualities of the phenomenon of the network are captured in the physical space where it occurs. The photographic visualisations spatialise the phenomenon and through contextualising it in the situation gives the phenomenon a material quality. Second, the process of creating the light paintings requires us to both develop instruments for revealing invisible networks, and find and photograph these networks in the city. This process of investigation also acts as a way of contextualising the phenomenon of Wi-Fi through finding and revealing it in the spaces and environments where it exists. This practice-based design research involves the interplay of interaction design and the development of electronics instruments, urban and architectural photography, and explorative fieldwork.

In the field

Figure 16.5 shows the measuring rod being moved across the foreground of the Oslo School of Architecture and Design (AHO). Here we see some variation in the signal strength of the Wi-Fi coming out of the building, but we also see the blurred image of the rod operator. This gives an impression of the scale of the visualisations as well as the size of the equipment. To create a successful visualisation we needed to be three people: a photographer, an operator carrying the rod and one person to keep it balanced and pointed towards the camera. As well as working technically and photographically, the measuring rod also has to work practically while outdoors. The rod has handles and a shoulder-rest for keeping it upright, waterproof housing for the



16.5
Walking with the Wi-Fi
measuring rod.

electronics and a hinge in the middle to make it easier to transport. The LEDs and electronic components are kept in place with solderless miniature screw connectors to make it possible to quickly maintain and fix the rod while in the field. The rod is designed and built specifically for fieldwork, and discussing this fieldwork can be a good starting point for exploring the material level of the phenomenon of Wi-Fi in a city. Our explorations have taken place in and around Grünerløkka in central Oslo, which consists of residential areas, educational institutions, cafés and shops.

As we are taking our equipment with us through the streets, we continuously scan for networks with a smartphone, looking for places with interesting network qualities. The lists the smartphone gives us reveals that the density of networks is high and that we are rarely completely without some form of Wi-Fi contact. When we start to photograph these networks we typically get pictures like the one shown in Figure 16.6. In Figure 16.6 we see a network that comes out of someone's apartment. The signal we get from this network is not very strong, but it reaches across the street and into a hedge. When we photograph the same network from a different angle, and move the rod along the facade, we can see how the network spills out onto small sections of the pavement (Figure 16.7). Larger institutional networks give us very different visualisations than the domestic networks extruding from apartment buildings.

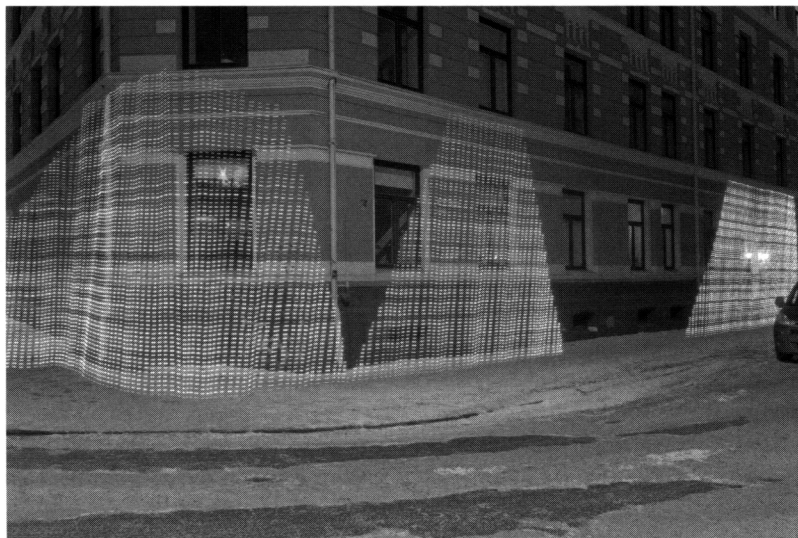
16.6

A domestic network reaching out into the street.



Figure 16.8 shows cross-sections of the Wi-Fi network of AHO reaching from the library on the left, to the Akerselva river on the right. This image gives an impression of the extent of the digital footprint of the building and how the open park allows the Wi-Fi radio waves to be cast far out of the large windows.

Wi-Fi networks at Grünerøkka in Oslo are ubiquitous, but highly local and qualitatively different. The strength, consistency and reach of the networks tell us something about their host, but also something about the built environment where



16.7
A domestic network spreading out along the pavement.



16.8
A large institutional network stretching across the park and into the river.

the network is set up. The open park around AHO is one example of this (Figure 16.8); another can be seen in Figure 16.9 where a high and street-long brick wall creates a shadow in the network.

Here the network comes from the Oslo National Academy of the Arts (KHiO), which lies behind the wall to the left. The brick wall absorbs the radio waves coming from the KHiO base station and creates a small shadow. The urban landscape, typology of buildings and building materials shape the way networks spread into the environment. This shows how these technological phenomena are highly contextual and behave differently when localised in different urban settings.

A related aspect is where and to whom the network is spread. In the case of the AHO network reaching through the neighbouring park, this makes it

16.9

Brick wall creating a shadow in the network.

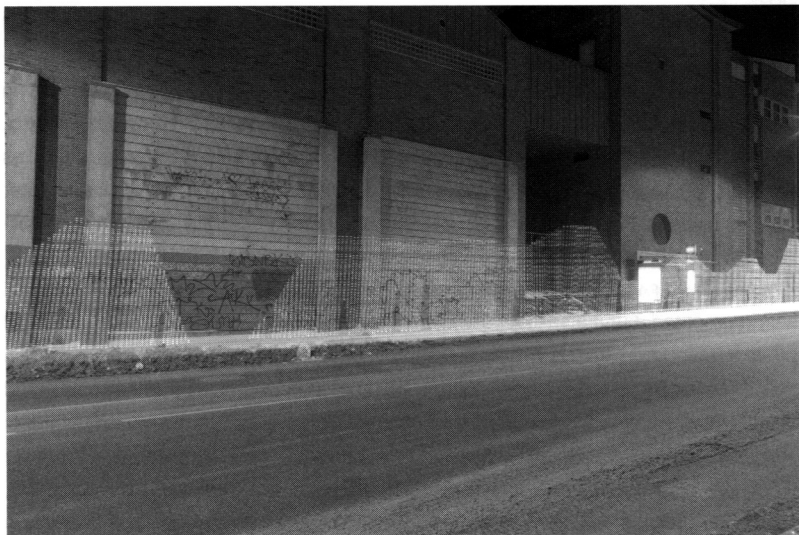


possible for AHO students to use the park as a networked area when the seasons allow it. For anyone else, this network is both technically invisible and practically unavailable (as it is also password protected).

Figure 16.10 shows the same far-reaching AHO network covering a nearby street and a busy bus stop. Here we have the overlapping of one invisible digital structure, the network, with the highly visible infrastructure of public transport. This unplanned overlap allows students and employees of AHO to use this bus stop as a space for accessing the Web while waiting. Here the wireless network connects the semi-private indoor work spaces with the public outdoor commuting environment. This illustrates how wireless networks, both practically and metaphorically, can connect different environments and settings.

16.10

Bus stop and Wi-Fi.



The phenomena that are generated by and surround our interactions with networked devices are complex and often black-boxed. Latour describes black-boxing as when 'technical work is made invisible by its own success' (1999: 304). When technologies work efficiently we only focus on their inputs and outputs, and their internal complexities become opaque and obscured (ibid.). Interestingly, Wi-Fi networks are both physically invisible and technically obscure, which makes them black-boxed on multiple levels. The detailed technical level of the infrastructures, data traffic and electromagnetic fields that our mobile devices are built upon are obviously complex and difficult to understand. However, there are also interactional and material aspects to how we experience these technologies that are similarly opaque and vaguely understood. This material level is especially important for design research as it is not only related to the technical and infrastructural properties of the technologies, but also to how they are experienced as spatial, material and interactive phenomena in the city. Through photographs and the process of creating them we have unpacked some of the qualities of Wi-Fi networks and make them understandable as spatial and contextual phenomena. This process of making the phenomena material through visualisation shows how digital structures and physical environments are interwoven elements of the urban landscape. It also illustrates how our interactions with devices and networks are a part of the fabric of everyday urban life.

In the discourse

Our investigations and visualisations of wireless networks work towards unpacking and discussing the immaterial landscape of interacting with devices in urban environments on multiple levels. First, they explore the material level, and as described above show how the phenomena can be visualised and contextualised, how Wi-Fi networks are a part of the urban landscape, and how the networks are both shaped by the environment, and shapes how the urban spaces can be used. Second, the visualisations and the process of creating them can also be used as illustrations on a conceptual or metaphorical level, connecting the interactive and technological phenomena of urban life to the macro-discourses around urban technologies and networked cities.

The contextualising of digital technologies in urban life is an emerging field of research that spans multiple disciplines and takes up a broad range of topics, including the development of new devices, services and infrastructures, and studies of how technologies affect city life. The design research presented in this chapter can be situated within these discourses, and it relates specifically to critical perspectives on research and development of new and emerging technologies.

Our visualisations show how Wi-Fi networks are highly local, informal and fragmented, but it also illustrates how these networks make up a highly evolved urban infrastructure that is largely created by its users. This connects with research and discussions from Bell and Dourish on how computing, digital networks and urban environments can be understood as interwoven layers of the city experience:

The spaces into which new technologies are deployed are not stable, not uniform, and not given. Technology can destabilise and transform

these interactions, but will only ever be one part of the mix. Digital technology is only another layer in the already dense and complex context of the city.

(Bell and Dourish 2004: 2)

Bell and Dourish argue for designing not just for urban settings, but for the behaviours and practices of the city and how these evolve (*ibid.*). These writers represent critical perspectives from within computer studies and human–computer interaction (HCI), and have used studies of daily uses of devices and networks to argue for new approaches to technology development that focus more on ‘the messiness of everyday life’ of the present than the envisioning of seamless infrastructures of the future (2007: 131).

Similar perspectives are also addressed in urban studies and cultural geography that work with urban life and technologies. Crang *et al.* (2007) discuss how people are reshaping daily life through the possibilities and limits of digital networks and communication technologies, and how the information landscape and daily life co-evolve. In their research detailed ethnographic studies are used to demonstrate how technology-based urban change ‘involves a layering, tangling, and imbrication of new practices and new possibilities alongside old ways and enduring demands’ (*ibid.*: 2407). Crang *et al.* discuss how interacting with new technologies is happening in between, alongside and within existing practices. The network photographs we show here can be seen as a way of spatialising this discussion through visualising how the technological phenomenon is situated within existing spaces and across urban environments, or as Bell and Dourish (2007) put it, as yet another part of the messiness of everyday life.

Architect Malcolm McCullough argues along similar lines for media urbanism to move from studying macro-infrastructures to focusing on the micro-scale of personal, situated bottom-up embedded computing. He claims that ‘there is urbanism in how people obtain, layer, and manage their connections. Like attention itself, any belonging to community or place is made continuous, partial, and multiple by this mediation’ (2006: 29).

These perspectives come from different backgrounds and have different research agendas, but have a number of central issues in common. They come out of a critique of technology-driven arguments that have dominated the discourses around digital technologies in the city, and move to demonstrate how interacting with digital technologies is interwoven with daily city life in many different ways. Significantly, they bring forward an understanding of technologies in urban contexts that take daily practices and everyday environments as a starting point.

In the design and research presented in this chapter we have taken up this thread and investigated phenomena of networked city life in the everyday environments where these occur. Through visualising, situating and spatialising the phenomena of wireless networks we contextualise and materialise otherwise invisible technological materials that make up the urban landscape. In doing so we suggest ways of unpacking and discussing networked technologies as a highly physical and interwoven part of daily life in cities, and grounding the discourses of technologies in urban life within the environments where this takes place. Seeing

our built environment populated with networks and data is one way of understanding the networked city. This could point towards new means for design research to discuss relationships between our interactions with devices and our interactions with our cities.

Acknowledgements

The work presented in this chapter has been developed together with Jørn Knutsen and Timo Arnall at the Oslo School of Architecture and Design. The work has been supported by Andrew Morrison and the research project YOUrban, funded by the VERDIKT programme, Research Council of Norway. More detail on this work and extended bibliographies can be found at the project's website: yourban.no.

Bibliography

- Arnall, T. and Martinussen, E. S. (2010). Depth of field – discursive design research through film. *FORMAkademisk*, 3(1): 100–122.
- Baldassari, A. (1997). *Picasso and Photography: The Dark Mirror*. Paris: Flammarion.
- Bell, G. and Dourish, P. (2004). Getting Out of the City: Meaning and Structure in Everyday Encounters with Space. Workshop on Ubiquitous Computing on the Urban Frontier (UbiComp 2004, Nottingham, UK).
- Bell, G. and Dourish, P. (2007). Yesterday's tomorrows: notes on ubiquitous computing's dominant vision. *Personal Ubiquitous Computing*, 11(2): 133–143.
- Chalmers, M. and Galani, A. (2004). Seamful interweaving. In *Proceedings of the 2004 Conference on Designing Interactive Systems Processes, Practices, Methods, and Techniques – DIS '04*. Cambridge, MA, 243.
- Crang, M., Crosbie, T. and Graham, S. (2007). Technology, Time – Space, and the Remediation of Neighbourhood Life. *Environment and Planning A*, 39(10): 2405–2422.
- Dunne, A. (2005). *Hertzian Tales: Electronic Products, Aesthetic Experience, and Critical Design*. Cambridge, MA: MIT Press.
- Dunne, A. and Raby, F. (1994–97). *Tuneable cities*. Available: <http://www.dunneandraby.co.uk/content/projects/67/0> [accessed 13 January 2011].
- Dunne, A. and Raby, F. (2001). *Design Noir: The Secret Life of Electronic Objects*. Basel: Birkhäuser.
- Foth, M. (ed.) (2009). *Handbook of Research on Urban Informatics*. Hershey, PA: Information Science Reference, IGI Globale.
- Galloway, A. (2008). *A Brief History of the Future of Urban Computing and Locative Media*. PhD. Carleton University Ottawa, Ontario.
- Graham, S. and Marvin, S. (2001). *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition*. London: Routledge.
- Jarman, R. and Gerhardt, J. (2007). *Magnetic Movie*. [Film] Available: http://www.animate-projects.org/films/by_date/2007/mag_mov [accessed 13 January 2011].
- Latour, B. (1999). *Pandora's Hope: An Essay on the Reality of Science Studies*. Harvard, MA: Harvard University Press.
- Mackenzie, A. (2010). *Wirelessness*. Cambridge, MA: MIT Press.
- Marien, M. W. (2006). *Photography: A Cultural History*, 2nd edn. London: Laurence King Publishing.
- McCullough, M. (2004). *Digital Ground: Architecture, Pervasive Computing, and Environmental Knowing*. Cambridge, MA: MIT Press.
- McCullough, M. (2006). On the urbanism of locative media [Media and the City]. *Places*, 18(2): 26–29.
- Mitchell, W. J. (2004). *Me++: The Cyborg Self and the Networked City*. Cambridge, MA: MIT Press.

- Paulos, E., Anderson, K. and Townsend, A. (2004). UbiComp in the urban frontier. *Human-Computer Interaction Institute*. Available: <http://repository.cmu.edu/hcii/213> [accessed 25 May 2010].
- Wi-Fi Alliance. (2011). *Five Steps to Creating a Wireless Network*. Available: http://www.wi-fi.org/knowledge_center/kc-fivestepsforcreatingwirelessnetwork [accessed 13 January 2011].

Article 3

Article 3, 'Pockets and Cities: Interaction Design and Popular Imagination in the Networked City' (Martinussen, 2013), is published in the journal *Design and Culture*.

Pockets and Cities: Interaction Design and Popular Imagination in the Networked City

Einar Sneve Martinussen

Einar Sneve Martinussen is an interaction designer and researcher working with technology, cities, and everyday life. Martinussen is taking a doctorate at the Oslo School of Architecture and Design as a part of the research project **YOUrban** on networked cities, social media, and design. His work includes visualizations of technology, films, interactive products, and exhibitions. Martinussen also teaches various areas of interaction design and is a part of the design studio **Voy**.
Websites: yourban.no / vayoslo.com.

ABSTRACT This article looks at the emergence of the networked city and how interactive technologies are becoming a part of the urban landscape. It discusses relationships between rapid technological development in cities, popular imagination, and the mundane, and investigates how these are manifested in, and through, interaction design. I ask how we may reveal and discuss networked technologies while they are constantly rendered invisible through cultural and technological processes. How, too, can we use design to generate alternative perspectives on the networked city? The article develops an argument about how our interactions with the networked city are experienced and

shaped through both popular culture and everyday life, and how they might be made visible and questioned through design. The work presented comes out of practice-based design research where academic reflection is joined with design practice as both analytical and generative processes for observation, exploration, and communication. I bring together concepts of the networked city with theories of everyday life to illustrate and problematize relations between interaction design, popular imagination, and technological change. I then present a design project about visualizing the invisible structures of the networked city. Here, the discussion covers a film called *Immaterials: Light Painting Wi-Fi*, which we produced to explore and communicate wireless networks in cities. This is analyzed as a response to the cultural and technical invisibility of the networked city.

KEYWORDS: interaction design, the networked city, everyday life, popular imagination, discursive design

Introduction

The jacket in the photograph with which this article opens appears to be rather ordinary (Figure 1). It is a lined parka bought at a suburban shopping mall outside Oslo in the fall of 2011. However, it is also an illustration of what network city life in Scandinavia looks like in the early 2010s. The jacket does not only insulate a weary commuter from the Oslo winter gales; it is also padded with significant computing power, sophisticated network connections, and cleverly designed interfaces. In the spacious pockets of this parka there is a collection of remarkable, but increasingly common, interactive and networked products that would have been unavailable, if not unimaginable, just a few years ago. Today these devices are becoming a taken-for-granted part of everyday culture in many cities.

It is these technical and cultural phenomena that I discuss in this article. I ask how we can reveal and discuss networked technologies while they are constantly rendered invisible through cultural and technological processes. How, too, can we use design to generate alternative perspectives on the networked city?

Let us return for a moment to the jacket. Clockwise, from the bottom left, the pockets contain: a smartphone (an Apple iPhone 4), an e-book reader (a fourth-generation Amazon Kindle), and a touchless electronic travel card (a branded 13.46 MHz RFID card). These are all products that rely on digital networks to operate; the RFID card uses distributed readers and databases to give access to public transport, the Kindle brings Amazon's online bookshop

into the parks and buses of the city, and smartphones are bringing the Web itself into everyday environments and activities, making the social Internet a part of the urban experience.

This collection of objects is interesting in several ways: as products, technological innovations and as cultural artifacts. Yet they are also devices that may themselves function communicatively and technically in relation to one another, for example when we look up the bus arrival on the smartphone GPS app, swipe the touchless travel card on the bus and then sit down to continue an e-book already half read. These assorted and assembled items provide a glimpse into an emerging form of networked everyday culture at a specific point in time. This is a time when many city dwellers are surrounded by sophisticated devices that represent promises of the future, and at the same time are about to find their place within the messiness of city life. The jacket might be specific to a northern climate and the devices will soon be outmoded by the rapid technological change that they are a part of, but together they provide us with a snapshot of a networked city in use. Importantly, this is a city already widely wired; it is a dynamic context for the continuing technical and cultural development of such technologies, devices, and their situated uses.

In this article I will look at how networked, interactive technologies are becoming part of the urban landscape. The jacket and the



Figure 1
A networked winter jacket.

devices in its pockets serve as a starting point for discussing how the networked city is realized through everyday life, popular culture, and design. There are three initial observations I want to draw from this example. First, the networked city is already taking place in the form of the sophisticated interactive products in pockets. The networked city is both spectacular and mundane at the same time; it carries promises of the near future while becoming a taken-for-granted part of the present. Second, the networked city is predominately experienced and understood through designed artifacts: as interfaces in our pockets, as digital services, and as representations in marketing and popular media. The socio-technical complexity of networked technologies is manifested in daily life through everyday interactions. Third, the networked city is built on technical infrastructures that for the most part go unnoticed. The devices in the jacket's pockets are made possible by wireless networks, radio signals from GPS satellites, and undersea fiber-optic cables. When interacting with digital devices we generate an ever denser weave of wireless communication and data. William Mitchell called this an “electromagnetic terrain” that is both intricate and invisible, and is only hinted at by the presence of antennas (Mitchell 2004: 55).

This article, then, is about making visible the invisible structures of the networked city. It discusses how the networked city takes place in culture and in space, and examines some of the technical and cultural structures that underlie these processes. I develop an argument about how the revealing of the invisible infrastructures of the networked city can reframe the cultural understanding of networked city life. At the center of this argument is a film about visualizing wireless networks called *Immaterials: Light Painting Wi-Fi* (Martinussen 2011a). This film comes out of a discursive design project that draws on the legacy of critical design (Dunne 2005). Dunne and Raby (2007) describe “critical design” as an approach where speculative or experimental design proposals are developed to challenge assumptions and preconditions in technical systems.¹ However, our intent is not necessarily to critique, but to use design in “contextualizing, conceptualizing and communicating emerging technology towards a broader public discourse” (Arnall and Martinussen 2010: 21).

The Networked City

Urban development today and tomorrow is not necessarily about urban planning projects or architectural debates, but about the technologies in our pockets, their design, and their cultural relationships to the urban contexts. The city is no longer shaped by materials such as concrete, glass, and steel alone, but by invisible and immaterial materials such as data, digital communication, and a dense electromagnetic urban landscape. Networked technologies are a part of the material that makes up the urban fabric and influence how the city is used and experienced. Amin and Thrift write that “nearly every urban

practice is becoming mediated by code" (Amin and Thrift 2002: 125) and that "code increasingly will be responsible for the future of cities" (2002: 127). Relationships between cities and emerging technologies like wireless networks, embedded sensors, and locative media have been taken up in several fields, including architecture, urbanism, computer science, anthropology, and design.

As is typical for areas involving emerging technologies, these developments have led to the coining of numerous terms and buzzwords that reflect different trends, perspectives, and research agendas, such as "smart city," the sentient city (Crang, Crosbie, and Graham 2007), urban informatics (Foth 2009), and urban computing (Kindberg, Chalmers, and Paulos 2007). The "networked city" is used more generally to describe the interweaving of networked technologies into urban environments. I have chosen use the "networked city" as a central term because it emphasizes networks and connectivity on multiple levels. It is not within the scope of this article to provide a broad review of the various positions and issues that networked city research entails (see Galloway 2008 for discussion). Instead, I point toward a few central approaches and perspectives to position my arguments and observations.

First, there is a prominent corporate and technological push toward developing so-called "smart cities." This approach is concerned with computational systems and infrastructures for automating and monitoring urban environments. This typically involves the envisioning of large-scale planned cities or urban systems driven by technological and infrastructural innovation; for example, the South Korean u-City projects, and specifically New Songdo, a planned city built on reclaimed land outside Seoul where ubiquitous computing is the key driver (Hwang 2009; O'Connell 2005). A similar vision of a smart city is the driver behind the Center for Innovation, Testing and Evaluation, an ongoing project in the New Mexico desert by Pegasus Holdings (Lindsay 2011). The company is constructing a laboratory test-town with buildings, roads, and infrastructures to support 35,000 people – but with no intended inhabitants. Instead, the town will serve as a site for large-scale testing of urban technology, such as traffic management, power grids, sensor systems, and surveillance. Such systems are in the process of being deployed by municipalities and corporations around the world, for instance in the Intelligent Operations Center for Rio de Janeiro by the IBM Smarter Cities group, which is meant to be a model for data-driven city management (Singer 2012), but which also illustrates the belief that cities should, and could, be controlled and optimized through technology. These "smart city" projects share many core arguments about the envisioned possibilities for technology in cities, and often promote a planning-led, top-down understanding of cities (Greenfield 2011).

The second set of perspectives on networked cities I want to point toward is contrary to the "smart city" discourse. These share a critical approach to urban technology developments, which places

the emphasis on urban life. The visions and trajectories proposed by “smart city” initiatives are challenged by Adam Greenfield, among others, who unpacks their urban understanding by focusing on the implications of pervasive technologies on public space, policy, and across civic life (Greenfield 2009, 2011, 2012). Similarly, Bell and Dourish (2004) bring together computer science and anthropology to examine how computing, digital networks, and urban environments need to be understood as interwoven layers of the city experience. Further, McCullough argues for moving beyond the study of macro-infrastructures to focus on the microscale of personal, situated, bottom-up, embedded computing. He claims that “There is urbanism in how people obtain, layer, and manage their connections. Like attention itself, any belonging to community or place is made continuous, partial, and multiple by this mediation” (McCullough 2006: 29). From social science Galloway too discusses the relationships between the envisioned futures of technology-driven research and social and cultural expectations of locative media:

Over the past two decades, the ability to imbue physical locations and objects with networked data has emerged not only as a social vision based on consumer capitalism, as well as values of access and connectivity, but also one predicated on substantial infrastructural (i.e., physical, political, and economic) change. (Galloway 2010: 34)

Galloway advocates we debate possible futures for the networked city with “a critical perspective that clearly situates itself in the present while also maintaining a view to the past” (ibid.). She emphasizes that technological change and cultural and social expectations shape how a number of possible and partial futures continuously unfold.

These alternate perspectives on the networked city share a concern for the tensions between top-down infrastructural and technology-driven understandings of the city and the often unruly and mixed practices of everyday life. The values, politics, and promises of emerging technology research are critiqued through examining their uptake in, and impact on, the lived realities of the city.

Spectacular and Mundane

The devices in our pockets may be read as expressions of technological development and innovation. Such devices may be deconstructed and analyzed as promises of the near future of networked products as portrayed in the popular technology press. However, they may also be seen as examples of how rapidly emerging technologies become embedded into the ordinariness of daily life. These devices may be both novel and entertaining, but they are also becoming a taken-for-granted part of the everyday. They may come across as spectacular and futuristic, but they quickly become mundanities that share our pockets with keys and receipts. Through

their multiple roles in the city, new information and communication technologies enable new forms of activity (Crang et al. 2007: 2419). Yet, as argued by Crang and colleagues, “They also create their own constraints, as they are mobilized to remediate the social relationships, transactional patterns, and logistical flows that together constitute everyday urban life” (ibid.). Importantly, these technologies are artifacts and devices of cultural interaction, and they are designed to facilitate our connectedness.

In my design and related research I connect the emerging technologies of the networked city to studies of everyday life. These represent a fruitful source of theories and concepts that are rarely taken into account in technology development, but are often manifest in the background of many design practices. Studies and critiques of everyday life occur in urban and cultural studies, sociology, and architecture, and take up a range of issues including macro-structures of power and politics as well as detailed studies of mundane practices (Gardiner 2000; Sheringham 2006). Here notions of everyday life, influenced by Léfèbvre (1991) and de Certeau (1984), prevail as socially and culturally situated; they are layered, embodied, and potentially transgressive. Studies of technoscience and everyday life apply these concepts to interactions with technology and provide interesting insights for questioning the relationships between design, technological developments, daily life, and popular culture. This entails engaging with “rapid change and quotidian repetition” (Michael 2006: 2). So as to develop an argument about design, technological change, and popular media, I now draw together two current perspectives on daily life.

First, the relationships between daily life and processes of change are central to studies of modernity and the everyday. Highmore (2002) discusses how modern life is characterized by both rapid change and the processes for absorbing this change where “The everyday marks the success and failure of this process. It witnesses the absorption of the most revolutionary inventions into the landscape of the mundane” (2002: 2). Through everyday life, technologies become ordinary and “fade from view” (Highmore 2009: 5), as exemplified by the jacket at the beginning the article. This is interesting within the context of design and the networked city: successful technological innovations are those that we take for granted and that turn the spectacular into the mundane. The more everyday they become, the more futuristic they are, in the sense that they become a part of a practical future. This process of embedding and absorbing technological change into daily life, however, does not drive itself or exist only in the relationship between technology and use. It is also interpreted and shaped through media and popular imagination.

Second is the role of media in the way that everyday life is experienced and understood. Drawing on Léfèbvre, Moran discusses how perceptions and expectations of the everyday are produced through media representations and how “Lived, social space is inextricably

linked to represented, imagined space, and that both are central to an understanding of everyday life” (Moran 2005: 33). What are the represented, imagined spaces of networked city life? How is it that we come to expect what we do from our devices? What are the implications of media representations on how interaction design and technology are understood and shaped? Emerging technologies do not only find their place in daily life through the direct interactions between users and products, but also through an entanglement of marketing, news, and gossip in conjunction with their design and contexts of use.

Critiquing Corporate Representations of Networked Lives

Next I look at a few of the ways in which networked life and interaction design are portrayed in popular media. Drawing on two examples of promotional representations of technology, I highlight issues around the relationships between everyday life and the envisioned future of corporate technology development, and the taken-for-granted cultural position of dominating technologies and products.

Unhelpful Futures

There is a trope among technology corporations of producing films about future trends in technology (Kinsley 2010). These typically involve envisioned futures where technological systems and products make life easier. These “vision films” illustrate a set of approaches and beliefs common within much technology development and can therefore be critiqued and discussed on many levels. I limit my scope to two key issues: interaction design and everyday life.

In the fall of 2011, Microsoft Office released a film entitled *Productivity Future Vision*, archetypical of how the networked life of the future is currently presented within corporate envisioning (Microsoft 2011). This film is a part of an ongoing series of popular “future vision” videos that Microsoft publishes online through their YouTube channel, and received 3.4 million views in its first six months. The film shows interactions with envisioned technologies in work settings, in the city, and at home. It is 6 minutes 18 seconds long, has no dialog and is set to dramatic, piano-driven pop music (Figure 2). The following description of scenarios, as I have summarized them, gives some sense of the character of the film.

Productivity Future Vision is a polished piece of online media and presents several compelling interface ideas. At the same time, the film is full of practical and conceptual inconsistencies, both in regard to interaction design and the activities the actors perform as examples of everyday practices. We are presented with a future where wireless networks and technological systems are fully integrated with each other, are tastefully designed, and work flawlessly. Importantly, this future is just out of reach and constitutes what Bell and Dourish call the ever-shifting “proximate future” of technology research (Bell

SCENARIO - 'Productivity Future Vision'

In the opening scene we see a woman exiting Johannesburg airport. As she approaches the taxi zone a yellow animation lights up the pavement to say "Hotel shuttle please wait". The woman then puts on a pair of glasses and looks around while the word "Translating" and a few pulsating dots are displayed on the glasses' arm. She takes the glasses off and gets into a taxi where the time to arrival at the hotel (in seconds) is displayed on the car's window. As she travels through the city information about her upcoming schedule is displayed on the window as overlays onto relevant building (e.g. "Your meeting tomorrow is here").

Throughout this car-journey the woman interacts with a glowing rectangular touch-screen device. Using a variety of finger-gestures she sends messages back home, checks in at her hotel and responds to business related requests. The remainder of the film unfolds in much the same vein: a number of people across the world make logistical operations (both family- and work-based) and perform various tasks on touch-screens of multiple sizes. The emphasis is on interactions with seamless networked systems using touch-gestures reminiscent of those used to operate a contemporary smartphone.

Figure 2

Description of the opening scenes of *Productivity Future Visions* (Microsoft 2011).

and Dourish 2007). This envisioned future is divorced from the often messy and "seamful" relations between technology and society in contemporary everyday practices (Chalmers and Galani 2004). This perspective is also connected to visions and expectations found within the "smart city" discourse, where technology is seen as having the potential to control and optimize the city as long as it is advanced and integrated enough.

There is a set of values, positions, and epistemological preconceptions engrained in Microsoft's film. The kind of future this film envisions advocates for specific understandings of everyday life. This becomes apparent when looking at how Microsoft describes its film online: "Watch how future technology will help people make better use of their time, focus their attention, and strengthen relationships while getting things done at work, home, and on the go" (Microsoft 2011).

This tells a story of optimizing attention, seamlessness, and efficiency. It is in stark opposition to the way that new technologies find their place in the "landscape of the mundane" (Highmore 2002). Highmore writes about how technological innovations "fade from view" over time, but he also describes how signs of failure are a part of the everyday: "The language of the everyday is not an upbeat endorsement of the new; it echoes with frustration, with the disappointment of broken promises" (Highmore 2002: 2).

From a design perspective, it is also interesting that Microsoft presents its vision of a technology-saturated society as a series of mediations of interaction design. This could be described as primarily a vision of the future of interaction design. Why, then, is this future populated with a derivative combination of existing interface

conventions and stale, recycled concepts of technological innovation? The future on offer is consistently built on current expectations, instead of questioning these expectations and examining how alternative futures might already be starting to unfold in daily life. This is obvious when looking closely at the forms of interaction design that are mediated. The interactions we encounter in the film primarily consist of typographical elements and motion graphics floating around on glowing or transparent surfaces, but without conveying any content or contextual connection. The seamless slickness of the way that interaction design is represented in this film manifests symptoms of an *everyday life deficiency*. It does not articulate or communicate at the level of daily life and lacks the everyday grounding needed to make this a culturally sensible vision of the future.

The Invisibility of Cultural Confidence

In contrast, the next example is an interactive product with a cunning cultural sensibility: the Apple iPhone. Since its introduction in 2007, the iPhone has both projected and established new conventions and expectations in mobile technology and has become a part of urban life and popular culture. I now briefly look at the recent cultural history of the iPhone through its marketing. This could be investigated from multiple perspectives (see Hjorth, Burgess, and Richardson 2012); my focus is on how relations between interaction design and everyday life are represented.

In June 2007 the first series of iPhone adverts was launched and made available online. These thirty-second films demonstrate what the iPhone is and what it can do. A phone is held against a black background while the camera follows gestures enacted by fingers on the touchscreen as features are demonstrated (music, video, mail, browser, map, etc.). The focus is on explaining new forms of interaction design and the concept of networked life where online resources “fit in your pocket.” The status of the product as new and in need of explanation is evident in how the films are narrated. The voiceover says: “There has never been an iPod that can do this,” followed by close-up demos of the touchscreen interactions. The film ends with the line “Or, for that matter, this,” and then the phone rings. Here the then dominant iPod is still the cultural reference, while the touchscreen interface is the selling point.

During the broadcast of the Academy Awards in March 2010, the first iPad advert was shown. Audiences saw a thirty-second film set to upbeat guitar music, where the iPad is primarily presented from the point of view of the user. The focus is on the interactions on the iPad’s screen and in the background we see glimpses of domestic situations where the device is being used. The form of the film is similar to the first iPhone adverts: it includes features such as photos, maps, mail, and browsing demonstrated through touchscreen interactions. Two aspects are different, however. First, there is no voiceover or explanation, only demonstrations of features through

interactions. There is no longer a need to explain the touchscreen as the iPhone is now the point of reference. Second, the interface is still a major selling point, but we see a form of mild contextualization pointing toward situations of use in daily life. As a new form of computer, the iPad is articulated both in the interfaces and product design, but also in the apparently casual contexts in which it is used.

In June 2010 Apple launched the iPhone 4 and presented this with a two-minute film about the video-calling feature, FaceTime, set to Louis Armstrong's "When You're Smiling (the Whole World Smiles With You)." This film is very different from the two other examples: we are shown a series of scenes where we get glimpses into domestic, everyday situations where the FaceTime videoconferencing application is used between families and friends. The film starts off with a baby waving to its father and it ends with a deaf couple signing to each other. This is no longer an advertisement about interactions with interfaces, but about the activities in which the phone is situated. We encounter a film about living with the technology and embedding the possibilities it offers into cultural contexts. Apple frame videoconferencing as a social activity rather than a technological feature. The marketing of the iPhone 4, therefore, can be seen as an indicator of how the cultural perception of the iPhone has changed in the first three years since its initial launch. It went from being demonstrated and explained through touchscreen interfaces to being portrayed as a casual cultural artifact of everyday life. There is a clear shift from interaction with technology represented as interface, to interactions with technology conveyed as socially embedded activities.

Kirby discusses how scientific and technological ideas become normalized through cinema and popular media. He describes how media representations can act as a process of "virtual witnessing" and contribute to the neutralization of change (Kirby 2011). In the case of the iPhone, the process of normalizing the product is closely linked with how it is embedded in everyday activities through advertisement. There is a strong relationship between how the interactions and the product are represented in popular culture and how they become an established part of daily life. Visual and narrative realism play an important part in this, but there is also an element of cultural confidence involved that has been iteratively developed through the product cycles. The processes of normalizing the product are both constructed and mirrored in how it is represented. There is an evolving relationship between how the interactions are portrayed and how they are expected to be experienced. This is almost hard to notice, especially because Apple has chosen to continuously remove traces of the online marketing of previous product cycles from their social media sites. As a result, the product seems continuously contemporary and yet it obscures its developmental history (Figure 3). This amplifies the need for research to further unpack the cultural constructs of interaction design in its promotional discourses and its everyday uses.

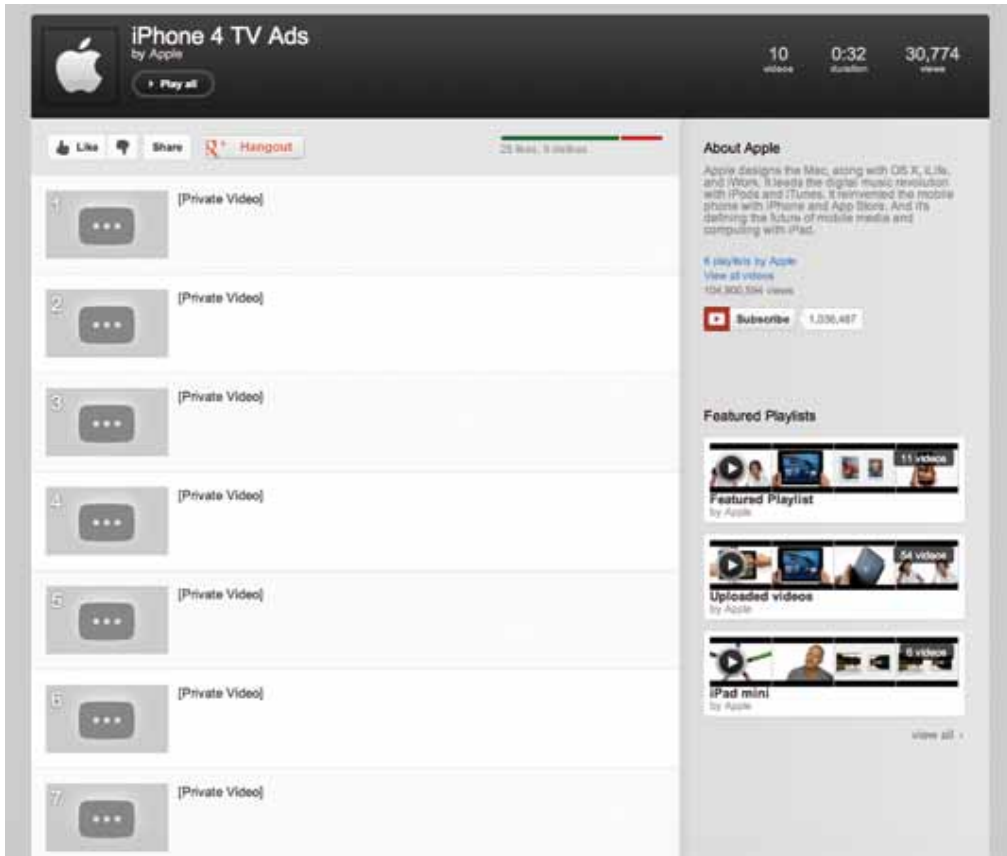


Figure 3

A screenshot of Apple's YouTube channel taken after the release of the iPhone 5. All iPhone 4 films have here been removed from the public domain by making the films "private." Screenshot by author created February 20, 2013.

However, daily life with a smartphone is not as it is portrayed in Apple adverts. The friction and unforeseen consequences in the ways that things like FaceTime and iPhones are actually adopted and used are overlooked or under-communicated in these promotional films. Smartphones have become a part of daily urban life and all that this entails: scratches, smudges, flat batteries, muggings, annoyances, and novelty apps. These gritty effects point to Apple's representations of interaction design also suffering from a deficiency in more accurately communicating the vagaries of everyday life. In many ways these representations have similarities with the typical persuasive corporate vision films. They are set in elegant, yet false, everyday contexts where networks and devices always work as intended. This is a representation of networked life that celebrates seamlessness and promotes a perspective on interaction design that has this stance as its central premise.

The effects of the cultural confidence of the iPhone are opaque in many ways. As this sector-changing product has become a normalized part of everyday culture, it has also created conventions and perspectives on technology. In this process it is also establishing – and continues to point toward – popular expectations of networked life, as well as shaping the imagination of designers, industry, and consumers. Over just a few years, Apple’s mobile products have become the major frame of reference for the design of networked devices. As a consequence, the product is also interwoven with how the networked city is experienced and understood.

Invisibility

Both the Microsoft and iPhone films mask aspects of the technologies they work with, yet in some ways they make the underlying systems, politics, and values less understandable. Both films produce invisibilities that derive from how they relate to everyday life and how they portray interactions with networked devices. The iPhone adverts create a cultural invisibility that comes out of the product’s efficiency at establishing new, taken-for-granted realities. The Microsoft *Vision* film promotes technological invisibility in how it presents inconsequential futurism that overlooks the practicalities of technology in favor of surface quality and spectacular interactions. In both these examples, networked technologies are portrayed as seamless, invisible systems that are unaffected by the physical and cultural contexts in which they take place.

The design decisions behind these promotional representations obviously serve each of the corporation’s commercial needs (Morrison and Skjulstad 2011). However, these mediations are also a part of popular culture where they propagate ideas about networked technologies that shape the understanding and expectations of these. In a way, these forms of promotional discourse limit what we can know about living with technologies and, importantly, also what the potential is for designing new forms of networked interaction.

In the context of the networked city, this is particularly relevant because the technologies of networked city life are often both technically obscure and culturally mundane at the same time. As a result, they are therefore doubly invisible. Within sociology Latour describes blackboxing as when “technical work is made invisible by its own success” (Latour 1999: 304). He writes that when technologies work efficiently we only focus on their inputs and outputs, and their internal complexities become opaque and obscured (*ibid.*). Many of the technologies of the networked city are technically invisible in the sense that the complex underlying systems and infrastructures are blackboxed and culturally invisible precisely because they become embedded in daily life.

Michael writes about how “Technoscience is mundanely manifested in the practical and often unnoticed technologies (and expertises) that cohabit the everyday with us” (Michael 2006: 33).

Importantly, such technologies are not simply material artifacts, but “incorporate a cultural baggage that ‘scripts’ how they might be used; as such, we see how the assumptions of technologists (and designers) infect with everyday exigencies” (ibid.). As discussed in the examples above, this is also the case for popular media representations of technologies. The images of networked life promoted through vision films and marketing also incorporate cultural perspectives and assumptions that shape everyday life.

The challenge arises then for interaction design as to how to tackle the invisible and immaterial qualities of the networked city. One way to examine “smart city” rhetorics and generate alternative perspectives is offered in the film *Immaterials: Light Painting Wi-Fi*.² Produced by a team of design researchers working with a research project that investigated the networked city as culture and design, the film visualizes one of the basic phenomena of the networked city: the wireless Wi-Fi network (Figure 4). The film starts off with the question of how the invisible landscapes of Wi-Fi signals in the city can be revealed. It then goes on to present a series of visualizations of Wi-Fi networks in urban spaces and the process of creating these (e.g., Figures 5 and 6).³



Figure 4

The Wi-Fi network of the Oslo School of Architecture and Design visualized across its forecourt. The graph of light represents signal strength and shows the peaks and troughs of the network as it is shaped by the physical environment. To create these visualizations, we developed a mapping technique using a specially designed instrument and a photographic method called light painting. The still image is from *Immaterials: Light Painting Wi-Fi*, 2011, Martinussen, Arnall, and Knutsen.

The film shows the design team developing an instrument for light painting Wi-Fi networks into the spaces where they occur.⁴ Our instrument is a 4m-long Wi-Fi measuring rod that monitors the strength of a Wi-Fi network and displays this as a bar of lights (Martinussen 2011b). The signal strength is displayed as bright LED lights going up or down the rod. The stronger the signal, the more lights turn on and the bar of lights becomes higher. When this Wi-Fi measuring rod is moved through space and photographed with a long exposure time, the result is graphs that draw out the signal strength through a particular cross-section of the space, creating a pattern of light that maps out the changes in the network. In the film we then walk around a typical neighborhood in Oslo and probe and capture networks as a form of urban photography (Figure 7).

It reveals the granular materiality of how the signals actually behave at a specific place and time. These cross-sections indicate that the network is not a seamless cloud, nor is it constant or given. Instead, the network is shaped by urban environments as it becomes mixed with the bricks, glass, and concrete of the streets (Figure 8). At the same time, the visualizations also show just how dense and pervasive the electromagnetic terrain of the city is becoming (Figure 9).



Figure 5

The instrument for visualizing Wi-Fi networks is a measuring rod that is 4m tall and covered with LEDs. As the rod is moved through space, the height of the lights corresponds to the signal strength of the network. A camera with a long exposure time allows us to capture this movement as a cross-section of the network. Still from *Immaterials: Light Painting Wi-Fi*, 2011, Martinussen, Arnall, and Knutsen.

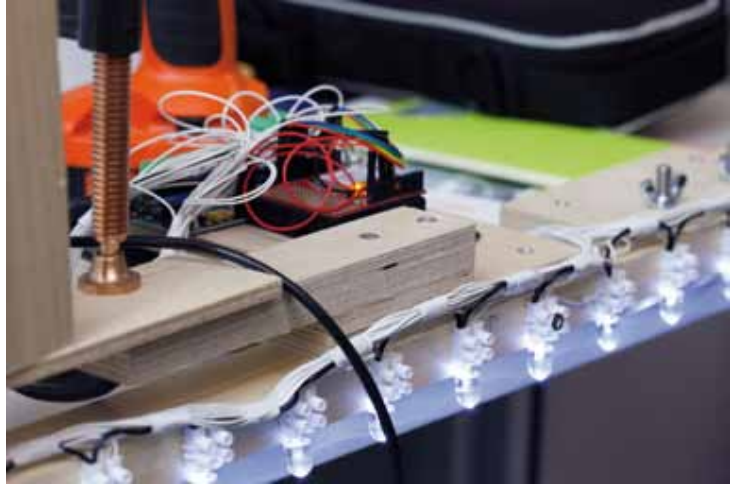


Figure 6

The Wi-Fi measuring rod uses a microcontroller and a small, commercial Wi-Fi unit to measure the networks. In the process of designing this instrument, we repurposed the tools and materials of interaction design to reveal the phenomena that they are a part of. Instead of using the devices to facilitate networked communication, we used them to make visible the underlying structures that make this connectedness possible.



Figure 7

The process of designing these images brought together technical and aesthetic considerations. It is about creating a visual language using measurement and code to draw in urban spaces. We have chosen to make the graphs 4m tall to reflect the architectural scale at which the networks operate. As well as using continuous edges and dotted lines to make graphs that at the same time are striking as well as being transparent enough to place them inside, instead of on top of the sites. Still from *Immaterials: Light Painting Wi-Fi*, 2011, Martinussen, Arnall, and Knutsen.



Figure 8

The image shows how the networks are shaped by the physical environment. Here a wall creates a shadow in a network at the far left side of the picture. The density of the bricks blocks the high-frequency radio waves that carry the digital information. Still image from *Immaterials: Light Painting Wi-Fi*, 2011, Martinussen, Arnall, and Knutsen.

Visualization as Cultural Intervention

The design and research challenge here is layered and brings together technology, interaction, and communication. First, in order to investigate Wi-Fi networks, there is a need to understand technological systems on a detailed level. In our design process this involved analyzing and programming industrial Wi-Fi components similar to those found in smartphones. In order to build the Wi-Fi light painting rod, this meant repurposing the technology as an in-situ measuring system rather than communication protocol. Second, in parallel to these technical investigations, we explored light painting, or light *mapping*, as a photographic technique for visualizing, situating, and contextualizing the phenomena (Martinussen 2011b). In previous projects we began using this technique to map invisible technologies into physical space and with the Wi-Fi visualizations this proved to be a fruitful approach to spatially situating technologies photographically (Arnall and Martinussen 2010). Third, the purpose of *Immaterials: Light Painting Wi-Fi* has been to find ways of materializing the networked city through visualization and to contribute to the broader discourse around technology in everyday urban life (Martinussen 2012a). The communicational aspects of the project



Figure 9

The visualizations of Wi-Fi signals along a main city street reveal the physical nature of the invisible networks, placing it alongside other urban phenomena. The film also points out how the networked city is both fragmented and pervasive: this neighborhood is saturated by often competing signals that serve any number of different purposes. Still image taken from *Immaterials: Light Painting Wi-Fi*, 2011, Martinussen, Arnall, and Knutsen.

are therefore central and they extend to careful use of online media-
tion and attention to popular culture aspects.

Immaterials: Light Painting Wi-Fi can be seen as a cultural intervention directed toward the broader media landscape. It has reached a wide audience and in the first year after being released on to the Internet, the film was seen over a million times. The film was propagated internationally through traditional news media, magazines, TV, radio, exhibitions, books, and awards, and was discussed on numerous blogs, websites, and in social media (Martinussen 2012b).

The far-reaching uptake of *Immaterials: Light Painting Wi-Fi* points specifically at the cultural gap between how wireless networks are both technically obscure and culturally invisible at the same time. The film and its visual narrative allow us to see how the streets are filled with the digital networks we take for granted. The film creates a new set of images of how the networked city is realized, and the propagation of these images points to the need for a visual language for imagining or understanding networked technologies. The images that are available for illustrating technological phenomena shapes how it can be discussed, and here there is a potential for using design practice for cultural interventions.

Design and Popular Imagination

One of the questions this article set out to explore was how design research might be used to generate alternative perspectives of the networked city. This opens up a methodological discussion about how to engage with the relationships between interaction design, everyday life, and popular culture. In tackling this problem, the production of *Immaterials: Light Painting Wi-Fi*, for example, relates to the approaches offered by critical design. Seago and Dunne describe critical design research as “using the process of invention as a mode of ‘discourse,’ a poetic invention that, by stretching established conventions, whether physical, social, or political, rather than simply affirming them, takes on a radical critical function” (Seago and Dunne 1999: 17). In this context the film can be read as a critique of the naturalizing power of corporate mediations of design and interaction. Yet, it is also a mediating artifact in its own right that others may also critique and it too may be seen as having its own technological and cultural configurations and limitations. That said, the film is not necessarily just a critical design argument that challenges the assumptions in technical systems. It is also a discursive project about using design practice to explore and communicate what is technically and culturally obscured.

Design can and should take on the role of negotiating and translating between popular culture and emerging technologies by creating alternative images and perspectives directed toward the popular imagination. *Immaterials: Light Painting Wi-Fi*, for instance, was designed and released as an online media intervention deliberately directed toward the social and cultural channels of the Web. Through online sharing, commentary, discussion and the multiple forms of distribution, the film itself became embedded in popular online media.

These discursive moves can be connected back to studies of everyday life and how “lived, social space is inextricably linked to represented, imagined space” (Moran 2005). As Moran points out, everyday life is shaped by media and popular culture and so are the represented, imagined spaces of new technology. Understandings and experiences of emerging technologies are shaped in relation to mediated articulations of technology and interaction. This is exactly what the likes of Apple and Microsoft try to do through their mediated representations of everyday interactions with technology.

However, as addressed with the Wi-Fi film, there is also a potential here for a different form of popular cultural invention within the same construct. This is one that critiques and explores technological and cultural developments as they happen and points at things that go unnoticed. Or, as suggested by Highmore, “If everyday life, for the most part, goes unnoticed (even as it is being revolutionized), then the first task for attending to it will be to make it noticeable” (Highmore 2002: 23). Similarly, within the networked city discourse, Greenfield argues for investigating and opening up technologies and

systems, thus “explaining their implications to the people whose neighbourhoods and choices and very lives are increasingly conditioned by them” (Greenfield 2009).

Interaction design typically takes place between technology development and use: interfaces, products, services, etc. There is potential, however, for design research to address specifically the understanding and expectations of technologies in daily life. Online mediation can play a central role in this process as “articulation of new concepts to a wide audience, and point[ing] towards the possibilities for using films as a means of probing the sociocultural aspects of emerging technology” (Arnall and Martinussen 2010: 119). Online film, as discursive design intervention, can act as boundary objects with the potential for revealing, explaining and translating complex technologies within a popular cultural frame and hopefully provoke reflection, discussion and critique (ibid.). As Michael explains, an important argument is that “The discourses, and sometimes spectacles, that ‘accompany’ technoscience into everyday life serve in the reordering of the present in order to fashion a future everyday life” (Michael 2006: 9).

Conclusions

The networked winter jacket is an everyday example of how the present is quietly reordered to become the future. In emptying its pockets it is possible to see that there is a reflexive relationship between the networked city and interaction design. Each can inform the other. Wireless networks and the devices in our pockets are examples of how networked city life is taking place today. They demonstrate how vast computational and communication infrastructures often are experienced and show what interaction design has made available for cultural and communicative use and expression. This relationship is not just about interfaces and products but about communication, explanation, and popular imagination.

Cities are sites where technological developments are manifested both in physical environments, social changes, and cultural conditions. As the corporate, technology-driven visions of the “smart city” become partial realities, it is within urban life that the politics, values, and perspectives that underlie these visions have their impact. The emergence of the networked city illustrates the invisibilities and tensions between technological development and daily life. It opens up the question of how these can be represented, reflected upon and discussed.

Interaction design exists in the intersection between technology, infrastructures, services, and citizens. Through both practice and products, designed interactions embody how we interact with and live with technologies in daily life. As emerging forms of products and interactions solidify and become conventions, opportunities are lost and challenges are overlooked. The challenge now is not just to understand the networked city, but to find ways of reframing and

reimagining its concepts and consequences. Here, the agency of the designer may be shifted from supporting and confirming processes of technological development toward problematizing discourses around those processes and through using media to be both critical and propositional within popular culture.

Notes

1. In this project my colleagues and I have developed techniques and instruments for creating images that reveal invisible networks in urban spaces. The film is about using these techniques to explore, visualize, and communicate about common, yet invisible network technologies toward a broad audience, using online media for distribution and discourse. We place this project within what we have earlier called discursive design (Morrison et al. 2011), where we make apparent and share, via designed communication, the materials, processes, and mediations of emerging technology.
2. *Immaterials: Light Painting Wi-Fi* premiered in February 2011.
3. Wi-Fi, or IEEE 802.11, is a technical standard for establishing wireless communication between devices such as laptops and smartphones. Wi-Fi uses high-frequency radio waves to transmit digital information and can operate over distances up to 100 meters (Wi-Fi Alliance 2011). Wi-Fi base stations are inexpensive consumer products that allow almost anyone to set up a network. As Wi-Fi signals propagate from base stations in homes, cafes, and offices, and into urban spaces, the radio waves become obstructed, reflected, and amplified by the physical environment.
4. Light painting is a photographic technique where a stationary camera with a long exposure time captures moving light in a dark environment.

References

- Amin, A. and N. Thrift. 2002. *Cities – Reimagining the Urban*. Cambridge: Polity Press.
- Arnall, T. and E. Martinussen. 2010. “Depth of Field – Discursive Design Research Through Film.” *FORMakademisk*, 3(1): 100–22.
- Bell, G. and P. Dourish. 2004. “Getting Out of the City: Meaning and Structure in Everyday Encounters with Space.” Workshop on Ubiquitous Computing on the Urban Frontier, Ubicomp 2004, Nottingham, UK.
- Bell, G. and P. Dourish. 2007. “Yesterday’s Tomorrows: Notes on Ubiquitous Computing’s Dominant Vision.” *Personal and Ubiquitous Computing*, 11(2): 133–43.
- Chalmers, M. and A. Galani. 2004. “Seamful Interweaving: Heterogeneity in the Theory and Design of Interactive Systems.” In *Proceedings of the 2004 Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques*, pp. 243–52. Cambridge, MA: ACM Press.

- Crang, M., T. Crosbie, and S. Graham. 2007. "Technology, Time – Space, and the Remediation of Neighbourhood Life." *Environment and Planning A*, 39(10): 2405–22.
- De Certeau, M. 1984. *The Practice of Everyday Life*. Berkeley: University of California Press.
- Dunne, A. 2005. *Hertzian Tales: Electronic Products, Aesthetic Experience, and Critical Design*, 2nd edn. Cambridge MA: MIT Press.
- Dunne, A. and F. Raby. 2007. "Critical Design FAQ." Dunne and Raby. Available online: <http://www.dunneandraby.co.uk/content/bydandr/13/0> (accessed January 3, 2012).
- Foth, M. (ed.). 2009. *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City*. Hershey, PA: Information Science Reference.
- Galloway, A. 2008. "A Brief History of the Future of Urban Computing and Locative Media." Ph.D. dissertation, Carleton University, Ontario, Canada.
- Galloway, A. 2010. "Locating Media Futures in the Present." *Aether: The Journal of Media Geography*, 5a: 27–36.
- Gardiner, M. 2000. *Critiques of Everyday Life*. London and New York: Routledge.
- Graham, S. and M. Crang. 2007. "Sentient Cities." *Information, Communication & Society*, 10(6): 789–817.
- Greenfield, A. 2009. "Digital Cities: Words on the Street." *Wired UK* (September 30). Available online: <http://www.wired.co.uk/magazine/archive/2009/11/features/digital-cities-words-on-the-street> (accessed May 10, 2012).
- Greenfield, A. 2011. "Wired 'Change Accelerator' Posts, in Convenient Single-Dose Form." *Adam Greenfield's Speedbird* (November 13). Available online: <http://speedbird.wordpress.com/2011/11/13/wired-change-accelerator-posts-in-convenient-single-dose-form/> (accessed May 10, 2012).
- Greenfield, A. 2012. "Week 61: Spontaneous Order (and Value) From the Bottom Up." *Urbanscale* (March 6). Available online: <http://urbanscale.org/news/2012/03/06/week-61-spontaneous-order-and-value-from-the-bottom-up/>. Accessed May 10, 2012.
- Highmore, B. 2002. *Everyday Life and Cultural Theory: An Introduction*. London and New York: Routledge.
- Highmore, B. (ed.) 2009. *The Design Culture Reader*. London and New York: Routledge.
- Hjorth, L., J. Burgess, and I. Richardson (eds). 2012. *Studying Mobile Media – Cultural Technologies, Mobile Communication, and the iPhone*. New York: Routledge.
- Hwang, J. 2009. "u-City: The Next Paradigm of Urban Development." In M. Foth (ed.), *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City*, pp. 367–78. Hershey, PA: Information Science Reference.

- Kindberg, T., M. Chalmers, and E. Paulos. 2007. "Guest Editors' Introduction: Urban Computing." *IEEE Pervasive Computing*, 6(3): 18–20.
- Kinsley, S. 2010. "Representing Things to Come: Feeling the Visions of Future Technologies." *Environment and Planning A*, 42(11): 2771–90.
- Kirby, D. 2011. *Lab Coats in Hollywood – Science, Scientists, and Cinema*. Cambridge, MA: MIT Press.
- Latour, B. 1999. *Pandora's Hope: An Essay on the Reality of Science Studies*. Harvard, MA: Harvard University Press.
- Léfèbvre, H. 1991. *The Production of Space*. London: Blackwell.
- Lindsay, G. 2011. "Not-So-Smart Cities." *New York Times* (September 24). Available online: <http://www.nytimes.com/2011/09/25/opinion/sunday/not-so-smart-cities.html> (accessed May 10, 2012).
- Martinussen, E.S. 2011a. "Immaterials: Light Painting Wi-Fi." *YOUrban.no* (February 22). Available online: <http://yourban.no/2011/02/22/immaterials-light-painting-wifi/> (accessed May 10, 2012).
- Martinussen, E.S. 2011b. "Making *Immaterials: Light Painting Wi-Fi*." *YOUrban.no* (March 7). Available online: <http://yourban.no/2011/03/07/making-immaterials-light-painting-wifi/> (accessed May 10, 2012).
- Martinussen, E.S. 2012a. "Making Material of the Networked City." In M. Hensel (ed.), *Design Innovation for the Built Environment*, pp. 235–47. London and New York: Routledge.
- Martinussen, E.S. 2012b. "Visualising Wi-Fi for the masses." *YOUrban.no* (June 1). Available online: <http://yourban.no/2012/06/01/visualising-wifi-for-the-masses/> (accessed June 5, 2012).
- McCullough, M. 2006. "On the Urbanism of Locative Media [Media and the City]." *Places*, 18(2): 26–29.
- Michael, M. 2006. *Technoscience and Everyday Life*. Maidenhead and New York: Open University Press.
- Microsoft. 2011. "Productivity Future Vision (2011)." Microsoft Office Videos, YouTube channel, October 25. Available online: <http://www.youtube.com/watch?v=a6cNdhOKwi0> (accessed May 10, 2012).
- Mitchell, W. 2004. *Me++: The Cyborg Self and the Networked City*. Cambridge, MA: MIT Press.
- Moran, J. 2005. *Reading the Everyday*. London and New York: Routledge.
- Morrison, A., T. Arnall, J. Knutsen, E. Martinussen, and K. Nordby. 2011. "Towards Discursive Design." In *Proceedings of IASDR2011, October 31–November 4 2011*. Available online: www.iasdr2011.org/.
- Morrison, A. and S. Skjulstad. 2011. "Laying Eggs in Other People's Pockets." In B. Gentakow, E. Skogseth, and S. Østerud (eds), *Literacy – Technology – Cultural Techniques. How Does*

Communication Technology Mediate Culture?, pp. 201–24.
Cresskill, NJ: Hampton Press.

O'Connell, P. 2005. "Korea's High-Tech Utopia, Where Everything Is Observed." *New York Times* (October 5). Available online: <http://www.nytimes.com/2005/10/05/technology/techspecial/05oconnell.html?pagewanted=all> (accessed May 10, 2012).

Seago, A. and A. Dunne. 1999. "New Methodologies in Art and Design Research: The Object as Discourse." *Design Issues*, 15(2): 11–17.

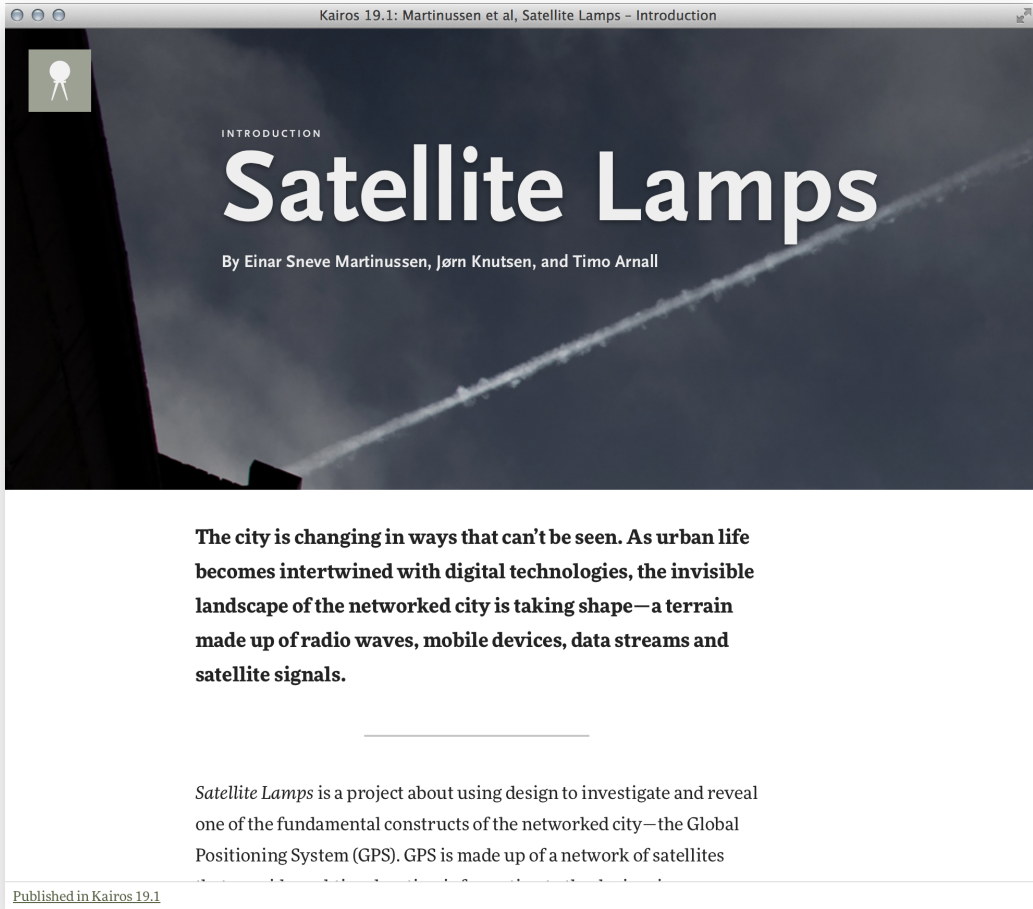
Sheringham, M. 2006. *Everyday Life – Theories and Practices from Surrealism to the Present*. Oxford: Oxford University Press.

Singer, N. 2012. "Mission Control, Built for Cities." *New York Times* (March 3). Available online: <http://www.nytimes.com/2012/03/04/business/ibm-takes-smarter-cities-concept-to-rio-de-janeiro.html?pagewanted=all> (accessed May 10, 2012).

Wi-Fi Alliance. 2011. "Five Steps to Creating a Wireless Network." Available online: http://www.wi-fi.org/knowledge_center/kc-fivestepsforcreatingwirelessnetwork (accessed May 10, 2012).

Article 4

Article 4, 'Satellite Lamps' (Martinussen et al., 2014), is published online in the journal *Kairos—A Journal of Rhetoric, Technology, and Pedagogy*.



Article 4, 'Satellite Lamps', is a webtext that is only available online:
<http://kairos.technorhetic.net/19.1/inventio/martinussen-et-al/>

Appendix A-D

As discussed in Chapter 3, online communication and documentation have been an important part of the design research practice. Appendix A-D includes a selection of four online articles that illustrate how the films have been disseminated, and how their cultural circulation have been documented and communicated. These are included here as screenshots alongside links to the full articles.

YOURban — Immaterials: Light painting WiFi

yourban.no/2011/02/22/immaterials-light-painting-wifi/ Reader

YOURban

STROLL OVERLAY PLAYUR

Publications People About


Immaterials: Light painting WiFi

Written by Einar Sneve Martinussen
Tuesday, 22 February, 2011

Immaterials Networked city
Visualisation WiFi

Related Posts:
Making 'Immaterials: Light painting WiFi'
Projects inspired by 'Immaterials: Light painting WiFi'

The city is filled with an invisible landscape of networks that is becoming an interwoven part of daily life. WiFi networks and increasingly sophisticated mobile phones are starting to influence how urban environments are experienced and understood. We want to explore and reveal what the immaterial terrain of WiFi looks like and how it relates to the city.



Immaterials: light painting WiFi film by Timo Arnall, Jørn Knutsen and Einar Sneve Martinussen.

This film is about investigating and contextualising WiFi networks through visualisation. It is made by Timo Arnall, Jørn Knutsen, Einar Sneve Martinussen.

Appendix A

The online article written for the launch of *Immaterials: Light Painting WiFi* (22.2.2011).

The article can be accessed at:

<http://yourban.no/2011/02/22/immaterials-light-painting-wifi/>

YOURban — Making 'Immaterials: Light painting WiFi'

yourban.no/2011/03/07/making-immaterials-light-painting-wifi/ Reader

YOURban

STROLL OVERLAY PLAYUR

Publications People About

Making 'Immaterials: Light painting WiFi'

Written by Einar Sneve Martinussen
Monday, 7 March, 2011

Design and development Film
Immaterials Networked city
Process Visualisation WiFi

Related Posts:
Immaterials: Light painting WiFi
Projects inspired by 'Immaterials: Light painting WiFi'
Visualising WiFi for the masses
Satellite Lamps

It has been very exciting to see how our film 'Immaterials: Light Painting WiFi' has been linked to and discussed across a broad range of audiences, disciplines and fields of research, including urbanism, technology, architecture, advertising and art.

A common question, particularly from interaction design and technology communities is how we designed and built the WiFi measuring rod. So we thought it would be a good idea to go into some details about the design and development of the probe and the techniques, and also point towards how design research can contribute to understanding immaterial phenomena of networks and the city.

Appendix B

An online article about how *Immaterials: Light Painting WiFi* was made (7.3.2011).

The article can be accessed at:

<http://yourban.no/2011/03/07/making-immaterials-light-painting-wifi/>

YOURban — Visualising WiFi for the masses

yourban.no/2012/06/01/visualising-wifi-for-the-masses/ Reader

YOURban

STROLL OVERLAY PLAYUR

Publications People About

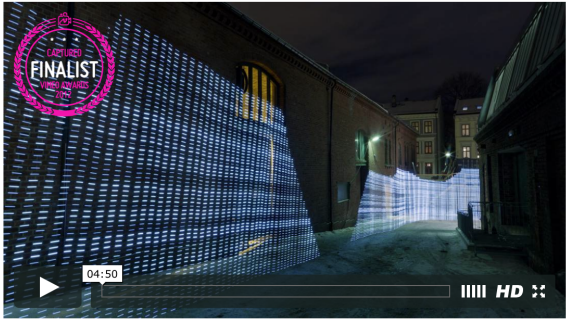
Visualising WiFi for the masses

Written by Einar Sneve Martinussen
Friday, 1 June, 2012

Film Immaterials Media Press

Related Posts:
Projects inspired by 'Immaterials: Light painting WiFi'

A year ago we released our film 'Immaterials: Light painting WiFi'. Since then the film has been viewed over a million times and spread far across the internet, finding its way into many different contexts and taken up in various fields. It has received broad international coverage through traditional news media, design magazines, television, radio, popular science, exhibitions, awards, books, and research. It is still being discussed on blogs, websites and is still being reported and shared on social media. In many ways, the film has become a part of popular culture.



04:50 HD ::

We have been trying to keep track of the propagation of the film for several

Appendix C

An online article documenting some of the cultural circulation of *Immaterials: Light Painting WiFi* (1.6.2012).

The article can be accessed at:

<http://yourban.no/2012/06/01/visualising-wifi-for-the-masses/>

YOURban — Immaterials: Light painting WiFi

yourban.no/2011/02/22/immaterials-light-painting-wifi/

STROLL OVERLAY PLAYUR

Publications People About

YOURban


Immaterials: Light painting WiFi

Written by Einar Sneve Martinussen
Tuesday, 22 February, 2011

Immaterials Networked city
Visualisation WiFi

Related Posts:
Making 'Immaterials: Light painting WiFi'
Projects inspired by 'Immaterials: Light painting WiFi'

The city is filled with an invisible landscape of networks that is becoming an interwoven part of daily life. WiFi networks and increasingly sophisticated mobile phones are starting to influence how urban environments are experienced and understood. We want to explore and reveal what the immaterial terrain of WiFi looks like and how it relates to the city.



Immaterials: light painting WiFi film by Timo Arnall, Jørn Knutsen and Einar Sneve Martinussen.

This film is about investigating and contextualising WiFi networks through visualisation. It is made by Timo Arnall, Jørn Knutsen, Einar Sneve Martinussen.

Appendix D

An online article about projects inspired by *Immaterials: Light Painting WiFi* (6.6.2012).

The article can be accessed at:

<http://yourban.no/2012/06/06/projects-inspired-by-immaterials-light-painting-wifi/>