From Smart City to Smartphone City:

Towards a Telematic Digital Strategy In Urban Environments

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Certificate of Authorship / Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree. I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Elmar Trefz **October, 2017**

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Abstract

Adam Greenfield has debunked the ‘Smart City’ as an unfeasible modernist vision. However, cities are already complex interactive systems, grown from the bottom up according to a complex combination of static, dynamic and interactive systems.

To represent a city as an interactive system would be as complex as the design of a future ‘Smart City’ itself. This research investigates the user’s experience of the city. It focuses not on individual interactive touch points, but on understanding urban user experience from a macro-perspective in the context of the everyday life of the digital age.

The research positions itself between contextual bases: digital product and service design (Jan Chipchase) and Public Life Studies (Jan Gehl). It spans digital products and services via individual systems in specific environmental contexts, and Public Life Studies from a spatial design perspective. The goal here is to investigate the interplay between the two.

Further, the research investigates the performative and telematic qualities of digital implementations in public space, based on the proliferation of Smartphones and spatial interaction design in the urban environment. It thereby extends the notion of engaging with virtual and mixed realities via digital interfaces, anticipating, with reference to Villem Flusser’s ‘Telematic Society’, the theory of engaging with a telematic reality.

The research findings point to a shift away from a Smart City approach towards a ‘Smartphone City’ approach, arguing for a stronger integration of Smartphones in the urban fabric rather than the deployment of new and expensive infrastructures.

Preface

Laurene leaves her home and walks to the bus stop. Pausing at the traffic lights, she checks the progress of her bus using the NextThere app on her iPhone. She crosses the street to the stop, and waits. The bus duly arrives and she enters, paying with her Opal card. At first she must stand, since there are no seats available. She proceeds to consult her iPhone while standing, reading news from the *Le Monde* news website. After the throng disperses at Bondi Junction she sits, continuing to scan the news. When done with reading, she keeps the phone in her hand for the entire trip. Laurene presently exits the

> bus (tapping off her Opal card) and walks to work. There, she enters the building with a swipe card. Laurene then spends nine hours, from 9am to 6pm, in her office - an advertising agency in the central business district of Sydney. We note that she eats her lunch at her desk. After work, she leaves her building and proceeds by foot to the bus stop. She awaits the bus while texting friends on her iPhone. Next, she boards, paying with her Opal card. During the trip she continues texting, then reads Elle Magazine on the Elle Magazine iPhone app. Presently she alights, tapping off the (very convenient) Opal card, crosses the street at the lights and heads home. After a pleasant walk, she arrives at her house.

The digital has transformed how you and I operate in everyday urban life - from convenient payment systems to asynchronous text and image communication, to hyperlinked news reading, to social networking, to location-based services… And yet, these novel digital systems lack integration with the urban systems that we know. Lawsuits against AirBnb and Uber are only the most current instances of such a lack of integration. In the face of high supply and demand, our authorities continue to struggle with the disruptiveness these new systems cause in our accepted urban systems.

Meanwhile, urban developers seek to equip new developments with infrastructure that supports digital systems. However, they struggle to identify use-cases that facilitate meaningful interactions (Greenfield 2013). For example, high-speed wireless internet infrastructures might be implemented, or large-scale screens on top of sensors and actuators. The problem is, integration from a user's use-case perspective is lacking due to poor general understanding of user needs (Kiib 2010).

Location-based services that directly interact with their surroundings like AirBnB, Uber or Tinder show that re-connection of the Smartphone within the urban environment is on the rise, without the need to deploy hardware infrastructure as promoted by urban developers and ICT companies such as IBM, Cisco and Siemens. Smartphones in fact bring the necessary computational power to achieve complex use-cases. What remains then, is the question of what those use-cases actually are, how they address citizens' needs, and how they should be implemented.

1 Introduction

1.1 The Telematic Digital Age: Beyond a dystopia of disunderstanding

Once upon a time, computers were tied to desks in homes and offices. Decades ago, Vilem Flusser foresaw what he referred to as a telematic society (Flusser 2011), one where people continually exchange ideas in a networked society. The mobile phone and Smartphone have now brought this continual networking experience into public space and the urban environment, creating what I call a ‘telematic reality’.

At a time when computers were limited to business, home computing or to gaming consoles in living rooms, people’s interactions with their machines were often referred to as virtual interactions, since the user would interact with a notional artificial reality in a virtual world (Steuer 1992). In the 1990s, computer games and movies such as *Johnny Mnemonic* (where an action hero would travel through virtual networks of corporations to fight against their power) formalised this virtual reality. William Gibson described this vision of a virtual networked world in his book *Neuromancer* (Gibson 2000), where Cyberpunks constantly travel through a dystopian reality in a networked society.

As we speak, the fact that remote events can be triggered and actuated through computer interfaces, requires us to question the virtuality of a cloud-stored reality. ‘Virtual Reality’ refers to the reality of an artificially-simulated separate world, where an example would be ‘second life’ (Boellstorff 2015). However, the telematic triggering of remote events through computer interfaces points toward another digitally-supported reality - that of a remote-controlled reality that telematically takes its commands from anywhere in the world, and actuates them into actions wherever end-devices are available.

Such a reality has been hinted at in disciplines such as those formalised by Tom Igoe in his book *Physical Computing* (Igoe et al.), where sensors and actuators trigger causes and effects in the physical world. This has led to the trend-phrase ‘Internet of Things’ (Gubbi et al. 2013), which argues that myriad internet-connected devices will be present in our physical surroundings in the near future: toasters, heaters, mixers, pillows or any electronic device able to receive and send commands to and from the internet and act as a sensor or actuator.

Such a direct world of physical computing, along with IoT with its focus on end devices, does not address the indirect layer whereby events in the physical world are sensed and actuated: for example, the mechanics set in motion when we order a book on amazon, the Uber driver who starts driving when we hit the button on our Smartphone app - or indeed the remote decision-making and emotional sensing and actuating of performative feelings through social media.

As long as networked devices were locked up in offices and homes, the telematic effect was contained in private space. Mobile devices however, bring this telematic sensing and actuating into the physical public space, where it proceeds to form not just a networked society but a telematic reality. We owe this to the actuator, the output of actions of end devices situated anywhere in the world.

Adam Curtis, in *HyperNormalisation* (Curtis 2016), shows that the complexity of this networked society - viewed as a dystopia by authors like William Gibson and as a utopia by Silicon Valley pioneers like John Perry Barlow (Barlow 1996) - creates uncontrollable complexities that neither politicians nor corporations can control. In fact, Curtis shows how complexity in our contemporary networked society affects reality itself - since the direct cause and effect of any given ‘fact’ can no longer be discussed or interpreted in isolation.

In consequence, there now exists a complete disconnect between the digital and interactive use of networks and understanding of the mechanics behind those networks. Such a disconnect certainly does not interfere with useability; in fact it fuels the complexity and abstraction pointed out by Adam Curtis. We may ask how knowledgeable a driver of a car is about how the engine works or how one gear shifts to another. We may also ask how much a Smartphone user knows about how a file is transmitted from his device to the cloud and on to another Smartphone. Such knowledge may be judged crucial in that it enhances the useability of mobile applications in general. On the other hand, creating these abstractions further fuels the complexity we face in our networked society and telematic reality.

Byung-Chul Han ventures further, arguing that useability works directly against us, in that ‘user-friendly’ technology - which lets us do more and more - simply enables us to exploit ourselves (Han 2015). Such ‘self-optimisation’ leads in turn, he says, to depression and attention-deficit disorders. Han forcefully argues that humans need emptiness and the silence for self-reflection, and that these are continually displaced by the digital noise created in the networked society.

The growth of complexity in the digital age, when viewed in the context of public space and urban environments, actually creates a level of denial of the urban. The networked layer, overlaying the physical urban environment, not only augments information beyond the physical, but interweaves its telematic properties into the urban fabric. Ordering with Uber, paying a parking meter with a Smartphone app, or navigating a neighbourhood with a map application: these fundamentally change how we would have otherwise interacted with this environment. The fact is, we do not interact with this new reality only in virtual form but in telematic form, since we still move through the space physically. We no longer merely create meaning in the physical environment, nor abstracted meaning in the virtual environment, but remote-controlled meaning through digital interfaces.

This new form of urban interaction surely challenges ‘the urban’ at its core. The urban used to refer to a messy constellation of apparently uncontrollable factors. In the context of the digital age and its aforementioned telematic properties, the urban purports to be controllable and manageable according to digital implementations - but only in the sense that they diffuse and disillusion the urban and urbane into a hyper-organised living machine (Greenfield 2013).

In light of this, what seems to be ignored is the actual needs of urban inhabitants. How can we possibly make sense of telematic reality in public space? How can we *formalise* what the urban experience in the digital age looks like, considering the complexity described above? Our need is surely to design a digital urban future that is human-centred, rather than one that mimics the dystopia envisioned by William Gibson or Byung-Chul Han.

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Over the past decade, Smart City developments have been carried out across a broad spectrum of urban environments, notably Masdar in Abu Dhabi, Songdo in South Korea and PlanIT Valley in Portugal. These are now largely considered failures (Greenfield 2013). Such developments were based on a vision of how future cities might perform based on digital innovations at the time of planning. Digital implementations have been referred to by generic labels such as ‘interactive smart wall’ or ‘interactive smart sensor’[1] to avoid specifying their use-cases and what they actually do for the inhabitant. Adam Greenfield (former user-experience design director for Nokia and now urban experience researcher for his practice Urban Scale, the London School of Economics and Bartlett School of Architecture) argues that such city developments neglect to account for how people actually use, live and interact in cities. Greenfield criticises PlanIT for essentially referring to every dive bar, farmers’ market, playground, cinematheque, Michelin-starred restaurant, bodega, bike shop, edgy boutique, rib shack, fetish club and flower festival – as well as everything implied by them - with the words ‘Occupant support and convenience system’. Greenfield effectively asserts that these so-called Smart Cities are not based on a user-centred design.[2]

Crucially, digital innovation has developed at a rapid rate: specifically, the near-omnipresent use of Smartphones and their constant increase in features and computational power.[3] Smartphones may well be ideally placed to address what Smart City concepts promised to deliver. To give an example: a future Smart City planner might have left a rectangular space for a multi-touch screen at a bus stop that would offer the commuter a timetable. This particular use-case may well be addressed by the commuter checking the timetable on his Smartphone. Further, the bus app on the Smartphone may offer location-based information, such as when to get off the bus or inform the commuter who is walking to the stop of the actual arrival time, so she knows whether to hurry or not. In this instance, the Smartphone application surpasses the multi-touch screen envisioned by the Smart City planner. This research therefore argues that to facilitate better user-centred design in future Smart City developments, we need a deeper understanding of urban user behaviour in the context of digital innovation and the complexity it creates.

Since the 1900s, the urban experience and behaviour of people in public life has been researched by pioneers such as George Simmel (Simmel 1903), Jane Jacobs (Jacobs 1961) and Jan Gehl (Gehl 2010). These researchers have been influential in developing research methodologies to investigate behaviour in public space. Jane Jacobs and Jan Gehl have criticised modernist developers such as Robert Moses for their failure to understand how people live and behave in urban environments, and thereby pointed out such developers' negative impact on public life.[4] Jan Gehl in 1971 published his academic research on public life studies in Life between Buildings (Gehl & Svarre 2013) therein establishing public life studies as a recognized field of research. Gehl's work is claimed to be responsible for the vibrant public life in Copenhagen and Melbourne, among many other cities.[5]

The use of digital applications in the urban environment such as Google Maps, NextThere, WhatsApp, Instagram, Yelp and Uber has fundamentally affected how we socially interact, communicate, behave, orientate and navigate in public space. These applications are enabled through navigation systems (Zhao 1997), mobile devices (Ballagas et al. 2006), location-based services (Schiller & Voisard 2004), high-speed mobile internet infrastructures (Khan et al. 2014) and various embedded sensors and actuators (Simons 2012). The research and development of digital applications specifically designed for urban use, is referred to by Marcus Foth as 'Urban Informatics' (Foth 2009). Urban Informatics applications can be deployed both on Smartphone systems and infrastructure systems embedded into the urban environment, notably interactive media architecture (Fox & Kemp 2009) and responsive buildings and environments (Bullivant 2006).

Martijn de Waal, a Smart City researcher at the Amsterdam University of Applied Science and author of City as Interface, argues that the disruption caused by digital applications produced an ever-widening gap between traditional understanding of public life and life in the digital age. He refers to Jane Jacobs' suggestion that 'word does not move around where public characters and sidewalk life is lacking' (Waal 2014). In today's digital age, however, social media applications facilitate the spreading of the word without the need for physical encounters on the street.

Current public life studies research the overall urban experience from an urban design perspective, while Urban Informatics research individual digital applications in an urban context. However, neither public life studies nor urban informatics tend to consider the collective influence of digital applications on the urban experience and public life.

Therefore, this research proposes to investigate this influence by drawing from both urban informatics and public life studies, in order to formulate the contemporary urban user experience and to inform and facilitate better user-centred design of future Smart City developments.

1.2 Focus

This writer's initial research focus was to investigate opportunities to expand an Urban Informatics project that I participated in, entitled 'Neighbourhood Scoreboards' (Moere et al. 2011). The project sought to develop prototyping techniques to probe urban user behaviour in relation to energy consumption on house facades, and to apply them digitally.[6] As well as seeking to understand peoples' digital behaviours in an urban environment augmented by digital information, the project also responded to the problem of high costs associated with deploying full-scale prototypes in urban environments.

This experience led me to the concept of Rapid Probing, where I would use prototyping techniques to probe urban user behaviour, seeking to gain insight into which digital use-cases offered potential for digital applications in an urban context. Despite the relatively low costs involved in Rapid Probing, the costs still proved to be too high to achieve a reasonable turnaround, that is, to remain 'rapid'. Public space access issues further slowed the Rapid Probing process.[7] The idea of a Rapid Probe was, rather than seeking to improve the prototype, to allow us to probe a digital use-case in public space and gather feedback from users that would let us better understand the user. For this reason, in order to compensate for negative probes that do not return satisfying results, a Rapid Probe would need to be deployed quickly and cheaply. Later I came to the conclusion that even Rapid Probes might be too restrictive, offering only a narrow window into understanding the context of urban users' needs and intentions.

From here I concluded that a more in-context research methodology was necessary: to draw a more specific image of urban users' experience in a city and formulate this experience so it can be useful to others. In parallel with my research, the rise in the use of Smartphones has been fundamentally disrupting public behaviour and interaction in urban space. My research thereby shifted focus towards understanding urban user behaviour in the context of digital innovation and complexity in general, rather than that of particular use-cases and applications. This led to the following research question, aim and objectives:

Research Question

Of what does the urban experience of Smartphone users consist in the digital age, and how can this best be communicated to the Smart City research community?

Aim

To conduct rigorous contextual research on urban inhabitants' use of analog and digital touch points in public space, and to synthesise outcomes into data models that formalise the consistency of urban experiences.

Objectives

- To conduct rigorous contextual research on urban inhabitants' use of analog and digital touch points in public space.
- To analyse collected data into research outcomes.
- To synthesise outcomes into visual data models.

1.3 Objectives

The objective of this research is to achieve a better understanding of the influence of digital innovation on urban experience and public life, and to formalize this insight into data models which illustrate these interactions. The research subjects are urban inhabitants in the context of their daily life. The primary focus is to capture the interactions of everyday urban users in public space, namely: the use of personal devices such as Smartphones, public touch points such as parking meters, and physical objects such as stairs, bus stops or benches. The research specifically focuses on public space in the course of an average work day. It does not capture subjects inside buildings unless the building can be considered public space - such as cafes or convenience stores. The research aims to expand public life studies and urban informatics in an enquiry that bridges both fields. It offers a digital perspective on public life that emerges out of urban informatics rather than urban design, and hence positions itself between both fields.[8]

1.4 Methodology

To facilitate this research, the framework known as Contextual Inquiry has been chosen. Contextual Inquiry is an established research method that facilitates investigation of user behaviour in the context of the user's environment, and is part of contextual design methodology (Beyer & Holtzblatt 1998).

The research conducts a contextual inquiry on inhabitants of Sydney's Eastern Suburbs[9]. Participants were researched in public space during average work days, during daytime hours and in average weather conditions. They were observed and interviewed in the space between when they left their house in the morning till when they returned home after work. Participants were solely observed outside, in public space, and not during work hours or within their work environments.

Each time a participant performed an action in the urban environment such as changing state or interacting with objects or people, photographs and notes were taken to capture the action. In-situ interview questions further probed the participant's actions.

Following the contextual inquiry process, the collected data is used to create three different models for each participant, the so-called 'Sequence', 'Flow', and 'Physical' models.[10] The Sequence Model shows the step-by-step actions the participant undertook over time. The Flow Model shows what the participant interacted with, and their relationship with different objects. The Physical Model shows the movement and actions of the participant in space and time.

The individual models are subsequently merged to create so-called 'consolidated' models out of similar individual models. Consolidated models represent 'abstract user types undergoing specific scenarios', thereby illustrating more abstract use-cases. The resulting use-cases allow us to envision new concepts for digital applications during a so-called 'visioning' stage. This latter stage is addressed in the Speculative Design Visions chapter (5.1) of this document.

Following the visioning stage, interaction patterns are developed which formalise the urban experience from a digital perspective, and address the key question in this research, namely: how to formalize the urban experience in the digital age.

The research also investigates, in relation to the contextual inquiry process, the theoretical and broader implications of the modelled data. This is to be found in Findings (Chapter 5).

In terms of outcomes, this research seeks to establish:

1. An approach to contextual inquiry that draws on public life studies and urban informatics.

2. Adjusted forms for modelling captured data, that adapt the contextual inquiry method to the urban environment.

3. Visions for digital applications in future Smart City developments.

4. A theory in relation to the influence of digital innovation on public life.

5. Formalisation of the urban experience in the digital age, to help Smart City researchers develop more user-centred digital strategies.

1.5 Chapter Overview

The work begins with an **Introduction (in Chapter 1)** that explores the field this research is positioned in, as well as its focus, objectives and motivations. Chapter 2 reviews the literature in the areas that influence our field of research. Chapter 3 describes contextual inquiry, the method used in this research. Chapter 4 describes the conduct of the research, which data was collected and how it was modelled to envision potential applications. Chapter 5 discusses the findings and the resulting theory. Chapter 6 channels the research into an overall conclusion.

Chapter 2: Literature Review

This chapter reviews the literature in the field of urban-user behaviour in public space, embracing five perspectives:

- Urban Informatics researches how hardware and software integrates with the urban environment along with the challenges that arise in implementing applications from an informatics perspective. Urban Informatics draws from computer science and user-centred HCI research.

- Public Life Studies (Gehl & Svarre 2013) researches a person's experience with a place within public space. It investigates the direct interaction between the physical form of public space and the user's feedback with it. Public Life Studies allege that urban planners do not adequately consider 'life and people between the buildings', arguing for research on that topic.

- Smart Cities (Greenfield 2013) investigate digital innovation from a master-planning perspective, along with the corporations who drive this agenda. In particular, we consider Adam Greenfield's critique against Smart Cities.

- Contextual Design investigates digital applications in the user's environment. This research specifically focuses on the work of Jan Chipchase[11] (Chipchase 2013) who researched mobile phone usage behaviour in global emerging markets, and Karen Holtzblatt (Beyer & Holtzblatt 1998), the founder of contextual design methodology. The latter investigates the context and requirements of people's interactions with digital products and services.

- Spatial Interaction Design stages interactive experiences in a particular environment. It differs from Interaction Design, which focuses on products and services. Spatial interaction design merges spatial design processes with user-centred HCI research to create digital spatial experiences.

Chapter 3: Methodology

This chapter explains the methodology of contextual design, in particular: contextual inquiry, the primary method used in this research.

Chapter 4: Contextual Inquiry Execution

This chapter explains how contextual inquiry was used to gather data, and how the data was modelled to extract meaning. It further envisions how we might act on the data, using examples of digital applications for Smart Cities.

Chapter 5: Findings and Theory

This chapter explains theoretical findings from the data analysis, and offers broader conclusions.

Chapter 6: Conclusion

This chapter summarizes the PHD's overall findings.

1.6 Motivation

Motivation for this research grew out of ten years of practical experience in digital innovation in spatial contexts. The researcher has created: spatial interactive artworks (PAÍS 2007), interactive brand experiences (Boffswana & Trefz 2010), interactive exhibition-design environments (Spinifex & Trefz 2008) and interactive architecture concepts (Trefz, Moere & Spinifex 2008). Further, the researcher has experience in Tangible Interaction Design (Trefz 2008) and Information Design (Spinifex & Trefz 2012) as well as fifteen years' experience in web design. This background delivers a practical knowledge base and skill-set that grounds his current motivation to carry out exhaustive research into digital innovation in the urban context.

It has become evident to the researcher in his practice that accepted standards in digital interaction design (both in products and services) have simply not penetrated into spatial interaction design and media architecture methods. Projects designed at a spatial scale have not applied the same research, rigour or testing in human-interaction design components as would have been applied in product-design cases. In some cases, this became even more critical when stakeholders from architecture, advertising and media production were involved - in which they insisted on classic 'waterfall' models of their disciplines (Royce 1970), in order to carry out design from their perspective. The issue was amplified when the researcher engaged with spatial interaction design projects in an urban context. These offered an even less user-centred approach, focusing rather on creating 'monumental' developments for their stakeholders.[12]

1.7 Preliminary Studies: Defining Spatial Interaction Design

This research applies the term 'spatial interaction design' to design artefacts that are typically of a scale larger than the human body, that blend into an architectural or urban context, and that conform to Gianetti's (Giannetti 2004b) definition of interaction. One noted pioneer in spatial interaction design is Joachim Sauter and his studio Art+Com in Berlin (Sauter 1988). Sauter designs innovative interactive exhibitions for global clients, and emphasises the use of new media tools to translate information into physical space, in order to offer a more natural user experience than computer monitors alone can. Our research defines spatial interaction design in relation to four established creative fields: Interactive Brand Experiences, Interactive Exhibition Design, Interactive Media Architecture and Interactive Art. The research outlines differences and similarities in each field and how they might be used to establish a tighter integration of spatial design and HCI in an urban context, for the sake of designing digital implementations.

1.7.1 Spatial Interaction Design: Interactive Brand Experiences

Interactive Brand Experiences have their roots in experiential marketing, whereby the brand aims at building an emotional relationship between brand and consumer (Smilansky 2009). In contrast to product interaction design, where the designer creates an object, here the designer creates a spatial experience for marketing purposes in the context of an advertising campaign. The current creation process for spatial interactive brand experiences still follows that of a traditional advertising agency, rather than an iterative and user-centred interaction design process. One reason for this is the hierarchical structure of advertising agencies; for example, the creative director in charge of the concept is not experienced with interactive technologies despite having to develop a top-level idea for a spatial interactive experience. One approach to solving this issue is the controversial introduction of the role of Creative Technologist (WK 2011).

This approach solves the technology illiteracy issue in advertising agencies to some extent but does not address the lack of a user-centred iterative design process.

Digital advertising agencies introduced the agile process (Martin 2003) into web development, but are challenged by rendering this process into a spatial scale. One could argue that this is a traditional difference between design studios and advertising agencies. However, while the 'waterfall' model works in traditional media, in interactive media the advertising agency needs to comprehend the interaction design process at the top-level concept stage. Further, an interactive brand experience typically has a very short (6 to 12 week) production timeframe, making the implementation of an iterative interaction design process even more challenging. A sample interactive brand project is the *Honda Dream Wall,* where visitors to the Sydney Motor Show could create animations by smiling (Boffswana & Trefz 2010). (See **Figure 1,** below)

Figure 1: *The Honda Dream Wall,* installed at the Sydney Motorshow.

1.7.2 Spatial Interaction Design: Interactive Exhibition Design

Interactive exhibition design offers interactive experiences for audiences at museums, galleries and exhibition centres. The objective is to communicate a body of information in an engaging and intuitive form. In contrast to interactive brand experiences, where the designer develops a spatial experience for marketing purposes, here the designer creates a spatial experience for the purpose of education in the context of an exhibition. Examples include *Whispering Table* (TheGreenEyl 2009) and *A la carte* (TheGreenEyl 2010) for the Kosher & Co exhibition at the Jewish Museum in Berlin. In *Whispering Table,* visitors explored festivities celebrated by distinct cultural groups by listening to networked dishes. The dishes told diverse stories depending on location and size. *A la carte* allowed the visitor to collect information about the exhibition by placing an RFID-enabled spoon onto different plates (See **Figure 2**, below). The visitor could later read more about the specific topics by following a unique web address on the spoon.

Figure 2: *Whispering Table* at the Jewish Museum in Berlin.

Interactive Exhibition Design and Interactive Brand Experiences may be considered very similar at first glance since they use similar technologies and methods, especially where exhibitions are designed for brands, such as the Level Green exhibition (see **Figure 3,** below) at Volkswagen Autostadt (Art+Com 2009). However, interactive exhibition design is not driven by a marketing campaign but by the communication of knowledge to a user. For example, *Level Green* (See **Figure 3**, below) explains the concept of sustainability and Co2 emissions through interaction. By contrast, interactive brand experiences create an emotional engagement similar to traditional advertising, just as the tobacco advertising character Marlboro Man did in print and TV (Starr 1984). Simon Penny describes this difference: ‘We should make a distinction between interface and interaction modalities which are deployed as a mechanism for exploring ‘content’, and modalities which themselves contribute to the accumulated meaning or experience of the work’ (Penny 2011). Penny implies that we need to distinguish between interfaces and interactions that serve to browse content and interfaces, and interactions that create an emotional experience between the user and the work - where the experience itself could be considered the content.

Figure 3: *Level Green* exhibition at Volkswagen Autostadt.

Moreover, interactive exhibitions are installed for months or years, whereas interactive brand experiences last for weeks - which fundamentally changes the production process. Interactive brand experiences are typically produced in 6 to 12 weeks, and interactive exhibitions in 6 to 12 months. The longer duration allows a much more considered approach to the engagement with space, whereas the short production process of the brand experience allows only shallow consideration. Interactive exhibition design has therefore the potential to actually implement a full interaction design process on a spatial scale. That said, it still faces issues, such as prototyping spatial experiences in large physical spaces.

1.7.3 Spatial Interaction Design: Interactive Media Architecture

The present research focuses also on interactive media architecture. It should be noted that media architecture can also be non-interactive, for example in the form of a media facade that displays time-based non-interactive content such as motion graphics animations, art and advertising.

Interactive media architecture merges interaction design with architectural practice and interior design. Typical fields relevant to both disciplines are physical computing (O'Sullivan & Igoe 2004) and generative design (McCormack & Dorin 2004). Interactive media architecture draws its inspiration from cybernetics and artificial intelligence. Gordon Pask, a cybernetics researcher from the 1960s, developed his 'Conversation Theory' (Pask 1975) which went on to influence architects into the 1970s and 1980s (Frazer 1993).

Usman Haque's interpretation suggests that interactive media architecture needs to create a circular loop between participant and the architecture to fulfill a conversation and exchange of information, rather than simply reacting to the user (Haque 2006). This emphasises the need for a more in-depth spatial interaction design process as opposed to the creation of flat reactive spatial interactions (Dalsgaard & Halskov 2010) that lack any meaningful feedback loop in terms of interactive media architecture.

Fox and Kemp argue for an integrated approach towards interactive media architecture, in that advancements can only be achieved if interactive technology is considered from the beginning. In this they reiterate the importance of integrating interaction design and spatial design: 'advancements will only be accomplished when interactive media architectural systems are addressed not primarily or singularly, but as an integral component of a larger vision that takes advantage of today's pervasive, constantly unfolding, and far-reaching technology' (Fox & Kemp 2009).

More contemporary approaches in interactive media architecture are inspired by organic and natural phenomena, resulting in a biomimicry approach (Berkebile & MeLennan 2004), that investigates responsiveness and interconnectedness down to the molecular detail. Philip Beesley's experiments in responsive architecture

(Beesley, Hirosue & Ruxton 2006) and (Beesley & Khan 2009), could act as a primer for how whole building structures might facilitate the conversational loop argued for by Usman Haque.

1.7.4 Spatial Interaction Design: Interactive Art

Interactive art has its roots in media art. Peter Weibel and Claudia Gianetti argue that interactive art is not defined through the use of new media forms but through the shift towards the creation of aesthetic systems that the spectator observes from within while affecting them at the same time, similar to the study of endophysics. Claudia Gianetti coined the term endoaesthetics (Giannetti 2004a) as a theoretical foundation for defining interactive systems. The theory is important in this spatial interaction design discourse because the design of interactive spaces introduces the design of interactive systems, and in a similar fashion shifts the design of a static space towards the system design of a spatial system.

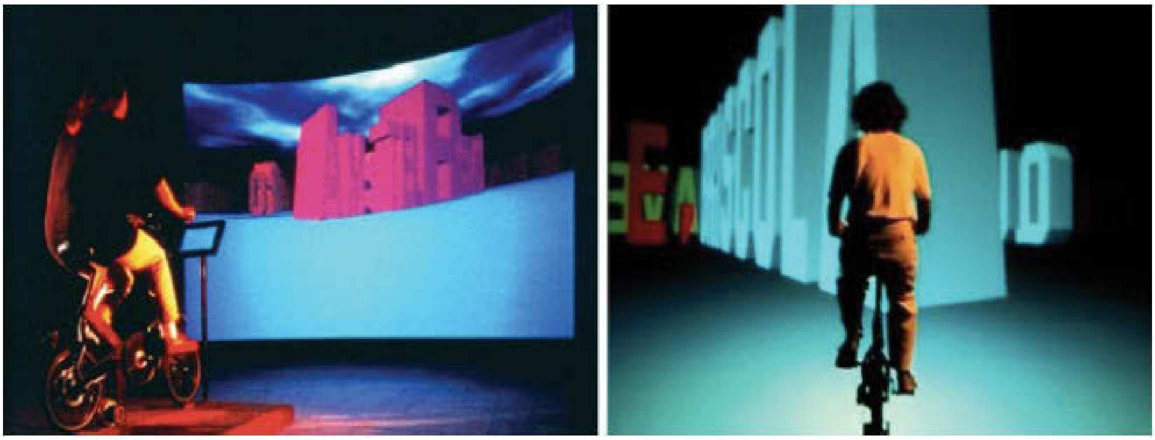

Figure 4: Jeffrey Shaw's *The Legible City* installation, in use.

Jeffrey Shaw, a pioneer of interactive art, created an early interactive immersive environment called *The Legible City* (Shaw 1989), (see **Figure 4,** above). Claudia Giannetti, in her work *Aesthetics of the Digital* (Giannetti 2004a) discusses historical theories in interactive art along with possible interactive dialogues between recipient and artwork, using physically-interactive systems as examples. The dialogue inherent in interactive art is the equivalent of Gordon Pask's and Usman Haque's ideal of a conversation between participants and architecture. Dialogue can therefore be identified as a key element in spatial interactive systems. Interactive and media art is often used as a source of inspiration by other spatial interaction design disciplines. For example, artworks like *The Wall of Lascaux* by Peter Weibel (Weibel 1993) (see **Figure 5,** below) use techniques that inspired interactive brand experiences such as the *LG Totems* installation by Boffswana for the LG brand (Boffswana & Trefz 2011) (see **Figure 6**, below).

All this illustrates how interactive art can act as a groundwork in spatial interaction design, to be used as a resource for interaction patterns that can be re-used in a different scale and context in other spatial interaction design disciplines. Simon Penny (Penny 2011) identifies a period of two decades in interactive art, roughly from 1985 to 2005, that he refers to as the pioneering experimental period. He argues this period was mostly driven by the expansion in technological capabilities rather than ideas. However, now that the interactive technological challenges of the 1990s have been effectively resolved, and the novelty of machines that respond to users in real time has declined, interactive art can now create works that focus on the user's experience. Since interactive art can act as a form of ground research for other spatial interaction design disciplines, Penny's point is applicable to all other spatial interaction design disciplines.

Figure 5: Peter Weibel's *The Wall of Lascaux* in use.

Figure 6: *The Wall of Lascaux* compared to Boffswana's *LG Totems* installation at Westfield in Melbourne.

1.7.5 Spatial Interaction Design: Urban Context

Spatial interaction design has branched out into public space, and into the urban context. The goal of urban spatial interaction design is to design a new public space experience, a new human-centred presence for an existing public space. Thereby, staging an urban experience lets the designer transform public space into an experiential place (Tuan 1979).

Prominent examples of urban interactive artworks are: *LASER* by the Graffiti Research Lab (Watson 2007), *Vectorial Elevation* (Lozano-Hemmer 1999) and *Body Movies* (Lozano-Hemmer 2001) by Rafael Lozano-Hemmer, and *Omnivisu* by The Green Eyl (TheGreenEyl 2004). These works all function in public space and enable the interaction of numerous unplanned users simultaneous with the work. Further, they create a relationship between user and architecture and facilitate a relational aesthetic (Bourriaud et al. 2002) on an urban scale.

Examples of urban interactive media architecture are *London Burble* by Usman Haque (Haque 2007) the *Flare Facade* by White Void (Void 2008), *Dune* by Studio Roosegaarde (Roosegaarde 2007) and the *Zaragoza Digital Mile* (Frenchman & Rojas 2006). These works take on a functional role in architectural space; for example, directing or shaping movement through buildings, informing external viewers of the internal function of a building, and communicating architectural intent to inhabitants.

It should be noted that none of the abovementioned spatial interaction design disciplines follows an iterative user-centred interaction design process, to the extent that it is used in product- or service-based interaction design - neither on an indoor spatial scale or an urban scale. They emerged instead out of marketing, exhibition design, art and architecture, and still treat interactivity from their own perspectives rather than from one of interaction design.

1.8 Preliminary Studies: Defining Rapid Probing

1.8.1 Generative Methods versus Observational Methods

Generative Methods in HCI refer to methods which argue that observation, such as Contextual Inquiry, can only capture the current situation; for example, what people say or do, but not what they desire, know or feel. (See **Figure 7**, below) To capture these intrinsic needs, generative methods are used. These openly and fluidly expand interaction possibilities through objects or stimuli that generate new insights.

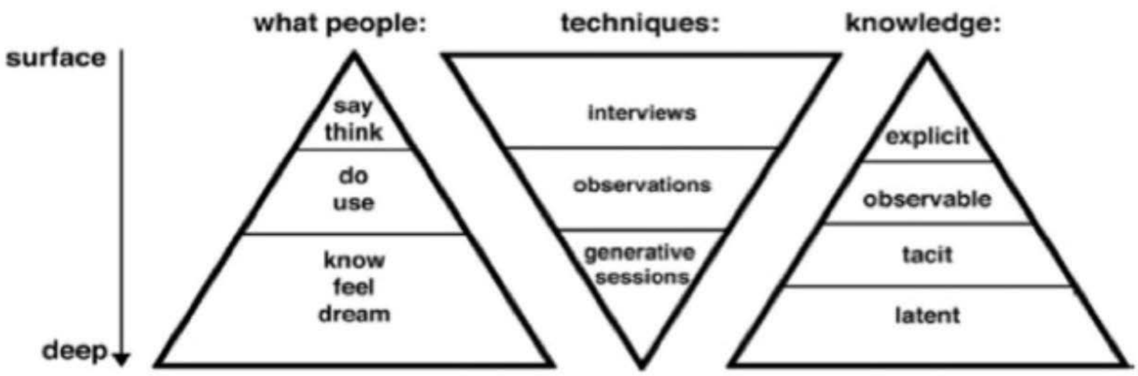

Figure 7: Comparison of Interview, Observation and Generative methods.

Examples of generative techniques include Cognitive Maps (Park & Hannafin 1993), Card Sorting (Moggridge 2006), Co-Creation workshops (Brown 2008), Cultural Probes (Gaver, Dunne & Pacenti 1999) and Technology Probes (Hutchinson et al. 2003), all of which generate understanding of how users subconsciously perceive a user experience.

The Cognitive Maps technique asks a user to map a product experience. It reveals features and pathways of a product that are important to the visitor. The Card Sorting technique asks users to sort cards in categories that make sense to them. The cards contain features, functions or attributes related to a product. Their categorisation exposes users' mental models, expectations and priorities for a product. Co-Creation workshops ask participants to, for example, create their ideal dream product. The intent is not to have participants actually design an experience but to read what is on their mind and understand what their needs and wishes are. An example is the Nokia Open Studio by Jan Chipchase (Jung & Chipchase 2008) where the researcher, to understand the needs of a growing target market, asked inhabitants of shanty towns to design their dream mobile phones.

A further generative method is Technology Probes (Hutchinson et al. 2003) which is based on the method of cultural probing where participants are asked to self-document their everyday life using kits containing cameras and diaries (Gaver, Dunne & Pacenti 1999). Compared to Cultural Probing, Technology Probing uses a technology to provoke people's behaviour towards a technology in their everyday life. Technology Probes are implementations of a fully-functional technology in a real-world setting.

The Technology Probe method can be particularly useful in urban space, since it reduces the complexity of the urban space by focusing the user's behaviour with the probe.[13] Based on observations by Hutchinson et al, probes can 'help reveal practical needs and playful desires' and offer in-situ use scenarios with technologies that could not previously be observed or conceived. New avenues for bringing technologies into an environment can be explored as a step towards defining a design brief. One limitation of Technology Probing is that it deploys a fully-functional technology as a probe. In an urban space this is costlier and logistically difficult to achieve compared to a controlled product or service-based scenario.

While Cultural and Technology Probing is an exciting method for urban interaction design research, it could be improved for the urban scale by introducing the approach of rapid prototyping. Rapid prototyping has a long history in product design and has been more recently applied to service and interaction design as a means to quickly explore design options. Rapid prototyping allows the mocking-up of user experiences with materials that allow for a rapid implementation of a simple prototype of an idea for a product or service (Avrahami & Hudson 2002). These simple prototypes can vary in fidelity, which can range from lo-fi (low fidelity) to hi-fi (high fidelity) (Rettig 1994) . Lo-fi prototypes are not electronic, and use materials such as paper to simulate a user experience (Sefelin, Tscheligi & Giller 2003). Hi-fi prototypes are electronic but avoid expensive and time-consuming programming costs and mock-up user experiences with WYSIWYG (what you see is what you get) tools (Walker, Takayama & Landay 2002).

The current research evaluates the possibility of introducing rapid prototyping to Hutchinson et al.'s Technology Probes, developing a hybrid method that captures the generative quality of probing and the instant quality of rapid prototyping. This is referred to as 'Rapid Probing'.

1.8.1.1 Rapid Probing

This section explains how our research evaluated Rapid Probing and its qualities, in comparison to observational methods such as Contextual Inquiry. In general, generative methods like Rapid Probing provide deeper insight; however, in the context of urban environments they may face challenges that inhibit their use on a city-wide scale. In this case, observational methods may offer a more scaleable[14] approach . Our goal here is to describe in detail how Rapid Probing, with all its challenges and opportunities, might be used in urban environments.

A previous project in which the writer was involved, the Neighbourhood Scoreboards project (Moere et al. 2011) inspired the formation of the Rapid Probing method. Faced with the impracticality and expense of creating full-scale digital 'scoreboards' on the facades of domestic residences, Moere et al. opted for analogue boards, in which a digital use-case was replicated using chalk. (See **Figure 8**, below)

Figure 8: The Neighbourhood Scoreboards project installed in Chippendale, Sydney, Australia.

The project aimed to explore the impact of visualisation on behaviour change, where a series of boards attached to the facades of houses along a street visualised energy consumption on a daily basis. This sought to create positive competition between neighbours to stimulate behavioural change in energy consumption. Such a cheap and easily modifiable 'probe' offered a generative mode for gaining insight into the behaviours and attitudes of urban residents. This would not have been possible through direct observation or interviews on energy consumption.

The following section describes the strategies and criteria for developing and using a Rapid Probe in urban environments. We draw from the work of Hutchinson et al. and expand to an urban scale and context.

1.8.1.2 Defining Rapid Probing

Rapid Probing involves installing a hypothetical interactive concept into an urban space,[15] observing how it is used over a period of time and observing what new behaviours it provokes. Following this, we reflect on its ability to gather information and inspire ideas for new interactive use-cases. Rapid Probes are simple, flexible and adaptable, and a well-designed Probe should balance three interdisciplinary goals:

- Understanding the needs and desires of users
- Field testing of interactive use cases
- Inspiring users and researchers to think about new interactive use cases.

Rapid Probes are based on the idea of staging possible interactive urban-scale scenarios to provide users with ideas about potential applications and uses. The users' responses and feedback to the probes is captured to inform new ideas and concepts. As described by Hutchinson:

> A probe is an instrument that is deployed to find out about the unknown to hopefully return with useful or interesting data. There is an element of risk in deploying probes; they might fail or bring unexpected results (Hutchinson et al. 2003).

In terms of functionality, a Rapid Probe differs from a prototype, which is typically an early implementation of a design idea. Instead, it is a tool to inspire whichever forms of urban interactivity could be interesting to pursue. Instead of implementing a functional technology, Rapid Probes deploy lo-fi, mi-fi (mid-fidelity) or hi-fi versions of an interactive concept. The user is confronted with a Rapid Probe of a possible future use-case in his or her everyday life. The Probe is not intended to be tested for refinement but to provoke reaction and behaviour. In this way, they are open-ended and co-adaptive (Mackay 1990); that is, the users should adapt to the Rapid Probe but also adapt it towards their own needs. Probes are distinctly different from prototypes, not only because they are used in the early stage of the design process, but also in the ways they are designed and analysed. Probes explore a single function or behaviour, rather than prototypes which synthesise many. Probes are not designed to lead towards a refined final product, but to open up opportunities. Most importantly, Rapid Probes are intended to be distinctively different from existing interactive solutions in order to provoke both users and designers to consider new behaviours.

1.8.1.3 Steps and Evaluation

Rapid Probing starts with a general 'hunch' about an interactive opportunity in a public space, for example: 'we want to make the public library more interactive'. We may also have a more specific idea of what we want to facilitate, for example: 'we want library visitors to interact more, and exchange knowledge.' The Probe explicitly does not start with a technology, for example: 'we want to use RFID technology to make the library better'[16]. Based on the hunch, Rapid Probes of appropriate fidelity are created, deployed and evaluated, such as the ThinkPlayDiscuss wall in the library of the University of Technology, Sydney. (See **Figure 9**, below).

Figure 9: The ThinkPlayDiscuss Rapid Probe at the UTS library in Sydney, Australia.

The ThinkPlayDiscuss wall rapidly probed modes of interactive visitor engagement that could hypothetically be translated into digital services; for example, in the form of large interactive touch-screen walls within the library. Lo-fi Rapid Probes in the form of chalk and chalk board allowed the library to flexibly iterate visitor feedback and gain better insight into their needs and desires. Again, here the intention was not to refine an existing prototype but to gather insights from visitors on what might be a successful digital implementation.

1.8.1.4 From Probe to Prototype

By iterating several Probes, the designer moves closer to an actual prototype, meanwhile identifying more specific designs and technologies for use in a final design. (See **Figure 10** below).

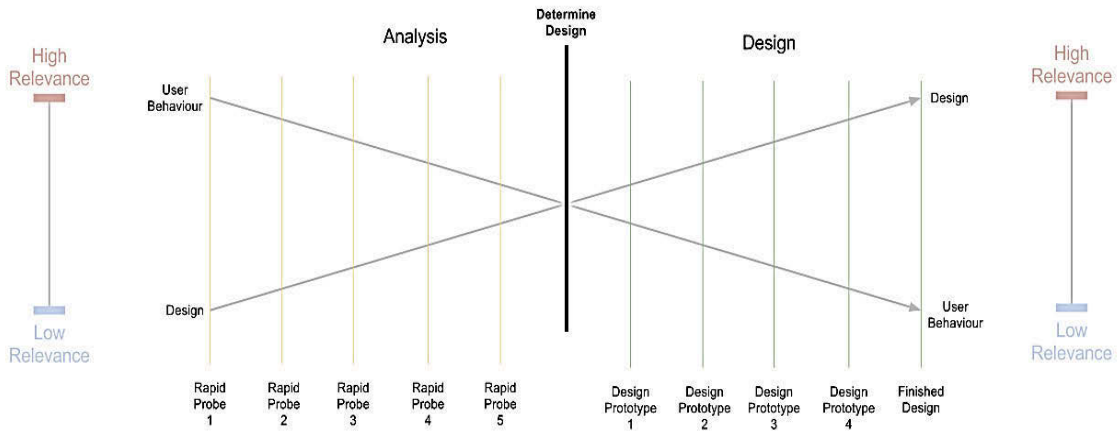

Figure 10: Diagram of the transition from Rapid Probing towards prototyping and design.

After determining a design and a technology, an iterative design process will refine the prototype into a final design. So that it can be easily abandoned if it should fail, a Probe should not take more than one week to produce and one month to test in the field.

Rapid Probing should not be limited to lo-fi probes. It should also be decided on a case-by-case basis which fidelity is feasible, ranging from lo-fi to hi-fi. It is important that the Probing be carried out rapidly to allow for a higher frequency, and to minimise the implications of Probes with negative results. As in technology Probes, the main criteria is that they are performative enough to provoke users to consider how the Probe does or does not fit into their lives. 'Performative'[17] refers to the way in which a Probe actuates a range of potential user behaviours, directly or indirectly, through media, shape or the modification of everyday objects (Kiib 2010).

In support of deployment and to determine its success and implications, analysis and evaluation needs to be carried out by users and researchers, both during and after. The analysis has three steps: 1. Pre- and post-probing interviews. 2. Log dates, times and actions to analyze use patterns. 3. Post-probing participatory design workshops (Schuler & Namioka 1993) to inspire new ideas.

1.8.1.5 Summary

We have explored a preliminary framework to establish the scope and conditions for a generative research method in HCI in an urban context. This leads us to an outline of the strategies and tools needed to transfer a generative method of product interaction design into the physical, social and public behaviours of cities. We have identified a need to work with generative methods that are rough, technology-independent, cheap, and able to generate new behaviours and ideas from user and designer alike.

Rapid Probes are in fact spatial experiments that test how interactivity that is abstracted from a specific technology can change the performativity of an urban space; that is, the way in which it actuates behaviour. Unlike many technology-based prototypes, Rapid Probes are not a tool to collect ‘unbiased’ ethnographic data. Instead, they provoke behaviour in users that tests the performative quality of the designed interaction in-situ. By operating predominantly with the human interaction through a mock-up of an interactive use case, the designer can observe and tweak the capacity of the probe to inspire and stimulate unique behaviours in the urban environment. While examples of performative environments in urban space are investigated by Kiib (Kiib 2010) and others such as the Institute for Spatial Experiments in Berlin[18], the introduction of interaction design principles through Rapid Probing is novel and offers a specific generative method that might lead to new avenues for using interaction design in urban space.

Rapid Probing introduces a new generative method that provokes reactions towards specific paradigms of interaction. This method helps designers to analyse people’s behaviour before making design decisions, and allows the finding of new ideas for interactive use-cases and concepts. Possible applications of Rapid Probing include use by urban designers to find possible new spatial interaction design opportunities in commercial projects, exploration by researchers to find new urban needs and use-cases that could be addressed with urban interaction design, and by companies who want to find new business opportunities in urban space. I believe that Rapid Probing can help overcome the challenges that occur when designers create digital urban implementations.

Rapid Probing is not just a new generative method but also a new starting point that questions the role of technology in urban space from the outset. The Neighbourhood Scoreboards example demonstrates lo-fi techniques in combination with Probing methods to enable an understanding of interactive potential in an urban space without the need to deploy expensive technology. Rapid Probes are not simply rapid prototypes; a key differentiator is their open-endedness. In short, they are not designed with a specific idea in mind but rather to inspire new ideas.

1.8.1.6 PhD Context

Rapid Probing in this research is an attempt to merge two interaction design research methods, namely Technology Probing and Rapid Prototyping, into a mixed spatial interaction design methodology that allows a more iterative user experience-centred research process to be carried out in public space. It serves to probe users for behavioural responses to technology implementations - not to improve the technology but to research behaviour according to the needs and requirements of a certain demographic.

It should be noted that while Rapid Probing is included in this research, the method was too challenging to fully implement within its scope, due to restrictions on budget and public space access. However, it led the researcher to the insight that public space access is highly restricted, even where funding is provided by sponsors such as Google - as was the case in one of our attempts to carry out Rapid Probing in public space. It also became clear that political and middle management issues might easily prevent a well-conceptualised research project. Notwithstanding, the insights gained in attempting Rapid Probing led directly to the Urban Contextual Inquiry method used in this research.

Following appraisal of these issues, the research shifted toward a broader objective of formalising the urban user experience from a shadowing perspective rather than a site-specific one. By this is meant that there is no investigation of a singular location whereby the behaviour of users passing through is probed, as in the approach of Jan Gehl. Rather, specific users are shadowed while passing through multiple locations from their own point of view - an approach typically carried out by contextual researchers Jan Chipchase and Karen Holtzblatt.

However, the research - using Rapid Probing - still sought to mix a site-specific approach with a user-shadowing approach by witnessing behaviour in various locations visited on a daily basis. This is evident in this research's physical models, whereby the journey from location to location is outlined in a storyboard format that shows the physical structure of the location as it influences the user's experience.

By framing Rapid Probing, the research explores in-depth opportunities for generative methods in an urban context along with its benefits, as compared with observational methods. As earlier stated, Rapid Probing requires access to suitable sites, for example in the Neighbourhood Scoreboards project, and this was not always achievable within the scope of the PhD. Further, I came to the conclusion that the site-specific qualities of Rapid Probing limit its scaleability to a larger demographic, and hence its ability to achieve greater understanding of the digital within the urban anatomy. I concluded that observational methods such as Contextual Inquiry are better positioned to achieve such outcomes.

2 Literature Review

This chapter reviews areas of research relevant to formalising the urban experience from a digital perspective. Research areas include Urban Informatics, Smart Cities, Public Life Studies, Contextual Design, and Spatial Interaction Design. These fields study people's interaction with public space, products, services and the digital, from diverse perspectives. In sum, the fields contribute to research on how digital interactions merge with physical and analog interactions in the urban environment.

Urban Informatics researches products and services in the urban environment from an application-specific perspective. The discipline employs user-centred HCI principles developed in Informatics and applies them in urban contexts. It tends however, to research applications from a micro-perspective rather than the Smart City macro-perspective, where the focus is on the ways numerous applications collectively change the urban user experience. Smart Cities thereby tend to be designed from a master-planning perspective rather than a user-centred HCI perspective. Meanwhile, Public Life Studies offer a user-centred perspective on master planning and urban design by researching the use of public space in terms of environmental observation. They tend however, to lack a digital perspective. In its turn, Contextual Inquiry provides a digital perspective on environmental observational research, yet tends to neglect the urban focus.

In the context of this research, the term Spatial Interaction Design refers to four disciplines that implement digital applications in spatial and environmental contexts rather than screen-based contexts. Interactive Brand Experiences, Interactive Exhibition Design, Interactive Media Architecture and Interactive Art are all concerned with the use of digital technology applications in environments, but tend to be driven from the perspective of advertising, exhibition design, architecture and art rather than that of user-centred HCI.

All the fields listed here fulfill a piece of the digital application puzzle in the urban environment. However, there tends to be a lack of interdisciplinary integration between them. This chapter reviews each field, then outlines how an interdisciplinary approach between Contextual Inquiry and Public Life Studies can bridge the gaps. We therefore conduct a Contextual Inquiry in the urban environment while taking on board Public Life Study principles.

A key component in formalising the user experience is user-experience research. Typically conducted in the early stages of a digital project, this enquiry lets stakeholders understand the needs of a particular demographic, envisioning both their current experience and a future improved experience. This vision is then incorporated in the design process. Crucially diverging from market research, user experience research shines a light on the edge-cases - the demographic extremes rather than the average.

This research therefore needed to review various user-centred research methods with a view to formalising diverse experiences; for example, Jan Gehl’s formalising of public life in public spaces. For this reason, the relevant literature is situated in the Literature Review section rather than the Methodologies section.

The particular research methodology used to conduct this research is a fusion of public life studies and contextual research - a necessary fusion for addressing the complexity of public life in the digital age. In fact, we merge Jan Gehl’s in-situ witnessing and shadowing in public space with the contextual research methods of Jan Chipchase and Karen Holtzblatt. This ‘mixing and merging’ process is a very different task from reviewing existing methodologies. Hence, the latter are to be found in the Literature Review and the former in the Methodologies chapter.

This literature review explores a precisely-focused range, seeking to bridge the substantial gap between public life studies and digital product- and service-focused contextual research. It seeks to outline both fields sufficient to positioning them in relation to the Smart City field. A broader literature review, or a deeper focus on digital user interfaces, would have distracted from aligning them in relation to Smart City research.

The review focuses on two key researchers: Jan Gehl in Public Life Studies and Jan Chipchase in Contextual Research. Although industry researchers, both are considered thought leaders in both fields and are frequently referenced in academic literature. To substantiate Jan Chipchase's work from an academic perspective, Karen Holtzblatt's literature is used, in that she laid the groundwork for his contextual research methods. She herself is a key academic in contextual research and design.

The review then coalesces both fields in terms of Smart Cities, and to achieve this, Smart City literature is introduced. We here insert a key author who is in fact critical of Smart City research. Adam Greenfield has a background in human-centred design and understands the issues of the technocratic focus that currently prevails in Smart City research. His book *Against the Smart City* exhaustively explains the diverse positions that currently obtain in Smart City research, and succinctly shows why a more human-centred approach is needed.

To balance this, the researcher introduces Urban Informatics literature by Marcus Foth. Urban Informatics offers a stronger focus on the individual implementation of digital applications and user interfaces, and is more pragmatic in its focus on implementing actual products and services in a city, rather than the urban planning perspective of Smart City research. Urban Informatics espouses a more human-centred approach, since it does not have to take into account the Smart City’s urban planning perspective.

Indeed, my own research seeks a human-centred approach from an urban planning perspective – and achieves this by bridging the urban planning perspective of Public Life Studies with the human-centred focus of Contextual Research.

To complement the literature on Smart Cities and Urban Informatics, we also introduce the field of Spatial Interaction Design. This field offers a site-specific perspective on implementing digital user interfaces, and deals with relevant architectural considerations for implementing digital applications in a spatial scenario. While the discipline is commonly applied in (smaller) private space scenarios, it is challenged with similar issues when implementing digital applications in urban environments where architectural design merges with interaction design. Spatial Interaction Design is thus introduced here to illuminate how its challenges relate to urban-scale Smart City spatial interaction design, in an urban planning context.

The current pool of disciplines that claim to solve Smart City planning issues include Urban Informatics, Spatial Interaction Design (which includes media architecture, media facades and urban screens) and urban design disciplines such as Performative Urban Design. Arising from different perspectives, these disciplines use processes originating from engineering, architecture, I.T and human-centred interaction design. Key here, is that some processes favour a 'waterfall' model and some an iterative design model. Waterfall models are traditionally less human-centred due to a lower focus on rapid prototyping, and iterative models are more human-centred due to their ability to test and iterate user needs.

The literature review also addresses the topic of digital user interfaces according to Jan Chipchase's literature and Karen Holtzblatt's research. Their work extensively covers the design and development of digital user interfaces, in particular mobile and public space solutions.

A broader review of digital-user interface design research would not have aided this thesis' focus on public space issues, particularly since it investigates user experience rather than user-interface issues. Issues concerning the user experience of digital implementations tend to address the overall narrative of that experience, while user interface issues tend to deal with the particular elements of an interface and how they might improve the product's usability. User interface issues are outside the scope of this research since they require the use of a specific user-experience design. The research rather aims to find opportunities for new user experiences in urban and public space, hence positioning itself at the earlier phase of the design process.

2.1 Urban Informatics

This chapter discusses Urban Informatics and the concept of the Urban Anatomy. It also shows which elements of Urban Informatics may be useful for the research of public space in the digital age. Urban Informatics refers to the research and development of hardware and software that allows us to address urban use-cases[19] with digital applications.

Marcus Foth defines Urban Informatics as the ‘research and development at the intersection of people, place and technology with a focus on cities, locative media and mobile technology’. Specifically, Foth argues that Urban Informatics investigates the field of urban experience in diverse situations based on novel forms of ubiquitous computing, real-time data processing and AR applications, that interweave the digital and physical worlds. He distinguishes urban informatics from ubiquitous computing by referring to urban foci and contexts addressed by urban informatics, in conjunction with the transdisciplinary aim of interweaving ubiquitous computing into social and architectural layers.

2.1.1 The Urban Anatomy

Urban informatics can address urban use-cases using digital applications. Marcus Foth, seeking a macro-perspective on an overall ecosystem of digital applications and how they collectively influence the urban experience, coins the term Urban Anatomy (Foth 2009).

Foth argues that cities are living organisms akin to a human body. He points out that although studying the ‘urban anatomy’ may seem straightforward at first, since there are ‘visible appearances and tangible objects that we can observe and examine’, to capture every part of the urban anatomy might result in large amounts of data that would be too complex for the extraction of useful meaning.

Foth further argues that a body is more than the sum of its parts: ‘Some of the fascination with human anatomy stems from the fact that a living body is more than the sum of its parts. Similarly, the city is more than the sum of its physical elements.’ He therefore asserts that urban anatomists face three distinct challenges:

- Cities consist of real-time systems that require appropriate real-time examination methods.
- The virtual layer that augments a city with invisible information requires appropriate methods for visualisation.

- Urban inhabitants introduce unpredictable socio-cultural variables and indistinct human behaviour.

Amanda Williams (Williams, Robles & Dourish 2009) similarly argues against a uniform understanding of the city, and for a paradigm shift in research of the urban experience. Current projects tend to focus on a uniform user, like the middle-class latter-day flâneur.[20] Williams rather argues for a generative understanding that considers the individual contexts of diverse inhabitants. She suggests that ethnography on individual urban experiences would offer a situated analysis, that may reveal valuable data for urban informatics.

Foth and Williams effectively argue that a city should not be researched as a whole but by dissection of its individual experiences, leading not to a uniform city model but to a generative understanding of the diverse experiences cities might facilitate.[21]

Foth asserts the need for more in-context research approaches that diverge from a 'universal' understanding of the city, and instead account for diverse demographics that cities have to offer:

> Any 'toolbox' for what could be termed anthropological urban anatomy thus involves research approaches that dissect and break apart 'universally-applicable' conceptions of 'The City' by being sensitive to individual circumstances, local characteristics and socio-cultural contexts (Foth 2009).

It is an explicit objective of my own research to investigate the urban anatomy in context and in real time. Following Williams' and Foth's suggestions, I do not seek to capture the urban anatomy as a whole, but rather individual urban experiences. For this I use an in-context research methodology referred to as Contextual Inquiry, which investigates real-time systems in an environmental setting. From this I hope to develop a generative understanding of the urban anatomy across diverse demographics rather than develop any uniform model. Indeed, that uniform models of the urban anatomy are too complex to deliver meaning is evident in the current issues Smart City developments are facing.[22] We shall explain these Smart City issues in the following chapter.

2.2 Smart Cities

The term 'Smart City' has been used to describe not only technological infrastructure innovation but also sustainability projects and diverse government initiatives designed to improve cities. In consequence, 'Smart City' has not yet been clearly defined.[23]

The UK's leading business technology publication *Information Age,* argues that the Smart City concept can be traced to a $25 million grant from the Clinton Foundation to Cisco, in support of more sustainable cities (*Information Age,* 2012). The grant resulted in the Connected Urban Development Program, carried out in San Francisco, Seoul and Amsterdam. Cisco then developed its Smart and Connected Communities division in 2010, that sought to commercialise the findings of the program. Cisco's new division inspired competitors such as IBM and Siemens to develop similar strategies for developing and distributing digital infrastructure hardware to cities.

Adam Greenfield criticises the Smart City agenda of these corporations in that it is not driven by user needs. Greenfield shows how current Smart City infrastructure is largely targeted at government control and the improvement of the city's business environment. He shows that Smart City planners make abstract what a city actually is, and that 'urban' hardly can be called 'urbane':

> Several decades from now cities will have countless autonomous, intelligently functioning IT systems that will have perfect knowledge of users' habits and energy consumption, providing optimum service... The goal of such a city is to optimally regulate and control resources by means of autonomous IT systems (Siemens 2008).

Siemens' sentiment not only constitutes a major invasion of privacy, but assumes that the world is perfectly knowable in that there are universal algorithmic solutions to individual needs. Adam Greenfield claims that Smart City issues are comparable with the motivations of modernist planning,[24] that is, a top-down approach asserting power and control rather than the individual needs of citizens.

Today, the corporations that drive the concept of Smart Cities are IBM (IBM 2015), Cisco (Hodgkinson 2011) and Siemens (Siemens 2015). Their proposals claim to make the urban experience seamless by removing inconveniences, doubts and delays; that is, to render the inhabitant blissfully unaware of the digital support systems in place. However Adam Greenfield argues that much of what makes a city interesting happens at the seams and hinges, and that 'smoothing out' the urban experience may prevent us from dealing effectively with something that is against our expectations.[25]

Smart City developers, with only vague use-cases in mind, insert technology into every part of the city's fabric. The time-frames in which these developments are proposed are so far in the future, that developers can hide behind speculations on how to implement them with technology they actually don't understand or that doesn't exist.[26] They tend to use generic labels like 'Interactive Smart Wall' or 'Incorporated Smart Sensor', ignoring the technologies' ability (of lack of it) to adapt to unforeseen use-cases, to updating, to maintenance and to the widespread adoption of

Smartphones. This leads Adam Greenfield to conclude that currently-proposed Smart Cities are actually designed for administrators, leaders, businesses and decision-makers, not for the everyday life of the inhabitants: ‘Any sense for the texture of everyday life as it is actually experienced is abstracted to the point of nonexistence’ (Greenfield 2013).

Rather than addressing citizen-centred issues, Smart Cities propose neo-liberal business-centred benefits, such as the privatisation of citizen services, deregulation, free trade and tax benefits for companies who set up in such a city. Even more worrisome is that the very technologies that enable the Smart City can be abused for authoritarian purposes. The possibility to biometrically track individuals through space and predict behaviour - no doubt for the optimisation of more efficient and convenient services - is a ready-to-use toolkit for abuse and control. For example, the Intelligent Operations Centre built by IBM in Rio de Janeiro, originally for mudslide prediction, is already computationally indicating which streets need more troops for favela-pacification operations (Lindsay 2010). Singapore’s similar City Cockpit (Siemens 2011) built by Siemens, in tandem with a Cisco report (Green 2011) suggest that ‘behaviour change’ is something a government might want to pursue using networked systems.

Greenfield claims that many simple pleasures cities afford would be overlooked by such optimisation or even destroyed. He states: ‘It’s the very qualities of slack and redundancy that turn out to be essential to the effective functioning of a city over the long term’ (Greenfield 2013). Further, he asks: ‘optimised toward what end and for whose benefit?’ Greenfield argues that the Smart City has nothing to do with urbanity; nor do their designers understand it. In fact, the goal of over-optimisation and control minimises urbanity. There is nothing particularly urban or even urbane[27] about proposed Smart Cities. ‘Cargo-cult’ urbanism badly misreads the dynamics that underpin quality in urban life. It ignores the informal sector - which in most cities is a critical part of the economy:

> Every dive bar and every farmers’ market, every playground or cinematheque or Michelin-starred restaurant, all the bodegas, bike shops and edgy boutiques, the rib shacks and fetish clubs and flower festivals - all of that, and everything implied by them, Living PlanIT reduces to those five fatal words ‘occupant support and convenience systems (Greenfield 2013).

Greenfield argues that historically we have been here before, and apparently have not learned our lesson. Everything that is basically wrong with the Smart City (he says) has been articulated in high modernist planning and has failed. Greenfield asserts that the planners of Smart Cities are simply discredited by their repetition of mistakes, namely their failure to consider the needs of the inhabitants and to plan Smart Cities as economic and political instruments of power and control.

A further issue is that current Smart Cities are based on proprietary solutions[28] rather than open source solutions (Sassen 2011). These proprietary solutions on which everyday life is built are privately owned and monetised, and even personal data created by such solutions is accessible only to those willing to pay for it.

Usman Haque, a London-based interactive architectural systems research artist and architect, calls for a messy city: ‘Messiness will inevitably arise in spite of Smart Cities’ (Haque 2013). Haque also argues against any top-down modernist perspective for Smart Cities, and cites Pruitt-Igoe by way of example. He further cites The Enlightenment and Grub Street to suggest a ‘Grub City’ in where citizens reject static urban data structures and solve issues through a bottom-up grassroots approach to urban data.[29]

Data, software and the digital in general favour bottom-up solutions, in that human-centred designs are found through iterative exploration rather than waterfall developments (Cooper, Reimann & Cronin 2007). Architecture and urban planning is in general a top-down practice. Therefore, within an ecosystem that Negroponte would call ‘bits vs. atoms’ (Negroponte 1996), we find a natural friction between two opposing disciplines and approaches: top-down versus bottom-up. It is the objective of my own research to find within this urban ‘interplay of bits and atoms’ a compromise between top-down and bottom-up strategies, for the sake of future Smart Cities.

The following section follows research of the urban experience that is influenced by atoms,[30] that is, how physical structures of urban design influence the urban anatomy according to Public Life Studies.

2.3 Public Life Studies

Public Life Studies tend not to be motivated by digital innovation but by the desire to understand peoples’ behaviour in public space and how built architecture modifies it. This chapter recounts the history of Public Life Studies, how modernist planning changed twentieth-century cities, and how researchers challenged the modernist approach with methodologies for more user-centred and participative urban design planning. Public Life Studies are conceptually simple, in that the basic activity of walking around and observing provides key insights into public-space interactions and public life. Public Life Studies emerged out of research into the work of scholars who globally criticised modernist planning in the 1960s, claiming that planners neglected the life of the city:

> Transport engineers concentrated on traffic; landscape architects dealt with parks and green areas; architects designed buildings; and urban planners looked at the big picture. Design and structure got serious attention, but public

life and the interaction between life and space was neglected (Gehl & Svarre 2013).

Modernist planners such as Le Corbusier viewed the traditional qualities of the city as a problem, and wanted to replace them with functional elements that enabled rapid urban growth while keeping the city operating.[31] Initially, health issues were the main concern. Spreading urban growth into the suburbs was seen as one solution, which involved making cars an integral part of life. This however, not only diluted the vibrancy of public life but induced a conflict where people and cars competed for public space. The focus shifted from '5 km/h architecture' to '60 km/h architecture'[32] (Gehl & Svarre 2013). New urban areas were established but traditional city life did not follow, and knowledge of the human scale was lost.[33] In reaction, public life studies emerged in the 1960s, incorporating social and psychological dimensions into urban planning to battle the 'poverty of experience' in modernist cities.

At the fore of those who criticised modernism as dealing on an inhuman scale, were Jane Jacobs and William H. Whyte from New York City, Jan Gehl from Copenhagen, Christopher Alexander from Berkeley and Aldo Rossi from Milan. Jane Jacobs' book *The Death and Life of Great American Cities* (Jacobs 1961) is key. It attacked the modernist city planning of Robert Moses and identified principles for what determines a city's life and spirit. Jacobs argued that people, not buildings, make cities. However, she offered few specific methods in support of this truth. Her mentor William H. Whyte did so however; in particular time-lapse videos as part of his film *The Social Life of Small Urban Spaces* (Whyte 1980). Jacobs and Whyte, in New York City, together were central to developing an academic-research approach to public life studies.

Copenhagen-based Jan Gehl tells us that in the early 1960s even he - until a client challenged his thinking and asked him to design a neighbourhood that was 'good for people' - was basing his work on modernist principles. Jan Gehl's wife Ingrid, a psychologist who studied urban human behaviours, complained to her husband that architects are not interested in people. This sentiment led Gehl to investigate the lack of human scale in urban planning and the 'interaction between public life and public space'.

Gehl posited that criticism was justified but that new tools were needed to investigate the underlying reasons. He began to research piazzas in Italy,[34] noting how people moved and behaved in such spaces during summer and winter. Gehl particularly came to understand the importance of observational studies, and developed a signature method of narratival photographs that depicted daily urban life. His observational methods began to produce not only examples of functioning city spaces, but statistics on why certain streets work and others do not.

Gehl's findings were published in 1971 in his work *Life Between Buildings* (Gehl 2011), which became a seminal text for Public Life Studies and strategic urban thinking. His analytical approach set him on a collision-course with artistically-oriented architects, in particular from the 1980s onwards. Even though there was evidence of increased focus on public space, human values, local perspective, mixed functions and 'human scale', cities took to hiring 'starchitects' to erect monumental architecture for marketing purposes, seeking to brand their city in relation to global competitors.

Cities such as Barcelona, Lyon and Copenhagen understood the importance of strategic public-space planning to make their city more attractive. The focus shifted from a 'leisure society', advocated between the 1960s and 1980s, to an 'experience society' in the 1990s. Cities now needed to provide experiences in public space, such as themed playgrounds, jogging paths and skate parks. Barcelona established the concept of the 'reconquered city', freeing its public spaces from traffic for the pursuit of activities. In this, Barcelona became an exemplar of public space architecture.

For Jan Gehl, Copenhagen has always been a living laboratory where he established his consulting firm Gehl Architects, conducted experiments and developed methods.[35] He notes in his work with global cities in various parts of the world that needs and conditions do not vary dramatically. Everyone has 'walking, a sensory apparatus, movement options and basic behaviour patterns in common' (Gehl & Svarre 2013). Similarities are far greater than differences. Demonstrations such as the Arab Spring or Occupy Wall Street show that despite the popularity of digital media and the performative qualities of social networks,[36] public spaces remain important forums for public opinion (Weibel 2012).

However, Gehl critiques the use of new technologies in public life studies as conducted by Bill Hillier and Tim Stonor,[37] in particular the use of GPS trackers and software analyses such as those used by Space Syntax (Rose & Stonor 2009). He argues that although these tools will create new knowledge in the field of public life studies, they are too abstracted from eye-level principles of observation. Being in the city, he states, is a prerequisite for understanding the interaction between life and form.

Indeed, the common thread in Public Life Studies research is the need to witness public life at eye level, with one's own eyes. This to some extent supports Nigel Thrift's suggestion of Witnessing (Thrift 2008), where he argues that representational methods cannot depict real situations.[38] One could argue that Jan Gehl, in advocating a combination of witnessing and representational methods, proves that digital representations such as advocated by Bill Hillier and Tim Stonor only work on an abstract level, lacking the witnessing of interactions with space. Although witnessed knowledge might not be directly represented in the material produced by a public life study, it indirectly shapes the representation by influencing (for example) the selection of photographs or the interpretation of data.

Observation in the digital age however, needs to extend traditional public life studies beyond registering the interactions of public life with public space, to registering interactions of public life with public and virtual space. This extends the observing of time in the urban environment to observing of time in the urban and virtual environments. In particular, it observes the interplay between physical and virtual time without isolating one from the other. Peter Weibel refers to virtual time as 'techno time' due to its being virtually independent of physical laws. This has an impact on how time is perceived (López del Rincón 2013). Thereby, to observe time in public space, combining physical and digital interactions, not only registers how we communicate, interact and navigate, but how we perceive and construct reality,[39] digitally and physically.

One researcher who has investigated virtual digital interactions in a mobile and environmental context is Jan Chipchase (Chipchase 2013). Chipchase's work is also based on observation, and uses a research method known as Contextual Inquiry. Contextual Inquiry was founded by Karen Holtzblatt and Hugh Beyer as part of their Contextual Design methodology (Holtzblatt, Wendell & Wood 2005). However, earlier observational work in HCI, originated from Lucy Suchmann's (Suchman 1987a) analysis of how people use office products and services. Contextual Inquiry has since been commonly used in office environments to register physical and digital interactions for the improvement of business processes.

2.4 Contextual Inquiry

Contextual Inquiry is an observational approach to understanding how people use digital applications in everyday life, seeking to understand how and why they may hinder or improve their situation. While Lucy Suchman (Suchman 1987a) laid its groundwork, Karen Holtzblatt (Beyer & Holtzblatt 1999) formalised contemporary Contextual Inquiry methods and contextual design methodology. Jan Chipchase (Chipchase 2013) is a highly prominent contextual researcher, working as lead contextual researcher at Nokia and Frog Design, following which he founded his own consultancy, Studio D Radiodurans. This chapter will outline his approach and perspective, and how it can aid research in urban anatomy. In particular it investigates a method known as 'shadowing',[40] which the current writer has adopted as his main research method, developing it into an 'urban shadowing' method for understanding how people use cities in the digital age.

Jan Chipchase employs Contextual Inquiry to investigate how we are defined by the products we carry. He posits that we carry what helps us to survive, thereby questioning what survival means in the digital age. Most people carry three fundamental products: keys, money and a mobile phone. Keys allow people to access shelter and keep things safe, while money allows access to food and sustenance. Mobile phones let people connect with others across space and time. Chipchase uses the specific contextual inquiry method referred to as 'shadowing' to research how people interact with the products they carry. He refers to his method as 'stalking with permission', wherein he follows participants during their daily life.

Chipchase explains that in order to learn why people do things the way they do, we need to not only 'research people who do things in context' but find the right places where they actually do it. In the digital age it is tempting to assume that online data will explain why people do things the way they do. Yet online data does not offer sufficient insight; it fails to show underlying cause and effect. Contextual research must occur within the context of doing.

Chipchase asserts that a key objective in contextual research is to understand how people solve their problems, rather than to assume how they do so. He offers an illuminating example relating to the potential for designing mobile phones for illiterate people. While studying mobile phone usage of illiterate people in India, Chipchase found they were able to manage standard mobile phones as long as there were people they could ask for occasional help. Further, he found that illiterate people didn't want a phone designed for them; rather, in order to fit in and appear normal, they wanted to use a normal phone. A bespoke phone for such people would have branded them illiterate. On the contrary, they developed workarounds for normal phones. Chipchase thereby argues that a sub-optimal product for that specific target audience is more optimal than a bespoke product that would cost more, carry social stigma and require a different learning curve.

The following section breaks down the diverse approaches used by Chipchase to grasp people's relationships and interactions with products and services. Initially, Chipchase employs threshold maps that chart how users engage and disengage with products and services depending on their circumstances. Next, he shows how products help people conduct their daily performance and how they present themselves, demonstrating how users abstract the product's value in material terms. Chipchase explains how products are adopted in five different steps by five different user types. Following this, he shows how we organise our belongings in our everyday life and surroundings and how this differs according to physical and virtual products. He goes on to stress the importance of place, where we should conduct contextual research, and how to research the place itself. Chipchase then argues that trust is an important factor in our interaction with products and services, and shows the different levels of trust required for a user to interact with a product or service. He also shows how we can innovate by stripping products and services to their essence and rebuilding them on the basis of simplicity. Finally, Chipchase explains how a sub-optimal product can be superior to an optimal one, given the right context and circumstances.

Threshold Maps

Chipchase researches the touch-points and triggers of products and services, that is, the times and places where people interact with these in the context of use. To understand these touch-points, he argues the need to understand the boundaries of use and disuse, namely, the threshold of where and whether someone is using a product in the context of doing or not doing. These behavioural parameters are not dictated merely by laws of state or nature, but by cultural norms, social contexts, interpersonal relationships, personalities and perceptions. Customer journey maps (Cruickshank 2011) are often used to map the parameters from collected data. Chipchase however, argues that 'threshold maps' constitute a superior method, in that they let us understand the use of the product or service in context, and what lies outside and inside the boundaries of acceptable use. Threshold maps in fact show how we make decisions based on our mental and physical states.

Companies typically have a good grasp of the 'normal use' of their products and services, but lack not only understanding of extremes, but in what circumstances they transition from disuse to use. Threshold maps reveal those tipping points, showing when a person is on the cusp of changing from disuse to use, and hence where she is most open to manipulation. Threshold maps thereby let us understand a person's everyday life, and further allow the clustering of people into archetypes. Chipchase uses the example of grooming. If we are to merely observe a person groom, we will know little about why they are doing it. Understanding the context of their everyday life lets us understand 'why'. In researching grooming behaviour, Chipchase classified archetypes into different comfort zones based on the social context they would interact in; for example, where cleanliness was the smallest factor and social embarrassment the biggest. He argues that social standards are like an aperture that contracts and expands the person's comfort zone within a threshold map, depending on the cultural context they interact in.

Threshold maps also explain, for example, why people would rather spend on a credit card than use cash. The mental threshold for the virtual interaction is smaller than for a physical interaction. This is referred to in behavioural economics as the mental transaction cost. A person has to think less about the credit card transaction; hence we prefer the card instead of (physical) cash, even though the outcome is financially identical. Chipchase posits that the first step in researching product and service behaviours is to understand that a threshold of use actually exists. He adds a caveat that threshold maps are a good way to understand the present, but cannot predict the future.

Veblen Goods and Time

Trends and the people who follow them, are valuable indicators of the Zeitgeist; however, trend-followers seek to be contemporary rather than produce trends themselves. Contextual Inquiry hence does not research trends but people's underlying needs and desires. Chipchase observes that when people put their belongings on display, they are in fact inviting us into their world. He draws parallels to Erving Goffman's *The Presentation of Self in Everyday Life* (Goffman 1959), whereby Hoffman explains that everyone is performing a daily theatrical performance in the absence of an underlying authentic personality. Similarly, certain situations contain established codes of behaviour that require people to perform in a specific way. Chipchase thereby frames our world in the context of Veblen goods (Veblen 1973). These goods do not denote physical value but the value they offer in supporting our actions within our theatrical performance. Veblen goods require us to acquire social excuses in order not to seem vain but to remain approachable. For example, owning a luxury sports car requires the social excuse that we are a sporty driver and therefore need the car for that purpose. Chipchase further argues that in the digital age where everyone needs to be connected, time is becoming a Veblen good in that the ability to 'go offline' becomes a privilege. Digital advances will no doubt make it easier to present time as a Veblen good in a virtual theatre performance; for example, presenting yourself having a great time on Instagram. He concludes with a threshold model, showing what is the minimum of Veblen goods needed to perform our theatrical performance, against the maximum required to avoid looking like a show-off.

Diffusion Process and Product Adoption

Chipchase shows that the adoption process for products and services follows a pattern identified by Beal and Bohlen, who initially discerned such a pattern in how farmers adopt hybrid corn seeds. Beal and Bohlen refer to this as the 'diffusion process' (Beal & Bohlen 1957). The five steps of this diffusion process are Awareness, Interest, Evaluation, Trial and Adoption. In the Awareness stage, the person learns about the existence of the product but does not necessarily understand its functionality. In the Interest stage, the person learns that it might be useful to him, but still does not fully understand its features. The Evaluation stage follows, where the person mentally tests whether the product could be truly useful to him. If successful, this results in the Trial stage, where the product is actually tried out. If the Trial stage succeeds it leads to Adoption, wherein the person needs to be satisfied with the product to actually adopt it.

Along with the diffusion process, Beal and Bohlen researched who adopts a product and when they do so. They identified five archetypes: Innovator, Early Adopter, Early Majority, Late Majority and Laggards. The Innovator is well connected to new product ideas and does not have to worry about losing money or prestige if a product fails. The Early Adopter adopts the product from the Innovator. Early Adopters are typically younger, well-educated and driven to investigate and explore new products and services, that thereby give them credibility within their networks and community. They are in fact key players for introducing new products and services into the market. Once the Early Adopter has successfully adopted, the Early majority follows. These might be older, less informed and less educated, yet their opinions are well respected and they will not risk that respect by adopting a bad product. Critically, they wait to see how a product pans out for the Early Adopters. Once the Early Majority has adopted, the Late Majority follows. This group is again older and not intimately connected with emerging trends. They learn about the products only from the Early Majority, yet typically follow the latter. Lastly come the Laggards, who are averse to change and are not connected to established technologies. We also see non-adopters, who may be separated into recusers and rejecters. Recusers think they have no need for a specific product and can live without it. Rejecters are against using a product on principle; for example, those who do not want to have a television at home.

For his part, Chipchase discusses the social pressures underlying product adoption. When, for example, Laggards are pressured into using a product or service, it can be seen that social norms have shifted and that product use is expected. Consider: in the adoption of mobile phones, at some stage people buy the product for others in order not to be inconvenienced by that fact that they cannot reach them. Chipchase also shows that social pressure differs significantly from culture to culture, and that 'cutting-edge' means something different in Tokyo, San Francisco, Kenya or Afghanistan. Nonetheless, social pressure can be a powerful tool for researching the same product in the context of different cultures; that is, since the product is consistently the same, cultural differences and needs can be isolated.

Range of Distribution

Chipchase uses a particular research lens while shadowing, called the 'Range of Distribution', which defines the distance between product and participant while the latter is out and about. For example, a user wears a backpack on the front instead of the back while traveling on a subway, to make sure no-one can steal from him while he is in transit. Range of distribution is not only defined by physical distance but also by mental distance, which plays an even more important role in the context of digital products. For example, a wallet with just a few dollars inside will have a different mental and physical range of distribution from a wallet containing hundreds of dollars.

The 'Centre of Gravity' is referred to as the area in private spaces where people set objects down, where objects are saved and from which they are (easily) retrieved, both physically and mentally. An example would be an area in a home (probably near the door) where the occupier deposits keys or other valuables she does not want to forget. This instance shows that physical convenience is as important as mental convenience, wherein the person can easily retrieve items yet also ensure they are not forgotten. However, when products become digital, the 'range of distribution' and 'centre of gravity' change. How can one check for digital objects in comparison with physical objects? A case in point: keys can be checked by physical touch, but value on a public transport card cannot. In the case of digital products, physical distance, time distance and distance from consciousness create different priorities.

Algorithms can play an important role in bringing digital products into a person's awareness, and save them from forgetting. A currently implemented example is the Gmail feature, where if the user writes the word 'attach' in a text, Gmail asks if they want to add an attachment. Similarly, location-based products and services can make use of AI to renegotiate the range of distribution and centre of gravity of digital products and services. Location-based data adds another layer to these, namely 'real-time decision making'. A clear example is a car-sharing service, which allows a person to use a car whenever and wherever they need it in the city. In the context of an online digital ecosystem, the question is posed: how do we find our belongings online? Where do we leave and retrieve them, and do we even need to own products any more? Spotify is an example of this radical shift in range of distribution and centre of gravity, where the user no longer needs to own the digital product but shares it, for a fee, with the Spotify community. Centre of gravity is expressed through the Spotify interface, which in turn suggests, using an AI algorithm, what the user might like.

Platzgeist

Chipchase elaborates on a method called 'macro tours' which serve to capture what he calls the 'Platzgeist'. Macro tours make use of macro-photography to capture the close-up textures of a place, that is, its sensory experience. Chipchase may then combine them with audio recordings. The macro photographs isolate things from their context, but when viewed in clusters can provide a cumulative experience of the place. Further, he might combine macro tours with fish-eye or panorama photographs of the same place. Chipchase concludes his polemic on the importance of place in contextual research with a more general question: why does location-specific contextual research matter? How does the localised understanding of a specific participant help our research? Chipchase argues that it is a great help to understand how people live in a particular context, and how they aspire to live. Quantitative demographics cannot deliver such understanding. Chipchase has identified a key challenge, which is to find the right balance between formal and informal data collection, as well as capturing the right quantum of data while avoiding overstimulation. He refers to this as finding the optimal 'Surface Area'. Being able to find this, is what (he argues) separates good researchers from great researchers.

Trust

Chipchase discusses the issue of trust when interacting in any product or service ecosystem. He considers it to be essential across the board, including in social connections and business transactions. Trust and how we evaluate it is classified in six dimensions: authenticity, fulfilment, value, reliability, safety and recourse:

1. Authenticity is defined by the expectations we have towards a product, that is, if a product fulfils our expectations we consider it to be authentic. 2. Fulfilment relates to when a product or service lives up to what it promises, establishing trust between product and person. If a product falls short of its promise, people distrust not

only the product but the brand that created it. 3. The value of a product is defined in terms of quality gained versus money spent. The better the value, the more we trust. 4. Reliability refers to the product's consistency, and is akin to fulfilment in that the more consistently it delivers on its promises, the more trust is established. 5. Safety simply refers to the harm a product can potentially cause to oneself, the other and the environment. The less the potential harm, the more trust is established. 6. Recourse is the assurance that if a product fails, we can get it fixed or replaced. The clearer the recourse options, the more trust is established towards the product and the brand in general.

Brands play an important role in the trust ecosystem for products and services, since past experience of a product of a certain brand shapes future trust in that brand as a whole. Chipchase asks how we can establish trust, in a new relationship with the new product of a new brand. How can one 'sniff out' a product to ensure it is trustworthy? Presenting the example of 'sniffing the milk before use', he argues for affordances that let us check the product's quality in order to develop initial trust.

Strip Down

Chipchase goes on to posit that stripping things back to their essence helps to rebuild products and services from the ground up. The purpose is to address local needs at the front end while leveraging a common back end. He uses the example of a humble gas station in China that uses a bottle and hose to provide the same function as a complex gas station in a western country. This 'stripping down to the essence' allows the reframing of products and services to create innovative offerings. He also notes that existing infrastructure can block such stripping down. It would be hard, for example, for BP or Shell to strip their offering to a bottle and hose, that is, to redesign their service around the humble Chinese premises. Complex distribution networks and existing investments in gas station facilities would prevent such a thing. A similar example is the disruption airlines experience from the internet. Established airlines could not strip their infrastructure to the level of 'Online Budget Airlines', since the complexity of their infrastructure and human resources is too great. This in turn will not allow them to lower their fares. Nonetheless, new airlines could do as Ryan Air did, focusing on budget travel as the essence and building a new service offering around it.

Chipchase refers to Don Norman (Norman 2013) and John Maeda (Maeda 2006), arguing for reducing and organising as first principles of good design, enabling the avoidance of 'feature creep'. Feature creep means overloading a product or service with features, rather than ensuring the essence is not overwhelmed by non-essential 'bells and whistles'. Two examples of research methods for finding the essence in a product or service are: performing contextual research in resource-constraint communities, and performing product strip-down workshops. The data captured is then reframed through exercises in lateral thinking. For instance, we may introduce an incongruous element such as developing a commercial banking service for a Chinese panda toy. This facilitates a structured process of deconstruction and reconstruction. The key purpose here is to find out what customers cannot live without.

In outlining all aspects of Contextual Design and Research, Jan Chipchase's work reveals the full spectrum of product- and service-related contextual research and how it is currently conducted, suggesting that it can indeed translate into an urban environment-focused approach.

The current research draws from specific Chipchase methods, in particular the ‘shadowing’ method. However, methods such as threshold maps, range of distribution, platzgeist and so on, will prove useful in future iterations of urban Contextual Inquiry. This research affirms that such inquiry should draw from these methods when conducted on larger scales. Within the scope of this PhD however, it was necessary to narrow the focus to the ‘shadowing’ method - the most applicable in this research context.

The leap from a product- and service- design approach to a spatial and urban approach is a key challenge in this research. This was bridged by drawing from Chipchase's urban shadowing principles and method and Karen Holtzblatt's more detailed contextual research approach.

Chipchase's work is relevant precisely in that he researches digital touchpoint interactions in a mobile and public space environment from a product and service design perspective. He might research how a user employs a particular map-navigation service on their phone, rather than investigating the user’s everyday urban life. His method, applying in public and urban space, only lacks an urban research perspective, and it is similar to Jan Gehl's shadowing method, which in supplying the urban perspective only lacks the digital perspective. The opportunity to merge these, by extending Chipchase’s product and service focus using Gehl’s urban perspective, resulted in the urban Contextual Inquiry method used in this research.

Since Jan Chipchase is an industry researcher, more rigorous methodology support was needed, and this is drawn from the work of Karen Holtzblatt, who in fact created the theoretical framework for contextual research and design. Jan Gehl on the other hand, is an industry researcher and academic. His research methods are therefore delivered in the Academic Literature section.

Karen Holtzblatt

Karen Holtzblatt (Holtzblatt, Wendell & Wood 2005) has produced an extensive body of research on in-context understanding of the digital user experience. Her contextual inquiry approach informs the design process with empathic user data.[41]

The data is captured by the researcher who, while following the user conducting tasks in their environment, asks in-context interview questions.

Holtzblatt's work is actually a more deeply applied iteration of the observational approach outlined by Lucy Suchman in *Plans and Situated Actions: The Problem of Human-machine Communication* (Suchman 1987a). Suchman provided the foundation for an observational approach in HCI by highlighting the influence of the user's environment on the interactive cognitive process. She also argued for a more thoroughly user-centred approach. Some of Suchmann's oft-cited work includes the observational research she conducted on understanding the use of photocopiers in the office environment.

Holtzblatt initially developed Contextual Inquiry to research how digital applications can be improved in the context of the physical work environment, in work processes, with co-workers and with cultural differences. The current research segues from Contextual Inquiry in the work environment to that of the urban environment,[42] seeking to understand how digital applications in the urban setting influence urban experience in the context of both the physical environment and the urban anatomy in general.

The overall Contextual Design methodology comprises:

- Contextual Inquiry:
  - researching the user in his or her environment
  - forming visual models from the captured data
  - consolidating the data models
  - envisioning new concepts based on the consolidated data.

- Design:
  - creating designs based on envisioned concepts.

- Prototyping:
  - prototyping new designs.

Due to time and budget restrictions, this research makes use only of the Contextual Inquiry component of Contextual Design.

Contextual Inquiry itself is based on **four principles**: context, partnership, interpretation and focus.

Principle 1: Context

The first principle of Contextual Inquiry is to observe the user in the context of their working environment. The approach used to collect data is referred to as the Master and Apprentice model, where the participant is considered to be the Master and the researcher the Apprentice. The approach allows for a natural relationship between participant and researcher, whereby the researcher asks questions and learns from the other. In turn, the participant can talk about his or her process, which helps participants elaborate on their own work. It is also the researcher's job to capture mundane tasks that the participant does not consciously recognise, since those tasks have become an invisible part of their routine. Participants also tend to abstraction when they talk about their work, so the researcher, to capture concrete data, needs to lead them back to talk about their experience.

Principle 2: Partnership

In a traditional interview power resides with the interviewer, who may ask whatever question they want, in any order. In a traditional Master - Apprentice scenario, power resides with the Master, who teaches the Apprentice what he wants at the time he sees fit. In Contextual Inquiry, the researcher does not seek to learn the work but to understand it to gain insight. Hence the researcher needs to accommodate a partnership relationship with the participant. One way of achieving this is to probe assumptions during interviews and to ask whether observations are correct or if certain suggestions would help.

Principle 3: Interpretation

The captured facts will always be subject to some form of interpretation by the researcher. It is crucial to verify the interpretation with the participant, since it is not the facts but the interpretation that will form the data. To verify is to 'fine-tune'. Holtzblatt gives the following example:

> 'It's like a travelling office,' you say, looking at how a salesman has set up his car. 'Well - like a traveling desk,' he responds. The difference is small but real, and people will be uncomfortable until they get a phrasing that fits exactly (Beyer & Holtzblatt 1998).

Principle 4: Focus

Lastly, focus setting is an important way to capture the right details for securing meaningful data. Without clear focus on what the researcher wants to achieve, key facts may not be captured or put in the proper perspective. The researcher can also steer the focus during interview or observation, into the direction in which he needs data. It is also important to watch for triggers that reveal the need to expand the focus, such as surprises and contradictions.

2.4.1 Rationale for Contextual Inquiry

The principles outlined above provide researchers with methods to investigate social settings, and to organise their observations into data models that allow for analysis that results in implications for design. Contextual Inquiry is aimed at those with neither the training nor the time to conduct a full ethnographic method. In fact, it allows them to conduct field research to collect design inspiration. Contextual Inquiry is not simply 'discount ethnography'. Rather, it produces new methods based on ethnography that put primary emphasis on implications for design. These methods offer a means to reduce the complexity of field research, delivering a stronger focus on how digital implementations should be applied in environmental settings (Grudin 1990).

Traditional ethnography does not simply capture what subjects say they experience, but rather the subject's actual experience and perspective. Thereby it offers a conceptual interpretation of relationships between subject observations. Anderson (Anderson 1994) argues that an ethnographic approach that focuses on design implications marginalises the analytical component, thereby limiting its full potential. Anderson outlines three key issues:

- Ethnography should be seen as a form of reportage.
- Examples should be employed in the form of strategic juxtapositions.
- Ethnography should not only consider the research subject, but the audience it caters for.

Ethnography cannot simply extract data from a research subject but must consider the setting from which it was extracted. In analysis therefore, the ethnographer must incorporate the context, along with the relationship between ethnographer, subject and setting. However, when working towards design requirements, this analysis tends not to be considered. Designers tend to conceptualise findings, ignoring the perspectival view of ethnography. This creates three key issues:

- Design is framed as the end point of the research, and the designer as the gatekeeper of that research.
- Ethnography is placed outside of the design process.
- Research subjects are placed outside the design process.

By way of example, Miller and Slater's research (Miller & Slater 2000) into the use of internet technologies in Trinidad does not suggest how digital implementations might be best designed to suit the Trinidadian context. It rather shows the dynamics between virtual and real-world issues as they are facilitated by digital implementations. Miller and Slater in fact show how these implementations do not create a place outside everyday life but instead form an integral part of the Trini experience.

When focusing on the implications for design, the question becomes: are we using ethnography's full potential, and are we getting the best results for those design implications? Further, at what point can ethnography have its biggest impact on the digital development process?

The 'implications for design' focus is designed to mediate the relationship between technology and practice, investigating the practice of everyday life on one hand and the design of digital technology on the other. Ackerman refers to this gap as the 'social-technical gap', and stresses the need to bridge it; that is, to combine technological understanding within the design process, and understanding of how technology is used in practice.

However, a broader ethnographic view that is not focused on the implications for design, can investigate how technology produces socio-cultural meaning. Perspectives on how people use technology for both intended and non-intended uses can engender a better grasp of the systems of practice they are embedded in. Lucy Suchman (Suchman 1987b) thereby argues for a reconfiguration of the power relationships within HCI ethnography; specifically, where the researcher does not report on the habits and practices witnessed (as in traditional anthropology) but rather frames encounters and partnerships between producers and consumers. Such partnerships and encounters thus attempt to respect and amplify practices rather than representing them as isolated insights for the implications for design. Suchman's approach thereby offers an alternative view on industrial ethnography and forms the basis for Contextual Inquiry.

The question then becomes not 'what do these people know,' but rather 'of what does their local knowledge consist, and how is it manifest?' It is crucial then to understand that the power lies within the ethnographer's imagination rather than his toolbox. That toolbox needs to go beyond implications for design; that is, it requires a sensitivity to the nature of the interaction between ethnographers and their subjects.

Finally, it matters less what the implications for design are but how and why they are arrived at, what commitments they embody and what models they reflect. It is important to make a distinction between the empirical and the analytic, whereby the empirical represents what happened, and the analytic represents how data is modelled to reveal partnerships and encounters in the context of the investigation. Contextual Inquiry provides designers and researchers with an approach that separates the empirical and the analytic to produce data models from field research that are intended to create inspiration for design decisions.

2.5 Telematics

The term telematics was first introduced by Simon Nora and Alain Minc as a combination of the words telecommunication and informatics, to describe the computerization of society and its social, economical and political implications (Simon Nora and Alain Minc). Technically, the term refers to telecommunication over digital networks in combination with information processing. More currently, the term is used to refer to the remote sensing and remote controlling of physical objects. The telematic process of remote controlling a specific mechanism is referred to as telemechanics. For example, the remote opening or closing of a door over a digital network is a telemechanic process. Outside the academic context, the term telematics is most commonly used to describe vehicle telematics. This refers to the remote monitoring and control of vehicles via GPS and wireless data networks. Medical telematics is another non-philosophical use of telematics, referring to remote patient monitoring, treatment and operating.

In an academic context, the term is used on one hand to describe the implications of digital networks on society as a whole, resulting in a networked society as initially outlined by George Simmel (Simmel 1903). Villem Flusser (Flusser 2011) argues that such a networked society based on telematic processes results in a telematic society, a true information society where actors constantly exchange ideas over a digital network. On the other hand, academic literature, in particular artistic literature, refers to telematics in the context of telepresence. Here, the causes and effects of virtual interactions create immediate feedback, resulting in a form of disembodiment of the user. Ken Goldberg's *TeleGarden* (Goldberg, Santarromana & Bekey 1995) is an early example of a telematic artwork, that allows internet users to maintain a real garden through a virtual interface and webcam. Further, Roy Ascott (Ascott & Shanken 2003) has defined the term telematic art as the staging of remote aesthetic encounters.

While the term telematic is indeed used in a broad sense, my own research uses the term in terms of the sensing and controlling of remote actors - be they machines, mechanisms or people. These actors are sensed or controlled to stage remote events.

2.5.1 Why Telematics

The introduction of the term telematics in this research distinguishes between virtual reality interactions, mixed reality interactions and what is referred to as telematic reality interactions. (See **Figure 11,** below).

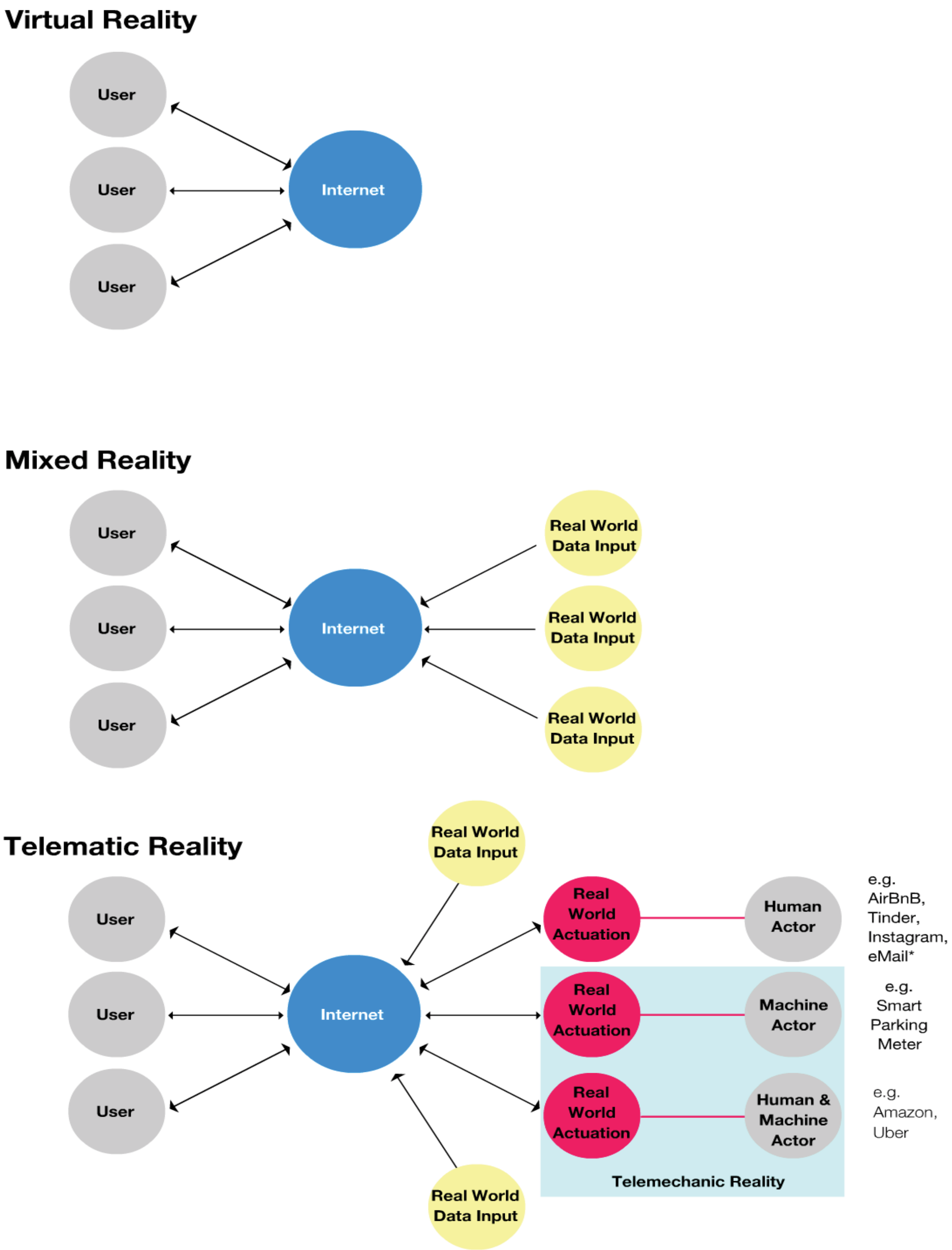

Figure 11: Diagram comparing between Virtual, Mixed and Telematic realities.

Virtual reality interactions refer to 'interactions with a virtual reality', that is, a digitally-constructed artificial reality that exists within a computer. Virtual reality does not actuate real-world processes as telematics does, but only receives inputs from the user. A computer game is an example of a virtual reality, as well as any website or internet service that only facilitates user input via basic controls such as the keyboard, mouse or joystick.

Mixed reality involves augmenting virtual reality with real world data. In a mixed reality, the virtual reality is not limited to user input but also inputs real-world information from third parties. The term is commonly used in the context of augmented reality, which is a form of mixed reality that uses a live video feed of the real world to overlay the video feed with virtual-reality objects of information. Mixed reality, however, does not actuate telematic processes.

Telematic reality uses virtual and mixed reality interfaces to actuate real-world processes. Arguably, any form of email or text messaging telecommunication can actuate real-world actions and hence would be telematic. However, our present definition of telematic reality refers to processes with a more structured mechanism of control, that allows the user to remotely actuate complex tasks. 'Complex' here refers to technically or socio-culturally complex tasks.

Digital applications we consider here to be telematic, include Uber, AirBNB, Tinder and online shopping websites such as Amazon, expressed in the following ways:

1. Uber is a telematic application since it allows the user to control a driver to drive their car to the user's current location, via a virtually-augmented Smartphone application with a single button-press on a virtual interface.
2. AirBNB is a telematic web application since it allows a user to gain remote access to a remote private property by interacting with a virtual interface.
3. Tinder is a telematic application since it allows a user to facilitate a real-world date with a person through a Smartphone application.
4. Amazon is a telematic web application since it allows a user to control the robots in the Amazon warehouse, and initiate the physical delivery-fulfilment process by interacting with a virtual interface.
5. The smart parking meter app (outlined in the Visioning chapter of this document) is a telematic application. That is, if a user can extend his parking meter time from his Smartphone when (for example) his meeting takes longer than expected, he is interacting in the realm of a telematic reality, not in that of a virtual or mixed reality.

2.5.2 Telematic Reality within this Research

A distinction is made within this research between virtual, mixed and telematic realities to show that Smartphone users, when interacting with their phones, are not only interacting with an artificial virtual reality, but using them to control the real world and hence manage their physical life. We therefore return to Villem Flusser's theory of a Telematic Society. In such a society, meaning is produced not only through a person’s physical location but also telematically, in remote locations through telematic processes.

It should be said that the shift towards a telematic reality and society has not suddenly appeared through the introduction of the aforementioned digital applications, but has gradually occurred following the invention of telecommunications technology. However, the simplification of actuating remote processes through informatics and telecommunication, in combination with Smartphone applications, has fundamentally reduced their complexity, and increased availability to the everyday Smartphone user. This allows us to address everyday public life processes telematically, and thereby increase the computerization of society and public life in general. Such computerization undoubtedly has implications for how a person experiences and interacts with the urban environment.

To understand the issues of telematic reality seems crucial in the context of future Smart City developments. Early Smart City developments such as ‘interactive smart walls’ and media-facades, seem to have grown out of the conceptualisation of a mixed reality; that is, that urban inhabitants want to interact with augmented information through novel interfaces.

2.6 Performativity

Judith Buttler argues that for something to be performative assumes that it produces a series of effects. She in particular refers to language that produces a series of effects after certain words are uttered in a performative way. The result of the series of effects is more important than the semantic meaning of the word. For example, Barack Obama’s 2008 campaign phrase ‘Yes We Can’, has for the general public an emotional response and significance when uttered, that is disproportional to its semantic meaning.
In general, political theatre offers a prime example of performative language theory, where how a thing is said and what meanings and effects it triggers, is more important than what is actually said. A more trivial example is the loaded ‘cup of coffee’ one might ask for after ‘walking someone home after a night out’. Again, the series of effects this utterance may trigger exceeds the semantic meaning of the words.

It is important to understand that when this research refers to performativity, it does not refer to ‘performance’. The latter refers to someone or something performing an act, such as a dancer performing choreography. The latter may be merely representational in that it may not lead to any series of effects.

J.L. Austin breaks down performative utterances into three acts: the locutionary act, the illocutionary act and the perlocutionary act. The locutionary act denotes the actual utterance of the word, how the word is pronounced, and its semantic meaning. The illocutionary act is the effect it has on another person, and the perlocutionary act is the response the utterance generates.

Contemporary art and design has seen the emergence of a new art-form with performative qualities, where a series of effects is triggered not by linguistic utterances but by the forms of objects. For example, Jeppe Hein's modified social benches show how diversifying the shapes of such common objects is a locutionary act that triggers an illocutionary act from the user, which then leads to a perlocutionary act; that is, novel user behaviour.

Such performative qualities in contemporary art and design have led to what Hans Kiib refers to as Performative Urban Design - where the performative urban designer seeks to activate public space by delivering new forms of objects that trigger behaviour in people, and lead to new behaviour in public space. The distinction between urban design and performative urban design is explained thus: a traditional urban designer might place existing objects in public space to stage a public space experience, whereas the performative urban designer designs a new object with performative qualities that is placed in public space to create new behaviour, and therefore a new public space experience.

This research argues that the performative urban design approach is not limited to physical objects in public space, but extends to digital objects, particularly the telematic reality referred to here. Digital objects, or a combination of digital and physical objects, may create a series of effects in public space that did not previously exist. These objects thus contain a performative quality that can be designed or staged. The sensing and actuating (triggering) of a series of effects by telematic hardware and software form a performative basis for the future Smart City and its resulting telematic reality. Interestingly, since hardware and software are controlled by code written in programming language, the form of digital objects is shaped by that language. One may argue that all programming languages are inherently performative since the sole purpose of such a language is to trigger a series of effects. We are led to conclude that the performative qualities of hardware and software, and thereby the performative qualities of the digital, actually lead - through the digital sensing and actuating of a remote series of effects - to the telematic reality discussed in this research.

2.7 Performative Urban Design

In investigating approaches that are deemed valid in a Smart City research context, a key consideration is that performative urban design should be inherently site-specific. The more deliberately site-specific the design in terms of its influence on local inhabitants, the more successful it tends to become. While overall performative urban design methodology may be applicable across cities, the outcome of a particular design solution is generally not scaleable to other urban design solutions.

An exception to this may be a performative urban design object that can be placed in any urban scenario and where the object maintains its performative quality. Jeppe Hein's modified social benches spring to mind here. A 'negative' example might be the table-tennis plates in public space in such cities as Berlin - whose performative qualities ensure that the act of playing table tennis in public space is less important than the social gatherings it produces. It should be added that randomly situating a table-tennis plate in another global city may not create the same series of effects as do its site-specific qualities in Berlin.

It should be noted that the current research seeks approaches for advancing Smart City research in general, rather than for site-specific work that might function at one location and not at another. We rather seek approaches to formalising a urban user experience that may be applied across numerous global cities.

Media facades, media architecture and urban screens undoubtedly offer great performative qualities - as acknowledged by Hans Kiib. However, on top of the need to consider their implementation in site-specific terms, their architectural nature demands a more 'waterfall-based' production process, making them less user-centred and more costly in terms of implementation and maintenance. Such issues makes these approaches even less scalable into generic Smart City solutions. This research does not dismiss the diverse forms of media facades, media architecture and urban screens. It rather argues that they may be confined to a novel form of public art. In the same way that public art influences urban design to a minor degree, media architecture may occupy a minor role in Smart City research.

2.8 Literature Review: Conclusion

The sum of the literature mentioned in this study reveals current perspectives on interactivity within cities, and cities have taken these strategies on board in one form or another. Such rapid and disruptive digital change has produced ever-new challenges. However, a coherent strategy (as the Smart Cities approach demands) has not yet been established. For Interaction Designers, this complex digitalisation of the urban experience offers huge opportunities for research, since these changes significantly impact inhabitants' perception of a city. The initial objective of my research was to investigate how spatial interaction design strategies, and approaches such as interactive architecture and media architecture, can improve the urban user experience in public space. The architectural context however, threw up significant challenges that were outside the scope of this PhD. Further, it emerged that those challenges are not exclusive to spatial interaction design but impact digital implementations in urban space in general. My research approach therefore shifted towards analysis of the digital urban-user experience in the digital age as it currently stands, in order to develop a foundation for future digital urban projects. This resulted in the question: 'How do urban users interact in the digital age in public space on an everyday basis, and how do digital touch-points influence these day-to-day interactions?' As outlined in the literature review, the urban experience is a complex combination of in-context sensations and interactions that are susceptible only to in-situ observation in the user's environment.

The foregoing is an overview of key areas of research and issues relevant to the design of digital implementations in the urban environment. While there is yet no specifically-defined approach to achieving well-designed digital public spaces, there are commonalities between the fields, offering approaches that can lead to a more defined perspective. In summary, the relevant issues for achieving this goal are:

- **A user centred approach** to the design of digital implementations on an urban scale.

- **A holistic perspective** towards researching the city and its complex systems similar to an urban anatomy. Smart Cities look at cities as a holistic product, but not from a user-centred perspective. There is hence a need to integrate the user-centred approach in HCI with the holistic understanding of master planning.

- **To question why we need Smart Cities** or digital implementations in urban space in any form, be it of physical or virtual nature. As Adam Greenfield states, most Smart City agendas are driven by corporations and authorities with non-human-centred motivations. Further, as Jan Chipchase outlines, the need to ask why people require or use a digital implementation is crucial to its development.

- User-centred research and design needs to take place **in the context of use**. Researching digital implementations in labs, or using online data-sets to understand urban users, does not provide the needed contextual understanding.

- **Urban-related HCI, Urban Informatics and Interaction Design research need to integrate with spatial design strategies on an urban scale.** Spatial Interaction Design strategies might offer solutions, but might also differ when applied in public space rather than in private space.

This research addresses these issues by conducting a Contextual Inquiry in the urban environment, while considering the spatial and environmental principles of public life studies. **We seek a macro-perspective** on the collective use of applications and interactions in cities from an HCI point of view. Such an approach supplements the micro-approach of urban informatics. This is similar to the micro-and macro-perspectives in economics, where the former researches a single entity and the latter the collective influence of all entities.

Chapter 3 outlines our approach to Contextual Inquiry in an urban context, along with the adaptations required when we adapt the process from a work environment to an urban environment. It also breaks the method into its component tools, demonstrating their benefit in researching the urban anatomy.

3 Urban Contextual Inquiry

3.1 Introduction

This chapter reveals in detail how Karen Holtzblatt's Contextual Inquiry, introduced in the previous chapter, can be applied to an urban context in tandem with the public life study principles of Jan Gehl.

To provide context for the description of the methodology, the chapter describes how a typical participant is researched, showing how interactions are registered with a camera and notepad while she is followed. It then outlines how the research inevitably introduces a non-impartial view - related to issues in endo-physics and endo-aesthetic systems research.

Second, the chapter shows how captured data is transcribed and transformed into data models. It then outlines how these models deliver insights for the visioning process, that in turn offer implications for design.

Third, the chapter explains Sequence, Flow and Physical models in detail, and how Karen Holtzblatt's original contextual inquiry models have been adapted to suit the urban environment. The Flow model has been adapted into the Flow Circle model, in order to better map participants' routines and commute patterns. In turn, the Physical model has been amended into a combination of Storyboard and Physical models. Since the latter are typically restricted to one place, our model tracks participants' moves both within and between places.

Finally, the chapter elaborates on participant demographics, who was selected, and for what reasons. Participants, all of whom are from the commuter demographic, comprise four groups divided into '9 to 5' and flexible-hours workers, and according to their use of either public transport or private cars. It is noted that the commuter group represents only 40% of the urban demographic. The other 60%, are more consuming to research, due to their diverse proliferation.

3.1.1 Understanding the User Experience

Karen Holtzblatt has built an extensive body of research on the in-context understanding of the digital user experience. Her contextual research approach informs the design process with empathic user data, captured using the above-mentioned interview-based observational process known as Contextual Inquiry. This involves the researcher following the user in pursuit of his tasks in his environment, and asking in-context questions. Such a method forms the general basis of my own approach to research. I have also absorbed the environmental approach Jan Gehl suggested towards public space, where he proposed that the only way to understand people's activity and behaviour in the urban environment is by observing them at eye-level. For example, Gehl argues against Space Syntax's (Bafna 2003) research, in that it only tracks behaviour from a birds-eye perspective, and fails to understand how people actually interface with the physical environment. In similar vein, Nigel Thrift (Thrift 2008) argues that representational methods for capturing human activity can never adequately 'represent' what actually happens. Like Gehl, Thrift argues for witnessing human activity in-situ. HCI and Public Life Studies have meanwhile researched user experiences in the digital and urban contexts respectively. Established quantitative and qualitative approaches, methodologies and methods in both fields, drawing equally from social science methodologies, have supported my own research into the complexity of the user experience. The core of my approach, however, is based on Karen Holtzblatt's Contextual Inquiry.

Key overall components of Contextual Design include:

1. Researching the user in his environment (Contextual Inquiry)
2. Forming visual models from captured data
3. Consolidating data models
4. Visioning new concepts based on the consolidated data
5. Creating designs based on the envisioned concepts
6. Prototyping new designs.

This research incorporates four steps:

- Using Contextual Inquiry to capture the urban experience of city inhabitants
- Forming visual models out of captured data
- Consolidating captured data into models that are analysed into findings
- Envisioning concepts to propose future solutions based on the findings.

Steps 5 and 6 of Contextual Design, those of design and prototyping, lie outside the scope of this research owing to budget and time restrictions. The present chapter explains how Contextual Inquiry, developed to understand complex interactive systems in work environments, has been applied in the urban environment.

In the present case, the different scale and scope of urban and work environments has necessitated changes to Contextual Inquiry.[43] We refer to the application of Contextual Inquiry in the urban environment as 'Urban Shadowing'. Contextual Inquiry into the urban environment is adopted according to four steps:

- Using shadowing and observational interview techniques, Contextual Inquiry is used to capture the urban experience of city dwellers
- Captured Data is transformed into visual models to represent individual data.

- Individual Data is formed into consolidated models to be analysed into insights.
- Concepts are envisioned to propose future solutions based on insights.

3.2 Conducting the Research

A typical research day involves the following processes:

The researcher meets the research subject at their home doorstep. The process begins once the subject leaves home and closes the door. The subject takes either public or private transport to their work location. The researcher observes how the subject is performing in public space, including within their chosen mode of transport. The researcher records all objects the subject gets in touch with, and which alter the subject's performance. The researcher stops the process when the subject arrives at their workplace and enters the door to that environment, that is, as they leave public space and enter private space. The researcher resumes when the subject finishes work, that is, leaves the work place and closes the door. The researcher again observes how the subject is performing in public space while commuting home. The researcher stops the shadowing process once the subject enters their home building and closes the door.

The research subjects agree to the shadowing process beforehand by signing a consent form. Interviews are conducted by following (shadowing) the subject with a camera and notepad. Whenever the subject performs an action or transitions from one state into another,[44] sequences of photographs are shot to capture the process. The researcher takes notes about any action, and ask questions about how and why the person performs the action in the specific context. When subjects interact with Smartphones, the researcher asks what interaction the subject is currently performing. Due to measurements being within the system itself, and with the subject being aware of the researcher, such an observational method inevitably introduces a non-impartial view. We are reminded of endo-physics research[45] and endo-aesthetic interactions (Giannetti 2004b). Interpretation of the resulting data therefore needs to take this non-impartial point of view into account.

3.3 Transcribing and Modelling the Data

Once an urban shadowing interview is finished, the data is transcribed into a transcript. Photographs are arranged into a storyboard order and notes are written below each. The transcript hence allows us to read the captured day in a narrative form. Based on the transcript, individual data models are developed. The individual models are then consolidated to extract meaning from the data. The data models consist of a text-based sequence model and two types of visual models: the flow and the physical. The sequence model allows us to structure the data in text form. The flow and physical models allow us to communicate the data from different visual perspectives. The purpose of these Contextual Inquiry data models is to inform design decisions based on the insight provided by the consolidated models. The process of informing design from data requires the following steps:

Individual Data Models - to Consolidated Data Models - to Insight - to Ideation or Visioning - to Design Decisions.

The data models need to be transformed into insight. Insight then informs ideation in a visioning process. The envisioned concepts may then inform design decisions. Impactful design decisions can only be made if the data and insight are communicated in an accessible form. The visual models thereby require graphic design efforts to form the data into models. Graphic design[46] plays an important role in communicating insight to decision makers. It builds the bridge between data and design by offering graphical models that help them internalize the insight.

As established by Karen Holtzblatt over the last twenty years, such steps are a reliable pathway for transforming data into implications for design. We can only learn from users by talking to them one by one. This process brings complex user data from diverse user backgrounds into a single, comprehensible coherent perspective. It depicts patterns without neglecting important variations and allows us to make design decisions. Structuring such complexity relies on creating diverse models that allow for different perspectives on the same data. We now describe the sequence, flow and physical models in detail.

3.3.1 Sequence Model

The Sequence Model represents the individual step-by-step actions taken by the actors (that is, the research subjects), including the triggers that cause the actions and the actions' intent. (See **Figure 12**, below) This representation shows why actions matter to actors, and why they perform them in the first place. To achieve insight into the intent of actors is key when addressing issues in the system within which they act. Actions can always be reformed as long as actors can still fulfill their intent. A typical system improvement objective can then be to reach intents more efficiently. The sequence model represents the low-level steps of the captured system. The sequence model differs from the flow model in the sense that it is linear but represents the trigger and intent of each step and action. Sequence Models are not intended to reveal patterns or repetition, but are intended to reveal details of interactions that other visual models cannot show. They represent the actions of actors in a system in their most granular form, and their goal is to reveal the structured details decision-makers need to improve systems.[47] Lastly, they link the other visual models together since they order actions by time.[48]

	Actions	Intent	Trigger
Street 1			
	Laurene leaves her home and walks to the bus		
	v		
	On the way at the traffic lights she checks if the bus is on time with the NextThere app	Being on time	Fear of running late
	v		
	She crosses the street and waits for the bus		
	v		
Bus 1			
	Enters the bus and pays with her Opal card	Convenient form of payment	Pay for bus fee
	v		
	She has to stand first		
	v		
	Starts using her phone while standing to read news	entertainment and education	boredom, urge to stay informed
	v		
	Then sits down after most people get out at Bondi Junction	travel more comfortable	
	v		
	She continuous to read the news	entertainment and education	boredom, stay informed
	v		
	when done she keeps the phone in her hands even when not using it		
	v		
	She gets of the bus tapping off her Opal card	Convenient form of payment	Pay for bus fee
	v		
Street 2			
	She walks to work		
	v		
	At work she enters her building with a swipe card	enter building	locked door
	v		

Figure 12: Example of a Sequence Model based on the participant Laurene.

3.3.2 Flow Model

The Flow Model visualises the interactions between actors, places and objects in the form of bubbles. Each bubble contains the relevant events that take place. The flow is visualised with arrows between bubbles, and objects are visualised with boxes. The Flow Model creates a top-down perspective on a system, showing the actors of that system and how they perform independent of time. Flow models deliberately discount time, instead focusing on the interactions between actors, places and objects. Automated systems[49] should not be represented on the flow model unless they act as a physical place, or are critical to the flow between other actors. It is critical to also represent informal interactions, as they often redefine formal interactions.[50] Informal interactions are invented by actors to create solutions to unforeseen issues. The Flow Model must represent those informal interactions that make the system work, and doing so can lead to formal innovations in the system.

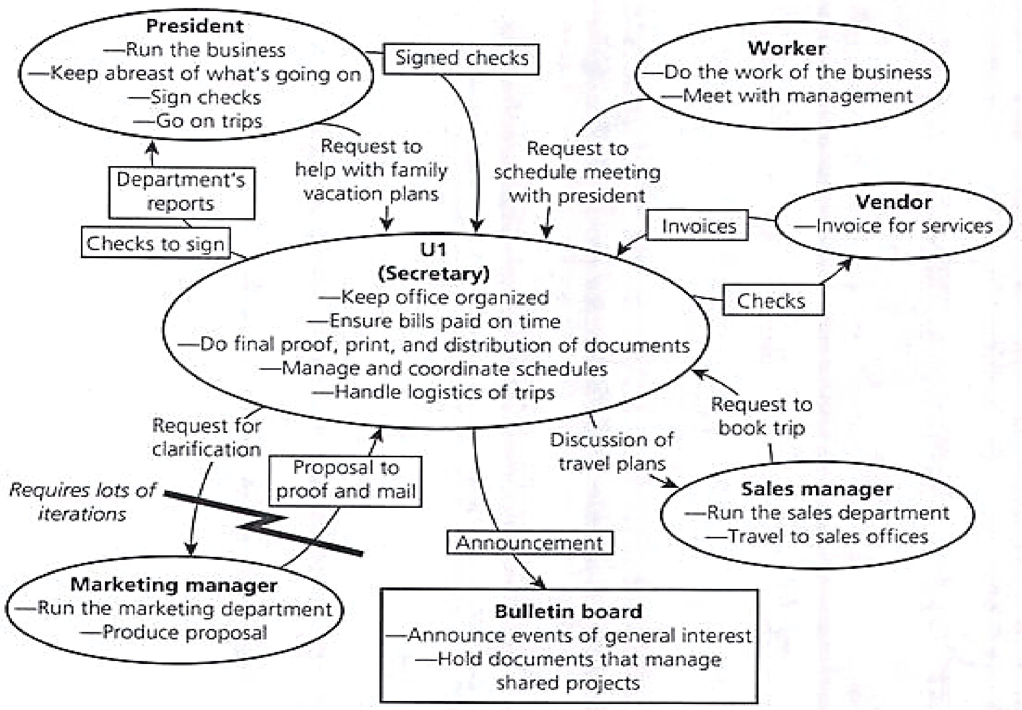

Figure 13: Original Flow Diagram by Karen Holtzblatt.

Figure 13 shows a typical Flow Model by Karen Holtzblatt. People and groups are represented as bubbles. The flow between the people is represented as arrows and the communication topics are written in text form on the arrows. Artifacts are shown as boxes, and places are shown as large boxes.

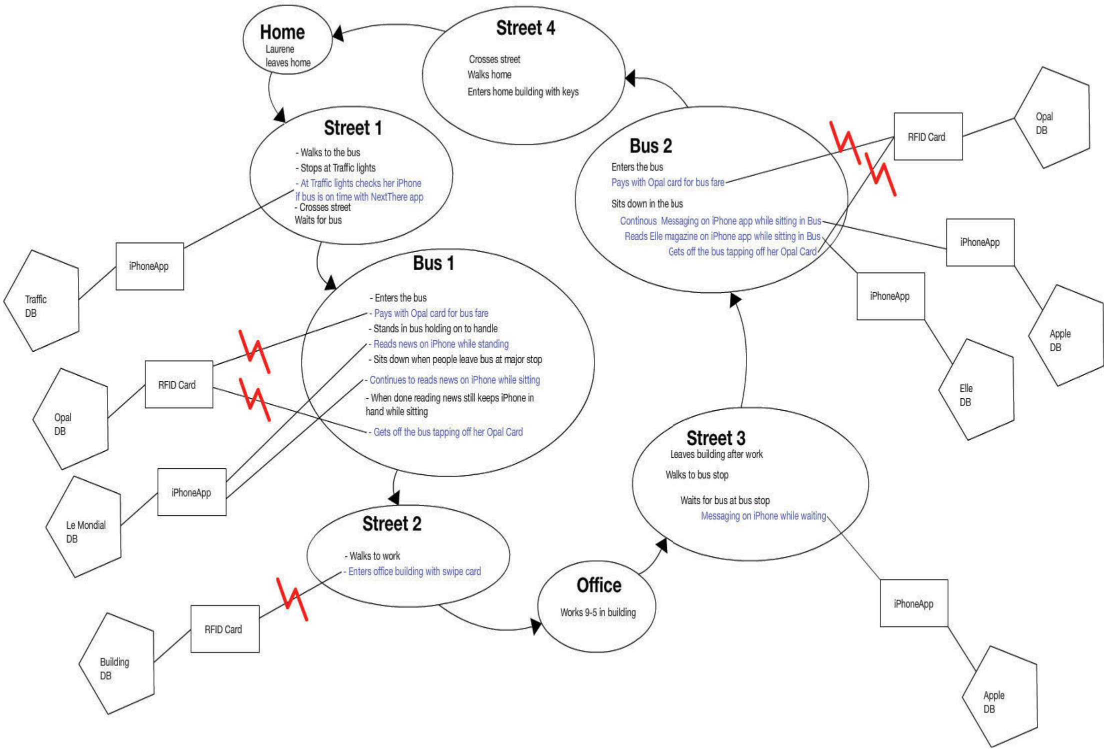

Figure 14: Flow Diagram of the participant Laurene.

In this adapted urban shadowing version of the flow model, we show exactly what the user interacts with during their activities in public life. In particular, the version highlights digital interactions and touch-points at specific places.[51] Instead of focusing on communicating between different people, we have shifted the focus towards the interaction between the subject and diverse places.[52] Places are shown as bubbles and the flow of movement between places, as arrows. Artifacts are shown as boxes, and virtual artifacts as hexagons. Interactions between them are also shown as arrows. The adapted Flow Model (see **Figure 14**, above) shows eight distinct places involved in the participant's day: Home, Street 1, Bus 1, Street 2, Office, Street 3, Bus 2, and Street 4. This version of the Flow Model shows key interactions - such as looking up bus arrival times on a Smartphone at Street 1 - by using a box to represent the artefact or interface, and a hexagon to show the interaction's end point, which in most cases is a cloud service database.[53]

In this iteration, Bus 1 shows an RFID-based opal card interaction. The Opal card interaction is a digital interaction based on a physical computing interface[54] rather than a Smartphone interface. This interaction can potentially be improved by using a Smartphone interaction. This would involve less hardware infrastructure and make the use-case more scaleable.

Circle Flow Model

To achieve a higher degree of comparability, a new Flow Model format has been developed in a circular form. (See **Figure 15**, below) This is more standardised and allows easier comparison of data. This new form is referred to as the Circle Flow Model.

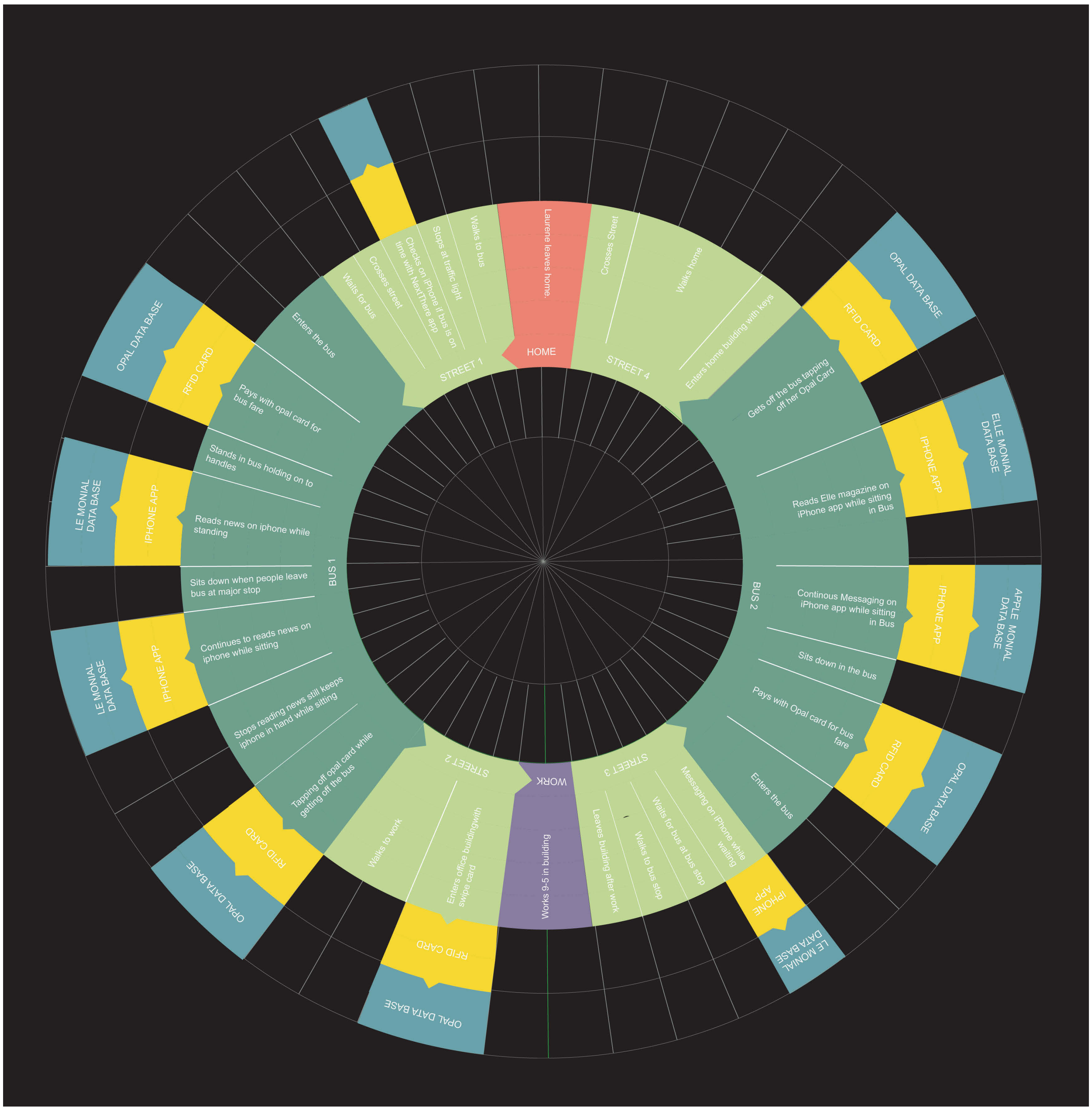

Figure 15: Flow Circle Diagram of the participant Laurene.

(Courtesy of Ralph Kenke, Pawan Jha, Elmar Trefz)

The Circle Flow model places home at the top of the circle and the office at the bottom of the circle. It tracks the pathway to work on the left side, and the pathway home on the right side. This is consistent with the original Flow Model diagram. However, the original model's use of bubbles, boxes and arrows is too loose to achieve consistent comparability between subjects. We have created a circle diagram in combination with a sunburst diagram to show the interaction touch-points of the actors as well as relevant parts of the daily routine. Digital interactions are shown in sunburst-type outbreaks into the outer circles. This combination of circular and sunburst diagram is made consistent by basing it on a circular grid. The new Circle Flow Model gives a more consistent overview of the amount and type of interactions a subject conducts during a day. It clearly shows how the interactions relate to each other, as well as how they relate to the daily routine. The diagram generates a more immediate quantitative understanding of the data, particularly the number of digital interactions. In this case, six digital interactions can be counted on the way to work, with five on the way home.

The circle flow model does not show the spatial context in which interactions occur. This element is shown in the following Physical Model, which offers a spatial overview of the subject's actions in the urban environment.

3.3.3 Physical Model

Public life takes place in a physical, urban environment. The urban environment either affords and enables actions and interactions in public space, or creates barriers and hinders actions – either by lacking affordances[55] or being in the way. The physical environment makes urban systems highly complex. It merges physical and digital interactions, creating the need to acknowledge them equally. Any urban system must acknowledge the limitations of the physical environment, and handle those limitations as design constraints. It is therefore important to represent these constraints in the physical model, to visualise how spaces are laid out and how they are used. How does public space support or hinder actions and the locations of interactive touch-points? The physical environment affects the urban system on every scale. It affects diverse places, their relationship to each other and how the actor performs in them. Within the physical models, we must represent the properties of physical structures that define the space, the movement patterns within the space, the touch-points and objects the actor interacts with, how actors communicate within the space, rapture points that show breakdowns in the physical environment - which in turn show how the physical environment hinders the actors' performance. While it is a straightforward affair to capture the actor in the physical environment, it is more complex to identify what is relevant to help the decision-maker improve the system.

Successful physical models represent:

- how the physical environment affects the performance of the actor.
- how strategies, intents, triggers and motivations are revealed by how the space is used.

- properties of the physical environment as far as they are relevant to the actor's performance and experience within the urban system. (The model operates in the same way as a caricature; it is not a floor plan).

According to the physical model (see **Figure 16**, below), places are broken down in a storyboard format but from a birds-eye view. This allows us to visualise how the subject's body moves in space and interacts with specific touch points. The model represents a more granular view than typical GPS-based spatial analysis (Bafna 2003). It also allows us to visualise interactions between the subject's body and the environment, which in turn shapes the subject's experience.

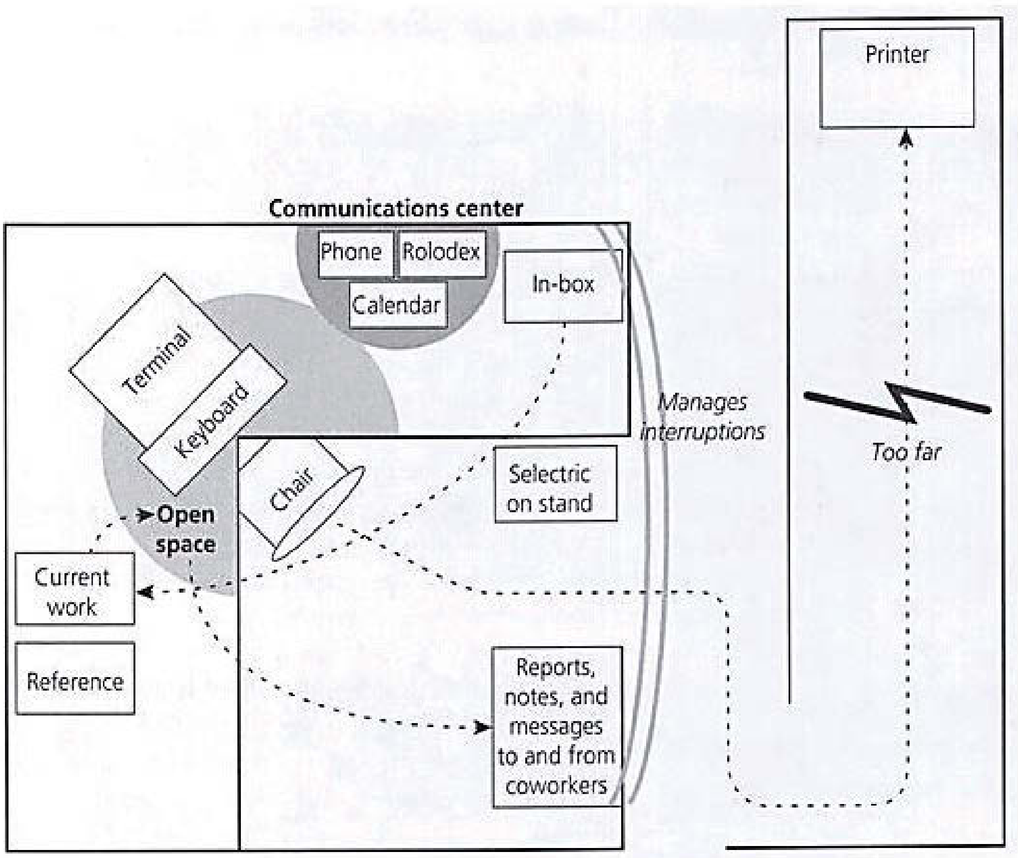

Figure 16: Original Physical Model by Karen Holtzblatt.

Holtzblatt's original Physical Model (see **Figure 16,** above) shows:

- Places such as rooms, workstations and coffee corners
- The structure of the space, such as walls, desks, file cabinets and large objects

- Movement and use of the space. How people perform within the actual environment
- Hardware, software and other tools people use to support their work
- The artifacts people come into touch with
- The layout of all of the above.

The Physical Model has been adapted into a storyboard format (see **Figure 17**, below), that allows us to visualise a narrative for the participant in their journeys from place to place.

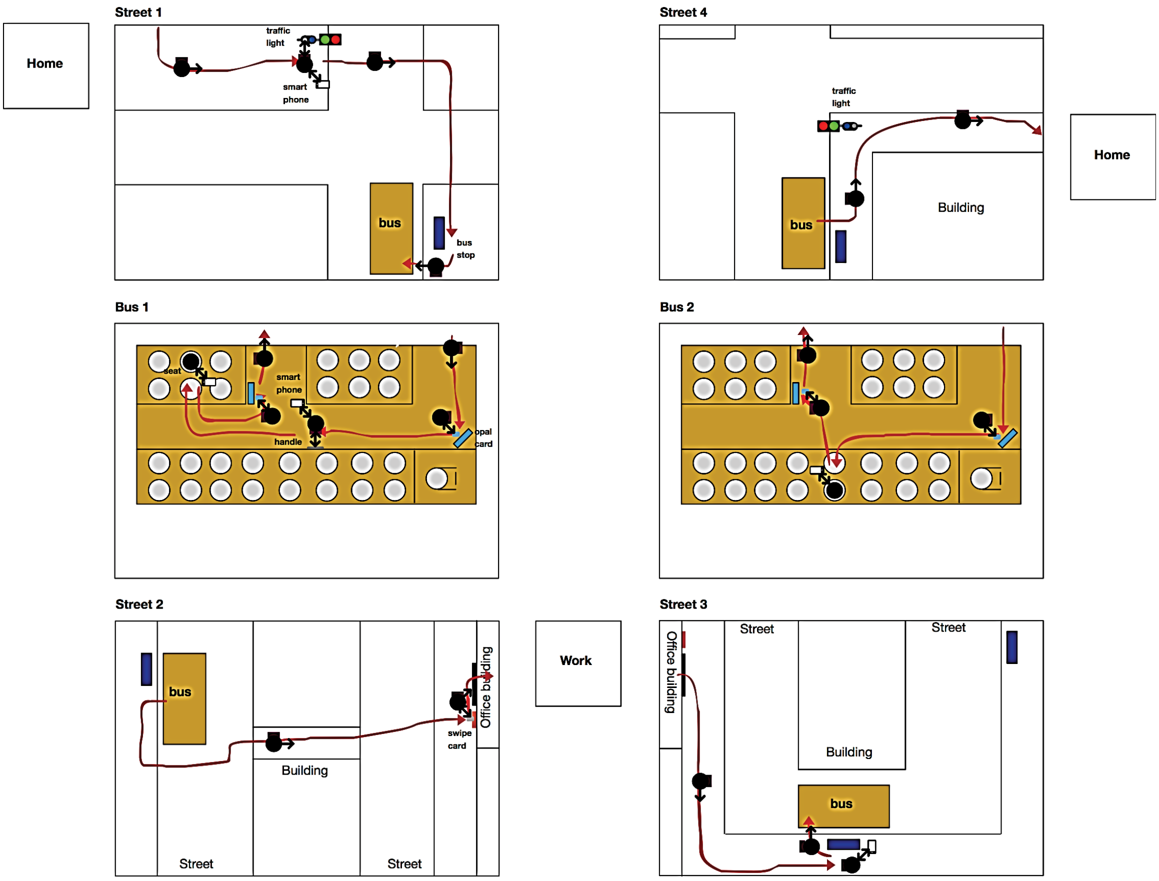

Figure 17: Physical Model of the participant Laurene.

The Model shows the eight places the participant visited during the day: Home, Street 1, Bus 1, Street 2, Office, Street 3, Bus 2, and Street 4.

This storyboard format of the Physical Model lets us visualise the person's actions and interactions within a chain of different spaces, and how they transition from one space into another over the course of the day. The storyboard format follows Karen Holtzblatt's, creating a caricature of the space by highlighting important places, structures, movements, hardware and software touch points, as well as artifacts and layout relevant to the actor. In the storyboard Physical Model, these are indicated by a red arrow, showing the participant's path on the street. Bi-directional black arrows show the participant’s interactions with objects such as a traffic light button or Smartphone. Uni-directional arrows show the sightline, indicating in which direction the participant is looking. A blue box indicates a bus stop the participant is waiting at, while an orange box labeled ‘bus’ indicates the bus the participant is entering.

3.4 Participant Demographic

In order to focus the research, the group of participants was limited to 20 to 40 year-old working professionals in Bondi, in the eastern suburbs of Sydney. The subjects were selected based on whether they work ‘9 to 5’ or as freelancers, and whether they commute to work using public transport or use private transport such as a car. From this approach four groups were developed:

- Group 1: Works 9 to 5 and uses public transport
- Group 2: Works 9 to 5 and uses private transport (car)
- Group 3: Works freelance or part-time and uses public transport
- Group 4: Works freelance or part-time and uses private transport (car).

Diverse Neighbourhood Population

The suburb of Bondi was chosen as a resource for research participants due to its complex mix of local residents, expatriates and a high transitory population. This mix of diverse backgrounds from countries including Italy, France, Brazil, Germany and many others, presents a diversity that does not exist in the same density elsewhere in Sydney. Further, Bondi provides a diversity of young female and male professionals between the ages of 20 and 40.

Young Urban Professionals

The segment ‘20 to 40 year-old young urban professional’ was selected to provide a baseline of digital savviness as well as urban activity. This research refers to ‘urban activity’ as the use of urban and suburban neighbourhoods on a regular, non-recreational basis. To further narrow the focus on the everyday use of public space, the research focuses on non-recreational urban activity, excluding recreational uses of public space such as tourism or sports activities in public space.

Digital Natives

20 to 40 years-olds generally fall into the age bracket known as ‘Digital Native’; that is, one that grew up with digital implementations. They use networked digital interfaces such as social media on a regular basis, incorporating a lot of digital product and service use in their everyday life. This demographic also works, thus

combining substantial digital and urban-use activity. Such a combination may not be found in younger or older age brackets - where younger demographics may have even higher digital usage but involve themselves in less non-recreational urban activity, and older demographics may have lower digital usage and lower levels of urban activity.

Diverse Income Brackets

Bondi offers a complex mix and range of income brackets, ranging from backpackers and low-income artists to investment bankers and plastic surgeons. However, rents remain among the highest in Sydney.

Modes of Transport

It is important for this research to distinguish the modes of transport participants use to conduct their urban activity, in particular, public and private. The most common public transport is bus and train, and most common private transport is the car. Distinctions between them matter when researching participants' urban activity, since they provide a fundamentally different form of urban interaction, requiring different forms of digital implementations to assist participants in their daily life. Public transport users for example, require real-time transport timetables and fare payment systems, whereas private transport users face the issue of continuous use of Smartphones while driving, as well as making use of navigation systems that offer the quickest routes in congested urban streets (even if the route is known).

Full-time and Flexible Working Hours

It is also important for this research to distinguish between participants who work standard working hours in full-time occupations (such as a 9 - 5 job) and flexible-hours workers such as freelancers. These modes involve fundamentally different urban activity in terms of how participants interact with their urban environment; for example, the diverse availability of free time in an average day, and the ability to flexibly rearrange time-slots during the day.

Participant Demographic Profile in Group 1

Laurene

Laurene lives in Bondi and works full-time in an advertising agency in the central business district of Sydney. Laurene takes the bus to work and has regular working hours from 9 am to 5 pm. She uses an iPhone as her mobile device.

Agathe

Agathe lives in Bondi and works full-time for a beverage company in Surry Hills, Sydney. She takes the bus to work and has regular working hours from 9 am to 5 pm. She uses an iPhone as her mobile device.

Peter

Peter lives in Bondi and works full-time for a web design company in the Rocks district in Sydney. Peter walks, uses his car and the harbour ferry to get to work. He has regular working hours from 9 am to 5 pm, and uses an Android Smartphone as his mobile device. Peter also surfs in the morning before work.

Participant Demographic Profile in Group 2

Sebastian

Sebastian lives in Bronte and runs his own architecture studio in Bondi, Sydney. Sebastian drives his car to work. He works regular working hours from 9 am to 5 pm. However, he often works overtime. He uses an iPhone as his mobile device. Sebastian also surfs during his lunch-breaks.

Matt

Matt lives in Bondi and works in a video production company in Paddington, Sydney. Matt drives his car to work. He works regular working hours from 9 am to 5 am. He uses an iPhone as his mobile device. Matt likes to go to the pub for a beer after work.

Participant Demographic Profile in Group 3

Lyia

Lyia lives in Randwick and is an artist who works in a studio space in Darlinghurst, Sydney. Lyia takes the bus to her studio and works non-regular hours depending on which art project she is working on. She uses an iPhone as her mobile device.

Kay

Kay lives in Bondi and works part-time for a retail store in the central business district of Sydney. He takes the bus and train to get to work. He works flexible hours depending on which time slots he is booked for. He uses an iPhone as his mobile device.

Participant Demographic Profile in Group 4

Ralph

Ralph lives in Bondi and works from home as a freelance graphic designer. He walks and uses his car to go shopping or meet clients. He works flexible hours depending on the project. He uses an iPhone as his mobile device. Ralph also likes to surf when the waves are good and takes time off from work when the conditions are right.

Heidi

Heidi lives in Tamarama and works freelance in a gallery in Double Bay. She drives her car to work and works flexible working hours, depending on which art project is current. Heidi also does client visits before and after working at the gallery, which she does by car. Heidi uses an iPhone as her mobile device.

Bea

Bea lives in Bondi and works from home as an academic. She gives lectures at UTS in Ultimo once a week. To get there, she uses a car. Otherwise, she uses her car for shopping and driving to the park to walk her dog. She uses an iPhone as her mobile device. She also likes to use her laptop at the beach.

Spatial Restrictions

The research is strictly limited to public space as well as semi-public space such as shops, pubs and cafes. Since the research is limited to public life, it excludes the activities of a participant after they enter their work environment; for example, an office building. However, research does include participants working in public space (for example, an architect conducting a site visit).

Time Restrictions

The research is limited to day-time on an average work day, in average weather. The research excludes the night-time economy and public life on weekends.

Demographics

Population statistics from the Australian Bureau of Statistics show that the majority of everyday urban users (ABS 2008) fall into a daily transit and commute pattern within public space. This is the demographic addressed in this research. While these commuters are the largest user-group in cities, they comprise only around 40% of all urban users.

Beyond the specific commuter user-group, the following user groups collectively constitute around 60% of urban users:

- 40% commuters
- 10% stay at home parents
- 8% working from home
- 7% senior citizens
- 5% tourists

Due to time and budget restrictions, addressing these other user groups is outside the scope of this research. This should not however be viewed as a problem, since the same process outlined in this research can be applied within each user group to refine our understanding of the urban anatomy of the city.

3.5 Conclusion

This chapter demonstrates how the research has amended Contextual Inquiry in relation to Public Life Studies, and how it has been applied as an urban shadowing process in the Eastern Suburbs neighbourhood of Sydney. It presents an overview of a typical research day and outlines how captured data is modelled for the visioning process, which in turn delivers conceptual implications for design and formalizes the urban user experience as it currently exists.

Each model adaption is explained in detail, and considerations for selection of the participant demographic are highlighted. Particular attention is paid to a) extrapolation of the Flow Model into the Circle Flow Model, and b) extrapolation of the Physical Model into a combination of physical and storyboard formats.

While the research covers a commuter demographic that represents 40%, it is argued that the remaining 60% of urban users offer opportunities for future investigation according to the same research process. Insights into the latter demographic are offered later in this document.

The objective of this research is to formalise the urban user experience in the digital age. Outlining the urban shadowing process addresses our objective of identifying a data-collection methodology that bridges Contextual Inquiry and Public Life Studies. To achieve a new understanding of user experience, the research needed to bridge the gap between Contextual Inquiry as conducted by Jan Chipchase and Karen Holtzblatt, and Public Life Studies as conducted by Jan Gehl. Urban shadowing allows us to conduct an urban Contextual Inquiry for the collection of data that is then modelled into user-experience personas, and patterns that define key interactions in the urban environment.

Chapter 4, which follows, shows our research results, how research was conducted in the field, and how the data was modelled, consolidated and analysed.

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4 Resulting Data Models

4.1 Individual Models

The individual data models, contained in **Appendix A** of this document, show each participant's data extrapolated into an individual Sequence Model, Circle Flow Model and a Physical Model. For each participant, the Physical Model is shown first, in combination with comments and photographs captured at each place. This allows for an overview of the participant's day and the interactions she conducted. The Physical Model does not highlight analog interactions; however, these are present in each photograph, supporting the context of each digital interaction.[56] Following the Physical Model, the Circle Flow Model is shown, summarising the participant's interactions and visualising how each digital interaction communicates with a database.[57]

The individual models have been placed in **Appendix A** of this document due to the high volume of imagery.[58] While individual models offer granular insights into people's everyday life, a further abstraction of the individual models is needed to summarise behavioural patterns, and to group them into consolidated models to extract more applicable meanings. The following Chapter explains this consolidation process.

4.2 Consolidated Models and Personas

This chapter consolidates the individual models in **Appendix A** into consolidated Models in distinct Personas:

Individuals from '9 to 5 worker and public transport' are consolidated into Persona 1.
Individuals from '9 to 5 worker and private transport' are consolidated into Persona 2.
Individuals from 'flexible worker and public transport' are consolidated into Persona

3. Individuals from ‘flexible worker and private transport’ are consolidated into Persona 4.

These consolidations merge specific data from each individual into consolidated data. Data that is only evident in one individual is consolidated to a degree that applies to other users. For example, surfing in the morning, going to the beach in the afternoon or to a restaurant after work are consolidated into a pre, during- or post-work activity. As a result, the Circle Flow and Physical Models are visually consolidated to mirror the consolidated data. Walking to the bus or to the office in the Physical Model is represented in a form that accommodates similar hindrances like crossing the street or using the traffic light, but does not reflect the actual architectural layout. Similarly, the Circle Flow Models are consolidated to reflect the meaning of the data but not the specific interactions. For example, browsing a specific news website or fashion magazine website is consolidated into ‘browsing a website’.

The Personas developed in this research revolve around the four initial demographic groups selected, according to the mode of transport and work hours the participant engages with. These two factors prove the dominant factors in how a participant engages with public space. For example, driving a car rather than taking public transport fundamentally alters opportunities for engaging with certain public space touch-points such as real-time public transport data.

Further, working full-time in an office space restricts opportunities for an individual to engage with public space in the same way as a participant with flexible working hours, since the latter has more time to spend in public space. The four Personas are thus drawn from the following demographic groups: using public transport and working full-time, using public transport and working part-time, using private transport and working full-time, and using private transport and working part-time.

The Physical Model developed in this research is fundamentally different from the top-down birds-eye view method criticised by Jan Gehl. The Physical Models developed here are developed out of observational data from a shadowing perspective. Hence, data is captured from a contextual rather than a birds-eye perspective. Following this, Physical Models are developed from a top-down view to illustrate their contextual data - which moves from one contextual situation to the next in a storyboard format. This differs fundamentally from capturing data from a birds-eye perspective, then representing it in a top-down model. Jan Gehl argues that when capturing data from a birds-eye perspective, the research loses important details that can only be captured if embedded with the research participant in the same context. Since here we have shadowed the participants in context, we have succeeded in capturing this detail. The captured data is only then shown as a Physical Model from a top-down view, to give an in-context overview of the data in relation to spatial features.

4.2.1 Consolidated Models: Persona 1

Sequence, Circle Flow and Physical Models

Persona 1 uses public transport and has a 9 to 5 job in Sydney.

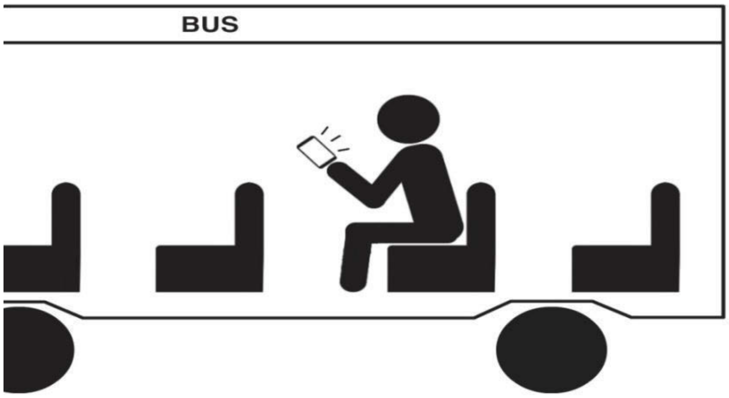


Figure 18: Persona 1 using their Smartphone on public transport.

Sequence Model

The Sequence Model shows **Persona 1's** step-by-step interactions, intentions, and triggers that caused the interactions.

	Actions	Intent	Trigger
Home			
	Leaves home to go to work		
Street 1			
	Walks to the bus	Commute	Distance to work place
	v		
	Interacting with Smartphone while walking	Checking real-time public transport information	Fear of running late
	v		
	Arrives at the bus stop		
	v		
	While waiting for the bus interacts with Smartphone	Communicate, educate or entertainment	Productivity, Boredom or need to be informed
Public Transport 1	v		
	Enters public transport		
	v		
	Validates fare at entrance	Paying	Cost of public transport
	v		

	Sits down in Bus	Travel more comfortable	Comfort of sitting
	v		
	Interacts with Smartphone for the whole trip.	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Gets off public transport	Arriving at correct location	Bus route
Street 2	v		
	Walks to work		
	v		
	Continues interacting with Smartphone while walking	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Enters office building		
Office	v		
	Works 9-5 in building	Enter building	Locked door
Street 3	v		
	Leaves building after work	Drive to building site	Need to inspect a building site
	v		
	Walks to bus stop		
	v		
	Interacts with Traffic Light	Cross Street	Traffic on Street
	v		
	Interacts with Smartphone while walking	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Arrives at the bus stop		
	v		
	Interacts with Smartphone while waiting for bus	Communicate, educate or entertainment	Productivity, boredom or need to be informed
Public Transport 2	v		
	Enters public transport	Entertainment and education	Boredom, urge to stay informed
	v		
	Validates fare at entrance	Paying	Cost of public transport
	v		
	Sits down in Bus	Travel more comfortable	Comfort of sitting
	v		
	Interacts with Smartphone for the whole trip.	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Gets off public transport	Arriving at correct location	Bus route
Street 4	v		
	Walks home	Arrive at home	Distance between bus stop and home
Home	v		
	Enters home building with keys	Entering home	Security

Physical Model

The Physical Model shows **Persona 1's** interactions in the physical environment, and within the narrative of their day, over time.

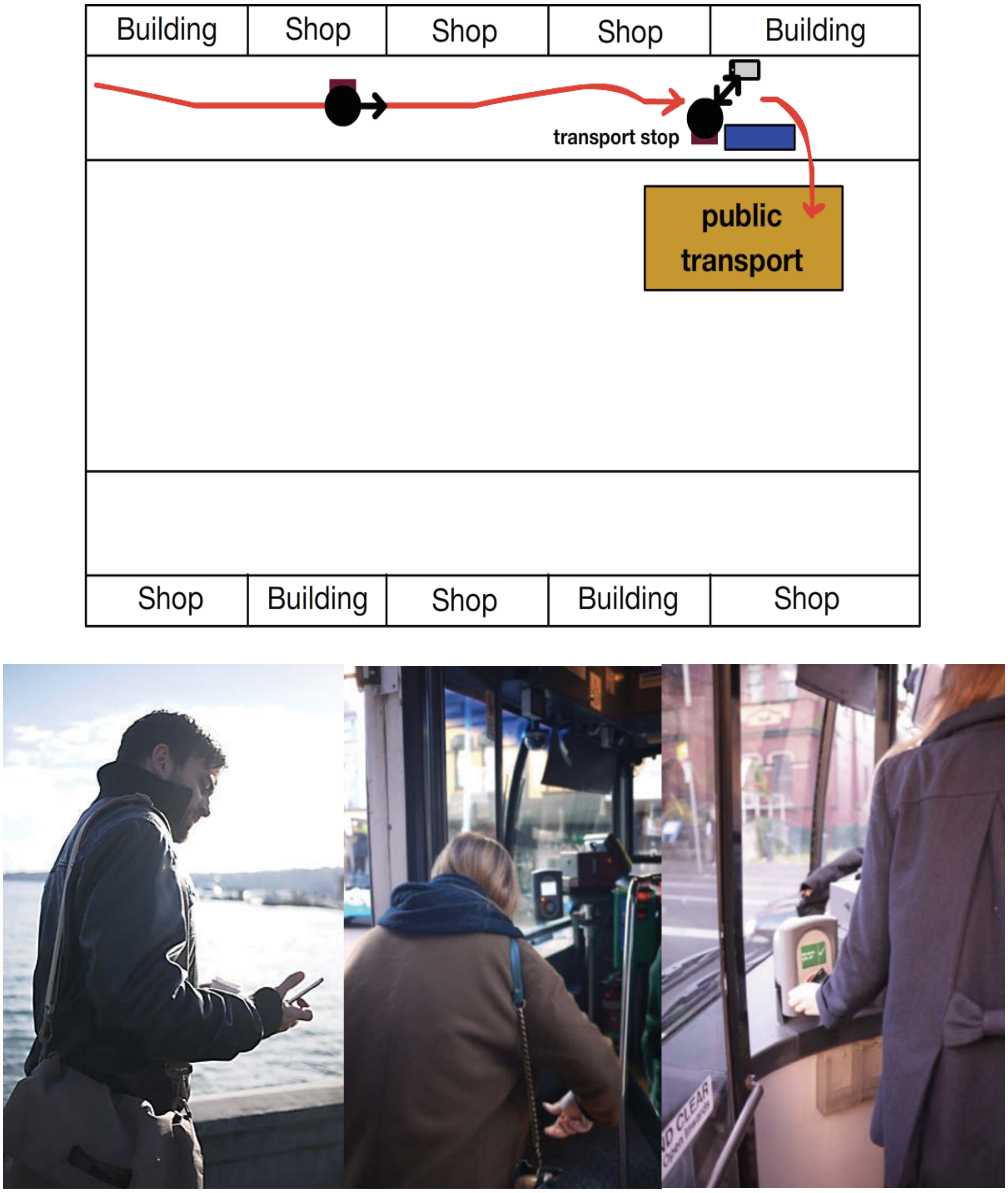


Figure 19: Physical Model Frame 1: **Persona 1.**

Persona 1 leaves home and uses a Smartphone on the way to the bus. On the way, Persona 1 checks transport times on their Smartphone to see if they should adjust their walking speed to catch their transportation. If they have to wait at the transport stop, they use their Smartphone to communicate, educate or entertain themselves (See **Figure 19**, above).

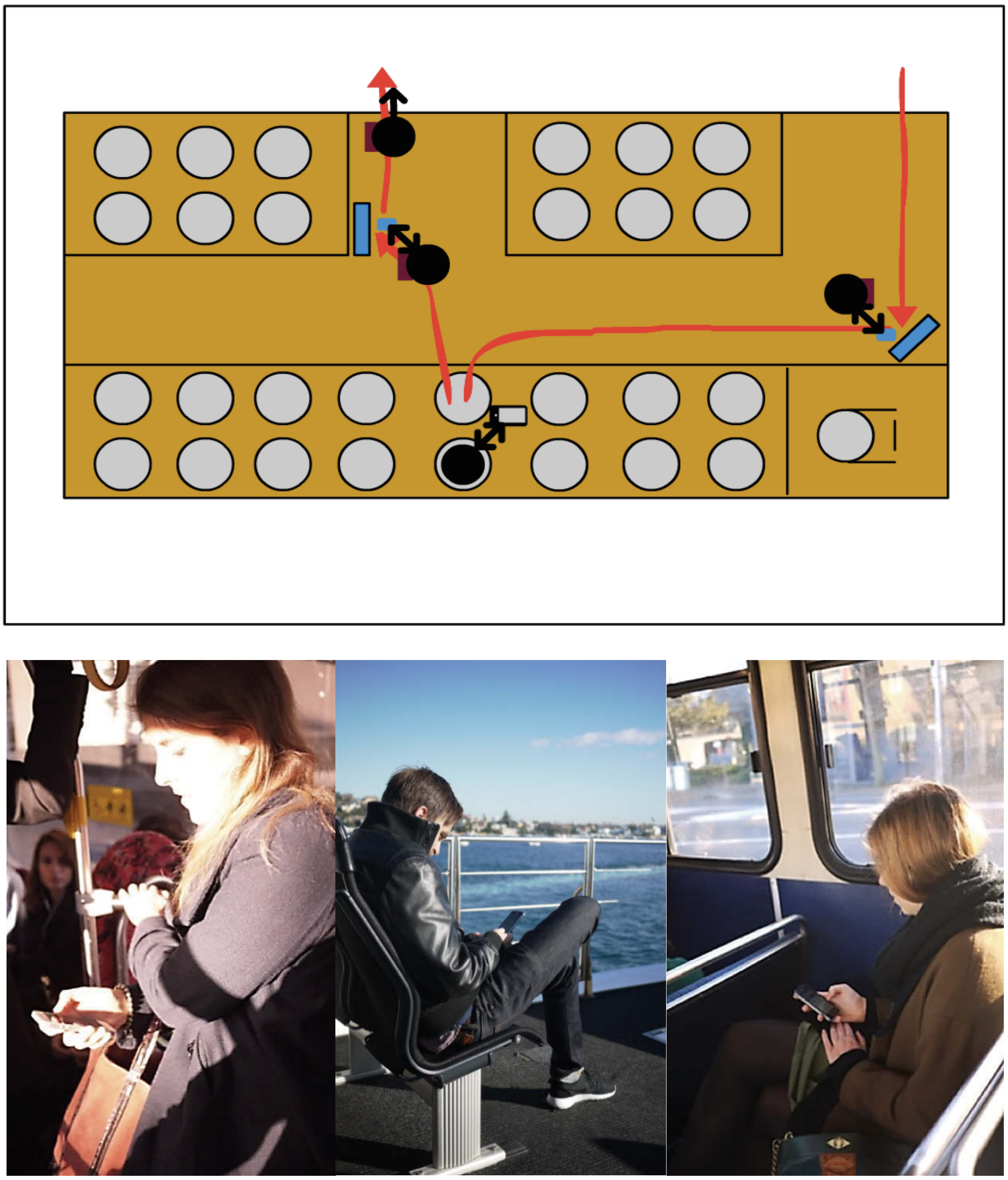


Figure 20: Physical Model Frame 2: **Persona 1.**

Persona 1 enters the bus, pays the fare with a paper or opal ticket. Persona 1 sits down and interacts with their Smartphone during the trip to communicate, educate or entertain themselves (See **Figure 20**, above).

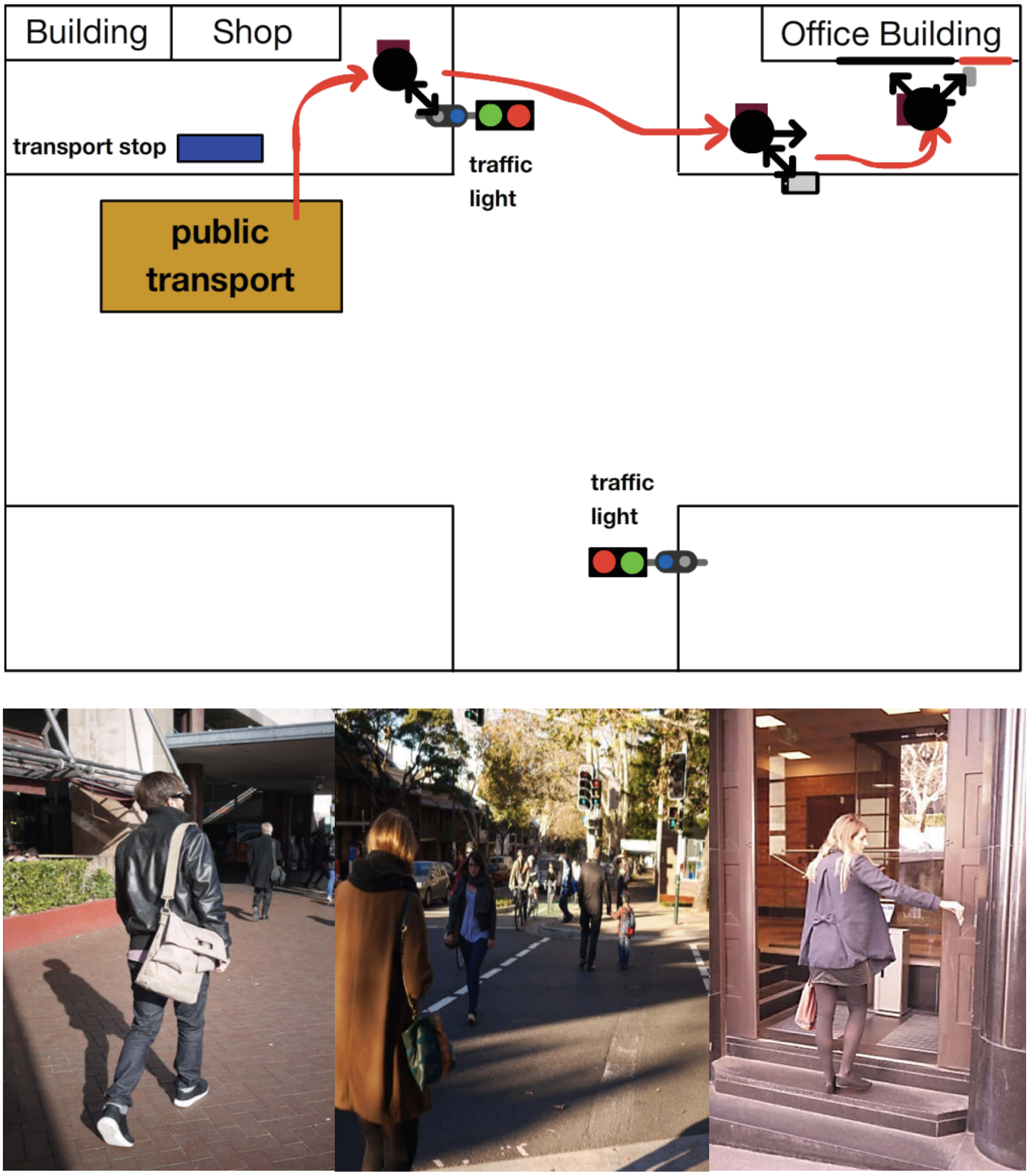


Figure 21: Physical Model Frame 3: **Persona 1.**

Persona 1 leaves public transport and crosses the street using a traffic light. Persona 1 walks to the office and interacts with a Smartphone while walking, to communicate, educate or entertain themselves. Persona 1 enters the office building. Persona 1 works at the office building from 9 to 5. (See **Figure 21**, above).

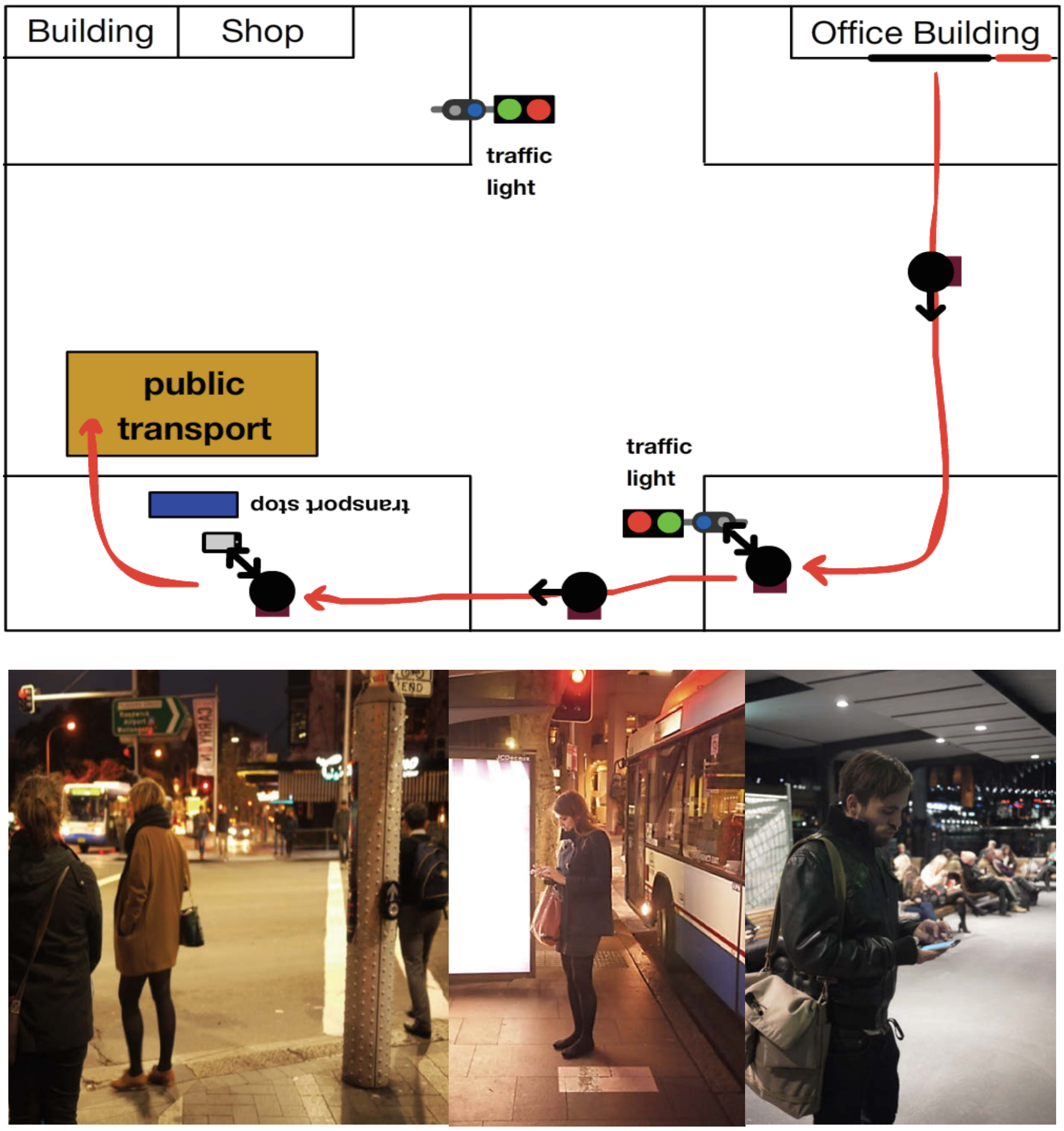


Figure 22: Physical Model Frame 4: **Persona 1.**

Persona 1 leaves their office building and walks back to the public transport stop. Persona 1 crosses the street using a traffic light and waits at the bus stop. Persona 1 interacts with Smartphone while walking and waiting, to communicate, educate or entertain themselves. (See **Figure 22**, above).

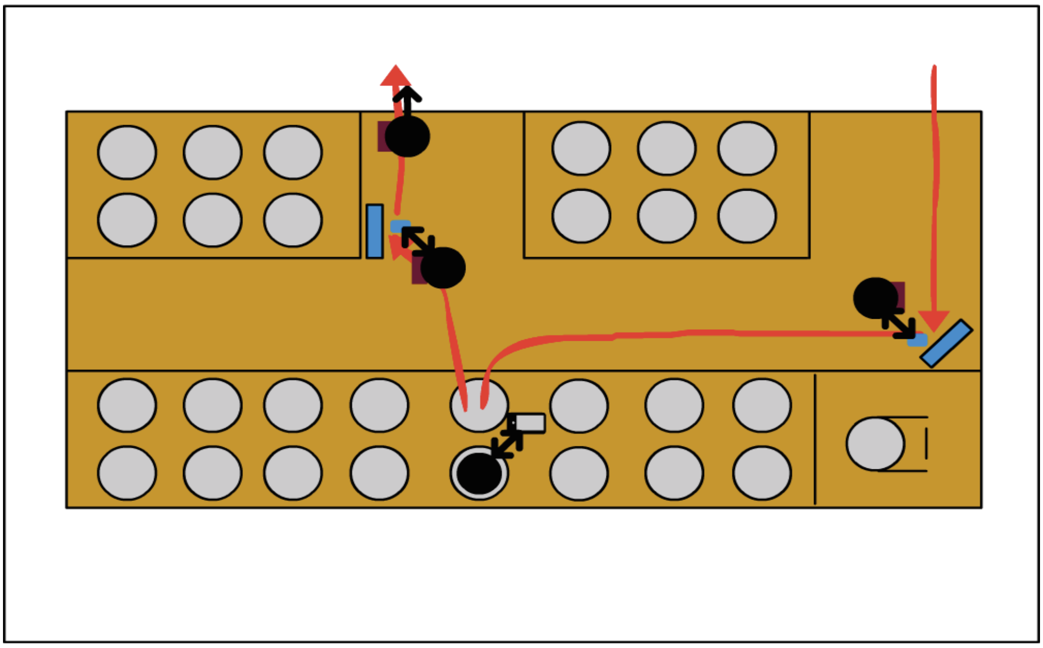


Figure 23: Physical Model Frame 5: **Persona 1.**

Persona 1 enters the bus, pays the fare with a paper or opal ticket. Persona 1 sits down and interacts with Smartphone during the trip, to communicate, educate or entertain themselves. (See **Figure 23**, above).

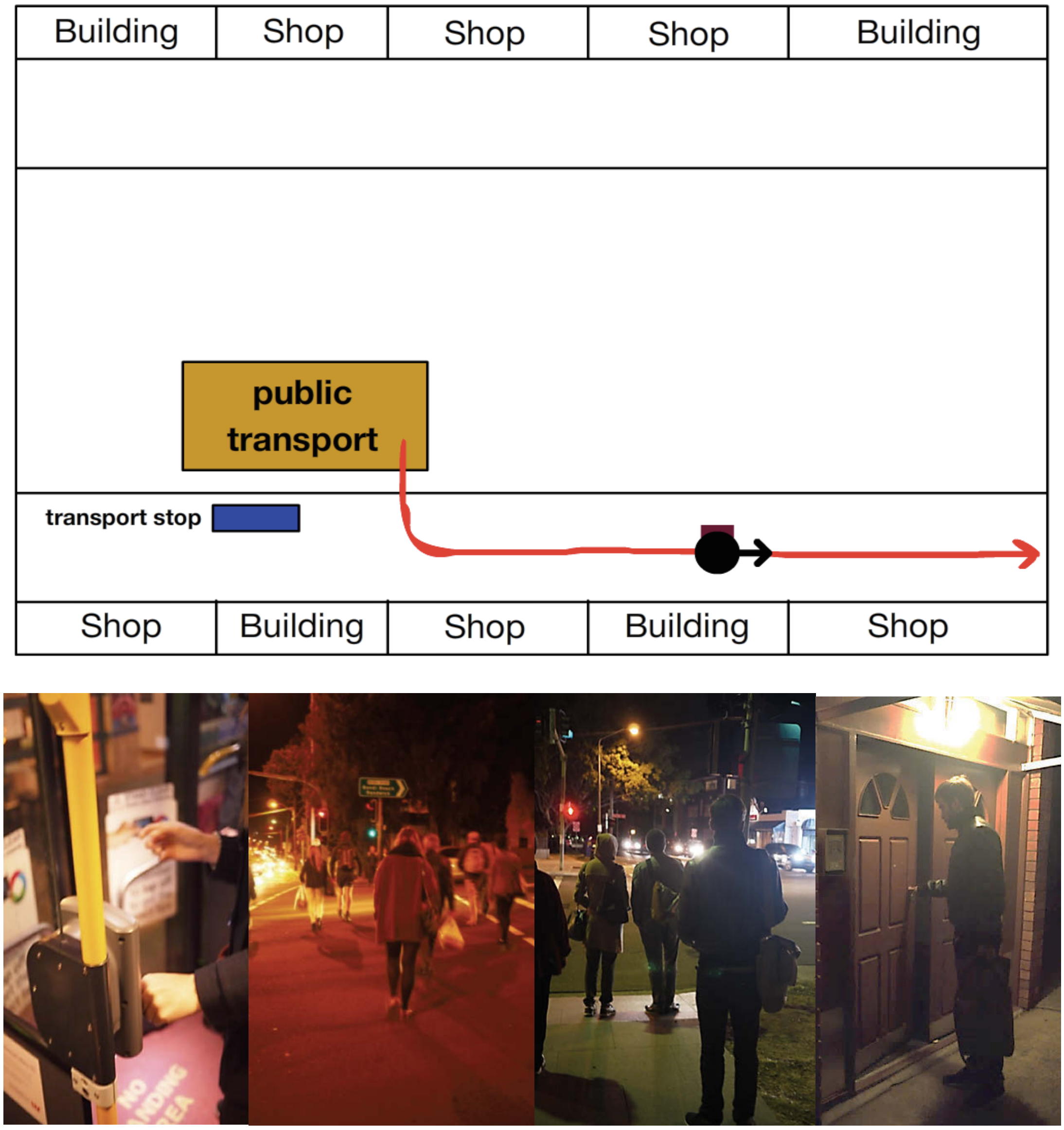


Figure 24: Physical Model Frame 6: **Persona 1.**

Persona 1 leaves the bus and walks home. While walking, Persona 1 does not use a Smartphone. Persona 1 arrives home and enters the building. (See **Figure 24**, above).

Circle Flow Model

The Circle Flow Model is an overview of data on **Persona 1's** everyday interactions. Note that the Model shows that digital interactions are consequentially database interactions. (See **Figure 25**, below).

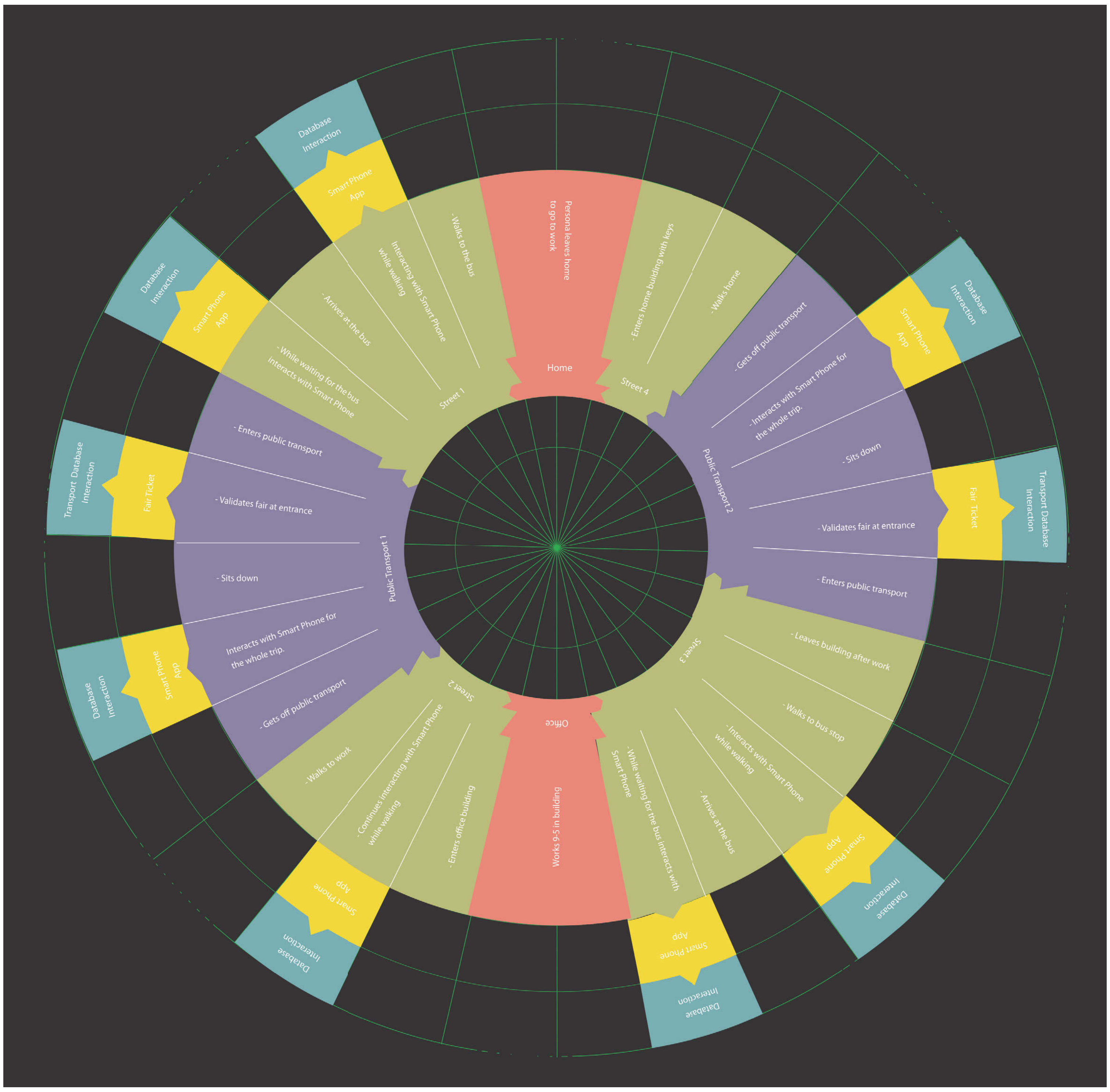


Figure 25: Circle Flow Model: **Persona 1.**

(Courtesy of Ralph Kenke, Pawan Jha, Elmar Trefz)

4.2.2 Consolidated Models: Persona 2

Circle Flow and Physical Models

Persona 2 uses private transport and has a 9 to 5 job in Sydney.

Figure 26: Persona 2 using her Smartphone in her car, waiting at a traffic light.

Sequence Model

The sequence model show's **Persona 2's** step-by-step interactions, her intentions, and the triggers that caused the interactions.

	Actions	Intent	Trigger
Home			
	Leaves home to go to work		
Street 1			
	Walks to the car	Commute	Distance to work place
	v		
	Open car door with remote	Getting into car	Security
Car 1	v		
	Gets into car		
	v		
	Connects Smartphone to in-car holder and stereo system	Use Smartphone while driving	Productivity, Boredom or need to be informed
	v		
	Starts car with car keys	Activate car	Security
	v		
	Starts driving	Commute with car	Distance to work place
	v		
	Constantly interacts with Smartphone while driving to check social networks, messages and listen to music	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Parks the car to get a coffee, gets out of the car	Closes car with car remote	Security
Street 2	v		
	Walks to coffee shop and enters	Buying coffee	Distance of coffee shop to parking spot
Coffe Shop	v		
	Orders coffee from Barista		
	v		
	Pays coffee with EFTPOS	Paying for coffee	Price of coffee
	v		
	Interacts with Smartphone while waiting for coffee order	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Receives coffee and leaves coffee shop		
Street 3	v		
	Walks back to the car		
	v		

	Open car door with remote	Getting into car	Security
Car 2	v		
	Gets in the car		
	v		
	Connects Smartphone to in-car holder and stereo system	Use Smartphone while driving	Productivity, boredom or need to be informed
	v		
	Puts coffee into coffee holder cup holder	Drink coffee while driving	Need to drink coffee
	v		
	Starts car with car keys	Activate car	Security
	v		
	Starts driving		
	v		
	Constantly interacts with Smartphone while driving to check social networks, messages and listen to music	Use Smartphone while driving	Productivity, boredom or need to be informed
	v		
	Parks car and gets out to get a ticket		
Street 4	v		
	Gets park permit	Paying for parking	Cost of parking spot
	v		
	Puts permit in car		
	v		
	Closes car with car remote	Locking car	Security
	v		
	Walks to work		
	v		
	Continues interacting with Smartphone while walking	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Enters office building with a swipe card	Transitioning from public to private space	Security
Office	v		
	Works 9-5 in building		
Street 5	v		
	Leaves office building after work	Go to post work activity	Need to socialise
	v		
	Walks to car		
	v		
	Opens car with car remote	Unlocking car	Security
Car 3	v		
	Gets into car		
	v		
	Connects Smartphone to in-car holder and stereo system	Use smart phone while driving	Productivity, boredom or need to be informed
	v		

	Starts car with car keys	Activate car	Security
	v		
	Starts driving		
	v		
	Interacts with Smartphone to listen to music	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Drives towards Post-Work Activity		
	v		
	Parks car and gets out to get a ticket		
Street 6	v		
	Gets out and buys a parking ticket at a parking computer	Paying for parking	Cost of parking spot
	v		
	Puts permit in car		
	v		
	Closes car with car remote	Locking car	Security
	v		
	Walks towards Post-Work Activity		
	v		
	Crosses a street using a traffic light, pushes a traffic light button and crosses when green	Cross Street	Traffic on Street
	v		
	Sends a text message from Smartphone while walking	Communicate	Social need
Post-Work Activity	v		
	Enters post-work activity building		
	v		
	Engage with post-work activity	Socialise and entertainment	Need to socialise
	v		
	Pay for post-work activity with EFTPOS	Paying for activity	Cost of activity
	v		
	Leave building		
Street 7	v		
	Walks back to the car		
	v		
	Crosses the street using a traffic light, presses the traffic light button and crosses the street when the light is green	Cross Street	Traffic on Street
	v		
	Arrives at car		
	v		
	Open car door with remote	Unlocking car	Security
Car 4	v		
	Gets into car		

	v		
	Connects Smartphone to in-car holder and stereo system	Use Smartphone while driving	Productivity, boredom or need to be informed
	v		
	Starts car with car keys	Activate car	Security
	v		
	Starts driving		
	v		
	Interacts with Smartphone to listen to music	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Drives towards home building		
	v		
	Parks car and gets out		
Street 8	v		
	Closes car with car remote	Locking car	Security
	v		
	Walks to home	Arrive at home	Distance between parking spot and home
Home	v		
	Enters home building with house keys	Entering home	Security

Physical Model

The physical model shows **Persona 2's** interactions in the physical environment and within the narrative of their day, over time.

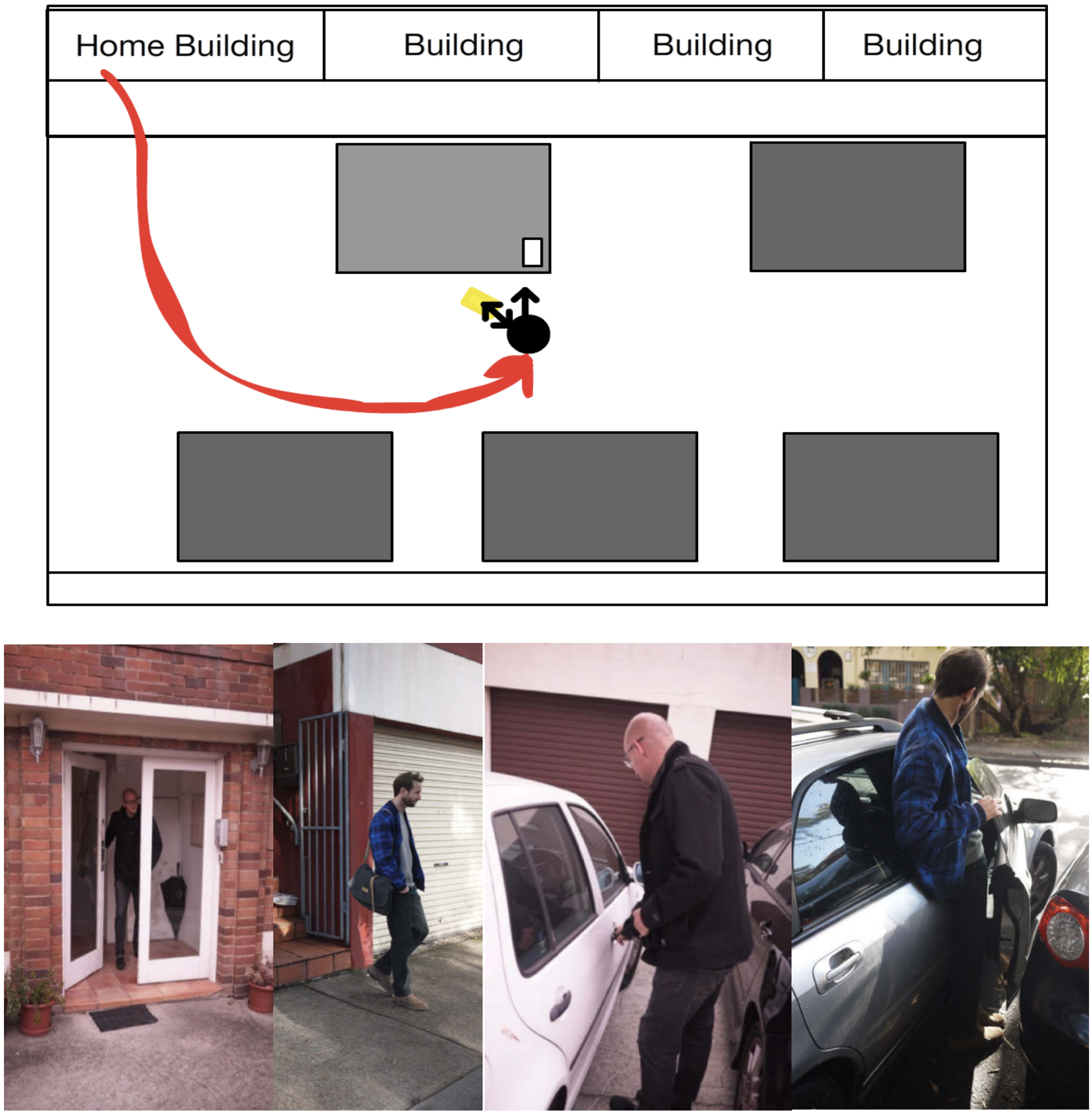


Figure 27: Physical Model Frame 1: **Persona 2.**

Persona 2 leaves home and walks to the car, opening the car with a remote control, then gets in. (See **Figure 27**, above).

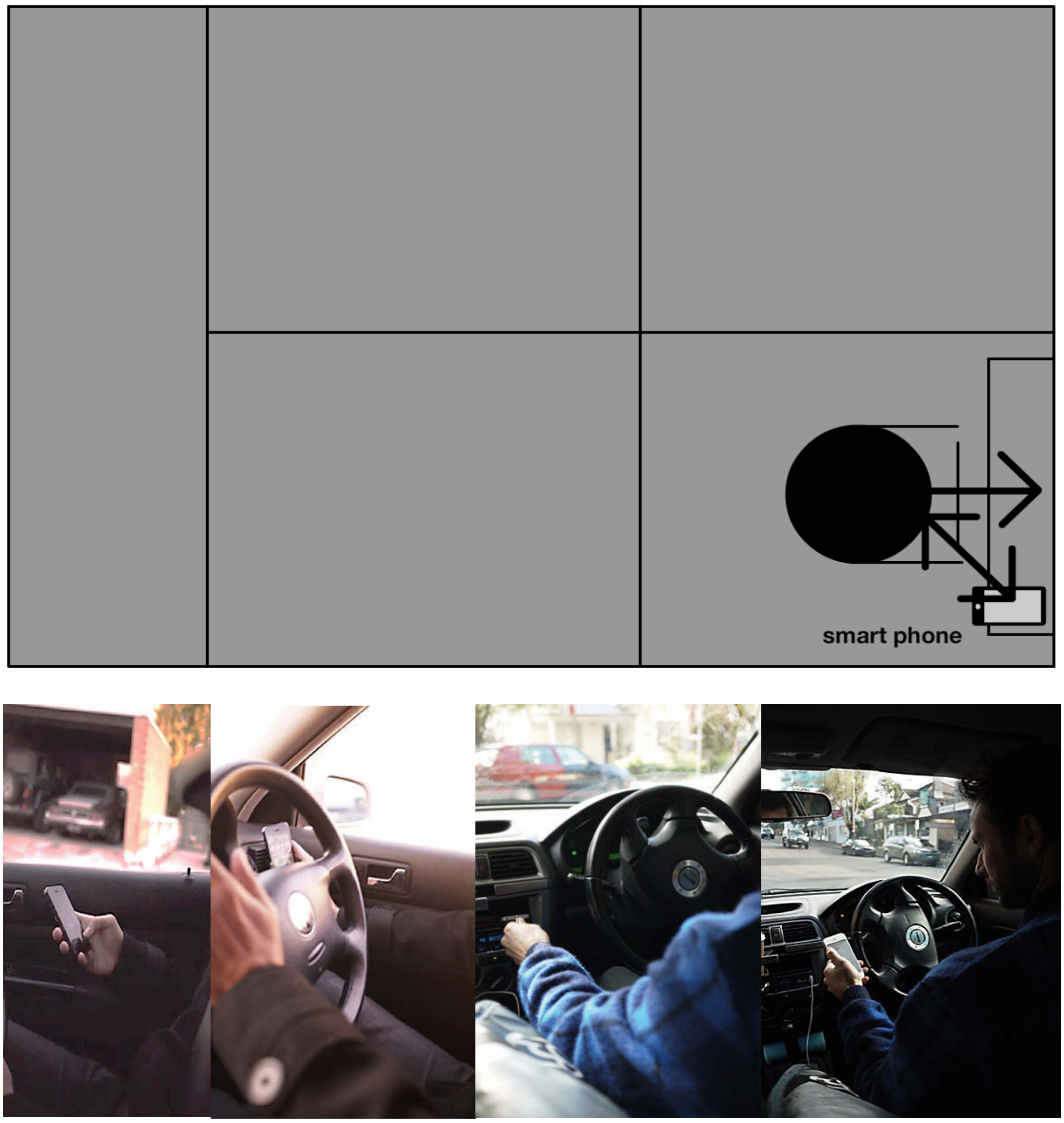


Figure 28: Physical Model Frame 2: **Persona 2**

Persona 2 mounts her Smartphone inside the car and starts driving. While driving Persona 2 interacts with the Smartphone, more so while stopping at traffic lights. To interact with Smartphone, Persona 2 continuously takes sightlines of the traffic while driving. (See **Figure 28**, above).

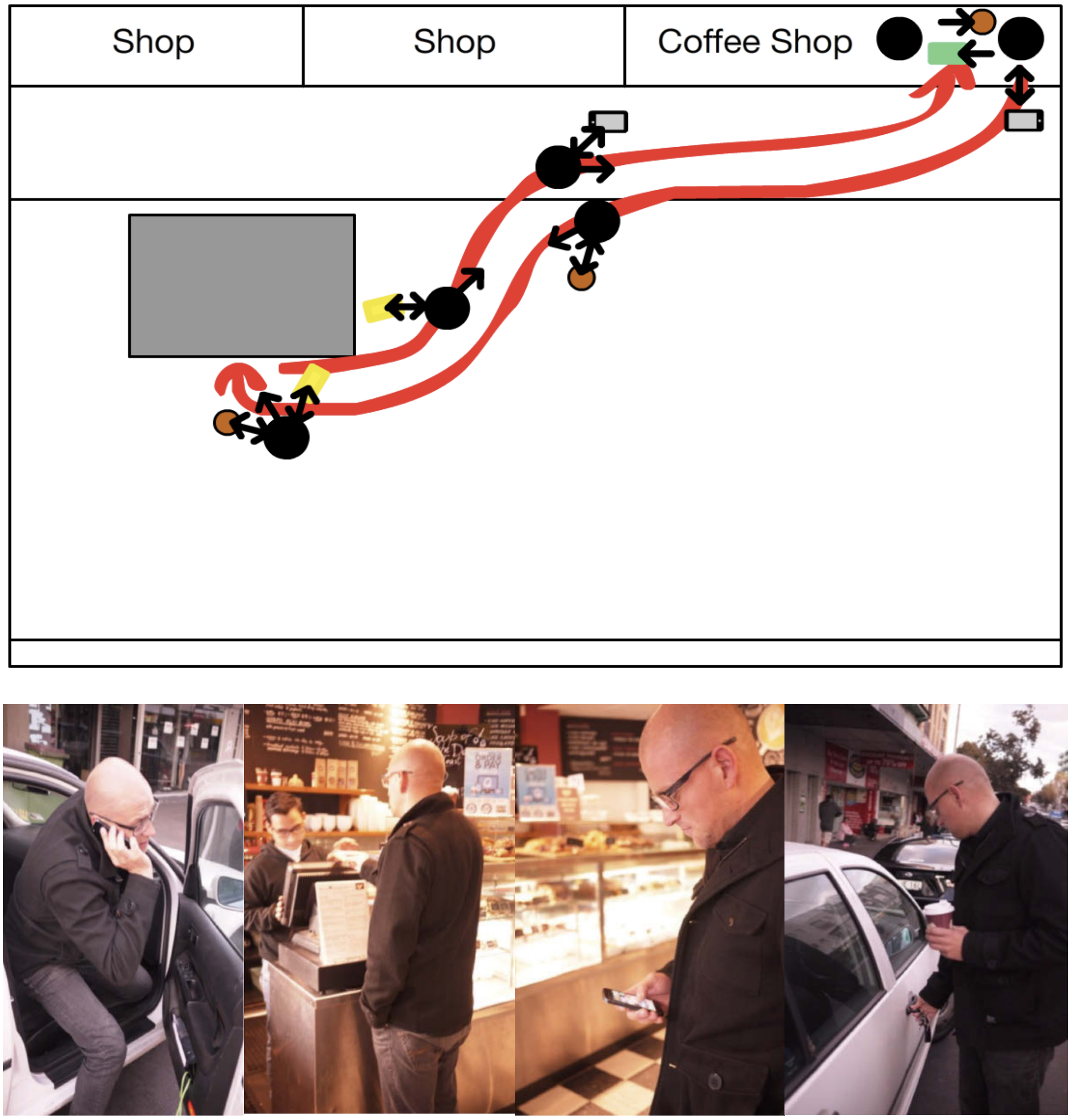


Figure 29: Physical Model Frame 3: **Persona 2.**

On his way to work, **Persona 2** stops at a coffee shop to grab a coffee. Persona 2 gets out of the car, walks to the coffee shop and orders, pays for coffee and interacts with Smartphone while waiting. Persona 2 then re-enters the car. (See **Figure 29**, above).

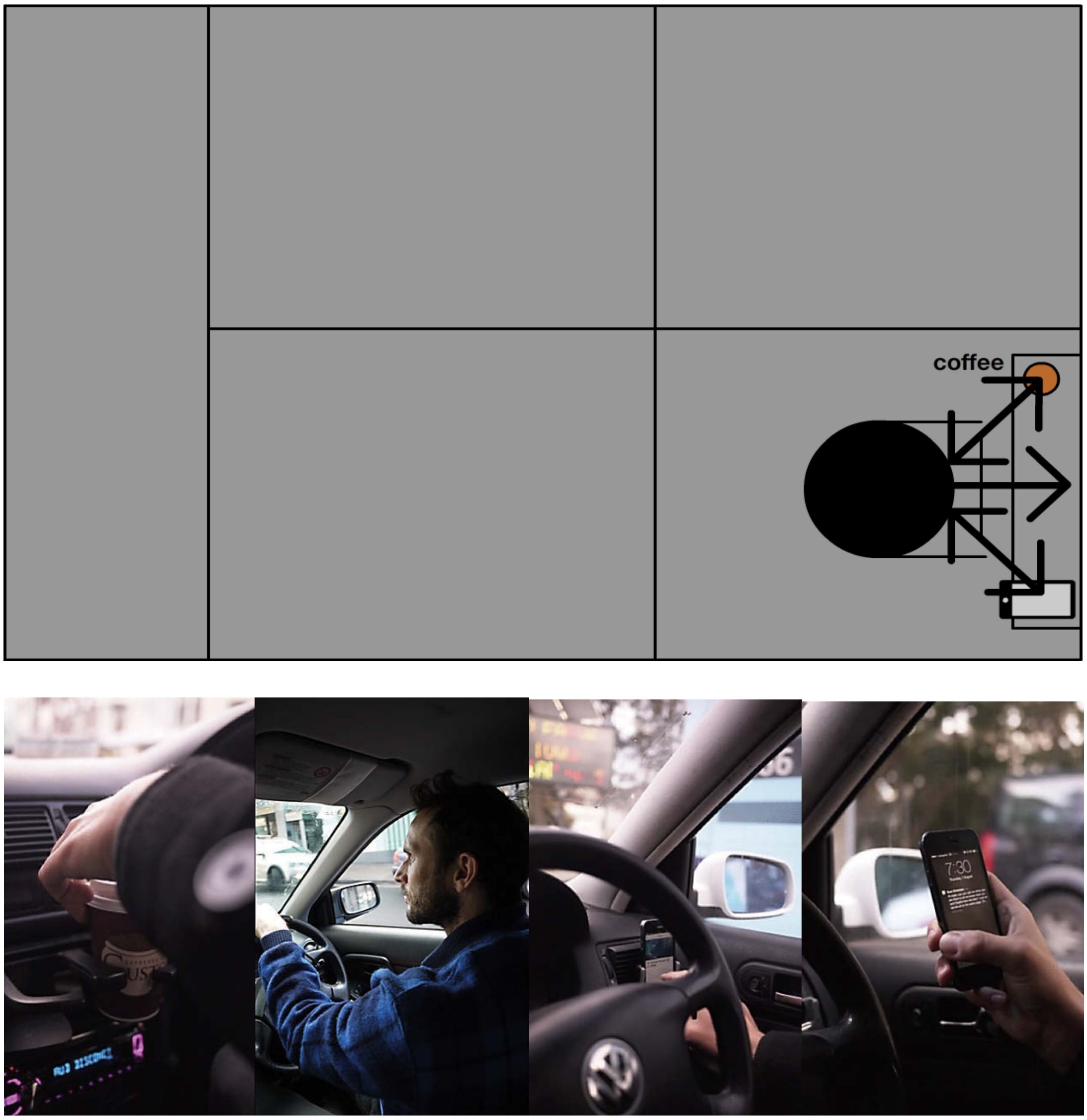


Figure 30: Physical Model Frame 4: **Persona 2.**

Persona 2 mounts coffee and Smartphone inside the car and starts driving. While driving, Persona 2 interacts with Smartphone and drinks coffee. (See **Figure 30,** above).

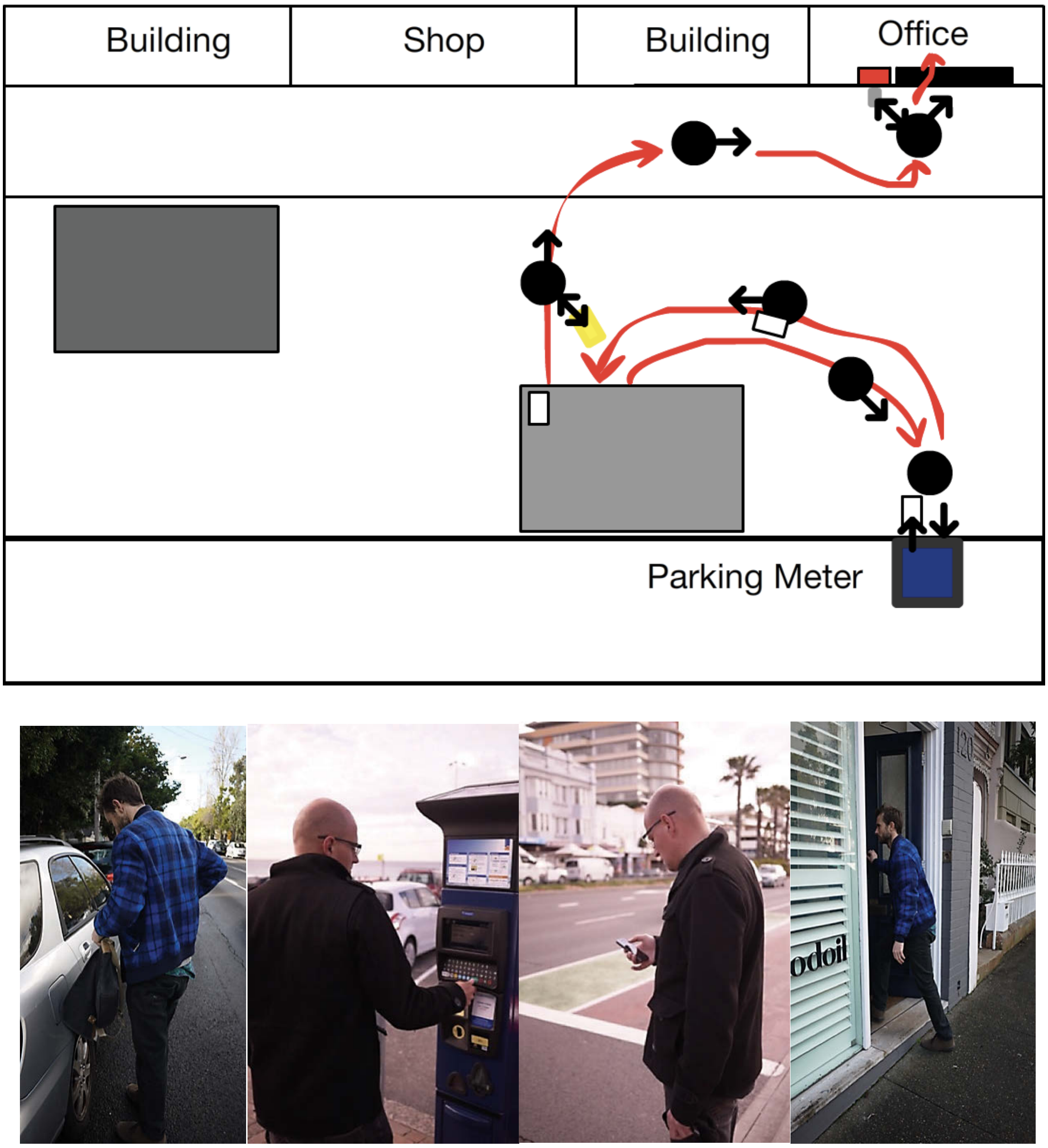


Figure 31: Physical Model Frame 5: **Persona 2.**

Persona 2 arrives at the office parking spot, validates parking, closes the car with remote control and walks to the office building. Persona 2 then enters the office building and works 9 to 5. (See **Figure 31**, above).

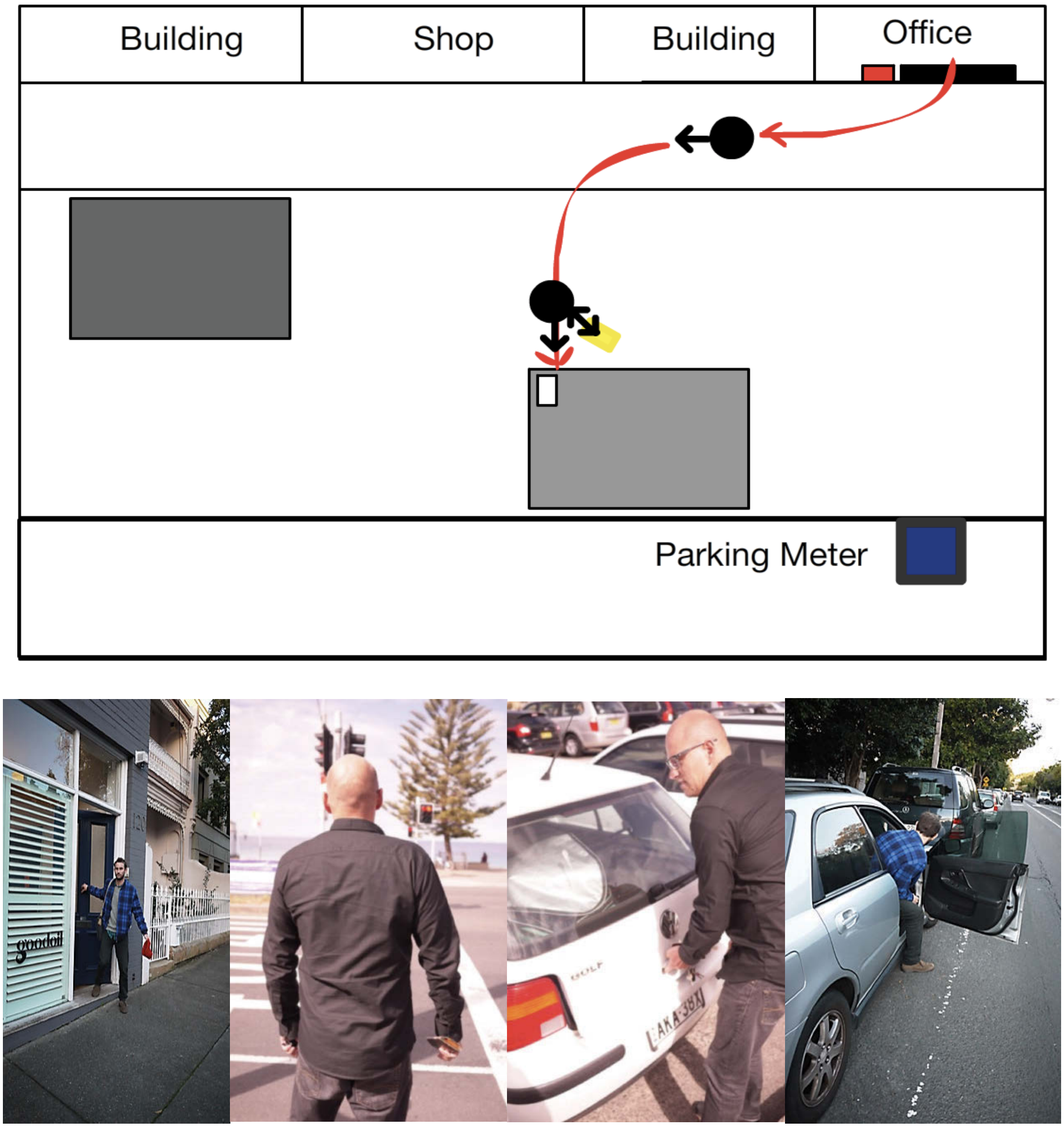


Figure 32: Physical Model Frame 6: **Persona 2.**

Persona 2 leaves the office building and walks back to the car. Persona 2 opens the car with the remote control and gets in. (See **Figure 32**, above).

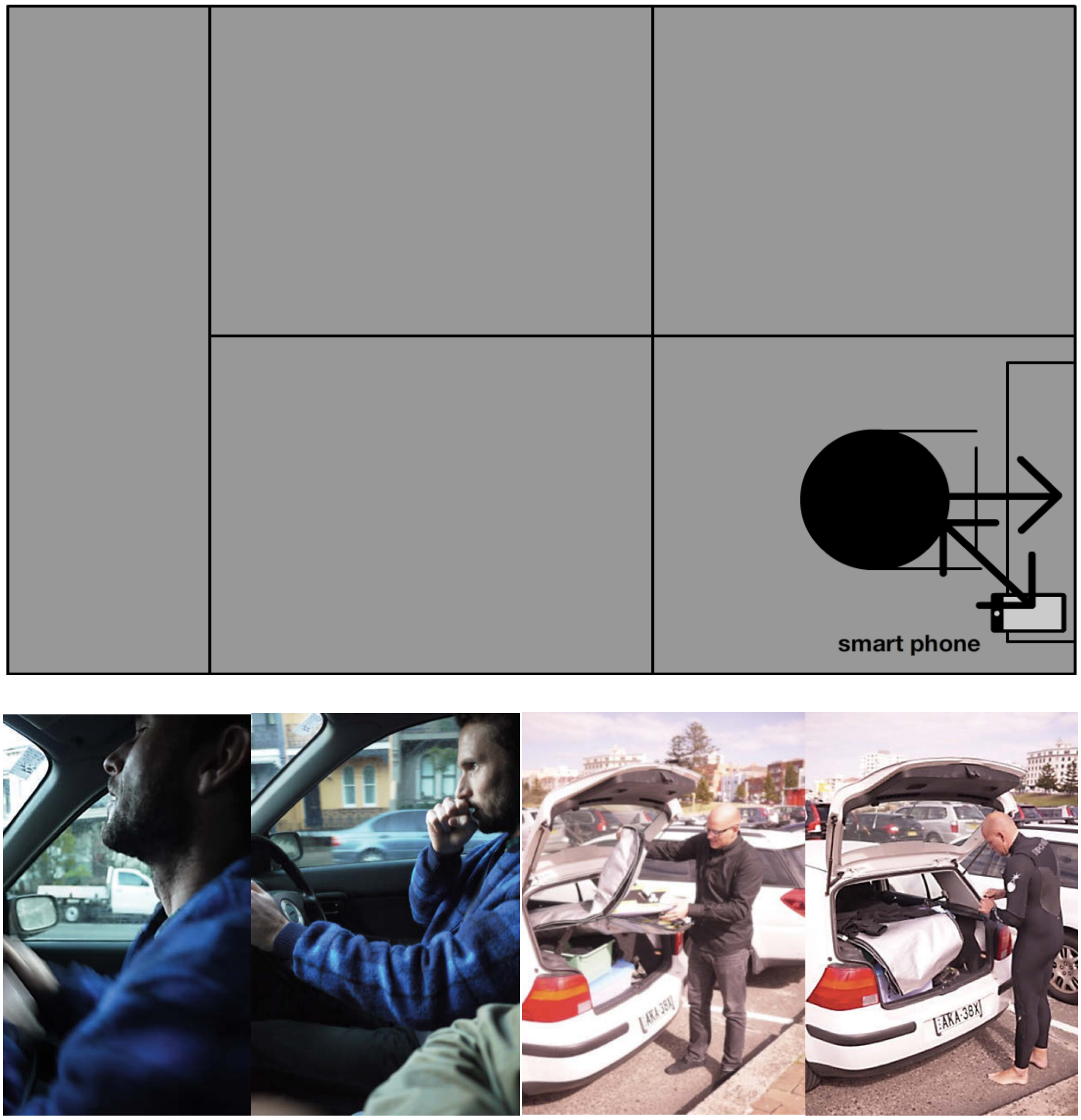


Figure 33: Physical Model Frame 7: **Persona 2**

Persona 2 mounts the Smartphone inside the car and stars driving. Persona 2 interacts with the Smartphone while driving. (See **Figure 33**, above).

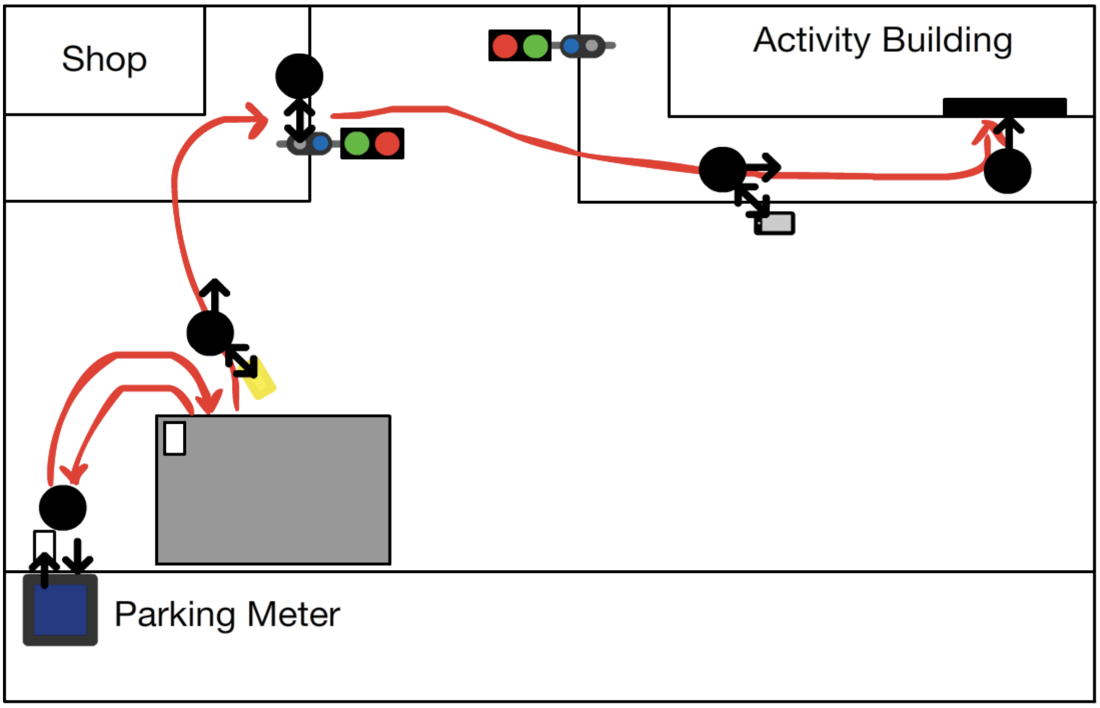


Figure 34: Physical Model Frame 8: **Persona 2.**

Persona 2 then stops at a post-work activity place, a pub, gym, beach or restaurant. Persona 2 parks the car, validates parking and closes the car with remote control. Persona 2 then walks to the post-work activity and enters. On the way, Persona 2 crosses a street using a traffic light and interacts with the Smartphone. (See **Figure 34**, above).

Figure 35: Physical Model Frame 9: **Persona 2**.

Persona 2 then conducts their post-work activity. (See **Figure 35**, above).

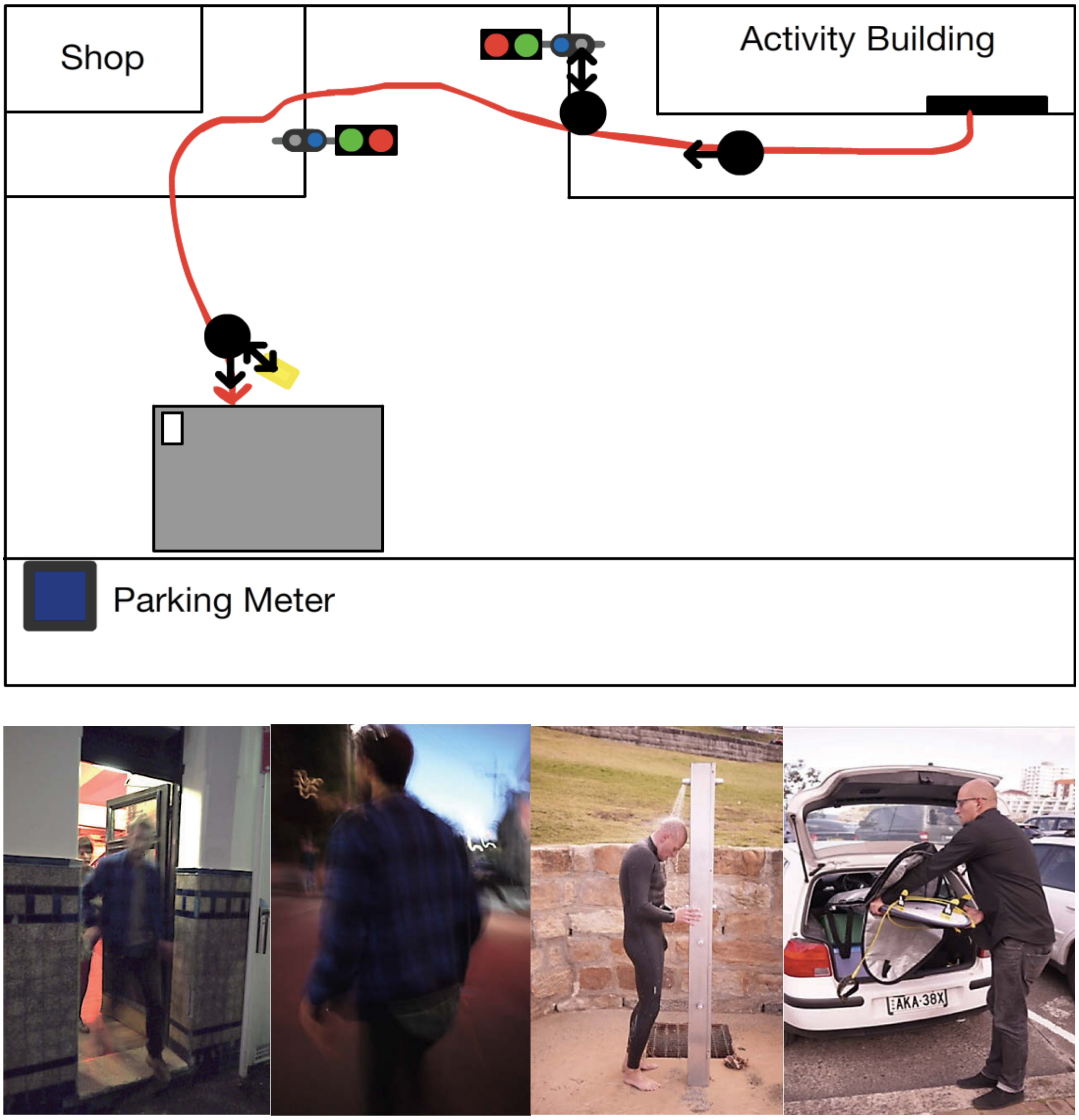


Figure 36: Physical Model Frame 10: **Persona 2.**

When finished with the post-work activity, **Persona 2** leaves the building and walks back to the car. On the way, Persona 2 crosses the street using a traffic light and opens the car door with a remote control. Persona 2 gets into car. (See **Figure 36**, above).

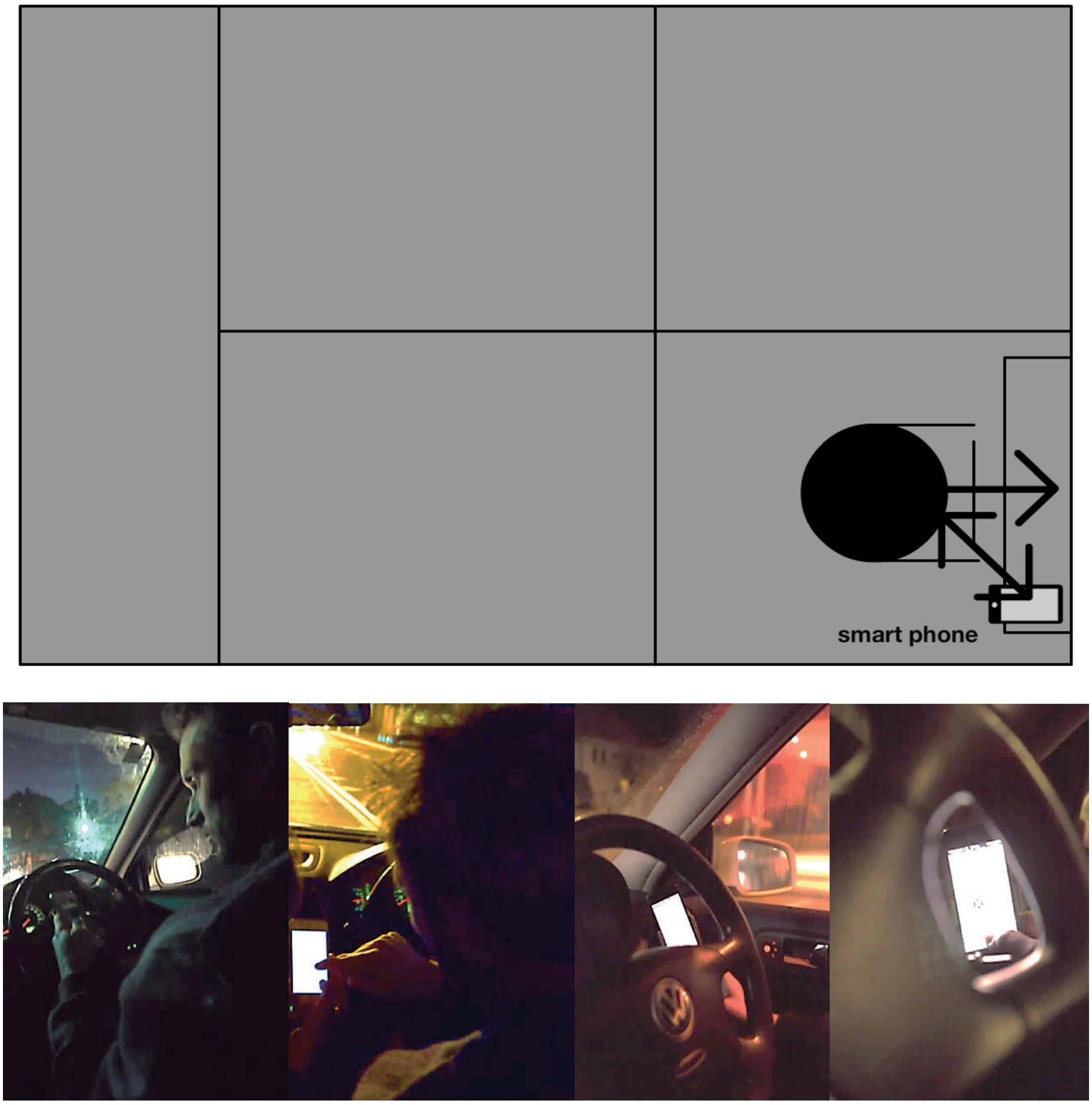


Figure 37: Physical Model Frame 11: **Persona 2.**

Persona 2 mounts their Smartphone inside the car and starts driving home. (See **Figure 37**, above).

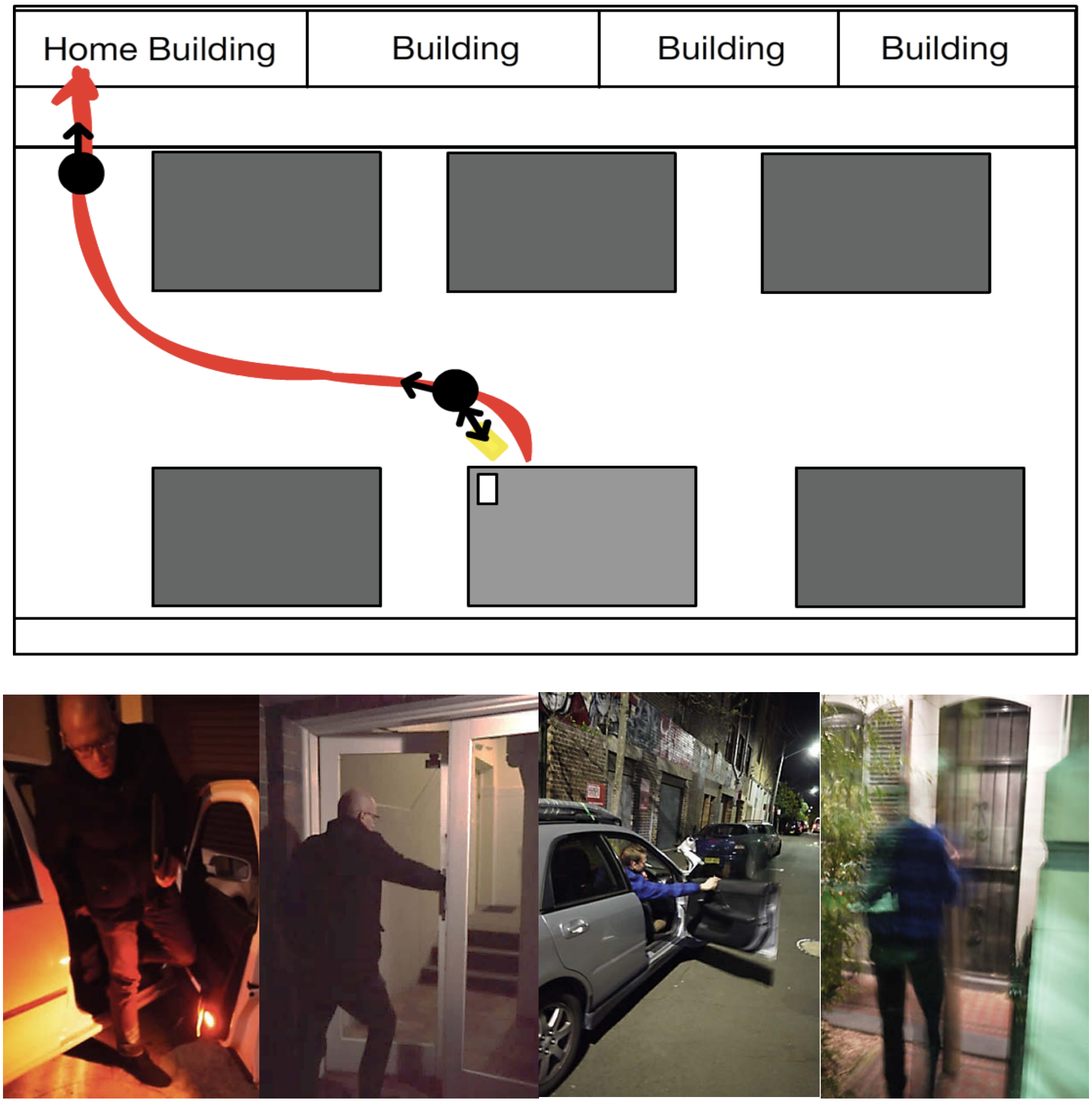


Figure 38: Physical Model Frame 12: **Persona 2.**

Persona 2 parks their car close to their home building and gets out. Persona 2 closes the car door with the remote control and walks towards the home building, then enters and arrives home. (See **Figure 38**, above).

Circle Flow Model

The Circle Flow Model (see **Figure 39**, below), is an overview of data on **Persona 2's** everyday interactions. Note that the Flow Model and Circle Diagram show how digital interactions are consequentially database interactions.

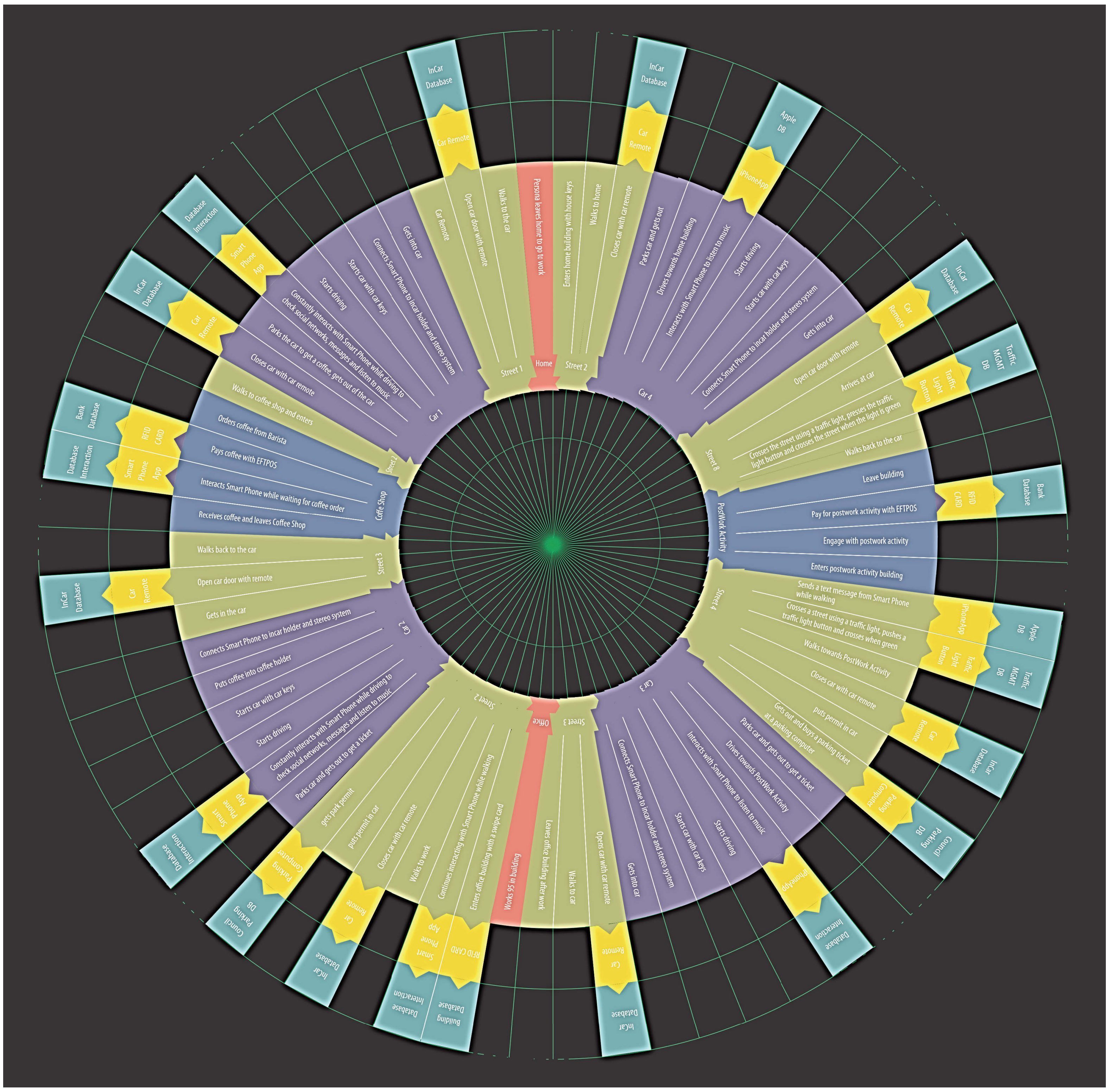


Figure 39: Circle Flow Model: **Persona 2.**

(Courtesy of Ralph Kenke, Pawan Jha, Elmar Trefz)

4.2.3 Consolidated Models: Persona 3

Circle Flow and Physical Models

Persona 3 uses public transport and has flexible working hours in Sydney.

Figure 40: Persona 3 uses her Smartphone while walking on the street and approaching a traffic light she is about to use.

Sequence Model

The Sequence Model shows **Persona 3's** step-by-step interactions, her intentions, and the triggers that caused the interactions.

	Actions	Intent	Trigger
Home			
	Leaves home to go to work		
Street 1	v		
	Gets out of the house to visits a cafe, shop or bakery	Have breakfast	Need to eat and drink
	v		
	While walking to the location on the street the is not using their smart phone		
Shop 1	v		
	At the location interacts with smart phone to read news, messages, listening to music or browse social media	Communicate, educate or entertainment	Productivity, Boredom or need to be informed
	v		
	Also people watches other people at the location.	People watching	Curiosity
	v		
	When finsihed consuming exits the shop		
Street 2	v		
	Walks to the bus stop and waits for the bus.	Commute	Distance to work place
	v		
	While walking and waiting continues interacting with the Smartphone	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Is not as interested in bus arrival times as Group 1 is. Also does not display the same sense of urgency as Group 1 is displaying for being on time.	No need to be on time	More flexible with time
Public Transport 1	v		
	Pays public transport with a pre-purchased paper ticket	Paying	Cost of public transport
	v		
	Sits down and continues interacting with smart phone.	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	However also puts Smartphone down and contemplates for periods of times.	Relaxation and Contemplation	A lesser need to optimise time
	v		

	Would use the Smartphone less frequently on public transport then Group 1		
Street 3	v		
	Leaves public transport and walks to work.		
	v		
	Crosses the street at traffic lights	Cross Street	Traffic on Street
	v		
	Walks slower and more casually from public transport to work than Group 1		
	v		
	Uses Smartphone while walking.	Communicate, educate or entertainment	Productivity, boredom or need to be informed
Work Location	v		
	Enters work location		
	v		
	Works for several hours.		
	v		
	Leaves work location.		
Street 4	v		
	After work interacts with smart phone and walks casually towards public transport interacting with email or instant messaging app	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Crosses street using a traffic light.	Cross Street	Traffic on Street
	v		
	Waits at public transport stop		
	v		
	Continues interacting with Smartphone while waiting interacting with email or instant messaging app	Communicate, educate or entertainment	Productivity, boredom or need to be informed
Public Transport 2	v		
	Enters public transport and pays fare with pre-purchased paper ticket	Paying	Cost of public transport
	v		
	Sits down and interacts with smart phone to communicate with friends interacting with eMail or instant messaging app.	Communicate with friends	Organising social live post work
	v		
	Again puts Smartphone down occasionally and contemplates	Relaxation and Contemplation	A lesser need to optimise time
	v		
	Again interacts less with Smartphone then Group 1 on public transport.		
	v		
	Leaves public transport		

Street 5	v		
	Walks home without interacting with Smartphone.	Arrive at home	Distance between bus stop and home
Home	v		
	Enters home building.	Entering home	Security

Physical Model

The physical model shows **Persona 3's** interactions in the physical environment, within the narrative of their day, over time.

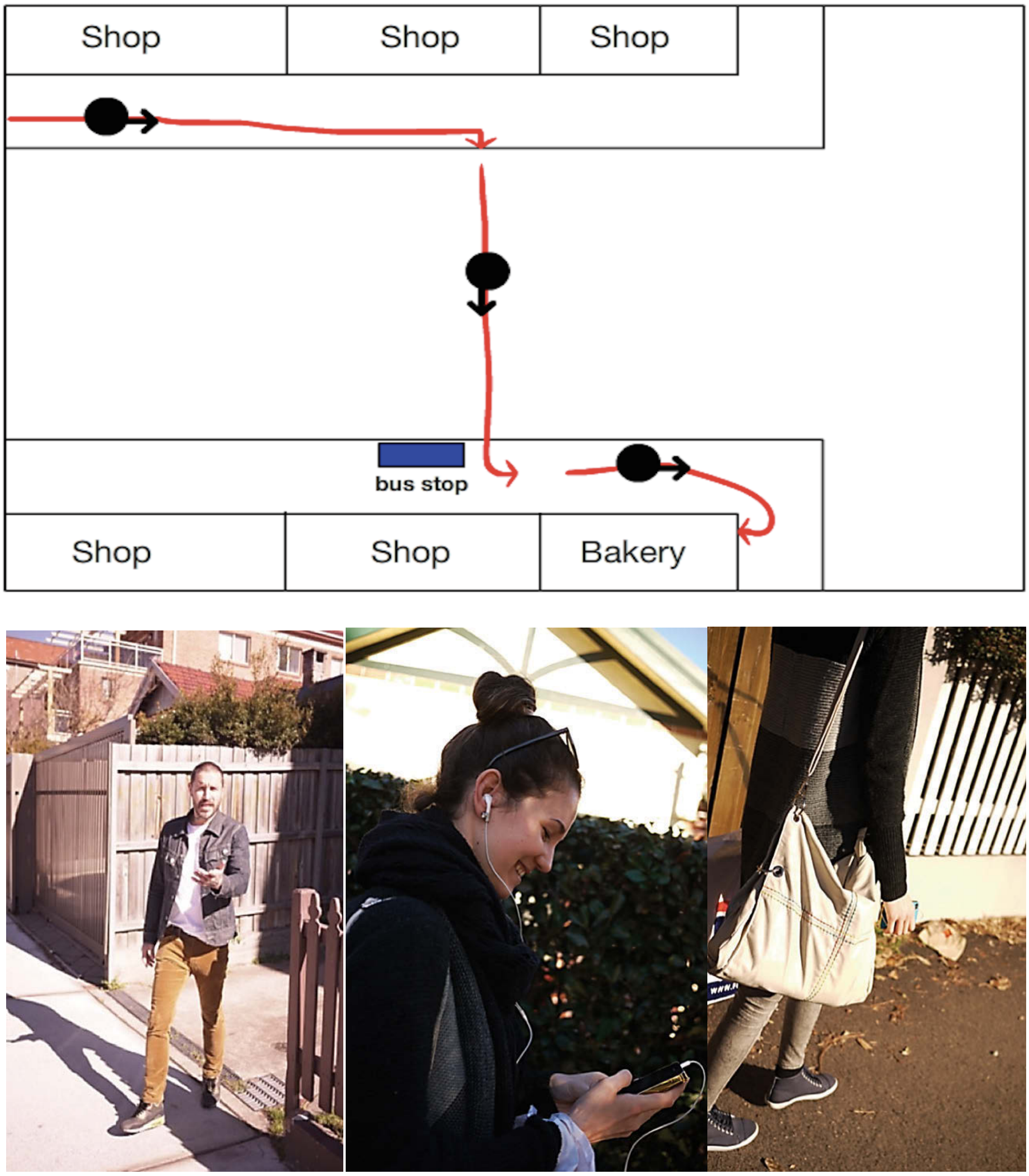


Figure 41: Physical Model Frame 1: **Persona 3**

Persona 3 visits a cafe, shop or bakery before going to work. While walking to the location, Persona 3 is not using her Smartphone. (See **Figure 41**, above).

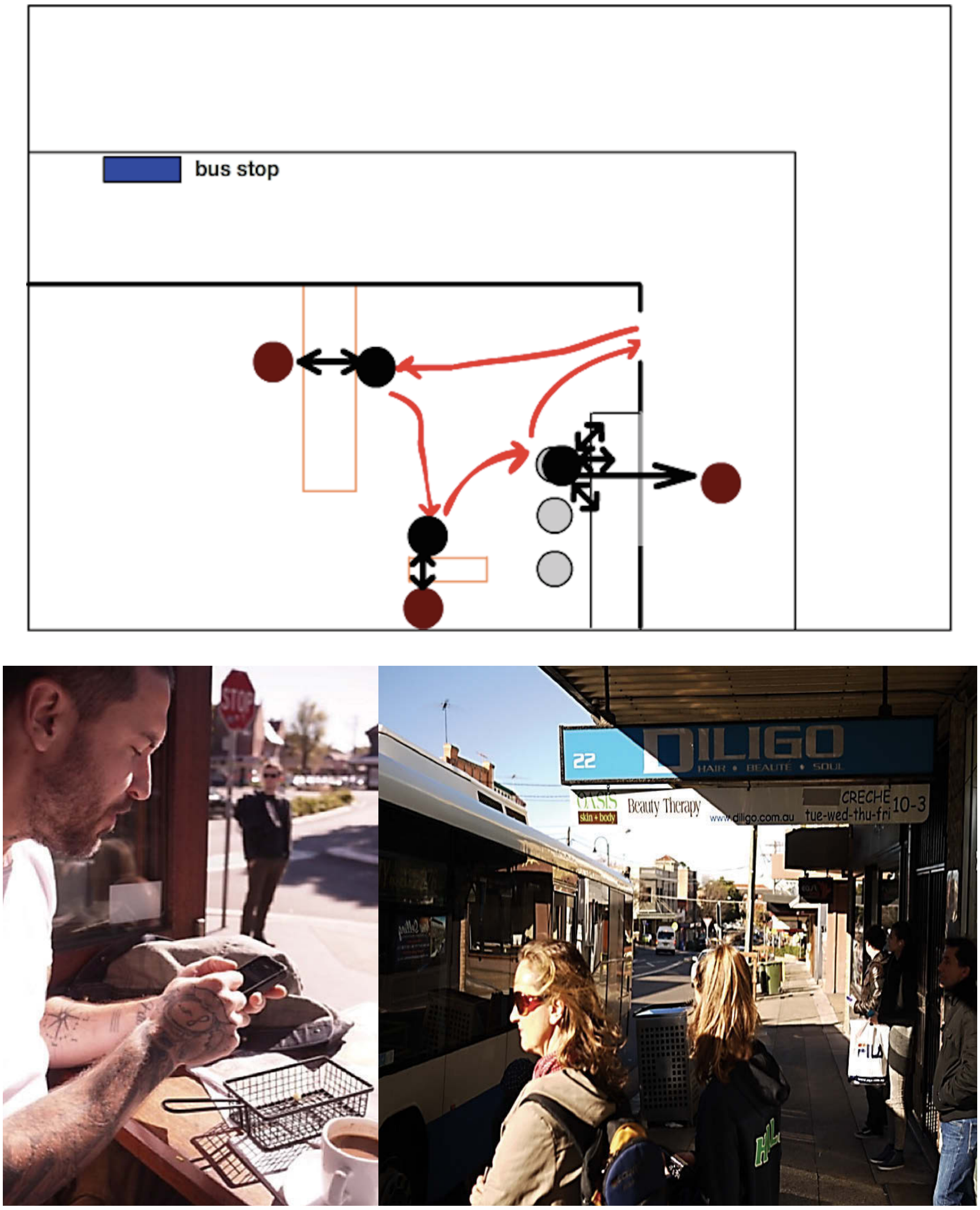


Figure 42: Physical Model Frame 2: **Persona 3.**

At the location, **Persona 3** interacts with their Smartphone to read news, messages, listen to music or browse social media. Persona 3 also people-watches at the location. (See **Figure 42**, above).

Figure 43: Physical Model Frame 3: **Persona 3.**

Persona 3 walks to the bus stop and waits for the bus. While walking and waiting, Persona 3 continues interacting with the Smartphone, to communicate, entertain or educate themselves. Persona 3 is not as interested in bus arrival times as Persona 1. Persona 3 does not display the same sense of urgency for being on time that Persona 1 displays. (See **Figure 43**, above).

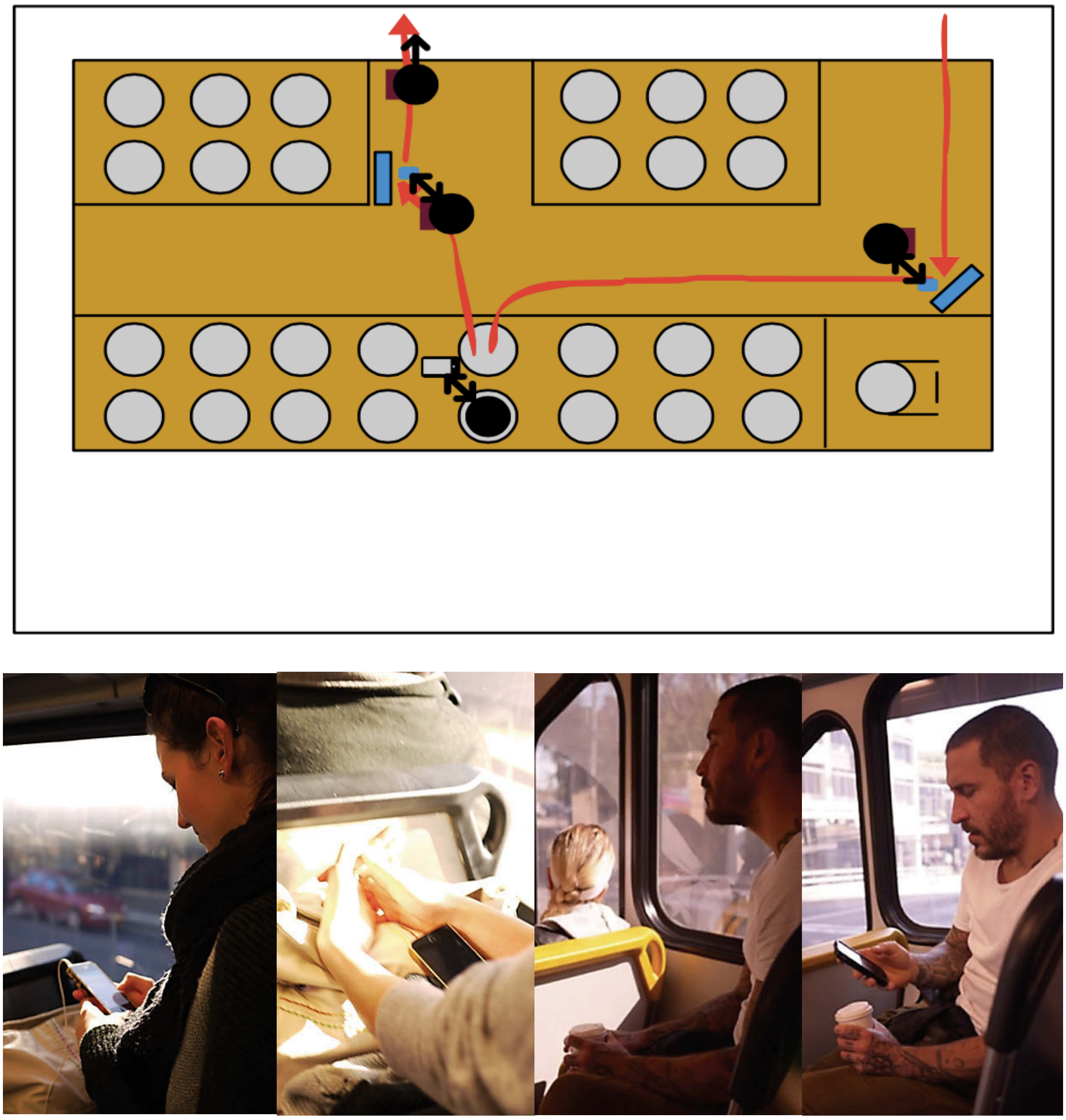


Figure 44: Physical Model Frame 4: **Persona 3.**

Persona 3 pays for public transport with a pre-purchased paper ticket, sits down and continues interacting with their Smartphone. Persona 3 however, also puts their Smartphone down and contemplates for periods of time. Persona 3 uses the Smartphone less frequently on public transport than Persona 1. (See **Figure 44**, above).

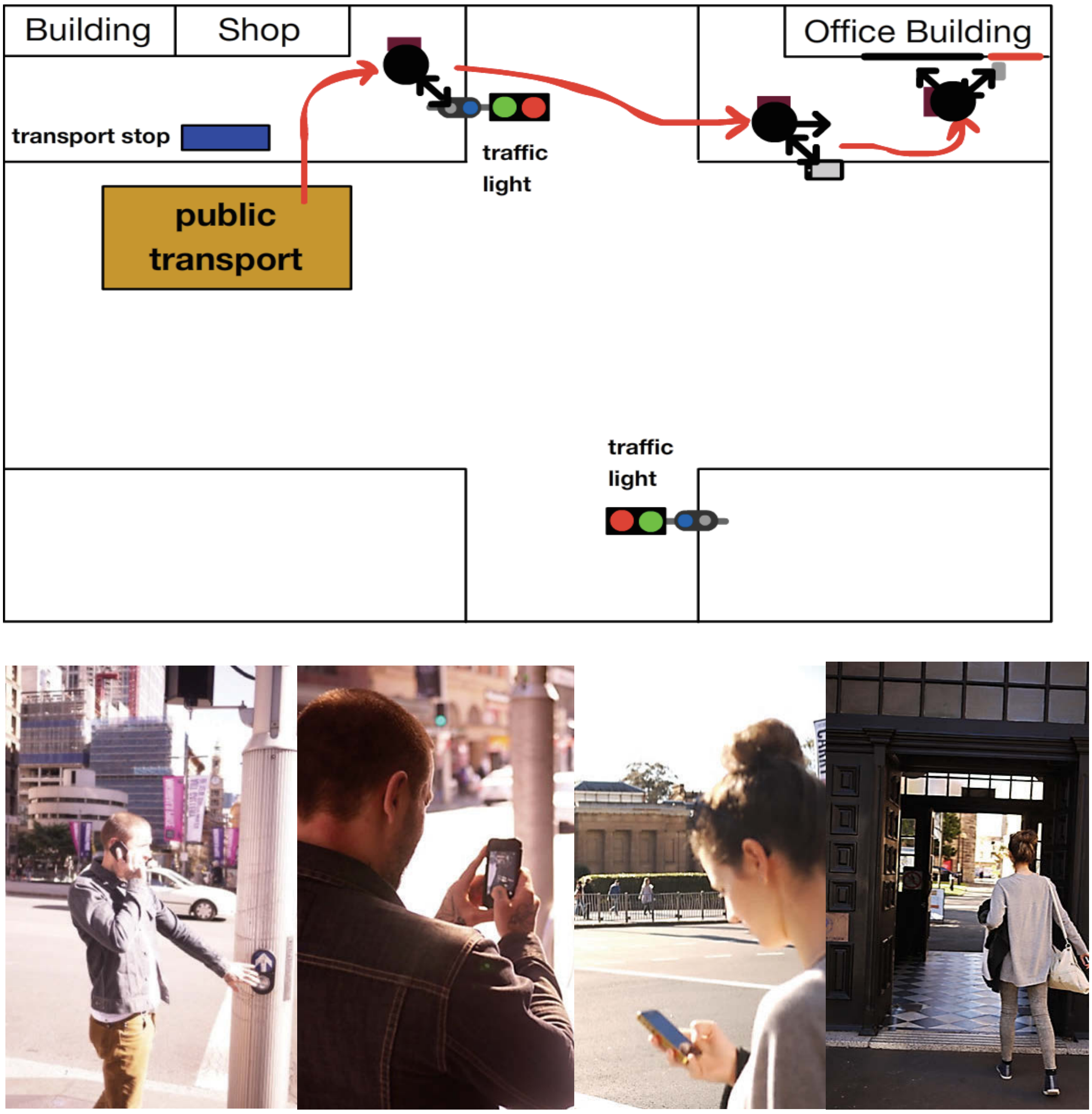


Figure 45: Physical Model Frame 5: **Persona 3.**

Persona 3 leaves public transport and keeps interacting with their Smartphone on the way to work. Persona 3 crosses the street at the traffic lights, keeps on walking and arrives at work. Persona 3 walks more slowly and casually from public transport to work than Persona 1. However, Persona 3 also uses their Smartphone to communicate, educate and entertain themselves. Persona 3 works for several hours. (See **Figure 45**, above).

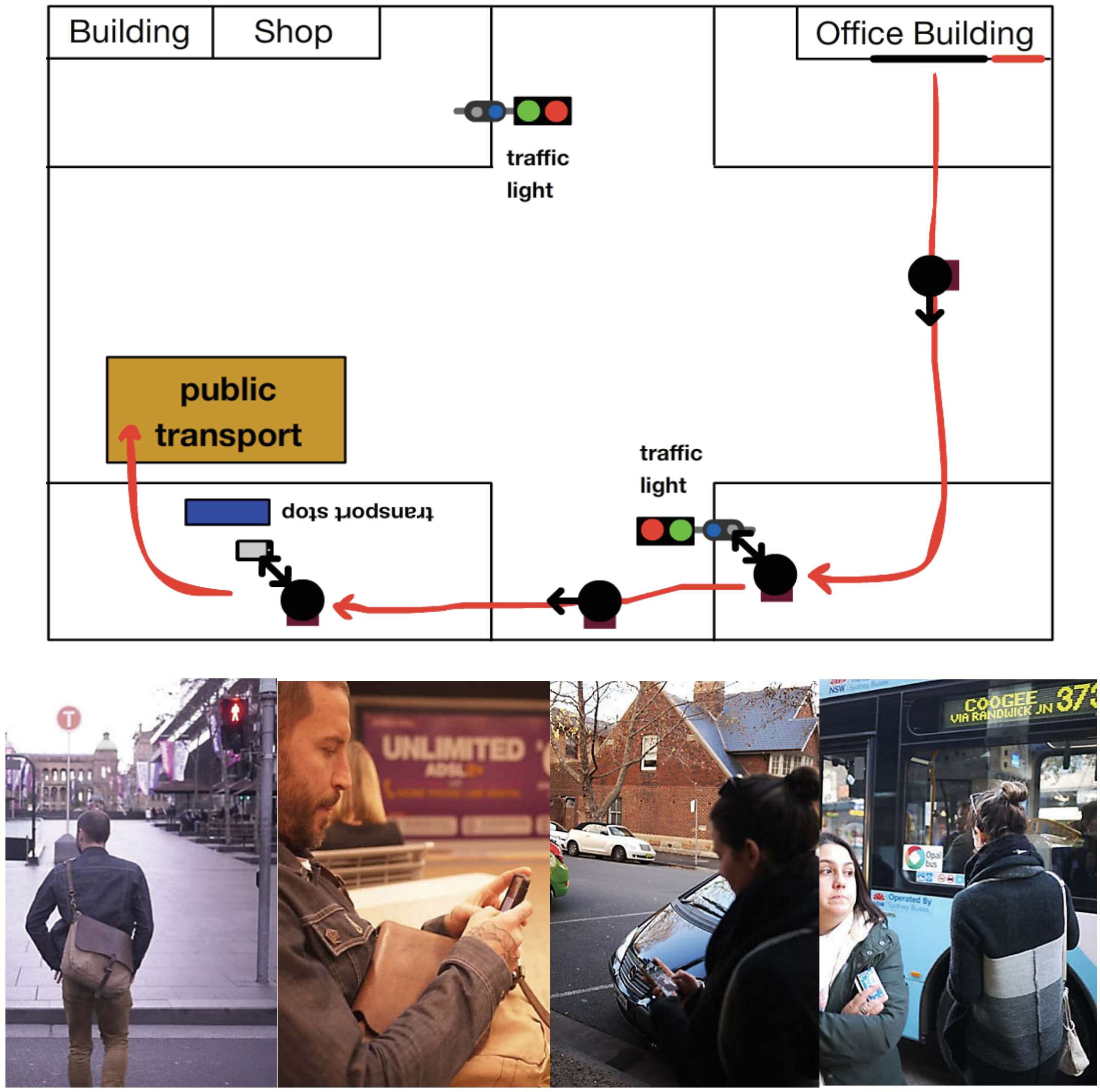


Figure 46: Physical Model Frame 6: **Persona 3.**

Persona 3 leaves work, interacts with their Smartphone, walks casually towards public transport and crosses the street using a traffic light. Persona 3 waits at the public transport stop and continues interacting with their Smartphone. See **Figure 46**, above).

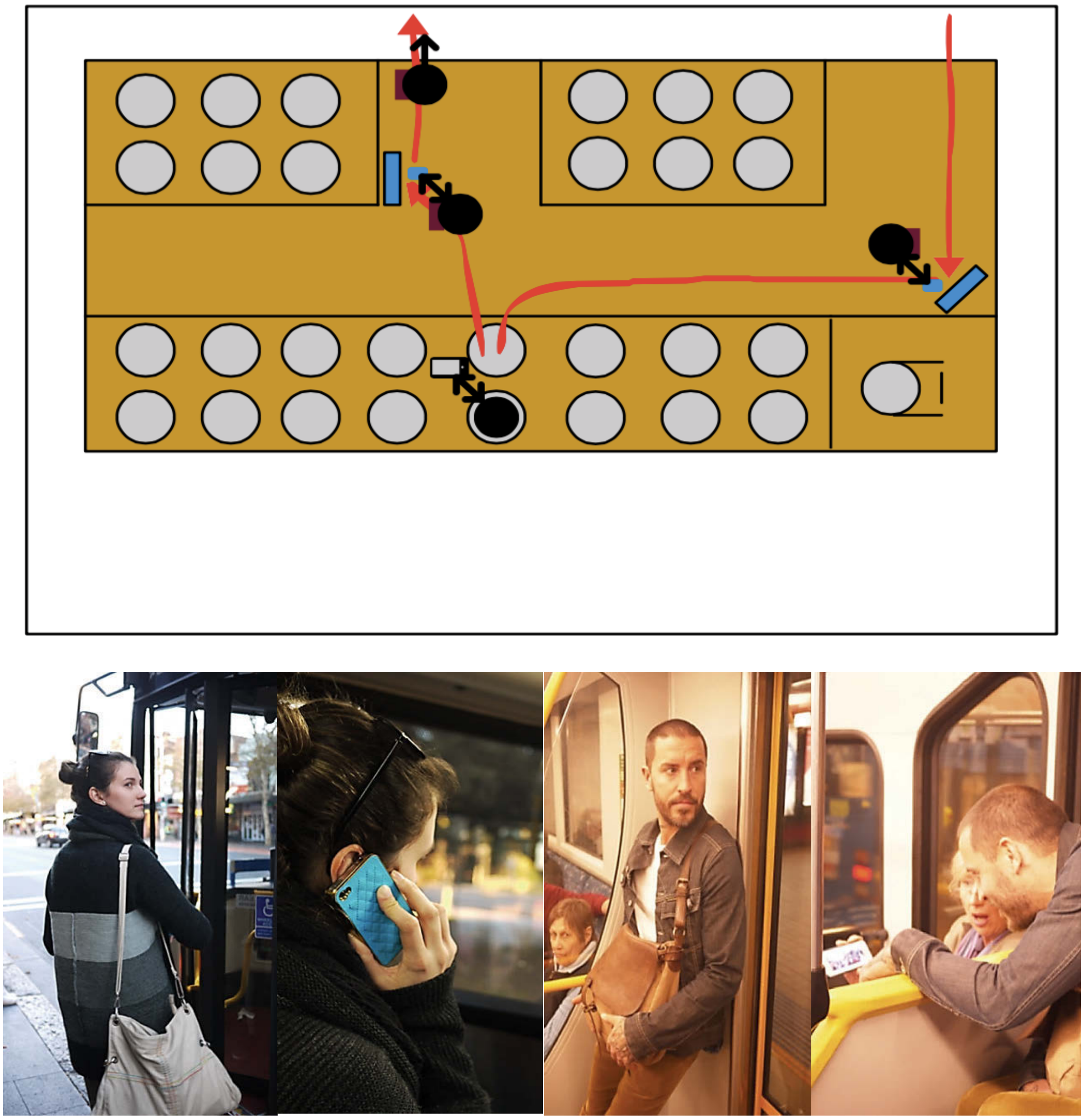


Figure 47: Physical Model Frame 7: **Persona 3.**

Persona 3 enters public transport and pays the fare with a pre-purchased paper ticket, sits down and interacts with the Smartphone to communicate with friends. Persona 3 again puts the Smartphone down occasionally and contemplates. Persona 3 again interacts less with their Smartphone on public transport than Persona 1. (See **Figure 47**, above).

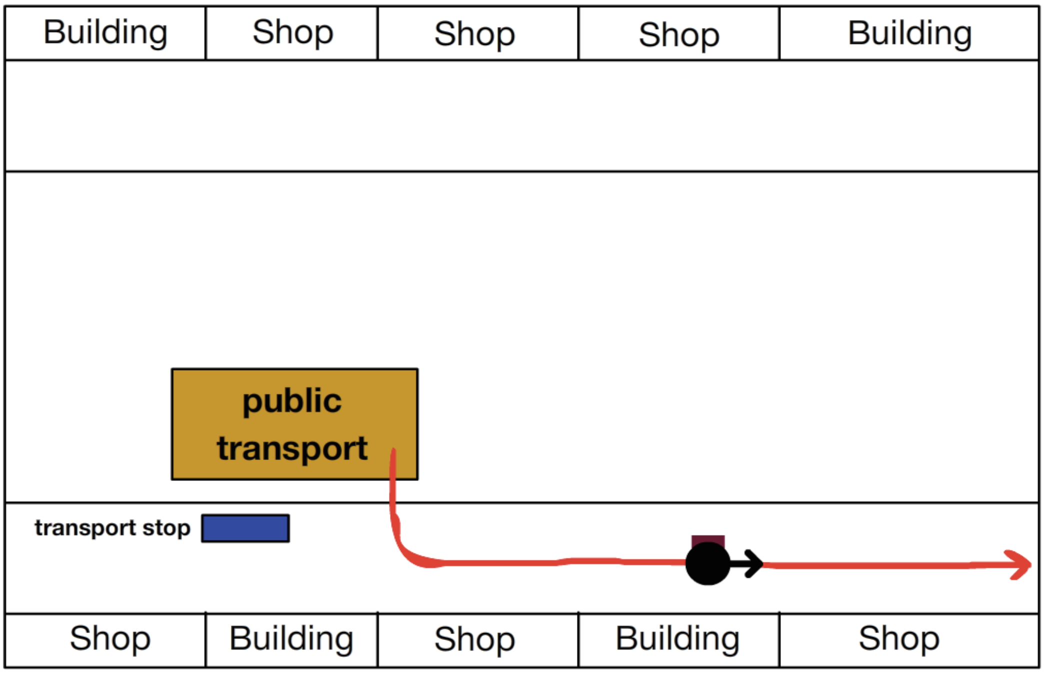


Figure 48: Physical Model Frame 8: **Persona 3.**

Persona 3 leaves public transport and walks home without interacting with their Smartphone. Persona 3 enters their home building. (See **Figure 48**, above).

Circle Flow Model

The Circle Flow Model (see **Figure 49**, below), is a data overview of **Persona 3's** everyday interactions. Note that the Flow Model and Circle Diagram show how digital interactions are consequentially database interactions.

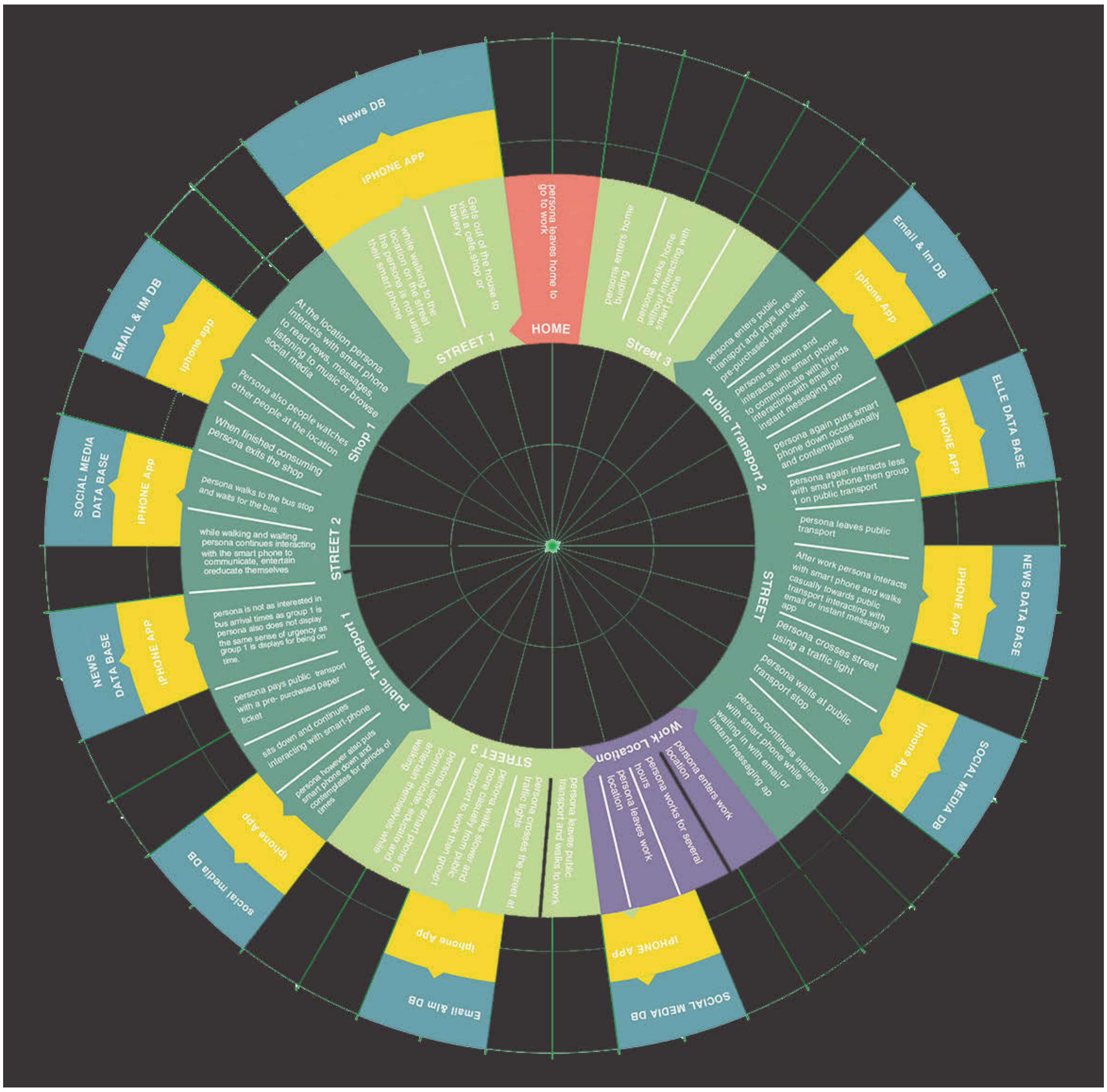


Figure 49: Circle Flow Model: **Persona 3.**

(Courtesy of Ralph Kenke, Pawan Jha, Elmar Trefz)

4.2.4 Consolidated Models: Persona 4

Circle Flow and **Physical Models**

Persona 4 uses private transport and has flexible working hours in Sydney.

Figure 50: Persona 4 using Smartphone while walking, getting a parking ticket for their car, then walking to their next destination.

Sequence Model

The Sequence Model shows **Persona 4's** step-by-step interactions, his intentions, and the triggers that caused the interactions.

	Actions	Intent	Trigger
Home			
	Leaves home to go to work		
Car 1	v		
	Gets out of the house to drive to a cafe, shop or bakery	Have breakfast	Need to eat and drink
	v		
	While driving to the location is not using Smartphone		
Shop 1	v		
	At the location interacts with smart phone to read news, messages, listening to music or browse social media.	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Also people watches other people at the location	People watching	Curiosity
	v		
	When finished consuming exits the shop.		
Car 2	v		
	Gets back into the car using a remote control	Unlocking car	Security
	v		
	While driving to the location is using their Smartphone to listen to music, check emails, instant messages or social media, most intensively at traffic lights	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Does not display the same sense of urgency as Group 2 is displaying for being on time.	No need to be on time	More flexible with time
Beach 1	v		
	Also visits the beach before, during or after work for an average of 30 minutes.	Relaxation and Contemplation	Proximity to beach
	v		
	Parks the car at the beach		
	v		
	Has free resident parking on the beach but needs to confirm the parking permit using the parking meter computer.	Validate parking	Cost of parking spot
	v		
	While at the beach interacts with social media and messaging applications.	Communicate, educate or entertainment	Productivity, boredom or need to be informed

	v		
	While walking back to the car interacts with Smartphone .	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Leaves beach and opens the car.	Unlocking car	Security
Car 3	v		
	Gets in the car		
	v		
	Puts Smartphone in a car holder and starts driving home	Use Smartphone while driving	Productivity, boredom or need to be informed
	v		
	Listens to music checks emails, text messages, and social media while driving and more so while stopping at traffic lights.	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Drives back home		
Home 2	v		
	Parks the car in front of their home		
	v		
	Locks the car door with a remote	Locking car	Security
	v		
	Enters the home building with a swipe card or key	Entering home	Security
	v		
	Leaves again for work		
	v		
	Leaves home and walks to her car		
Car 4	v		
	Opens the car with a remote or keys and gets into the car	Unlocking car	Security
	v		
	Puts Smartphone in a car holder and starts driving to work	Use Smartphone while driving	Productivity, boredom or need to be informed
	v		
	Listens to music checks emails, instant messages and social media while driving and more so while stopping at traffic lights.	Communicate, educate or entertainment	Productivity, boredom or need to be informed
Street 1	v		
	Parks car		
	v		
	Takes Smartphone out of holder and gets out of car		
	v		
	Validates parking	Paying for parking	Cost of parking spot
	v		
	Closes car and walks to destination	Lock car	Security
	v		

	While walking, keeps on checking Smartphone for emails and text messages	Communicate	Organise work or social life
	v		
	Arrives at the destination and enters the building	Transitioning from public to private space	Security
Work Location	v		
	Works for several hours		
	v		
	Finishes work		
Street 2	v		
	Walks back to the car		
	v		
	While walking, checks smart phone again for messages and emails.	Communicate	Organise work or social life
	v		
	Arrives a the car		
Car 5	v		
	Gets back into car using a remote or keys	Unlock car	Security
	v		
	Puts Smartphone into holder and starts driving	Use Smartphone while driving	Productivity, boredom or need to be informed
	v		
	While driving keeps on interacting with Smartphone in the Smartphone holder to check emails, messages and social media, most frequently at traffic light stops	Communicate, educate or entertainment	Productivity, boredom or need to be informed
Street 3	v		
	Parks the car, gets out of the car		
	v		
	Gets Parking ticket	Paying for parking	Cost of parking spot
	v		
	Closes the car with remote or keys	Lock car	Security
	v		
	Walks away towards activity building		
	v		
	While walking, interacts with the Smartphone to read messages, emails and social media	Communicate, educate or entertainment	Productivity, boredom or need to be informed
	v		
	Crosses street using a traffic light on the way	Cross Street	Traffic on Street
Activity Building	v		
	Enters activity building like yoga, gym, restaurant or shopping	Conduct activity	Need to shop, socialise or excersie
	v		
	Exits activity building when finished		

Street 4	v		
	Crosses street using traffic lights on the way back to the car	Cross Street	Traffic on Street
	v		
	Does not use Smartphone while walking	Relaxation and Contemplation	A lesser need to optimise time
Car 6	v		
	Gets back into the car with remote or key	Unlock car	Security
	v		
	Drives home		
	v		
	Parks and locks the car in front of the house	Locking car	Security
Home	v		
	Gets out and enters the building with a swipe card or keys	Entering home	Security

Physical Model

The Physical Model shows the interactions of **Persona 4** in the physical environment and within the narrative of the day, over time.

Figure 51: Physical Model Frame 1: **Persona 4.**

Persona 4 visits a cafe, shop or bakery before going to work. Persona 4 is not using the Smartphone on the way. (See **Figure 51**, above).

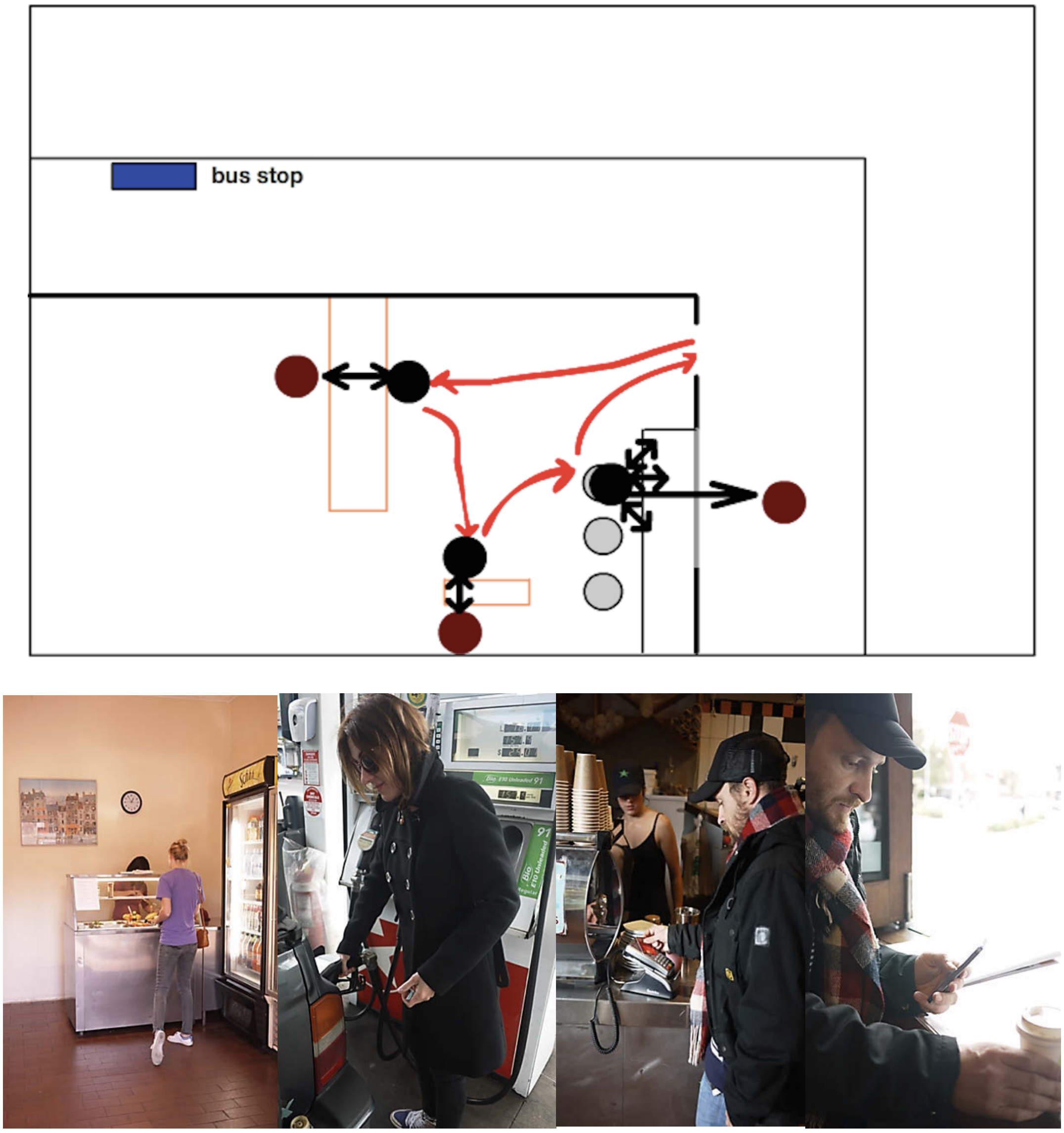


Figure 52: Physical Model Frame 2: **Persona 4.**

At the location, **Persona 4** interacts with the Smartphone to read news, messages or browse social media. Persona 4 is also people-watching at the location. (See **Figure 52**, above).

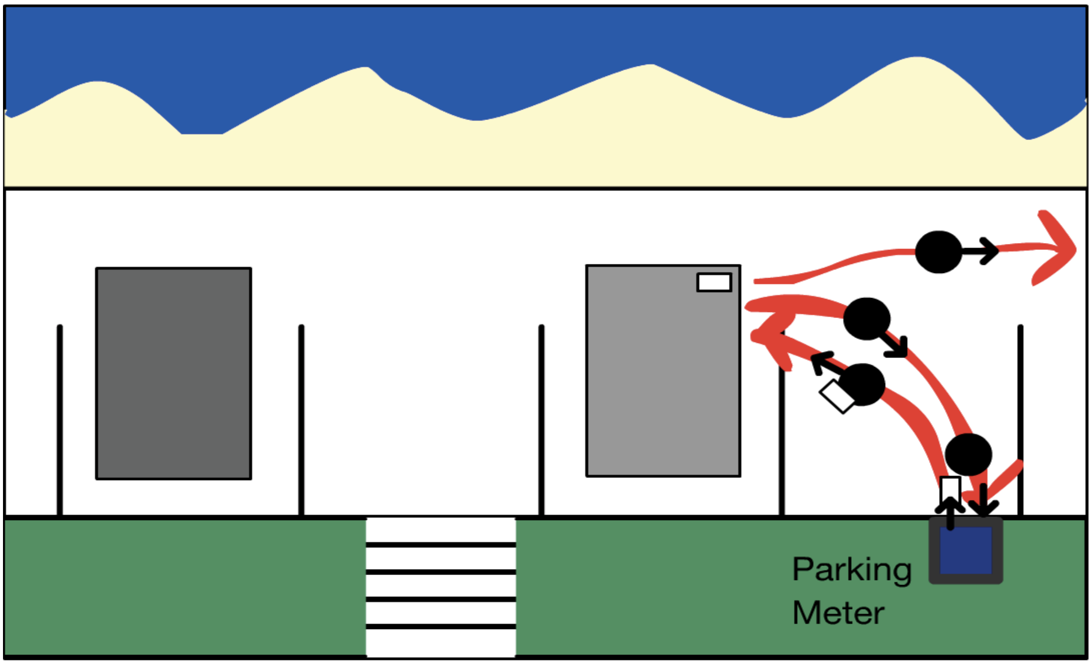


Figure 53: Physical Model Frame 3: **Persona 4.**

Persona 4 visits the beach before, during or after work for an average of 30 minutes. Persona 4 parks the car at the beach and validates a parking ticket. Persona 4 has free resident parking on the beach but needs to confirm the parking permit using the parking meter computer. While at the beach, Persona 4 interacts with social media and messaging applications. (See **Figure 53**, above).

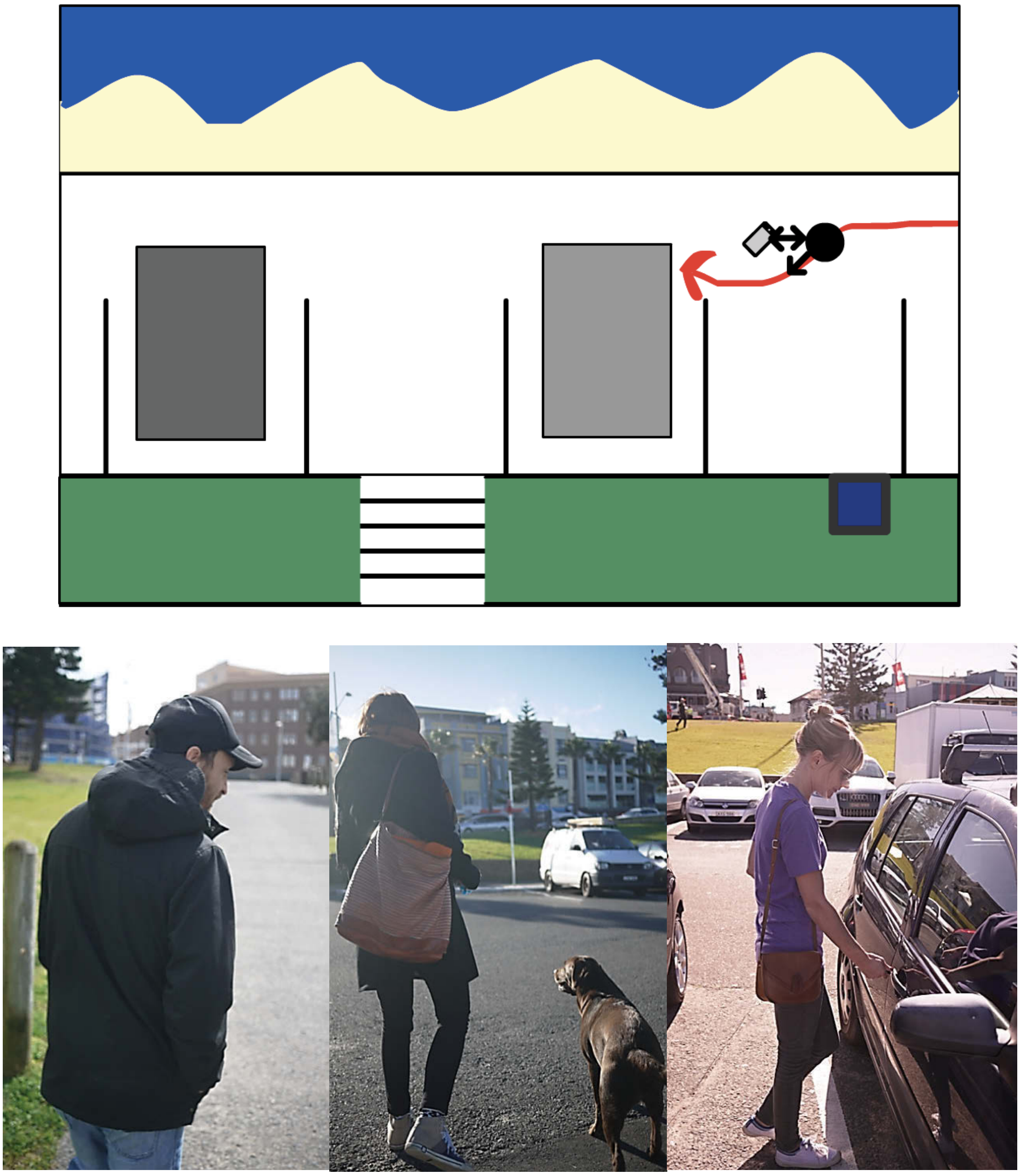


Figure 54: Physical Model Frame 4: **Persona 4.**

Persona 4 leaves the beach and gets back into their car. While walking back to the car, Persona 4 interacts with their Smartphone. (See **Figure 54**, above).

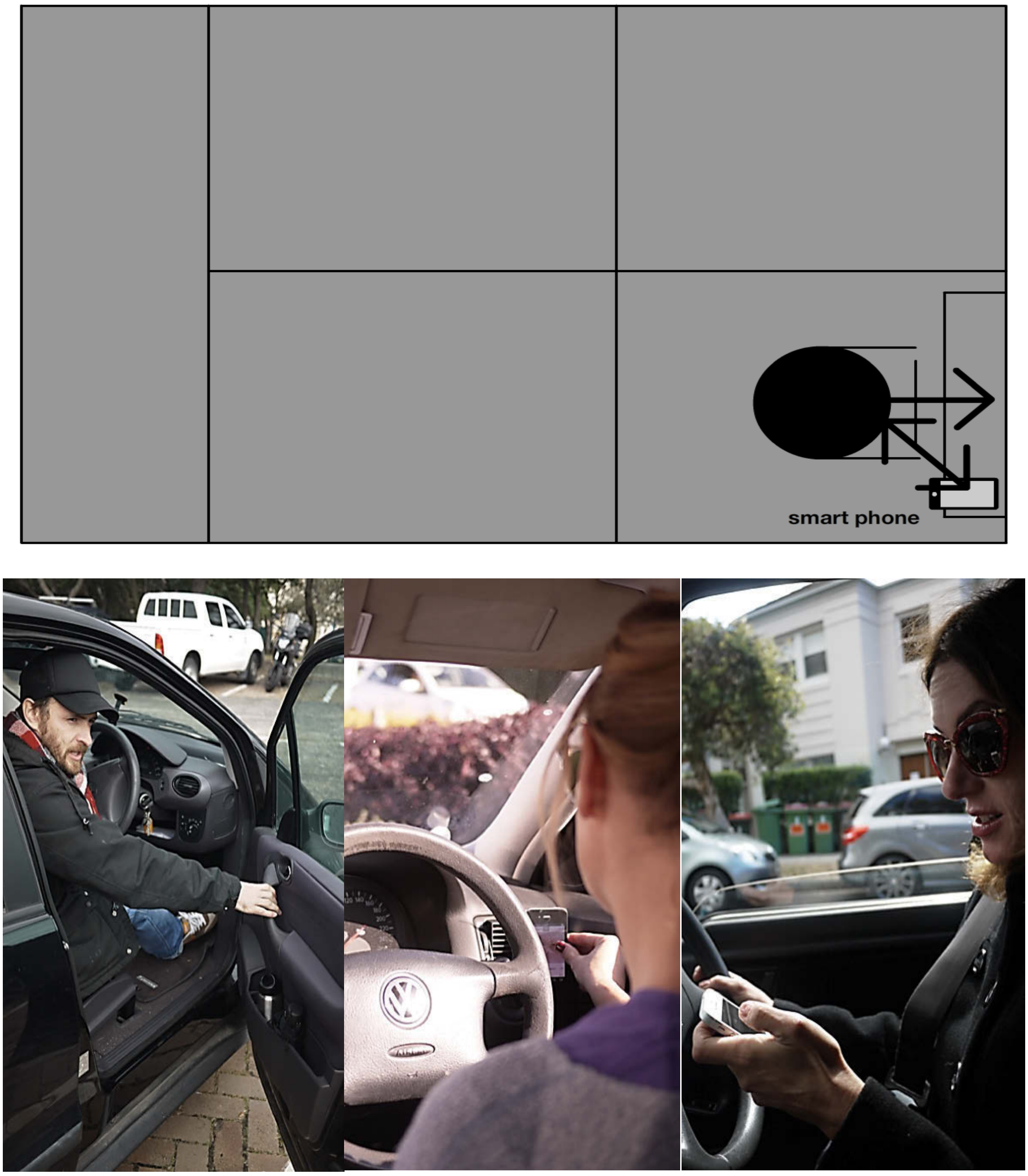


Figure 55: Physical Model Frame 5: **Persona 4.**

Persona 4 gets into the car, puts the Smartphone in a car holder and starts driving home. While driving, Persona 4 checks emails, text messages, news and social media. This activity increases while Persona 4 stops at traffic lights. (See **Figure 55**, above).

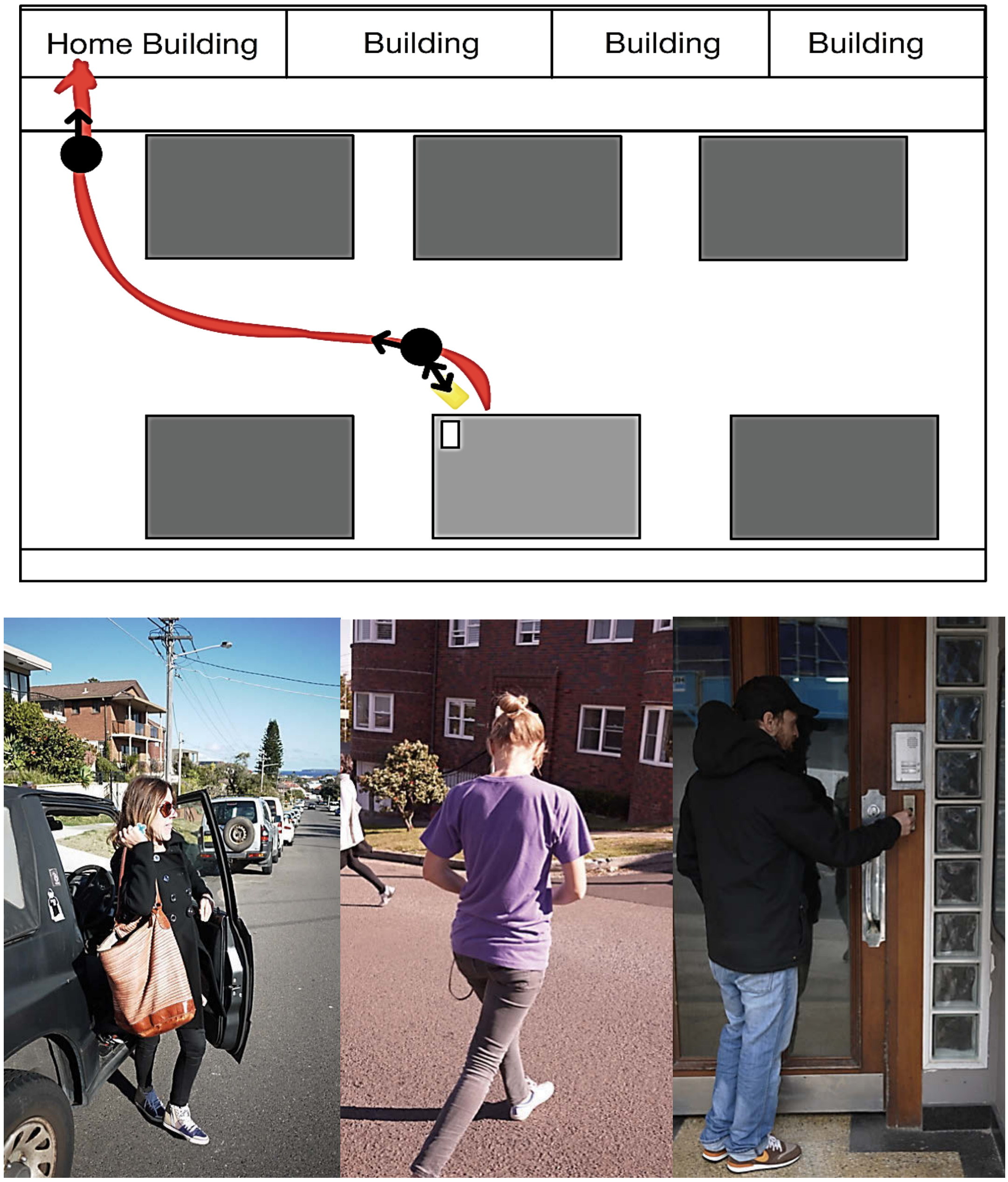


Figure 56: Physical Model Frame 6 : **Persona 4.**

Persona 4 drives back home, parks the car in front of the home, locks the car door with a remote or key and enters the home building with a swipe card or key. (See **Figure 56**, above).

Figure 57: Physical Model Frame 7: **Persona 4.**

Persona 4 then leaves again for work. Persona 4 walks to the car, opens the car with a remote or keys and gets in. (See **Figure 57**, above).

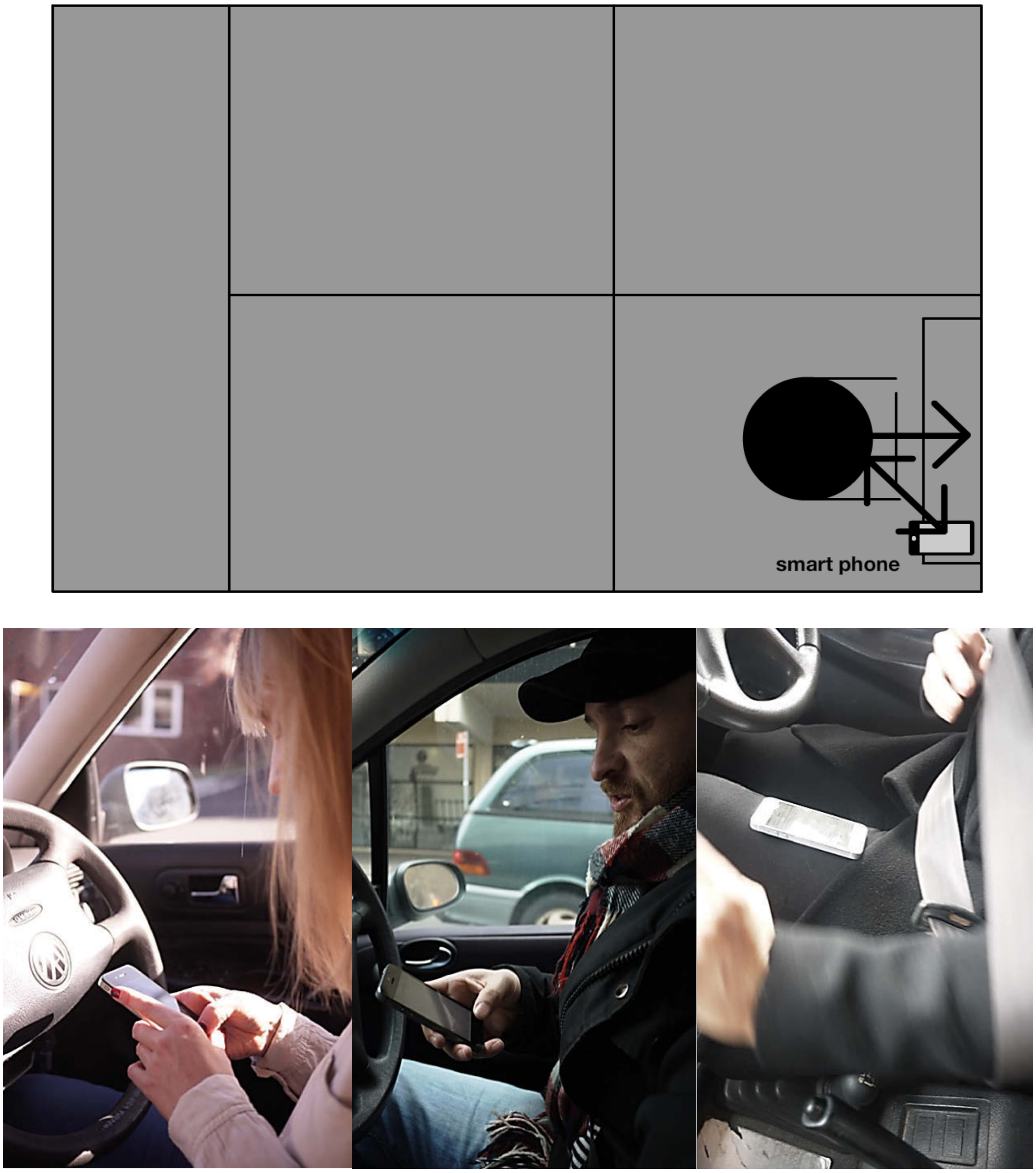


Figure 58: Physical Model Frame 8: **Persona 4.**

Persona 4 puts the Smartphone in a car holder and starts driving to work. While driving, Persona 4 checks emails, text messages, news and social media. This activity increases while stopping at traffic lights. (See **Figure 58**, above).

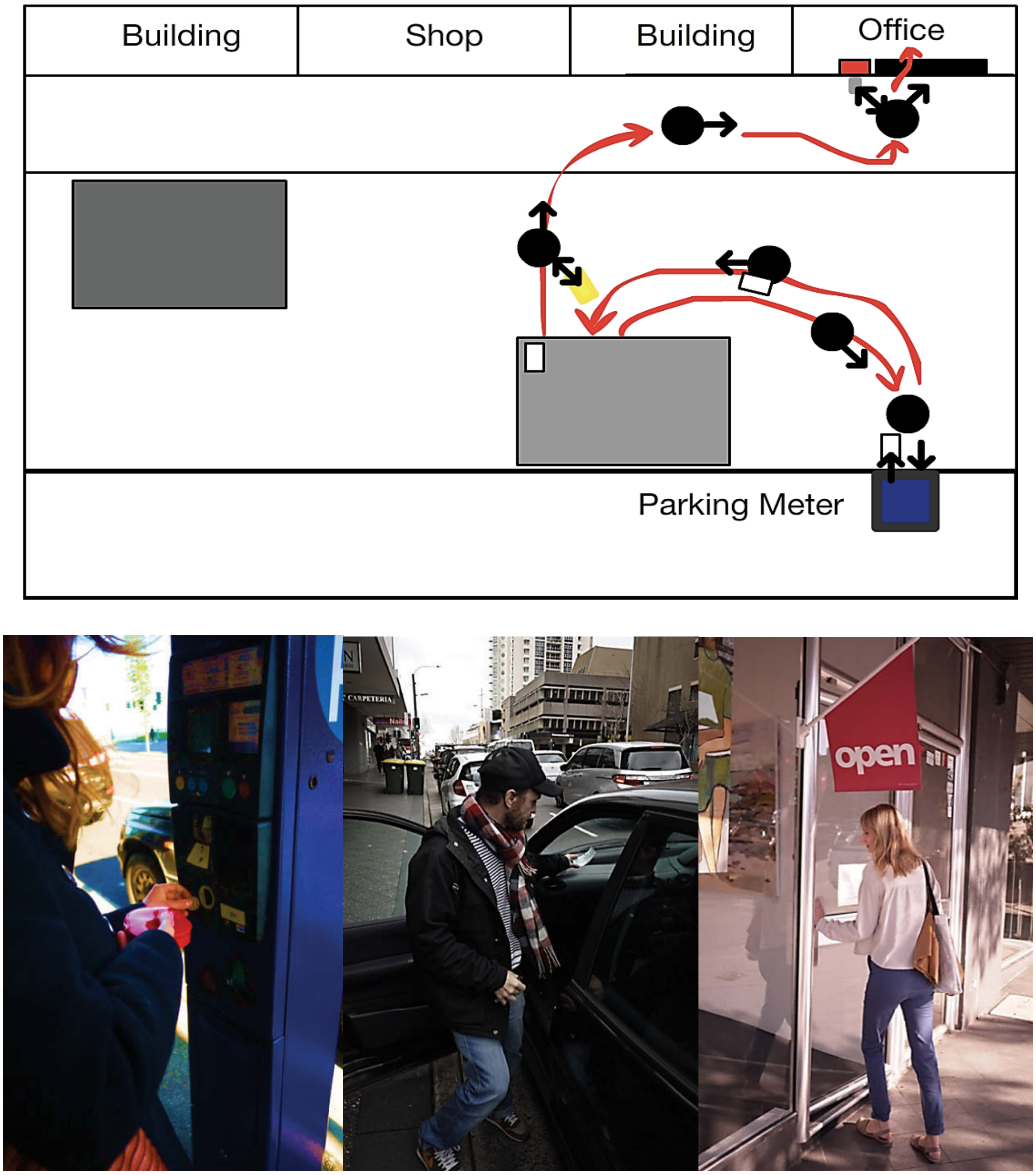


Figure 59: Physical Model Frame 9: **Persona 4.**

Persona 4 parks the car, takes the Smartphone out of holder and gets out. Persona 4 validates parking, closes the car and walks to their destination. While walking, Persona 4 keeps checking the Smartphone for emails and text messages. Persona 4 arrives at the destination, enters the building and works or shops for several hours. (See **Figure 59**, above).

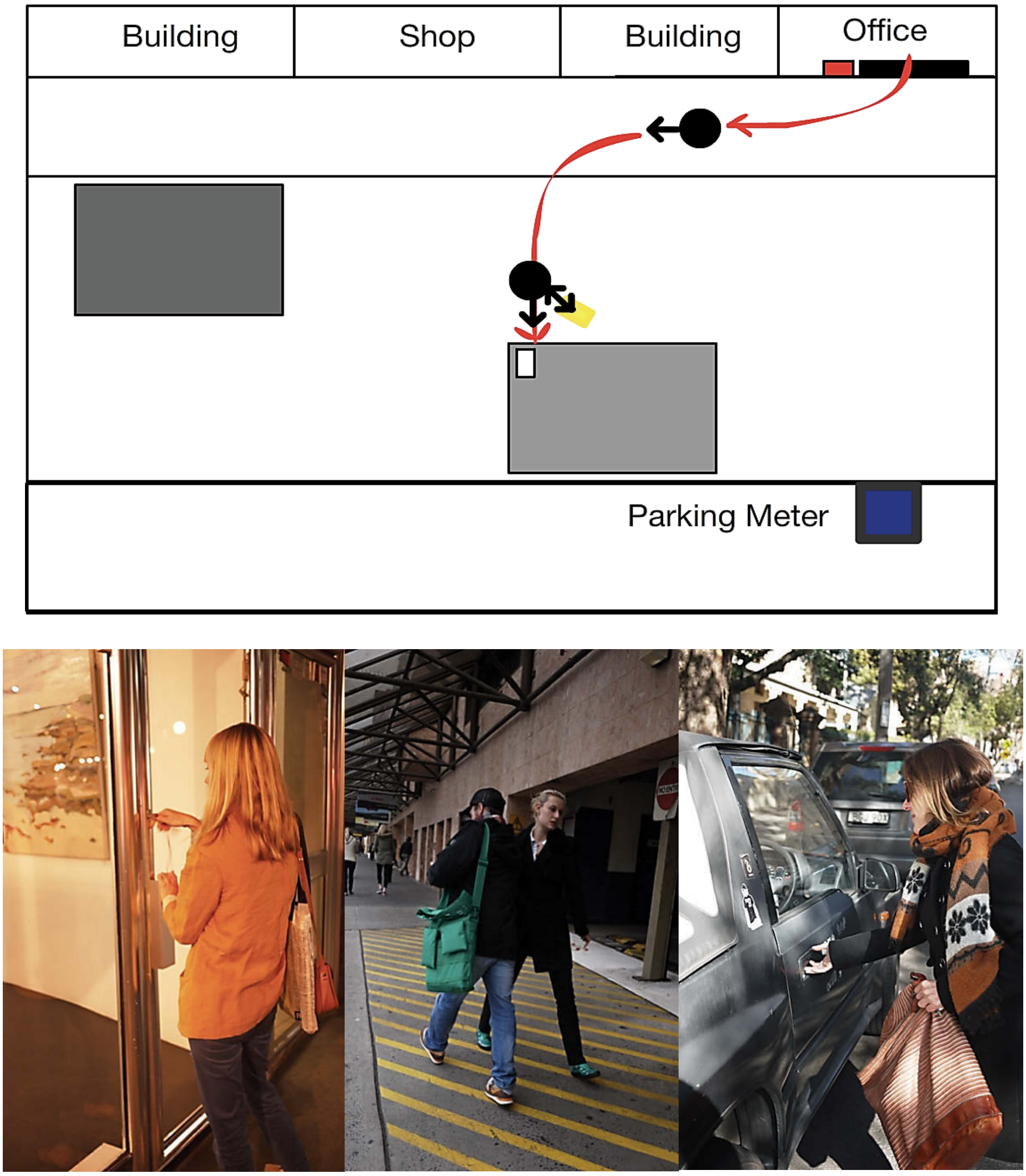
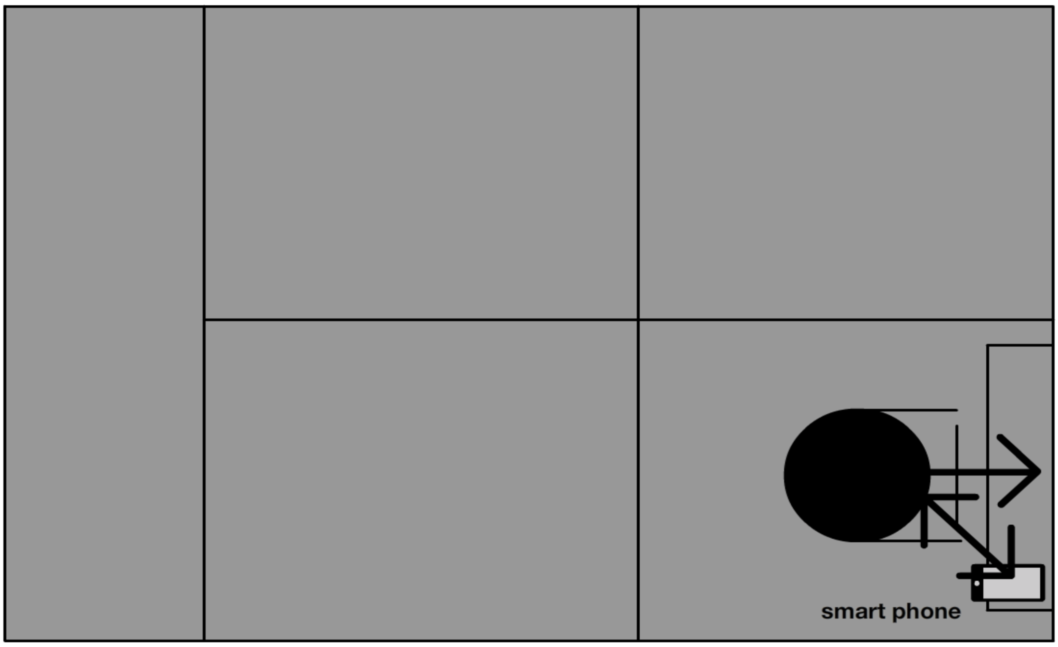


Figure 60: Physical Model Frame 10: **Persona 4.**

Persona 4 finishes work and walks back to the car. While walking, Persona 4 checks the Smartphone again for messages, emails, news, and browses social media. Persona 4 arrives at the car and gets back in, using a remote or keys. (See **Figure 60**, above).



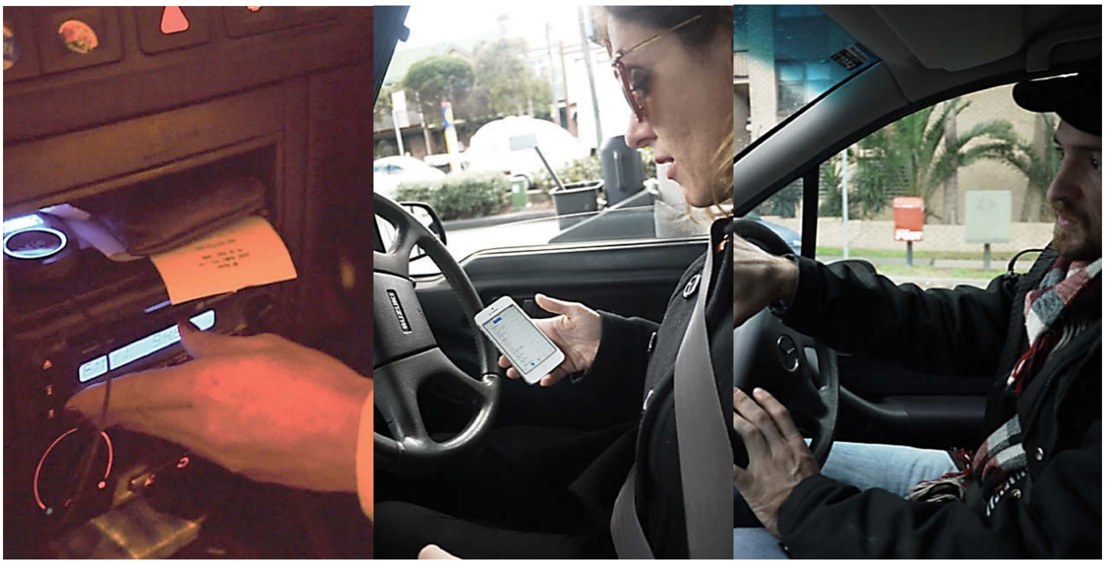


Figure 61: Physical Model Frame 11: **Persona 4.**

Persona 4 puts their Smartphone into the holder and starts driving. While driving, Persona 4 keeps interacting with the Smartphone in the Smartphone holder, to check emails, messages and social media. Persona 4 does this most frequently at traffic light stops. See **Figure 61**, above).

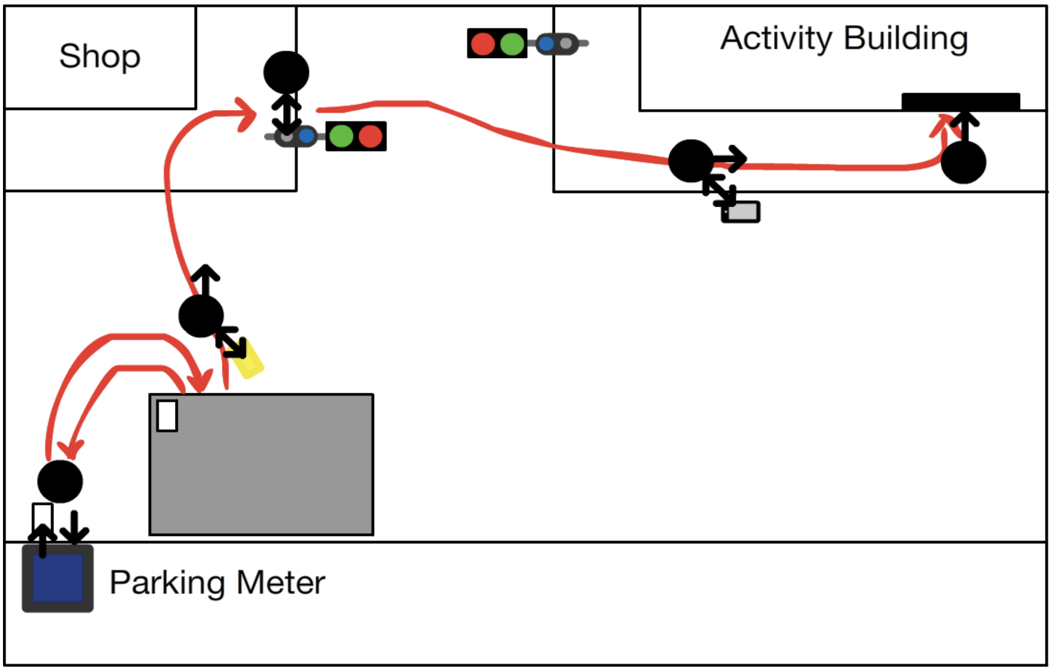


Figure 62: Physical Model Frame 12: **Persona 4.**

Persona 4 parks the car, gets out, validates parking, closes the car with remote or keys. Persona 4 walks away towards the shops, goes shopping. While shopping, Persona 4 interacts with the Smartphone to read messages, emails and social media. Persona 4 crosses the street using a traffic light. (See **Figure 62**, above).

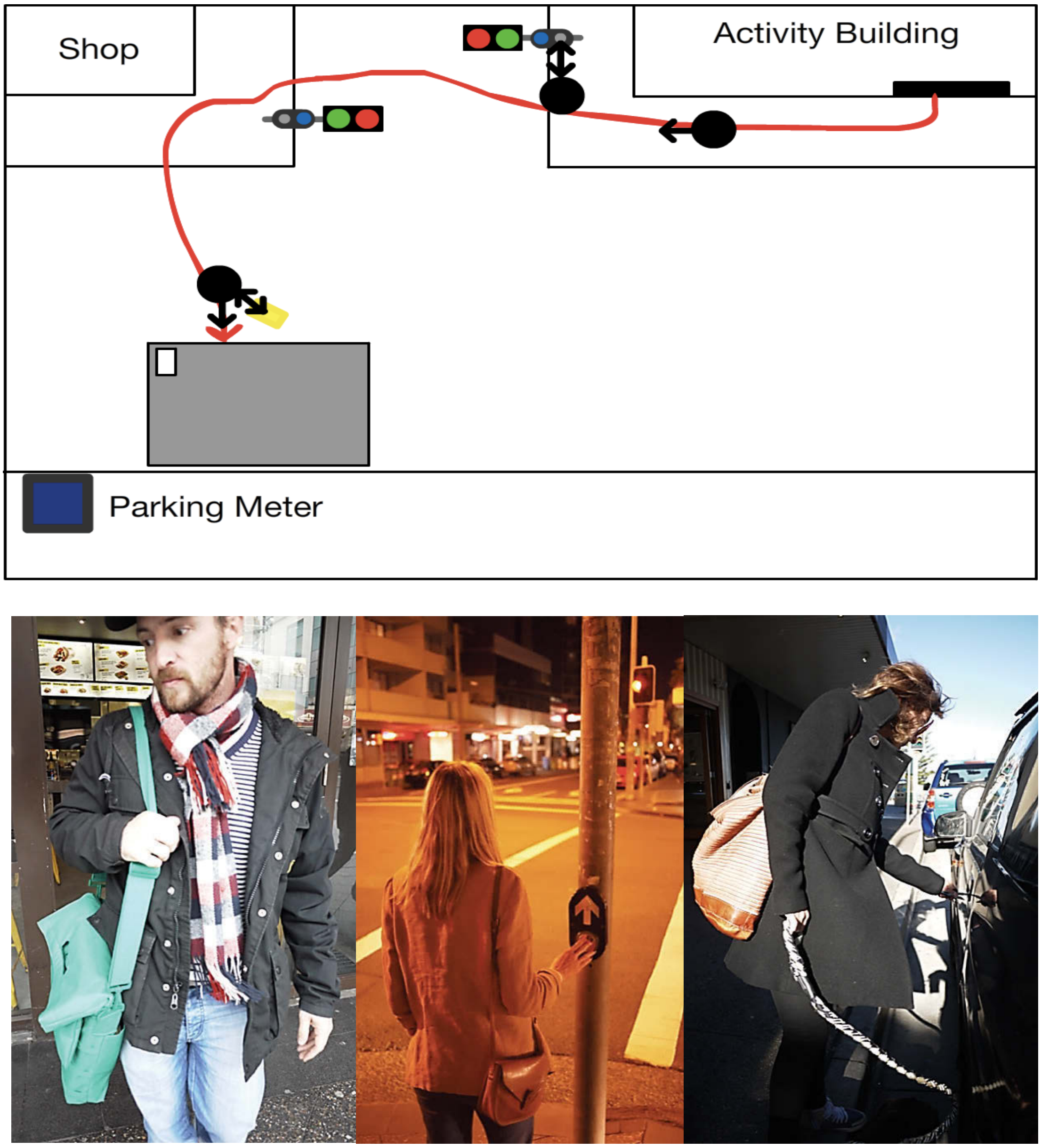


Figure 63: Physical Model Frame 13: **Persona 4**

When finished, **Persona 4** gets back into their car with remote or key and drives home. Persona 4 crosses the street using traffic lights on the way back to the car. (See **Figure 63**, above).

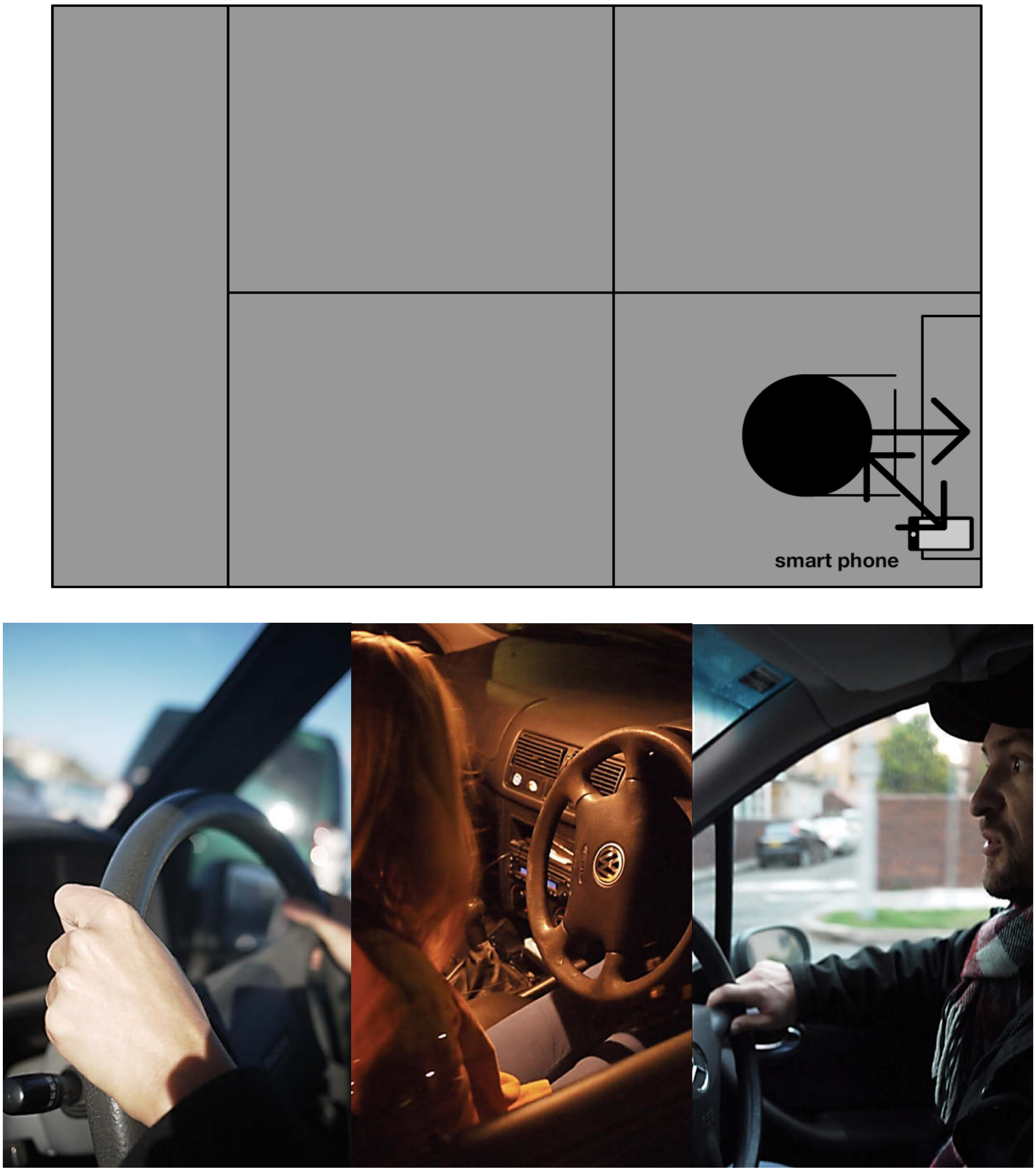


Figure 64: Physical Model Frame 14: **Persona 4.**

Persona 4 drives back home. Persona 4 does not use the Smartphone while driving home. (See **Figure 64**, above).

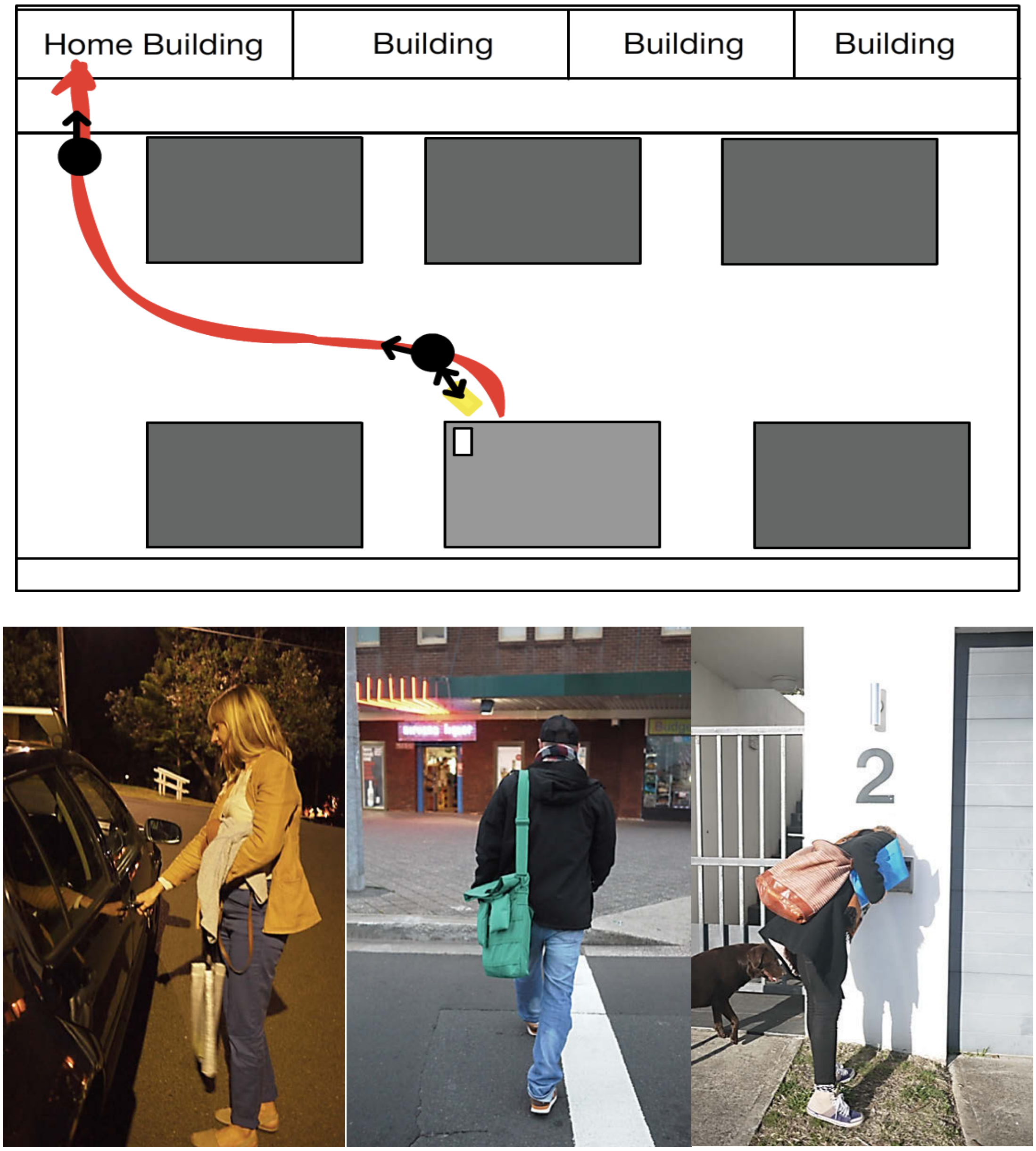


Figure 65: Physical Model Frame 15: **Persona 4.**

Persona 4 parks the car in front of the house, gets out, walks back home, and enters the building with a swipe card or keys. (See **Figure 65**, above).

Circle Flow Model

The Circle Flow Model (See **Figure 66**, below) is an data overview of **Persona 4's** everyday interactions. Note that the Flow Model and Circle Diagram show that digital interactions are consequentially database interactions.

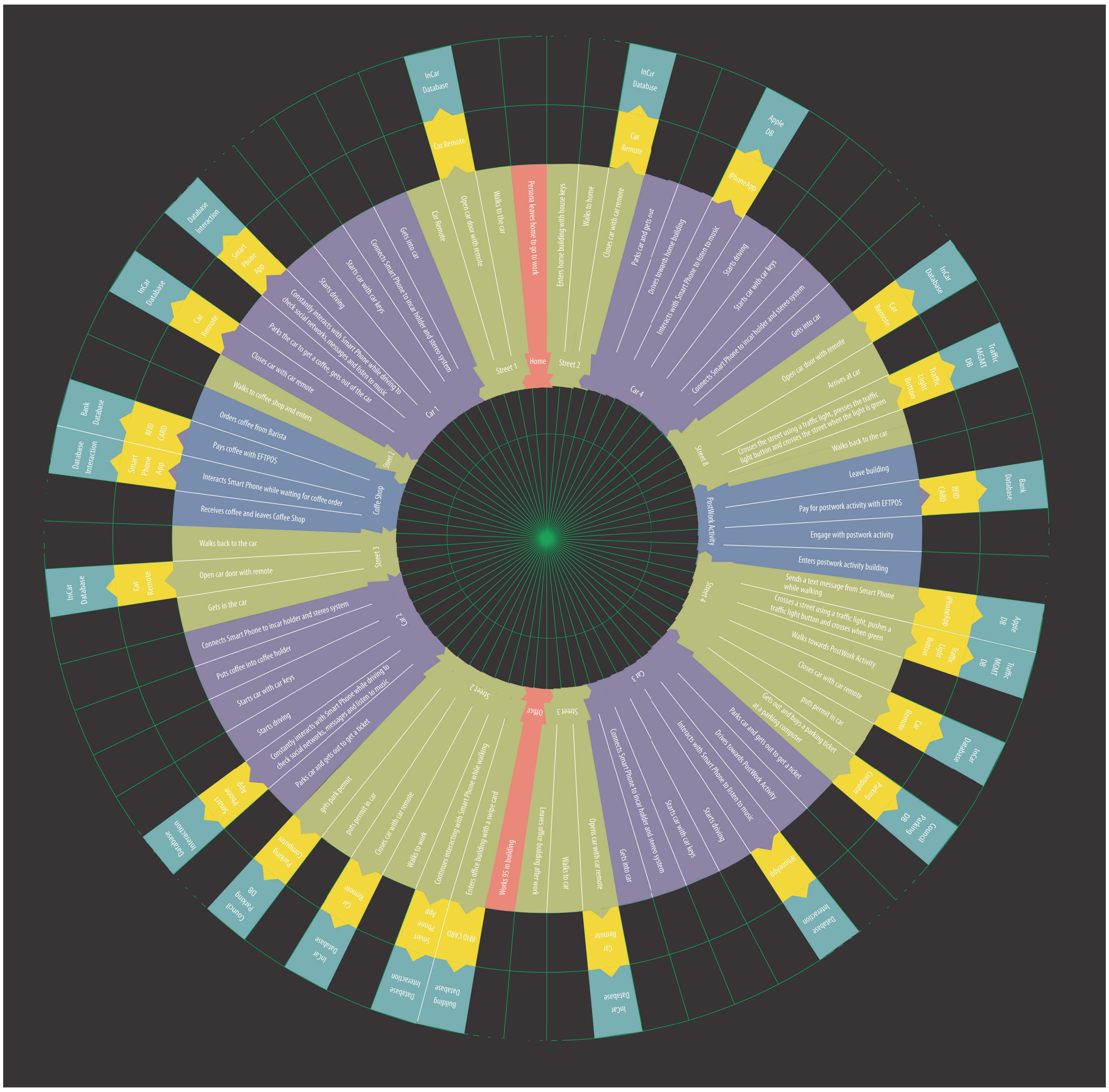


Figure 66: Circle Flow Model: **Persona 4.**

(Courtesy of Ralph Kenke, Pawan Jha, Elmar Trefz)

4.2.5 Consolidated Models: Conclusion

The foregoing **Personas** extract insights from the individual models, and form a basis for analysis in the next chapter (4.3). The four distinct Personas show in detail which actions and interactions matter to each, and which can be used for future design decisions.

Such analysis may seem to some extent mundane, in that participants only ever perform mundane interactions in public space. However, understanding these interactions collectively is key to defining and understanding the diversity of urban user groups,[59] and to achieving better understanding of how digital implementations collectively formalize the urban user experience. As Jan Chipchase argues, important insights are 'hidden in plain sight' in everyday interactions of the general public, whereby those insights may open up new markets for entirely new innovations.[60]

The development of these Personas addresses the objective of formalizing the urban user experience in the digital age. They are the link between collected data and the next step: analyzing and formalizing the user experience. A user-centred approach in future Smart City developments can only be achieved if users' requirements are understood on a contextual level. The Personas point to future design decisions based on the actual behavior of urban inhabitants, rather than the development of Smart Cities from a technocratic perspective (as criticised by Adam Greenfield), where they are designed by Corporations interested only in deploying their hardware solutions instead of addressing the actual interests of inhabitants.

4.3 Model Analysis

This chapter analyses the Consolidated Models into a basis for the Speculative Design Visioning process in the next chapter (5.1). The analysis outlines the key interactions conducted by each user group, and lists the devices most commonly used in their everyday life. The analysis also considers those things of no interest to the users, and what is their general intent throughout the day. For example, the 9 to 5 worker is more focused on streamlining their commute than the flexible worker. The 9 to 5 worker is therefore more reluctant to spend time in public space than the flexible worker. Lastly, the chapter offers overall analysis of all groups combined, to identify which interactions are held in common and could be considered a general urban user need.

Detailed individual activities have been abstracted into the consolidation process. For example, a 9 to 5 worker who uses public transport might go for a surf in Bondi Beach in the morning before work. Other 9 to 5 workers using public transport might perform other activities outside work. Such activities may offer further insights for digital innovation. However, these activities have to be researched individually. For example, one might conduct a Contextual Inquiry on pre-work activities at Bondi Beach between 6am and 8am, where digital innovation might help to organise activities in public space or even allow for entirely new activities.

4.3.1 Model Analysis : Persona 1

Persona 1 works 9 to 5 and uses Public Transport.

Persona 1 is in constant transit and does not spend much dwell time in public space. The only dwell time to be recorded is at public transport spots such as bus stops or train stations.[61] Persona 1 uses public space only to commute to work and back. During their commute they continually use their Smartphones, for location-specific and non- location specific applications.

- The most frequent use cases are: reading the news, email and instant message communication, listening to music and social networking. In particular, Smartphones are used constantly on bus and train rides.
- The second most-used devices are traffic light buttons.
- The third most-used devices are RFID swipe cards for public transport tickets and building access.

Participants showed little interest in interacting with location-based information or site-specific touch points[62] in public space, which would increase their dwell time and slow down their commute. The only information of interest was transport time, which they would check on a Smartphone app while walking towards the transport stop. Participants were focused on optimising their commute time and reducing their dwell time in public space. Exceptions were participants who performed an outdoor activity on the beach before work.

4.3.2 Model Analysis: Persona 2

Persona 2 works 9 to 5 and uses Private Transport.

Persona 2 is in constant transit and does not spend much dwell time in public space. The only dwell time that can be recorded is at a coffee shop. Persona 2 hence uses public space only to commute to work and back. During their commute in their car they continually use their Smartphone in combination with a phone holder, for mostly non-location specific applications.

- The most frequent use cases are reading the news, email and instant message communication, listening to music and social networking. In particular, participants interacted with their Smartphones the most while stopped at traffic lights.

- The second most-used devices are analog or electric keys to enter and exit the car.

- The third most-used devices are car stereos to either play music from the Smartphone[63] or an analog radio station.

- The fourth most-used devices are parking meters.

- The fifth most-used devices are traffic light buttons.

Participants showed little interest in interacting with location-based information or site-specific touch points in public space, which would increase their dwell time and slow down their commute. Participants were interested in optimising their commute time, and reducing their dwell time in public space. Exceptions were participants who performed an indoor or outdoor activity during or after work hours.

4.3.3 Model Analysis: Persona 3

Persona 3 works Flexible Hours and uses Public Transport.

Persona 3 is using public space mostly for transit but also spends some dwell time there, mainly for eating, waiting or relaxing. During their commute on public transport they continually use their Smartphone, for mostly non-location-specific use cases.

- The most frequent use cases are reading the news, email and instant message communication, listening to music and social networking.

- The second most-used devices are traffic light buttons.

- The third most-used devices are paper-based tickets for public transport.[64]

Participants showed little interest in interacting with location-based information or site-specific touch points in public space. They were also less interested in streamlining their commute to be on time, and did not worry about public transport timetables as Persona 1 did. When dwelling in public space they were either eating food in a café, or waiting or relaxing at a location convenient to them, which, we might add, was not necessarily designed for this purpose.[65] Even when waiting or relaxing they would use their Smartphones to browse social media, emails and news, or take photographs.

4.3.4 Model Analysis: Persona 4

Persona 4 works Flexible Hours and uses Private Transport.

Persona 4 is using public space mostly for transit and shopping, but also spends some dwell time in public space, mainly for eating, waiting and relaxing. During their car-commute they continually use their Smartphone, in combination with a phone holder, for mostly non-location specific applications.

- The most frequent use cases are reading the news, email and instant message communication, listening to music and social networking. In particular, participants interacted with their Smartphones the most while stopped at traffic lights.[66]

- The second most-used devices are analog or electric keys to enter and exit the car.

- The third most-used devices are car stereos to play music either from the Smartphone or an analog radio station.

- The fourth most-used devices are parking meters.

- The fifth most-used devices are traffic light buttons.

Participants showed little interest in interacting with location-based information or site-specific touch points in public space. In comparison with Persona 2, they also were less interested in streamlining their commute to be on time. When dwelling in public space they were either eating food in a cafe or on the beach, or were waiting or relaxing at a location convenient to them, which was not necessarily designed for this purpose. Even when waiting or relaxing they would use their Smartphone or computer to browse social media, emails, news or take photographs. All three participants went to the beach during the day, unlike any of the other groups.[67]

4.3.5 Model Analysis by Use Case

Use of Public Space

- 1a) The 9 to 5 worker is in constant transit and does not spend much dwell time in public space. She uses public space only to commute to work and back. **Personas 1 and 2.**

- 1b) The flexible worker is using public space mostly for transit and shopping, but also spends some dwell time in public space. **Personas 3 and 4.**

Dwell Time in Public Space

- 2a) The only dwell time recorded for 9 to 5 workers who use public transport is at public transport spots such as bus stops or train stations. **Persona 1.**

- 2b) The only dwell time recorded for 9 to 5 workers who use private transport is at coffee shops. **Persona 2.**

- 2c) Dwell time for the flexible worker in public space is used to eat, wait or relax. **Personas 3 and 4.**

Frequent Smartphone Interactions

- 3a) During their commute on public transport, urban users interact frequently with their Smartphone, for mostly non-location specific applications. **Personas 1 and 3.**

- 3b) During their commute in their cars, urban users interact frequently with their Smartphone, in combination with a phone holder, for mostly non-location specific applications. **Personas 2 and 4.**

Smartphone Use Cases

- 4a) The most frequent use cases are reading the news, email and instant message communication, listening to music and social networking. **Personas 1, 2, 3, 4.**

Traffic Lights

- 5a) Each persona interacted with traffic light buttons often. **Personas 1, 2, 3, 4.**

Public Transport Fares

- 6a) Persona 1 is the only persona who interacts with RFID swipe cards for public transport tickets and building access. **Persona 1.**

- 6b) Persona 3 is the only Persona who interacts with paper-based tickets for public transport. **Persona 3.**

Car Keys

- 7a) Car commuters interact with analog or electric keys to enter and exit the car. **Personas 2 and 4.**

Car Stereos

- 8a) Car commuters interact with car stereos to play music either from the Smartphone or an analog radio station. **Personas 2 and 4.**

Parking Meters

- 9a) Car commuters interact frequently with parking meters. **Personas 2 and 4.**

Location-Based Interactions

- 10a) Urban users show little interest in interacting with location-based information or site-specific touch points in public space, that would increase their dwell time and slow down their public transport commute. The exception is transport timetables, which are checked on a Smartphone while walking to the public transport stop. **Persona 1.**

- 10b) Urban users show little interest in interacting with location-based information or site-specific touch points in public space, which would increase their dwell time and slow their car commute. **Persona 2.**

- 10c) Urban users show little interest in interacting with location-based information or site-specific touch points in public space. Persona 3 is less interested in streamlining their commute to be on time. They do not consider public transport timetables, as Persona 1 does. **Persona 3.**

- 10d) Urban users show little interest in interacting with location-based information or site-specific touch points in public space. Compared with Persona 2, Persona 4 is less interested in streamlining their car commute to be on time. **Persona 4.**

Streamlining Commute

- 11a) 9 to 5 workers are interested in streamlining their commute time and reducing their dwell time in public space. Exceptions include participants who perform an outdoor activity on the beach before work. **Personas 1 and 2.**

- 11b) Flexible workers when dwelling in public space are either eating food in a cafe or on the beach, or are waiting or relaxing at a location convenient to them, that is not necessarily designed for this purpose. Even when waiting or relaxing, they use their Smartphones to browse social media, emails and news, or take photographs. **Personas 3 and 4.**

4.3.6 Analysis of All Consolidated Models

The following is a summary of all models, aimed at extracting further commonalities between all Personas, in order to define which interactions matter to all users in the urban environment.

All Personas are mostly in transit for the purpose of commuting to work and back, or going shopping. They spend a comparatively small time dwelling in public space to eat, wait or relax. During their commute they use their Smartphones constantly, and for mostly non-location-specific applications. The most frequent use cases are reading the news, email and instant message communication, listening to music and social networking. In particular, participants interact with their Smartphones while stopped at traffic lights, either while driving or walking.

Participants show little interest in interacting with location-based information or site-specific touch points in public space, which would increase their dwell time and slow down their commute. Participants are interested in optimising their commute time and reducing their dwell time in public space. Exceptions include participants who perform an indoor or outdoor activity before, during or after work.

When dwelling in public space, participants are either eating food in a café, or waiting or relaxing at a location convenient to them, which is not necessarily designed for this purpose. Even when waiting or relaxing, they use their Smartphones or computers to browse social media, emails and news, or take photographs.

4.3.7 Model Analysis: Conclusion

We have analysed the consolidated models to form a basis for the visioning process in the next chapter. Our analysis shows that common behavioural patterns exist, as well as commonly-used devices. Since consolidation naturally forfeits individual detail, analysis of the consolidated models should not be considered without the individual models.[68] The latter provide necessary context for understanding the consolidated models, and for analysis. Data should be viewed as a whole, from individual to consolidated models, to analysis and visioning, in order to grasp the context of the insight and argument.

In Contextual Inquiry, analysis and insight provide inspiration, trigger new ideas for innovations and form implications for design.[69] Insight is not to be viewed in terms of quantitative facts but rather as a qualitative narrative that explains a user's situation and context, and that may lead us to new ideas on how to improve a situation. Our Visioning in the following chapter is based on this qualitative approach; that is, we outline the urban user's narrative rather than seeking to capture its quantitative facts.

The above analysis forms the first step to the key objective in this research, that of formalizing the urban user experience in the digital age. The analysis extracts key patterns from Personas and frames them around use cases that personas interact within. The next step completes this objective by developing patterns around the interactions, and formalizes how inhabitants interact in public space via digital interactions, with a view to positioning them in a telematics reality.

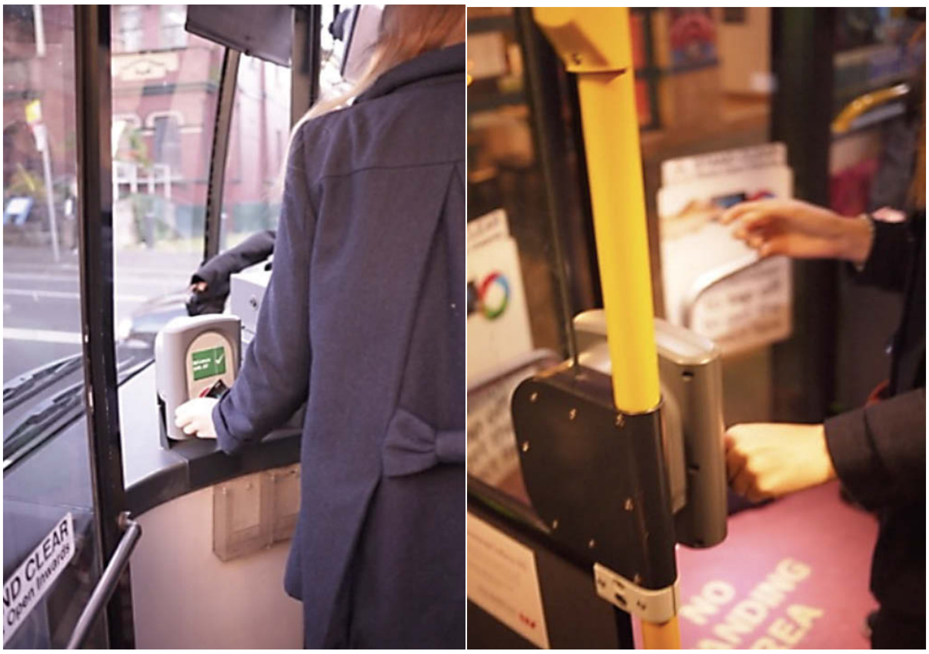
4.4 Smartphone Interaction Patterns in Public Space

Interaction patterns have been developed in this thesis that formalizes the research outcomes. If a user interacts with virtual information, there is no need for urban integration. 'Telematic' is defined as that which actively senses or actuates in the physical world using a virtual or cloud-based infrastructure. From a Smart City perspective, non-telematic urban integration is only necessary if a user interacts telematically, or has the need for a telematic use case that still needs to be implemented.

4.4.1 Smartphone Payments

Pattern 1: Payment interactions using swipe cards (Telematic)

Smartphone users employ RFID or NFC cards as a convenient form of payment. Swiping a card at a card reader saves time and offers more specific control of the travel budget. However, since Smartphones have NFC integration, the swipe card can be integrated into the phone.



Swipe card-based public transport ticketing systems have been investigated and implemented in some global cities, such as London's Oyster card or Sydney's Opal card. The common justified use case for this implementation is that public transport users can recharge their travel card more conveniently, and that validating the ticket when getting on or off the bus or train is more convenient. Modern Smartphones have integrated swipe card type RFID or NFC chips, and could hence simply act as a swipe card. Thereby, swipe cards might act only as an interim solution until Smartphones are used as swipe cards. However, installing RFID/NFC-based swipe card readers across every public transport touchpoint in a city, entails large hardware and maintenance costs. A GPS-based solution that does not require infrastructure deployment might be a preferable solution, particularly in smaller cities with lower budgets, and with less need to be innovative on the level of global cities.

4.4.2 Public Transport: Information-Entertainment-Messaging

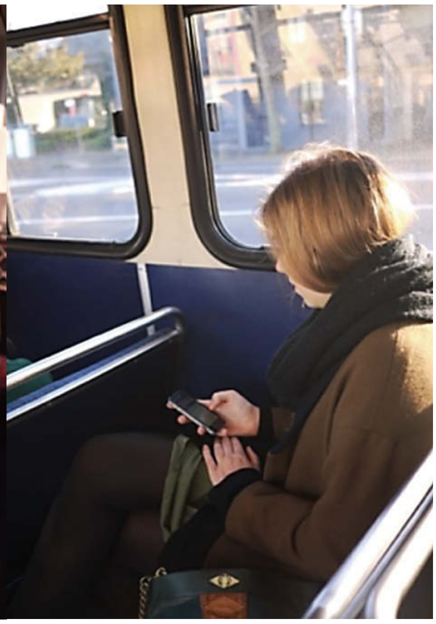
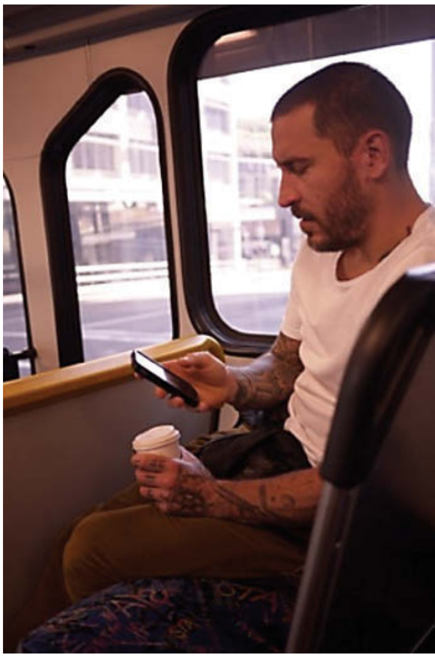
Pattern 2: Interaction with real-time public transport data (Telematic)

Smartphone users tend to require public transport information before arriving at their transport stop. They check the transport times on their device and hence adjust their travel speed.

Smart public transport stops have been investigated by Smart City research, incorporating large-scale multi-touch displays into bus and train stops in combination with bespoke hardware and software. The common justified use case for this implementation is that users can check public transport timetables, in combination with other relevant information at the bus stop. The current research has shown however, that users do need the public transport time before they arrive at the bus stop, in order to be at the stop at the right time. Further, users are already interacting with their Smartphones at public transport stops. Hence, another large-scale display tends to be redundant. Some cities are currently investing in smart infrastructure such as smart bus stops. However, even if a relevant use case is discovered, scaling every bus stop into a smart bus stop instead of allowing for the use of Smartphones, seems to be obsolete.

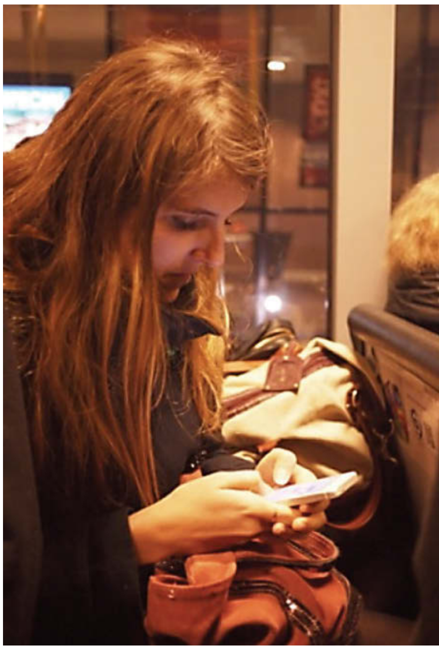
Pattern 3: Virtual Interactions for entertainment and information (Non-Telematic)

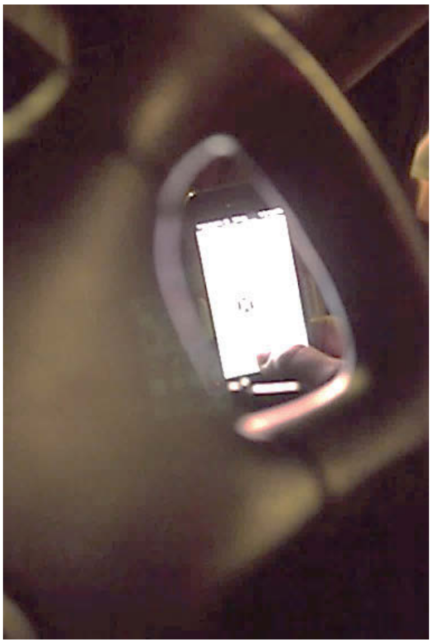
Smartphone users employ their device on public transport for entertainment, educational and informative purposes, tending to read news websites or social media as a source of information.


Pattern 4: Communication Interactions (Non-Telematic Communication)

Smart phone users tend to communicate on public transport after work on their way home, organising meetings with friends or family using instant messaging applications.



4.4.3 The Car Commute

Pattern 5: Communication Interactions (Non-Telematic Communication)

Smart phone users make phone calls when commuting by car. They prefer hands-free methods, but when these fail or are not available, they will take their hands off the wheel and interact with the phone.

Pattern 6: Virtual Interactions for entertainment and information (Non-Telematic)

When commuting by car, smart phone users consult their device for entertainment, educational and informative purposes. They tend to read news websites or social media while driving. Incautious users interact with their phones and take their hands off the steering wheel, while more cautious users only consult their phones while waiting at traffic lights.

Pattern 7: Communication Interactions (Non-Telematic Communication)

Smartphone users communicate via instant messaging services while driving. Incautious users text while driving and take their hands off the steering wheel. More cautious users only text while waiting at traffic lights.

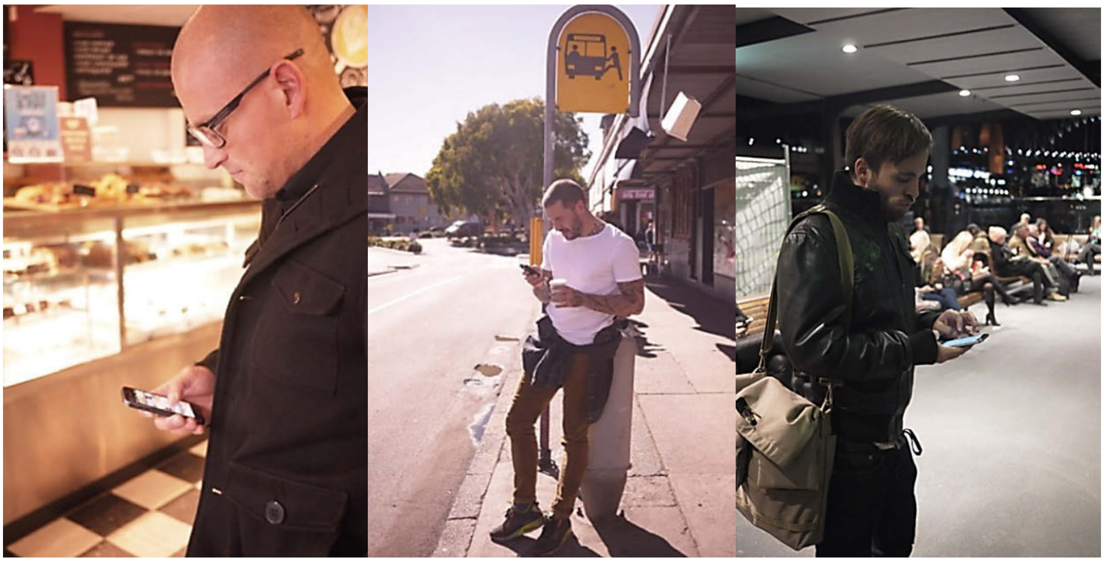
Pattern 8: Communication Interactions (Non-Telematic Communication)

Smartphone users tend to communicate while driving in a car on their way home after work. They organise meetings with friends or family using instant messaging applications or phone calls, using hands-free or no-hands-free options. The urge to communicate while driving is usually higher than concerns for security.

4.4.4 Waiting

Pattern 9: Virtual Interactions for entertainment and information (Non-Telematic)

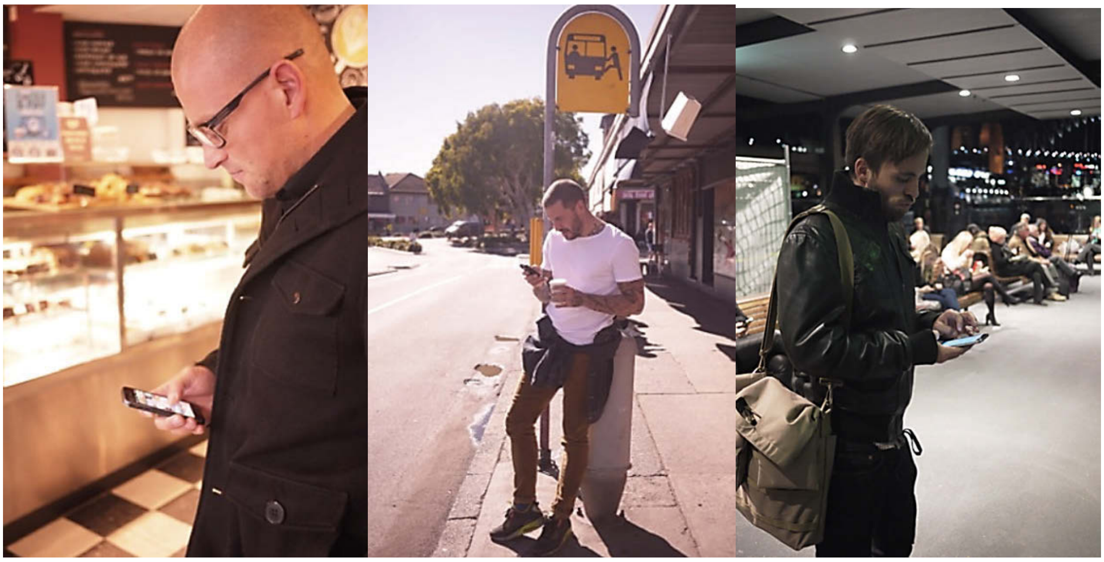
Smartphone users use their device during waiting times when commuting, for example: when stopping for a coffee and waiting for the order, or waiting for a bus. They tend to read news websites and social media as sources of entertainment, information and education.



4.4.5 Physical Tasks and Communication

Pattern 10: Concurrent Interactions between physical and virtual (Non-Telematic)

Smartphone users communicate frequently via instant messaging or email when in public space, concurrent to performing other physical tasks such as walking, closing a car door, donning a piece of clothing (like a jacket) or paying for a service or product.

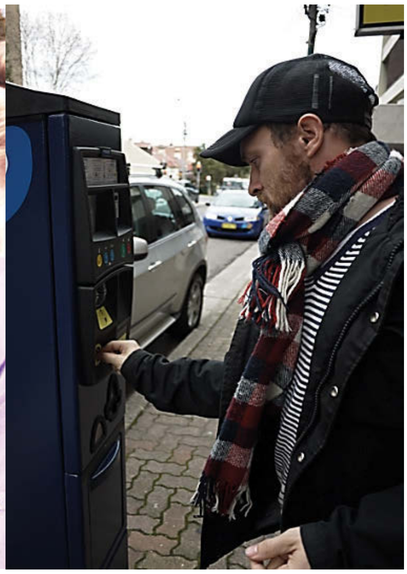


4.4.6 Smart Parking

Pattern 11: Parking Meter Interaction (Telematic)

When parking a car, Smartphone users are still required to buy a paper ticket to pay for a parking permit. This process could be integrated into a Smartphone application to make payment more convenient.





Smart parking meters or parking meter apps have been investigated or developed in global cities. However, most cities still use paper-based or meter-based payment solutions. Current parking meters still require the user to walk to the meter to initially pay or repay. A solution allowing the user to pay and repay from the

Smartphone would make for a less time-consuming and more convenient process. Such parking payment solutions can use GPS rather than physical parking meters, which would, in addition to facilitating payment for parking, allow the user to see where vacant spots are available.

4.4.7 Photo Sharing

Pattern 12: Photo Sharing Interaction (Telematic)

Smartphone users take photos in public space and post them to social media, to entertain themselves and to share their experience with friends. Photos tend to be taken where they are performing another physical task such as walking. Such situations tend to be serendipitous in that the user sees something and shares the moment.

4.4.8 Email and Commuting

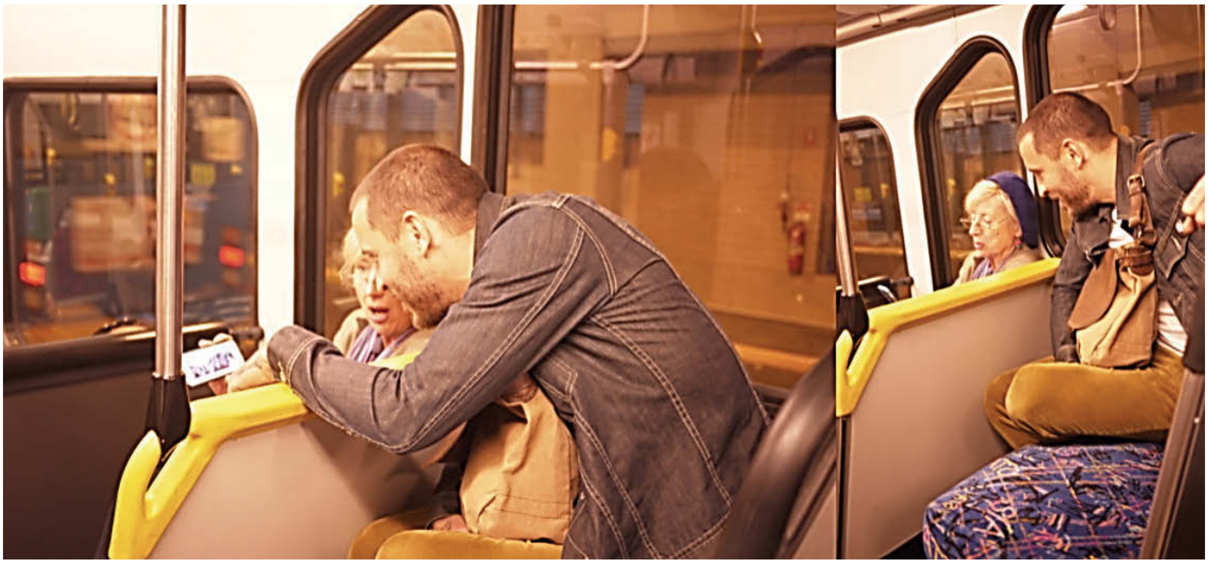
Pattern 13: Email Interactions (Non-Telematic Communication)

While commuting on public transport or by car, Smartphone users communicate via email to organise personal or business affairs. These interactions tend to need more consideration than those with friends or family. They demand more attention and take more time, hence are less frequent.

4.4.9 Public Chats

Pattern 14: Shared Screen Interactions (Non-Telematic)

Smartphone users employ their devices in public space to show photos to other Smartphone users. These interactions tend to support a conversation rather than the sharing of the image alone.



4.4.10 Traffic-Light Easy

Pattern 15: Traffic Light Interactions (Telematic)

Smartphone users still need to push traffic-light buttons when crossing a street. This interaction could be integrated with their Smartphone to (in some instances) streamline their commute.

For most participants in this research, triggering a traffic-light button and waiting for the red light to turn green was an accepted, if annoying, interaction. The current traffic light system is based on user feedback, so that when a user wants to cross the streets, the system reactively manages traffic so that the user can cross. However, based on anonymous infrastructure-free Smartphone tracking, the traffic management system could pro-actively control lights so that they are green when a pedestrian approaches. Tracking anonymous footfall traffic would also allow the city to integrate Smartphones into the urban environment on a more direct level. Obviously, privacy issues need to be solved first, to ensure tracking is anonymous, and differential privacy could play a big role in ensuring anonymity.

4.4.11 The Time in Public

Pattern 16: Smartphone as timepiece interaction (Non-Telematic)

Smartphone users frequently check the time on their devices while walking. Such situations include needing to know if they are on time for their public transport connection.

4.4.12 Mobile Weather

Pattern 17: Interacting with future environmental conditions (Non-Telematic)

Smartphone users check the weather on their devices to plan future activities. This is done in tandem with a physical task in public space, such as walking or driving.

4.4.13 Opening Doors

Pattern 18: Public to Private Space Interface Interaction (Telematic)

Smartphone users still have to manually open their cars. This event could be streamlined by opening the door by means of a Smartphone rf sensor when the user is nearby.

While this pattern is witnessed in public space, cars are private objects, so that opening and closing doors using Smartphones would need to be implemented by private car companies. Some companies already allow the closing and opening from Smartphones or detect rf keys from a distance.

Pattern 19: Public to Private Space Interface Interaction (Telematic)

When entering a building, Smartphone users still need to open doors manually with a key or swipe card. This could be streamlined by using the device's NFC capability or rf sensor to open on approach.

Similar to opening car doors, this pattern is witnessed in public space. However, since most buildings are privately owned, opening and closing doors with Smartphones would need to be implemented by private developing companies.

4.4.14 Music and the Commute

Pattern 20: Music Interactions (Non-Telematic)

Smartphone users listen to music when commuting by car or public transport. They tend to use streaming music services such as Spotify.

4.4.15 Public Wifi

Pattern 21: Public WiFi Interactions (Non-Telematic)

Smartphone users, due to the limited availability of public wifi, tend to tether their 4G connection when using their laptops in public space.

4.4.16 Walking Liability

Pattern 22: Disembodied Interactions (Non-Telematic)

Smartphone users tend to bump into other people while walking and gazing at their screens. Such interaction with the device tends to make users unaware of their immediate surroundings, moment to moment.

When conducting this research, the writer witnessed several bump-ins with users on the street, and managed to capture one incident on camera. Since users tend to walk and interact with their Smartphone at the same time, users are disconnected from their environment. However, a user still seems to think he is able to navigate with peripheral vision. It is questionable whether it is necessary to address this issue with a solution. Perhaps more appropriate, would be more modest Smartphone consumption while walking. A technical solution may be that the Smartphone sense another device's Bluetooth signal and actively analyses the other's movement vectors relative to itself, while actively warning both parties if they are on a collision course.

4.4.17 Interaction Patterns: Conclusion

The afore-listed interaction patterns for urban inhabitants interacting in public space with digital and non-digital touch points, addresses the overall objective of this research; namely, formalizing the urban user experience in the digital age. Our key objective is to track individuals in context and in real time from both digital and urban perspectives, and to show their interactions in a form that is transferable and readable by designers and decision-makers of future Smart City developments. The patterns developed here are a first iteration of this approach and would benefit from future research. However, it successfully bridges the digital and the urban - in fact, the approaches outlined by Jan Gehl within public space, and the digital approaches of Jan Chipchase and Karen Hotlzblatt.

5 Findings

5.1 Speculative Design Visions

We now turn to three envisioned concepts that address the issues found in our analysis. The three most frequent interactions and use cases identified in the research are: parking meter interactions with Personas 2 and 4, public transport ticket interactions with Personas 1 and 3, and traffic light interactions with all Personas.

5.1.1 Speculative Design 1: Smart Parking Meters (Personas 2 and 4)

Most current parking meters still use the old model of retrieving paper-based parking tickets or entering a parking spot number. The high penetration of Smartphones allows for a more convenient Smartphone-based parking payment model that would save time and allow remote re-bookings.[70] Smartphones can identify a driver's location via GPS, and hence allow for a location-based parking booking system. When a driver parks his car he can open a parking app that would identify its street location. He can then choose to pay with a single click. The driver's number plate would be registered with the transport authorities' database. The system then maps the location and paid amount, by means of the numberplate. Parking inspectors then check if a driver has paid by taking a photograph of the number plate, revealing whether the driver has paid the correct fee. If the driver is away from his vehicle, he can rebook his fee with a single Smartphone interaction, thus extending his parking time.

Such a solution is not only more convenient for the driver, but requires no physical implementation of hardware infrastructure. Cities can thereby roll out the system without expensive implementation costs. A similar solution is already in place in Moscow, referred to as 'Moscow Parking' (Styrin 2014). Further, a Smartphone-based solution would allow for tracking vacant parking spaces, and would let drivers browse free parking spots. Free parking spot solutions have been trialled in cities such as San Francisco, with hardware sensors embedded in the streets (Simons 2012). However, these have as yet been deemed too expensive to roll out on a larger scale.

Despite this solution exemplifying how even workable hardware solutions are not scaleable due to high implementation and maintenance costs, it shows how a virtual-based solution that makes use of high Smartphone penetration can solve the scalability issue. Based on usage pattern analysis, any future iteration may incorporate a 'calm technology' approach. Calm technology denotes a system that only comes to the user's attention when it is relevant to them, and otherwise stays in the background (Weiser & Brown 1996). Such calm technology could sense when a driver is parking, and the Smartphone could ask him if he wants to pay for his parking fee. This would further simplify the parking ticket acquisition process. iBeacon technology (Newman 2014) could also be used to enhance accuracy in the system, although it would again increase roll-out costs. It would seem that location approximation and software solutions are the most scalable approach to identifying parked cars.

5.1.2 Speculative Design 2: Smart Public Transport Tickets (Personas 1 and 3)

Public Transport tickets are still mostly paper-based. In some global cities RFID-based solutions such as the Opal card (Humphries 2014) and the Oyster card (Bassoli et al. 2007) are digitalising this use case. However, RFID solutions still involve expensive roll-out costs. Similar to smart parking meters, a Smartphone-based solution for public transport tickets could increase convenience for passengers and reduce implementation and maintenance costs for cities. When entering public transport, a passenger might buy a ticket on his Smartphone. The bought ticket tracks travel time and identifies where a passenger gets on and off.[71] A ticket inspector can identify where the trip began by checking the tracked travel time and location. In future iterations, calm technology-based solutions could sense when a passenger gets on or off and charge the passenger accordingly. This process could either be automatised to work in the background, or the passenger could confirm his trip fare via push notification.[72] The higher the use of the system, the more use patterns can be analysed, to be formed into calmer technologies that enhance passenger convenience and allow the city to improve service.[73]

5.1.3 Speculative Design 3: Smart Traffic Lights (for all Personas)

Traffic lights similarly require physical interaction to be activated. A smart traffic light may sense the presence of a pedestrian, and activate if they are standing close. An LED on the traffic light switching from red to green, can indicate if a pedestrian has been detected and switch to activated. Several hardware-based solutions could be used to sense the presence of pedestrians, such as camera tracking (Cox & Dean 2014), pressure sensors, iBeacons/BLE (Newman 2014) or Wifi triangulation (Navizon 1999). However, a Smartphone-based solution that requires a no- or low-cost infrastructure roll-out is more scalable. A system similar to iBeacon/BLE but based on virtual hotspots,[74] can identify when a person stands close to a traffic light and thereby activate it. This solution would improve convenience for pedestrian and car traffic, allowing the city to streamline traffic light management. Again, based on usage-pattern analysis, vehicle and pedestrian traffic flow systems can be improved over time, whereby the system discerns when pedestrians approach a traffic light from far away and activates it before the pedestrian gets close.

5.1.4 Speculative Design 4: UrbanAPI - Urban Data Sharing Platform

The foregoing solutions all require virtual infrastructure and would benefit from a unified API that allows developers to create future applications not only for single solutions but that allow cross-integrating solutions.[75] Such a unified API is referred to in academic literature as UrbanAPI or CitySDK (Carter 2013). This unified data-sharing platform is not only relevant for specific single applications but relates to the data layer often referenced in Urban Informatics and Smart City literature (that Urban Informatics solutions can tap into) - metaphorically visualised as a cloud that hovers above the city. (See **Figure 67**, below),

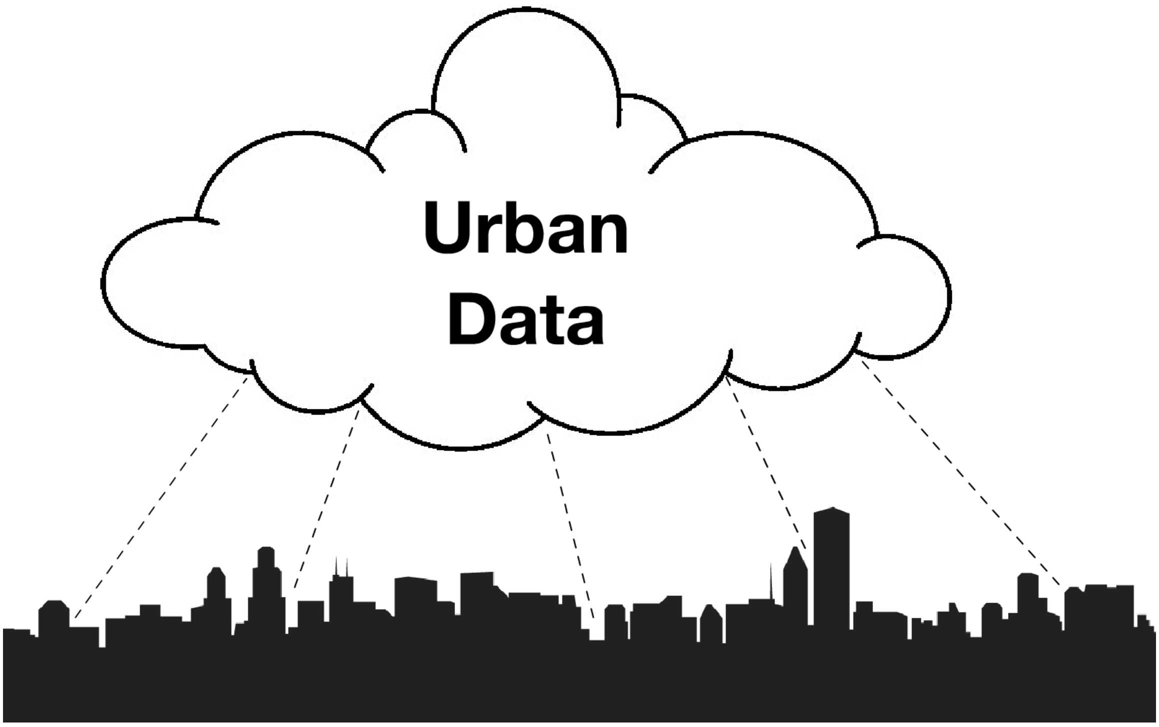


Figure 67: Urban Data layer, as currently envisioned by researchers

> 'We can't see how the street is immersed in a twitching, pulsing cloud of data. This is over and above the well-established electromagnetic radiation, crackles of static, radio waves conveying radio and television broadcasts in digital and analogue forms, police voice traffic. This is a new kind of data, collective and individual, aggregated and discrete, open and closed, constantly logging impossibly-detailed patterns of behaviour. The behaviour of the street' (Hill 2008).

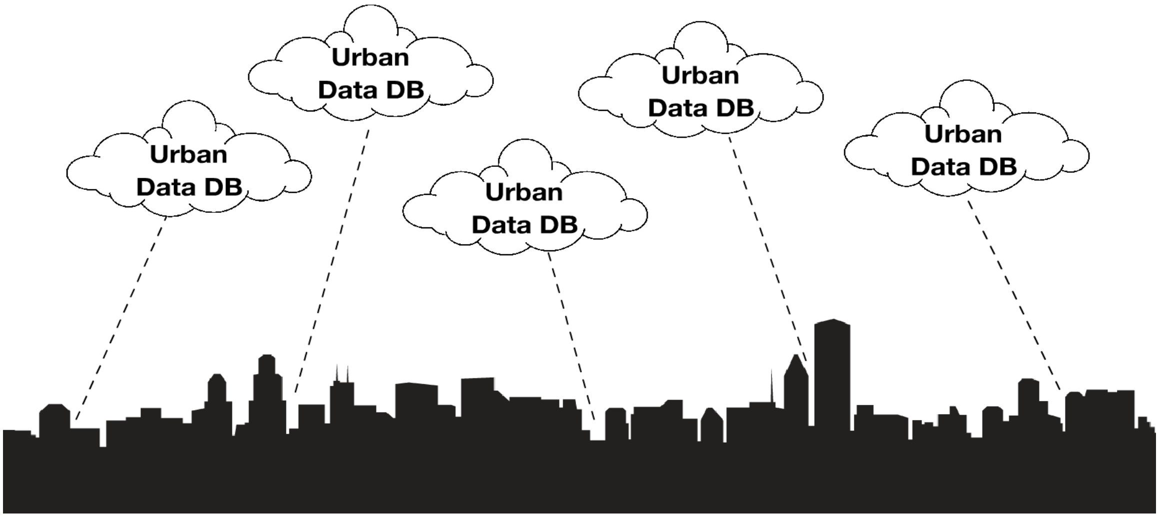


Figure 68: Urban Data layer, as currently technically present.

What Hill's quote currently ignores, is that this data-layer is highly scattered and non-integrated (see **Figure 68**, above). It is comparable more to many little clouds rather than one big cloud, or technically speaking, many individual databases that Smartphones interact with (as this research's Circle Flow Models showed). Solution providers and developers struggle with such scattered data and diverging formats and protocols used by each cloud/database for bespoke purposes. This scattering mitigates against integrated solutions, as well as solutions that would make use of several clouds or databases within one city. Hence an UrbanAPI that unifies the proliferated clouds into one, opens opportunities for solution providers and allows for better cross-integration (see **Figure 69**, below).

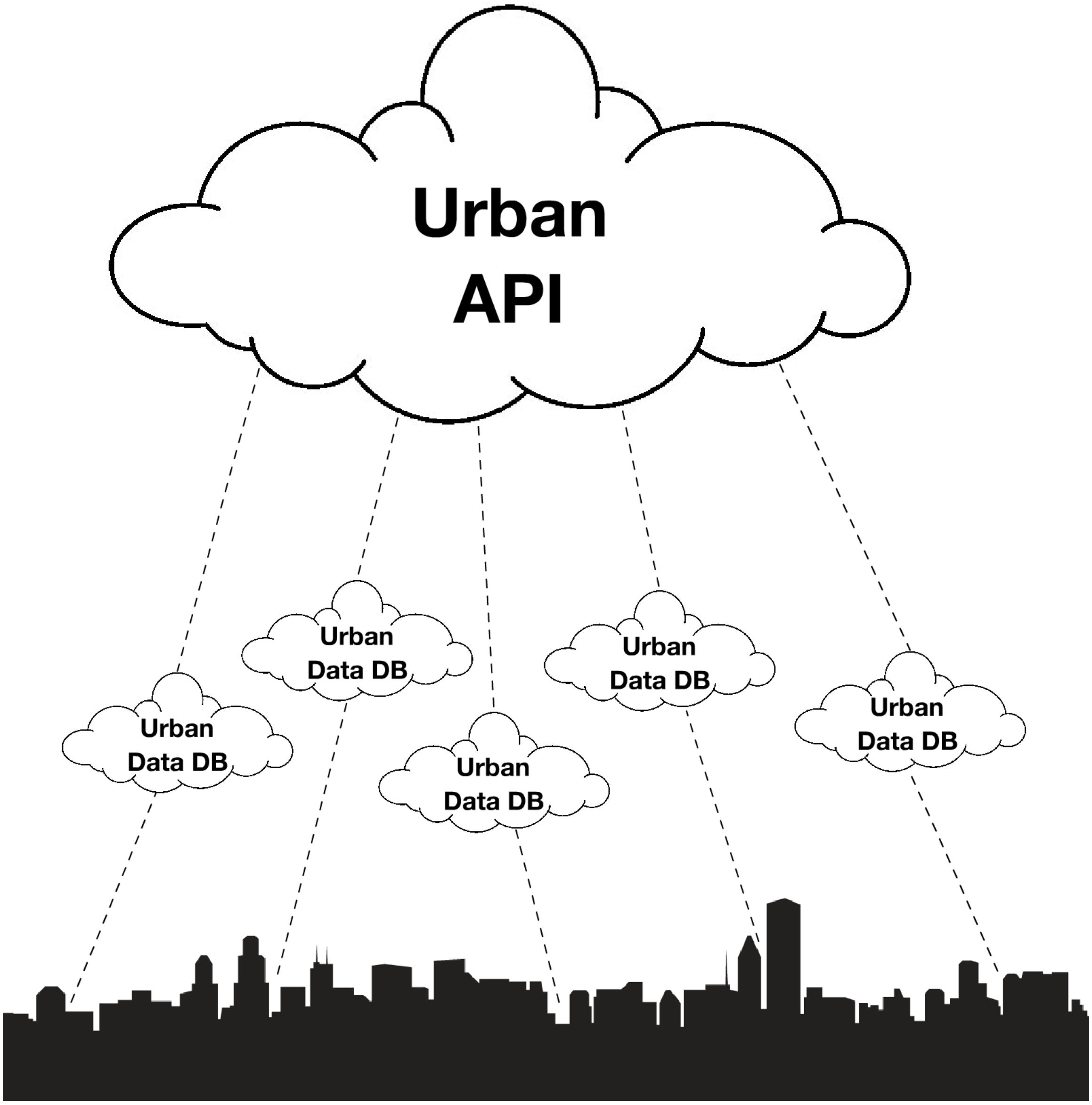


Figure 69: Urban API, which unifes the databases into an Urban Cloud as envisioned by researchers.

One initiative known as the CitySDK (Carter 2013) is aiming to provide a solution. However, CitySDK only identifies dedicated uses cases and provides software solutions rather than a hosted cloud service. The latter is necessary to enable convenient scalability and integration of services.[76] Such a hosted solution would allow datasets that are currently only accessible in spreadsheets, to be accessible and uploaded by cities through an ubiquitous API layer and protocol.

An UrbanAPI implementation would need to make a distinction between a public and a private UrbanAPI. Sensitive information like parking data or public transport fare tickets would need to be facilitated in a private UrbanAPI platform that could also facilitate financial transactions. Data such as public transport timetables or tourist information would however be facilitated on an open online platform that could host existing city datasets, making access to them more convenient and streamlined. Similar to a code-sharing platform like GitHub (Dabbish et al. 2012), a data-sharing platform for urban data would accelerate the development of digital urban implementations.

Currently, most cities have available large numbers of datasets that could be used by the public. However, they are usually hard to find on government websites, and have bespoke formatting. A unified data-sharing API would not only make data accessible on a central platform, but would format the data to a standard easy to interface on an API level. Further, the UrbanAPI would need a protocol to ensure standardisations that developers could rely on when developing applications. One project with such an approach was called Pachube (Haque 2004). Yet, while it focused on hardware sensors and actuators, it had architectural applications in mind.

5.2 Synchronisation

Synchronisation, in the present context, refers to the use-patterns performed by different Personas in public space, based on work hours and mode of transport. The more synchronised the Personas, the more similar were their digital interactions in public space. The less synchronised the Personas, the more diverse were their digital interactions in public space. Members from the ‘9 to 5’ Personas left their home at the same time, and performed similar interactions during their commute using public transport. Thereby, these Personas were exposed to similar public space scenarios more than less-synchronised Personas.

The most synchronised Personas are the 9 to 5 group that uses public transport. Less synchronised Personas would be the 9 to 5 group, which works the same hours but has more flexibility and mobility by using a car. Less synchronised still are the flexible working hours Personas that use public transport. They encounters similar places to the 9 to 5 public transport Personas, but at different times and in a less structured form. The least synchronised Personas are the flexible working hours group that uses a car. These have great flexibility in terms of working hours and mobility. On a spectrum of diversity, we therefore note that digital interactions in public space shift from synchronised Personas with little diversity to unsynchronised Personas with great diversity. (See **Figure 70,** below).

We conclude that synchronisation of Personas may be a more specific way to build Personas for digital interactions in public space. Defining them across similar use of space and time allows us to abstract from more specific job descriptions and transport usage. However, it also leads to a conclusion that the more flexible Personas are in terms of working hours and mobility, the less predictable are their digital interactions, and the more proliferated the use-cases may become. This makes it harder to design for more flexible Personas than for the 9 to 5 commuter. However the more diverse interaction patterns of flexible Personas might offer more opportunities to design novel digital implementations for these target audiences. The more flexible a Persona, the more fragmented this target audience becomes and therefore poses a smaller target audience then the more synchronized Personas. The most synchronized Persona is the commuter persona which offers the largest target audience, hence the more flexible the smaller the target audience might become.

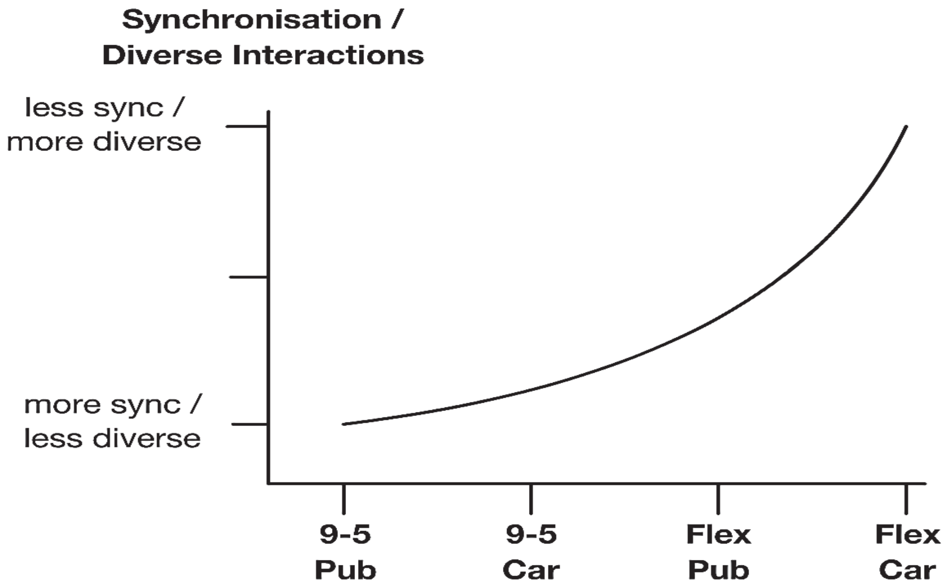


Figure 70: The rise in the complexity of diverse interactions towards unsynchronised users.

The more flexible the Persona is in terms of work and mobility, the more proliferated he becomes in general. This creates exponential growth in terms of diversity of digital interactions,[77] since the Persona has proliferated along with the digital interactions within his grouping. However, unsynchronised Personas will still follow similar behavioural patterns to synchronised ones, but will perform interactions in a different fashion: more casually, more often and in different scenarios.[78]

5.3 From Smart City to Smartphone City

This research shows that participants are in constant touch with their Smartphones. This leads to the crucial question: why would a city need technological hardware infrastructure to be embedded in its environment, as Smart Cities suggest, if the inhabitant has a computer or screen constantly on them? (See **Figure 71**, below) The question becomes more pressing if the previously-envisioned use cases of the

‘Interactive Smart Wall’ and ‘Interactive Smart Sensor’ can also be addressed with digital Smartphone applications.

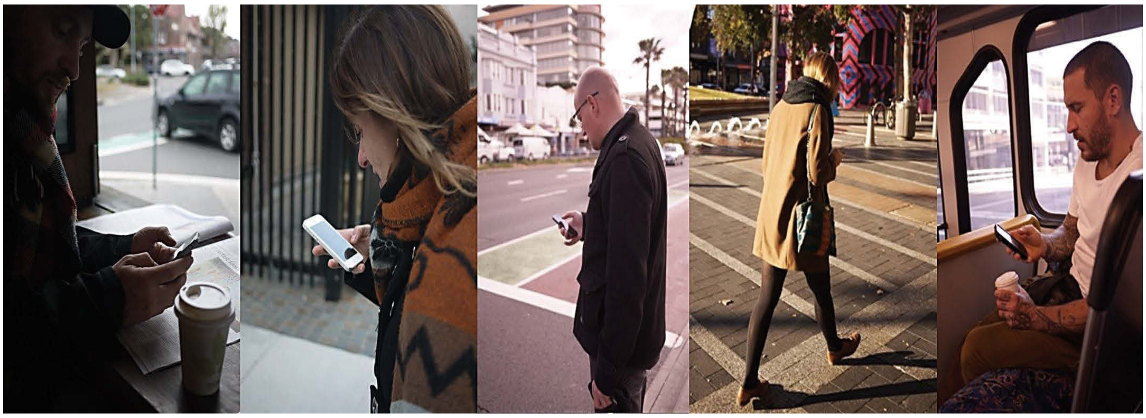


Figure 71: Urban Smartphone users are in constant touch with their devices.

While Smartphones offer different user experiences,[79] they address use cases in more scaleable and cost-efficient forms. One may argue that certain sensors (Zennaro et al. 2010) in the urban fabric can still deliver data that Smartphones cannot measure. However, continual advances in Smartphones and their ability to sense the environment will surely address this in future. Further, such developments may realise Usman Haque’s aspiration for sensing a ‘messy city’ by the people, rather than by an authority.

This all begs the question: how can cities support Smartphone use to provide meaningful urban solutions to their users? Since city councils do not need to implement expensive ICT infrastructure to offer interactive solutions to Smartphone users, the question shifts to how cities can provide virtual infrastructure, and to what degree it is still useful to implement supporting infrastructure such as iBeacon hardware (Newman 2014), analog visual markers (Liu, Yang & Liu 2008) and analog signage.

5.3.1 Example: Real-Time Transport Information

Research by the University of Calgary (Rahman, Wirasinghe & Kattan 2012) shows that real-time bus information will increase the use of public transport and make journeys more efficient. The research also shows that physical real-time displays at bus stops[80] are preferable to Smartphone applications.[81] It also cites, however, the high installation and operating costs of such displays.

Such research results have to be seen as valid only for isolated locations. They are not scaleable to hundreds of bus stops across a city due to installation and operational costs - particularly if there is a low-cost Smartphone alternative readily available that addresses the same use case.

The research further ignores the added functionality that Smartphone apps can deliver compared to real-time displays. According to my own research, participants checked real-time bus arrival times while walking to the stop; that is, to see if they have to change pace, as well as perhaps buy coffee or breakfast on the way. (See **Figure 72,** below).

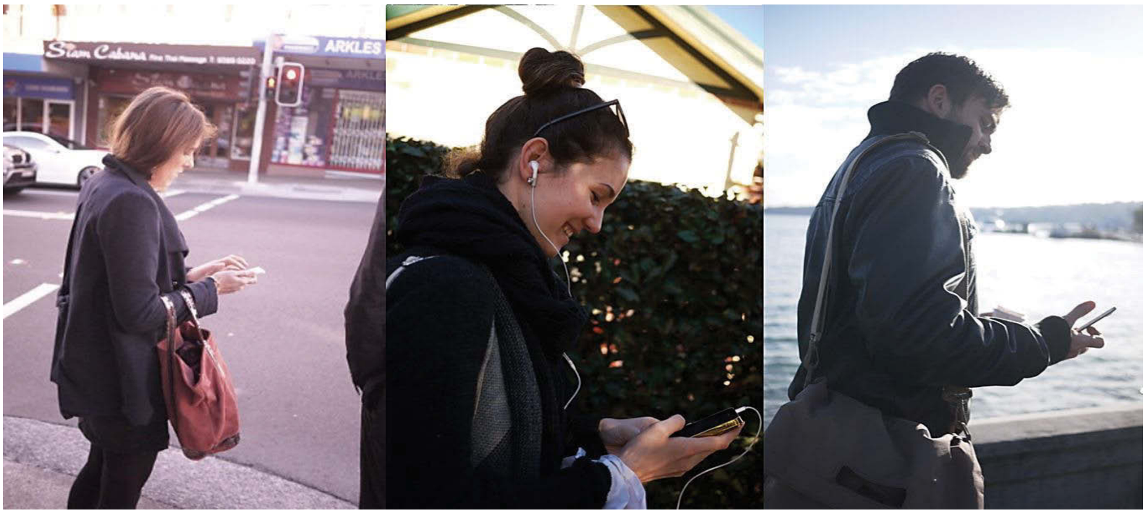


Figure 72: Urban Smartphone users checking public transport time en route to their transport stop.

Other known use cases (that were not observed in this research but are known to be popular) include:

1. On-board bus stop announcements. Such a feature is particularly important for visually- and motor-impaired users who need to know when to get off.

2. Receiving audio bus-progress announcements at the stop, so that the user does not have to pay attention to traffic, and can be better prepared to get aboard once the bus arrives.

The main argument against physical displays over Smartphone applications when disseminating real-time transport information, is the cost involved in implementing displays across a city. These costs are far higher than Smartphone-based solutions and take longer to implement. Further, Smartphone apps offer more features than real-time displays and address more lateral use cases.

5.3.2 Spatial Interaction Design in the Smartphone City

It is clear that a Smartphone provides a more private and more customised Urban Informatics experience than interactive media architecture can promise.[82] Interactive media architecture still offers applications in the context of monumental artistic form (see **Figure 73**, below) or, on a smaller scale, in an advertising context (see **Figure 74**, below) for experimental marketing in the form of interactive brand experiences.

Figure 73: Crown Fountain in Chicago, USA.

Figure 74: Interactive Brand Experience in Stuttgart, Germany, for SNCF France.

In the context of place-making, Hans Kiib has comprehensively outlined how Performative Urban Design (Kiib 2010) can make use of the performative qualities of spatial interaction design to create more meaningful places (Uhlir 2005). (See **Figure 75**, below).

Figure 75: Performative Interactive installation *Under Halvtaget* in Carlsberg, Denmark.

However, such a Performative Urban Design approach is bespoke and site-specific and hence not scaleable[83] into greater Urban Informatics solutions (See **Figure 76**, below).

Figure 76: Performative Interactive installation *Under Halvtaget* in Carlsberg, Denmark.

5.3.3 Cost Limitations and Scaleability

The challenges of digital implementations in public space do not only result from identifying appropriate use cases. If a suitable use case is discovered it can still struggle with the issues of implementation, maintenance costs and scaleability.

Figure 77: Neighbourhood Scoreboards installation in Chippendale, Sydney, Australia.

For example, the neighbourhood scoreboards (Moere et al. 2011) project (see **Figure 77**, above), was a successful urban spatial interaction design piece. However, it was only successful since it was built using lo-fi prototyping materials in analog form. Building the same interaction design piece on many facades of many Sydney buildings is obviously not scaleable according to implementation, maintenance and operational costs. Significantly, it would be possible to implement the same use case more cheaply and scaleably using a virtual mobile AR solution (Höllerer & Feiner 2004) (see **Figure 78**, below). While not being as gaze-able[84] and as spatially present as a physical installation (resulting in a different user experience), it would nonetheless have been a solution allowing scaleability across a wider urban area.

Figure 78: Augmented Reality Smartphone application displaying digital information about a building.

In view of these issues, my research findings suggest a further need to investigate how target audiences and demographics can actually benefit from interactive media architecture.[85] A starting point may be to understand which place-making and urban design strategies presently work for which demographics. Works such as Rafael-Lozarno Hemmer's Body Movies (Lozano-Hemmer 2001) are undoubtedly successful, as well as interactive installations at the VIVID festival in Sydney (Haeusler 2015). These however, are temporary in nature. Successful permanent screens such as the large screen at Melbourne's Federation Square (Struppek 2006) (see **Figure 79,** below), are generally not spatial interaction design pieces as such, but trivial screens re-purposed for multiple applications of diverse use cases. This might prove a meaningful departure point for media architecture, whereby the focus is less on bespoke design solutions and more on implementing flexible technologies that cater for diverse use cases and offer a platform for designers and architects to implement temporary works over time.

Figure 79: Public screen at Federation Square in Melbourne, Australia.

Bespoke permanent media architecture solutions have been shown to be unsustainable, according to the majority of everyday urban users' commute patterns shown in my research findings. Unless a use case is discovered that addresses a need not solvable by mobile solutions, and justifies the implementation, maintenance and operational costs that hardware implementations produce, I propose (based on these research findings) that we truly cater to the premier demographic of commuters and shift away from physical media architecture solutions. Instead we need to focus on a virtual infrastructure that uses mobile devices as their core interface, and avoid costly and unscalable hardware implementations. Mobile devices may well use physical signage to link physical and spatial location-based information to the urban user's Smartphone to address related use cases. However, these can be of analog nature to improve cost factors and scaleability. QR codes (Liu, Yang & Liu 2008) are an example of this strategy. However, more sophisticated markers and computer-vision solutions based on neural networks and machine learning may improve this process (Cox & Dean 2014). One example is the Tesco supermarket (see **Figure 80**, below) that uses visual markers in a Korean subway station (Almehairi & Bhatti 2014). This case cleverly fits with the commute patterns of urban users, and uses mobile phone infrastructure in combination with analog markers to implement the use case.

Figure 80: Tesco Supermarket installation based in computer vision and analog markers in Seoul, Korea.

We must conclude that on an everyday basis at least, the Smartphone will be the interface to the future Smart City. The Smartphone acts as the 'smart lens' into the virtual urban data layer, ideally integrated through the earlier-mentioned UrbanAPI and computer vision solutions. We therefore argue for a shift from a 'Smart City' approach towards a 'Smartphone City' approach.

5.4 Towards a telematic reality through disembodiment, telepresence and Smartphone use.

Research data in this thesis indicates that participants use Smartphones continually.[86] During a daily commute on public transport, the Smartphone is indifferent to any newspapers or books a commuter might read (see **Figure 81**, below). However, the Smartphone connected to the internet allows for more telematic interactions than could any analog media. In telematics, the actor interacts with physical reality which triggers physical mechanisms and events via a virtual interface. A telematic reality is created when the information a user sends is received and processed by another remote physical actor. The actor, which can be a human or machine, then actuates a physical response. In a telematic reality, the virtual is used not to simulate or augment physical reality but to interact with it. The more automated the process actuated by the remote actor, the more telemechanic the reality becomes. Telematic reality might not replace virtual or mixed reality, but it extends it and uses its features to control physical reality.

Figure 81: Public transport users reading books and interacting with Smartphones.

The implications for designing future digital strategies in urban environments in context of a telematic reality perspective are, that shifting away from a virtual, augmented or mixed reality paradigm will produce more physically embedded designs rather than digital implementations which focus on digital place making or media facades alone. By focusing on a telematics approach designers can develop applications which interact with physical remote actors that follow the current use cases of remote controlled events through smart phone interactions such as ordering a ride sharing vehicle or remotely paying for a parking meter from a smart phone.

The telematic reality approach further allows designer to go beyond an emebed IoT device approach in urban environments and allows to draw from all virtual reality, augmented and mixed reality as well as IoT devices to develop digital implementations which create remote physical events in urban environments.

5.5 Evaluation: Contextual Inquiry as an urban research methodology

This research employs Contextual Inquiry (CI) to produce greater understanding of how urban inhabitants use in-context digital implementations, that is, in the urban environment and their everyday life. Contextual Inquiry presented itself as a suitable methodology to investigate individual needs and requirements and formalised the urban user experience into data models.

Contextual Inquiry, however, is a streamlined ethnographic research methodology geared towards the ‘implications of design’. It produces applied design ideas within its visioning process based on captured research data. While its visioning process encourages conceptual ideas and concepts, it tends not to lend itself to deeper and broader analysis of the captured data. Paul Dourish makes such a critique in his paper ‘Implications for Design’ (Dourish 2006), arguing that such ethnographic research methodologies that focus on the implications for design, consider ethnography too narrowly. That is, they constrain ethnography and do not allow for the insights it can provide. In my own research, this is visible in the division of outcomes into chapters on Visioning and Findings.

In this Findings chapter, I outline design implications to the extent that I conceptualise new ideas based on the captured data. Contextual Inquiry typically ends here. This chapter seeks to extend outcomes into broader implications. The great body of my captured data allows us to conceptualise broader implications crucial to the shift into a new information society. This I refer to as Telematic Reality, while Vilem Flusser refers to it as the Telematic Society. These broader implications allow us to reframe the idea of the Smart City, and to produce further core implications for applied design.

I argue that the challenges of applying Contextual Inquiry in an urban environment not only produce mapping challenges between workplace and environment, but also demand new ways in which Contextual Inquiry in the urban context can address broader concerns. An approach beyond the modelling and visioning stages of CI is necessary, for the sake of deeper and broader implications. Ideally the latter should not be an add-on after the visioning process, but should inform the whole CI process; for example: to not only note the marking of breakdowns and rapture points in an interactive system, but also to mark actions, interactions and elements that will spur questions in the wider philosophic context.

How in particular this may be developed requires further research, but would facilitate uses of CI in urban theory that are concerned with greater understanding of urban space, rather than merely understanding its failures from a systems-design perspective. This critique however, applies mainly to CI’s analysis and modelling stages. The actual field research component of CI - in my case, shadowing - which I refer to as urban shadowing, produces great amounts of data. The challenge then, is to not only analyse and model the data for design implications, but develop methods that allow for more philosophic inquiry.

It is important now to describe the applied issues I encountered when adapting CI into the urban environment. Flow Models and Physical Models are used to systematically understand the issues of existing interactive systems, in particular how people and technology work together from a holistic perspective. Contextual Inquiry’s attributes are thereby proven to match the issues of understanding how digitisation affects urban systems as a whole.

Adapting a methodology developed for the work and office environment into the larger urban environment posed substantial challenges in terms of the diversity of touch points and scale. Work and office environments have a denser physical environment and denser quantum of tasks. The urban environment is a more diffuse environment with fewer tasks. A key issue is to map the interactions of the urban user in comparison to the office worker. We know that the higher density of tasks in a work or office environment lets us isolate breakdowns and tasks more distinctly. In public space, users typically have a familiar process that works for them. Breakdowns and issues are therefore less readily identified as actual breakdowns; that is, not in terms of something that doesn't work for them, but as something that works but could be improved.

The modelling and analysis of user data threw up the following issue: that the modelling of individual users into abstract consolidated user models neglects a lot of detail captured in the user's individual model. This is due to the great diversity of participants, and we draw the comparison again to an office environment where users are less diverse, working as they do in a department dedicated to a certain function and following certain corporate standards.

Participants in this study were chosen to reflect a diverse group of commuters. Depending on their mode of transport and work hours, they were less or more synchronised or diverse in terms of their interactions and activities. This fed the issue of the loss of detail when consolidating the models. Therefore, we state again that when applying CI in an urban context, the individual models should rate high importance when viewing the consolidated models. Without the context of the former, the latter lack context. Within my research scope of ten participants, allowing for individual contexts within consolidated models is still achievable. However, when scaling CI into wider participant research, we may well need further research to understand how to ensure that consolidated models properly reflect the context of individual models.

One approach may be to further clarify the demographics towards which one would apply CI. One might apply CI to less diverse sub-groups who conduct less diverse interactions and activities. However, to isolate demographics into such sub-groups may introduce further challenges, as outlined in the research. For example, while 40% of urban inhabitants are commuters, user groups quickly proliferate into sub-groups of 8% and smaller.

Notwithstanding, an activity-based focus setting could help define sub-groups in terms of meaningful urban improvements. For example: how do parents digitally interact when bringing their kids to playgrounds, and how do they digitally behave when in the playground? Here we specifically introduce the connection of a sub-group demographic to a place. From this, we can further narrow the diversity of activities.

My research, for the sake of generically understanding urban interactions, aimed to avoid binding activities to distinct places. However, when drilling into other sub-groups, place-binding may well be necessary; that is, we may need a narrower focus setting to more specifically target urban dwellers' needs and requirements.

In general, I conclude that CI has great potential for research in the digitalisation of the urban environment. Its in-context production of knowledge is in line with such disciplines as Jan Gehl's Public Life Studies and Nigel Thrift's non-representational theory. However, CI's deep roots in HCI ensure a digitally native approach.

As we have stressed, the application of CI in urban environments needs further research and improvement. Both conceptual and applied issues still exist. Meanwhile, Contextual Inquiry eclipses more standard ethnographic research methods, in that it offers tools and methods to systematically analyse the urban environment as an interactive system from the user's perspective. It therefore stands as a powerful platform and departure point for the refinement of research methodologies in the service of our future cities.

5.6 Conclusion: Findings

This Findings chapter interprets the research data through a broader lens, theorising greater implications for digital disruption in the urban environment. It looks at how synchronised digital interactions patterns have been based on more or less standardised modes of transport and working hours. It questions the current Smart City approach of implementing physical hardware in the urban environment in the age of the Smartphone. Further, the chapter questions the implications of introducing a telematic reality into public space, based on advances in Smartphone technology and internet services that allow us to sense and control real-world processes. Finally, we have evaluated our own use of Contextual Inquiry in the urban environment, and its strengths and weaknesses.

6 Conclusion

In introducing this research, I outlined how current digital technology applications in the urban environment, as can be found in Smart City concepts and spatial interaction design, tend to lack the in-context user-centred approach commonly found in HCI and interaction design. I hence established a gap between current Smart City and spatial interaction design approaches and existing HCI practices. Specifically, I located this gap between five diverse disciplines: Smart Cities, Urban Informatics, Public Life Studies, Contextual Inquiry and Spatial Interaction Design.

I highlighted the following key issues:

1. Smart Cities are driven by the interests of corporations and governments, and while they intend to implement digital technologies on an urban scale, they fail to approach this implementation from a user-centred perspective.

2. Urban Informatics implements user-centred design in the urban environment, but on a micro / product- or service-design scale rather than an macro / urban scale.

3. Public Life Studies seek only to understand the urban environment from a user-centred urban design perspective; that is, they are traditional and non-digital.

4. Contextual Inquiry seeks an in-context, user-centred understanding of digital implementations, most commonly in work and office environments, but not necessarily in the wider urban environment.

5. Four disciplines, namely Interactive Brand Experiences, Interactive Exhibition Design, Interactive Media Architecture and Interactive Art, deal with the spatial implementation of digital implementations in environments. These I summarised into the category of Spatial Interaction Design. However, I concluded that these disciplines, akin to the issues described in Smart City implementations, tend to be driven from the perspective of their parent disciplines; that is, Advertising, Exhibition Design, Architecture and Art, and less from the perspective of user-centred design processes.

The limitations of all these disciplines required that I identified the overlaps of each, and connected them with each other. This allowed me to address the lack of a user-centred perspective in Smart Cities and spatial interaction design, and thereby to research digital implementations in the urban environment from a user-centred perspective. As a departure point, I used the two currently-established in-context environmental research approaches in urban design and HCI: Public Life Studies and Contextual Inquiry. While Public Life Studies focus on the physical design of urban environments, Contextual Inquiry addresses the in-context use of digital implementations in work and office environments. By manufacturing an approach that borrows from both, I sought to bridge the gaps between Spatial Interaction Design, Urban Informatics and Smart Cities.

The core principle of both Public Life Studies and Contextual Inquiry is in-context observation. However, the former focuses on places, whereas the latter focuses on the user's routine. I hence aimed at merging the place-based approach with an everyday-life approach, that is, by following the user during his typical day and illustrating his interactions at each visited place. The initial objective was to register analog as well as digital interactions. This however became too complex to achieve within the scope of this research, particularly in the data analysis and modelling stages. I shadowed ten people (who live in the Eastern Suburbs of Sydney) for an average day, taking photographs and registering their interactions with a notepad. The data was then transcribed and modelled into individual user-models, and these were combined into more abstract consolidated models.

Contextual Inquiry typically uses data models as inspiration in their ensuing Visioning stage, whereby researchers produce ideas for addressing each model's requirements from a user-centred design perspective. The Visioning stage is driven from a qualitative rather than quantitative understanding of the data models, and thereby produces urban-scale concepts that address urban user needs from a user-centred design perspective.

The distinction between the urban-scale and product- and service-design scale, I defined according to a digital technology application that typically requires implementation by a government authority (usually a city council) across a municipality, such as is currently referred to in Smart Cities.

Contextual Inquiry has been developed around the specific objecgive of delivering 'implications for design'. Where the process fell short, in my view, was in its narrow focus. However, since Contextual Inquiry is based on an ethnographic research process, it was able to deliver broader insights. I therefore extended the process into a Findings chapter in which I focused on the broader implications of my research data.

In the Speculative Design Visions section I developed four concepts that could be implemented in a design process: a smart parking meter, smart transport ticket, smart traffic light, and an UrbanAPI, necessary for implementing each of these applications.

In the Findings chapter, broader theories included synchronisation between different user groups, the shift from a Smartphone approach towards a 'Smartphone City' approach, identification of a shift towards a telematic reality that extends virtual and mixed realities, and the implications this shift has for Smart City strategies and spatial interaction design.

All such concepts are based on the finding that research participants are in constant touch with their Smartphones. This led me to conclude that the notion that physical infrastructure should be implemented in cities in the forms proposed by Smart City and spatial interaction design, is redundant. Smart City approaches should rather implement virtual infrastructure in the form of an UrbanAPI. This enables digital Smartphone applications that address use cases previously envisioned by Smart Cities but from a more user-centred perspective, and without the need to implement physical touch points. This allows me in my Findings chapter to argue for a shift 'from Smart City to Smartphone City'.

Further, my participants' constant use of Smartphones in public space led me to conclude that this produces a telematic reality, as Vilem Flusser envisioned, within the urban environment. While telematic reality is not a new concept, and has evolved with advances in digital technology, the fact that mobile devices can bring it to an urban environment is a key implication for urban design and Smart Cities.

Smart Cities and spatial interaction design tend to be based on the idea that users gain access to a mixed reality through interactive touch-points in the urban environment. Telematic reality however, argues that users interact remotely with actual physical-world processes. Contemporary internet applications have largely acknowledged the shift toward telematic applications that allow us to manage daily life more efficiently. Smart City strategies meanwhile, tend to neglect functional use cases in everyday life. For example, my concept of a smart parking meter is a telematic application that lets us remotely manage a parking spot. Conversely, any interactive display that offers location-based information (as evident in Smart City concepts and interactive media architecture) is based on the idea of a mixed reality, and does not allow for telematic remote control.

In summary, I consider that my application of Contextual Inquiry beyond the work environment into the urban environment, while addressing Public Life Studies principles, has been largely successful. However, I believe research of more granular demographics has a serious distance to travel. My research, representing 40% of urban users, focused solely on users with commute patterns. Research of smaller urban user groups is clearly necessary for the sake of a more complete formalization of the urban user experience in the digital age.

It is my belief that my wider findings - those that show the need to shift from a Smart City to a Smartphone City based on the telematic features of Smartphone applications in urban environments - constitute a significant contribution to Smart City literature.

The initial key question in my research: 'How can we formalize the urban experience in the digital age to help Smart City researchers develop more user-centred digital strategies?' has been addressed by contextual, user-centred research that formalises the outcomes into data models and resulting interaction patterns for future Smart City researchers. This research has largely achieved a formalization of the urban user experience in the digital age, allowing researchers who utilize contextual research and its resulting data models and interaction patterns to develop a more user-centred digital strategy for future Smart City developments.

Further, the formalization of the urban user experience of captured participants led to a theory of telematic reality within everyday life. This finding exceeds the initial objectives of this research - namely that formalization would lead to more applicable user-experience findings which might lead to more pragmatic influences on urban digital strategy. The modeled data revealed the existence of a telematic reality that has not hitherto been framed and positioned as such.

This perspective of a telematic reality within the urban environment based on mobile devices, also has pragmatic implications for how future Smart City research and development should be conducted. In the view of this researcher, the perspective is equally important as a definition of the process of urban Contextual Inquiry itself.

It was therefore exciting and gratifying for the researcher to achieve this additional outcome, particularly in the knowledge that Vilem Flusser's conception of a telematic reality had not been shown in actual existence. The introduction of mobile devices has amplified the need to understand telematic reality and its opportunities and challenges within the context of Smart City research. The researcher is therefore deeply motivated to conduct new research into urban Contextual Inquiry and the understanding of telematic reality in the immediate future.

7 Endnotes

[1] 'Interactive smart walls' or 'interactive smart sensors' simply do not exist. The most optimistic explanation for such generic labels is that they act as placeholders for future digital implementations that the Smart City project planner cannot yet describe. A valid explanation of an 'interactive smart wall' for example might be: 'A multi-touch screen allowing the user to check the timetable at a bus stop'. Such a description clearly explains the use case and reason for its digital implementation. Smart City planners however, have hitherto seemed to deliberately avoid explanations like these.

[2] User-centred design is based on a detailed understanding of how a target audience needs to use a product or service. User-centred design is deliberately not driven by technological possibility. Smart City developments however, seem to be driven by technological possibility rather than by understanding what urban users actually need in their everyday life.

[3] Today's Smartphones are as fast and as powerful as PCs. Further, due to their GPS capabilities they can target location-based use cases that PCs cannot.

[4] Jane Jacobs successfully fought against the Lower Manhattan Expressway envisioned by Robert Moses. Under Moses' previous planning activities, 500 000 New Yorkers had been displaced. Jacobs argued that such displacement had a negative effect on the public life of New York's neighbourhoods. The Lower Manhattan Expressway would have displaced many people from Greenwich Village, which today is a prime example of functioning public life in New York City. In fact, many people attribute the current public life in Greenwich Village to Jane Jacobs.

[5] Jan Gehl advised Melbourne and Copenhagen on how to bring back public life to their city centres. Melbourne for example was hitherto called a 'doughnut city'; that is, a lot happens on the city fringes but nothing in the middle. After Gehl's suggestions were implemented, public life returned to Melbourne's city centre and revitalised its laneways, now often cited as one of the city's attractions. Prior to Melbourne, Jan Gehl advised his home town of Copenhagen. In particular, his work on the Strøget car-free zone offered a template for his success in Melbourne and many other world cities.

[6] Dan Hill first conceptualised this idea as 'The Personal Well-Tempered Environment' on his blog CityOfSound.com. This was taken further by Andrew Van de Moere, implemented under a research grant from the University of Sydney.

[7] I in fact approached several city councils who were interested in developing Rapid Probes, along with Google, who would fund them. The city councils however invariably backed out at a late stage. This cost me many months in research and preparation.

[8] Currently, urban designers tend to lack Informatics knowledge. Likewise, Informatics researchers tend to lack urban design knowledge. This research aims to broaden knowledge of Urban Informatics by introducing urban design knowledge to the field.

[9] Sydney's Eastern Suburbs were chosen as a research location due to the researcher's familiarity with the area, and its proximity to Sydney's CBD.

[10] Sequence, flow and physical models were chosen from Karen Holtzblatt's Contextual Design methodology, due to their suitability for the urban environment. Models we chose to exclude, include the Artifact and Cultural Model and the Affinity Diagram.

[11] Although Jan Chipchase is an industry researcher, he is considered a thought-leader in this field.

[12] In relation to monumental developments, we refer to projects that cities simply wanted as show-off pieces in aid of appearing to be 'the most digitally-advanced city', while considering not at all any possible usefulness to their inhabitants. Sadly, this is literally the brief your writer received for several global projects he was involved in.

[13] In researching digital implementation use cases in the urban environment, one issue can be the multiple factors of the urban environment. Multiple users, multiple interaction touch points, multiple unforeseeable distractions and what Marcus Foth calls 'human fuzziness'. Probing allows us to explicitly propose a use case and a list of tasks to the user, as well as to clearly establish touch points and scope the number of users who may interact with the probe. In this way, a probe lets us narrow down the focus.

[14] With 'scaleable', we refer to the ability to more cost-effectively research more locations and research participants, as well as avoiding the need for permission for each research location. While Rapid Probing might provide deeper insight, such challenges might hinder its effective use.

[15] A Rapid Probe is physically installed in the urban environment to be visible to the public. It should provoke an interaction with the digital implementation.

[16] This writer's own experience of working in the industry shows that clients often refer to a technology they would like to implement, to create some form of innovation. Meanwhile, they are not sure about what the innovation actually is.

[17] With the term performative we refer to the definition of Judith Buttler: 'for something to be performative means that it produces a series of effects'. In this case, it means how much the Probe is actually able to engage the user with the digital implementation, that is, how much the Probe is able to produce a series of effects.

[18] Olafur Elliason of The Institute for Spatial Experiments in Berlin conducted experiments on how people interact with the built environment, that is, how they orientate, perceive and engage with space from a cognitive perspective.

[19] A 'use case' is a step-by-step list of interactions with a digital application, which addresses a situation that creates a need. For example, the situation of needing cash while being outside, can be addressed by the use case of withdrawing money from an ATM. A detailed use case then systematically describes how the actor interacts with the digital ATM application to withdraw their money.

[20] Amanda Williams here refers to the fact that current Smart City and media architecture projects tend to focus on a uniform idea of the user, and that there is no demographic diversification when considering the target audience for digital implementations in urban environments. Worse, the stereotype imagined by those implementations, rather than representing the majority of urban inhabitants, is simply a middle-class person who has endless time to walk around the city all day.

[21] Foth and Williams argue for a shift away from researching the city as a single product to research into the experiences individuals have with that city. This in turn lets us employ purpose-made user experience methodologies.

[22] Smart City developments such as Masdar, PlanIT or Songdo have been designed and developed within a uniform vision of a futuristic city.

[23] The term Smart City originated from a vision to improve future city developments with information-technology infrastructure. However. it became conflated with any form of urban innovation, and morphed into new terminology such as the 'Smart Citizen'.

[24] Adam Greenfield here refers to modernist urban planners of the mid 20th century such as Robert Moses and Le Corbusier, who focused on a functional approach based on industrial infrastructure innovations of the time. This was memorably expressed in the phrase 'houses are machines for living'. Greenfield argues that Smart City planners in the information age follow the same pattern as Moses and Le Corbusier

did in the industrial age, and that they likewise focus too narrowly on functional features.

[25] Greenfield here refers to the idea that the more unpredictable a city, the more vibrant it becomes. Thereby, the more predictable, the less vibrant it becomes, since it does not allow for lateral interactions and chance encounters as much as an unpredictable city. Predictability is related to regulation and control and to what degree a city aims to regulate and control its citizens. Greenfield hence argues that the more regulated, controlled and predictable a city is, the less urbane it becomes.

[26] Smart City proposals often refer to generic labels such as 'interactive smart wall' or similar jargonistic buzzwords, to indicate some kind of innovative technology that does magical things within its contextual space. This, to the technology-savvy, reveals low-level knowledge on the planner's part.

[27] The term 'urbane' refers to social and cultural behaviour that results from living in urban communities. Urbane behaviour is cited as being more suave, polished or sophisticated than in non-urban communities. George Simmel refers to a blasé attitude, developed by inhabitants of urban communities to protect themselves from the over-stimulus imposed on them by their environment.

[28] A proprietary solution is a hardware or software product developed by a company that denies other entities access to the mechanics of the solution, positioning themselves as the only provider of the solution. This contrasts with an open source solution, where a company, with the intent to innovate in collaboration with the general public, shares the mechanics of a solution. The iPhone operating system is an example of a proprietary solution, and the Android operating system is an example of an open source solution.

[29] Haque's grassroots approach to urban data refers to the idea that urban inhabitants should decide which urban data is important. They should also capture and submit this data to an online platform that allows sharing with the general public in a format the citizens think right (in contrast to urban authorities capturing and sharing the urban data and deciding on the data and format).

[30] Atoms refer to any non-digital urban structure designed in a city. We use the analogy of atoms here to later make a comparison with 'bits'. Nicholas Negroponte describes the process of digitalisation as an interplay between bits and atoms.

[31] The industrial age ushered in the fast growth of cities, with workers moving in to work in factories. This created high demand for affordable living spaces and new housing, in response to which urban Planners considered modernist planning the solution.

[32] Jan Gehl refers with this phrase to the change the car brought to urban planning; namely, that cities were traditionally planned around interactions based on the pace of walking. Cities then came to be planned around the car, which changed how inhabitants interacted with their urban environment. People moved into the suburbs but kept offices in the city, which in turn had negative effects on public life in the city centres.

[33] Gehl here argues that before the industrial revolution and modernist planning, urban planning was done intuitively on a human scale, whereby people could relate to the scale of the developed architecture. The introduction of the car and large-scale urban developments debased this intuitive understanding of what works on the human level.

[34] Gehl‘s field research in Italy, where he observed public life in Italian piazzas, helped him understand why public life there had more vibrancy than in Denmark.

[35] Gehl Architects' gehlarchitects.com continues to be a leading urban design consultancy, applying Gehl's theories in practice.

[36] Peter Weibel argues that prior to the internet, only politicians could 'do things with words' in the political domain. Today, through the internet the general public can do the same. Doing things with words was described by J.L. Austin as the performative speech act. This, in Peter Weibel's opinion, shifts a representive democracy towards a perfomative one. He uses the Arab Spring as an example. In the long run however, this act not only shifts power but also responsibility to the people - which they must be prepared to take on.

[37] Bill Hillier and Tim Stonor use GPS technology to observe public life from a bird's-eye perspective. While this methodology can reveal patterns that public life studies cannot show, it cannot register the interactions of people with the urban environment. In fact, all the GPS tracker can deliver is a person's X and Y coordinates.

[38] Nigel Thrift developed non-representational theory, a theory in human geography that focuses on embodied experience rather than representation. Witnessing is a key component of non-representational theory, which Thrift argues produces 'knowledge without contemplation' - of human and non-human actors' performances in the researched environment.

[39] The combination of physical and virtual reality not only creates a mixed reality but a telematic one. This telematic reality is created when an actor actuates a physical process via a virtual interface. One might, for example, order a taxi on the Uber Smartphone app or the grocery shop online. Both interactions actuate physical

processes, and hence create a telematic reality that produces a telepresence of the interactor. This thesis will elaborate on this topic in the Findings chapter.

[40] 'Shadowing' refers to the practice of following a user and observing his interactions with a digital system during his everyday activities. Shadowing offers a greater understanding of the context in which a digital implementation is used, delivering greater insight than research performed on the user in a lab environment.

[41] Empathic user data refers to understanding the user of a digital implementation from their own point of view, hence producing data from their perspective.

[42] Contextual Inquiry is a human computer-interaction research methodology that considers the physical environment. It can act as a basis for researching the urban environment, where few research methodologies are explicitly developed to do so.

[43] Contextual Inquiry in the work environment has a more granular approach, since distances are shorter, with task and interactions conducted in a more controlled indoor environment.

[44] With state transition, we refer to a situation from which the participant moves into another state. For example, a participant stands at a bus stop waiting. He then walks into a bus and sits down. This is a change of state.

[45] Otto E. Rössler, the founder of Endo-physics, argues that a researcher who is observing a system from within, unavoidably changes the system so that he cannot observe it in its normal state. Based on this theory, Claudia Gianetti argues that similarly interactive systems cannot be observed from the outside but only from within. Hence, the observer will always change the observed system.

[46] We refer here to the specific graphic design discipline of information design, which can communicate the captured data in visual form.

[47] Contextual Inquiry seeks to reveal implications for design. Decision makers refers to designers who gain insight into the researched demographic, then make considered decisions to improve the design.

[48] All other visual models deliberately discount time, in order to focus on the interactions between participant, environment and actors around them.

[49] Automated systems are systems that do not require any form of interaction in order to function.

[50] Informal interactions comprise any interactions not foreseen in the designed system. These might be work-arounds or any other form of supportive interaction a participant

conducts to successfully conduct a formal interaction. For example, shielding their Smartphone screen from the sunlight so that they can clearly see it.

[51] Our intial adaptation also included any form of analog interaction. This, however, created major complexity in modelling the data within the scope of this research. We hence focused only on digital interactions.

[52] Contextual Inquiry in work environments focuses strongly on interactions between workers. In this adaptation, participants mostly commuted to work without any form of social interaction. However, they visited many diverse places, causing us to shift the focus from interacting with people to interacting with places in the urban environment.

[53] A Cloud Service Database is a database that is accessible via an internet connection and supports a dedicated service, commonly referred to as The Cloud.

[54] Physical computing refers to interaction with interactive systems through a tangible interface rather than a visual screen-based interface. For example, paying a bus fare with a swipe card lets the user interact with the transport database with a simple physical swipe.

[55] Affordances' are physical and visual elements that prompt a person to conduct a certain action. A straight park bench might afford or communicate to a user to sit. A circular park bench might prompt a user to sit and start a conversation. Here we cite the example of Jeppe Hein's social benches, which are benches modified in shape to afford different types of interactions. Similarly, digital interfaces might afford the user different types of actions or interactions. One may argue that the better the affordance, the better informed a user is that this interaction is actually available. Conversely, the worse the affordance, the more likely the user will miss that this interaction is actually available at this juncture. Thereby, the better the affordance of an interaction, the more we promote the performative qualities of any interactive system.

[56] Analog interactions are not included in the visual models, since this creates too much complexity and would negatively influence the models' legibility.

[57] Databases here refer to databases that are accessible via an internet connection, commonly referred to as The Cloud.

[58] I excluded the individual models due to the high volume of photography supporting them. This would have made the document harder to read. The individual models are still important for the reader however, to understand the context of the consolidated models.

[59] Interactions captured at the single interaction level might seem trivial or mundane, yet the collection of all interactions draws a specific picture of a persona or demographic who might require certain use cases that could assist them in everyday life.

[60] Use cases hidden in everyday interactions can be discovered between existing interactions, since the use cases reflect only needs that a user may already have identified. These new use cases are to be discovered by the researcher, who can read everyday life from the perspective of digital implementation.

[61] 'Dwell time' here refers to a person stopping during their journey through the urban environment. Dwell time might be waiting at a bus stop, eating lunch on the beach or in the park, or sitting down to wait or relax. Dwell time can also be time spent with an interactive touch point such as a media facade. Overall, for the participants, dwell time mostly involved interaction with Smartphones.

[62] The assumption of media facades or any other form of public intervention in the form of digital implementation, is that the public is actually interested in interaction with site-specific information at a specific location. Due to the high level of connectedness shown by the participants' Smartphone use, such site-specific use cases seemed irrelevant. Participants rather seemed willing to interact with site-specific information by means of their Smartphones.

[63] Music on Smartphones was mostly played from a streaming service such as Spotify, and connected to the listener via headphones, or via bluetooth to the car stereo.

[64] At the time of the research, paper tickets for public transport were still available. Now, all public transport tickets are based on RFID swipe cards, referred to in Sydney as the Opal card. At the time, some frequent public transport users who are tech-savvy would use Opal cards, while less frequent and less tech-savvy users would opt for paper tickets.

[65] Participants would sit on steps or on grassy spots that allowed space to sit or spread out.

[66] Participants when driving cars in particular, would interact with their Smartphones while waiting at traffic lights, to a degree where the car behind them would need to honk to remind them the light is green.

[67] Participants with flexible working hours and mode of transport, used this flexibilty to go to the beach. In particular, participants who only used private transport did not take that opportunity.

[68] This rule also applies when reading this document. The Individual models are placed in the Appendix to make the core document more readable.

[69] Contextual Inquiry aims at inspiring design decisions. It is not aimed at delivering quantitative results.

[70] Mobile phone parking-meter systems are currently being trialled in several global cities, including Moscow and Brisbane.

[71] Tracking can be facilitated through a background GPS process.

[72] A background process can track the user's GPS pattern, and assume when they get on or off. When the system assumes the user boards, a push notification is sent, inviting them to pay for the fare on their Smartphone.

[73] The term 'calm technology', coined by ubiquitous computing expert Mark Weiser, refers to a technology that runs at the periphery of the user's attention until they need to pay attention; otherwise it sits in the background and monitors performance and tracks for patterns whereby it should intervene.

[74] A technology acting as an iBeacon or BLE beacon that sends a push notification to the Smartphone when a user approaches a specific location where GPS is available, would allow more cost-efficent digital implementations of iBeacon type use cases. A system could monitor the GPS location at all times, and interact with the user to address a certain use case. This may impose privacy issues; however, end to end encryption and differential privacy might solve the issue.

[75] While single-data-source solutions are helpful for urban inhabitants, such as real-time bus traffic information, integrated solutions that draw from multiple data sources can solve entirely new use cases. A trivial example might be an app that tells us if we would make it in time to a store, for which we need to take public transport before it closes.

[76] Developments like the CitySDK provide a solution on an SDK and API level, but not a hosted solution. An UrbanAPI solution, hosted similarly to GitHub, to which any city and citizen can submit urban data, could be highly relevant.

[77] 'Diversity of digital interactions' refers to how and why the user uses a specific implementation. The more diverse the user's digital interactions, the more diverse the use of applications and websites.

[78] 'Different scenarios' in this case means situations that allow for different use cases and hence different interactions.

[79] A use case can be addressed by different forms of digital implementation. While the issue and the result are the same, how they are achieved will be experientially different.

[80] MIT developed an interactive bus-stop installation, as did the University of Sydney with its concept of INTERCHANGING, for future bus shelters. Meanwhile, Smartphone apps such as TripView address a similar use case.

[81] TripView is an example of a real-time Smartphone application used in Sydney.

[82] The big difference between media architecture and Smartphones is that every user has a private screen, whereas media architecture acts as a public screen. This is crucial when developing digital implementations for urban use cases.

[83] While media architecture can produce great performative artworks such as the Crown Fountain in Chicago, such digital implementations are hard to roll out across other cities, due to installation and maintenance costs, as well as public space accessibility issues.

[84] 'Gaze-able' is a ubiquitous term used in computing and interaction design. It refers to information that might be visually present in the user's environment, that can be engaged peripherally. One argument in favour of media architecture is that we can provide a user with information that she would not necessarily look for. In the Neighbourhood Scoreboards project , for example, the visual information on energy consumption was present in the user's visual periphere. Hence she would look at it because something in her 'usual' environment was 'different' and attacted her attention. In comparison to an AR application, the user would have needed to know about the availability of the application, downloaded it and actually been interested enough to hold the Smartphone up to get the information. On the other hand, a similar push into the user's awareness might be achieved with a push notification on their Smartphone.

[85] A key issue uncovered in this research, is that the demographics addressed by media architecture are not clearly defined. As Amanda Williams suggests, only a stereotypical general-purpose user is defined. Not knowing one's demographic and persona is a great faux pas in interaction design.

[86] Either to entertain themselves, retrieve information, or for a contextual functional use case.

8 References

Almehairi, M. and Bhatti, T. (2014), 'Adoption of Virtual Shopping: Using Smartphones and QR codes', *Journal of Management and Marketing Research*, vol. 17, pp. 1–12.

Ananny, M. and Strohecker, C. n.d., 'TexTales', in M. Foth (ed.), *Handbook of Research on Urban Informatics*, IGI Global, Hershey, Pa., pp. 68–86.

Anderson, R. J. (1994), 'Representations and Requirements: The Value of Ethnography in System Design', *Human-Computer Interaction*, vol. 9, no. 3, pp. 151–82.

Art+Com (2009), *Level Green* Exhibition, *Autostadt*, Wolfsburg.

Ascott, R. and Shanken, E.A. (2003), *Telematic Embrace: Visionary Theories of Art, Technology, and Consciousness,* University of California Press.

Australian Bureau of Statistics (2008), ‘POPULATION’, *Australian Bureau of Statistics Year Book*, Canberra, Australia, viewed 9 October 2017, http://www.abs.gov.au/AUSSTATS/abs@.nsf/bb8db737e2af84b8ca2571780015701e/0ad628d49c8b6a73ca2573d20010fc5e!OpenDocument.

Avrahami, D. and Hudson, S. E. (2002), 'Forming interactivity', *Proceedings of the 4th Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques*, ACM Press, New York, New York, USA, pp. 141–6.

Bafna, S. (2003), 'Space Syntax: A Brief Introduction to its Logic and Analytical Techniques', *Environment and Behavior*, vol. 35, no. 1, pp. 17–29.

Ballagas, R., Borchers, J., Rohs, M. and Sheridan, J.G. (2006), 'The Smart Phone: A Ubiquitous Input Device', *IEEE Pervasive Computing*, vol. 5, no. 1, pp. 70–7.

Barlow, J. P. (1996), ‘Declaration of Independence for Cyberspace’, viewed 9 October 2017, https://www.eff.org/cyberspace-independence.

Bassoli, A., Brewer, J., Martin, K., Dourish, P. and Mainwaring, S. (2007), 'Underground Aesthetics: Rethinking Urban Computing', *Pervasive Computing, IEEE*, vol. 6, no. 3, pp. 39–45.

Beal, G. M. and Bohlen, J. M. (1957), 'The Diffusion Process', *Agricultural Experiment Station*, Iowa State College.

Beesley, P. and Khan, O. (2009), *Situated Technologies Pamphlets 4*, O. Khan, T. Scholz and M. Shepard (eds), The Architectural League of New York, New York.

Beesley, P., Hirosue, S. and Ruxton, J. (2006), 'Toward Responsive Architectures', *RESPONSIVE aRCHITECTURES sUBTLE tECHNOLOGIES*, Responsive Architectures: …, Toronto, pp. 3–11.

Berkebile, B. and MeLennan, J. (2004), 'The Living Building: Biomimicry in Architecture, Integrating Technology with Nature', *BioInspire Magazine*, no. 18.

Beyer, H. and Holtzblatt, K. (1998), *Contextual Design*, 1st edn, Morgan Kaufmann, San Francisco.

Beyer, H. and Holtzblatt, K. (1999), 'Contextual Design', *Interactions*, vol. 6, no. 1, pp. 32–42.

Boellstorff, T. (2015), *Coming of Age in Second Life: An Anthropologist Explores the Virtually Human,* Princeton University Press.

Boffswana and Trefz, E. (2010), *Honda Dream Wall,* Interactive Installation*,* Sydney Motor Show, Sydney.

Boffswana and Trefz, E. (2011), *LG – Totems,* Interactive Installation*,* Westfield Mall, Melbourne.

Bourriaud, N., Pleasance, S., Woods, F. and Copeland, M. (2002), *Relational Aesthetics*, Les presses du réel, Dijon.

Brown, T. (2008), 'Design Thinking', *Harvard Business Review,* June, pp. 84-92.

Bullivant, L. (2006), *Responsive Environments: Architecture, Art and Design*, Victoria and Albert Museum, London.

Carter, D. (2013), 'Smart Citizens in Smart Cities', *Digital Governance: From Local Data to European Policies*, Prague, pp. 143–4.

Chipchase, J. (2013), *Hidden in Plain Sight*, Harper Collins, New York.

Cooper, A., Reimann, R. and Cronin, D. (2007), *About Face 3*, Third Edition, Wiley Publishing Inc., Indianapolis, IN 46256.

Cox, D. D. and Dean, T. (2014), 'Neural Networks and Neuroscience-inspired Computer Vision', *Current Biology*, vol. 24, no. 18, pp. R921–9.

Cruickshank, P. (2011), *Customer Journey Mapping*, S.C. Project (ed.), 1e edn, Smart Cities Project, Edinburgh.

Curtis, A. (2016), 'HyperNormalisation', London: BBC, 2016.

Dabbish, L., Stuart, C., Tsay, J. and Herbsleb, J. (2012), *Social Coding in GitHub: Transparency and Collaboration in an Open Software Repository*, ACM, New York, New York, USA.

Dalsgaard, P. and Halskov, K. (2010), 'Designing Urban Media Façades: Cases and Challenges', *Proceedings of the sIGCHI Conference on Human Factors in Computing Systems*, ACM Request Permissions, Atlanta, pp. 2277–86.

Dourish, P. (2006), *Implications for Design*, ACM, New York, New York, USA.

EL PAÍS, (2007), Disonancias Los Nuevos Leonardos', *Edición impresa, EL PAÍS*.

Flusser, V. (2011), *Into the Universe of Technical Images*, University of Minnesota Press.

Foth, M. (2009), *Handbook of Research on Urban Informatics*, M. Foth (ed.), IGI Global, Hershey, Pa.

Fox, M. and Kemp, M. (2009), *Interactive Architecture*, vol. 1, Princeton Architectural Press, Princeton.

Frazer, J. H. (1993), 'The Architectural Relevance of Cybernetics', *Systems Research*, vol. 10, no. 3, pp. 43–8.

Frenchman, D. and Rojas, F. (2006), 'Zaragoza's Digital Mile', *Places*, vol. 18, no. 2, pp. 16–25.

Gaver, B., Dunne, T. and Pacenti, E. (1999), 'Design: Cultural Probes', *Interactions*, vol. 6, no. 1, pp. 21–9.

Gehl, J. (2011), *Life Between Buildings*, Island Press, Washington DC.

Gehl, J. (2010), *Master Planner Jan Gehl*, Monocle Magazine, viewed 9 October 2017, https://monocle.com/film/design/master-planner-jan-gehl

Gehl, J. and Svarre, B. (2013), *How to Study Public Life,* Island Press.

Giannetti, C. (2004a), 'Aesthetics and Communicative Context', viewed 9 October 2017, http://www.*Medienkunstnetz.de*.

Giannetti, C. (2004b), *Ästhetik des Digitalen*, Springer, Wien / NewYork.

Gibson, William. (2000), *Neuromancer,* Penguin.

Goffman, E. (1959), *The Presentation of Self in Everyday Life*, Doubleday, Garden City.

Goldberg, K., Santarromana, J. and Bekey, G. (1995), 'The Telegarden', *Proceedings of ACM SIGGRAPH* pp. 135-140.

Green, J. (2011), *Digital Urban Renewal*, Ovum, London.

Greenfield, A. (2013), *Against the Smart City*, Do projects; Do projects, New York.

Grudin, J. (1990), *The Computer Reaches Out: The Historical Continuity of Interface Design*, ACM, New York, New York, USA.

Gubbi, J., Rajkumar B., Marusic, S. and Palaniswami, M. (2013), ‘Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions’, *Future Generation Computer Systems,* vol. 29, no. 7, pp. 1645-1660.

Haeusler, M. H. (2015), 'The Sydney Vivid Festival: From Place Branding to Smart Cities', *Cities of light*, pp. 144–8, Routledge, New York.

Han, Byung-Chul, (2015), *The Burnout Society,* Stanford University Press.

Haque, U. (2006), *Architecture, Interaction, Systems,* AU: Arquitetura & Urbanismo, 149, pp. 1-5.

Haque, U. (2007), *Burble London*, Interactive Installation, *London Fashion Week*, London.

Haque, U. (2013), *Messiness will Inevitably Arise in Spite of Smart Cities, Wired,* July 2013.

Haque, U. (2004), *Pachube,* viewed 9 October 2017, *http://www.pachube.com.*

Hill, D. (2008), *City of Sound:* Essay: The Street as Platform', viewed 9 October 2017, http://www.cityofsound.com/blog/2008/02/the-street-as-p.html.

Hodgkinson, S. (2011), *Is Your City Smart Enough?*, Ovum, London.

Holtzblatt, K., Wendell, J. B. and Wood, S. (2005), *Rapid Contextual Design*, Elsevier.

Höllerer, T. and Feiner, S. (2004), 'Mobile Augmented Reality', *Telegeoinformatics: Location-Based Computing and Services. Taylor and Francis Books Ltd., London, UK*, vol. 21.

Humphries, G. (2014), 'Opal cards not gems yet for all commuters', viewed 9 October 2017, http://www.illawarramercury.com.au/story/2450677/opal-card-a-real-rare-gem/.

Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B. B., Druin, A., Plaisant, C., Beaudouin-Lafon, M., Conversy, S., Evans, H. and Hansen, H. (2003), 'Technology Probes: Inspiring Design For and With Families', *CHI ’03*, ACM, pp. 17–24.

IBM (2015), 'Smarter Cities: Future Cities', viewed 9 October 2017, https://www.ibm.com/smarterplanet/us/en/smarter_cities/overview/.

Information Age (2012), 'IBM, Cisco and the business of smart cities', viewed 9 October 2017, http://www.information-age.com/ibm-cisco-and-the-business-of-smart-cities-2087993/.

Igoe, O' Sullivan, and Dan. (2004), *Physical Computing: Sensing and Controlling the Physical World with Computers,* Course Technology Press, 2004.

Jacobs, J. (1961), *The Death and Life of Great American Cities*, Vintage books, New York.

Jung, Y. and Chipchase, J. (2008), 'Nokia Open Studio: Engaging Communities', *Technical report*, Nokia Research, pp. 1-24.

Khan, A. H., Qadeer, M. A., Ansari, J. A. and Waheed, S. (2014), '4G as a Next Generation Wireless Network', *2009 International Conference on Future Computer and Communication (iCFCC)*, IEEE, pp. 334–8.

Kiib, H. (2010), *Performative Urban Design*, First Edition., forlag.aau.dk, Aalborg.

Lindsay, G. (2010), 'Building a Smarter Favela: IBM Signs Up Rio', viewed 9 October 2017, http://www. fastcompany.com/1712443/building-a-smarter-favela-ibm-signs-up-rio.

Liu, Y., Yang, J. and Liu, M. (2008), *Recognition of QR Code with Mobile Phones*, Mohamed Ally and Gill Needham, eds, pp. 203–6.

Lozano-Hemmer, R. (2001), *Body Movies.*

Lozano-Hemmer, R. (1999), *Vectorial Elevation.*

López del Rincón, D. (2013), Rematerialised Tendencies in Media Art? From Silicon to Carbon-based Art, *Sociología y tecnociencia/ Sociology & Technoscience/ Sociologia e tecnociência*, vol. 1, no. 3, pp. 32–56.

Maeda, J. (2006), *The Laws of Simplicity.*

Martin, R. C. (2003), *Agile Software Development: Principles, Patterns, and Practices*, Prentice Hall, PTR.

McCormack, J. and Dorin, A. (2004), 'Generative Design: a Paradigm for Design Research', in Weitelartz, K. M., *Processes of Making,* Kassel University Press.

Miller, D. and Slater, D. (2000), *The Internet*, Bloomsbury Academic.

Moere, A. V., Tomitsch, M., Hoinkis, M., Trefz, E., Johansen, S. and Jones, A. 2011, 'Comparative Feedback in the Street: Exposing Residential Energy Consumption on House Façades', *Usability and internationalization. hCI and culture*, pp. 470–88, Springer Berlin Heidelberg, Berlin, Heidelberg.

Moggridge, B. (2006), *Designing Interactions*, The MIT Press, Cambridge, Massachusetts.

Navizon (1999), 'Navizon WiFi Location and Cell-id Triangulation for Wireless Devices', viewed 9 October 2017, http://www.*navizon.com*.

Negroponte, N. (1996), *Being Digital*, Knopf Doubleday Publishing Group, New York.

Newman, N. (2014), 'Apple iBeacon Technology Briefing', *Journal of Direct, Data and Digital Marketing Practice*, vol. 15, no. 3, pp. 222–5.

Norman, D. A. (2013), *The Design of Everyday Things: Revised and Expanded Edition,* Basic Books.

O'Sullivan, D. and Igoe, T. (2004), *'Physical Computing: Sensing and Controlling the Physical World with Computers,* Thompson, Boston.

Park, I. and Hannafin, M. J. (1993), 'Empirically-based Guidelines for the Design of Interactive Multimedia', *Educational Technology Research and Development*, vol. 41, no. 3, pp. 63–85.

Pask, G. (1975), *Conversation, Cognition and Learning,* Elsevier, Amsterdam.

Penny, S. (2011), 'Towards a Performative Aesthetics of Interactivity', *The Fibreculture Journal,* vol. 19.

Rahman, M. M., Wirasinghe, S .C. and Kattan, L. (2012), 'Users' Views on Current and Future Real-Time Bus Information Systems', *Journal of Advanced Transportation*, vol. 47, no. 3, pp. 336–54.

Rettig, M. (1994), 'Prototyping for Tiny Fingers', *Communications of the ACM*, vol. 37, no. 4, pp. 21–7.

Boffswana and Trefz, E. (2011), *LG – Totems,* Interactive Installation*,* Westfield Mall, Melbourne.

Roosegaarde, S. (2007), *Dune,* Interactive Installation*, City of Architecture*, Rotterdam.

Rose, A. and Stonor, T. (2009), 'Syntax Planning Urban Accessibility', *Access for all*, pp. 78–93, Birkhäuser Basel, Berlin, Boston.

Royce, W. (1970), *'Managing the development of large software systems: concepts and techniques,* IEEE WESCON, pp.1-9.

Sassen, S. (2011), *Open Source Urbanism. Domus*, Gabler, Wiesbaden.

Sauter, J. (1988), *'ART+COM', Spatial Interaction Design*, Design Practice, Berlin.

Schiller, J. and Voisard, A. (2004), *Location-Based Services,* Elsevier.

Schuler, D. and Namioka, A. (1993), *Participatory Design: Principles and Practices,* Lawrence Erlbaum Associates, New Jersey.

Sefelin, R., Tscheligi, M. and Giller, V. (2003), 'Paper prototyping: what is it good for?: a comparison of paper-and computer-based low-fidelity prototyping', *CHI '03 extended abstracts on human factors in computing systems*, ACM, pp. 778–9.

Sevtsuk, A. and Ratti, C. (2005), 'iSPOTS. How wireless technology is changing life on the MIT campus', Proceedings of the 9th International Conference on Computers in Urban ...

Shaw, J. (1989), *The Legible City,* Interactive Installation, Artec 89, Nagoya.

Siemens (2011), 'Collective Intelligence: City Cockpit, Real-Time Government', viewed 9 October 2017, https://www.siemens.com/digitalization/public/pdf/collective-intelligence-city-dashboard.pdf .

Siemens (2015), 'Smart City: Through Intelligent Automated Infrastructure', viewed 9 October 2017, https://www.slideshare.net/MphasisIntern/smart-city-through-intelligent-automated-infrastructure.

Siemens (2008), 'Sustainable Buildings Networked Technologies: Smart Homes and Cities', viewed 9 October 2017, http://legiblepolicy.info/citizen-engagement-in-and-beyond-smart-cities/.

Simmel, G. (1903), *The Metropolis and Mental Life,* in K. H Wolff (ed.), *The Sociology of Georg Simmel,* New York Free Press.

Simons, D. (2012), 'SFPark: San Francisco Knows How To Park It ', *Sustainable Transport*, Institute for Transportation and Development Policy, Vol. 23, pp. 26–27.

Smilansky, S. (2009), *Experiential Marketing: A Practical Guide to Interactive Brand Experiences*, Kogan Page.

Spinifex and Trefz, E. (2008), '*Back O' Bourke',* Interactive Exhibition, Bourke Museum, Bourke.

Spinifex and Trefz, E. (2012), '*Come to Your Census',* Interactive Installation, Vivid Festival, Sydney.

Starr, M. E. (1984), 'The Marlboro Man: Cigarette Smoking and Masculinity in America', *The Journal of Popular Culture*, vol. 17, no. 4, pp. 45–57.

Steuer, J. (1992), 'Defining Virtual Reality: Dimensions Determining Telepresence', *Journal of Communication,* Vol. 42, no. 4 (1992): 73-93.

Struppek, M. (2006), 'The Social Potential of Urban Screens', *Visual Communication*, vol. 5, no. 2, p. 173.

Styrin, E. M. (2014), ‘The Formation of a System of Open Government in Russia: Experience and Prospects’, *Information Science Reference,* Hershey, New York.

Suchman, L. A. (1987a), *Plans and Situated Actions*, Cambridge University Press.

Suchman, L. A. (1987b), *Plans and Situated Actions*, Cambridge University Press.

TheGreenEyl (2010), *À la carte,* Interactive Installation, Jewish Museum*,* Berlin.

TheGreenEyl (2004), *Omnivisu,* Interactive Installation, Oberbaum Bridge*,* Berlin.

TheGreenEyl (2009), *Whispering Table,* Interactive Installation, Jewish Museum*,* Berlin.

Thrift, N. (2008), 'Non-Representational Theory: Space, Politics, Affect ', Routledge, New York.

Trefz, E. (2008), ‘*WAVE PILLOW’, Leonardo*, vol. 41, no.3 (2008), pp. 207-207.

Trefz, E., Moere, A. V. and Spinifex (2008), *San Jose Climate Clock Concept,* Interactive Installation, Climate Clock Exhibition, San Jose.

Tuan, Y.-F. (1979), 'Space and Place: Humanistic Perspective', *Philosophy in Geography*, pp. 387–427, Springer Netherlands, Dordrecht.

Uhlir, E. K. (2005), 'The Millennium Park Effect', *Economic Development Journal*, vol. 4, no. 2, p. 7.

Veblen, T. (1899), *The Theory of the Leisure Class: An Economic Study in the Evolution of Institutions,* Macmillan*.*

Void, W. (2008), *FLARE-façade,* Interactive Installation, Material Xperience, Rotterdam.

Waal, M. de (2014), *The City as Interface*, NAI Publishers.

Walker, M., Takayama, L. and Landay, J. A. (2002), 'High-fidelity or low-fidelity, paper or computer? Choosing attributes when testing web prototypes', *Proceedings of the human factors and ergonomics society 46th annual meeting*, pp. 661–5.

Watson, T. (2007), *L.A.S.E.R. Tag,* Interactive Installation, Art Rotterdam, Rotterdam*.*

Weibel, P. (1993), *The Wall of Lascaux,* Interactive Installation, ZKM, Karlsruhe.

Weibel, P. (2012), 'The WE Brings Performative Aspects Into The Arts ', *we and the arts*, no. 7, pp. 64–73.

Weiser, M. and Brown, J. S. (1996), 'Designing Calm Technology', *PowerGrid Journal*, vol. 1, no. 1, pp. 75–85.

Whyte, W. H. (1980), *The Social Life of Small Urban Spaces*, Project for Public Spaces, New York.

Williams, A., Robles, E. and Dourish, P. (2009), 'Urbane-ing the City: Examining and refining the assumptions behind urban informatics', in M. Foth (ed), *Handbook of Research on Urban Informatics: The Practice and Promise of the Real Time City,* Hershey.

Willis, K. S.(n.d.), 'Information Places', in M. Foth (ed.), *Handbook of Research on Urban Informatics*, pp. 206-18, IGI Global, Hershey, Pa.

WK (2011), 'Why We're Not Hiring Creative Technologists', viewed 9 October 2017, http://blog.wk.com/2011/10/21/why-we-are-not-hiring-creative-technologists/.

Zennaro, M., Bagula, A., Gascon, D. and Noveleta, A. B. (2010), *Long Distance Wireless Sensor Networks: Simulation vs Reality*, ACM, New York, New York, USA.

Zhao, Y. (1997), *Vehicle Location and Navigation Systems*, Artech House on Demand, Norwood.

Appendix A

1 Individual Models

1.1 Flow Models

1.1.1 Laurene

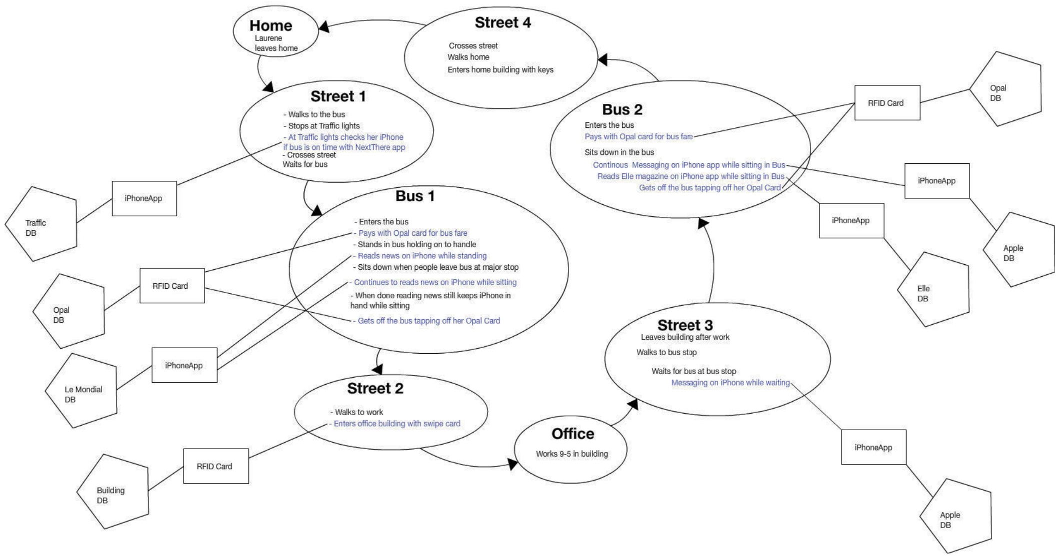


Figure 1: Flow Model Laurene

1.1.2 Sebastian

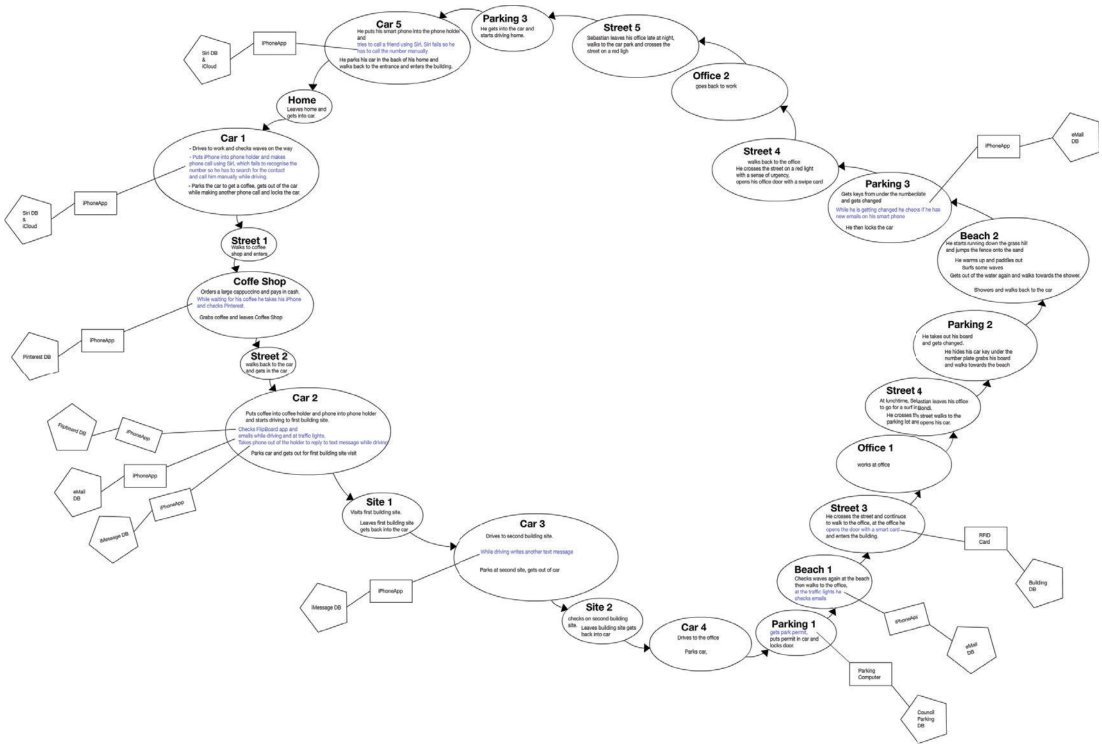


Figure 2: Flow Model Sebastian

1.1.3 Agathe

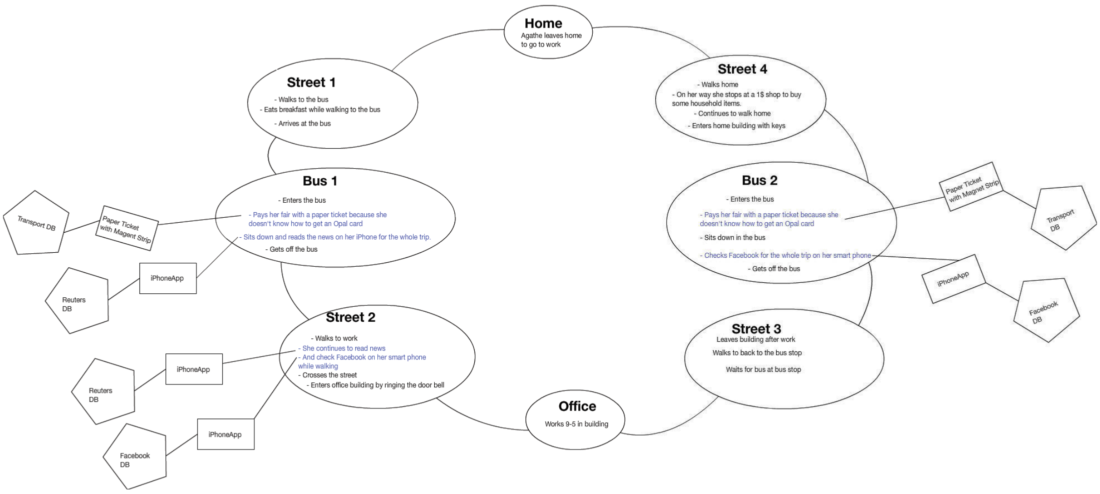


Figure 3: Flow Model Agathe

1.1.4 Kay

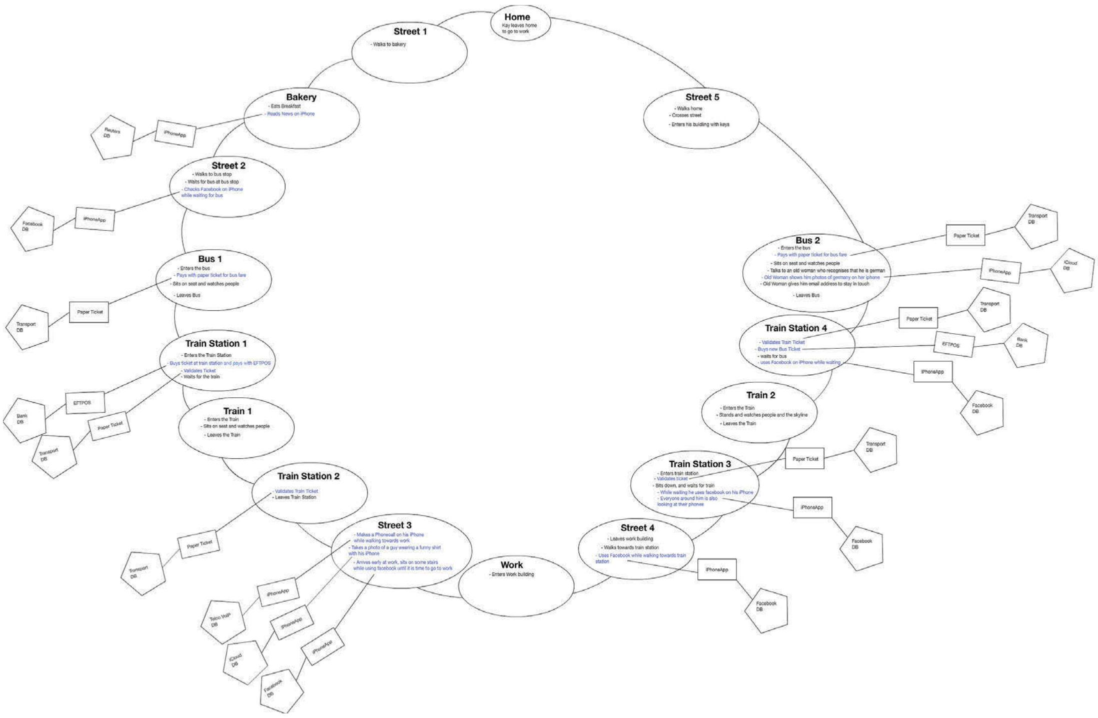


Figure 4: Flow Model Kay

1.1.5 Peter

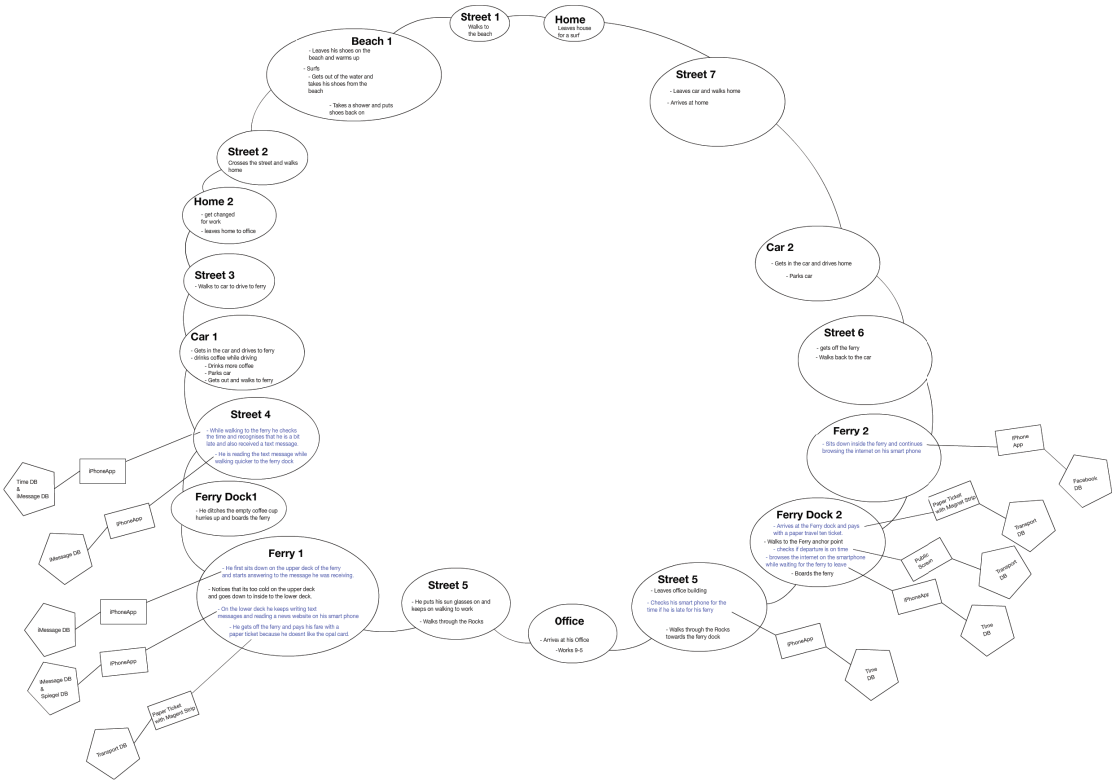


Figure 5: Flow Model Peter

1.1.6 Liya

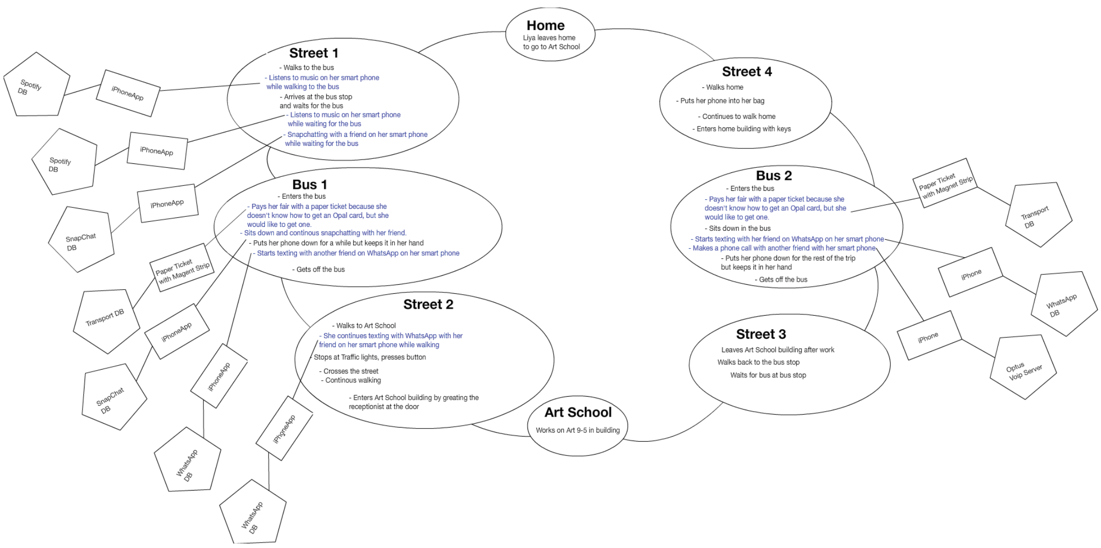


Figure 6: Flow Model Liya

1.1.7 Matt

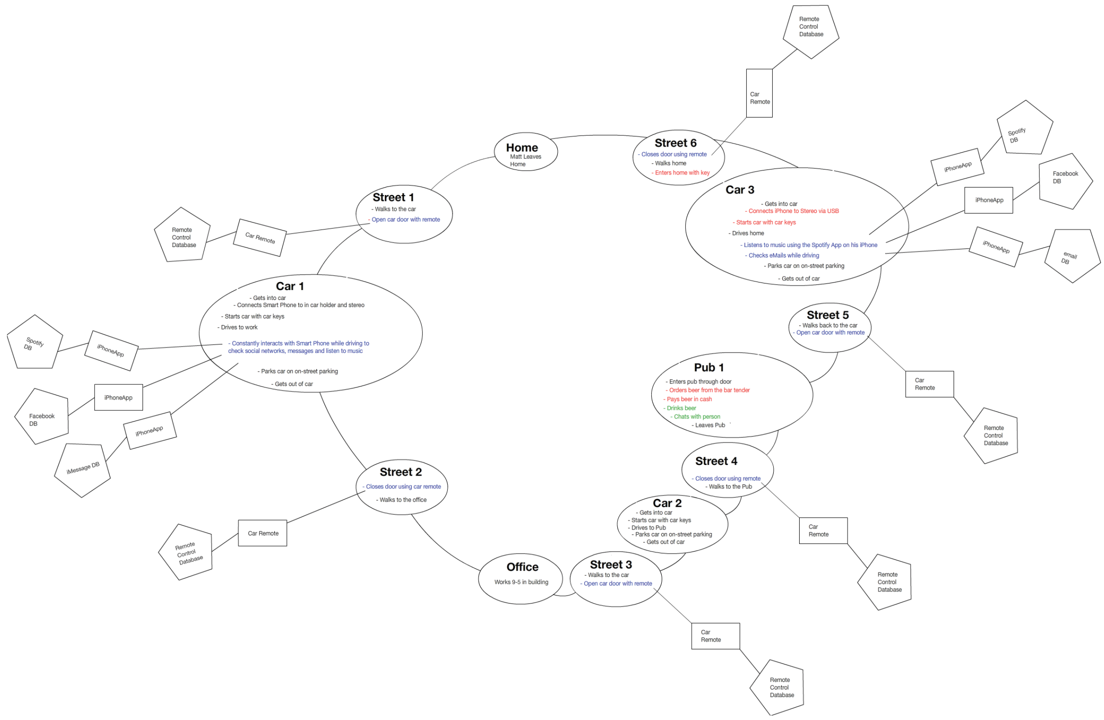


Figure 7: Flow Model Matt

1.1.8 Bea

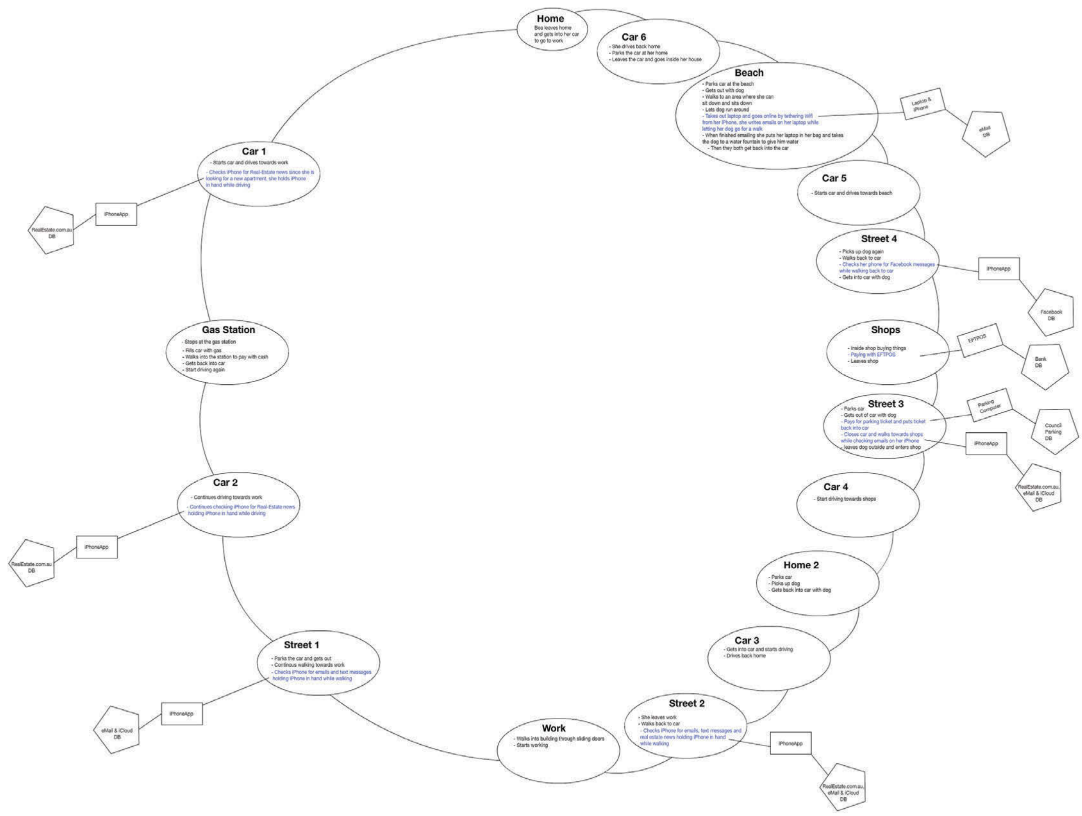


Figure 8: Flow Model Bea

1.1.9 Heidi

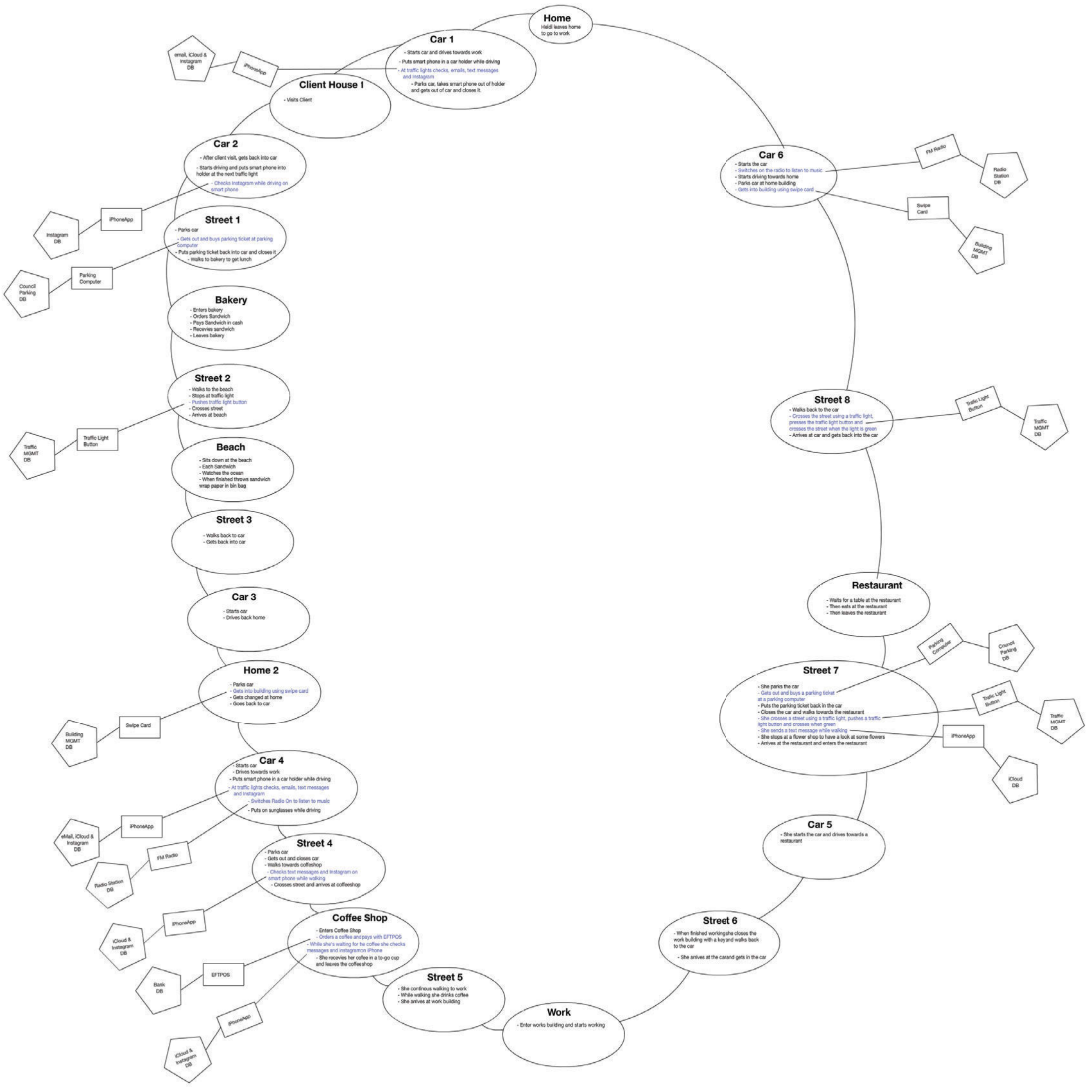


Figure 9: Flow Model Heidi

1.1.10 Ralph

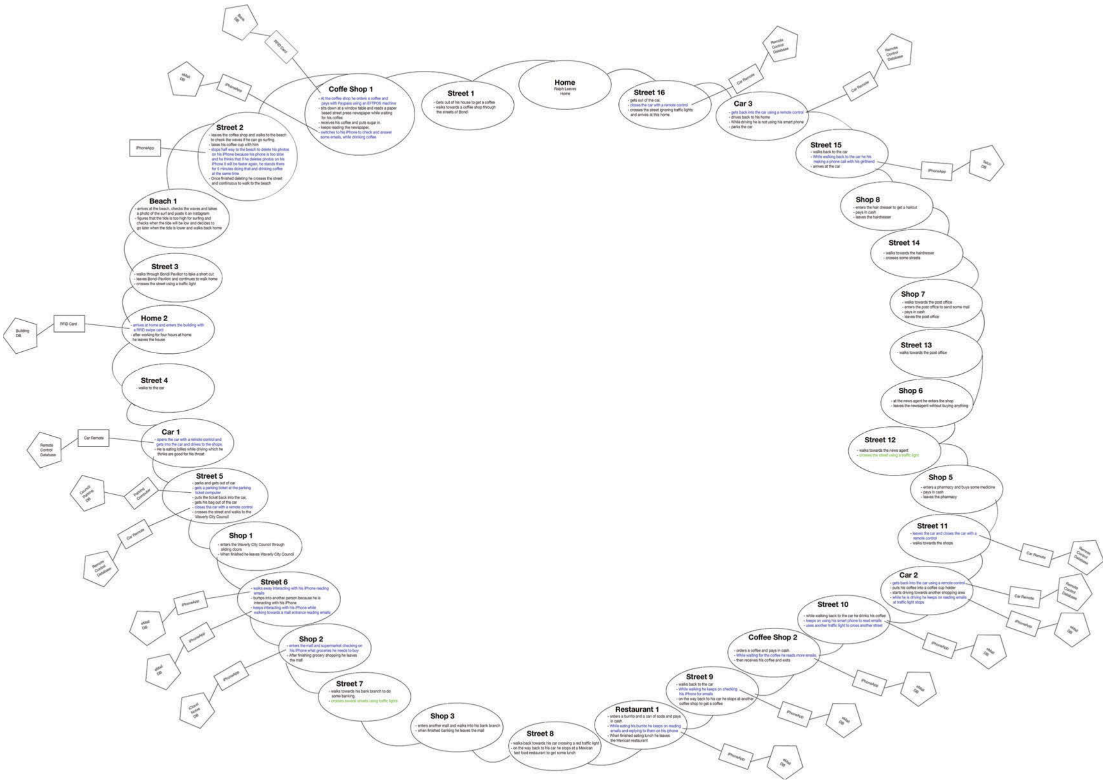


Figure 10: Flow Model Ralph

1.2 Sequence Models

1.2.1 Laurene

	Actions	Intent	Trigger
Street 1			
	Laurene leaves her home and walks to the bus		
	v		
	On the way at the traffic lights she checks if the bus is on time with the NextThere app	Being on time	Fear of running late
	v		
	She crosses the street and waits for the bus		
	v		
Bus 1			
	Enters the bus and pays with her Opal card	Convenient form of payment	Pay for bus fee
	v		
	She has to stand first		
	v		
	Starts using her phone while standing to read news	entertainment and education	boredom, urge to stay informed
	v		
	Then sits down after most people get out at Bondi Junction	travel more comfortable	
	v		

	She continuous to read the news	entertainment and education	boredom, stay informed
	V		
	when done she keeps the phone in her hands even when not using it		
	V		
	She gets of the bus tapping off her Opal card	Convenient form of payment	Pay for bus fee
	V		
Street 2			
	She walks to work		
	V		
	At work she enters her building with a swipe card	enter building	locked door
	V		
Office			
	She works 9-5 at an advertising agency in the Sydney CBD	Work	make a living
	V		
Street 3			
	After work she leaves her building and walks to the bus stop.	Catching the bus	Time finished work
	V		
	She waits for the bus texting on her phone with friends	Communication with friend	Txt message from friend
	V		
	Gets on the bus paying with the Opal card	Convenient form of payment	Pay for bus fee

	v		
Bus 2			
	On the bus she sits down and	Travel comofortably	existens of available seat
	v		
	Continuous texting with her friend	Communication with friend	Txt message from friend
	v		
	She reads Elle Magazine on the Elle Magazine app.	entertainment and education	boredom, urge to stay informed
	v		
	She gets off the bus, tapping of her Opal card,	Convenient form of payment	Pay for bus fee
	v		
Street 4			
	Crosses the street and walks home	getting home	bus arrival time
	v		
Home			
	Enters home with her keys	enter building	locked door

Figure 11: Sequence Model Laurene

1.2.2 Sebastian

	Actions	Intent	Trigger
Car 1			
	Drives to work and checks waves on the way		
	v		
	- Puts smart phone into phone holder and makes call using Siri, which fails to recognise the number so he has to search for the contact and make the call manually while driving.	Making a phone call	Need to talk
	v		
	- Parks the car to get a coffee, gets out of the car while making another phone call and locks the car.		
	v		
Street 1			
	Parks car and walks to coffee shop and enters	Get coffee	be more alert
Coffee Shop	v		
	Orders a large cappuccino and pays in cash.	Paying	Cost of coffee
	v		
	While waiting for his coffee he takes his smart phone and checks Pinterest.	Entertainment and Inspiration	boredom, urge to stay informed
	v		
	Grabs coffee and leaves Coffee Shop	drink coffee	be more alert
Street 2	v		
	Walks back to the car and gets in the car	drive to building site	need to inspect a building site

Car 2	v		
	Puts coffee into coffee holder and phone into phone holder.		
	v		
	Checks FlipBoard app and emails while driving and while stopping at traffic lights. Takes phone out of holder to reply to text messages while driving.	Entertainment and Inspiration	boredom, urge to stay informed
	v		
	Parks car and gets out for first building site visit	inspect building site	need to inspect a building site
Site 1	v		
	Visit first building site.	enter building	locked door
	v		
	Leaves first building site, gets back into car	drive to building site	need to inspect a building site
Car 3	v		
	Drives to second building site.		
	v		
	While driving writes another text message	Communication with client	Txt message from client
	v		
	Parks at second site, gets out of car	inspect building site	need to inspect a building site
Site 2	v		
	Checks on second building site	inspect building site	need to inspect a building site
	v		
	Leaves second building site, gets back into car	drive to office	need to work in office
Car 4	v		
	Drives to the office.		
	v		
	Parks car at the beach on a parking spot		

	v		
	Showers and walks back to the car.	Getting back to the office	need to work in office
Parking 3	v		
	Gets key from under the numberplate and gets changed.	Getting back to the office	need to work in office
	v		
	While he is getting changed he checks if he has new emails on his smart phone.	Communication with client	Email message from client
	v		
	He then locks the car.	Getting back to the office	need to work in office
Street 4	v		
	Walks back to the office.	Getting back to the office	need to work in office
	v		
	He crosses the street on a red light with a sense of urgency.	Getting back to the office	need to work in office
	v		
	Opens his office door with a swipe card.	Getting back to the office	need to work in office
Office 2	v		
	Goes back to work		
Street 5	v		
	Sebastian leaves his office late at night, walks to the car park and crosses the street on a red light	Getting home	Sleeping
Parking 3	v		
	He gets into the car and starts driving home.	Getting home	Sleeping
Car 5	v		
	He puts his smart phone into the phone holder.	Secure smart phone	Keep smart phone at arms length
	v		
	Tries to call a friend using Siri, Siri fails so he has to call the number manually.	Communication with friend	Missed call from friend
	v		
	He parks his car in the back of his home and walks back to the entrance and enters the building.	Getting home	Sleeping

Parking 1	v		
	gets park permit from parking computer	park legally	park car to go to work
Beach 1	v		
	Checks waves again at the beach then walks to the office.	check surf conditions	stay informed about surf conditions to go for a surf during the day
Street 3	v		
	He crosses the street and continuous to walk to the office, at the office he opens the door with a smart card and enters the building	Go to office	need to work in office
	v		
	While walking to the office he also reads emails	Communication with client	Email message from client
Office 1	v		
	Works at Office		
Street 4	v		
	At lunchtime, Sebastian leaves his office to go for a surf in Bondi.	Go Surfing	Exercise and Entertainment
	v		
	He crosses the street, walks to the parking lot and opens his car.	Go Surfing	Exercise and Entertainment
Parking 4	v		
	He takes out his board and gets changed.	Go Surfing	Exercise and Entertainment
	v		
	He hides his car key under the number plate, grabs his board and walks towards the beach.	Go Surfing	Exercise and Entertainment
Parking 2	v		
	He starts running down the grass hill and jumps the fence onto the sand.	Go Surfing	Exercise and Entertainment
	v		
	He warms up and paddles out. Surfs some waves. Gets out of the water again and walks towards the shower.	Go Surfing	Exercise and Entertainment

Figure 12: Sequence Model Sebastian

1.2.3 Agathe

	Actions	Intent	Trigger
Street 1			
	Walks to the bus		
	v		
	Eats breakfast while walking to the bus	Being on time	Fear of running late
	v		
	Arrives at the bus stop		
	v		
Bus 1			
	Enters the bus and pays with paper ticket, doesn't know how to get an Opal card	Convenient form of payment	Pay for bus fee
	v		
	Sits down and reads the news on her iPhone for the whole trip		
	v		
	Gets off the bus		

	v		
Street 2			
	She walks to work		
	v		
	She continues to read news and check Facebook while walking	entertainment and education	boredom, urge to stay informed
	v		
	Crosses the street		
	v		
	Enters office building by ringin the door bell	enter building	locked door
	v		
Office			
	She works 9-5 at a beverage company in Surry Hills		
	v		
Street 3			
	After work she leaves her building and walks to the bus stop.	Catching the bus	Need for transport
	v		
	Gets on the bus paying with a paper ticket	Classic form of payment	Pay for bus fee
	v		

Bus 2			
	On the bus she sits down	Travel comofortably	existens of available seat
	v		
	Checks Facebook for the whole trip on her smart phone	Communication with friend	Txt message from friend
	v		
	She gets off the bus		
	v		
Street 4			
	Crosses the street and walks home		
	v		
	On her way she stops at a 1$ shop to buy some household items.	Inform about products	Need for household products
	v		
	Continues to walk home		
	v		
Home			
	Enters home with her keys	enter building	locked door

Figure 13: Sequence Model Agathe

1.2.4 Kay

	Actions	Intent	Trigger
Street 1			
	- Kay leaves his home in the morning and walks to bakery	Eat breakfast	hungry
Bakery	v		
	- Buys breakfast at his local bakery, pays in cash and eats it at the window table inside the bakery,	Pay for food	Need to Receive food
	v		
	- He watches people on the street	entertainement	Need to be entertained
	v		
	- Reads news on Facebook while eating.	Entertainment and education	Need to feel connected and stay up to date
	v		
	- When finished he gets another coffee to-go, pays in cash	Drink coffe on the way to work	Need to drink more coffee
Street 2	v		
	- Walks to bus stop		
	v		
	- Waits for his bus at the bus stop		
	v		
	- At the bus stop he continuous to reads the news using Facebook on his iPhone	Entertainment and education	Need to feel connected and stay up to date
Bus 1	v		
	- Pays the bus with a pre-purchased paper ticket, he doesn't know how to get an opal card	Classic form of payment	Pay busfare
	v		
	- In the bus he deliberately avoids his iPhone and rather watches people.	entertainement	Need to be entertained
	v		
	- He is curious what other people are reading on their smart phone	Need to be entertained	Need to be entertained
	v		
	- Ends up checking the time on his iPhone	Checks if he is too early for work	Be on time for work
Train 1	v		
	- Kay leaves the bus and enters Bondi Junction station	Commute to work	Bus route does not go past his workplace

	v		
	- Inside he station Kay purchases a train ticket and uses the Eftpos machine to pay.	Convienent form of payment	Pay for train fare
	v		
	- He validates his ticket	Legal transport	Pay for train fare
	v		
	- Goes down the escalator and throws his coffee to-go cup in the bin.		
	v		
	- He enters the train and sits down		
	v		
	- He again doesn't use his smart phone on the train but starts people watching and contemplating.	entertainement	Need to be entertained
	v		
	- Kay leaves the train at Martin Place station and walks up the escalator		
	v		
	- Kay validates his ticket at the exit of the train station and leaves the station on to Martin Place	Exit trainstation	Pay correct fare
Street 3	v		
	- While walking towards his workplace, he calls a friend from Melbourne for a chat. The chat goes for 10 minutes, Kay walks slower when talking on the phone.	Catch up with friend	Social need
	v		
	- When finished with the call he takes a photo of a guy with what he thinks is a funny shirt.	entertainement	Need to be entertained
	v		
	- He takes his jacket off because he is feeling hot and continues walking.	Feeling comfortable	Hot day
	v		
	- Kay is 20 minutes early for work, so he decides to sit down on a step in the sun and check Instagram and he's posting the photo of the funny shirt he took before.	entertainement	Need to be entertained
	v		
	- He enters his workplace.		
Work	v		
	- Kay works for 6 hours.		
Street 4	v		
	- Kay leaves work with his duffel bag he left at his workplace previously.		
	v		

	- After work he checks Facebook and walks towards Martin Place station.	entertainement	Need to be entertained
	v		
	- On the way he contemplates on a new building structure for 5 minute and keeps on walking.	Wants to analyse new building	Interest in architecture
	v		
	- He crosses a red traffic light without paying attention to traffic.		
Train 2	v		
	- He enters Martin Place station and validates his paper ticket.	Legal transport	Pay transport fare
	v		
	- Walks down the escalators.		
	v		
	- He sits down on one of the benches while waiting for his train and checks Facebook on his smart phone.	entertainement	Need to be entertained
	v		
	- All the other people around him are also interacting with their smart phone	entertainement	Need to be entertained
	v		
	- Checks eMails while driving	Organise life	Email request which require his attention
	v		
	- Kay approaches the arriving train covers his ears because the break sound is very loud.	Stay comfortable	Loud noise
	v		
	- Enters train and looks for a space to sit down.		
	v		
	- Kay decides to stand instead even though there is seats available and contemplates on the skyline of Sydney while looking through the train window	entertainement	Need to be entertained
	v		
	- Kay leaves the train goes up the escalator to the upper area of the train station where he validates his paper ticket and where the busses leave.	Legal transport	Pay transport fare
	v		
	- Kay buys a bus ticket and pays in cash.	Legal transport	Pay transport fare
	v		
	- He checks Facebook while waiting for the bus.	entertainement	Need to be entertained
	v		

	- Since the bus is late he decides to sit down while waiting.	Being comfortable	Bus is late
Bus 2	v		
	- Kay enters the bus paying with his purchased paper ticket.	Legal transport	Pay transport fare
	v		
	- When sitting down a women recognises that Kay is German.	communication	Kay said something in german
	v		
	- She pulls out an iPhone and start showing him photos of her travelling through east Berlin in the 70s.	Social entertainment	Mutual interest
	v		
	- Kay is interested and starts chatting to her and mentions he grew up in east Germany.	Social entertainment	Mutual interest
	v		
	- They chat about the photos for the whole trip and the women hands over Kay her email address so they can stay in touch.	Staying in touch	Social need
Street 5	v		
	- Kay leaves the bus and walks home.	Getting home	Being home
	v		
	- He crosses the street using a traffic light.		
	v		
	- Enters his home building using analog keys	enter building	Locked door

Figure 14: Sequence Model Kay

1.2.5 Peter

	Actions	Intent	Trigger
Street 1			
	- Peter leaves his home and walks to the beach for a surf	entertainment	Good waves
	v		
	- He is wearing canvas shoes to be able to walk more comfortably on the street.		
Beach	v		
	- He leaves his shoes on the ramp and warms up on the sand		
	v		
	- He then surfs for 45 minutes		
	v		
	- When finished he gets out and grabs his shoes from the ramp.		
	v		
	- He takes a shower and puts his shoes back on.	Cleaning himself	Salt water on skin
Street 2	v		
	- He walks home.		
	v		
	- When walking home he crosses the street.		
Home	v		
	- He enters his home with analog keys.	Entering building	Locked door
	v		
	- At home he gets changed for work and makes a coffee.		
	v		
	- He then leaves his home.		
Street 3	v		
	- He walks to his car to drive to the ferry	Getting to work	Needs to work
Car 1	v		
	- He gets in the car with analog keys	commuting	Closed car door
	v		
	- He drives to the ferry		
	v		
	- He drinks coffee while driving and puts his coffee cup into a coffee cup holder	Drink coffee while commuting	Needs to drink coffee

	v		
	- He then parks the car.		
Street 4	v		
	- He gets out of car and walks to ferry	Commuting to work	Fery is quicker then train
	v		
	- While walking to the ferry he drinks more coffee.	Drink coffee while commuting	Needs to drink coffee
	v		
	- He checks the time on his smart phone and recognises that he is a bit late and also received a text message.	Being on time	Fear of running late
	v		
	- He is reading the text message while walking quicker to the ferry.	communicate	Recived text message which needs his attention
	v		
	- He ditches the empty coffee cup and hurries up.		
Ferry 1	v		
	- He boards the ferry		
	v		
	- He first sits down on the upper deck and starts answering the message he received.		
	v		
	- He notices that its too cold on the upper deck and goes down inside to the lower deck.	communicate	Recived text message which needs his attention
	v		
	- On the lower deck he keeps writing text messages and reading websites while standing, since there are no more seats available.	Communicate and entertainment	Recived text message which needs his attention and need to be entertained
Street 5	v		
	- He gets off the ferry and validates his fare with a paper ticket because he doesn't like the opal card.	Legal transport	Pay transport fare
	v		
	- He puts his sunglasses on and keeps on walking to work.	Staying comfortable	Strong sunlight
	v		
	- He walks through the Rocks district and arrives at work.		
Work	v		
	- He then works 9-5		
Street 6	v		

	- When finished working he leaves work and checks his phone for the time if he is late for his ferry.	Being on time	Fear of running late
	v		
	- He decides to walk slower since he is early for the Ferry.		
	v		
	- He then walks through the Rocks towards the ferry terminal.		
	v		
	- When he arrives at the ferry terminal he pays with a paper ticket and checks if the ferry is delayed on a digital screen and sees that the ferry is on time.	Legal transport	Pay transport fare
	v		
	- He then walks to the ferry dock.		
	v		
	- While waiting for the ferry he starts browsing the internet on his smart phone to check tomorrows surf conditions.	information	Need for surf entertainment
Ferry 2	v		
	- He enters the Ferry sits down in the back of the ferry.		
	v		
	- He continues browsing the internet for surf related news.	entertainment	Need to be entertained
	v		
	- He leaves the ferry.		
Street 7	v		
	- He leaves the terminal and walks back to the car.	Commute home	Being home
Car 2	v		
	- He gets in the car with analog keys.	Getting into car	Closed car door
	v		
	- He drives home without looking at his smart phone.	Commute home	Being home
	- He leaves the car, closes it with analog keys.	Close car	Keep car safe
Street 8	v		
	- He walks home		
Home	v		
	- He arrives at home and opens the door with analog keys.	Entering building	Locked door

Figure 15: Sequence Model Peter

1.2.6 Liya

	Actions	Intent	Trigger
Street 1			
	Walks to the bus	Commuting to work	Need to be at work
	v		
	Listens to music on her smart phone using Spotify while walking to the bus	entertainement	Need to be entertained
	v		
	Arrives at the bus stop and waits for the bus		
	v		
	Listens to music on her smart phone while waiting for the bus	entertainement	Need to be entertained
	v		
	Snapchatting with a friend on her smart phone while waiting for the bus	communicating	Need for social communication
	v		
Bus 1			
	Enters the bus and pays with paper ticket, doesn't know how to get an Opal card but would like to get one	Classic form of payment	Pay for bus fee

	v		
	Sits down and continues snapchatting with her friend on her iPhone.	communicating	Need for social communication
	v		
	Puts her phone down for a while but keeps it in her hand.		
	v		
	Starts texting with another friend on WhatsApp on her smart phone	communicating	Address received message
	v		
	Gets off the bus		
	v		
Street 2			
	She walks to Art School		
	v		
	She continues texting with WhatsApp with her friend on her smart phone while walking	communicating	Received message
	v		
	Stops at Traffic lights, presses button		
	v		
	Crosses the street and continues walking		

	v		
	Enters Art School building by creating the receptionist at the door	enter building	locked door
	v		
Office			
	She works 9-5 on Art in an Art School building in Darlinghurst		
	v		
Street 3			
	After work she leaves Art School building and walks to the bus stop and waits for the bus.	Catching the bus	Time finished work
	v		
	Gets on the bus paying with a paper ticket	Classic form of payment	Pay for bus fee
	v		
Bus 2			
	On the bus she sits down	Travel comofortably	existens of available seat
	v		
	Starts texting with another friend on WhatsApp on her smart phone	Communicating	Received message
	v		
	Puts her phone down for the rest of the trip but keeps it in her hand		
	v		

	She gets off the bus		
	v		
Street 4			
	Walks home	getting home	bus arrival time
	v		
	Puts her phone into her bag		
	v		
	Continues to walk home		
	v		
Home			
	Enters home with her keys	enter building	locked door

Figure 16: Sequence Model Liya

1.2.7 Matt

	Actions	Intent	Trigger
Street 1			
	- Walks to the car		
	v		
	- Open car door with remote	Getting into car	Driving to work
Car 1	v		
	- Gets into car		
	v		
	- Connects Smart Phone to in car holder and stereo	Make hands free phone calls	Need to communicate
	v		
	- Starts car with car keys		
	v		
	- Drives to work	Commute to work	Need to go to work
	v		
	- Constantly interacts with Smart Phone while driving to check social networks, messages and listen to music	Communicate, educate and entertain	Need to stay online

	v		
	- Parks car on on-street parking		
	v		
	- Gets out of car		
Street 2	v		
	- Closes door using car remote	Close door	Keep car safe
	v		
	- Walks to the office		
Office	v		
	Works 9-5 in building		
Street 3	v		
	- Walks to the car		
	v		
	- Open car door with remote	Getting into car	Driving to Pub
Car 2	v		
	- Gets into car		
	v		
	- Starts car with car keys		
	v		

	- Drives to Pub	Have beer with friend	Need to socialise
	v		
	- Parks car on on-street parking		
	v		
	- Gets out of car		
Street 4	v		
	- Closes door using remote	Close door	Keep car safe
	v		
	- Walks to the Pub		
Pub	v		
	- Enters pub through door		
	v		
	- Orders beer from the bar tender	Get beer	Wants to drink beer with friend
	v		
	- Pays beer in cash	pay beer	Needs to pay for beer
	v		
	- Drinks beer		
	v		
	- Chats with person	communicate	Need to socialise

	v		
	- Leaves Pub		
Street 5	v		
	- Walks back to the car		
	v		
	- Open car door with remote	Getting into car	Driving to home
Car 3	v		
	- Gets into car		
	v		
	- Connects iPhone to Stereo via USB	entertainment	Wants to Play music through car speaker
	v		
	- Starts car with car keys		
	v		
	- Drives home		
	v		
	- Listens to music using the Spotify App on his iPhone	entertainment	Need for entertainment
	v		
	- Checks eMails while driving	communication	Conduct business

	v		
	- Parks car on on-street parking		
	v		
	- Gets out of car		
Street 6	v		
	- Closes door using remote	Close car door	Keep car sage
	v		
	- Walks home		
	v		
	- Enters home with key	enter building	Locked door

Figure 17: Sequence Model Matt

1.2.8 Bea

	Actions	Intent	Trigger
Street 1			
	- Bea leaves her home and walks to her car.		
Car 1	v		
	- Bea opens her car with analog keys.	Getting into car	Closed car door
	v		
	- She gets in the car and starts driving to work.	Commute to work	Need to be at work
	v		
	- She checks her iPhone for real-estate news since she is looking for a new apartment while she is driving.	Check realestate website	Need to find appartment
	v		
	- She is holding her phone in her hand at all times while driving since she does not have a smart phone holder.	Check realestate website	Need to find appartment
	v		
	- In particular, at traffic lights she interacts with her iPhone the most.	Check realestate website in more detail	Traffic light
	v		
	- She is also listening to music on her car stereo which is tuned into a radio station an starts playing when she started the car.	entertainment	Need to be entertained
	v		
	- She did not have to touch the radio to turn on the music since it was switched on already.		
Petrol Station	v		
	- Bea stops at a petrol station to get gas.	Refill gas tank	Empty gas tank
	v		
	- She refills her tank and walks into the station to pay.	Pay gas	Price of gas
	v		
	- She pays in cash inside the station.	Legal payment	Gas costs
	v		
	- She leaves the station and gets back into the car.	Commute to work	Need to be at work
Car 2	v		
	- Bea checks her iPhone for more real-estate postings while she is putting on the seatbelt and starts driving.	Check realestate website Driving safely	Need to find apartment Accident risk

	v		
	- She continuous driving to work.		
	v		
	- She parks the car.		
Street 4	v		
	- She gets out of the car and continuous walking to work.		
	v		
	- She doesn't close her car since the back window is open anyway.		
	v		
	- But she needs to use analog keys to open the car door.		
	v		
	- While walking she keeps on checking her iPhone for emails and text messages	Check realestate website	Need to find apartment
	v		
	- She arrives at her work and enters the building.		
Work	v		
	- She works for four hours.		
Street 5	v		
	- She leaves work and walks back to her car		
	v		
	- While walking she checks her iPhone again for messages, emails and Real-estate posts.	Check realestate website Communicate	Need to find apartment Received email
	v		
	- She gets in her car		
Car 3	v		
	- She starts her car and drives home.	Commute home	Getting dog and go to park to use laptop
	v		
	- She is not using her iPhone while driving back home.		
	v		
	- She parks her car.		
Home 2	v		
	- She gets out of her car and walks home to pick up her dog	Take dog for a walk	Dogs needs to walk
	v		

	- She opens her home door using analog keys.	Getting into building	Closed door
	v		
	- She gets her dog and walks back to the car		
Car 4	v		
	- She lets the dog into her car		
	v		
	- She gets into her car and drives to the post office.	Drive to post office	Need to Send mail
	v		
	- She parks the car and gets out.		
Street 6	v		
	- She gets a parking ticket from the parking machines.	Pay parking costs	Parking laws
	v		
	- She puts the parking ticket back into the car.		
	v		
	- She lets the dog out and puts the dog on the leash.		
	v		
	- She walks with the dog to the post office.		
	v		
	- She's checking more emails on her smart phone while walking.	communication	Received email
	v		
	- She leaves the dog outside and ties the dog to a pole and enters post office.	Keep dog safe Send mail	Dogs temperament Need to send mail
	v		
	- The dog waits outside.		
	v		
	- She comes back out while checking her smart phone for more messages.	communication	Received text messages
	v		
	- She picks up her dog and walks back to car.		
	v		
	- She crosses the street.		
Car 5	v		
	- She lets the dog back into the car		
	v		

	- She gets back into the car and starts driving to the beach.	Driving to beach	Let dog for a walk, beach is nice to work at
	v		
	- She drives to the beach		
	v		
	- She gets out and lets her dog out of the car.		
Beach	v		
	- She walks down to the beach.		
	v		
	- She sits down and goes online with her laptop.	Check realestate website Communicate	Need to find an appartment
	v		
	- She tethers the internet from her iPhone because the BondiBeach WiFi is too slow.	Teteher 4g to Laptop	Bad free wifi
	v		
	- She writes emails while she is letting her dog go for a walk on the grass.	communicate	Eceived email
	v		
	- When she is done with her Laptop, she wraps up and picks up her dog		
	v		
	- She walks the dog to the water fountain to give him water to drink.	Give dog some water	Dog is thirsty
Car 6	v		
	- She opens the car		
	v		
	- They both get back into the car		
	v		
	- She drives back home	Driving home	Being home
Home 3	v		
	- She parks the car		
	v		
	- She gets out of the car		
	v		
	- She walks back home with the dog		
	v		
	- She checks her mailbox and enters the building with analog keys.	Checking mail	Need to communicate

Figure 18: Sequence Model Bea

1.2.9 Heidi

	Actions	Intent	Trigger
Street 1			
	- Heidi leaves her home in the morning.		
	v		
	- She is checking her mailbox when she leaves the house	Checking mail	Need to communicate
	v		
	- She then walks to the car.		
Car 1	v		
	- She opens car with analog keys .	Getting into car	Closed car door
	v		
	- She starts the car and drives to her work location.	Commute to work	Need to be at work
	v		
	- She puts her smart phone in a smart phone holder while driving.	Use smarphone	Driving laws, need to communicate
	v		
	- At traffic lights she checks, emails, text messages and Instagram.	Communicate and enterainment	Received messages and need to be entertained
	v		
	- She parks her car.		
	v		
	- She takes the smart phone out of the holder and gets out of car		
	v		
	- She closes the car with analog keys.	Close car door	Keep car safe
Work	v		
	- She visits a client.	Work with client	Client meeting
	v		
	- When she finishes the client visit she gets back into car using analog keys.	Getting into car	Closed car door
Car 2	v		
	- She starts driving.	Driving to lunch location	hungry
	v		
	- She puts her smart phone into the smart phone holder at the next traffic lights.	Use smartphone	Driving laws, need to communicate and be entertained
	v		

	- She checks Instagram on her smart phone while driving.	entertainement	Need to be entertained
Beach	v		
	- She parks her car at the beach to get lunch.		
	v		
	- She walks to the parking ticket machine	Getting parking ticket	Parking laws
	v		
	- She gets a free parking ticket from a parking computer since she has a parking permission.		
	v		
	- The parking ticket computer checks her parking rights and prints a parking ticket.		
	v		
	- She takes the parking ticket and walks back to the car.		
	v		
	- She puts the parking ticket into car and close the car with analog keys.		
	v		
	- She leaves the parking lot and walks towards the shops.		
Street 2	v		
	- While walking she checks her iPhone again for messages, emails	communication	Received messages and emails
	v		
	- She crosses a street using a traffic light.		
Shop 1	v		
	- She enters the shop and orders a sandwich.	Buy sandwich	hungry
	v		
	- She pays in cash because the shop does not offer EFTPOS.	Convienent form of payment	Cost of sandwich
Street 3	v		
	- She leaves the store and goes back to the beach.		
	v		
	- She again crosses the street using a traffic light.		
Beach 2	v		
	- She sits down on the grass at the beach and enjoys her lunch.	Eating and enjoying the beach	Hungry and eating and an enjoyable location

	v		
	- She leaves her smart phone in her handbag while eating.		
	v		
	- She finishes her lunch.		
	v		
	- She bins her leftovers and stays a bit longer on the beach looking at the ocean.		
Car 3	v		
	- She gets back into her car using analog keys.	Closed car door	Locked car
	v		
	- She drives back home to get changed	Driving home	Need to change clothes
	v		
	- She is not using her smart phone on this trip.		
Home	v		
	- She parks her car.		
	v		
	- She closes the car with analog keys.	Closing car door	Keep car safe
	v		
	- She walks back towards the home building.		
	v		
	- She enters the door with a RFID swipe card.	Getting into building	Locked door
	v		
	- She leaves the house and walks back to the car.		
Car 4	v		
	- She gets back into the car using analog keys.	Getting into car	Closed car door
	v		
	- She checks her smart phone for messages in the car before starting the car.	communication	Received messages
	v		
	- She starts driving and switches on the radio for the first time to listen to music.	entertainment	Need to be entertained
	v		
	- She puts on her sunglasses while driving and does not use her smart phone while driving.	Being comfortable	Strong sunlight
	v		

	- She parks her car and gets out.		
	V		
	- She locks the car with analog keys	Close car door	Keep car safe
Street 4	V		
	- She walks to work checking messages and Instagram on her smart phone while walking.	Communication and entertainement	Received messages and need to be entertained
	V		
	- She crosses the street and enters a coffee shop.	buying coffee	Need to drink coffee
Coffee Shop	V		
	- She orders a coffee to-go and pays with Paypass on an EFTPOS machine.	Convenient form of payment	Cost of coffee
	V		
	- While she waits for her coffee she checks emails on her smart phone then picks up the coffee.	communication	Received email
Street 5	V		
	- She continuous her way to work holding the coffee cup, crosses the street and enters her workplace.	Drinking coffee while walking	Need to drink coffee
Work	V		
	- She works for four hours		
	V		
	- She finishes work and closes the door with analog keys.	Close door	Keep office safe
Street 6	V		
	- She walks back to her car		
	V		
	- She opens the car with analog keys and gets into the car.	Drive to restaurant	Hungry
Car 5	V		
	- She drives to a restaurant to have dinner.		
	V		
	- She is not using her smart phone while driving.		
	V		
	- She parks the car.		
Street 7	V		
	- She leaves the car gets a parking ticket from the ticket computer and puts the parking ticket back into the car.	Get parking ticket	Parking laws
	V		

	- She closes the car door with analog keys	Close car door	Keep car safe
	v		
	- She walks to the restaurant checking her messages on the way.	communication	Received message
	v		
	- She crosses a street using a traffic light.		
	v		
	- She texts on the way, while walking.	communication	Received message
	v		
	- She stops at a flower shop to look at some flowers but does not buy anything.	Looking at flowers	Interest in flowers
Restaurant	v		
	- She arrives at a Sushi restaurant and waits for a table.		
	v		
	- She then eats Sushi.	Eats sushi	Hungry
Street 8	v		
	- When finished at the restaurant she walks back to the car.		
	v		
	- Crosses the street again using a traffic light.		
	v		
	- She then arrives at the car and unlocks the car using analog keys.	Getting into car	Closed car door
Car 6	v		
	- She gets in the car.		
	v		
	- She starts the car and drives back home	Commute home	Wants to be home
	v		
	- She switches on the radio while driving.	entertainment	Need for entertainment
	v		
	- She parks the car and gets out.		
Home 2	v		
	- She locks the car using analog keys	Closing car door	Keep car safe
	v		
	- She walks towards the home building.		
	v		

	- When she arrives at home she unlocks the door with a RFID smart card and enters her home.	Getting into building	Closed door

Figure 19: Sequence Model Heidi

1.2.10 Ralph

	Actions	Intent	Trigger
Street 1			
	- Ralph leaves his house to get a coffee.	Getting coffee	Need to drink coffee
	v		
	- He walks towards a coffee shop through the streets of Bondi.		
Coffee Shop	v		
	- At the coffee shop he orders a coffee and pays with Paypass using an EFTPOS machine.	Convenient form of payment	Cost of coffee
	v		
	- He sits down at a window table and reads a paper based street press newspaper while waiting for his coffee.	Educate and entertainment	Need to be entertained and informed
	v		
	- He receives his coffee and puts sugar in.		
	v		
	- He keeps reading the newspaper.	Educate and entertainment	Need to be entertained and informed
	v		
	- He then switches to his iPhone to check and answer some emails, while drinking coffee.	communication	Received emails
	v		
	- He leaves the coffee shop.		
Street 2	v		
	- He walks to the beach to check the waves if he can go surfing.	entertainment	Need for surf entertainment
	v		
	- He takes his coffee cup with him.	Drink coffee while walking	Need to drink coffee
	v		
	- He stops half way to the beach to delete his photos on his iPhone because his phone is too slow and he thinks that if he deletes photos on his iPhone it will be faster again, he stands there for 5 minutes doing that and drinking coffee at the same time.	Free up storage space on smartphone	Slow smartphone
	v		

	- Once finished deleting he crosses the street and continuous to walk to the beach.		
Beach	v		
	- He arrives at the beach.		
	v		
	- He checks the waves, if they are good for surfing.	entertainment	Need for surf entertainment
	v		
	- He takes a photo of the surf and posts it on Instagram.	Social entertainment	Need for social entertainment
	v		
	- He figures that the tide is too high for surfing and checks when the tide will be low and decides to go later when the tide is lower.		
	v		
	- He walks back home.	Getting home	Need to work from home
	v		
	- He walks through Bondi Pavilion to take a short cut.		
	v		
	- He leaves Bondi Pavilion and continues to walk home.		
Street 3	v		
	- He crosses the street using a traffic light.		
Home	v		
	- When he arrives at home he enters the building with a RFID swipe card.	Getting into building	Closed door
	v		
	- He works from home for four hours		
	v		
	- After working for four hours at home he leaves the house again	Going shopping	In need of products, needs to run errends and get a haircut
Street 4	v		
	- He walks to the car		
	v		
	- He opens the car with a remote control.	Getting into car	Closed car door
Car 1	v		

	- He gets into the car and drives to the shops.	Drive to shops	Shops are not in walking distance
	v		
	- He is eating lollies while driving which he thinks are good for his throat	Sooth throat	Sore throat
	v		
	- He then parks the car.		
Street 5	v		
	- He gets out of the car.		
	v		
	- He gets a parking ticket at the parking ticket computer.	Get parking ticket	Parking laws
	v		
	- He puts the ticket back into the car.		
	v		
	- He gets his bag out of the car and closes the car with a remote control.	Close car door	Keep car safe
	v		
	- He crosses the street and walks to the Waverly City Council.		
	v		
	- He enters the Waverly City Council through sliding doors.		
	v		
	- When finished he leaves Waverly City Council and walks away interacting with his iPhone checking messages	communicate	Received message
	v		
	- He bumps into another person because he is interacting with his iPhone.	Unintended accident	Attention was on screen not on street
	v		
	- Ralph keeps interacting with his iPhone while walking towards a mall entrance checking messages	communicate	Received message
	v		
	- He enters the mall and supermarket checking on his iPhone what groceries he needs to buy.	Remind himself of what to buy	Need for products
	v		
	- After finishing grocery shopping he leaves the mall and walks towards his bank branch to do some banking.	Get cash from bank	Needs cash
	v		
	- He crosses several streets using traffic lights.		

	v		
	- He then enters another mall and walks into his bank branch		
	v		
	- When finished banking he leaves the mall and walks back towards his car crossing a red traffic light.		
	v		
	- On the way back to his car he stops at a Mexican fast food restaurant to get some lunch.	Eat food	Hungry
Restaurant	v		
	- He orders a burrito and a can of soda and pays in cash.	Pay food	Cost of food
	v		
	- While eating his burrito he keeps on reading emails and replying to them.	communication	Received emails
	v		
	- When finished eating lunch he leaves the Mexican restaurant.		
Street 6	v		
	- He walks back to the car		
	v		
	- While walking he keeps on checking his iPhone for messages.	communication	Received messages
	v		
	- On the way back to his car he stops at another coffee shop to get a coffee.	Getting coffee	Need to drink coffee
Coffee Shop 2	v		
	- He orders a coffee and pays in cash.	Pay coffee	Cost of coffee
	v		
	- While waiting for the coffee he reads more emails.	communication	Received messages
	v		
	- He then receives his coffee and leaves the coffee shop.		
Street 7	v		
	- He walks back to the car.		
	v		
	- While walking back to the car he drinks his coffee.	Drink coffee while walking	Need to drink coffee
	v		
	- He keeps on using his smart phone to read emails.	Communication	Received emails

	v		
	- He also uses another traffic light to cross another street.		
	v		
	- He gets back into the car using a remote control.	Getting into car	Closed car door
Car 2	v		
	- He puts his coffee into a coffee cup holder.	Drink coffee while driving	Need to drink coffee
	v		
	- He starts driving towards another shopping area.	Driving to other shops	Need for more products
	v		
	- While he is driving he keeps on reading emails at traffic light stops.	communication	Received emails
	v		
	- He parks the car		
	v		
	- He leaves the car and closes the car with a remote control	Close car door	Keep car safe
Street 8	v		
	- He walks towards the shops		
	v		
	- He enters a pharmacy and buys some medicine.	Buy medicine	Need for medicine
	v		
	- He leaves the pharmacy and walks towards the news agent		
	v		
	- He crosses the street using a traffic light		
	v		
	- He pushes a button and waits for the traffic light to switch to green.		
	v		
	- At the newsagent he enters the shop.	Buy newsagent product	Need for newsagent product
	v		
	- He leaves the newsagent and walks towards the post office		
	v		
	- He enters the post office to send some mail.	Send mail	Need to send mail

	v		
	- He then leaves the post office and walks towards the hairdresser.		
	v		
	- He crosses some streets and enters the hair dresser to get a haircut	Get a haircut	Need for haircut
	v		
	- He leaves the hairdresser and walks back to the car.		
	v		
	- While walking back to the car he his making a phone call with his girlfriend.	communication	Receives call from girlfriend
	v		
	- He then arrives at the car		
Car 3	v		
	- He gets back into the car using a remote control	Getting into car	Closed car door
	v		
	- He drives back to his home.	Getting home	Need to work more from home
	v		
	- While driving he is not using his smart phone.		
Street 9	v		
	- He parks the car		
	v		
	- He gets out of the car		
	v		
	- He closes the car with a remote control	Close car door	Keep car safe
	v		
	- He crosses the street and arrives at this home		
Home	v		
	- He opens his home door with an RFID based swipe card and enters the building.	Getting into building	Closed door

Figure 20: Sequence Model Ralph

1.2.11 Individual Data Models - Laurene (9-5 worker using Public Transport) - Circle Flow & Physical Model

The first participant researched was Laurene who uses public transport and has a 9-5 job in the Central Business District in Sydney.

Physical Model:

The physical model show's Lauren's interactions situated in the physical environment and within the narrative of her day over time.

Figure 21: Laurene Physical Model Frame 1

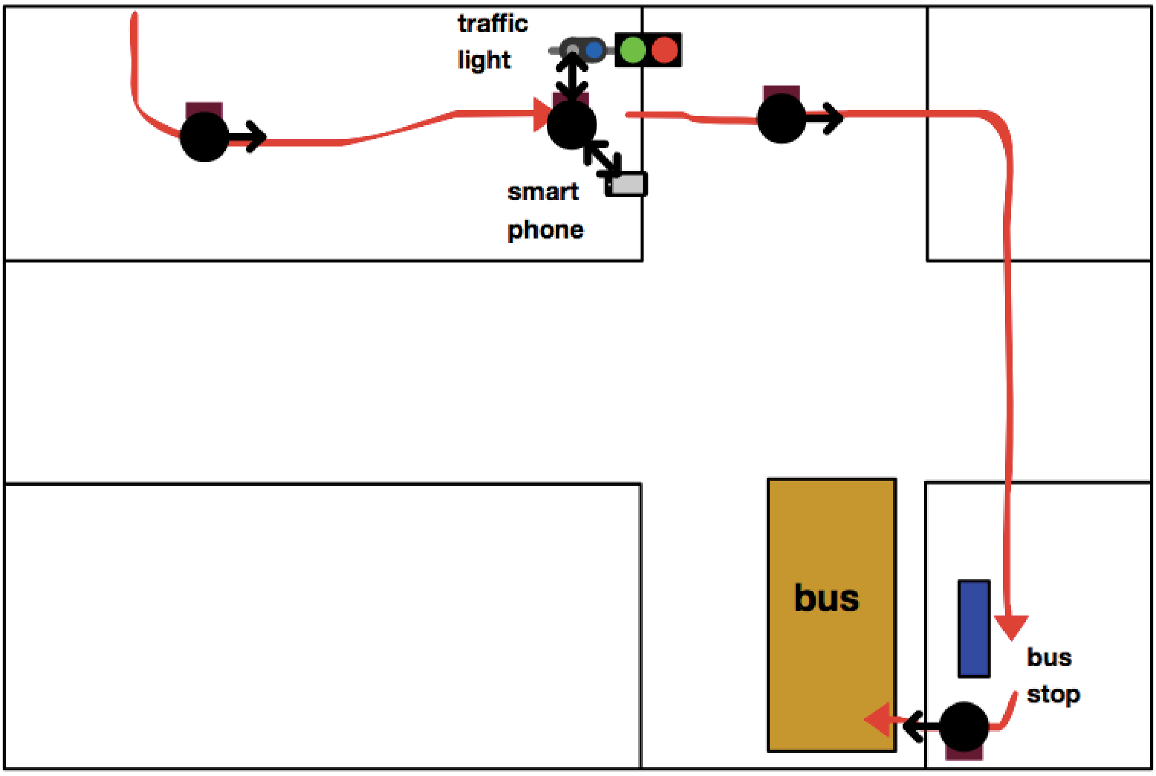


Figure 22: Laurene Physical Model Frame 2

Figure 23: Laurene Physical Model Frame 3

Laurene leaves her home location carrying her hand bag walking towards the traffic lights. She stops at the traffic lights interacting with the traffic light button and interacting with her smart phone to look up bus arrival times on the NextThere app to check if she needs to walk faster or can walk slower to the bus stop. The bus is arriving soon so she decides to walk faster. She crosses the street at the traffic lights and waits for the bus at the bus stop. When the bus arrives, she enters the bus.

Figure 24: Laurene Physical Model Frame 4

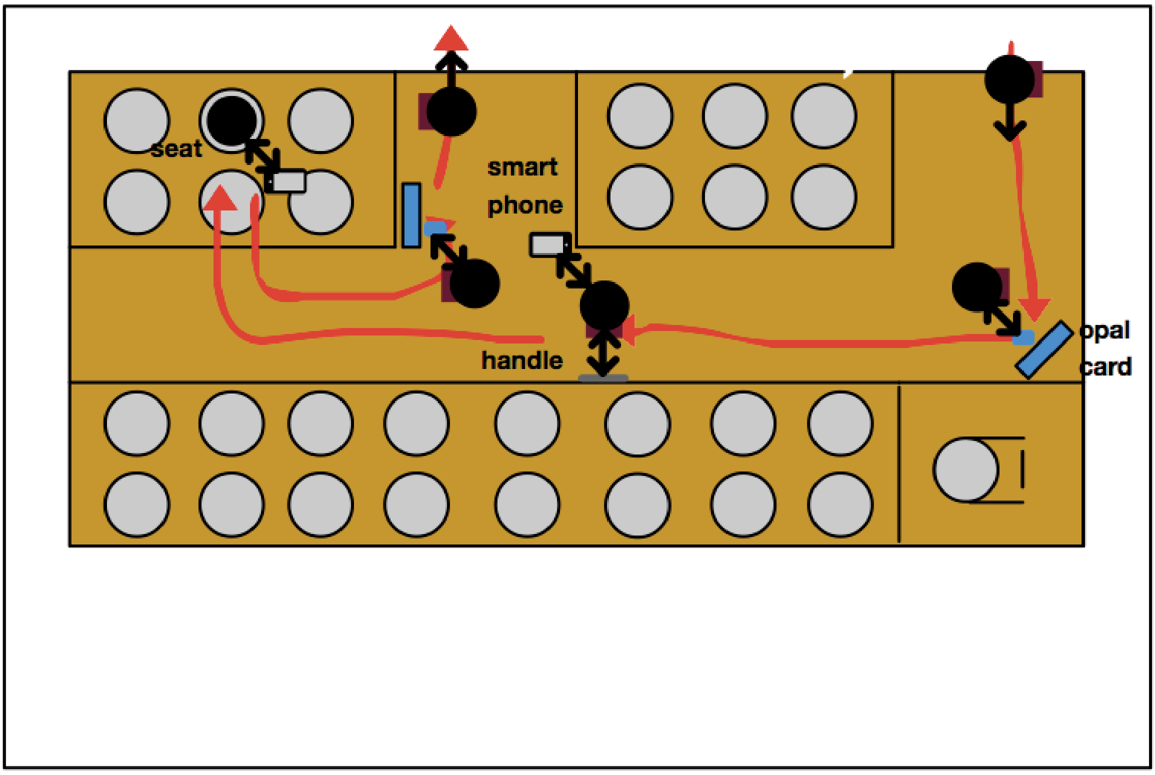


Figure 25: Laurene Physical Model Frame 5

After entering the bus her next interaction is paying with the RFID based Opal card. The opal card connects to the transport database and confirms that she has enough balance to pay for her trip. The Opal card interaction is a digital interaction which is based on a physical computing interface rather then a smart phone interface. This interaction is marked as a disruption with red arrows, since it potentially can be improved with smart phone interactions. Laurene then rides in the bus standing first and later, after most people get out at Bondi Junction, would sit down further back in the bus. While riding in the bus she would interact with her smart phone most of the time. She mostly read news on a french news website to educate and entertain herself during the ride. When done reading she keeps the phone in her hands even when not using it.

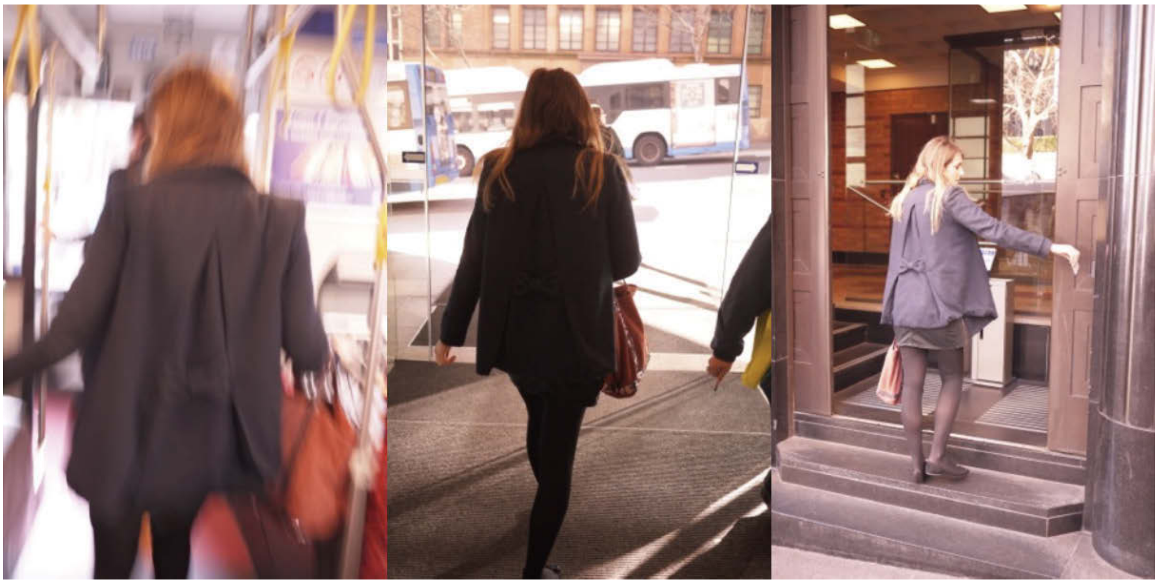


Figure 26: Laurene Physical Model Frame 6

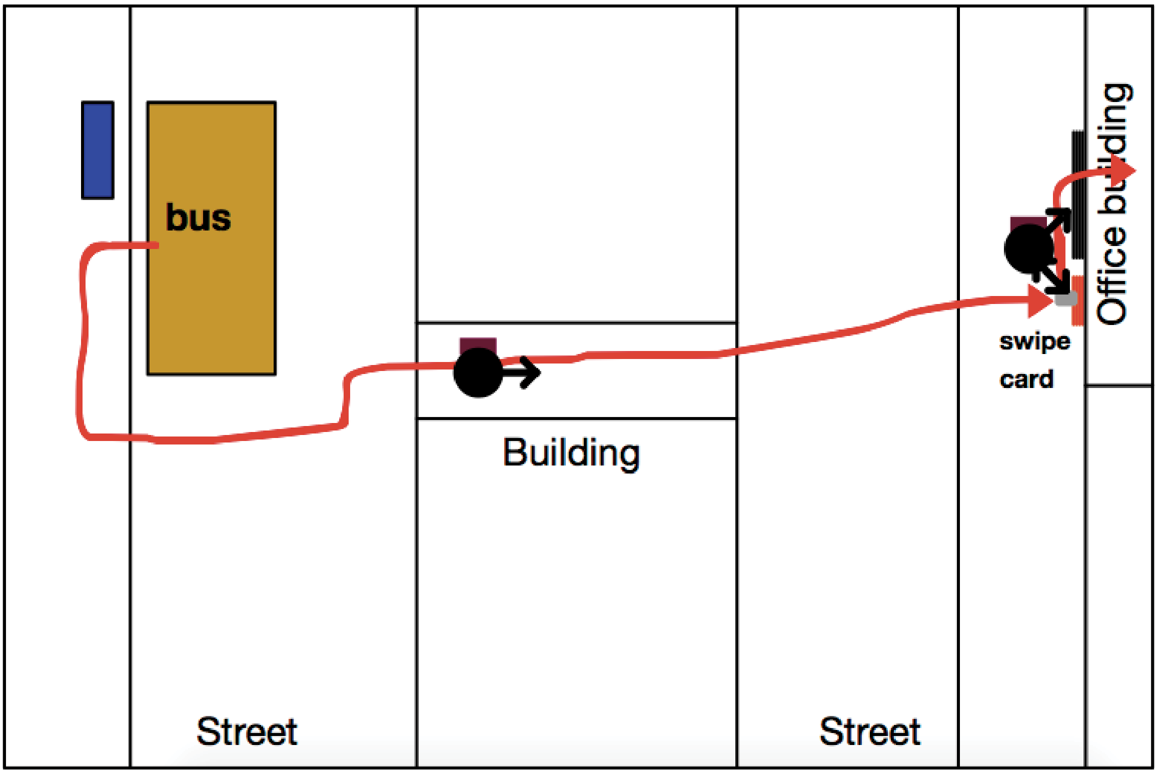


Figure 27: Laurene Physical Model Frame 7

When exiting the bus Laurene again interacts with the Opal card interface to mark the end of her trip. The Opal card system requires this second interaction to pay the correct fee. Laurene then leaves the bus and walks through another building to her office building and interacts with the entrance door using a physical computing system based on a RFID swipe card. This RFID card interacts with the building management database to ensure Laurene has sufficient access rights. Laurene then works 9-5 in the office building.

Figure 28: Laurene Physical Model Frame 8

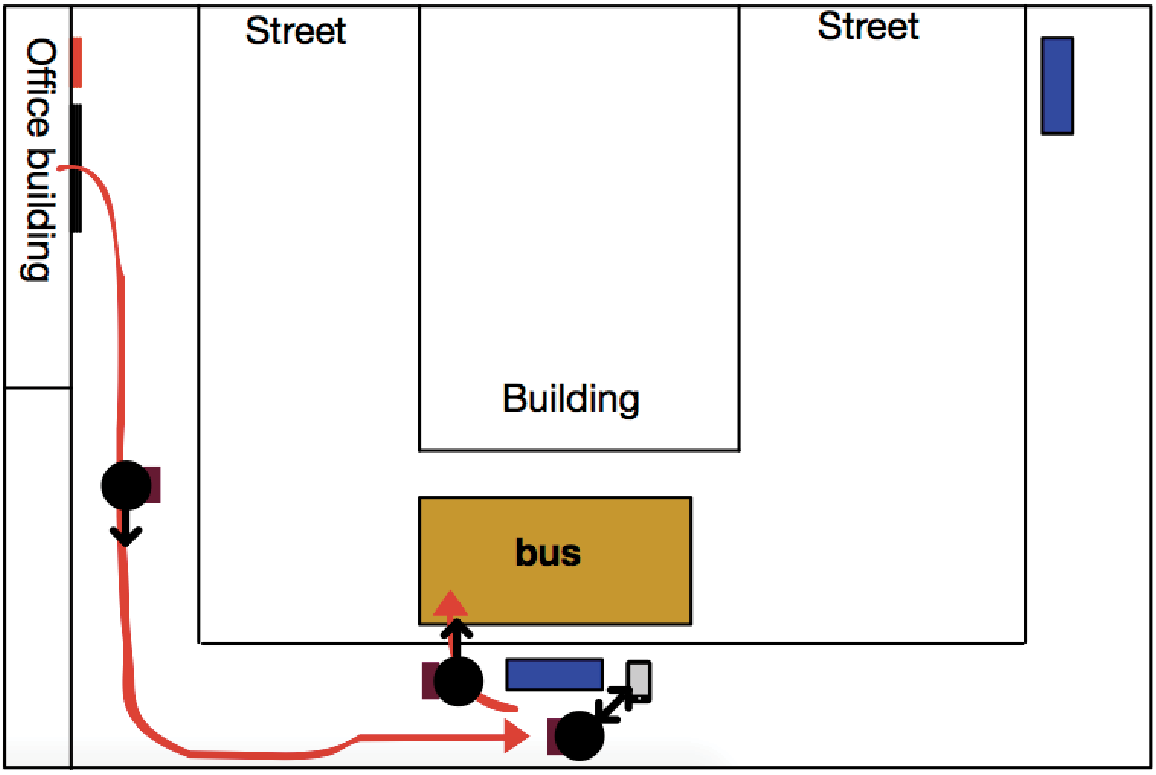


Figure 29: Laurene Physical Model Frame 9

Figure 30: Laurene Physical Model Frame 10

When finished working Laurene walks back to the bus stop, carrying her hand bag at all times. Her next interaction is sending a text message to a friend, while waiting for the bus at the bus stop. This interaction uses the iMessage database of Apple's iCloud. Lauren then enters the bus. When entering the bus Laurene again interacts with the Opal card system.

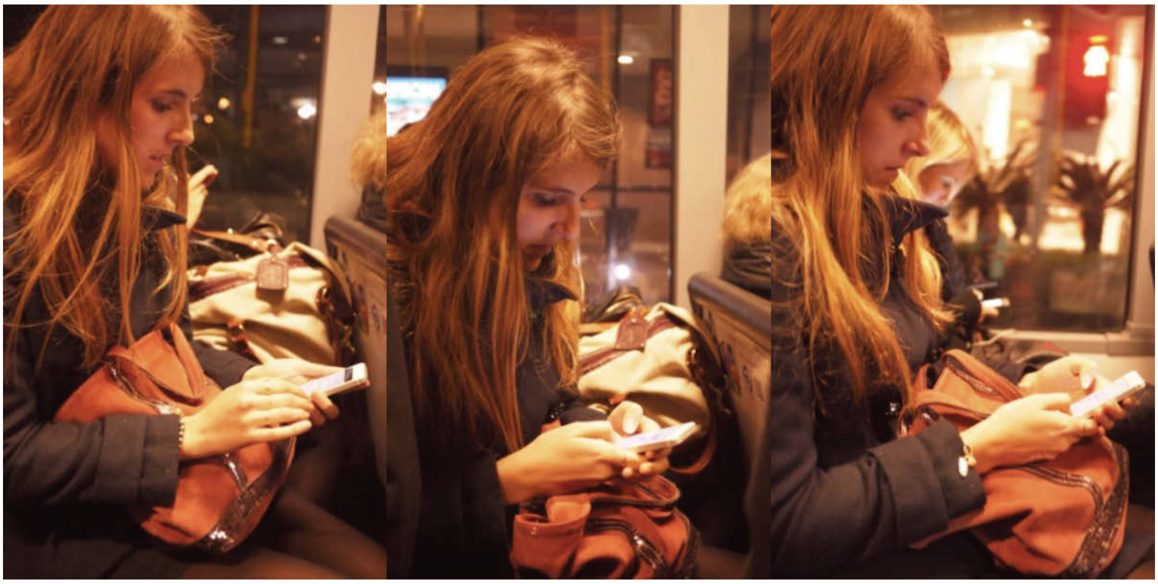


Figure 31: Laurene Physical Model Frame 11

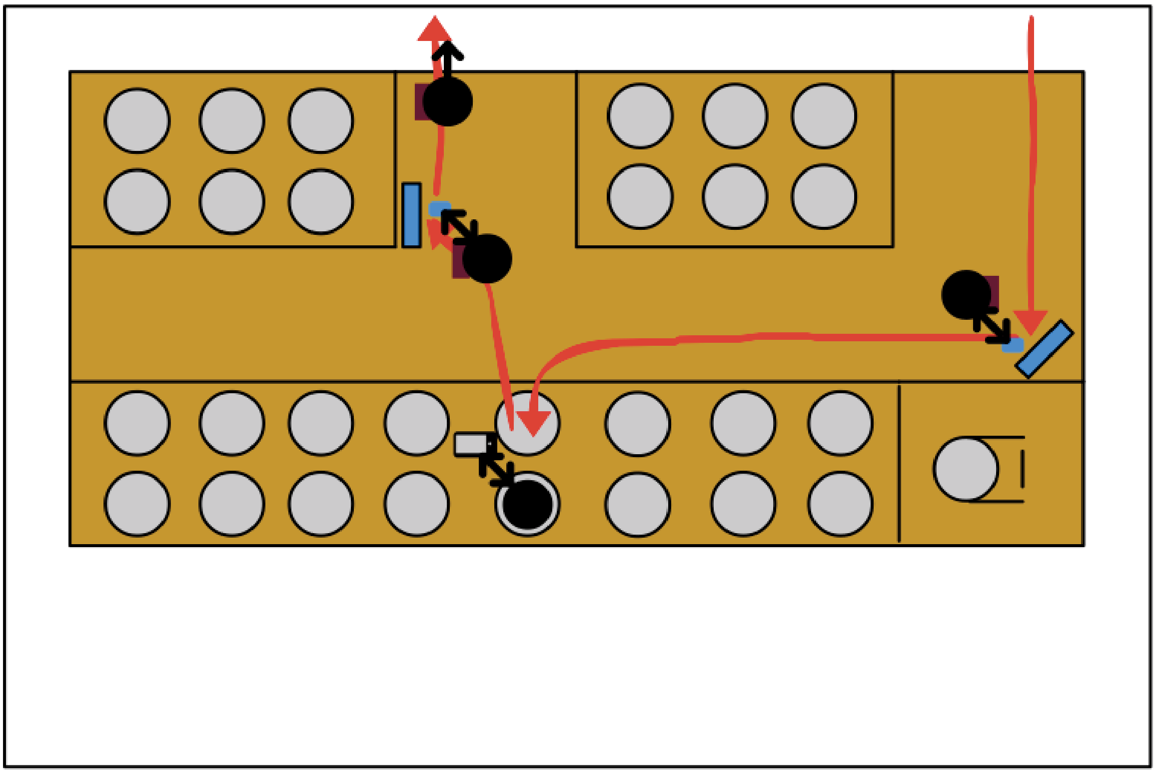


Figure 32: Laurene Physical Model Frame 12

On the Bus Laurene again continuously interacts with her smart phone. She interacts sending text messages using the iMessage system to communicate with friends and interacts with the Elle Magazine app to interact with the Elle magazine content. This time Laurene does not need to stand and can sit for the whole trip.

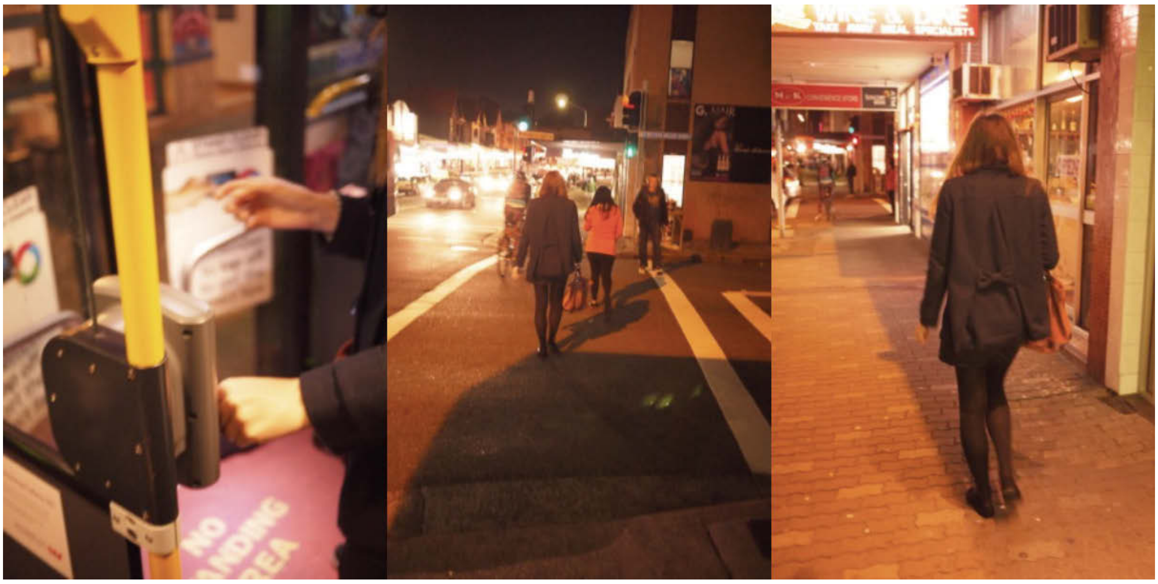


Figure 33: Laurene Physical Model Frame 13

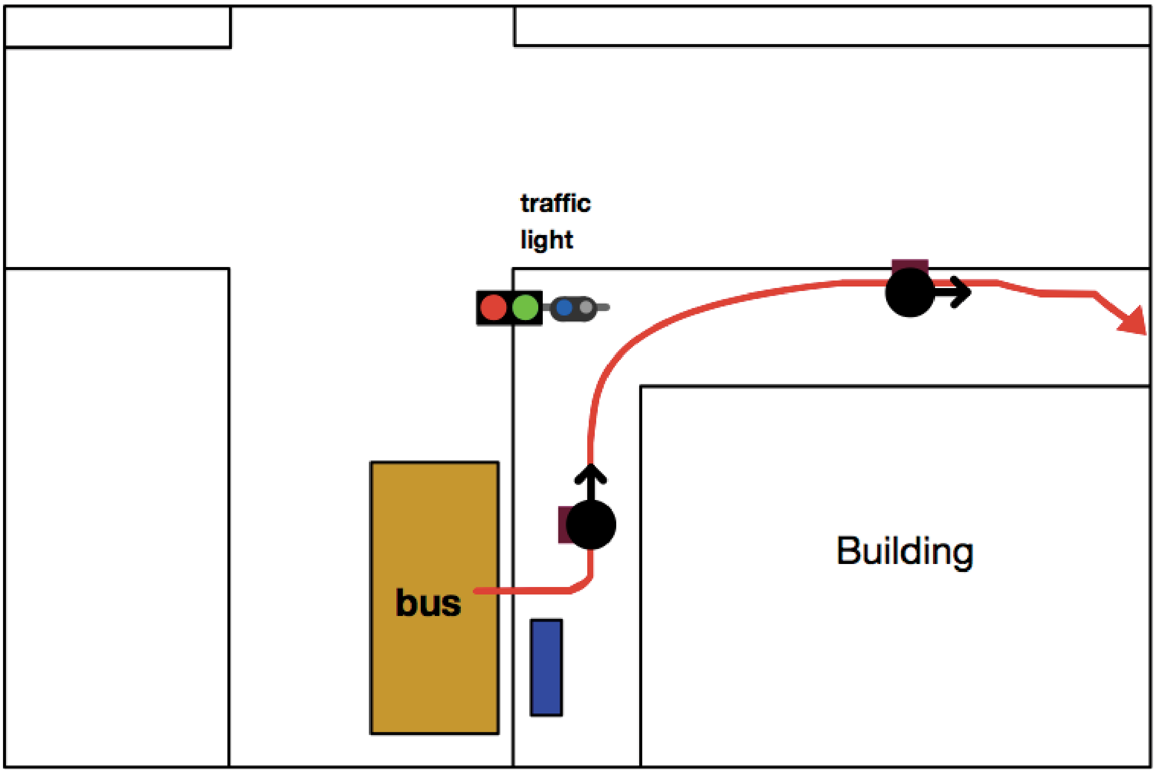


Figure 34: Laurene Physical Model Frame 14

Figure 35: Laurene Physical Model Frame 15

When exiting the bus she again interacts with the Opal Card system to ensure the correct travel time and fare recorded in the Sydney transport database. She then walks home and enters her home building with an analog key.

Circle Flow Model:

The Circle Flow model is an overview of Lauren's data of her everyday interactions.

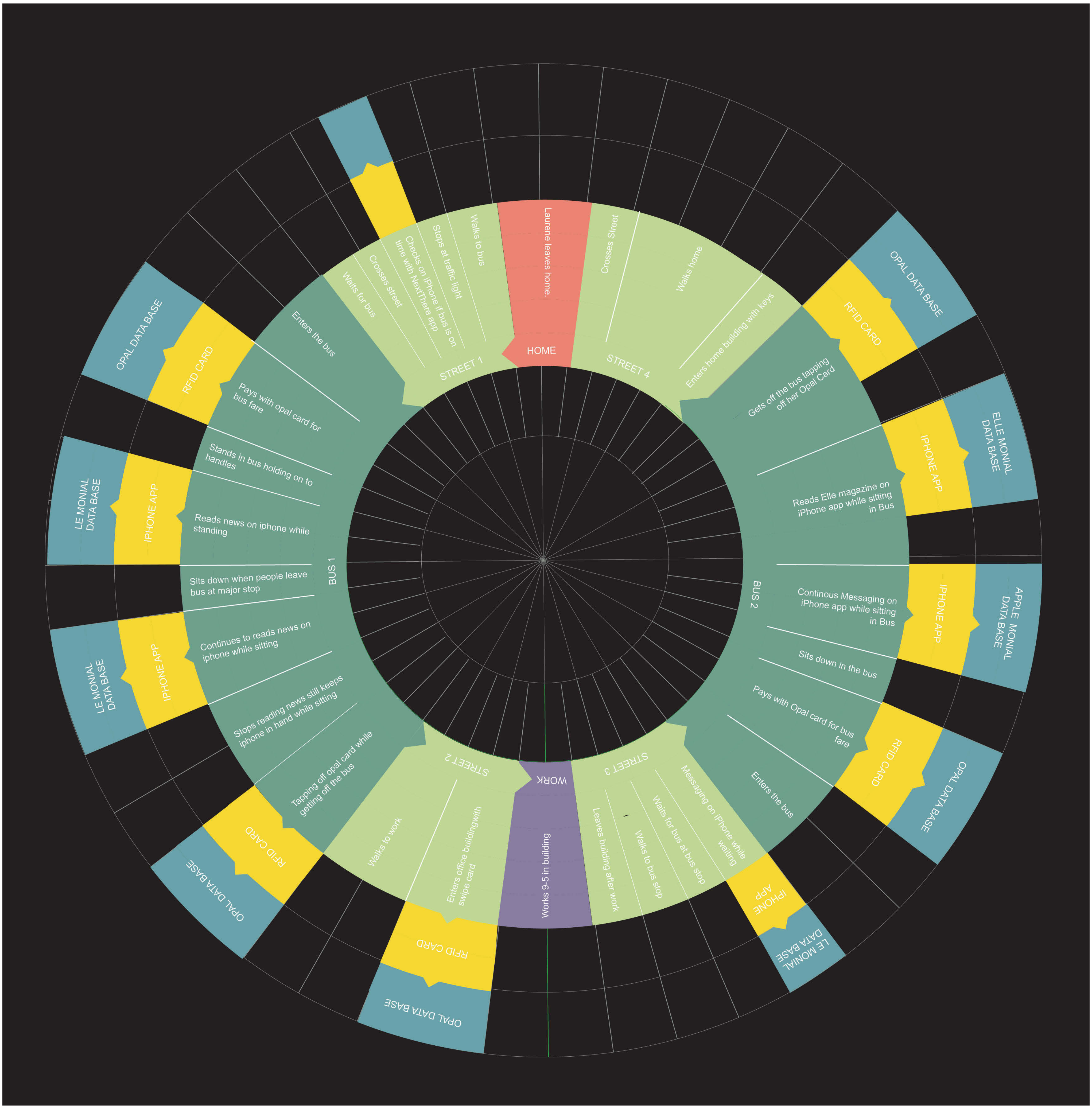


Figure 36: Laurene Circle Flow Model

1.2.12 Individual Data Models - Agathe (9-5 worker using Public Transport) - Circle Flow & Physical Model

The second participant researched was Agathe who uses public transport and has a 9-5 job in the neighbourhood of Surry Hills in Sydney.

Physical Model:

The physical model show's Agathe's interactions situated in the physical environment and within the narrative of her day over time.

Figure 37: Agathe Physical Model Frame 1

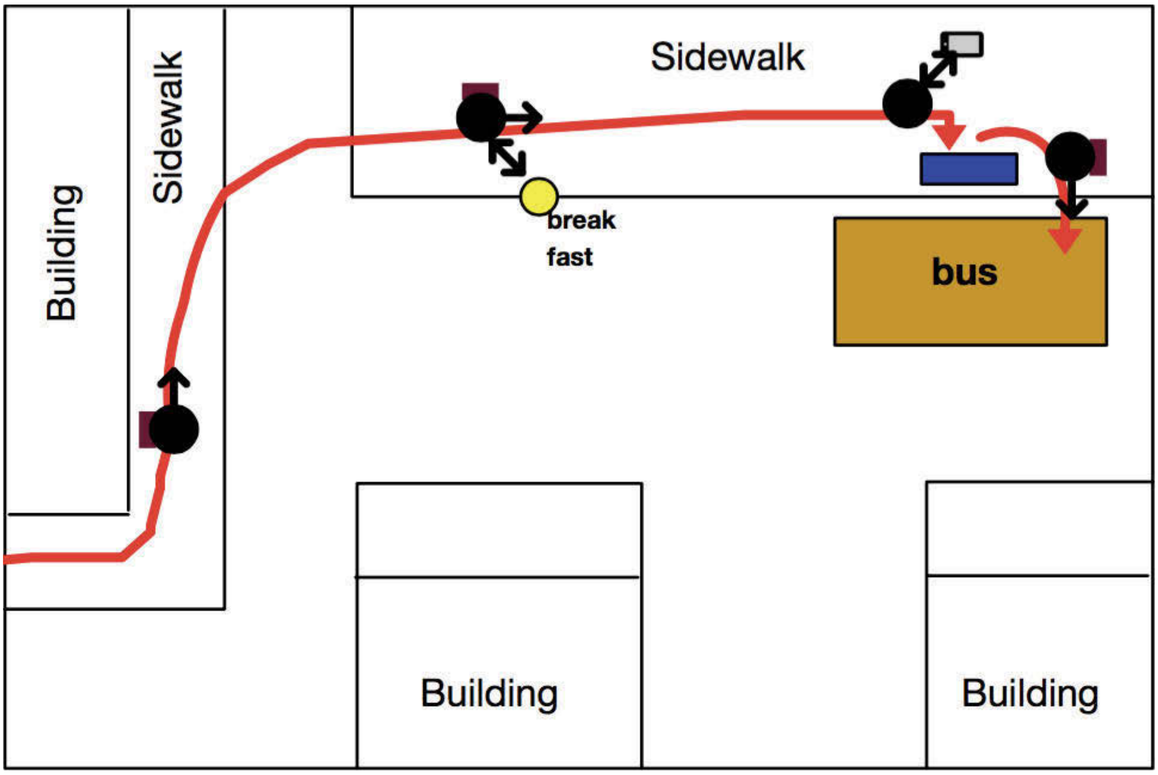


Figure 38: Agathe Physical Model Frame 2

Agathe leaves home and eats breakfast on the way to the bus

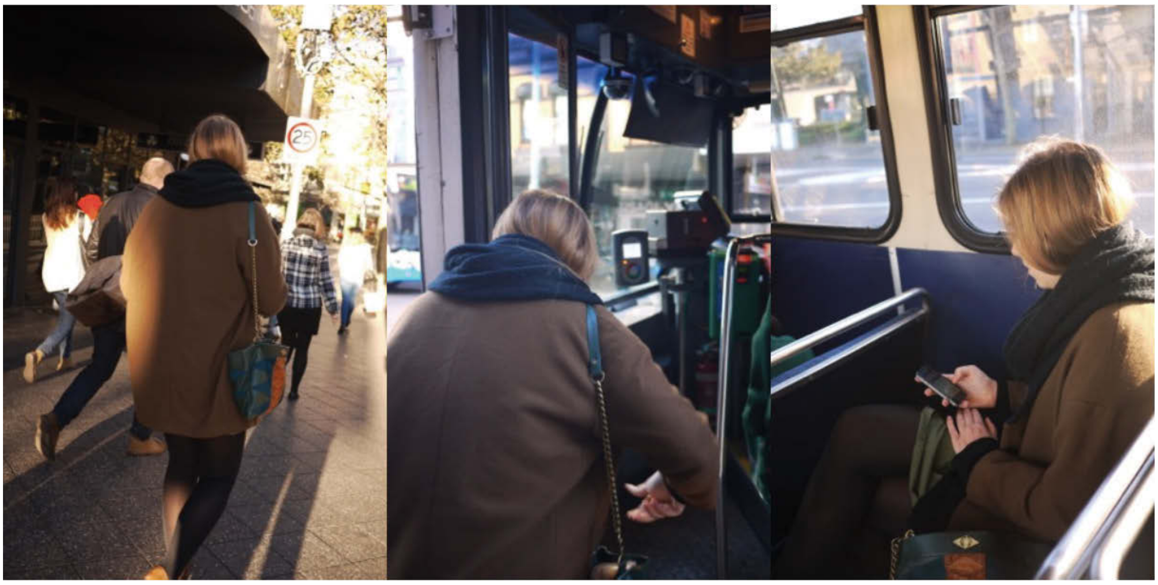


Figure 39: Agathe Physical Model Frame 3

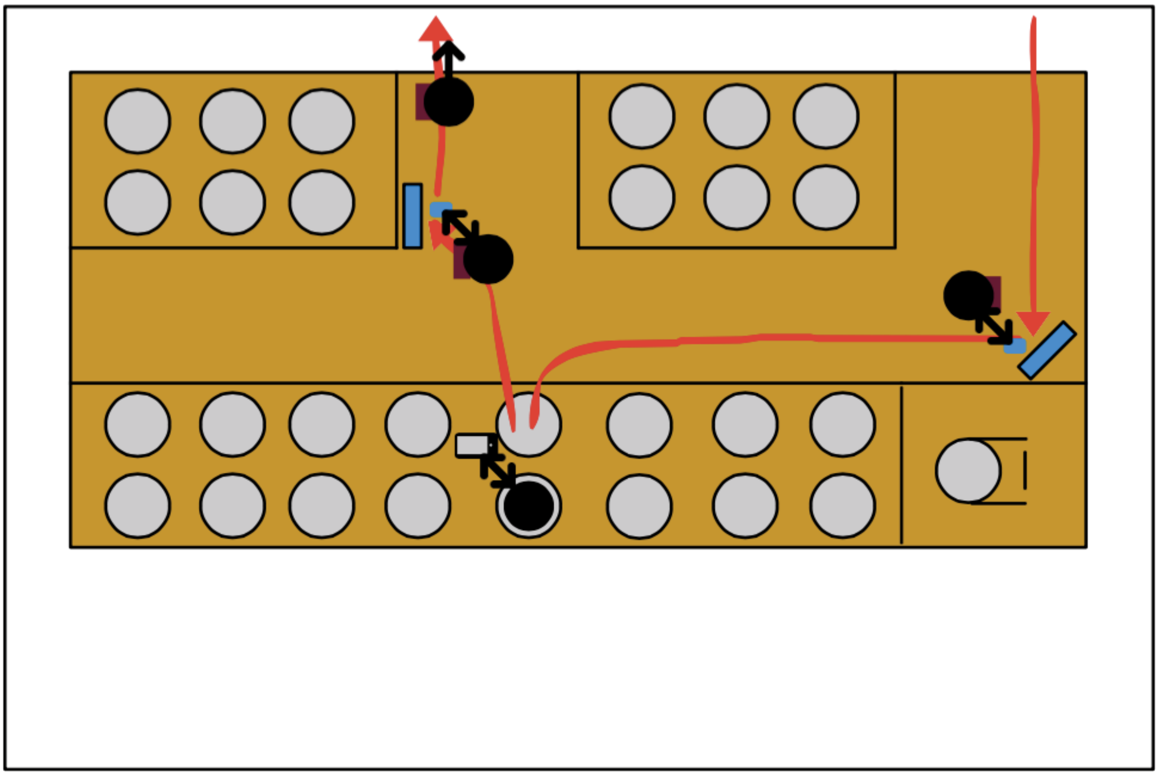


Figure 40: Agathe Physical Model Frame 4

Agathe arrives at the bus, pays her fair with a paper ticket cause she doesn't know how to get an Opal card. Agathe sits down and reads the news on her iPhone for the whole trip.

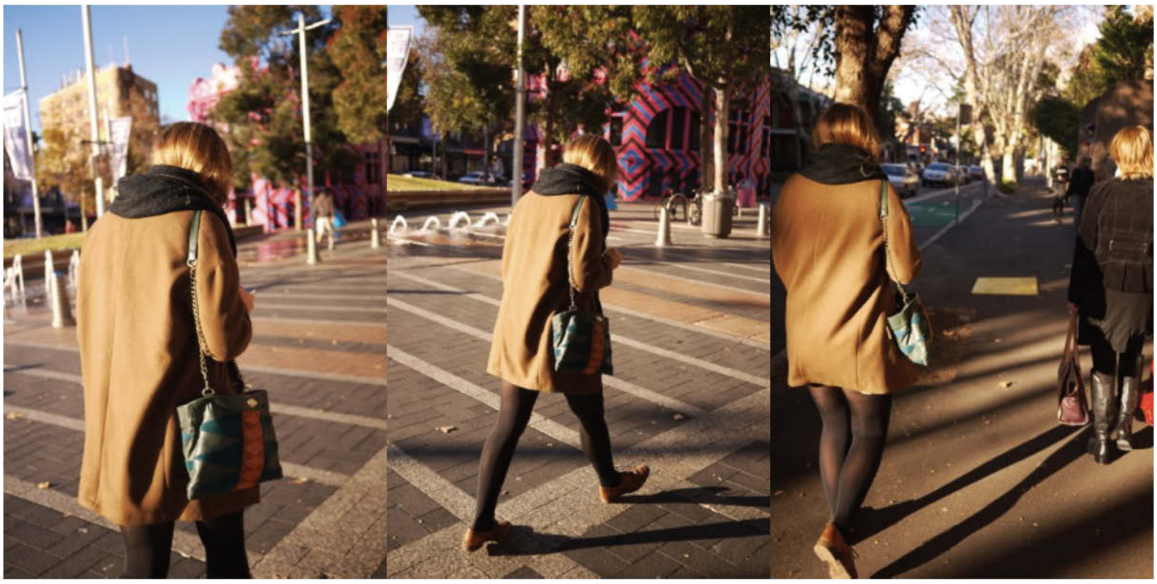


Figure 41: Agathe Physical Model Frame 5

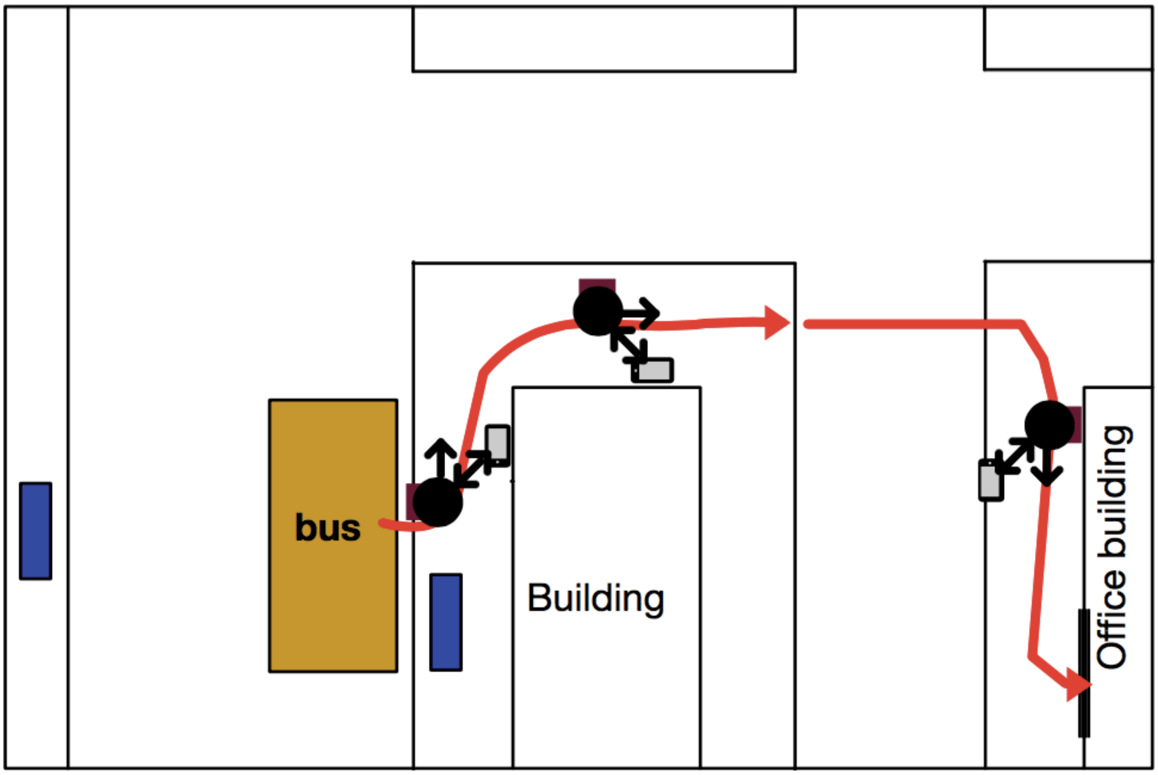


Figure 42: Agathe Physical Model Frame 6

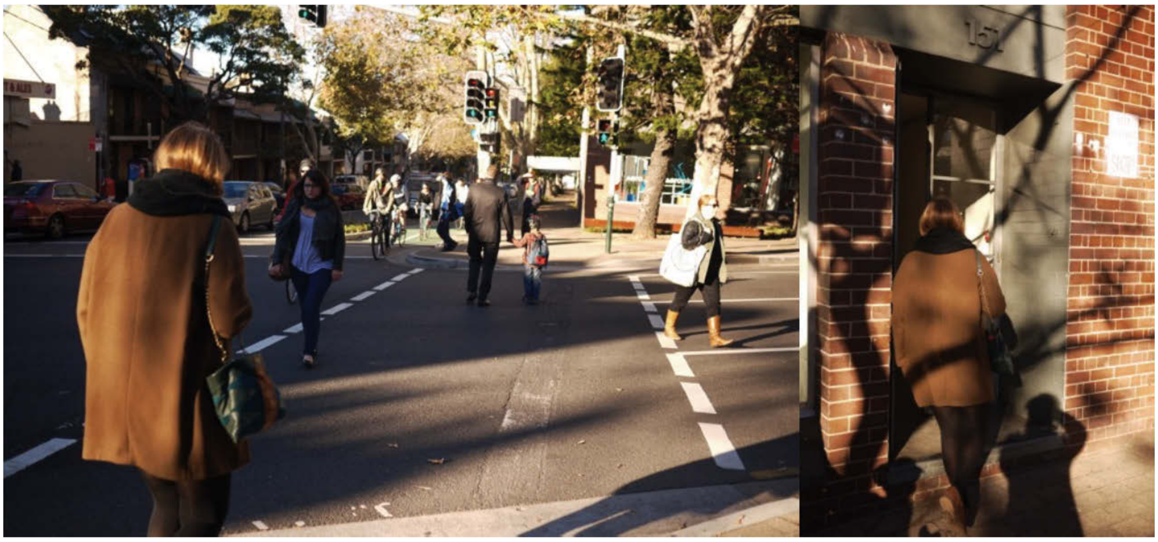


Figure 43: Agathe Physical Model Frame 7

Agathe gets off the bus in Surry Hills. She continues to check Facebook and read news on her phone while walking to her office from the bus stop.

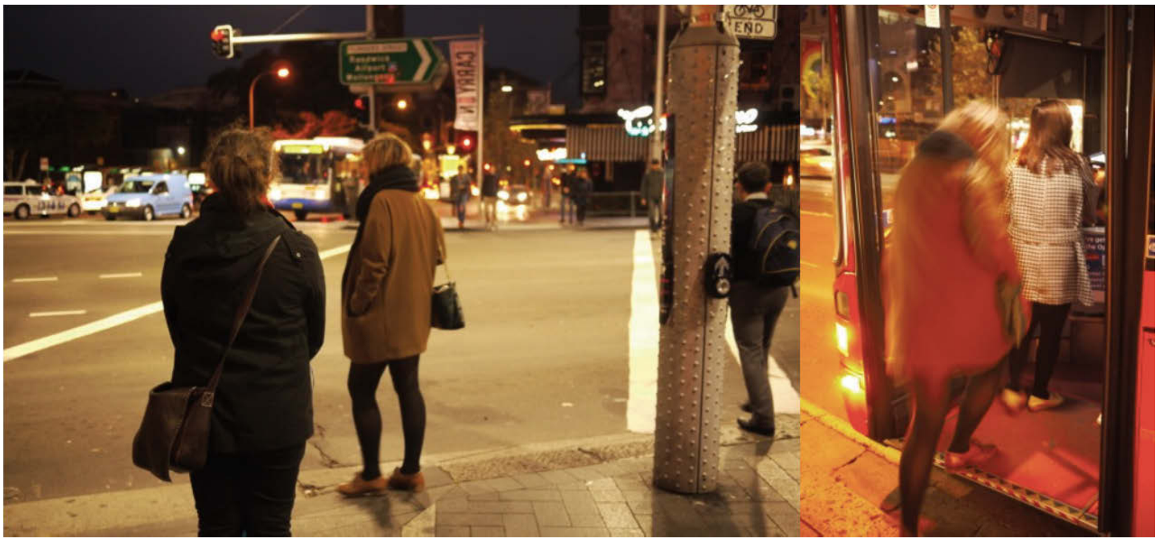


Figure 44: Agathe Physical Model Frame 8

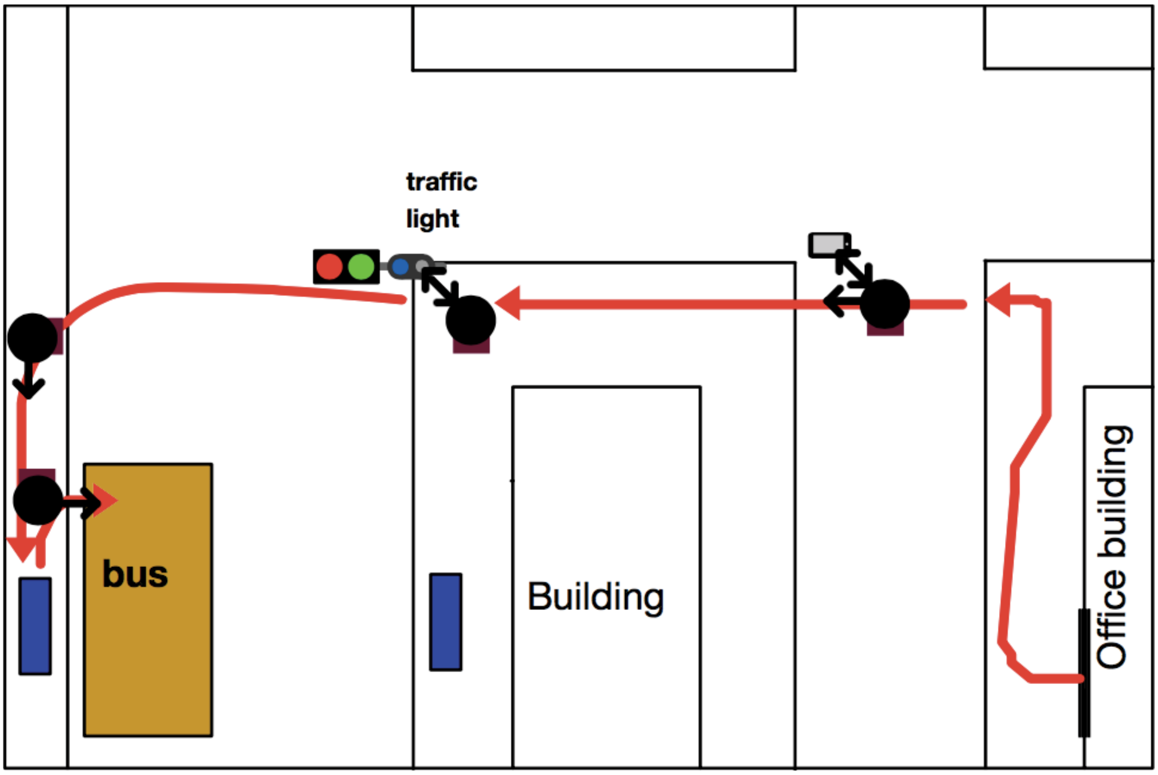


Figure 45: Agathe Physical Model Frame 9

After work, Agathe walks back to the bus stop. While walking back she did not use here smart phone, but was simply walking. She uses the traffic lights to cross the street. At the bus stop she waits for the Bus to arrive and enters the bus. She pays with a paper ticket and walks towards the back of the bus.

Figure 46: Agathe Physical Model Frame 10

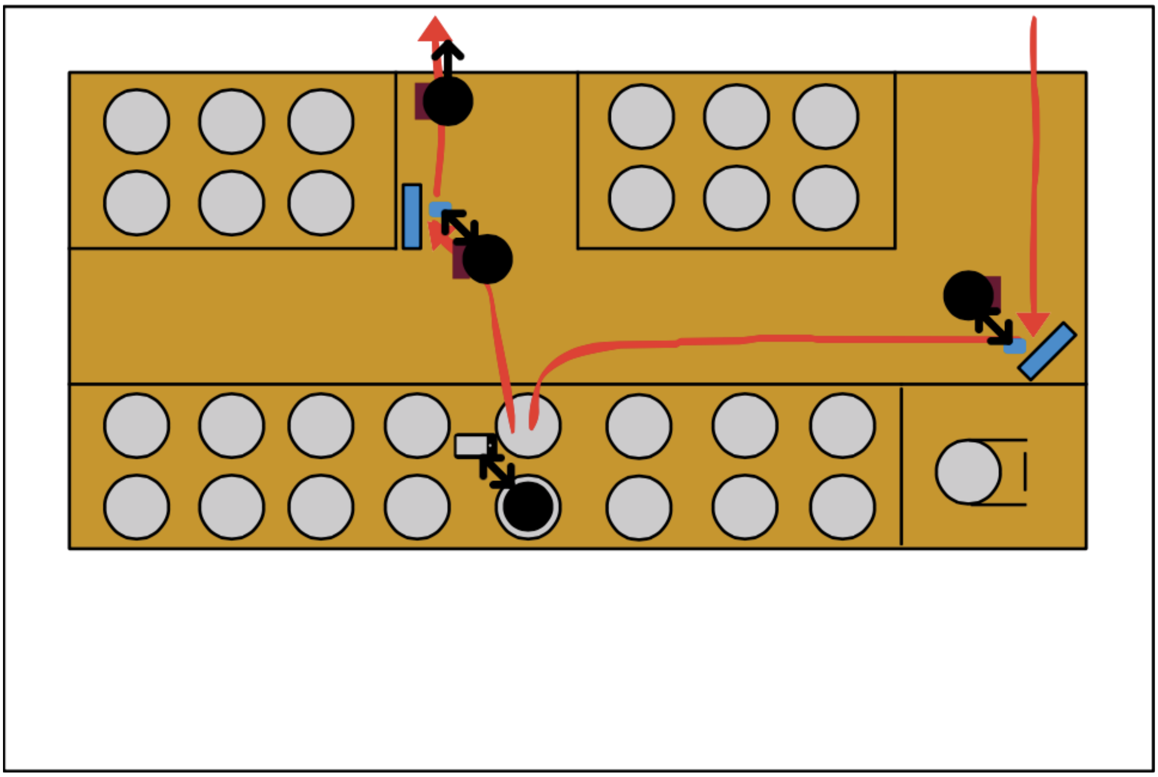


Figure 47: Agathe Physical Model Frame 11

Agathe sits down and takes her iPhone and checks Facebook for the rest of the trip.

Figure 48: Agathe Physical Model Frame 12

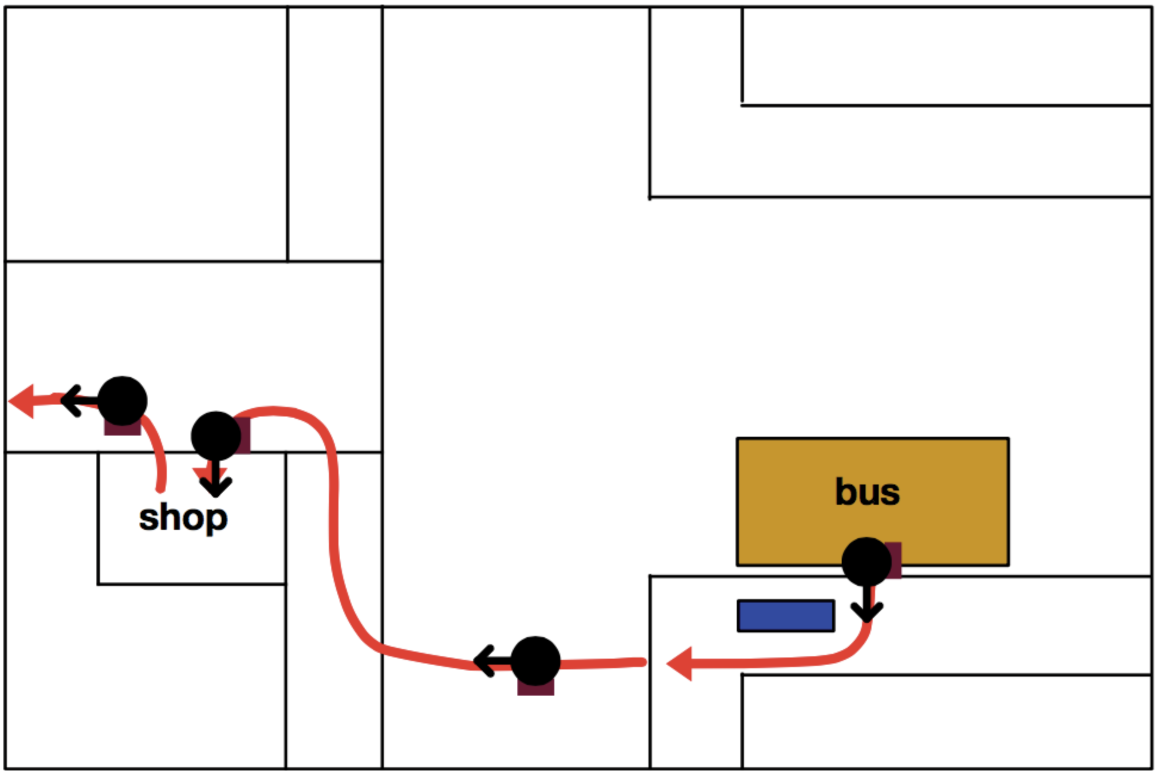


Figure 49: Agathe Physical Model Frame 13

Agathe gets off the bus and walks home, on her way she stops at a 1$ shop to buy some household items.

Figure 50: Agathe Physical Model Frame 14

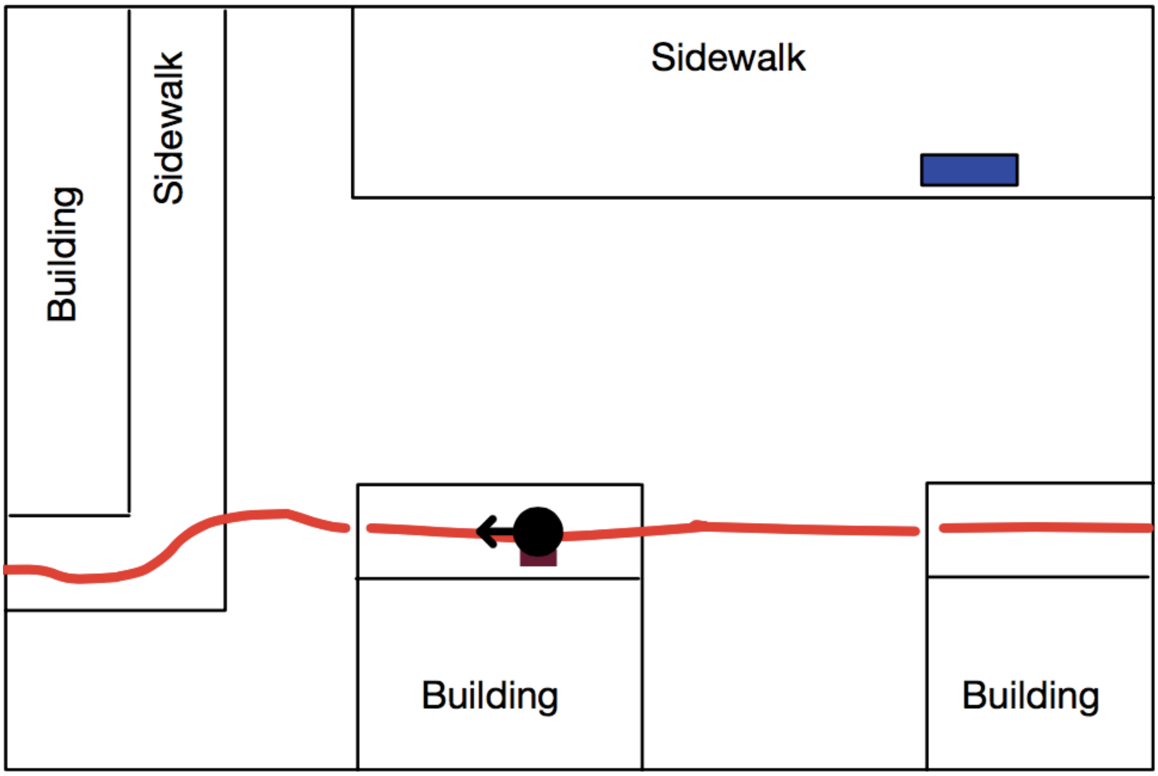


Figure 51: Agathe Physical Model Frame 15

After shopping Agathe continues to walk home. She crosses a street using the traffic lights and when arriving home she enters her house with analog keys.

Circle Flow Model:

The Circle Flow model is an overview of Agathe's data of her everyday interactions.

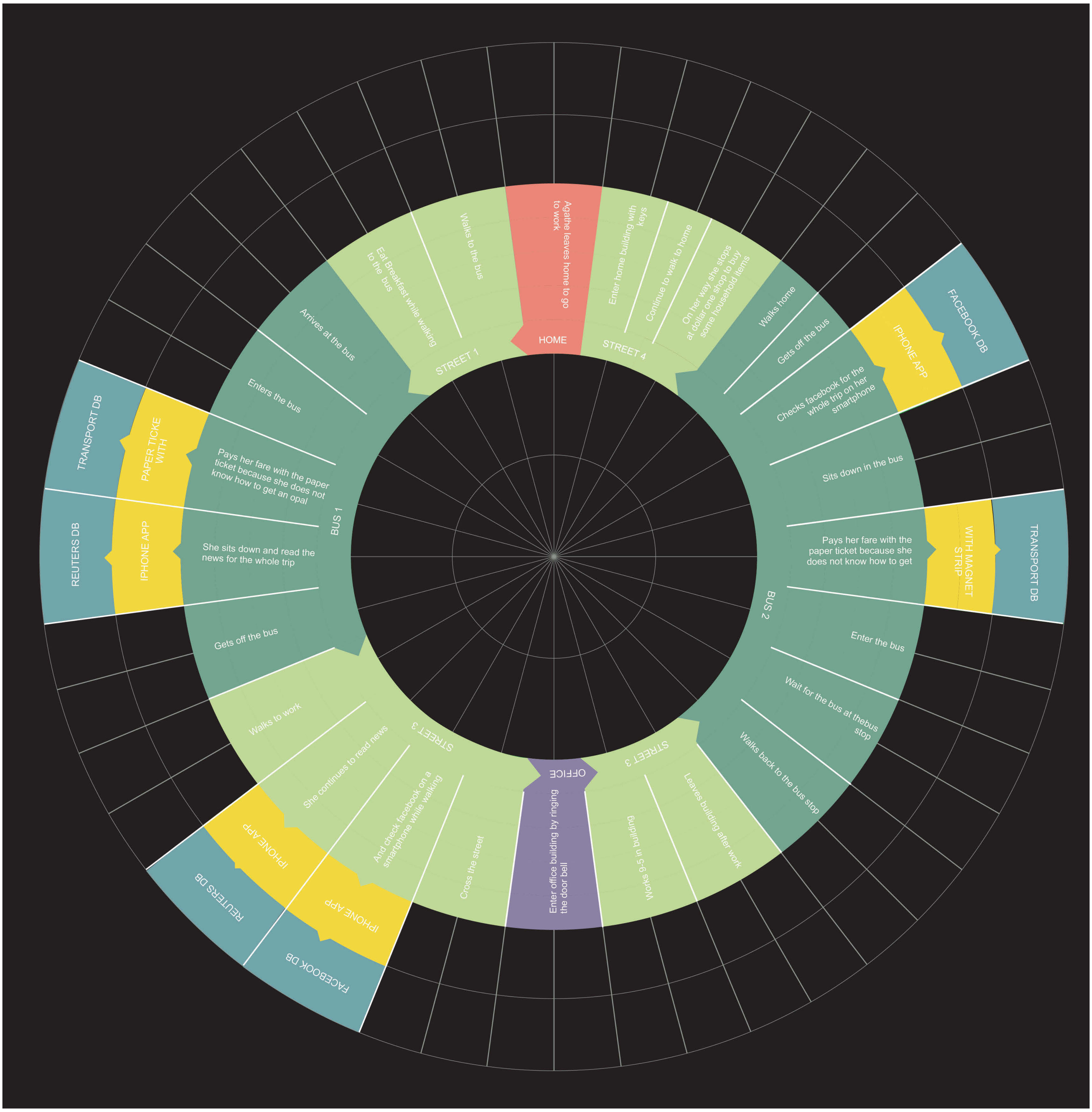


Figure 52: Agathe Circle Flow Model

1.2.13 Individual Data Models - Peter (9-5 worker using Public Transport) - Circle Flow & Physical Model

The third participant researched was Peter who uses public as well as private transport and has a 9-5 job in the Rocks neighbourhood in Sydney.

Physical Model:

The physical model show's Peter's interactions situated in the physical environment and within the narrative of his day over time.

Figure 53: Peter Physical Model Frame 1

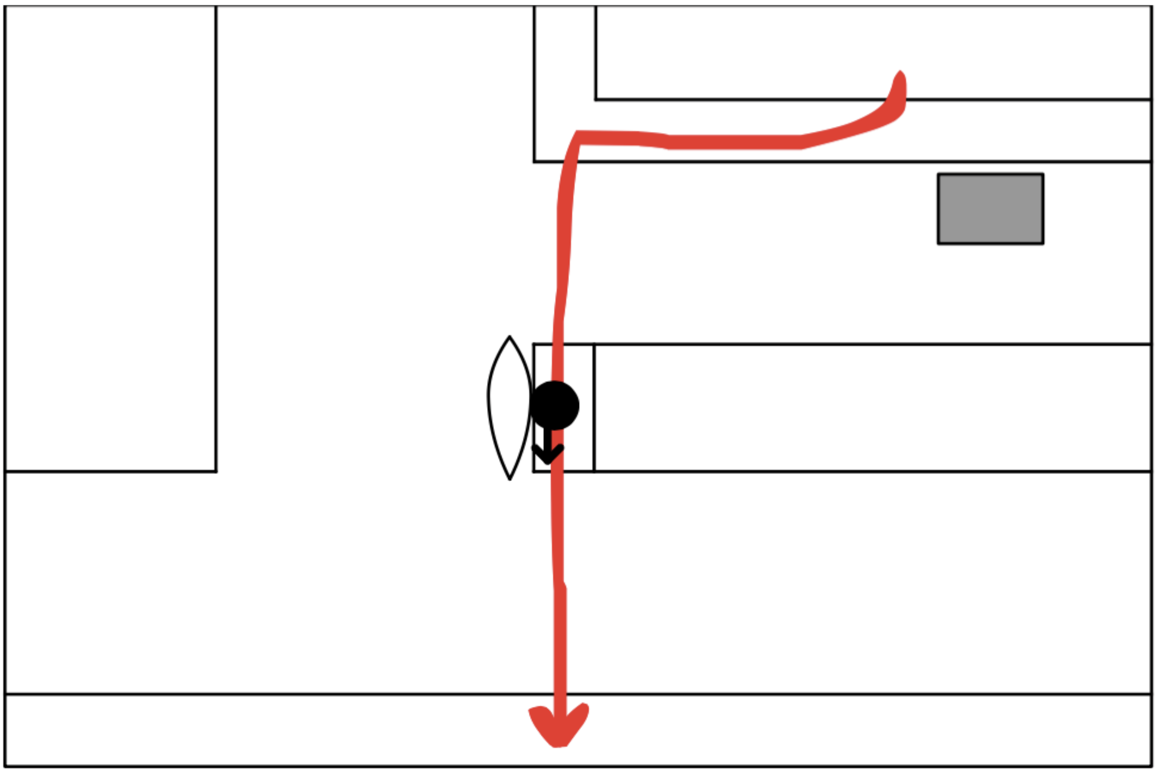


Figure 54: Peter Physical Model Frame 2

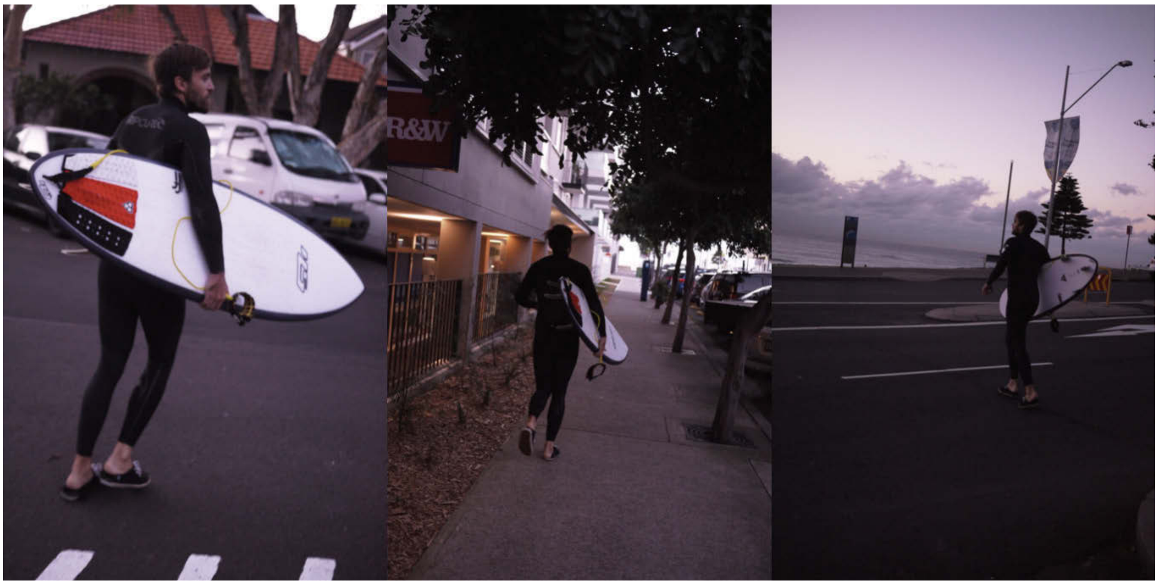


Figure 55: Peter Physical Model Frame 3

Peter leaves his home and walks to the beach for a surf. He is wearing canvas shoes to be able to walk more comfortably on the street.

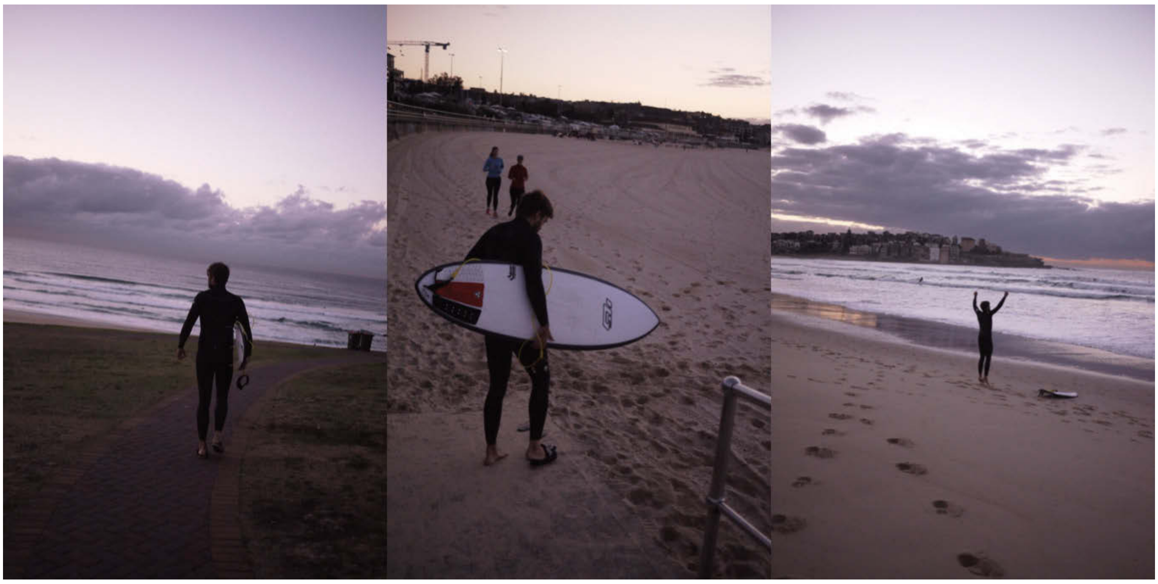


Figure 56: Peter Physical Model Frame 4

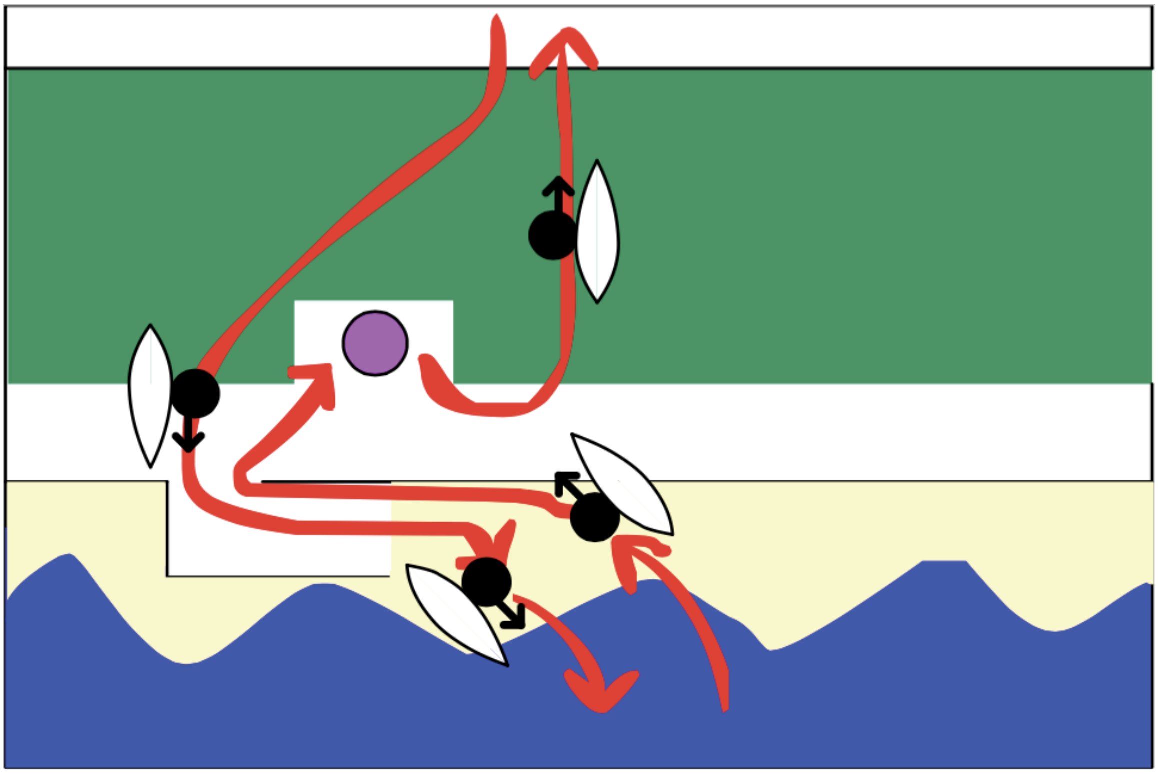


Figure 57: Peter Physical Model Frame 5

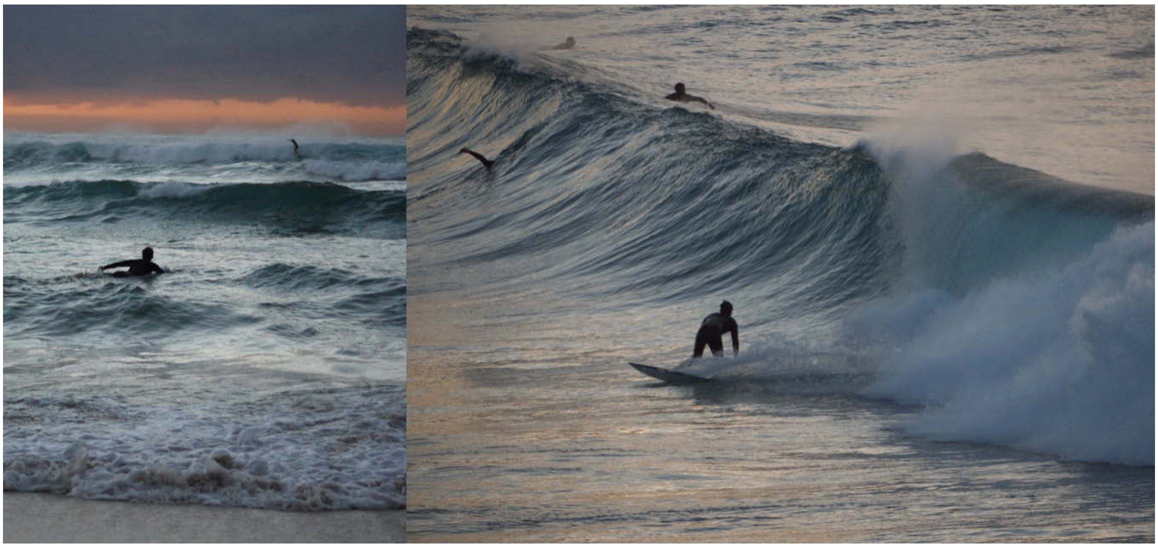


Figure 58: Peter Physical Model Frame 6

Figure 59: Peter Physical Model Frame 7

Figure 60: Peter Physical Model Frame 8

He leaves his shoes on the ramp and warms up on the sand. He then surfs for 45 minutes. When finished he gets out and grabs his shoes from the ramp. He takes a shower, puts his shoes back on and walks home.

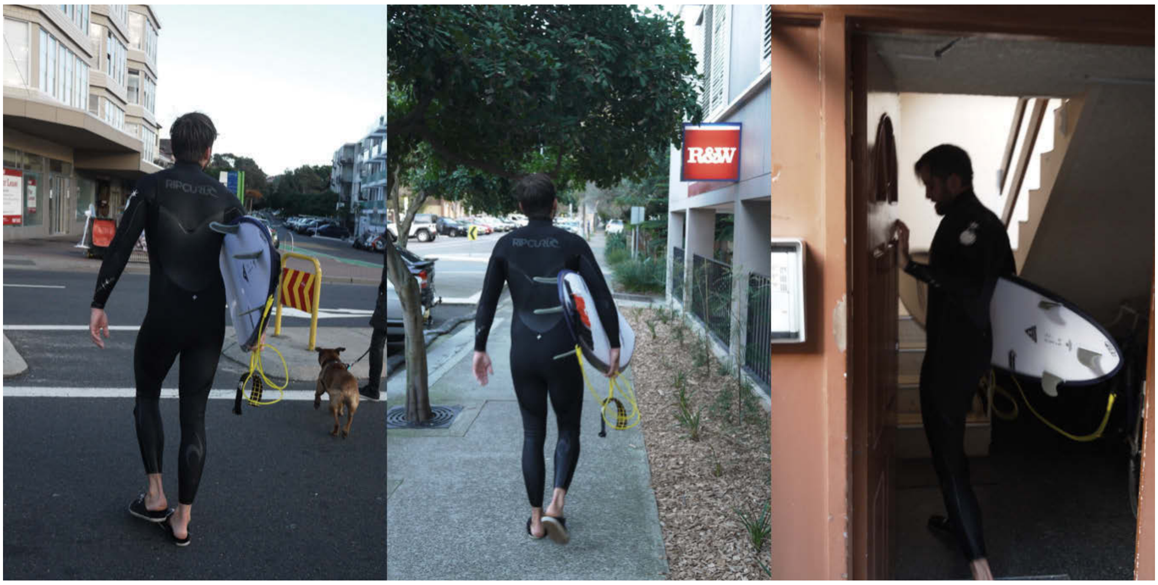


Figure 61: Peter Physical Model Frame 9

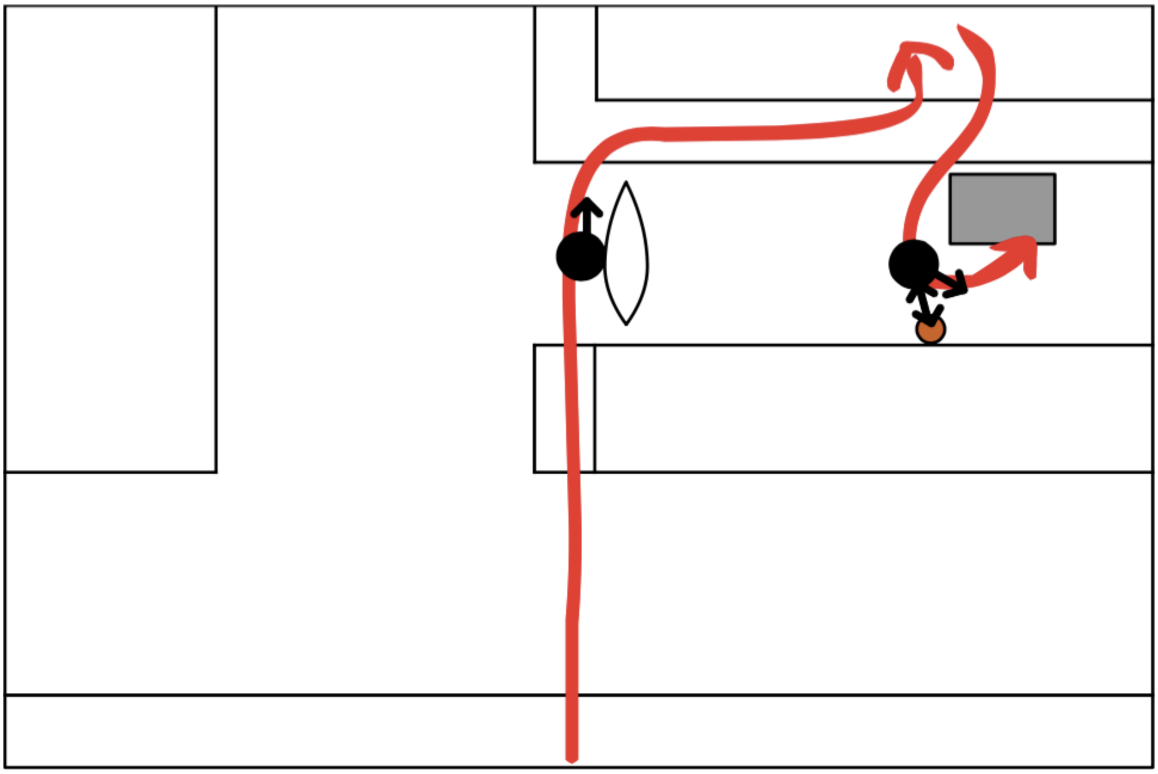


Figure 62: Peter Physical Model Frame 10

Figure 63: Peter Physical Model Frame 11

When walking home he crosses the street and enters his home with analog keys. At home he gets changed for work and makes a coffee. He then leaves his home and walks to his car to drive to the ferry.

Figure 64: Peter Physical Model Frame 12

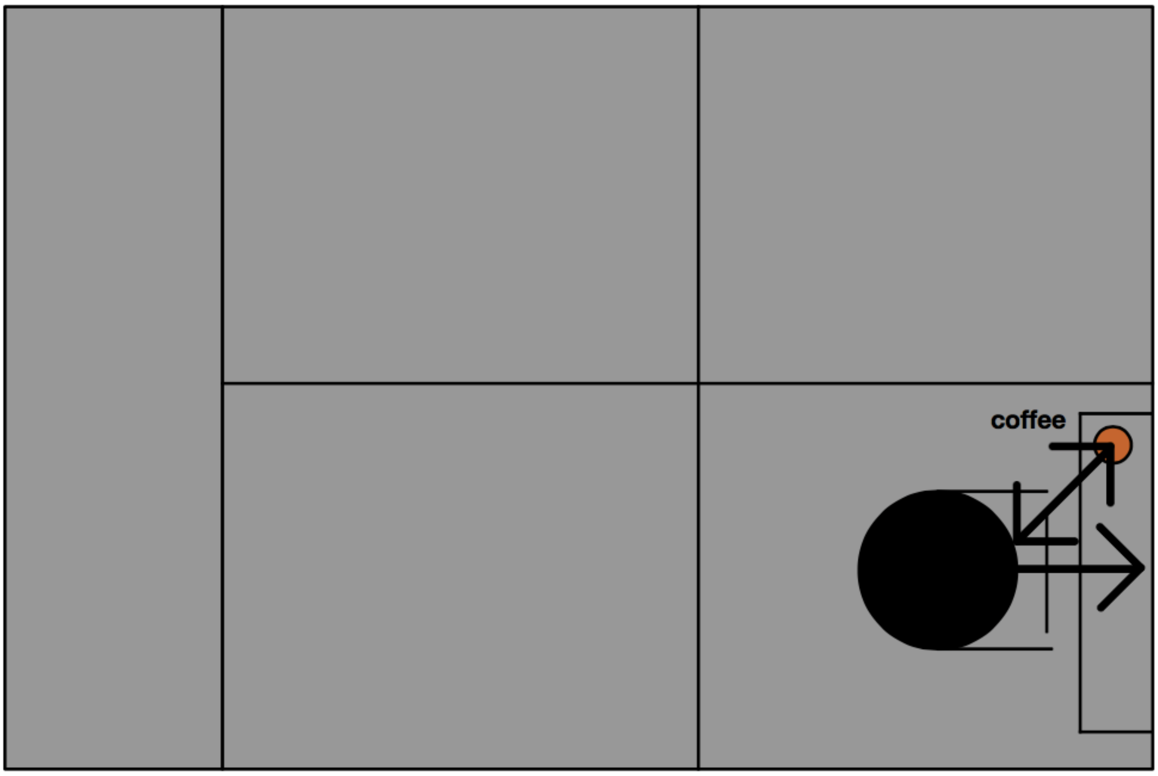


Figure 65: Peter Physical Model Frame 13

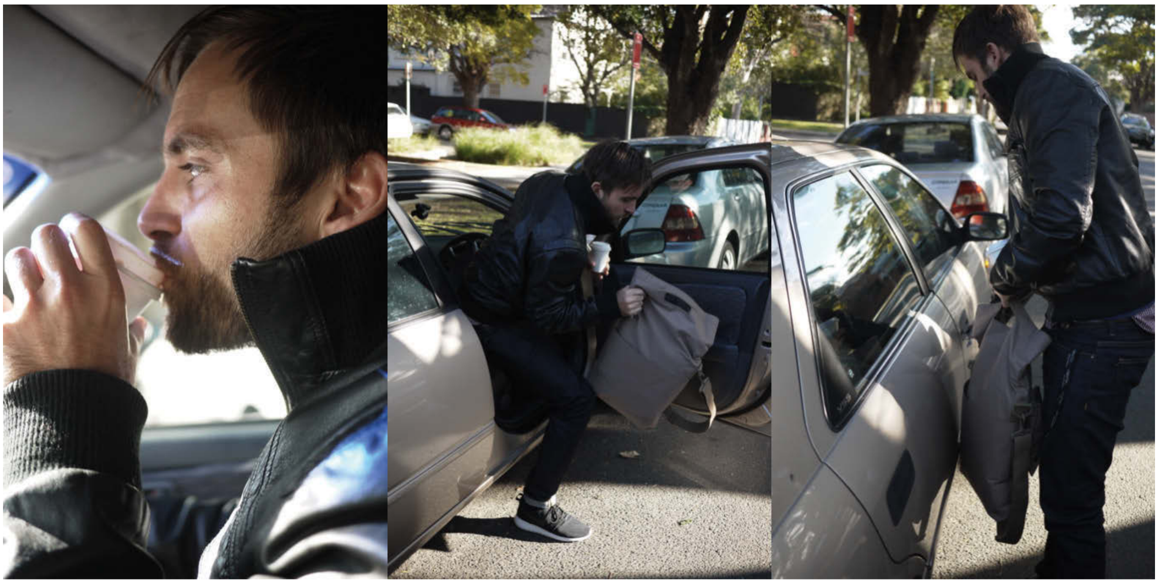


Figure 66: Peter Physical Model Frame 14

He gets in the car with analog keys and drives to ferry. He drinks coffee while driving and puts his coffee cup into a coffee cup holder. He then parks the car, gets out and walks to ferry.

Figure 67: Peter Physical Model Frame 15

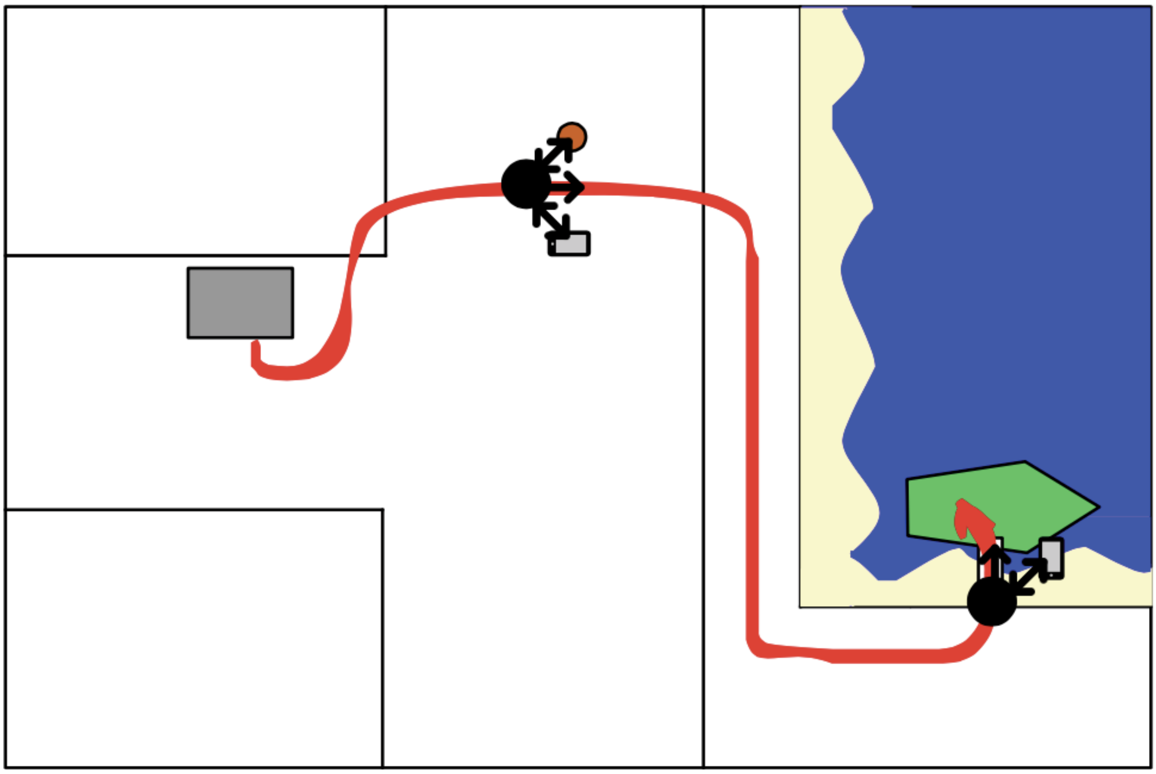


Figure 68: Peter Physical Model Frame 16

Figure 69: Peter Physical Model Frame 17

While walking to the ferry he drinks more coffee and checks the time and recognises that he is a bit late and also received a text message. He is reading the text message while walking quicker to the ferry. He ditches the empty coffee cup hurries up and boards the ferry.

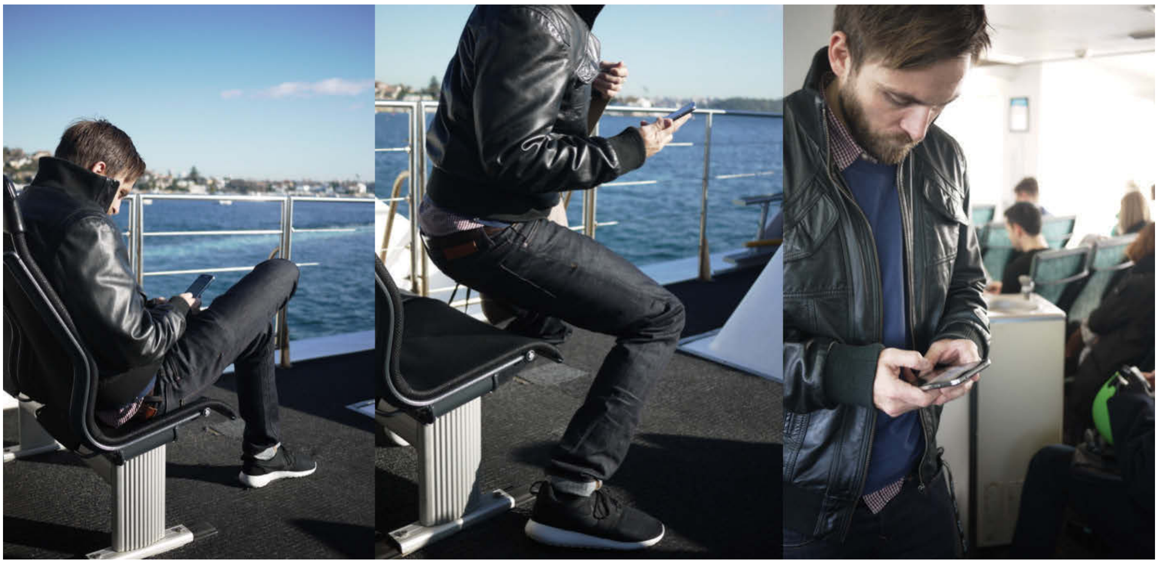


Figure 70: Peter Physical Model Frame 18

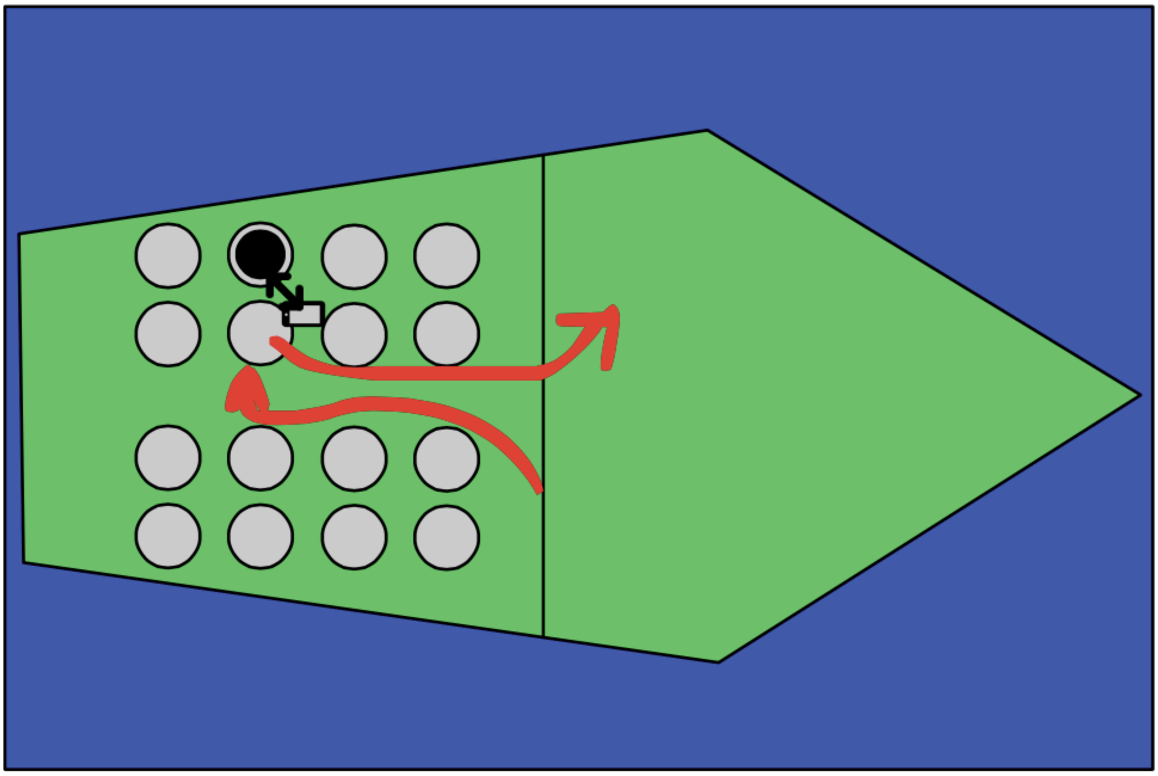


Figure 71: Peter Physical Model Frame 19

He first sits down on the upper deck and starts answering to the message he received, notices that its too cold on the upper deck and goes down inside to the lower deck.

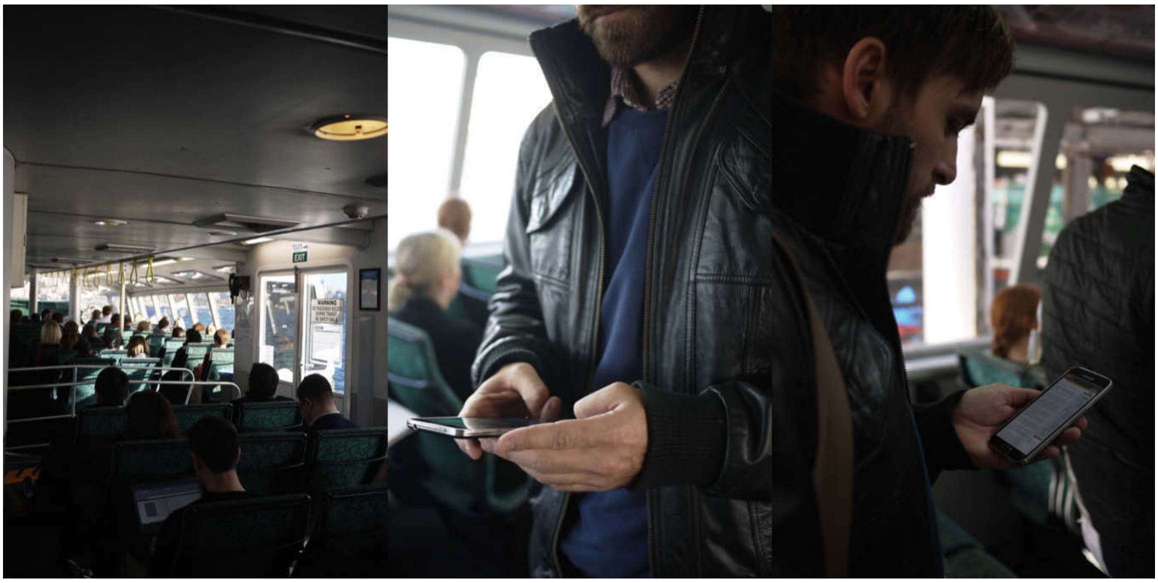


Figure 72: Peter Physical Model Frame 20

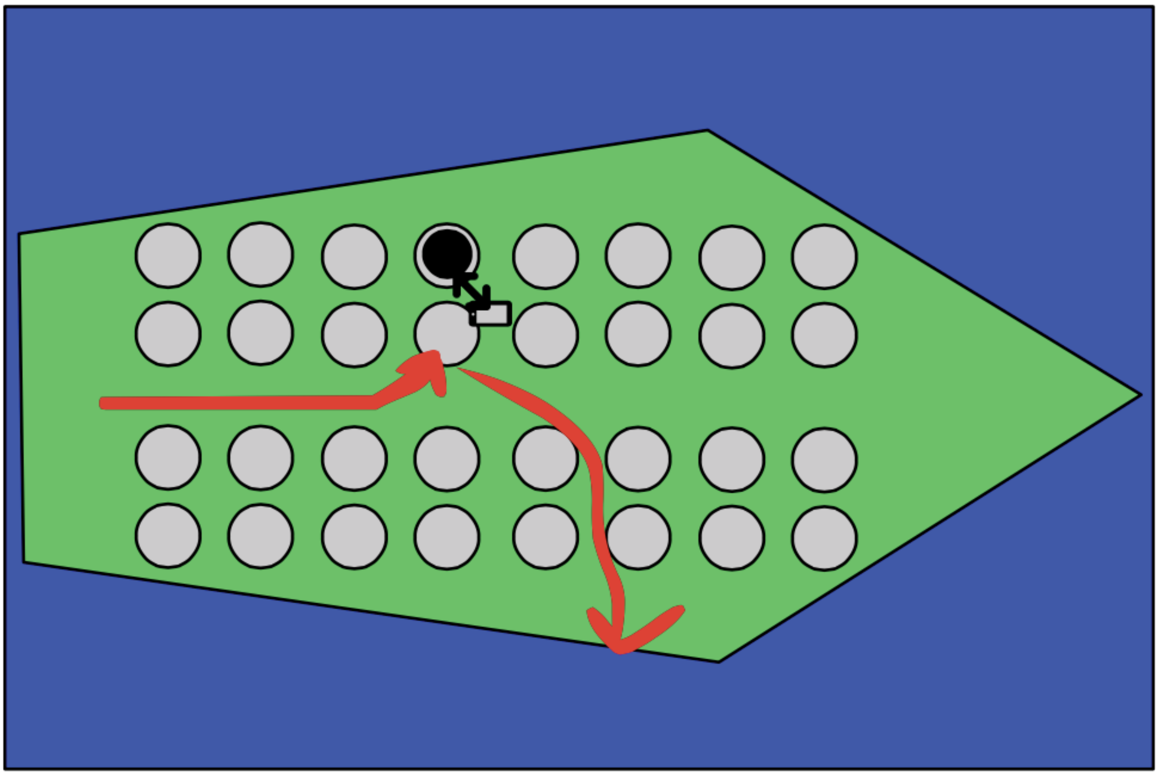


Figure 73: Peter Physical Model Frame 21

On the lower deck he keeps writing text messages and reading websites while standing, since there are no more seats available.

Figure 74: Peter Physical Model Frame 22

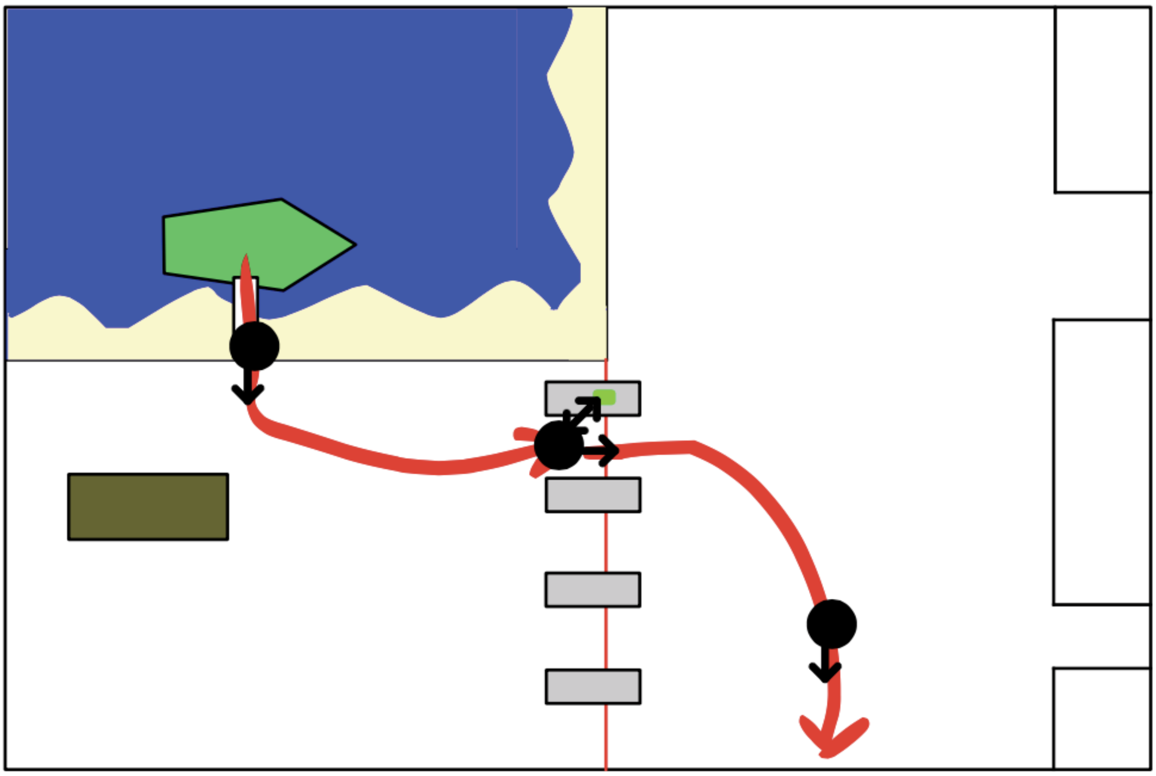


Figure 75: Peter Physical Model Frame 23

Figure 76: Peter Physical Model Frame 24

He gets off the ferry and validates his fare with a paper ticket because he doesn't like the opal card. He puts his sunglasses on and keeps on walking to work.

Figure 77: Peter Physical Model Frame 25

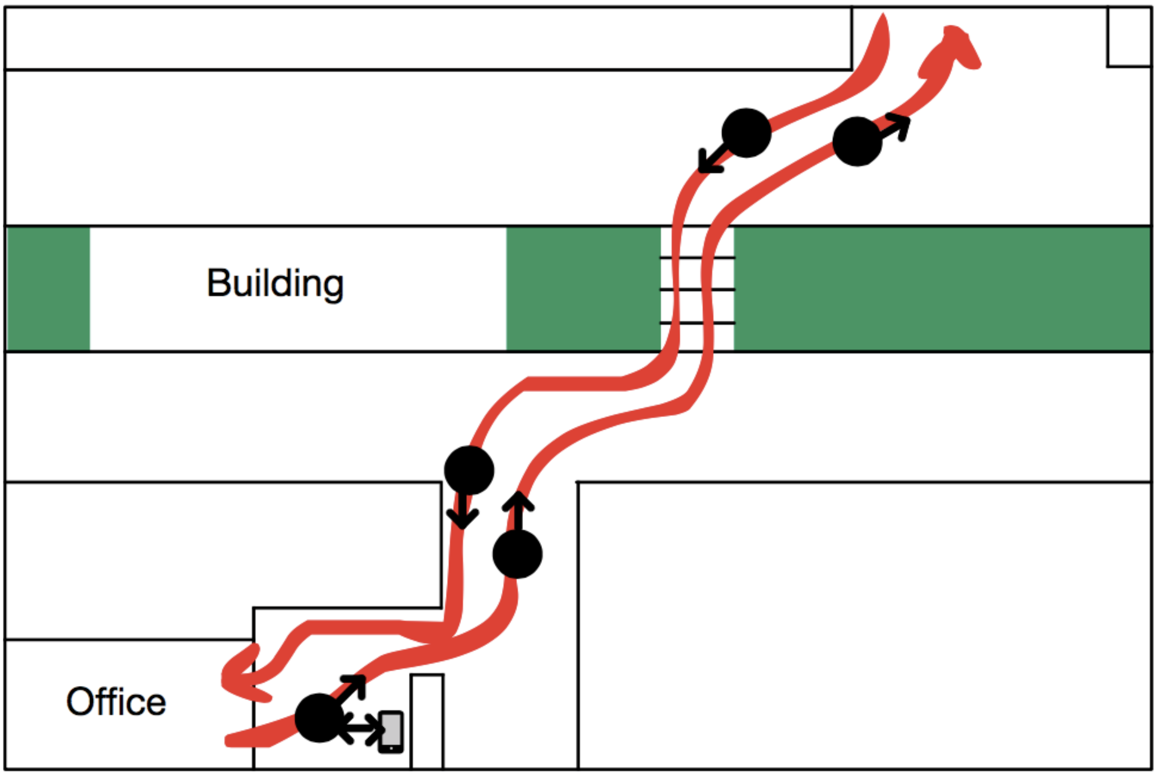


Figure 78: Peter Physical Model Frame 26

Figure 79: Peter Physical Model Frame 27

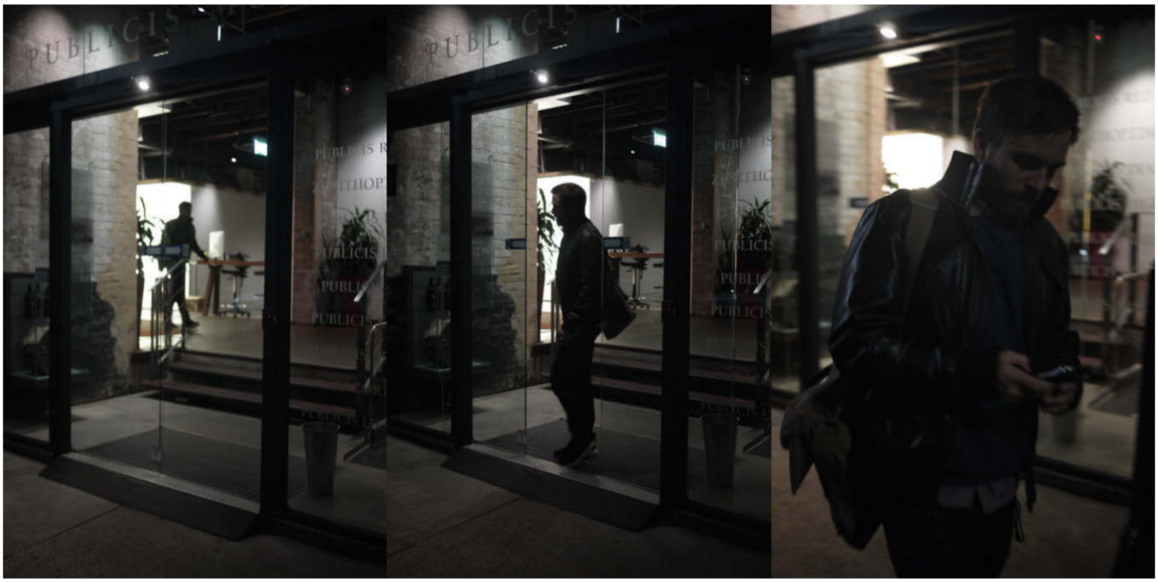


Figure 80: Peter Physical Model Frame 28

Figure 81: Peter Physical Model Frame 29

He walks through the Rocks and arrives at work. He then works 9-5. When finished working he leaves work and checks his phone for the time if he is late for his ferry. He decides to walk slower since he is early for the Ferry. He then walks through the Rocks towards the ferry terminal.

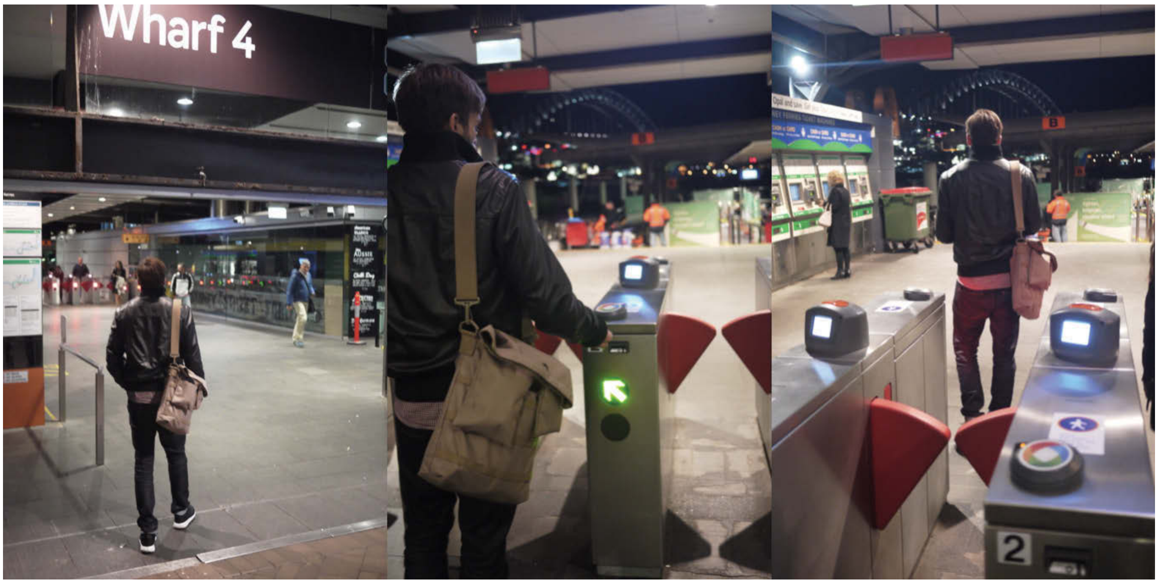


Figure 82: Peter Physical Model Frame 30

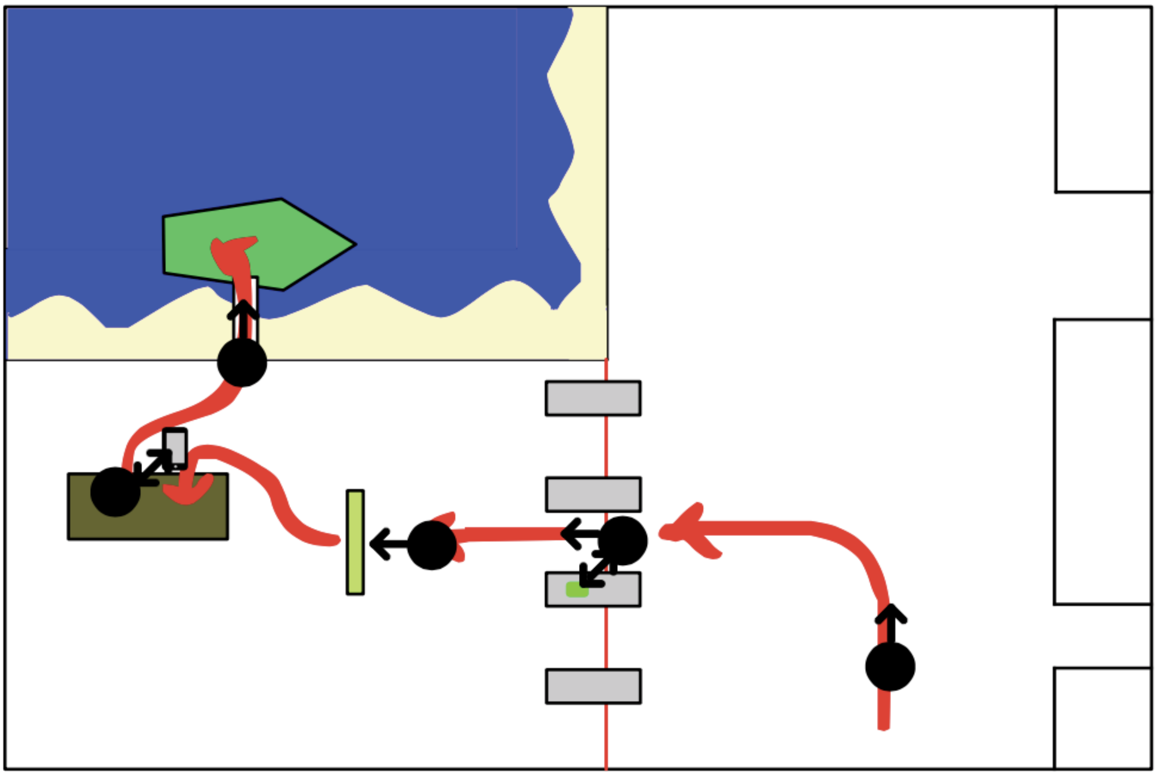


Figure 83: Peter Physical Model Frame 31

Figure 84: Peter Physical Model Frame 32

When he arrives at the ferry terminal he pays with a paper ticket and checks if the ferry is delayed on a digital screen and sees that the ferry is on time. He then walks to the ferry dock. While waiting for the ferry he starts browsing the internet on his smart phone to check tomorrows surf conditions.

Figure 85: Peter Physical Model Frame 33

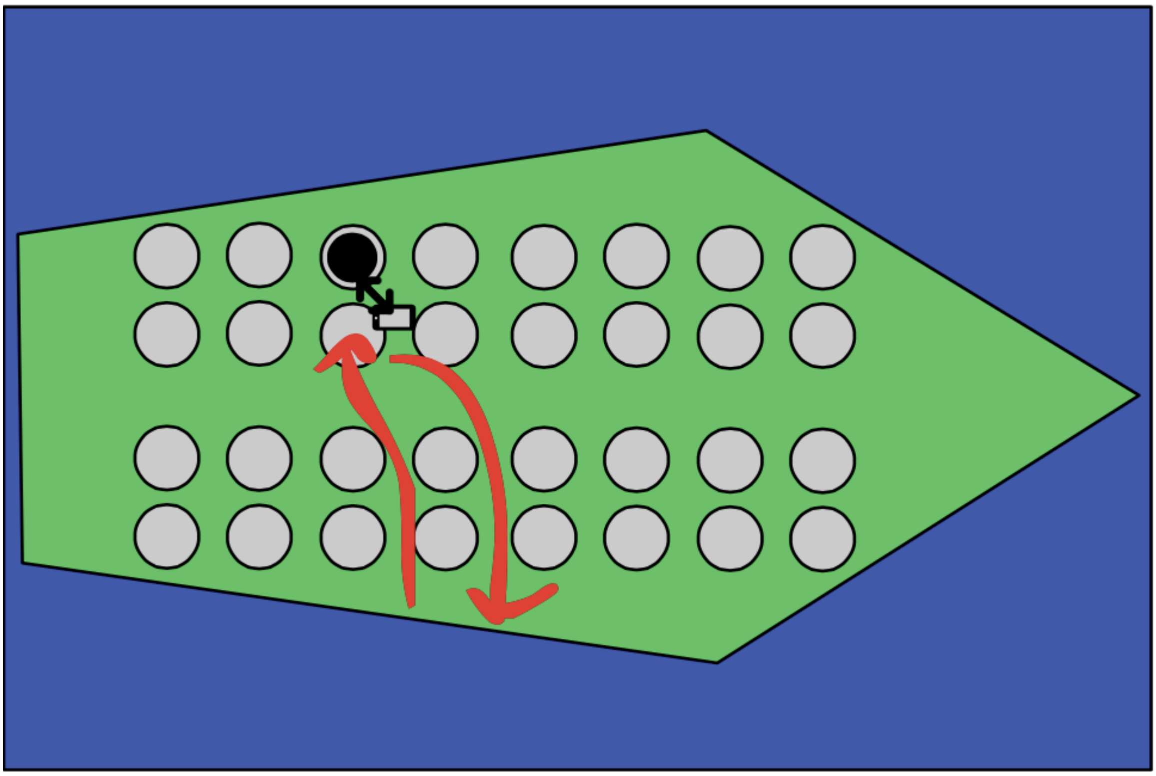


Figure 86: Peter Physical Model Frame 34

He enters the Ferry sits down in the back of the ferry and continues browsing the internet for surf related news.

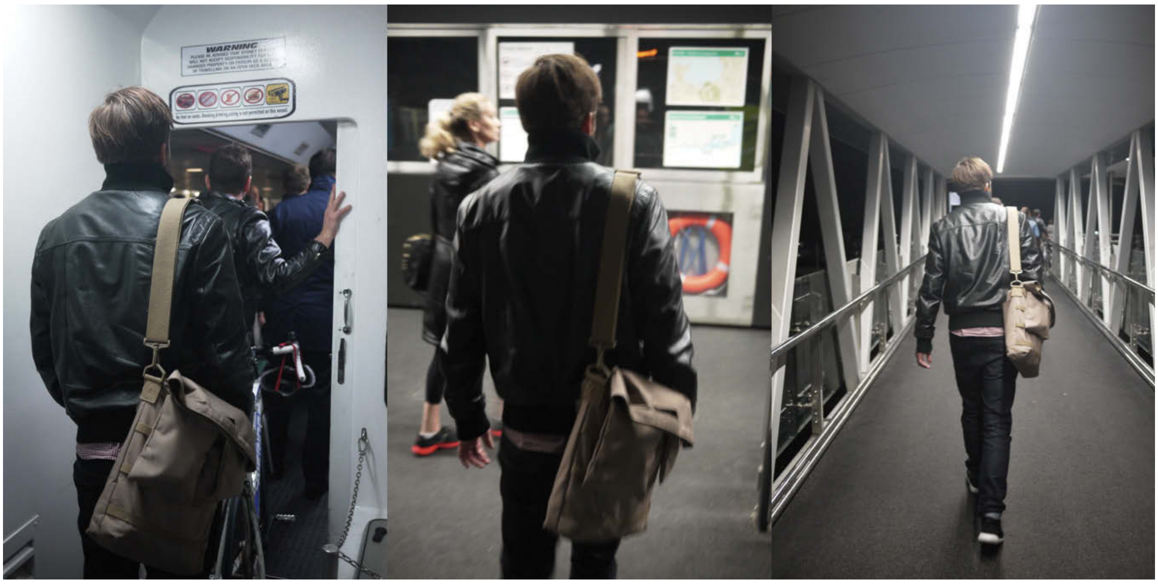


Figure 87: Peter Physical Model Frame 35

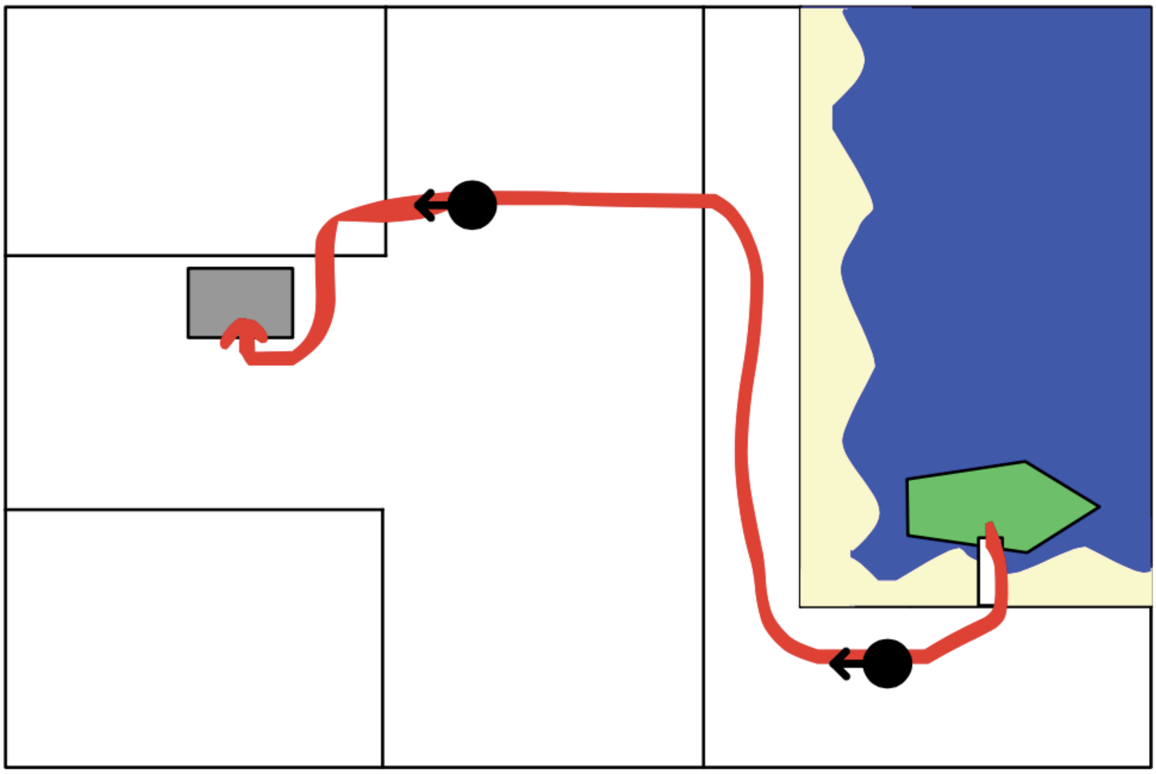


Figure 88: Peter Physical Model Frame 36

Figure 89: Peter Physical Model Frame 37

He leaves the ferry and leaves the terminal and walks back to the car.

Figure 90: Peter Physical Model Frame 38

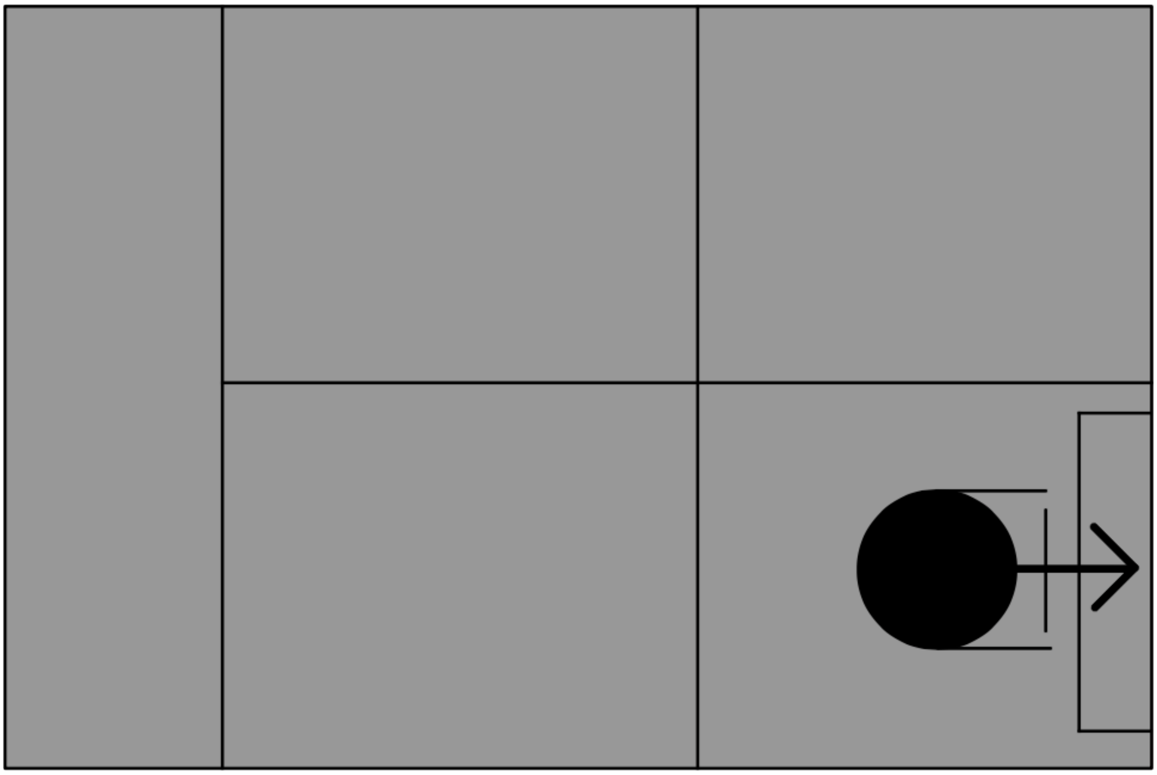


Figure 91: Peter Physical Model Frame 39

He gets in the car with analog keys and drives home without looking at his smart phone.

Figure 92: Peter Physical Model Frame 40

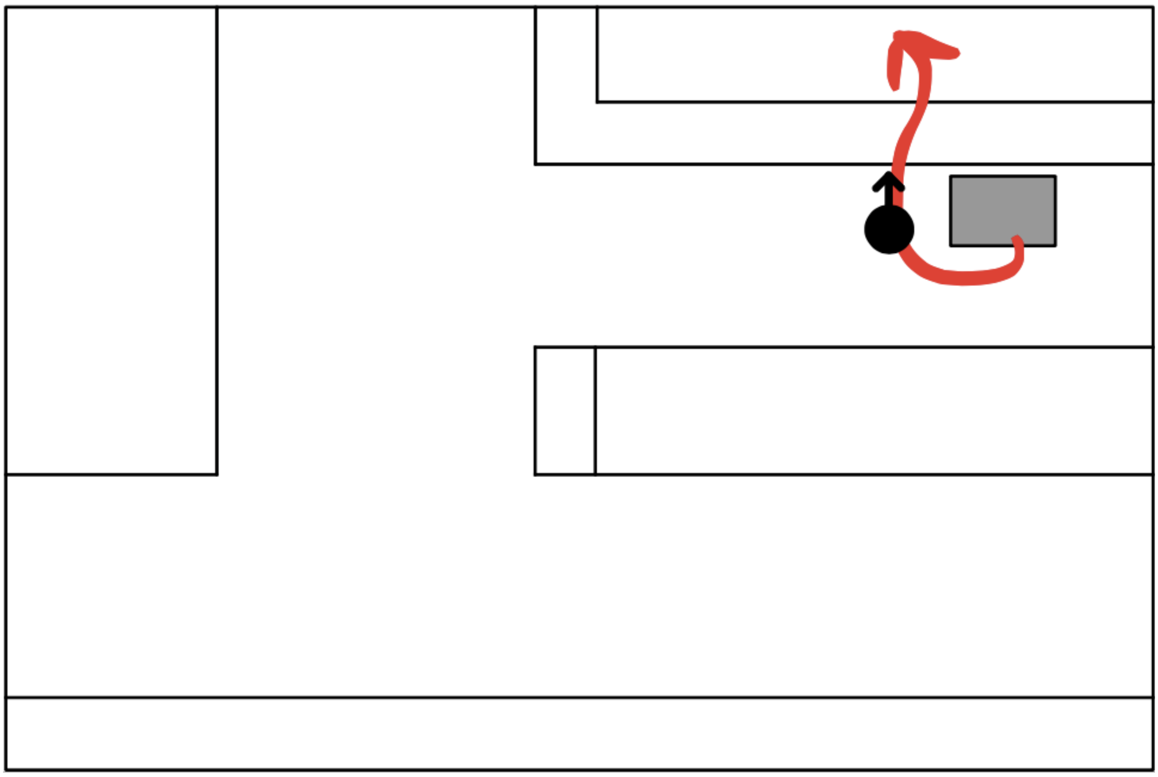


Figure 93: Peter Physical Model Frame 41

Figure 94: Peter Physical Model Frame 42

He leaves the car, closes it with analog keys and walks home. He arrives at home and opens the door with analog keys.

Circle Flow Model:

The Circle Flow model is an overview of Peter's data of his everyday interactions.

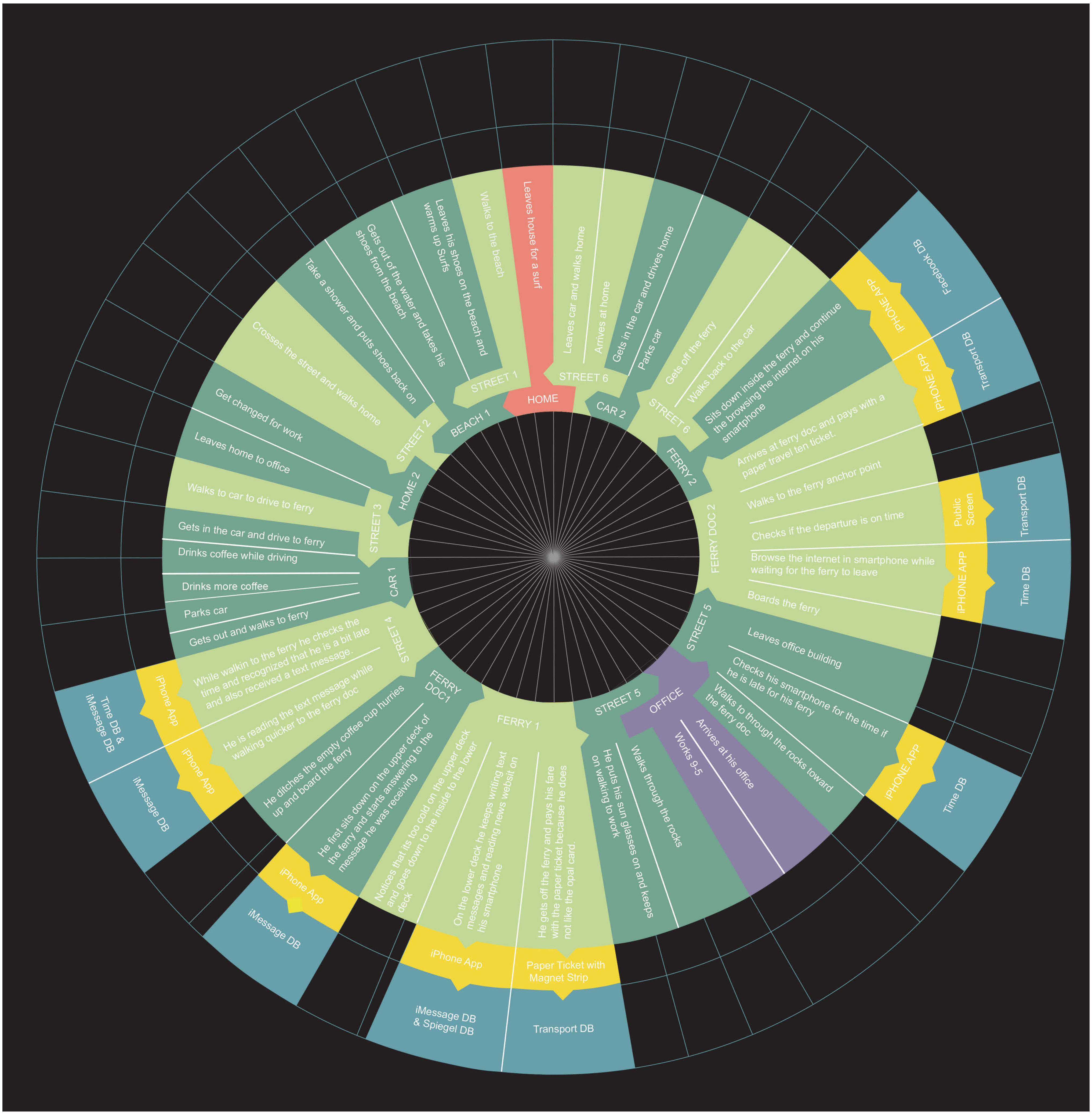


Figure 95: Peter Circle Flow Model

1.2.14 Individual Data Models - Sebastian (9-5 worker using Private Transport) - Circle Flow & Physical Model

The fourth participant researched was Sebastian who has a 9-5 job in Bondi Beach and uses a car as private transport.

Physical Model:

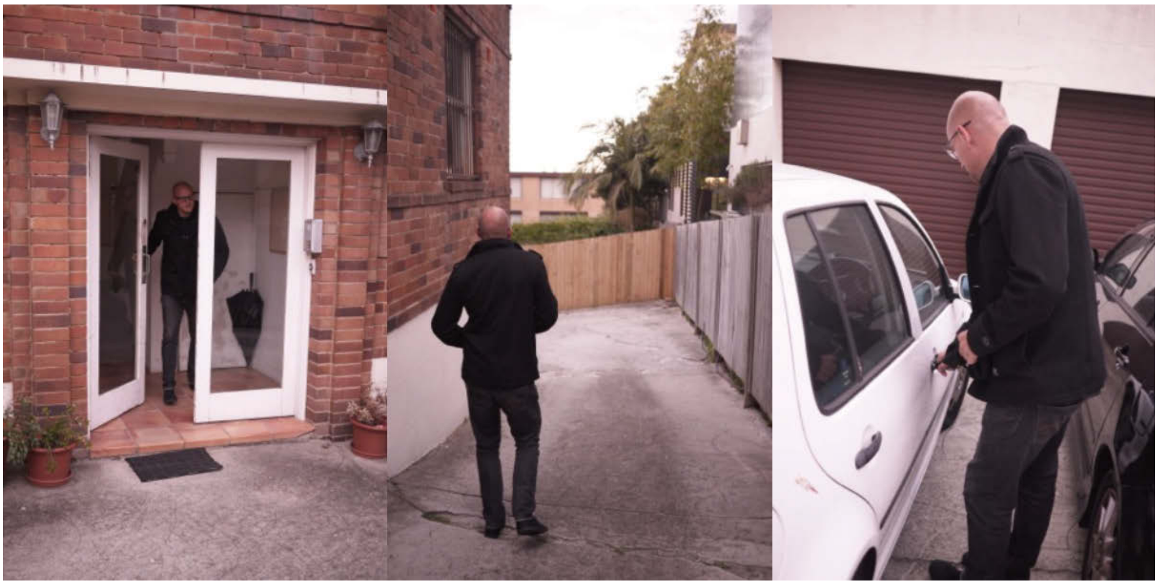


Figure 96: Sebastian Physical Model Frame 1

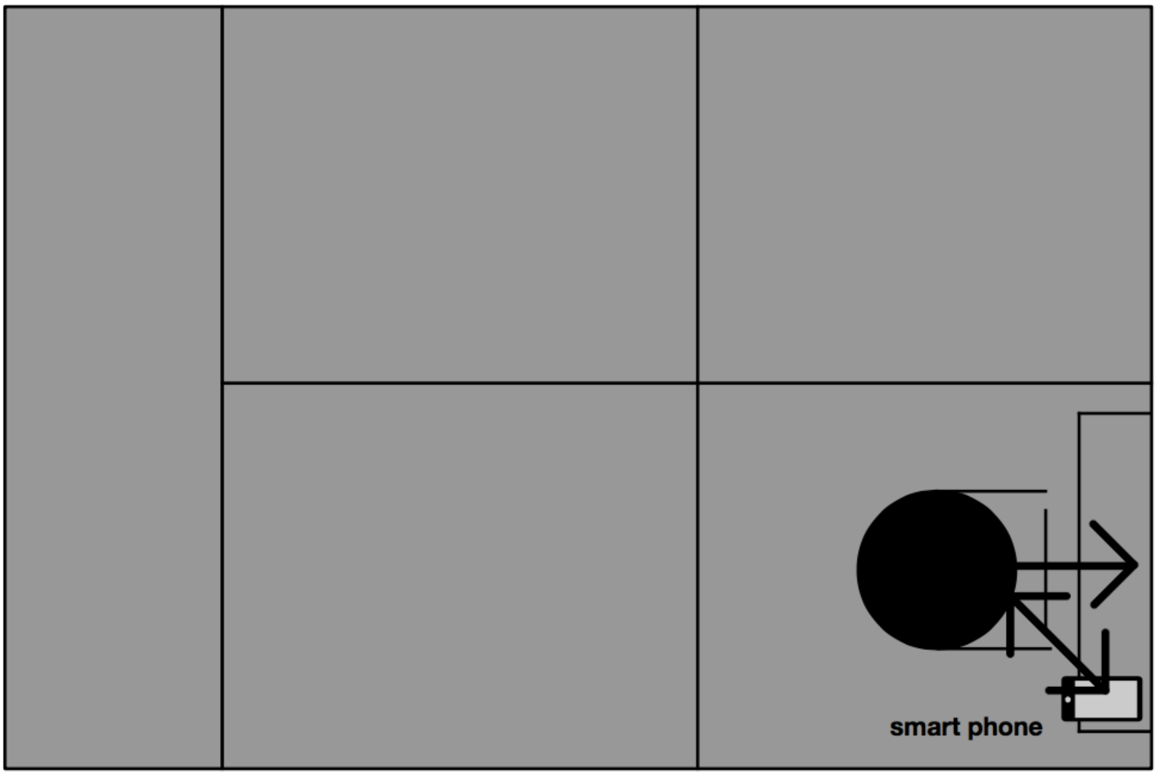


Figure 97: Sebastian Physical Model Frame 2

Figure 98: Sebastian Physical Model Frame 3

Figure 99: Sebastian Physical Model Frame 4

Sebastian is leaving his home location in his car, which is parked in his home parking spot. While he is driving he is checking the waves in the ocean and is putting his smart phone in his smart phone card holder and interacts with it while driving taking it in and out of the holder as required. Sebastian's first interaction is making a phone call while driving in Car 1, his first attempt of making a call is using Siri connected to the Apple iCloud database, while the smart phone is held in the car phone holder. Siri fails and he has to manually search for the contact and make the phone call via a manual touch interaction instead of a voice interaction. For this he has to take the smart phone out of the holder and take one hand of the wheel and his eyes of the street while driving.

Figure 100: Sebastian Physical Model Frame 5

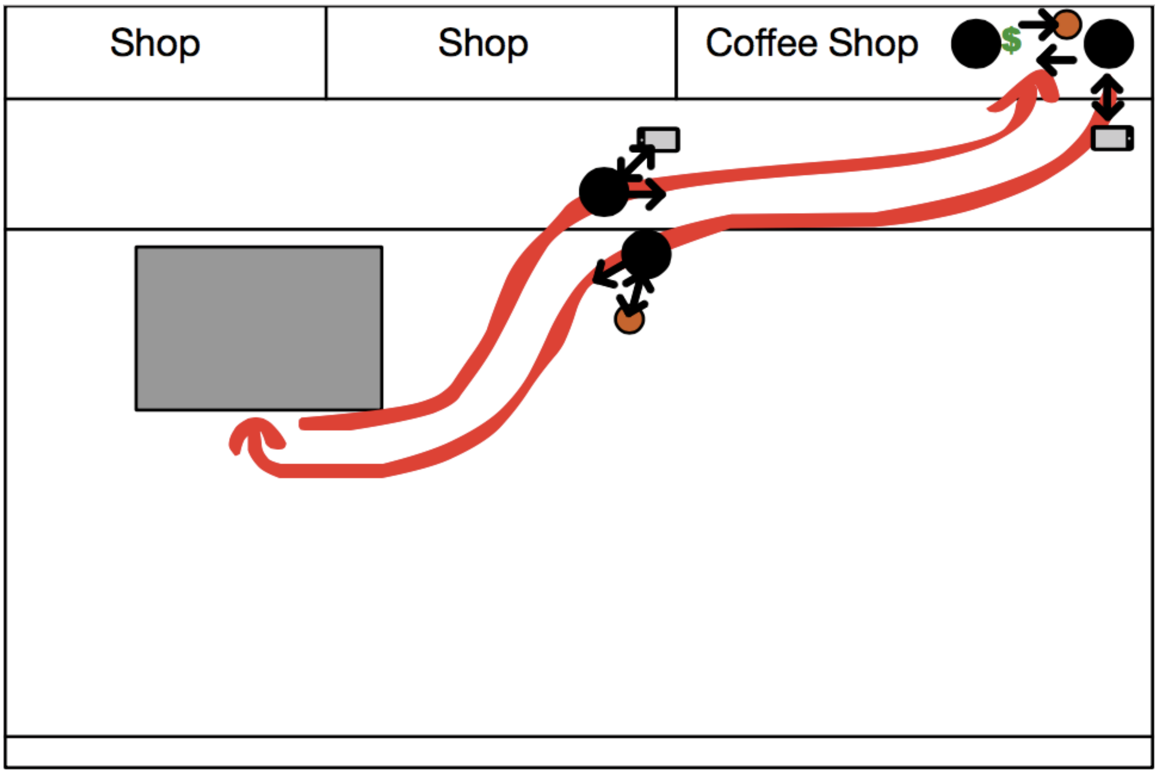


Figure 101: Sebastian Physical Model Frame 6

Figure 102: Sebastian Physical Model Frame 7

Figure 103: Sebastian Physical Model Frame 8

In frame 2 Sebastian parks his car to get a coffee, gets out of the car while making another phone call and locks the car. He then walks to the coffee shop and enters. In the coffee shop he orders a large cappuccino and pays in cash. He then interacts with his smart phone browsing Pinterest connected to the Pinterest database while waiting for his coffee order. Sebastian uses Pinterest to collect ideas and inspirational pieces for his Architecture practice. He then receives his coffee in a to go cup and walks back to the car and gets back into the car.

Figure 104: Sebastian Physical Model Frame 9

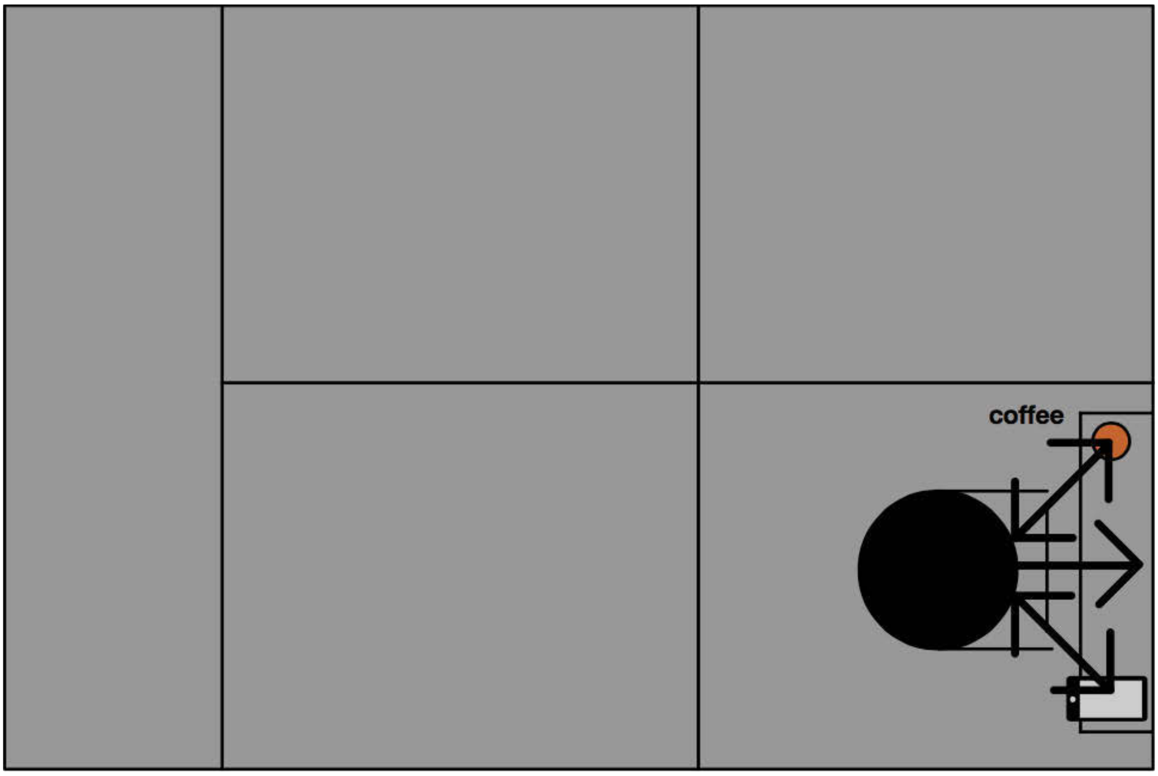


Figure 105: Sebastian Physical Model Frame 10

Figure 106: Sebastian Physical Model Frame 11

Figure 107: Sebastian Physical Model Frame 12

Back in the car in frame 3 Sebastian puts his phone back in the smart phone holder and his coffee in the cup holder of his car. He then starts driving to his first building site which he has to inspect. While driving he uses Flipboard connected to the Flipboard database, to browse for new inspirational work, Sebastian uses Flipboard the same way as Pinterest. Sebastian also reads some emails while driving and sends some text messages using iMessage connected to the iCloud database. He uses his smart phone in combination with his car phone holder, sometimes in his hand sometimes in the holder. In parallel he would drink coffee and interact with his smart phone while driving. He would also interact more intensely with his smart phone while stopping at traffic lights.

Figure 108: Sebastian Physical Model Frame 13

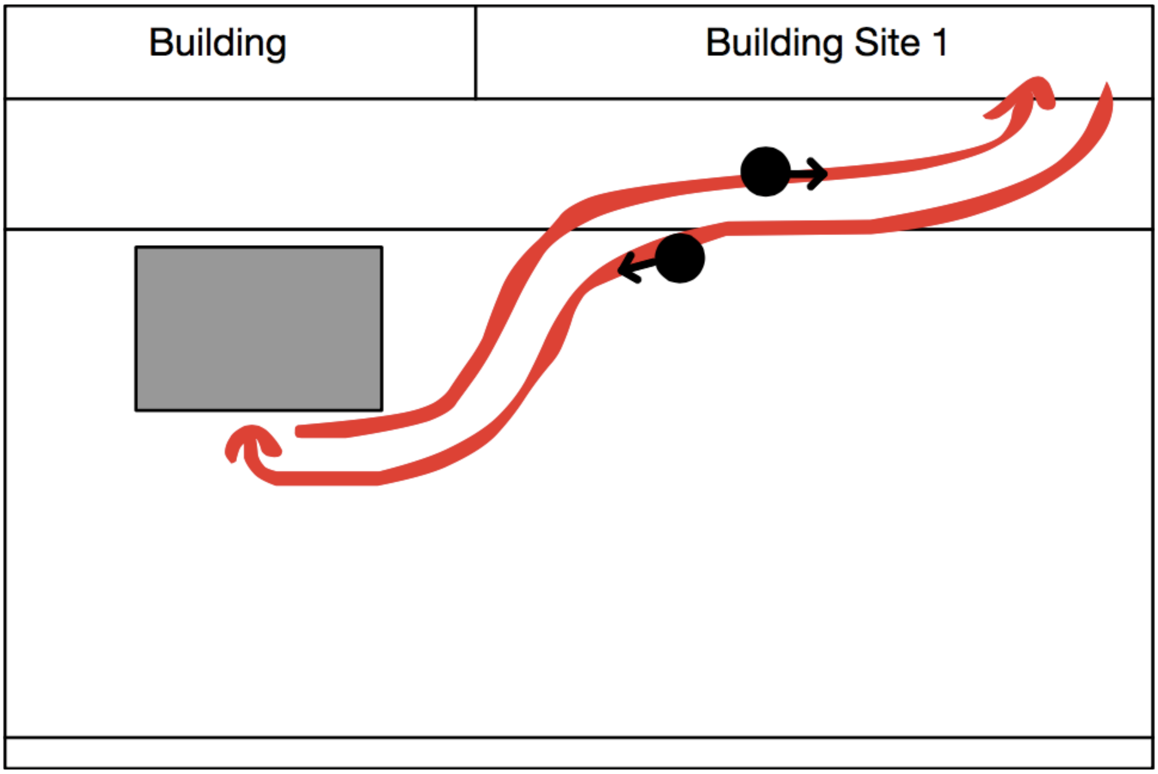


Figure 109: Sebastian Physical Model Frame 14

Figure 110: Sebastian Physical Model Frame 15

In frame 4 Sebastian visits a building site, he parks his car and walks in and out of the building site. After he visited his first building site he gets back into the car and is driving to a second building site.

Figure 111: Sebastian Physical Model Frame 16

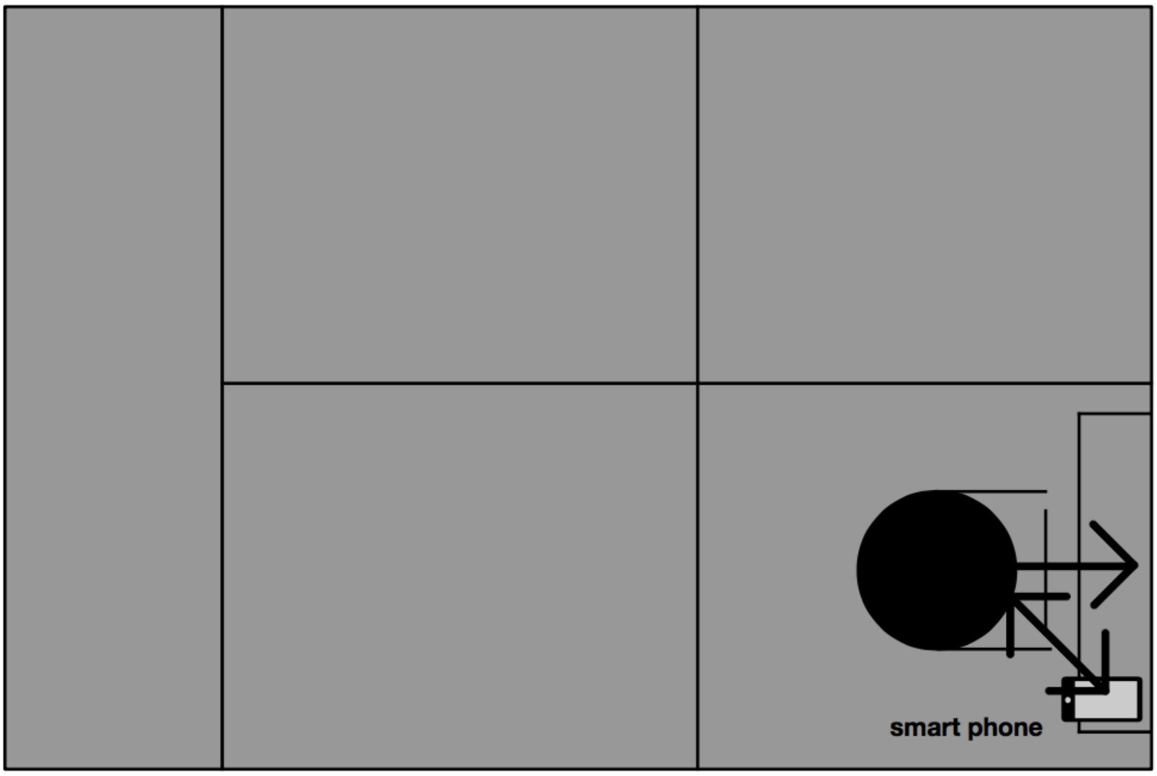


Figure 112: Sebastian Physical Model Frame 17

In frame 5 Sebastian starts driving his car towards the second building site, again interacting with his smart phone while driving, he writes text messages using iMessage via the iCloud database.

Figure 113: Sebastian Physical Model Frame 18

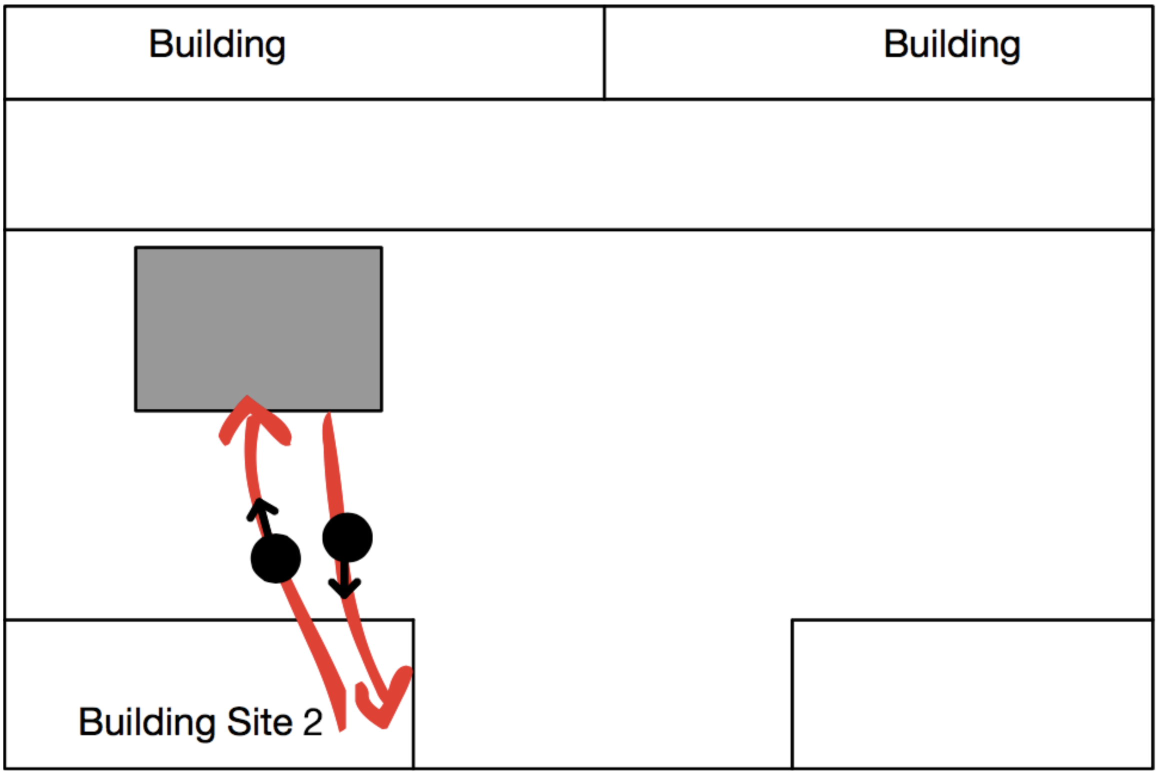


Figure 114: Sebastian Physical Model Frame 19

In frame 6 Sebastian again parks his car and walks in and out of the second building site.

Figure 115: Sebastian Physical Model Frame 20

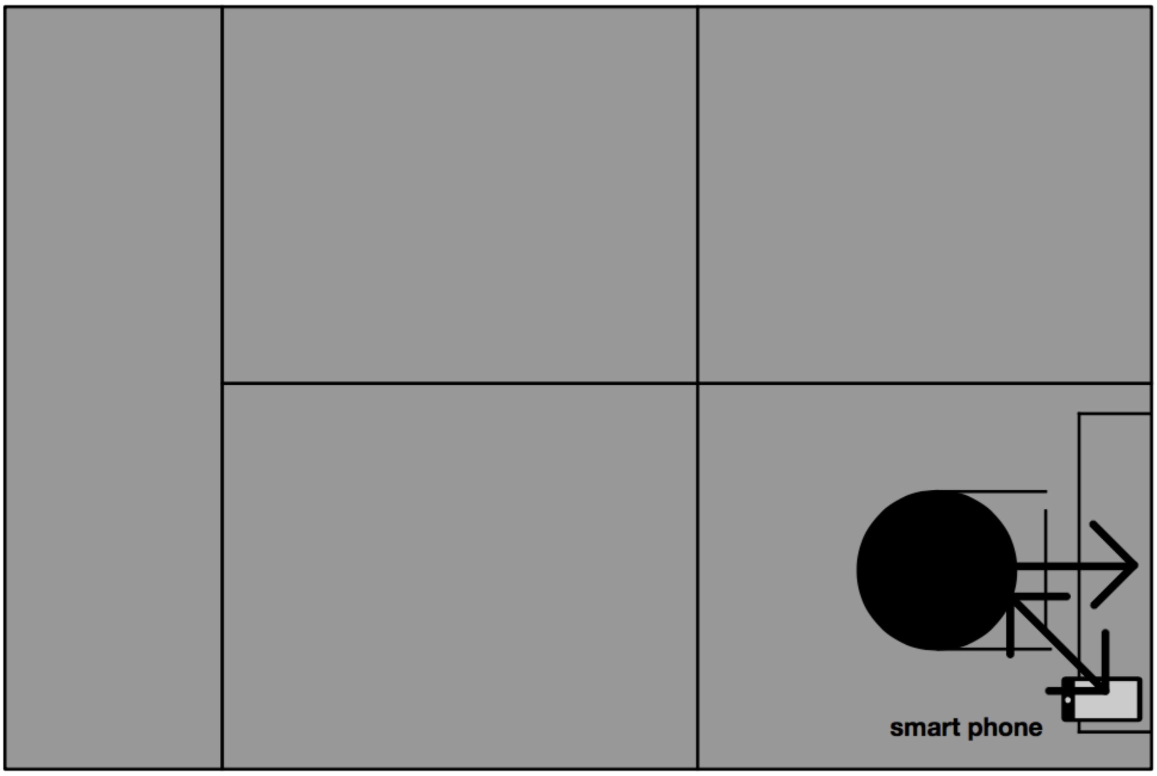


Figure 116: Sebastian Physical Model Frame 21

After inspecting the building site he gets back into his car and drives towards his office which is close to the beach in Bondi.

Figure 117: Sebastian Physical Model Frame 22

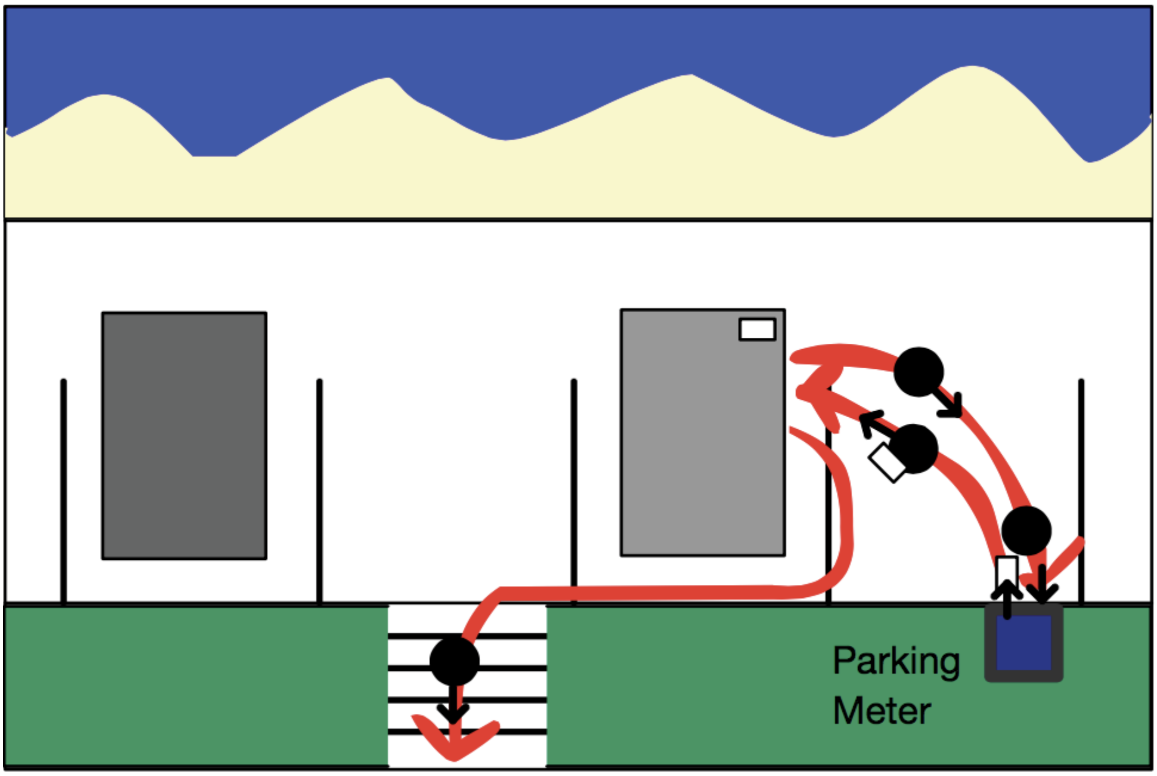


Figure 118: Sebastian Physical Model Frame 23

Frame 7 shows Sebastian parking in a parking lot at the beach. He requests a parking ticket from the parking meter computer for free since he has a parking permit. The parking computer has to access the council parking database to ensure Sebastian has a valid permission to park for free. Once the permission is confirmed the parking computer prints out a free ticket. Once he receives the ticket he places it inside the car and closes his car and walks to his office, on his way he checks waves again if they are good for surfing today. He is then walking up a set of stairs towards the street his office is located in.

Figure 119: Sebastian Physical Model Frame 24

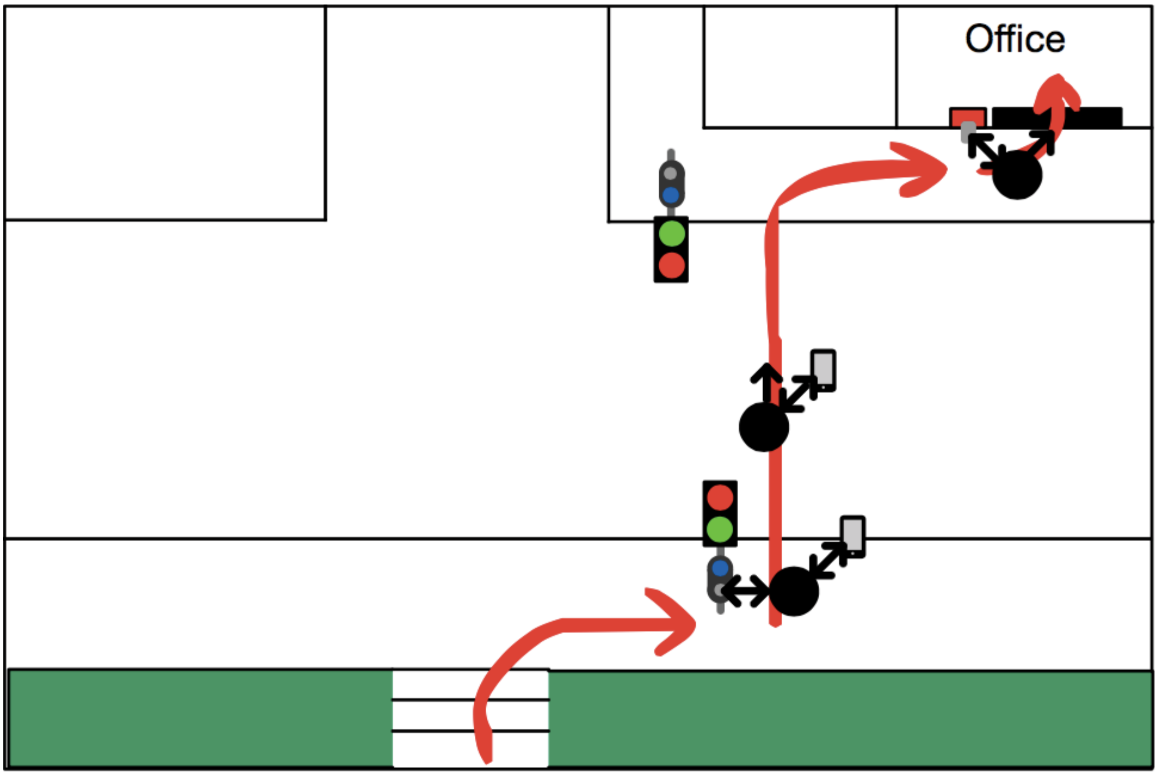


Figure 120: Sebastian Physical Model Frame 25

Figure 121: Sebastian Physical Model Frame 26

Frame 8 shows Sebastian walking from the beach parking to the office, interacting with the traffic light button which communicates with the Sydney traffic database to give green light. In parallel Sebastian interacts with his smart phone to read emails, communicating with his email database. When given green light by the traffic light he crosses the street and walks towards his office building door. Sebastian then interacts with the office building door using an RFID swipe card which communicates with the building database using a physical computing interface to check for valid access rights. Sebastian then works from 10am to 1pm in his office.

Figure 122: Sebastian Physical Model Frame 27

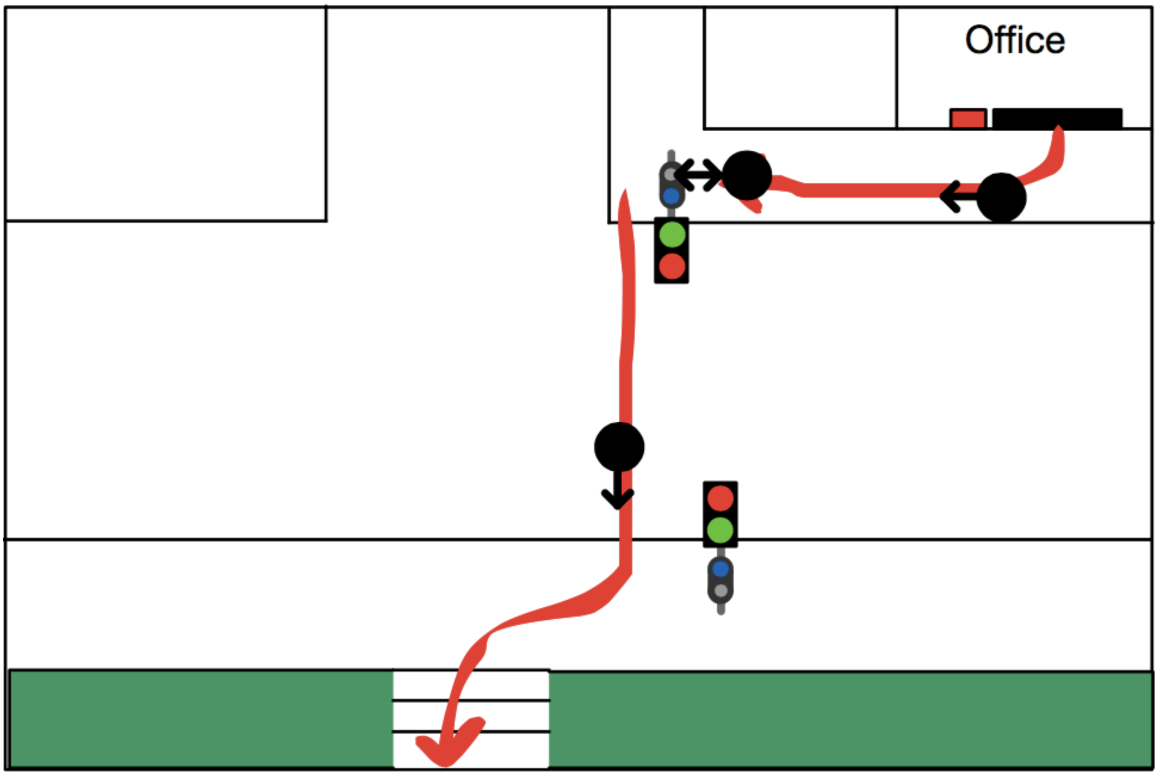


Figure 123: Sebastian Physical Model Frame 28

Frame 9 shows Sebastian leaving his office building to go for a surf during his lunch break. He is walking back towards the car park at the beach. He again pushes the traffic light button and crosses the street on green light, then walks down the stairs to the parking spot.

Figure 124: Sebastian Physical Model Frame 29

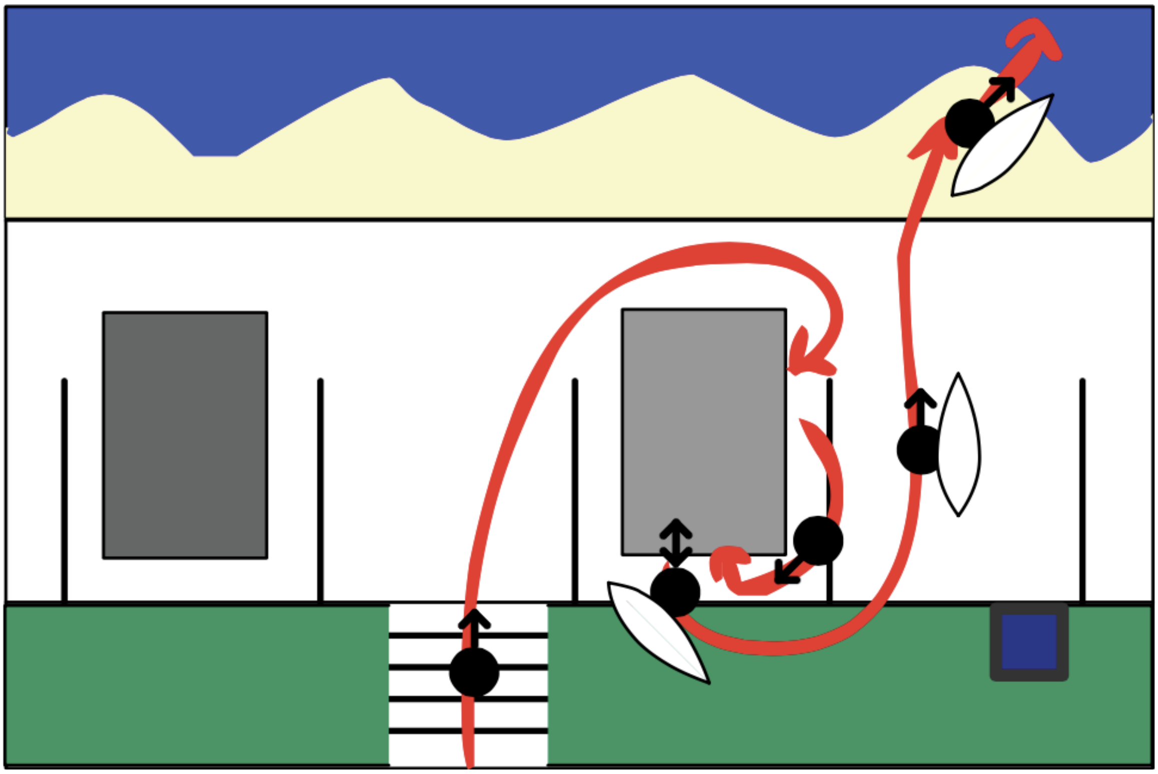


Figure 125: Sebastian Physical Model Frame 30

Figure 126: Sebastian Physical Model Frame 31

Figure 127: Sebastian Physical Model Frame 32

Figure 128: Sebastian Physical Model Frame 33

At his car frame 10 shows Sebastian opening his car and getting his surfboard out of the car and getting changed. He hides his keys under the back numberplate of his car grabs his board and walks towards the beach. He starts running down the grass hill then jumps over the fence down to the sand.

Figure 129: Sebastian Physical Model Frame 34

Figure 130: Sebastian Physical Model Frame 35

On the sand he warms up and paddles out into the ocean, where he surfs for 45 minutes.

Figure 131: Sebastian Physical Model Frame 36

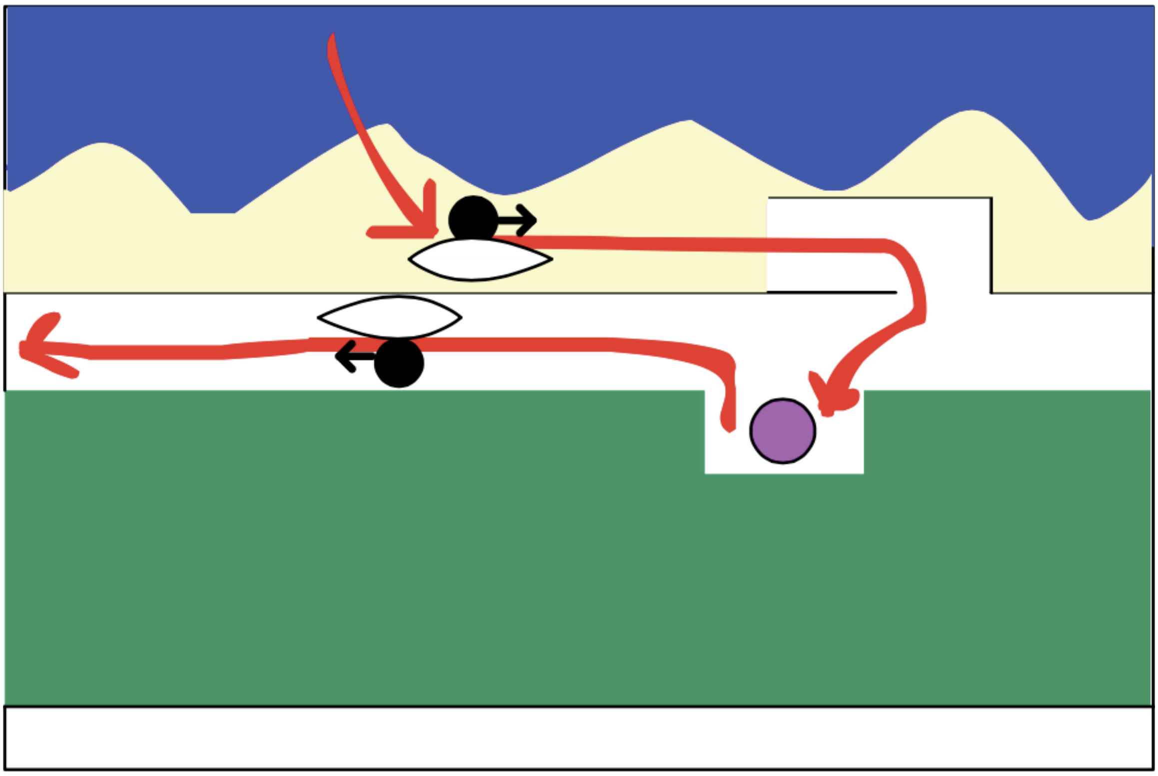


Figure 132: Sebastian Physical Model Frame 37

Figure 133: Sebastian Physical Model Frame 38

Frame 11 shows Sebastian coming in from the ocean, taking a shower at a beach shower. Then Sebastian walks back to his car parking spot.

Figure 134: Sebastian Physical Model Frame 39

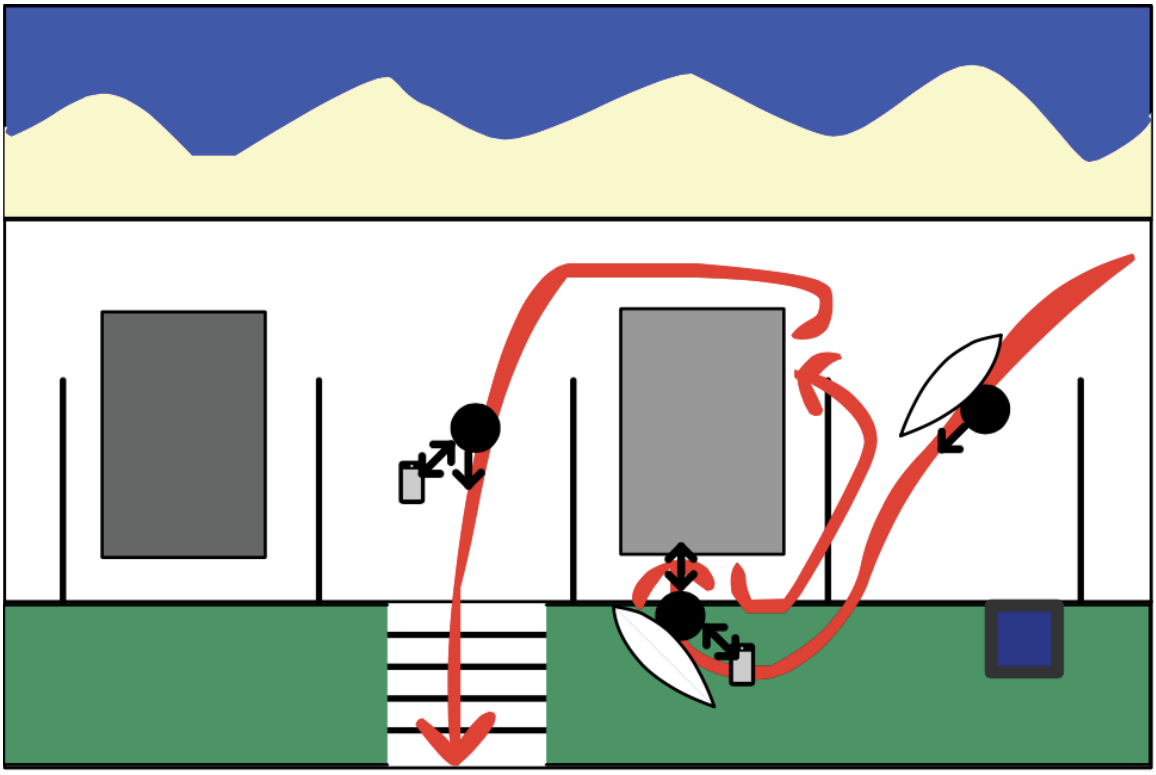


Figure 135: Sebastian Physical Model Frame 40

Figure 136: Sebastian Physical Model Frame 41

Frame 12 shows Sebastian getting keys from under the numberplate getting changed and putting his surfboard back into his car. He checks email on his smart phone while he is getting changed

Figure 137: Sebastian Physical Model Frame 42

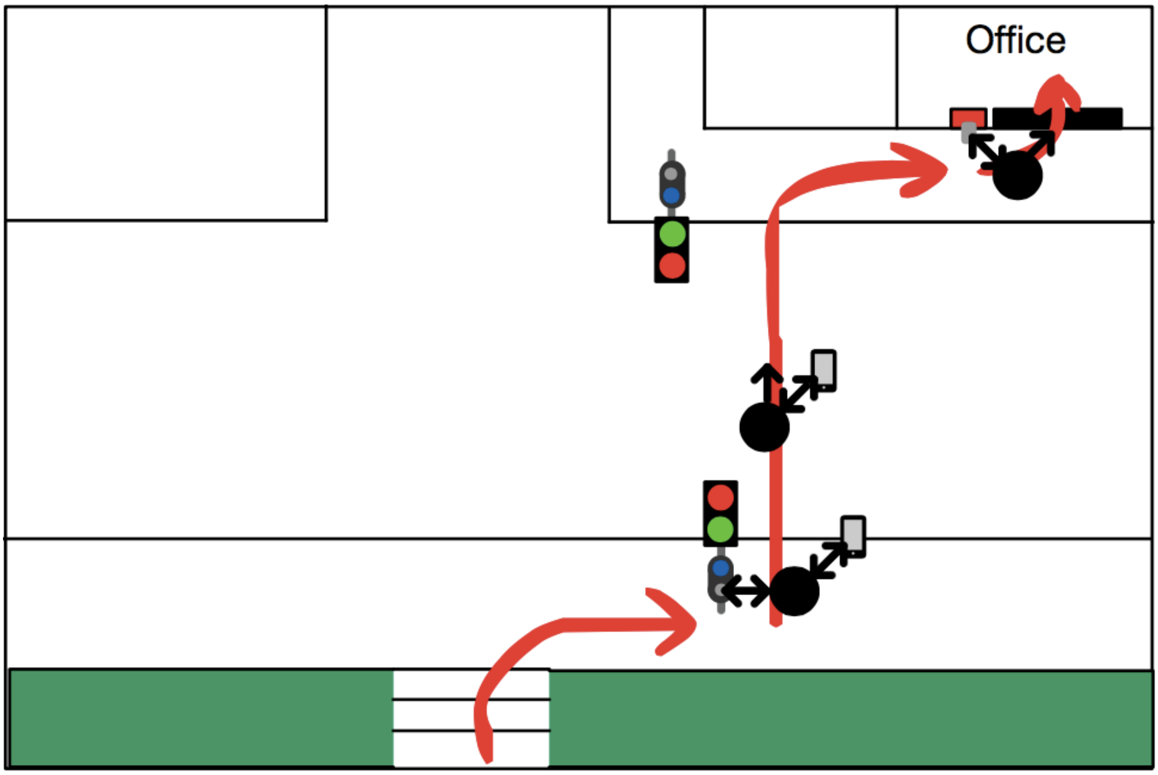


Figure 138: Sebastian Physical Model Frame 43

Figure 139: Sebastian Physical Model Frame 44

Frame 13 shows Sebastian closing his car and walking back towards his office. He continues interacting with his smart phone to check emails and pushes the traffic light button. When having green light Sebastian crosses the street and enters his office again with an RFID swipe card.

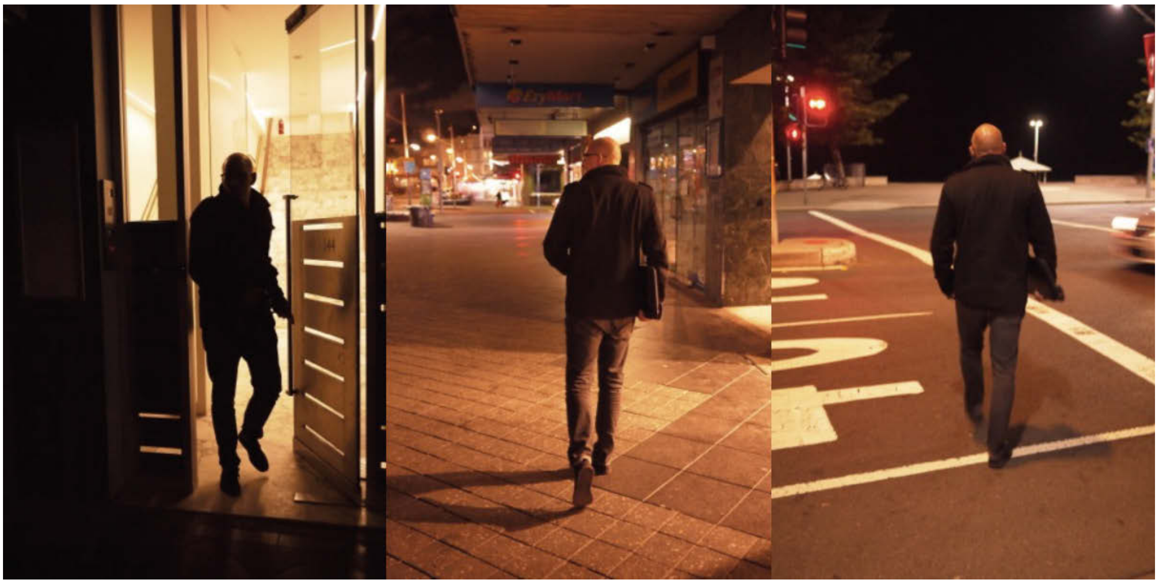


Figure 140: Sebastian Physical Model Frame 45

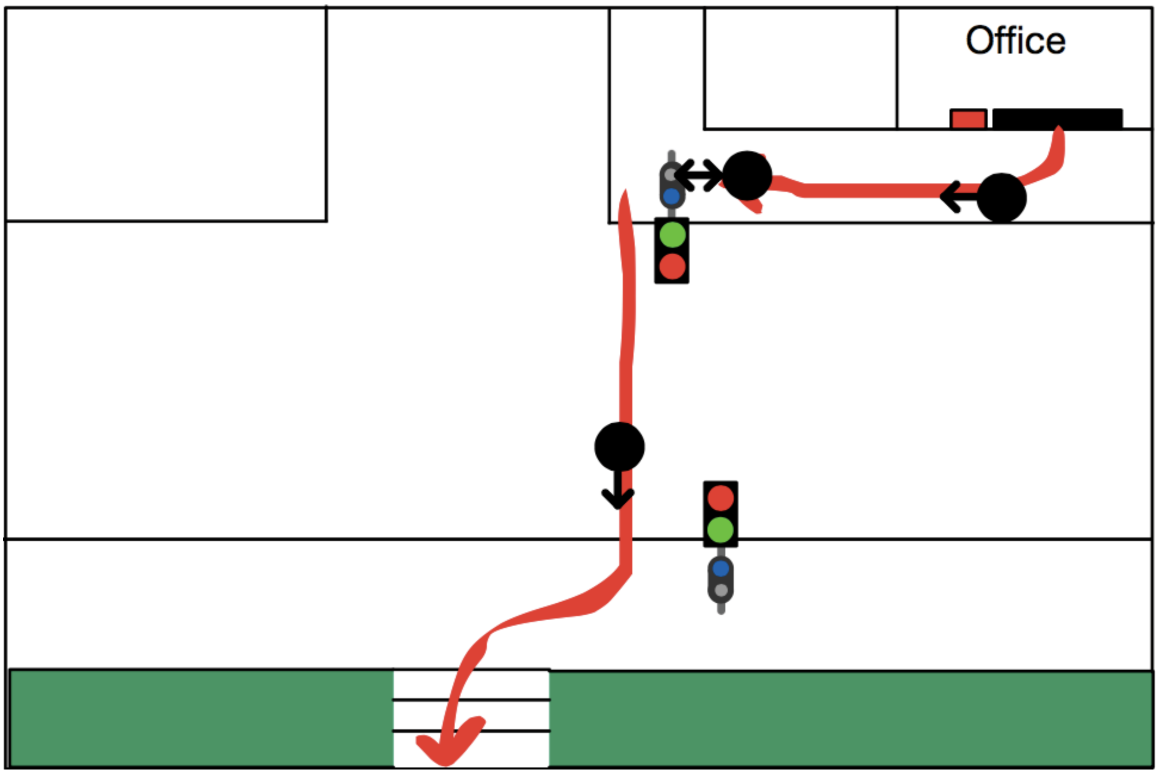


Figure 141: Sebastian Physical Model Frame 46

Frame 14 shows Sebastian leaving his office. At the traffic lights he is crossing the street on a red light walking towards his parking spot at the beach.

Figure 142: Sebastian Physical Model Frame 47

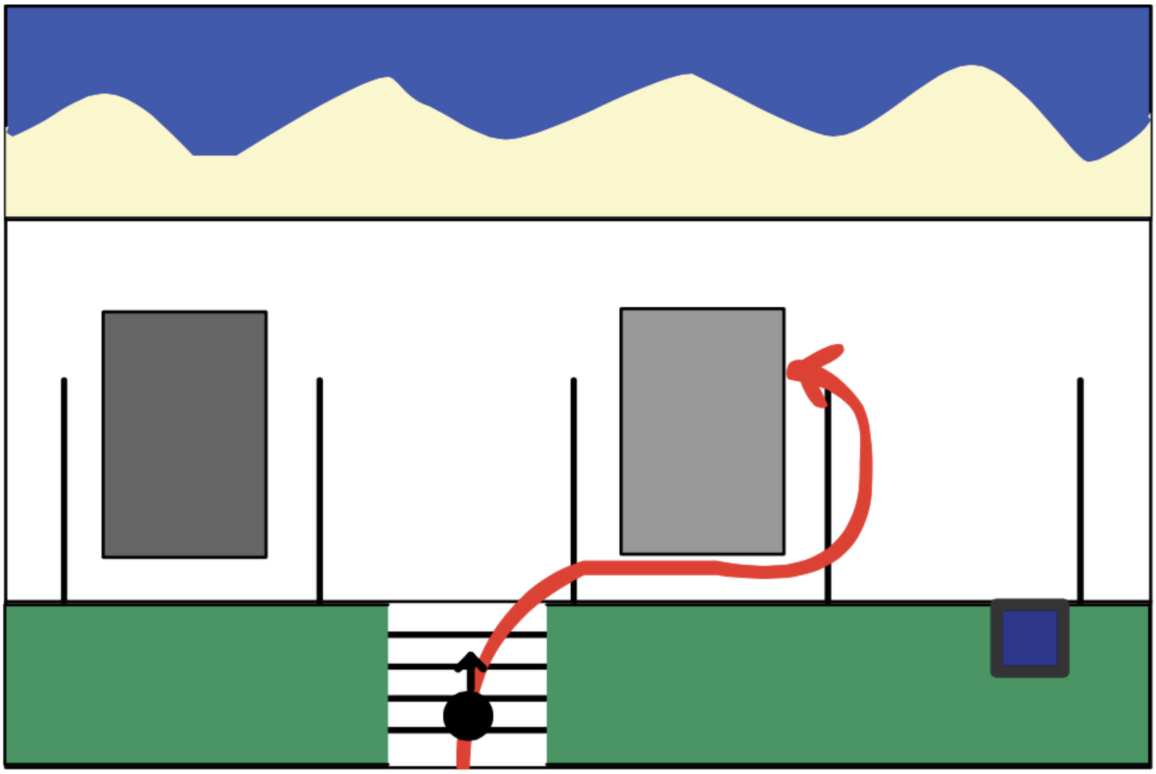


Figure 143: Sebastian Physical Model Frame 48

Frame 15 shows Sebastian getting into his car and starts driving home.

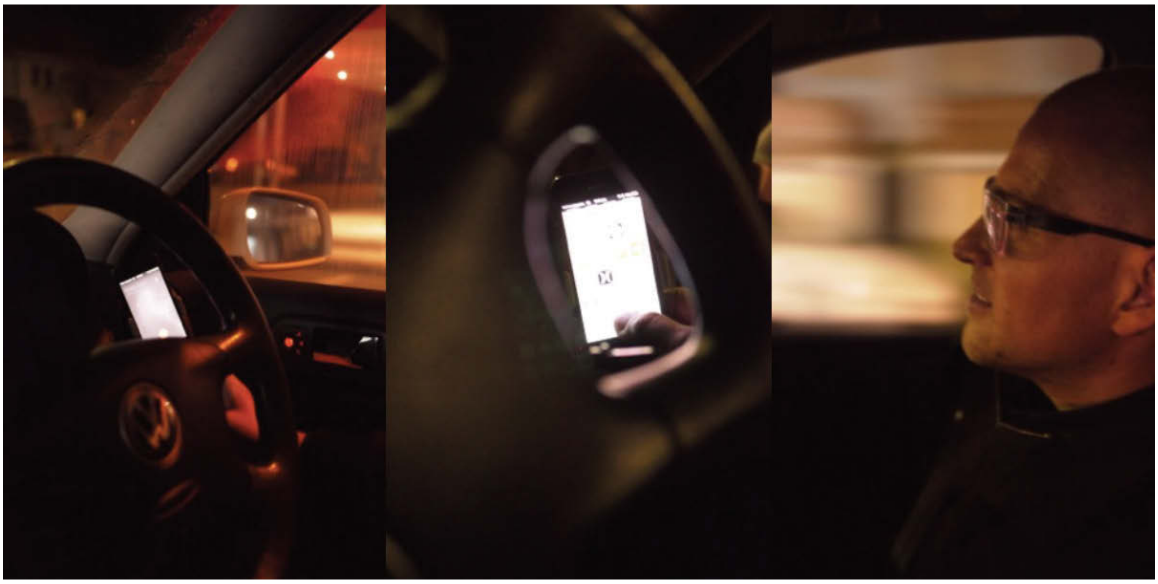


Figure 144: Sebastian Physical Model Frame 49

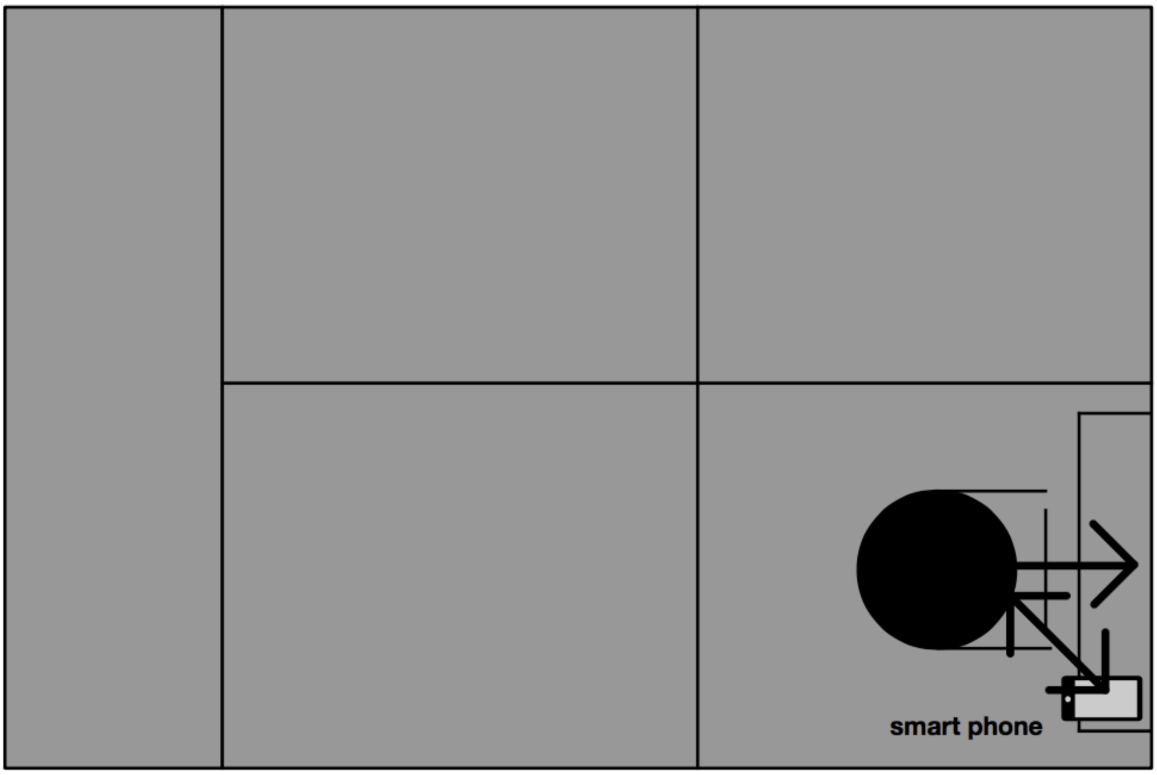


Figure 145: Sebastian Physical Model Frame 50

Figure 146: Sebastian Physical Model Frame 51

Frame 16 shows Sebastian in the car putting his smart phone into the smart phone holder. Where he makes a phone call again while driving back home. He tries to make the call using Siri, Siri fails so he has to call the number manually. At home Sebastian then parks his car on his home building parking spot at his house and walks into the entrance to enter the building.

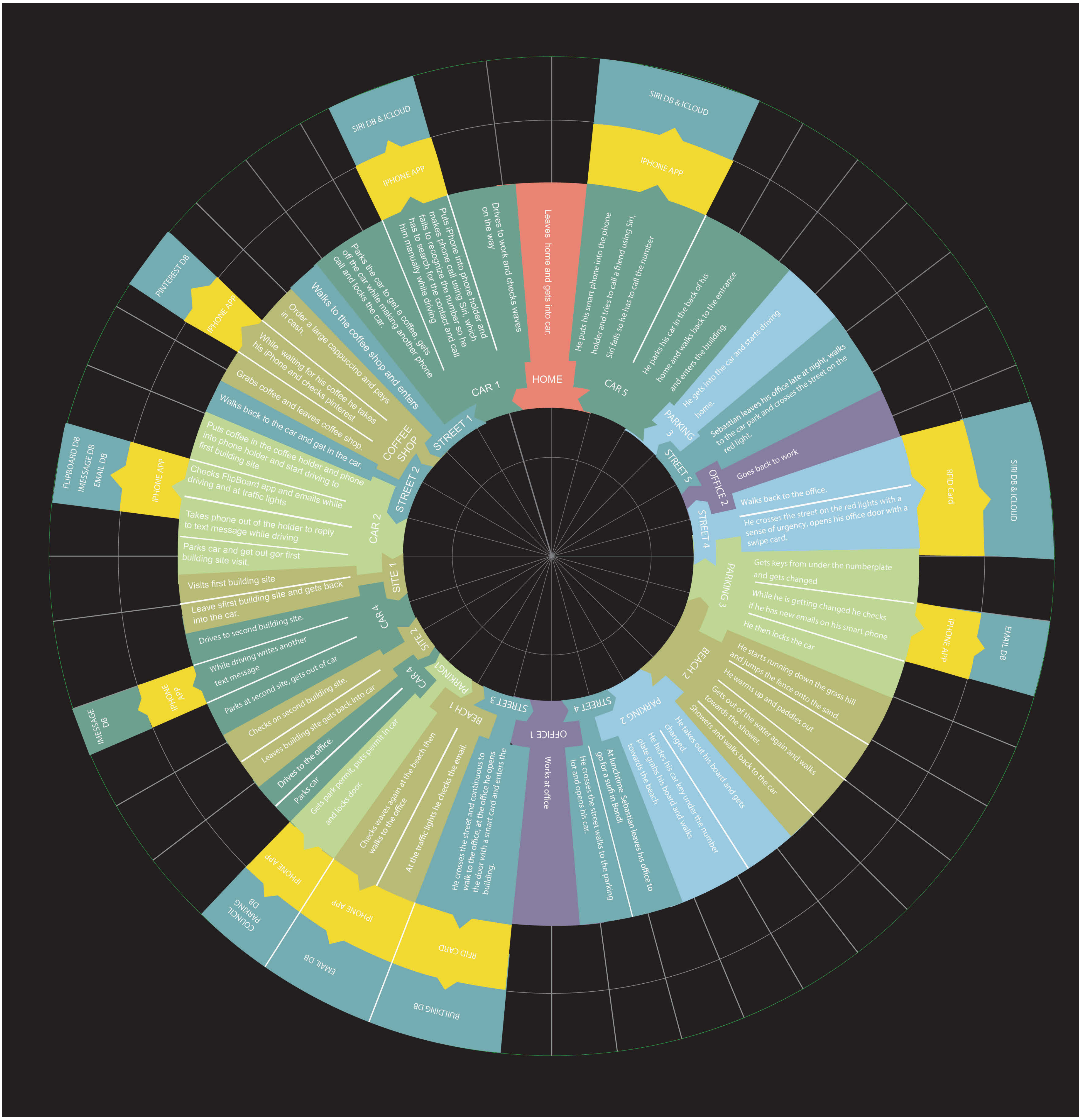


Figure 147: Sebastian Circle Flow Model

1.2.15 Individual Data Models - Matt (9-5 worker using Private Transport) - Circle Flow & Physical Model

The fifth participant researched was Matt who uses private transport and has a 9-5 job in the neighbourhood of Paddington in Sydney.

Physical Model:

The physical model show's Matt's interactions situated in the physical environment and within the narrative of his day over time.

Figure 148: Matt Physical Model Frame 1

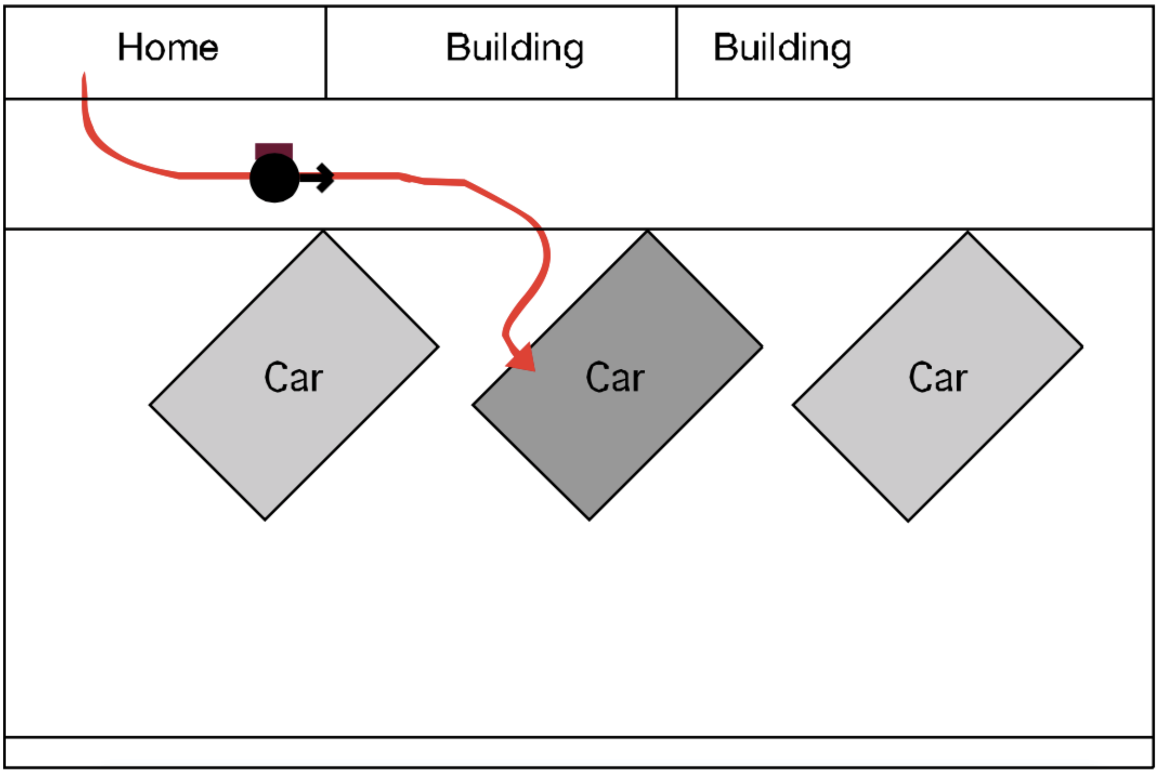


Figure 149: Matt Physical Model Frame 2

Matt leaves his home and walks to his car, at the car he uses his remote control to open the door and gets in. In the car he connects his iPhone to his stereo using a USB cable.

Figure 150: Matt Physical Model Frame 3

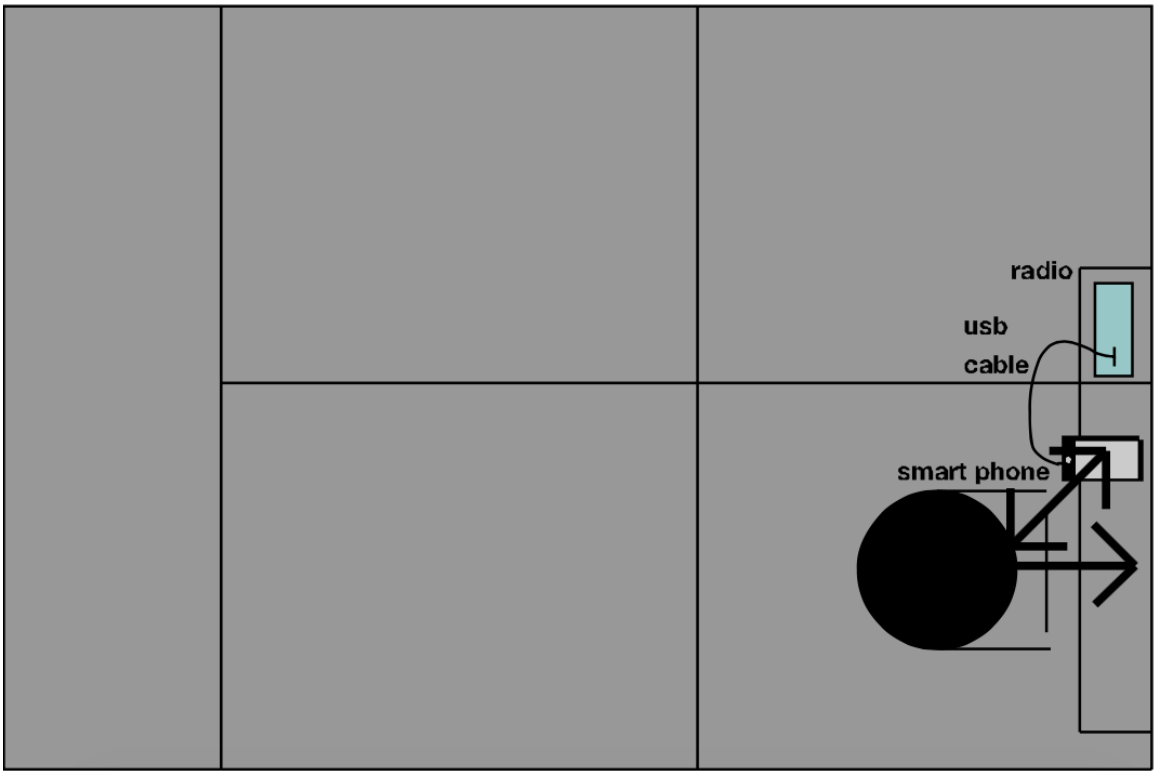


Figure 151: Matt Physical Model Frame 4

He starts the car with his car keys and starts driving towards his office. While driving he uses his iPhone to listen to music using the Spotify app. While driving he is also checking if he received new emails and replies to important ones.

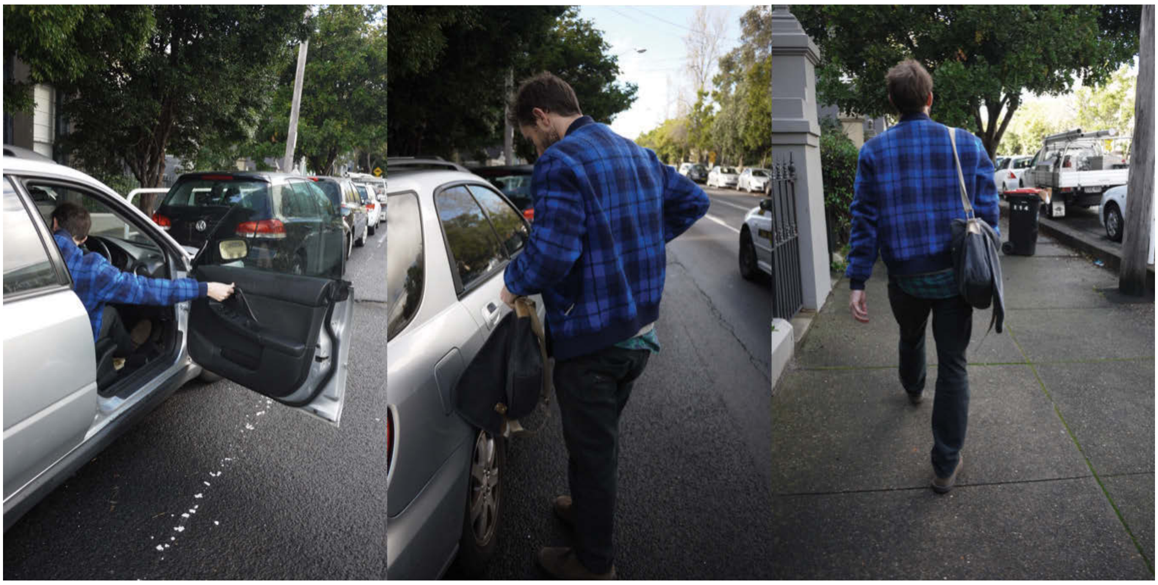


Figure 152: Matt Physical Model Frame 5

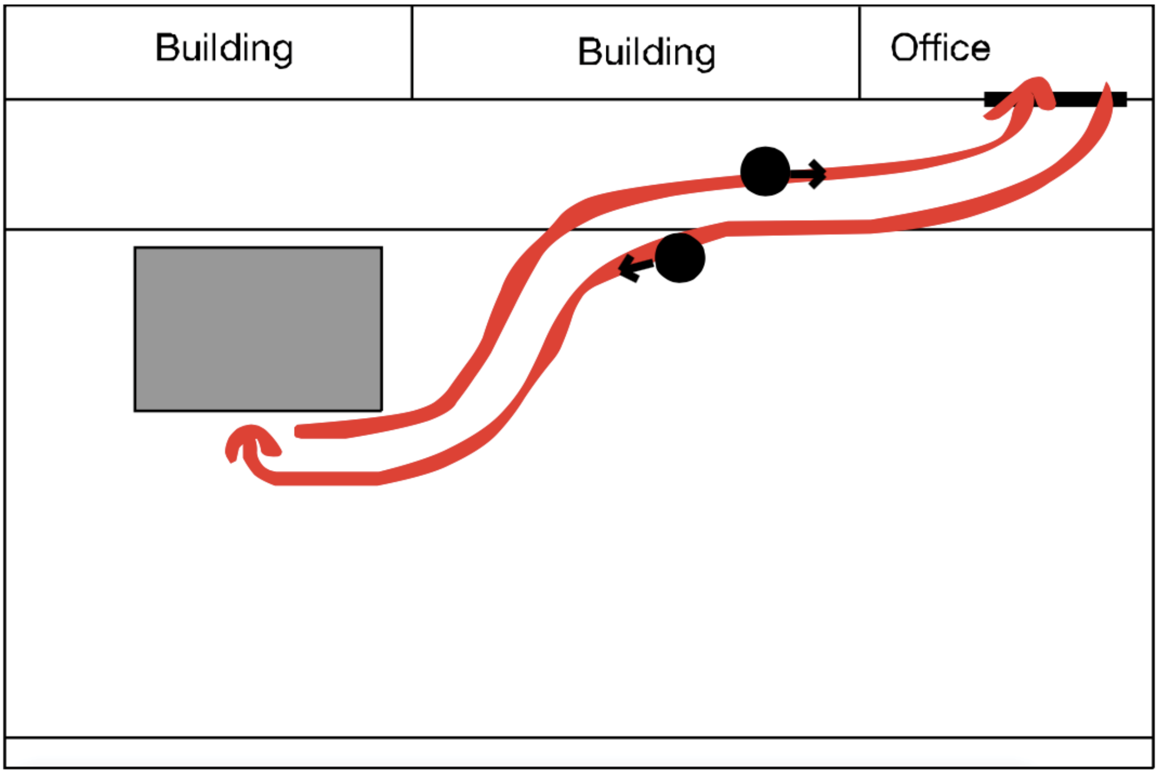


Figure 153: Matt Physical Model Frame 6

Figure 154: Matt Physical Model Frame 7

He parks his car on an on street parking spot and opens the door to get out. He then closes the door using his remote control. He then walks to his office. At the office he opens the office door and walks in. He stays inside the office from 9-5pm working on TV commercials. At 5pm he leaves the office.

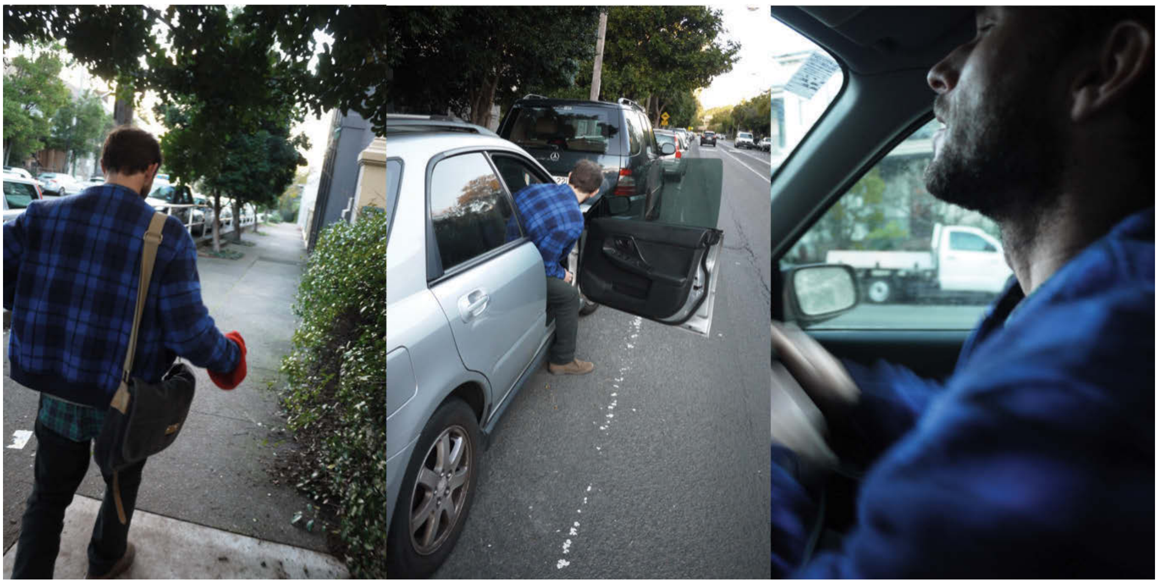


Figure 155: Matt Physical Model Frame 8

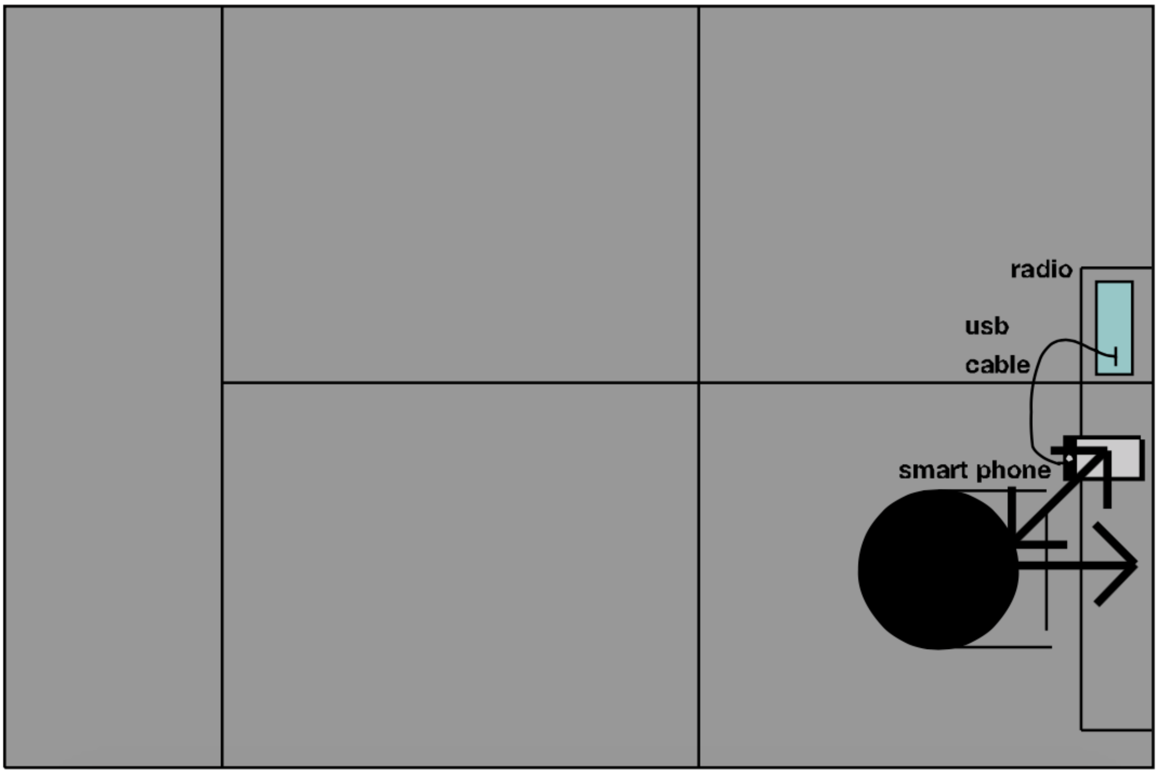


Figure 156: Matt Physical Model Frame 9

He walks back to the car, opens the car with his remote control and gets in, connects his iPhone via USB cable to the car stereo, starts listening to music using the Spotify app and starts driving.

Figure 157: Matt Physical Model Frame 10

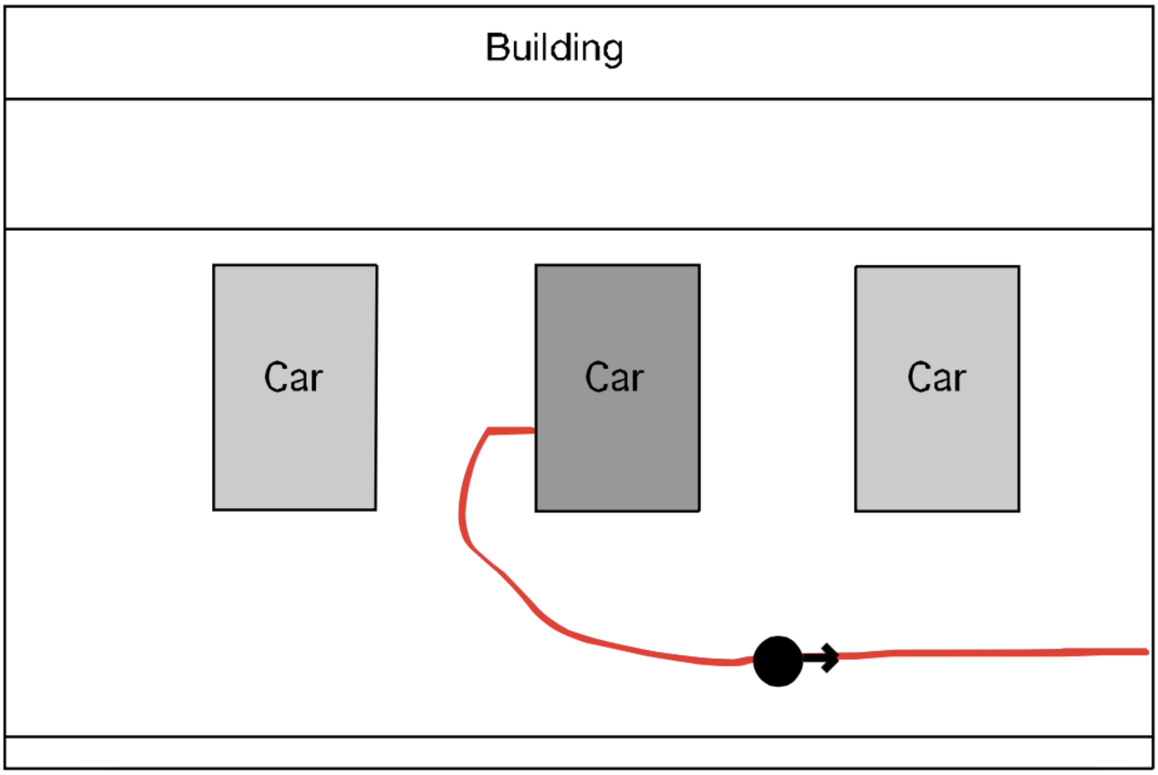


Figure 158: Matt Physical Model Frame 11

He is driving to a pub close by to meet a friend and have a beer. He parks the car close by to the pub, gets out and then closes the car using his remote control.

Figure 159: Matt Physical Model Frame 12

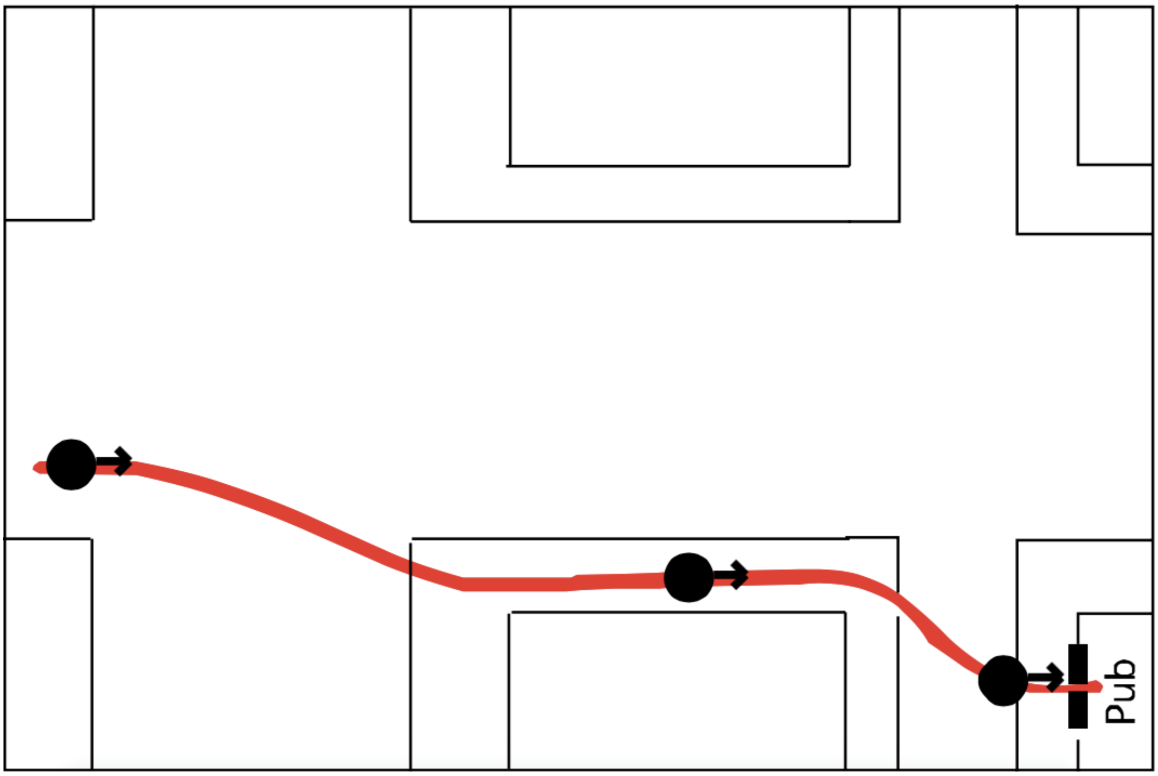


Figure 160: Matt Physical Model Frame 13

He jaywalks across a street, then continuous walking to the pub and enters through a door. He orders a beer from the bar tender.

Figure 161: Matt Physical Model Frame 14

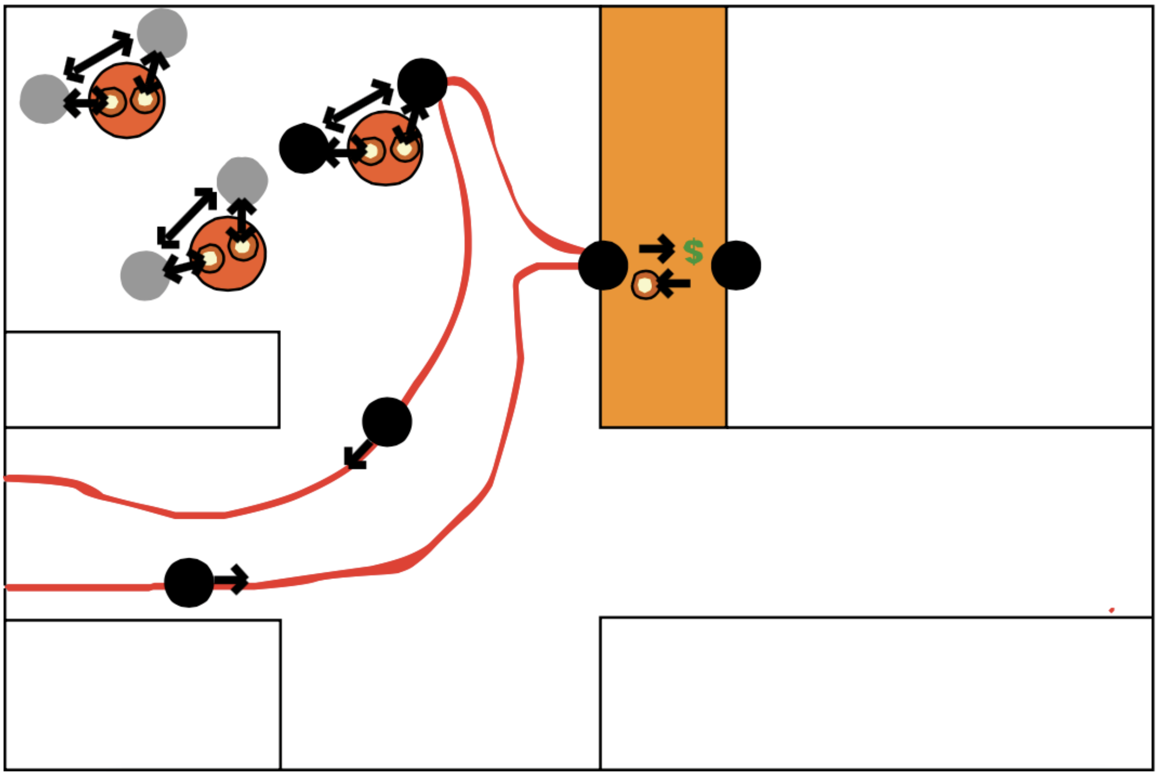


Figure 162: Matt Physical Model Frame 15

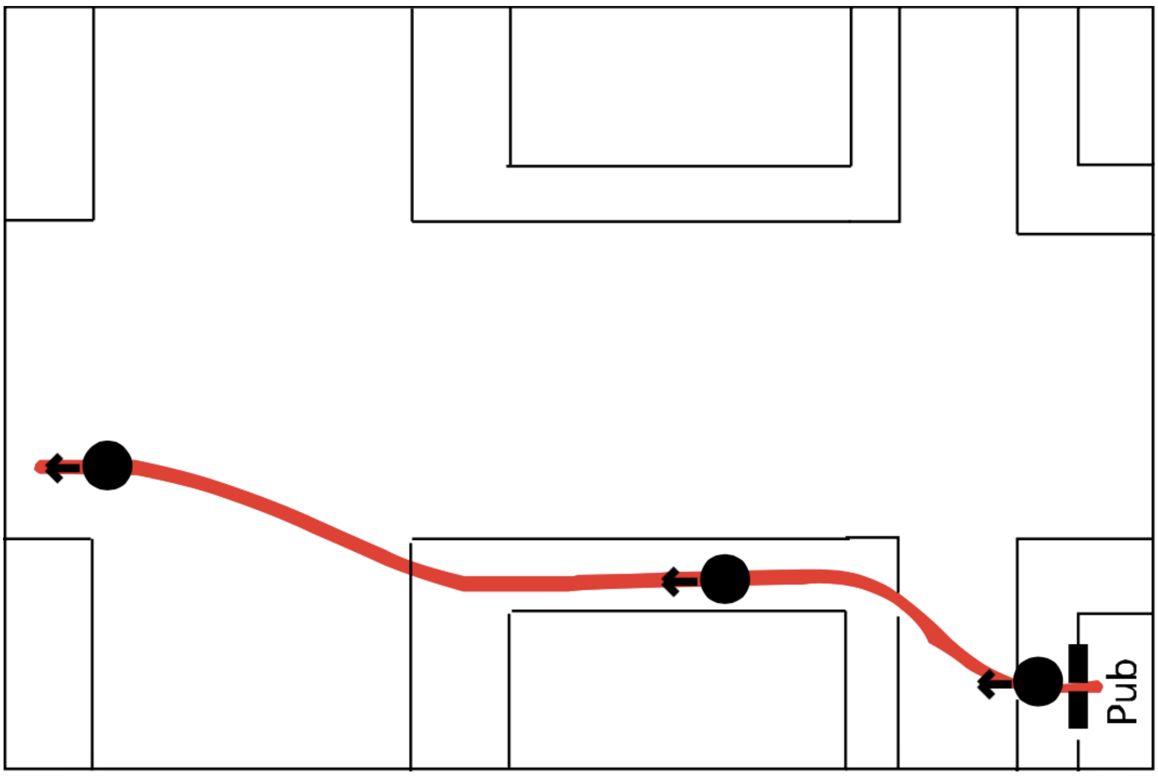


Figure 163: Matt Physical Model Frame 16

He pays the beer in cash when he receives it. Then drinks and enjoys his beer while chatting to a friend at a table in the pub. When finished he leaves the pub and walks back to his car. He jaywalks back across a street an arrives at his car.

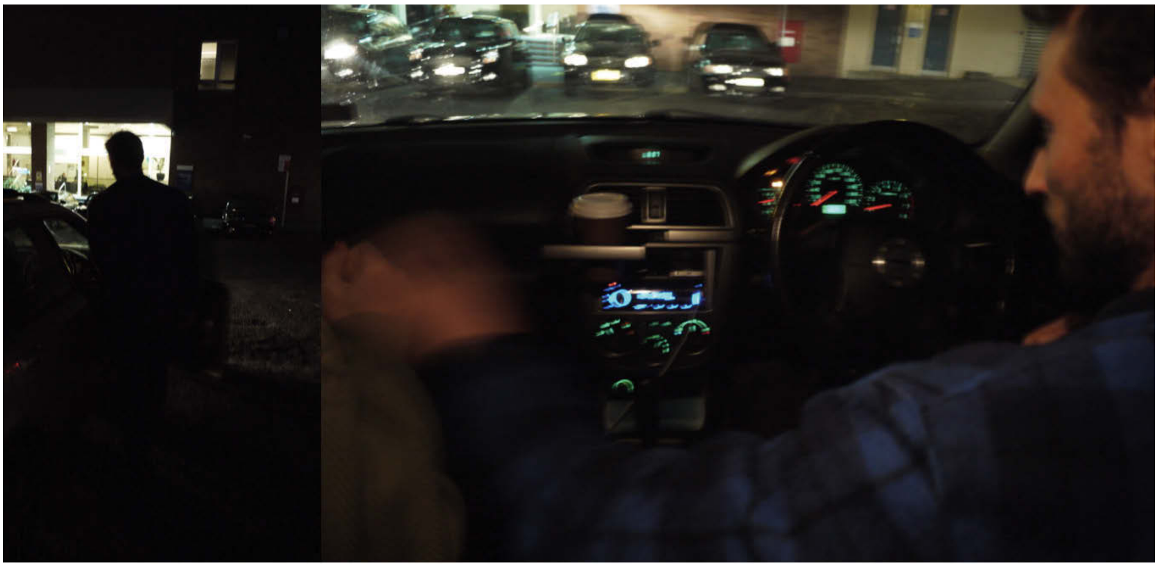


Figure 164: Matt Physical Model Frame 17

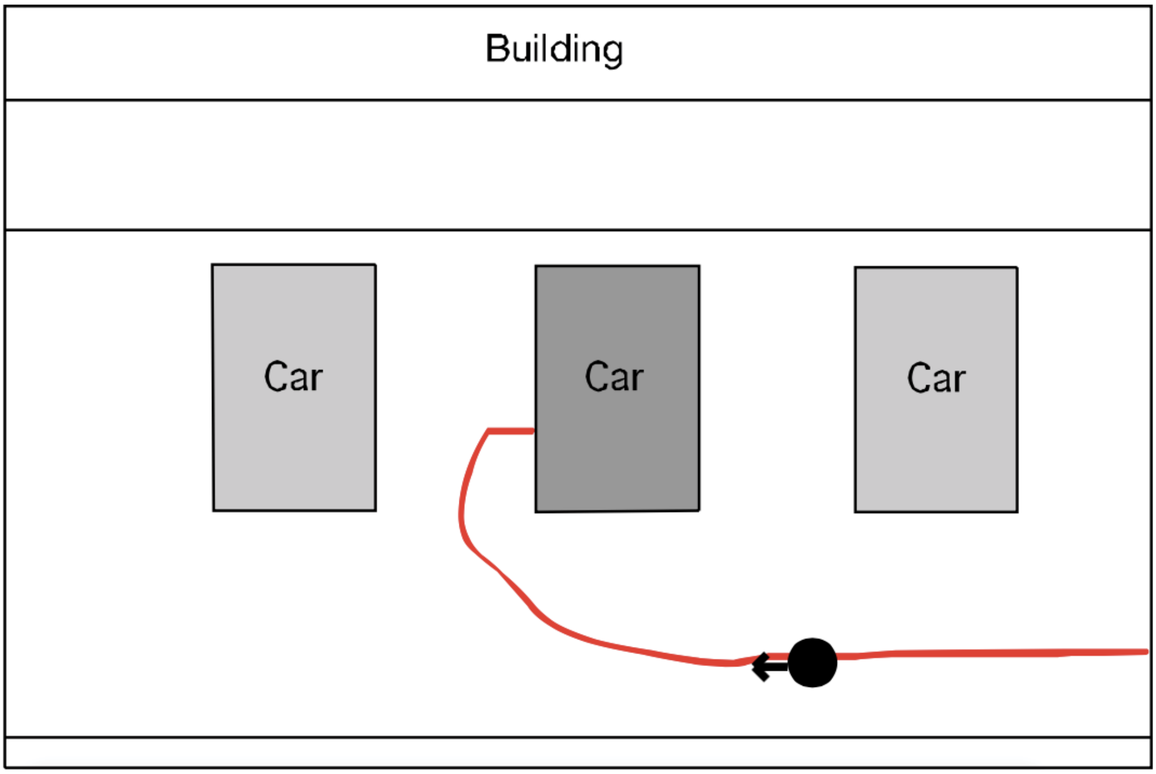


Figure 165: Matt Physical Model Frame 18

He opens his car with his remote control and gets in. In the car he connects his iPhone via the USB cable to the car stereo and listen to music using the Spotify app.

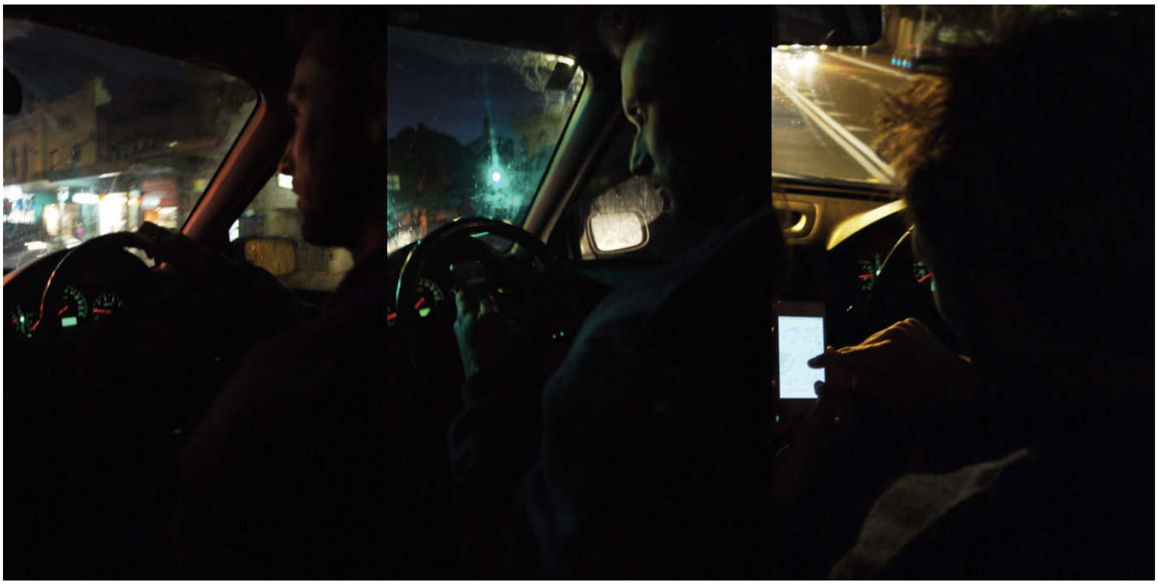


Figure 166: Matt Physical Model Frame 19

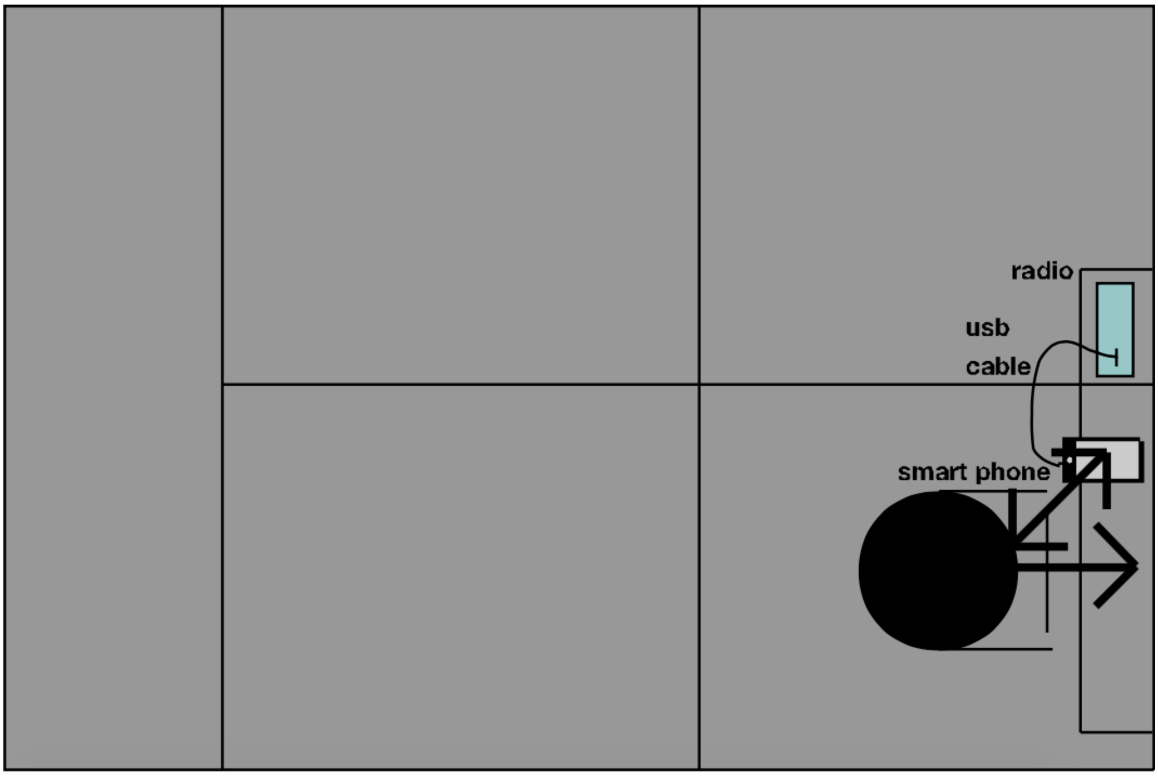


Figure 167: Matt Physical Model Frame 20

He then starts the car with his keys and drives off. While driving he picks different songs and reads some more emails on his iPhone.

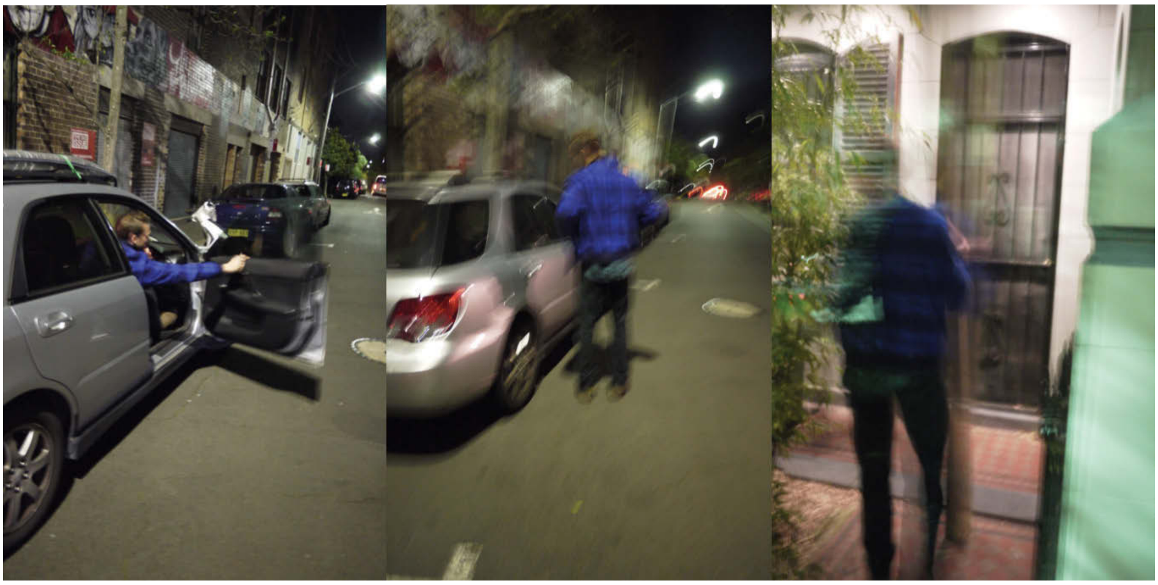


Figure 168: Matt Physical Model Frame 21

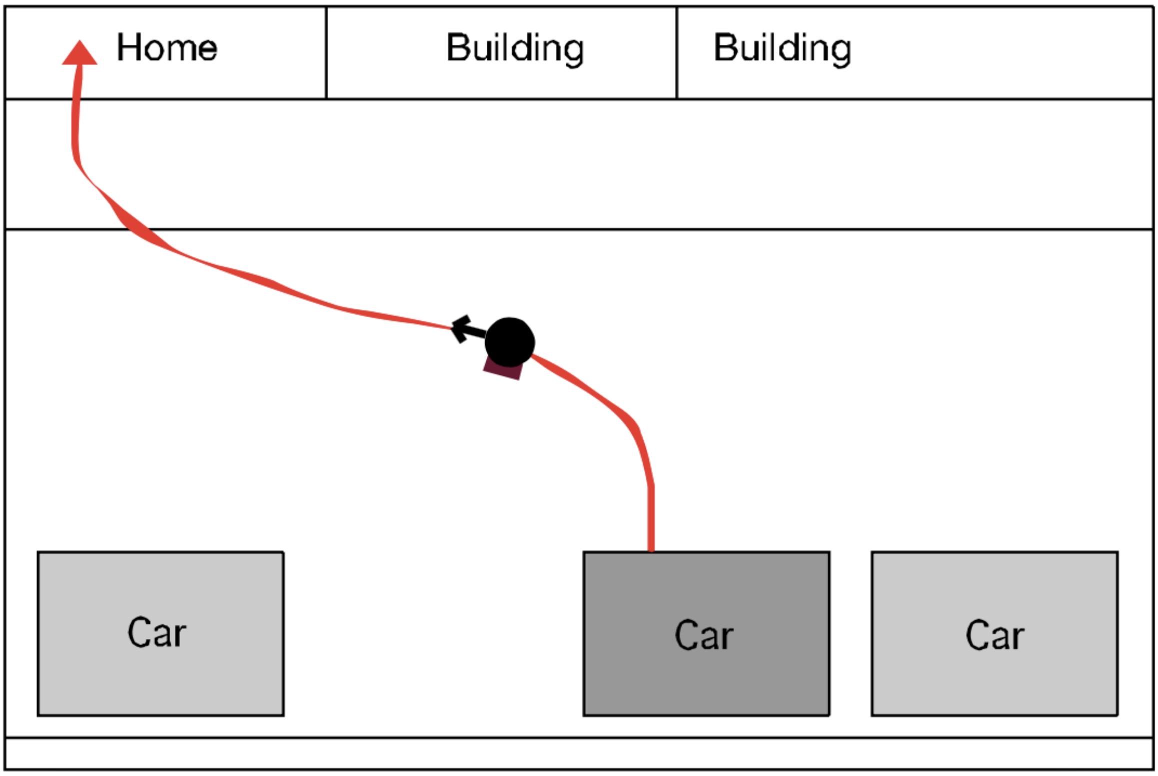


Figure 169: Matt Physical Model Frame 22

He then parks his car close to his home, gets out of the car and closes the car with his remote control. He then walks back to his house and enters through the door using analog keys.

Circle Flow Model:

The Circle Flow model is an overview of Matt's data of his everyday interactions.

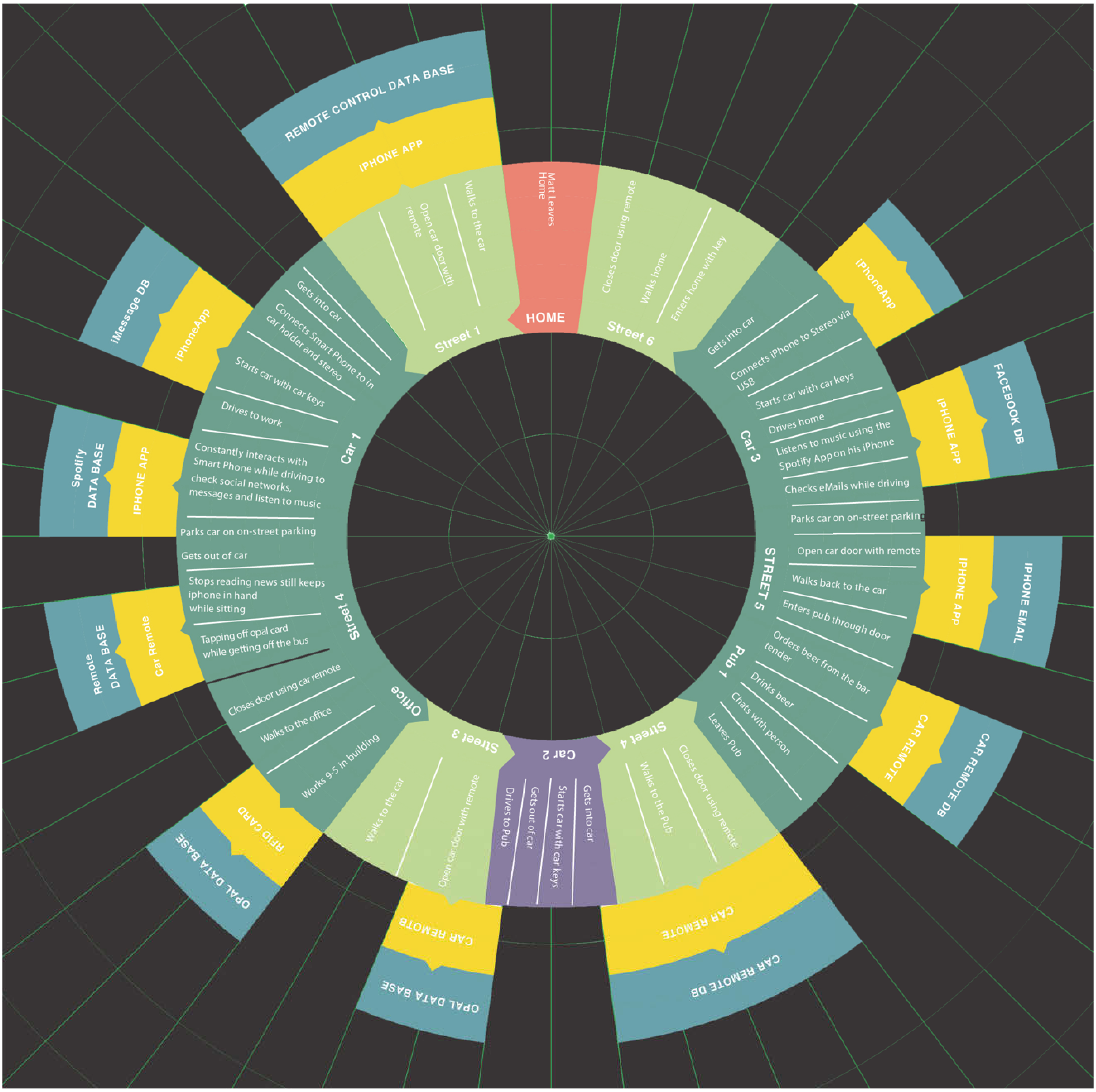


Figure 170: Matt Circle Flow Model

1.2.16 Individual Data Models - Kay (Flexible worker using Public Transport)- Circle Flow & Physical Model

The sixth participant researched was Kay who has a part-time job in the Central Business District in Sydney and uses public transport.

Physical Model of Kay:

Figure 171: Kay Physical Model Frame 1

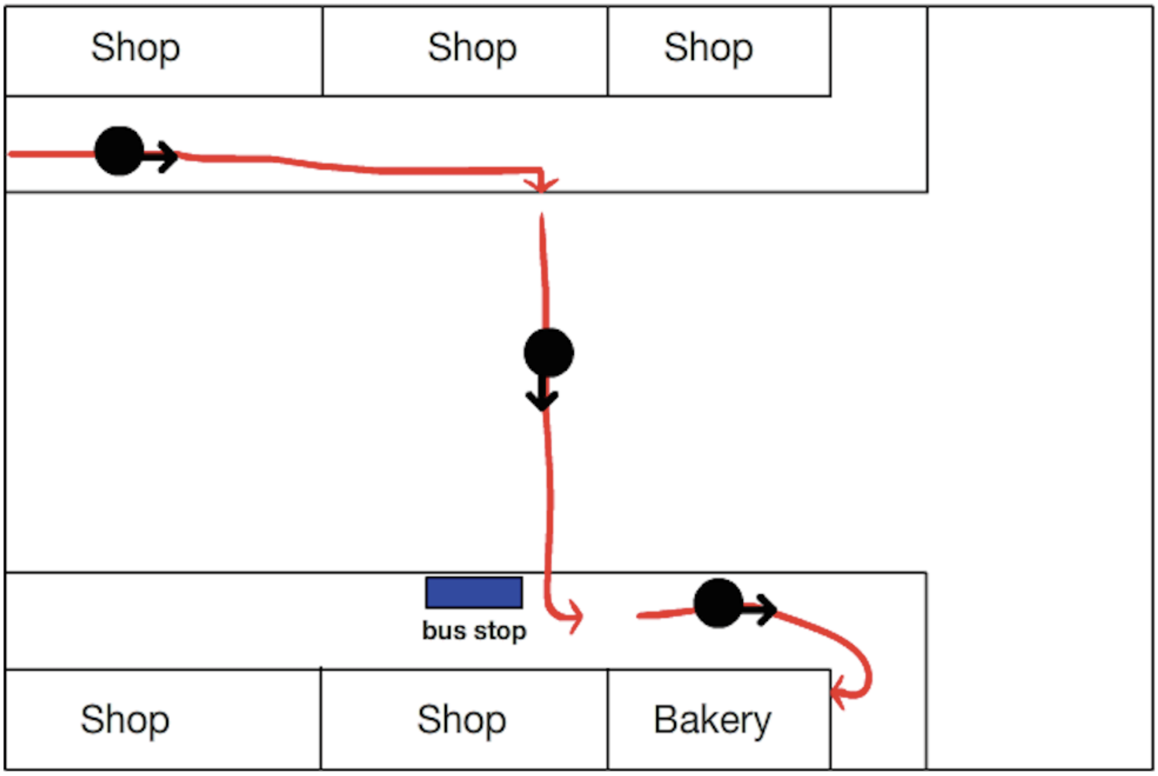


Figure 172: Kay Physical Model Frame 2

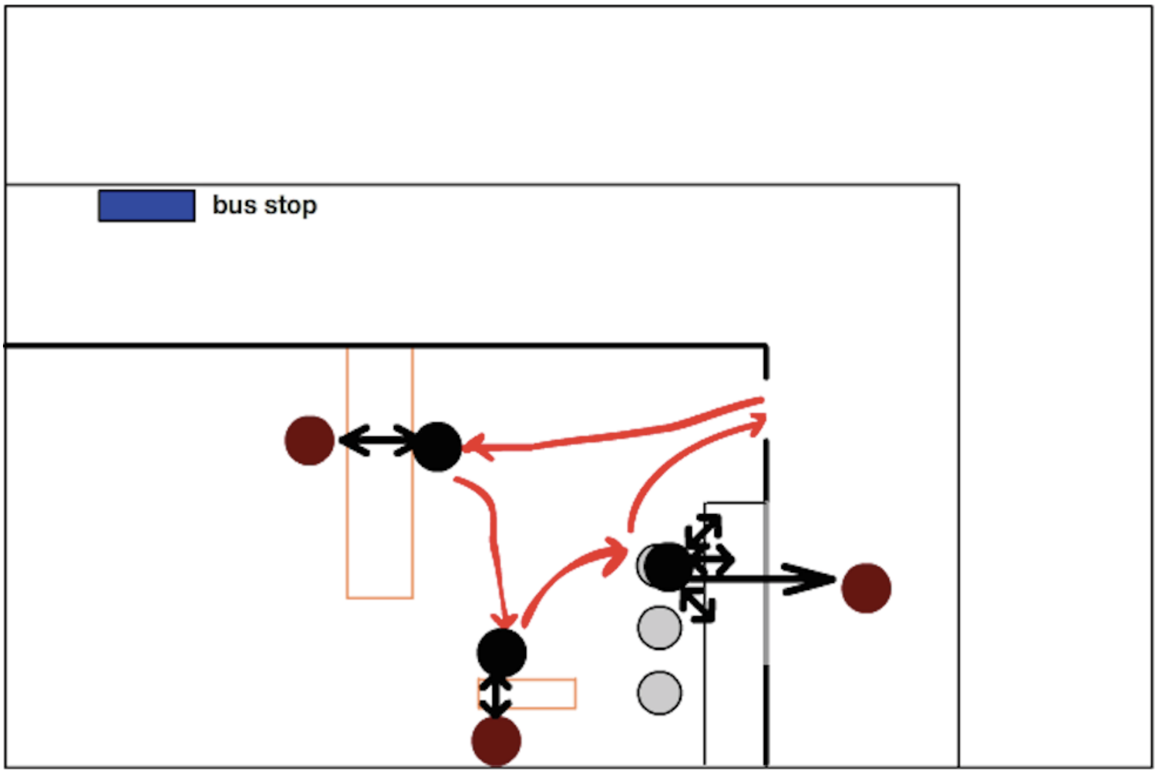


Figure 173: Kay Physical Model Frame 3

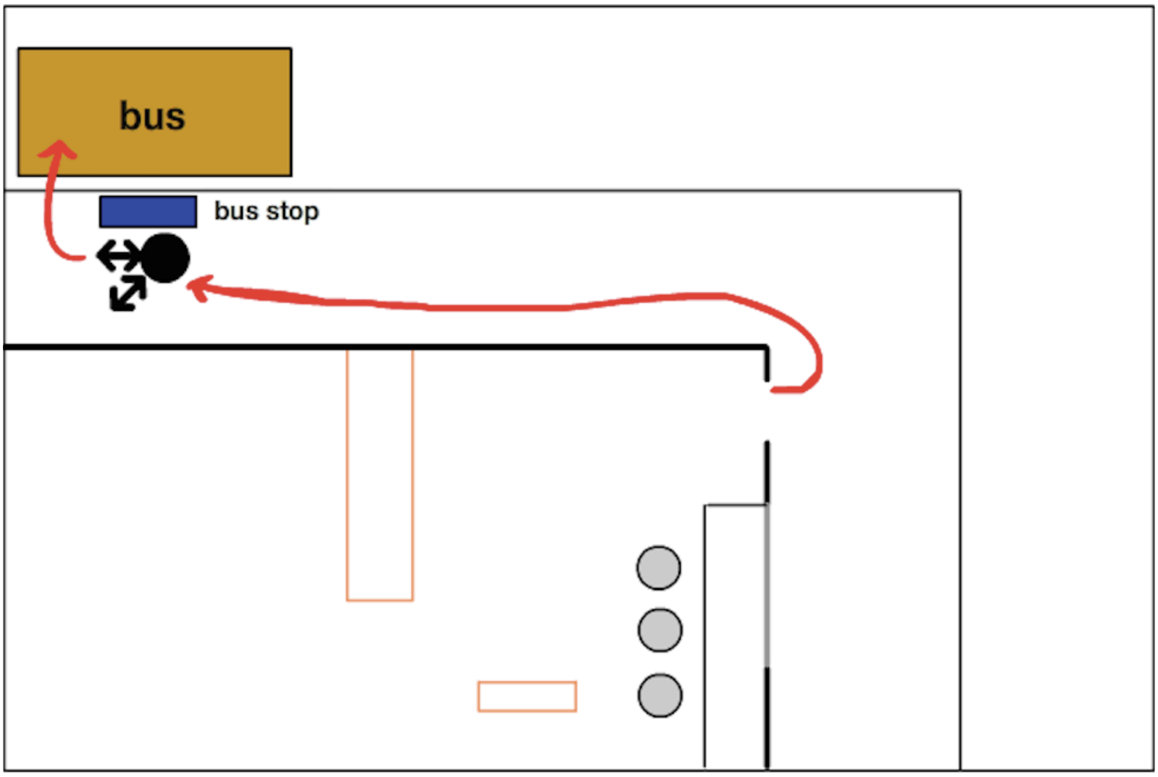


Figure 174: Kay Physical Model Frame 4

Kay leaves his home in the morning, buys breakfast at his local bakery, pays in cash and eats it at the window table inside the bakery, where he watches people on the street and reads news on Facebook while eating. When finished he gets another coffee to-go, pays in cash and waits for his bus at the bus stop. At the bus stop he continuous to reads the news using Facebook on his iPhone.

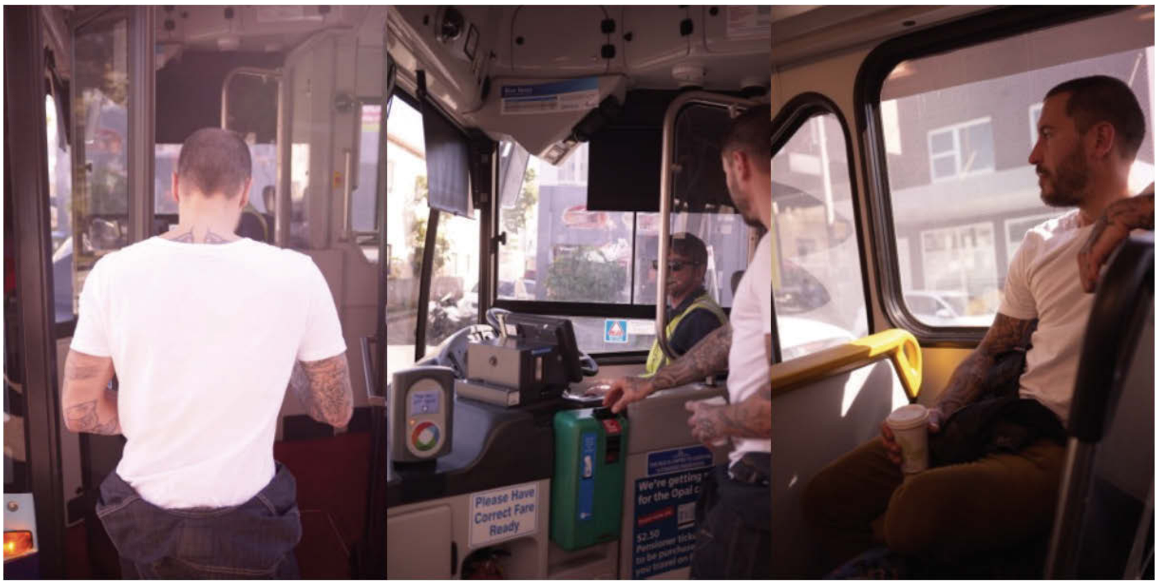


Figure 175: Kay Physical Model Frame 5

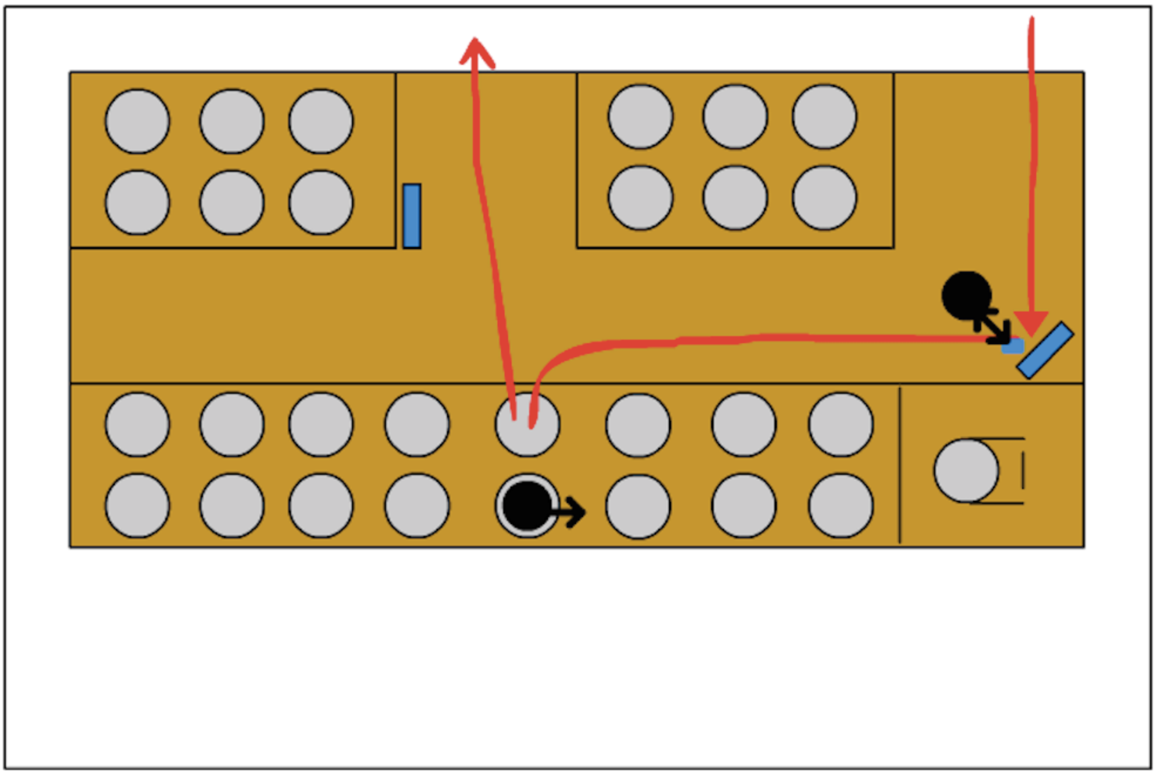


Figure 176: Kay Physical Model Frame 6

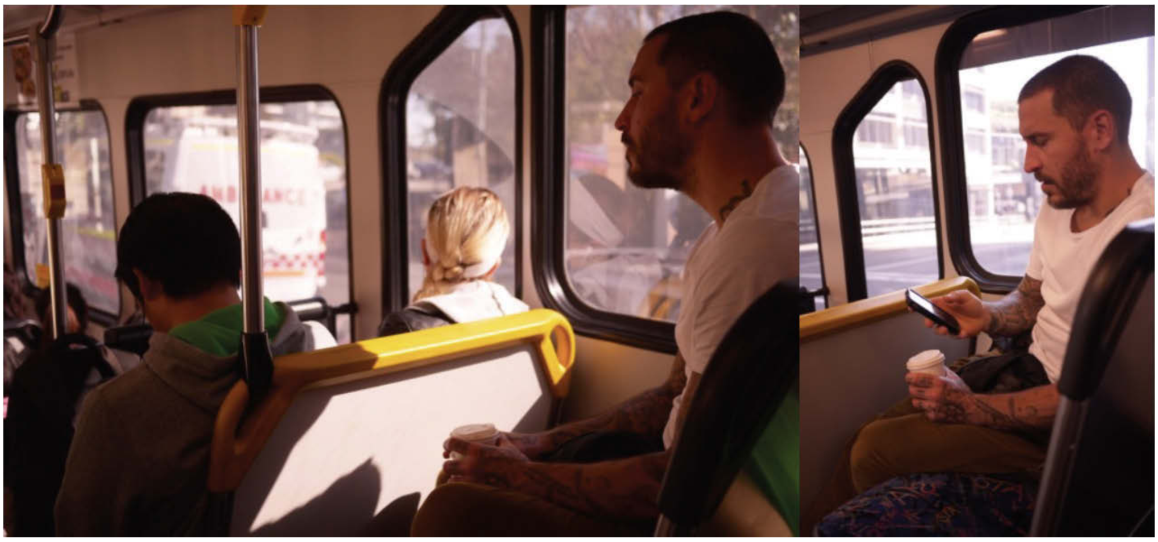


Figure 177: Kay Physical Model Frame 7

In frame 2 he pays the bus with a pre-purchased paper ticket, he doesn't know how to get an opal card. In the bus he deliberately avoids his iPhone and rather watches people. He is curious what other people are reading on their smart phone and ends up checking the time on his iPhone.

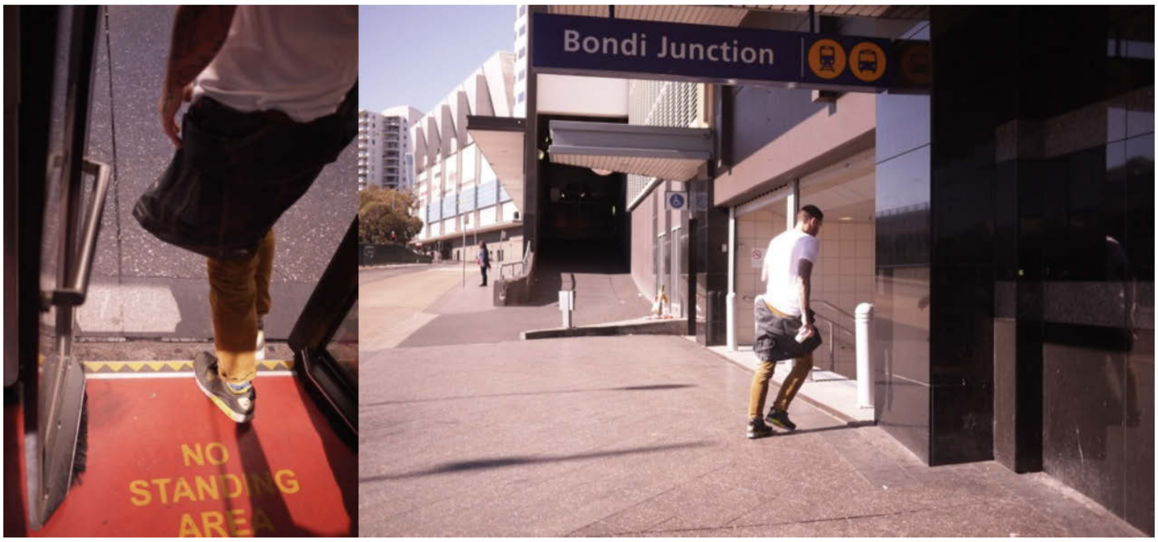


Figure 178: Kay Physical Model Frame 8

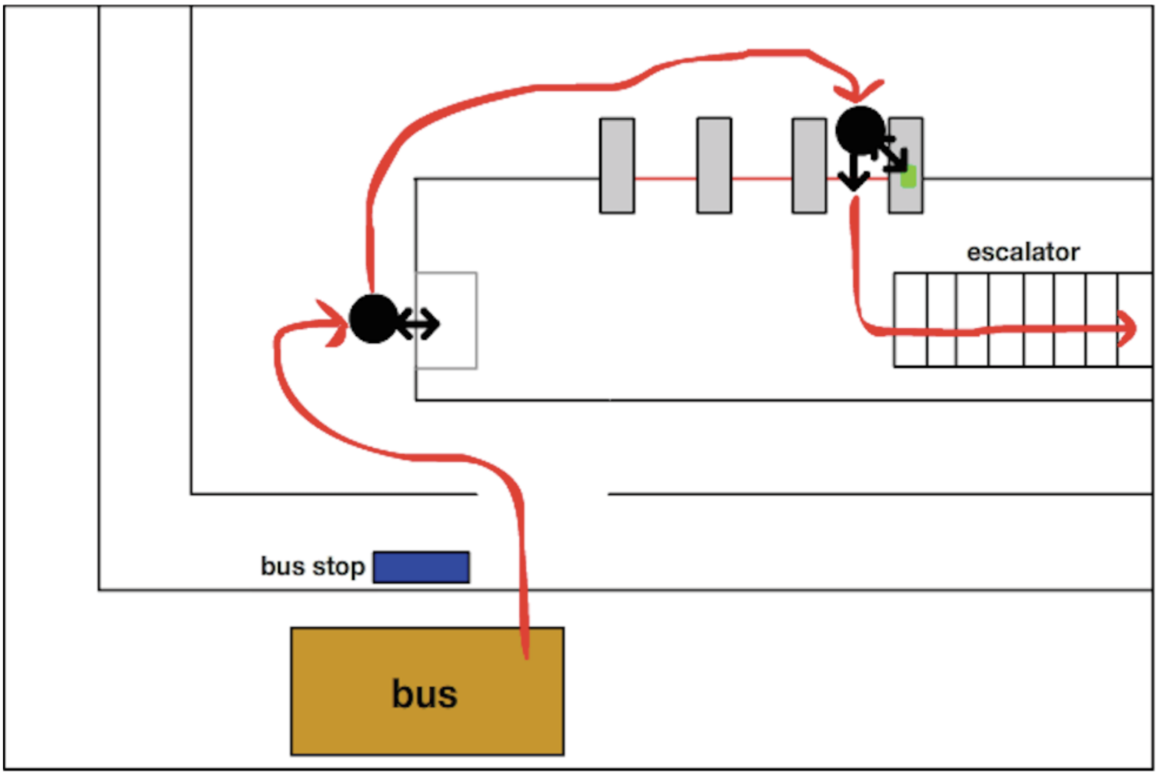


Figure 179: Kay Physical Model Frame 9

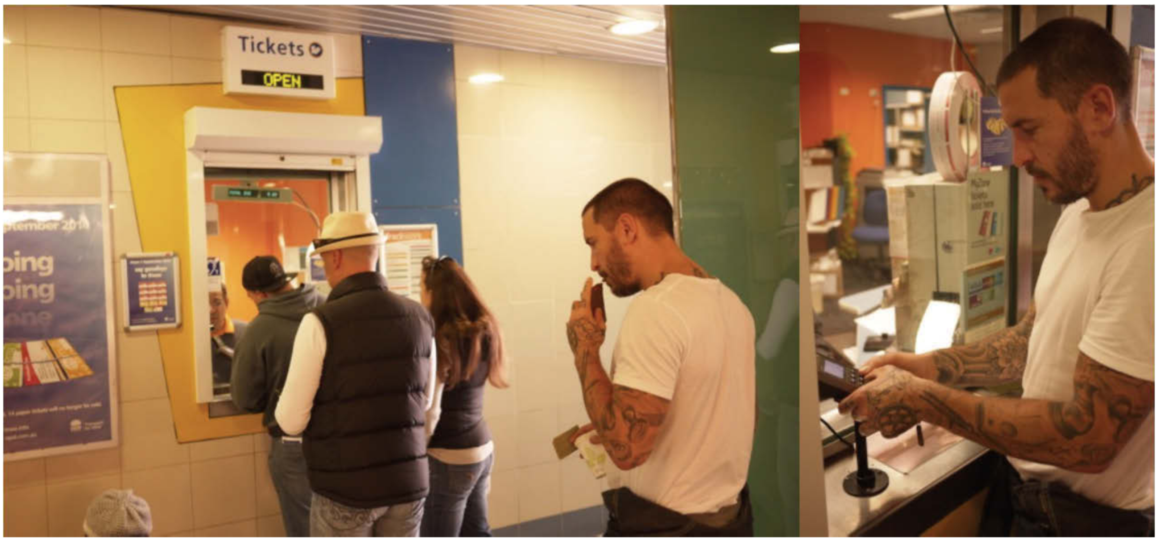


Figure 180: Kay Physical Model Frame 10

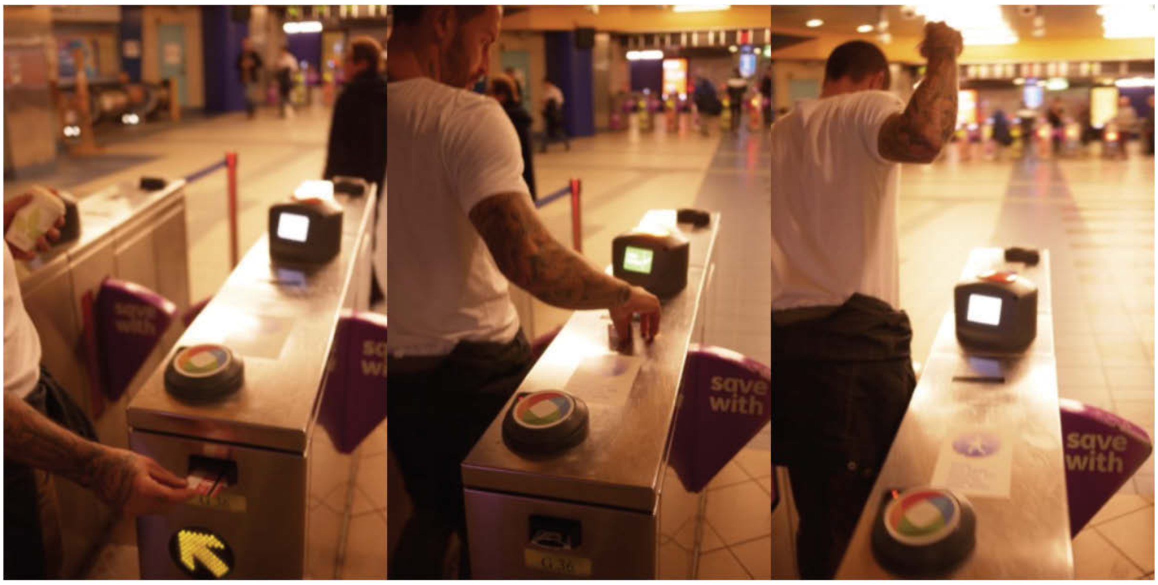


Figure 181: Kay Physical Model Frame 12

Figure 182: Kay Physical Model Frame 13

Kay leaves the bus and enters Bondi Junction station. Inside he station Kay purchases a train ticket and uses the Eftpos machine to pay. He validates his ticket. Goes down the escalator and throws his coffee to-go cup in the bin.

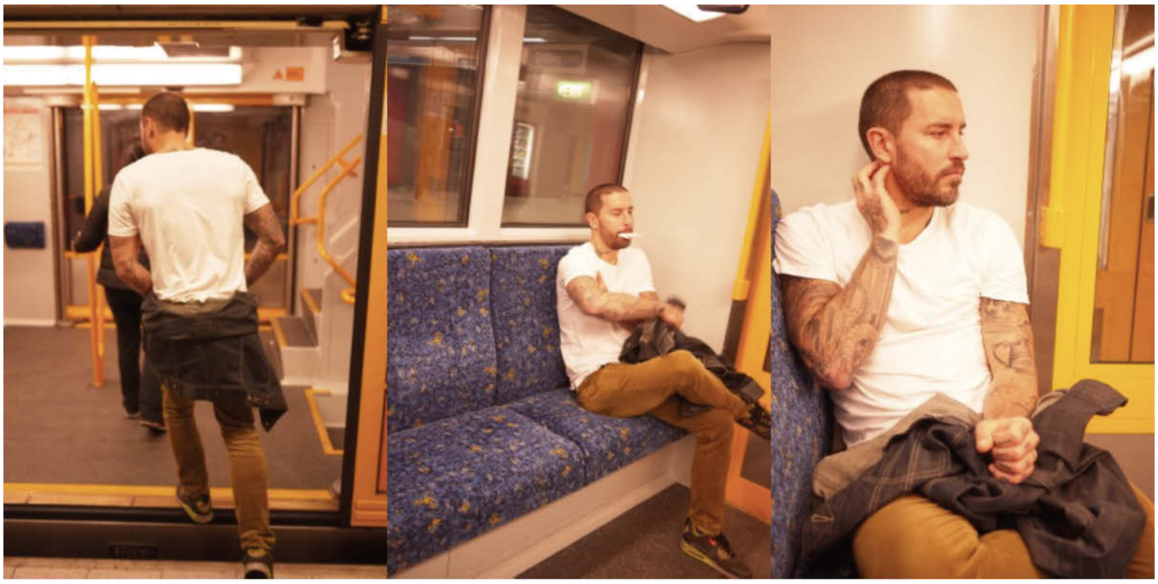


Figure 183: Kay Physical Model Frame 14

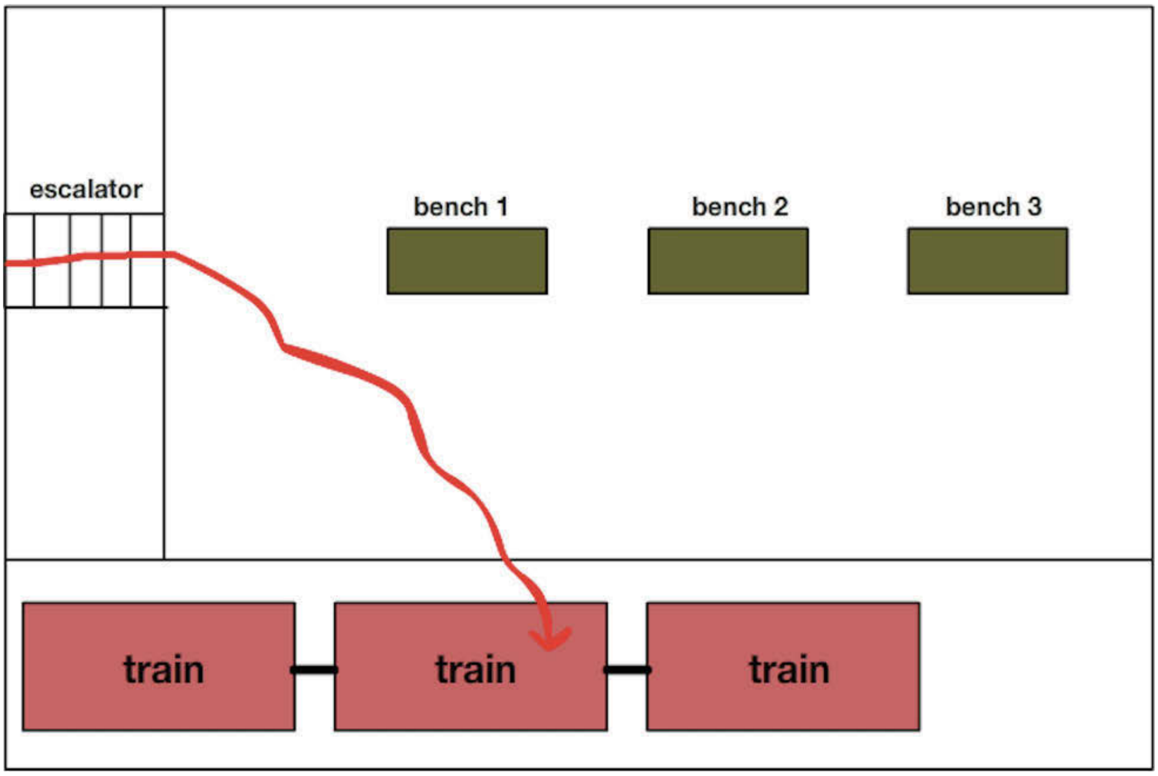


Figure 184: Kay Physical Model Frame 15

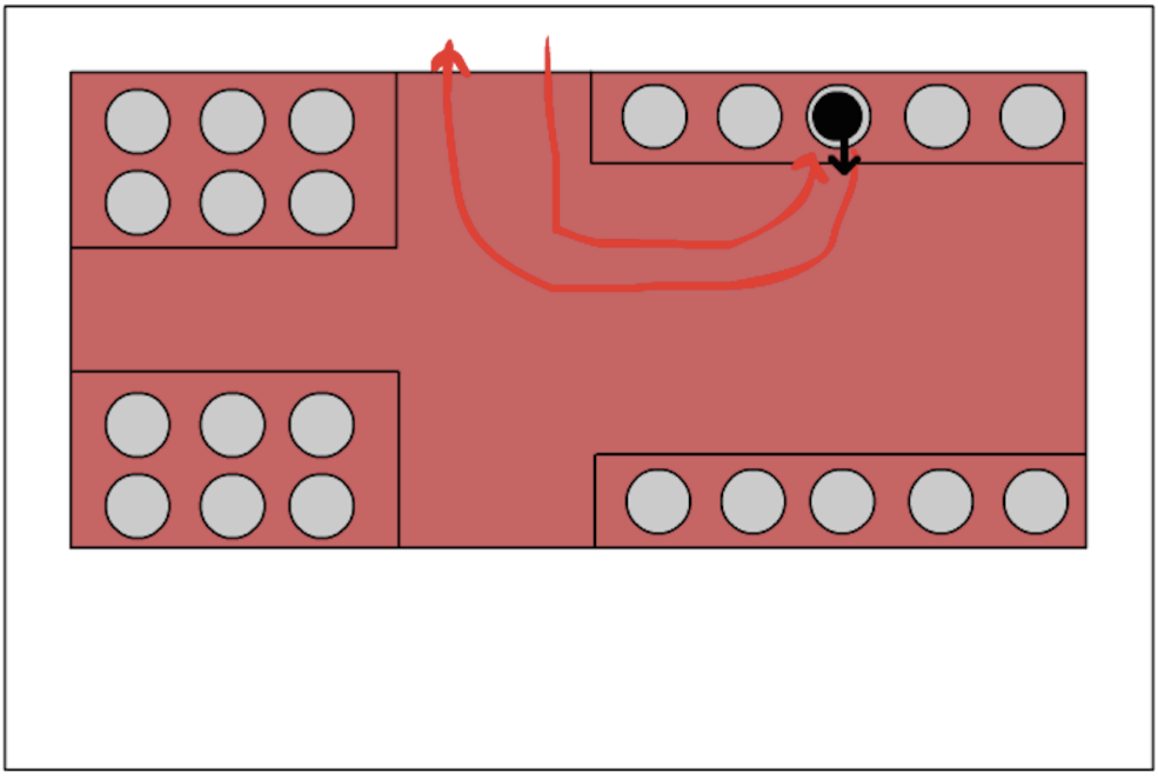


Figure 185: Kay Physical Model Frame 16

He enters the train and sits down. He again doesn't use his smart phone on the train but starts people watching and contemplating.

Figure 186: Kay Physical Model Frame 17

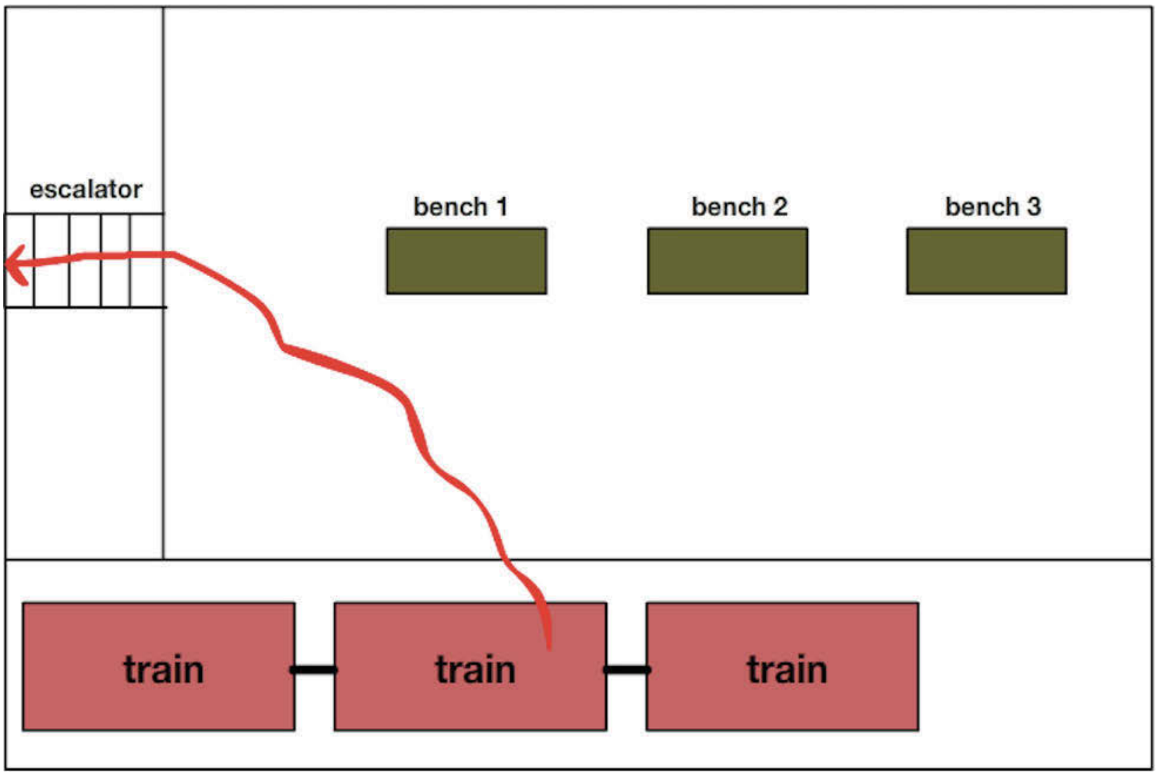


Figure 187: Kay Physical Model Frame 18

Kay leaves the train at Martin Place station and walks up the escalator.

Figure 188: Kay Physical Model Frame 19

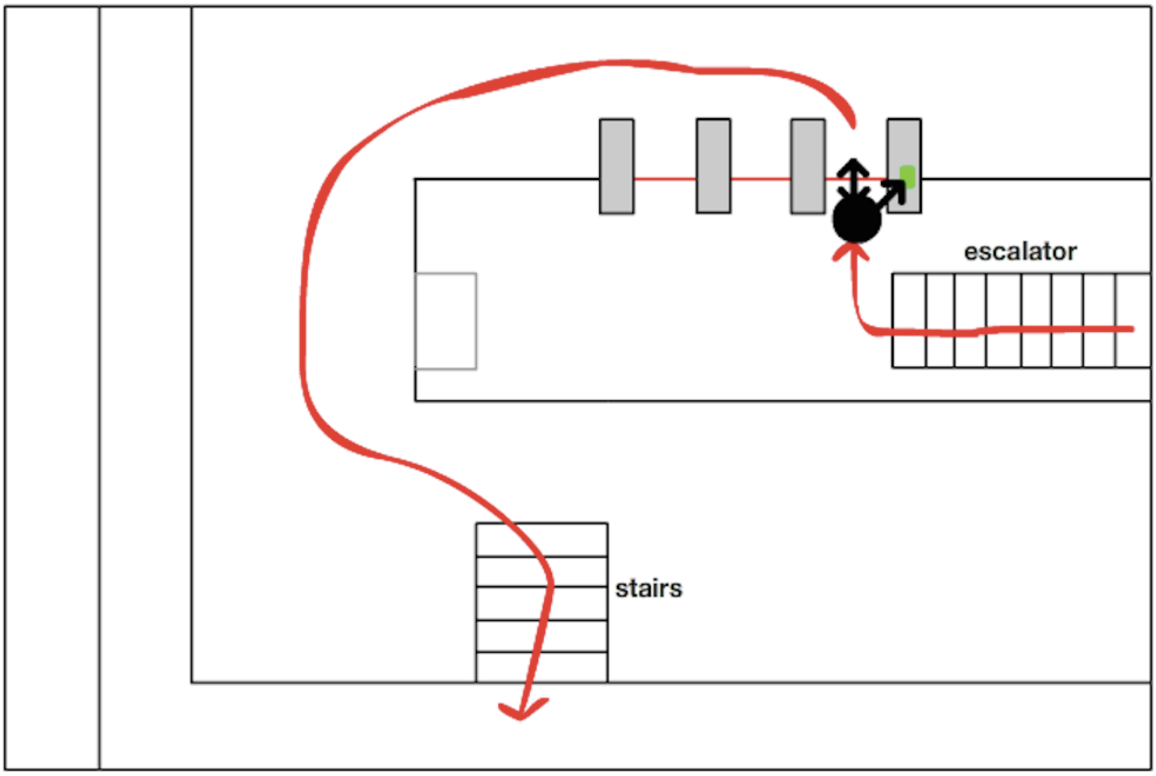


Figure 189: Kay Physical Model Frame 20

Kay validates his ticket at the exit of the train station and leaves the station on to Martin Place.

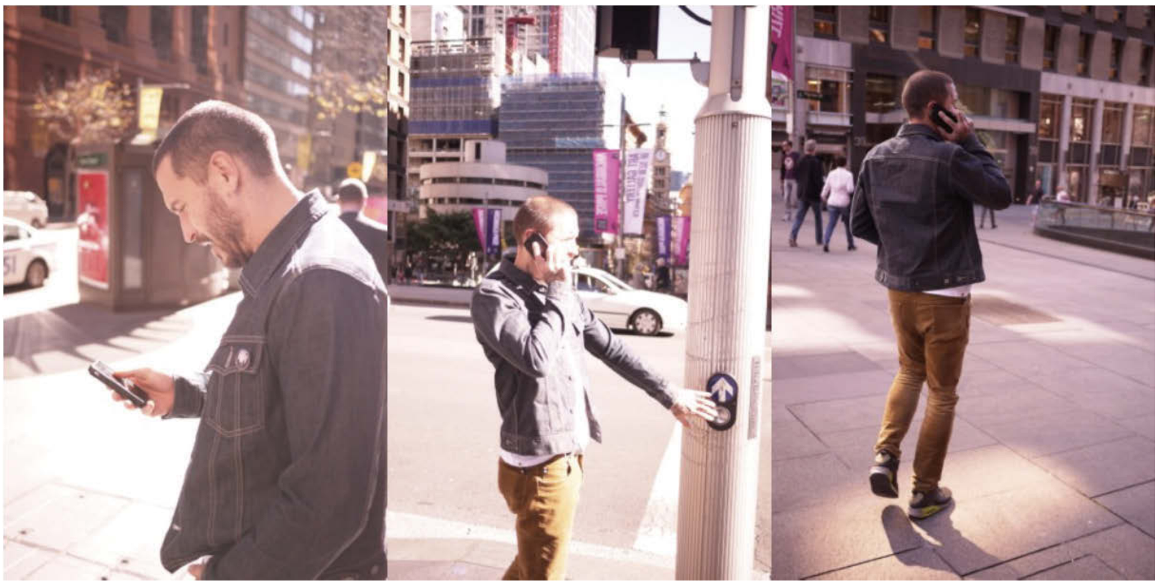


Figure 190: Kay Physical Model Frame 21

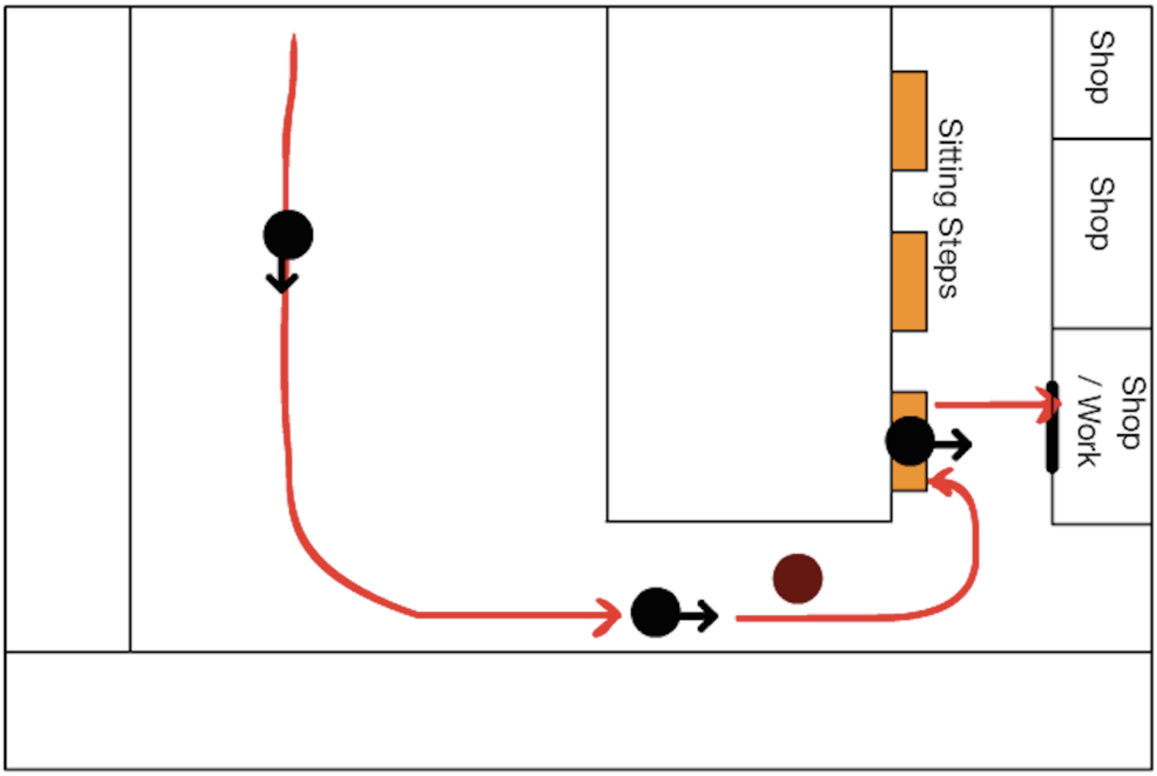


Figure 191: Kay Physical Model Frame 22

Figure 192: Kay Physical Model Frame 23

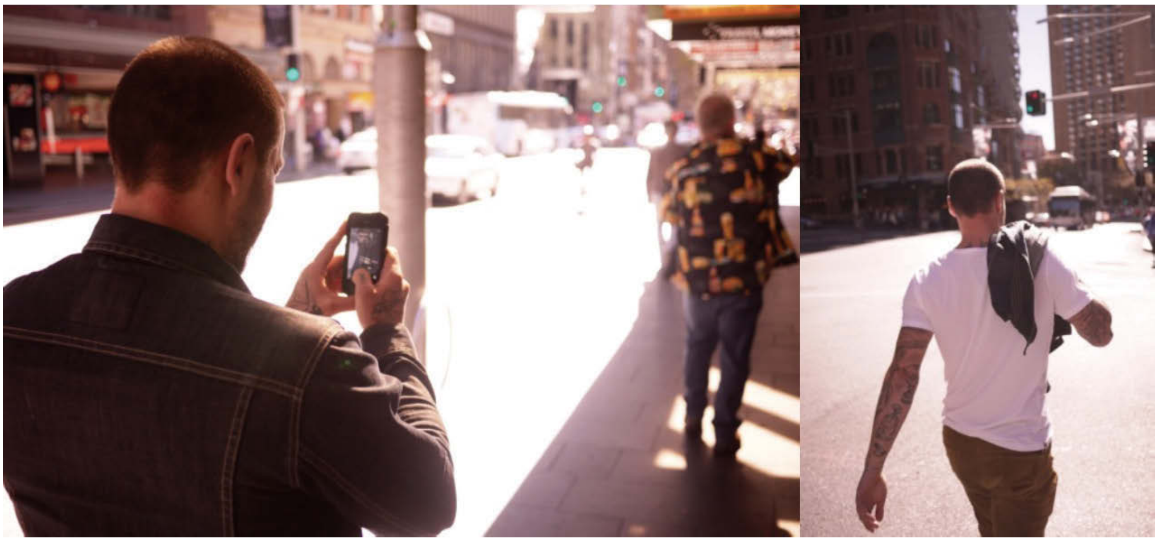


Figure 193: Kay Physical Model Frame 24

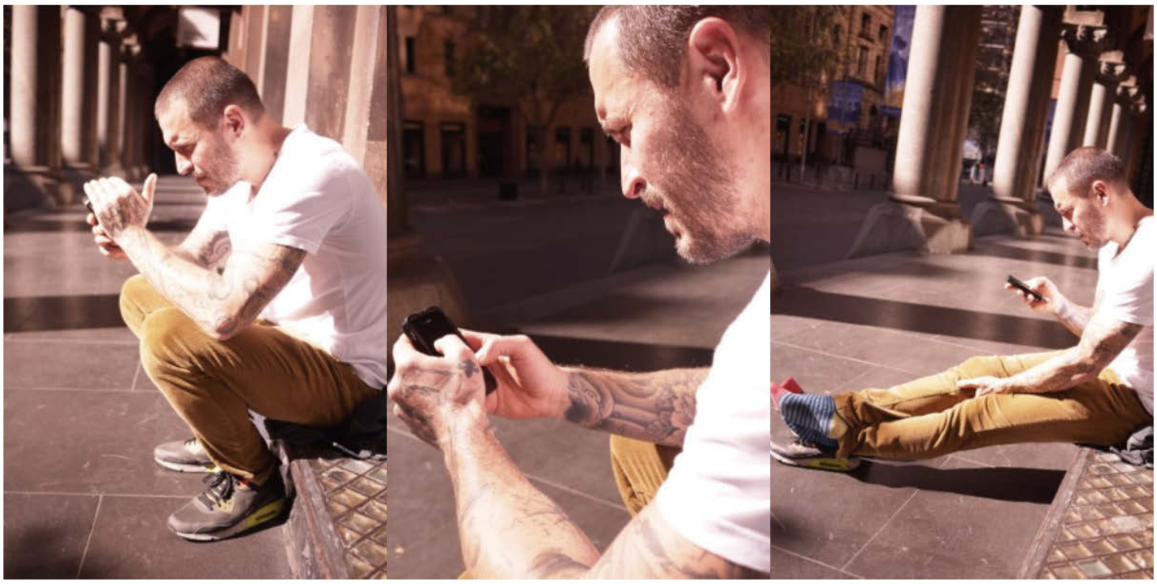


Figure 194: Kay Physical Model Frame 25

Figure 195: Kay Physical Model Frame 26

While walking towards his workplace, he calls a friend from Melbourne for a chat. The chat goes for 10 minutes, Kay walks slower when talking on the phone. When finished with the call he takes a photo of a guy with what he thinks is a funny shirt. He takes his jacket off because he is feeling hot and continues walking. Kay is 20 minutes early for work, so he decides to sit down on a step in the sun and check Instagram and he's posting the photo of the funny shirt he took before. He enters his workplace. Kay works for 6 hours.

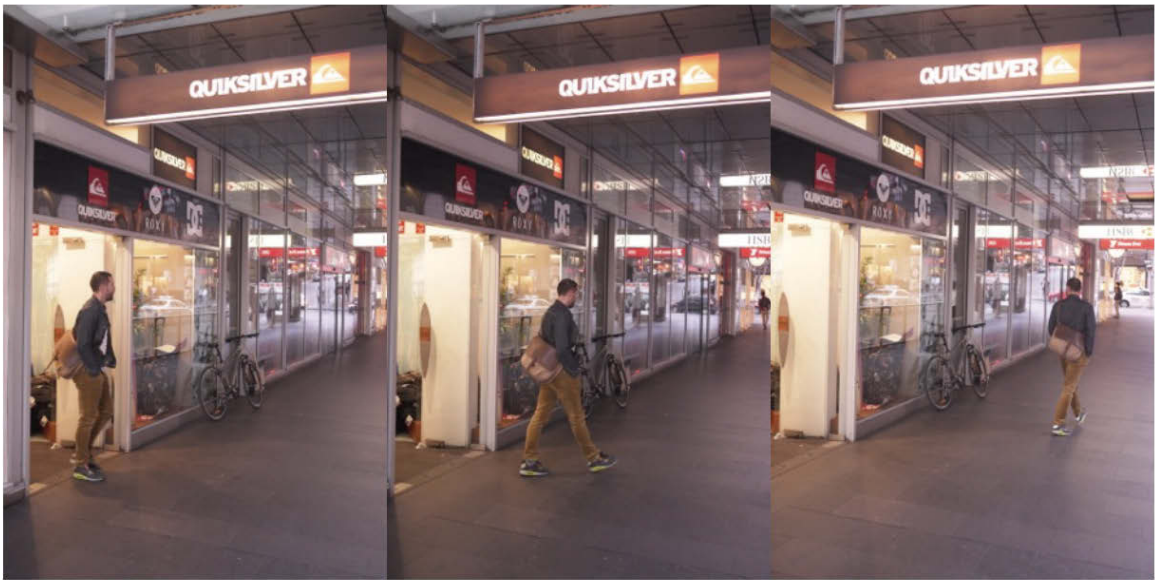


Figure 196: Kay Physical Model Frame 27

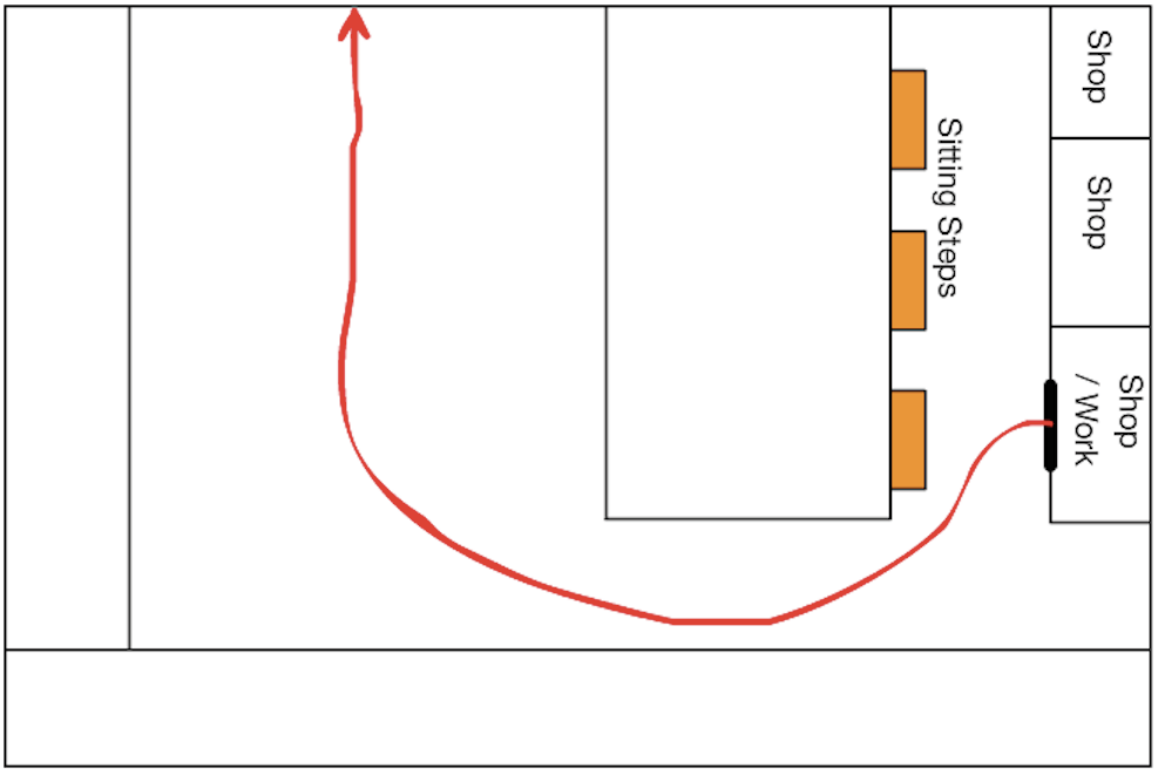


Figure 197: Kay Physical Model Frame 28

Figure 198: Kay Physical Model Frame 29

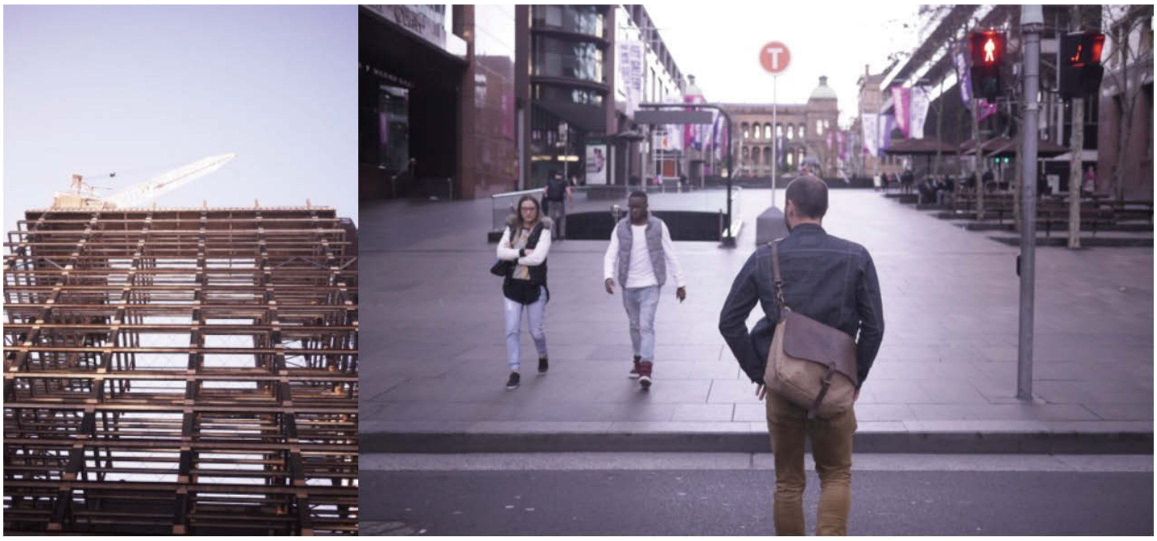


Figure 199: Kay Physical Model Frame 30

Kay leaves work with his duffel bag he left at his workplace previously. After work he checks Facebook and walks towards Martin Place station. On the way he contemplates on a new building structure for 5 minute and keeps on walking. He crosses a red traffic light without paying attention to traffic.

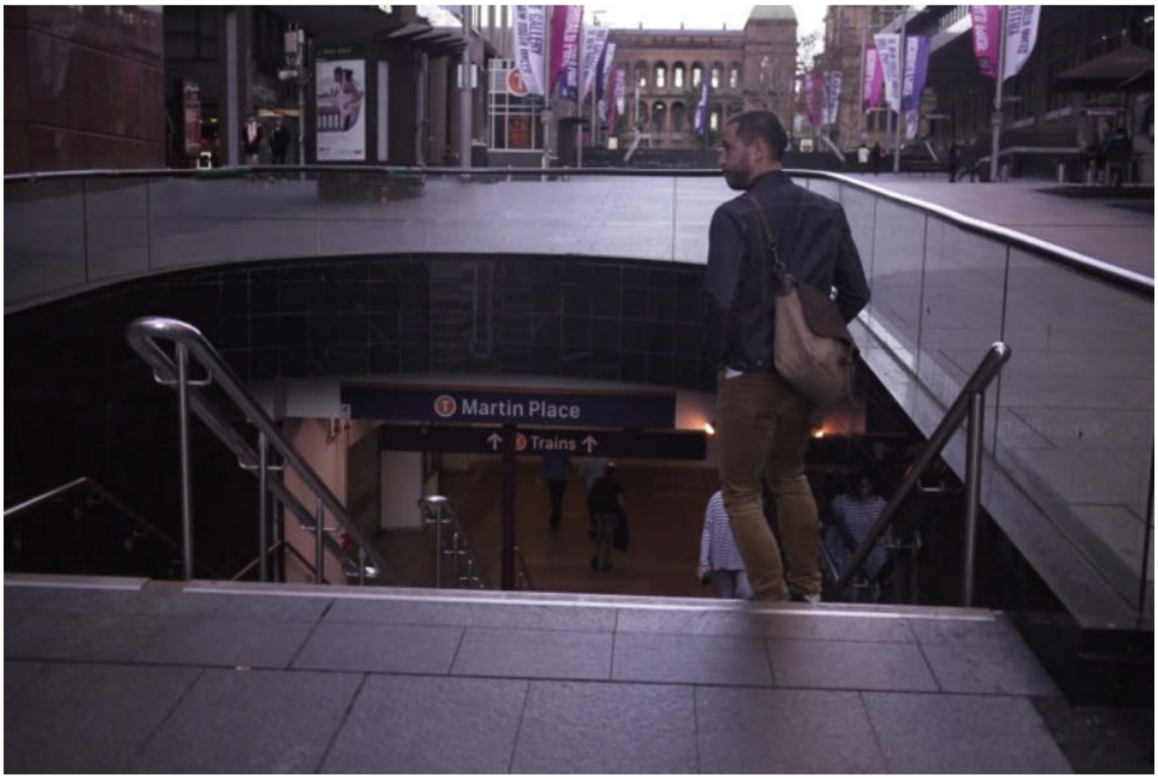


Figure 200: Kay Physical Model Frame 31

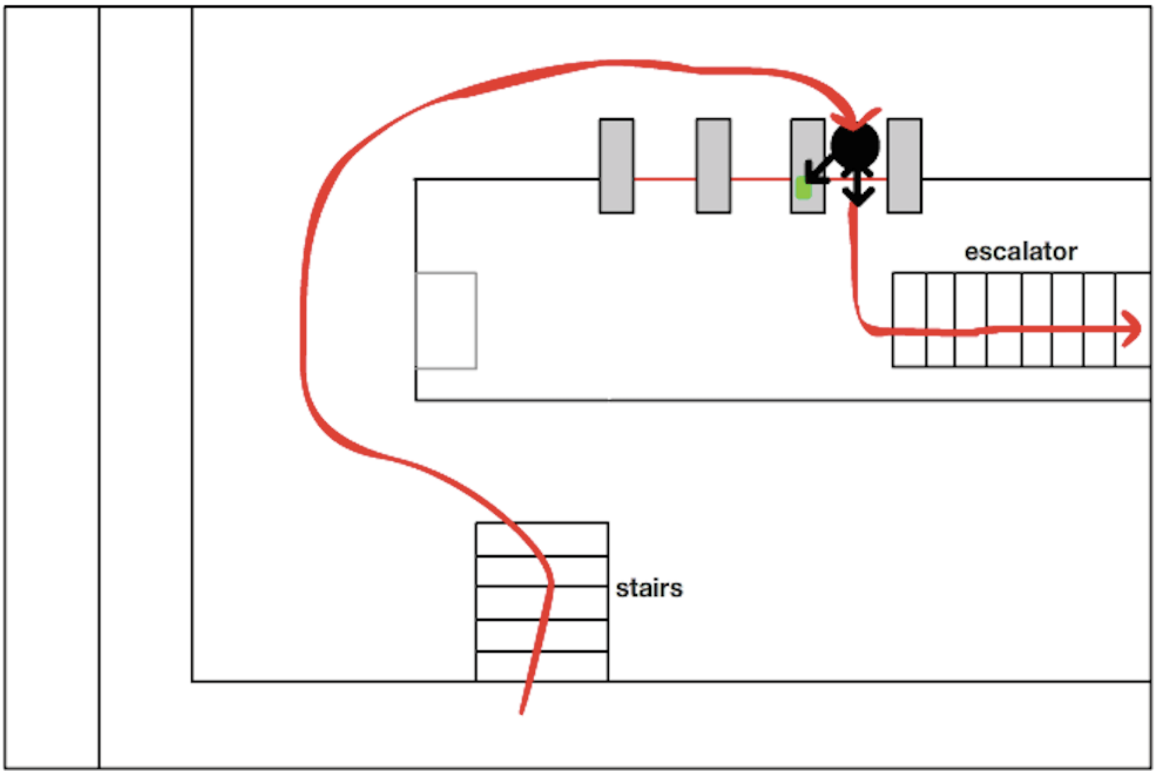


Figure 201: Kay Physical Model Frame 32

Figure 202: Kay Physical Model Frame 33

He enters Martin Place station and validates his paper ticket and walks down the escalators.

Figure 203: Kay Physical Model Frame 34

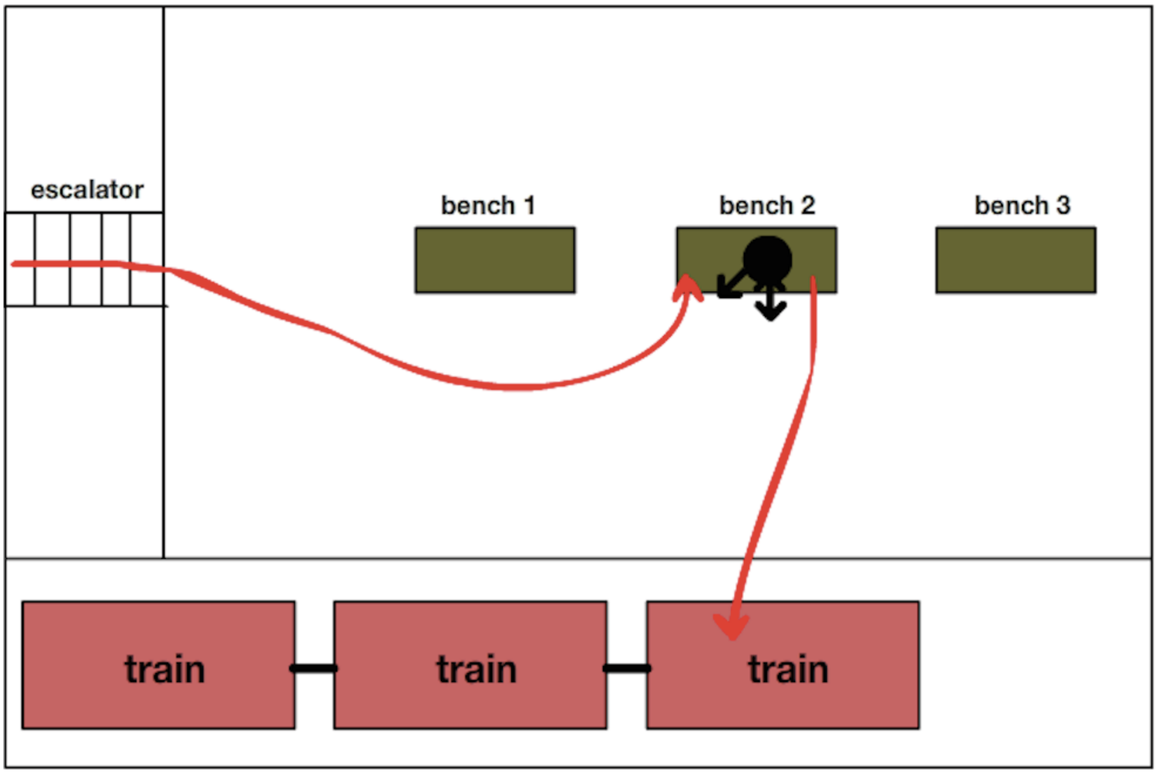


Figure 204: Kay Physical Model Frame 35

Figure 205: Kay Physical Model Frame 36

He sits down on one of the benches while waiting for his train and checks Facebook on his smart phone. All the other people around him are also interacting with their smart phone. Kay approaches the arriving train covers his ears because the break sound is very loud then enters train and looks for a space to sit down.

Figure 206: Kay Physical Model Frame 37

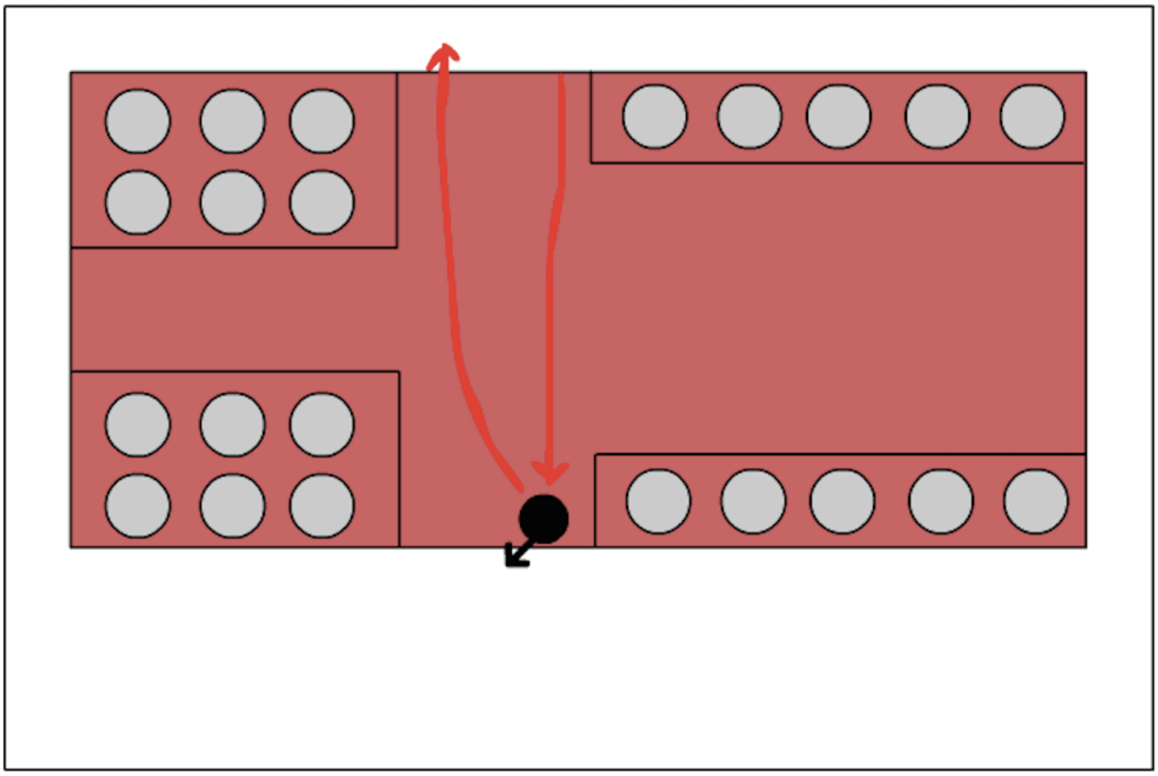


Figure 207: Kay Physical Model Frame 38

Kay decides to stand instead even though there is seats available and contemplates on the skyline of Sydney while looking through the train window.

Figure 208: Kay Physical Model Frame 39

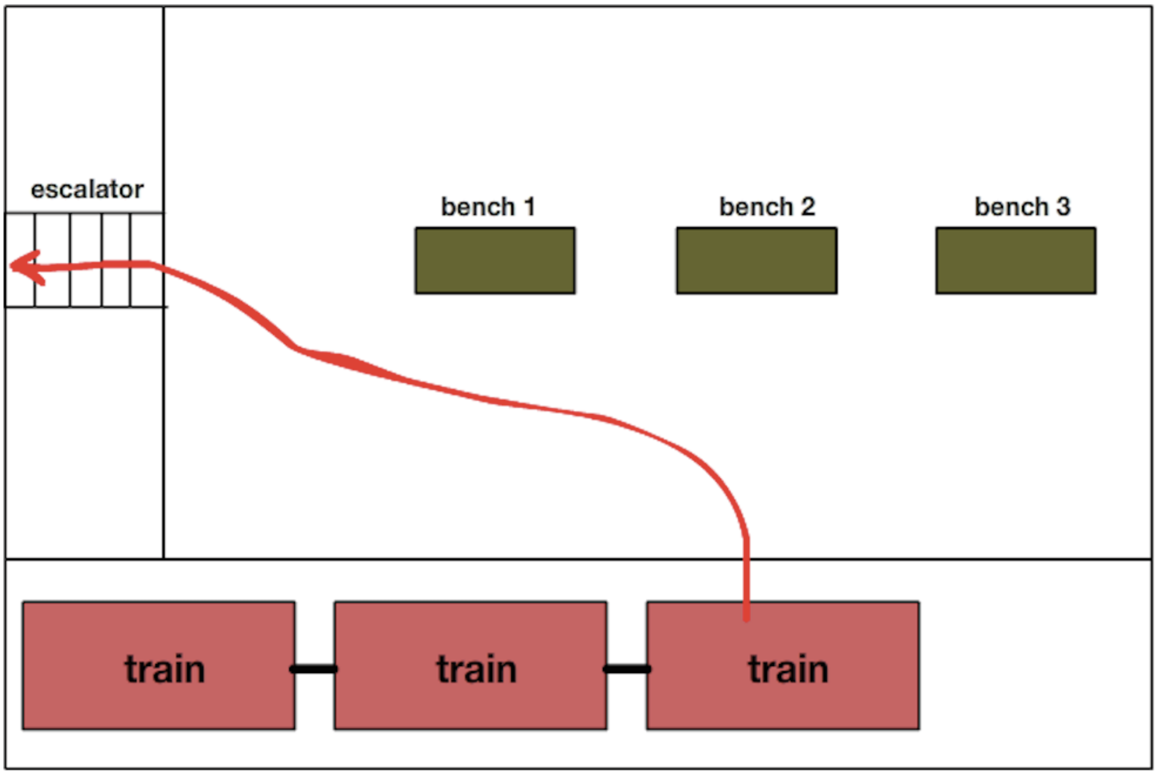


Figure 209: Kay Physical Model Frame 40

Kay leaves the train goes up the escalator to the upper area of the train station where he validates his paper ticket and where the busses leave.

Figure 210: Kay Physical Model Frame 41

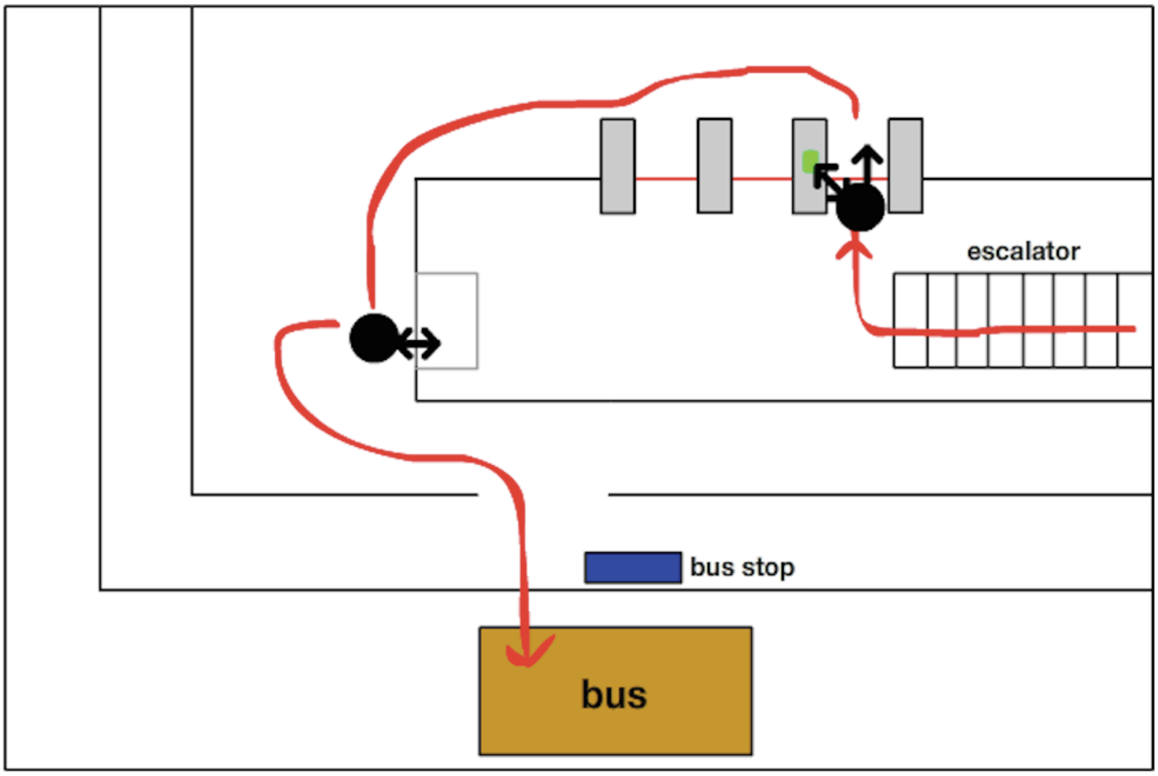


Figure 211: Kay Physical Model Frame 42

Kay buys a bus ticket and pays in cash, he checks Facebook while waiting for the bus. Since the bus is late he decides to sit down while waiting.

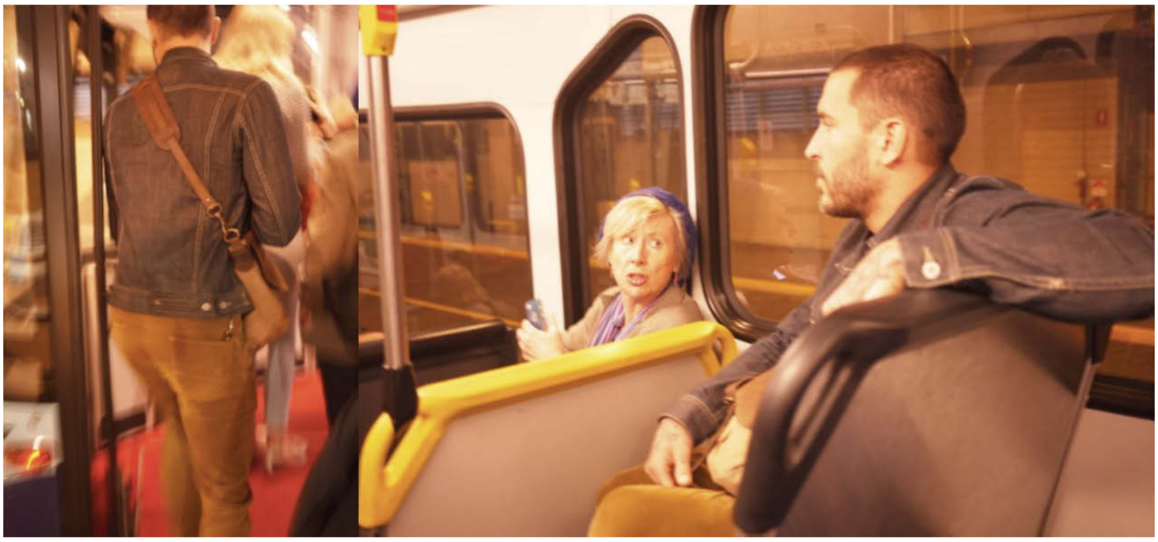


Figure 212: Kay Physical Model Frame 43

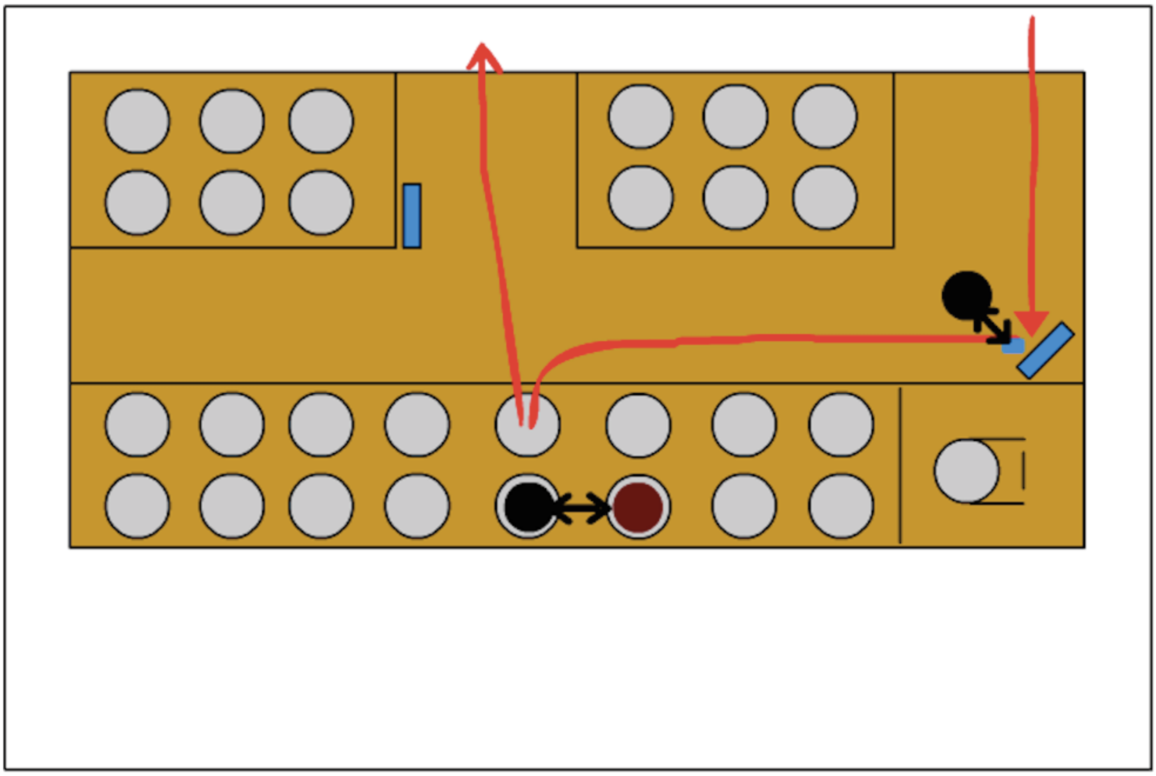


Figure 213: Kay Physical Model Frame 44

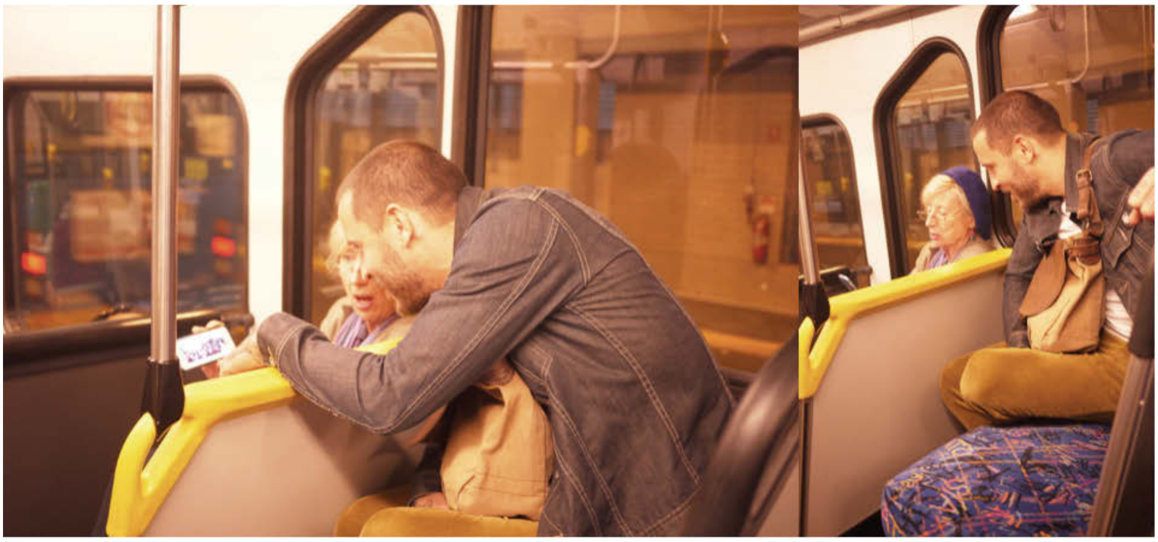


Figure 214: Kay Physical Model Frame 45

Kay enters the bus paying with his purchased paper ticket. When sitting down a women recognises that Kay is German. She pulls out an iPhone and start showing him photos of her travelling through east Berlin in the 70s. Kay is interested and starts chatting to her and mentions he grew up in east Germany. They chat about the photos for the whole trip and the women hands over Kay her email address so they can stay in touch.

Figure 215: Kay Physical Model Frame 46

Kay leaves the bus and walks home. He crosses the street using a traffic light and enters his home building using analog keys.

Circle Flow Model:

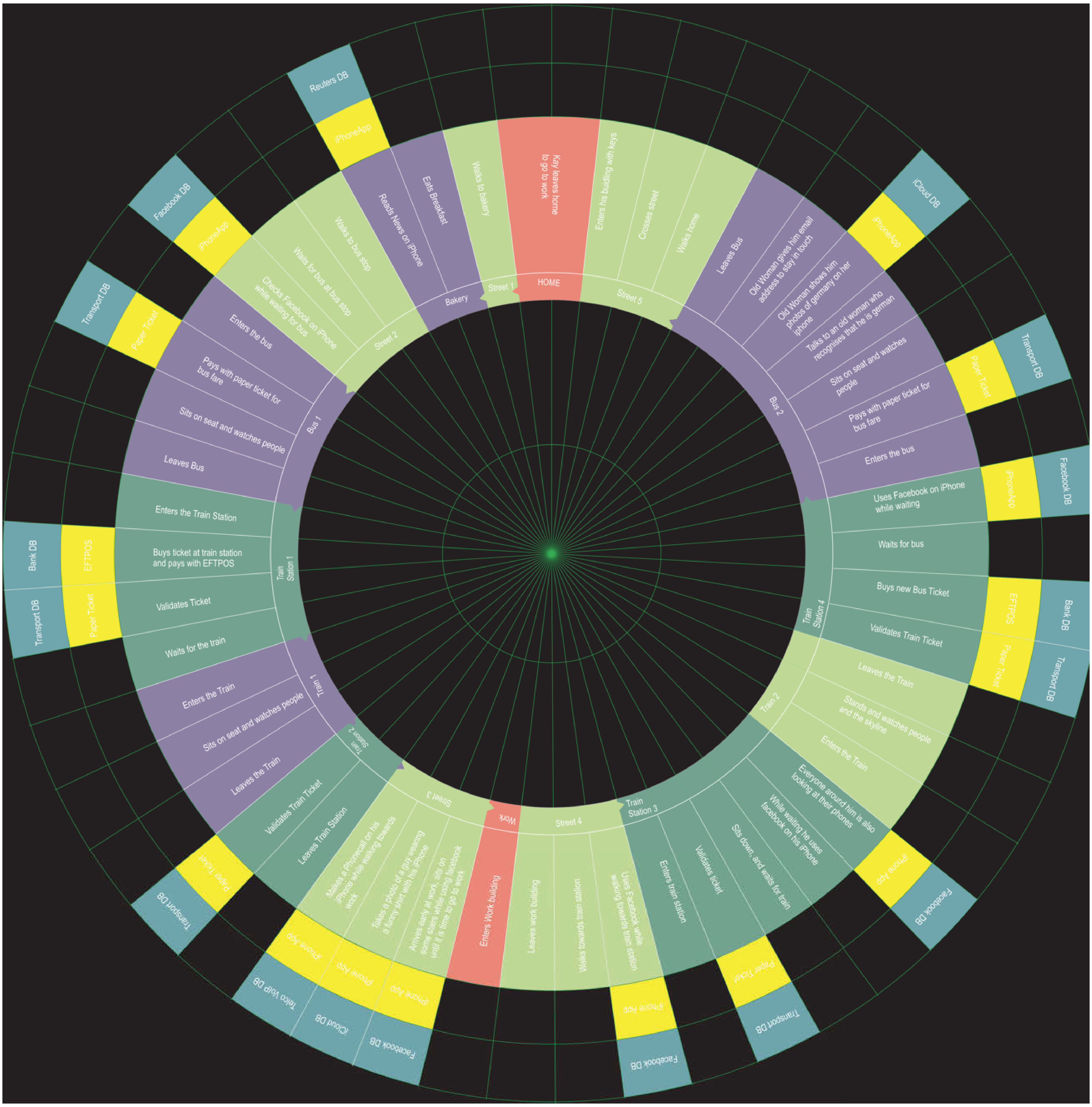


Figure 216: Kay Circle Flow Model

1.2.17 Individual Data Models - Liya (Flexible worker using Public Transport)- Circle Flow & Physical Model

The seventh participant researched was Liya who uses public transport and has a flexible job in the neighbourhood of Darlinghurst in Sydney.

Physical Model:

The physical model show's Liya's interactions situated in the physical environment and within the narrative of her day over time.

Figure 217: Liya Physical Model Frame 1

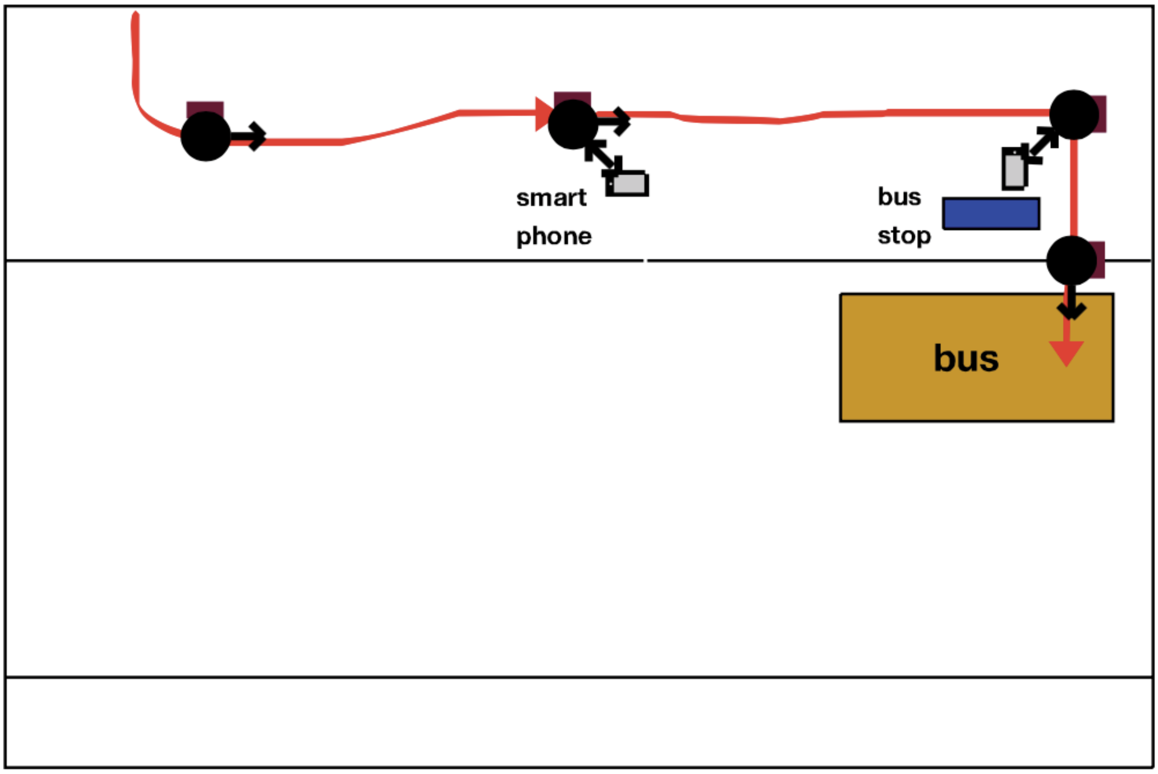


Figure 218: Liya Physical Model Frame 2

Figure 219: Liya Physical Model Frame 3

Liya leaves home and walks to the bus stop listening to music on her iPhone. At the bus stop Liya waits for the bus, listening to music and Snapchatting to a friend.

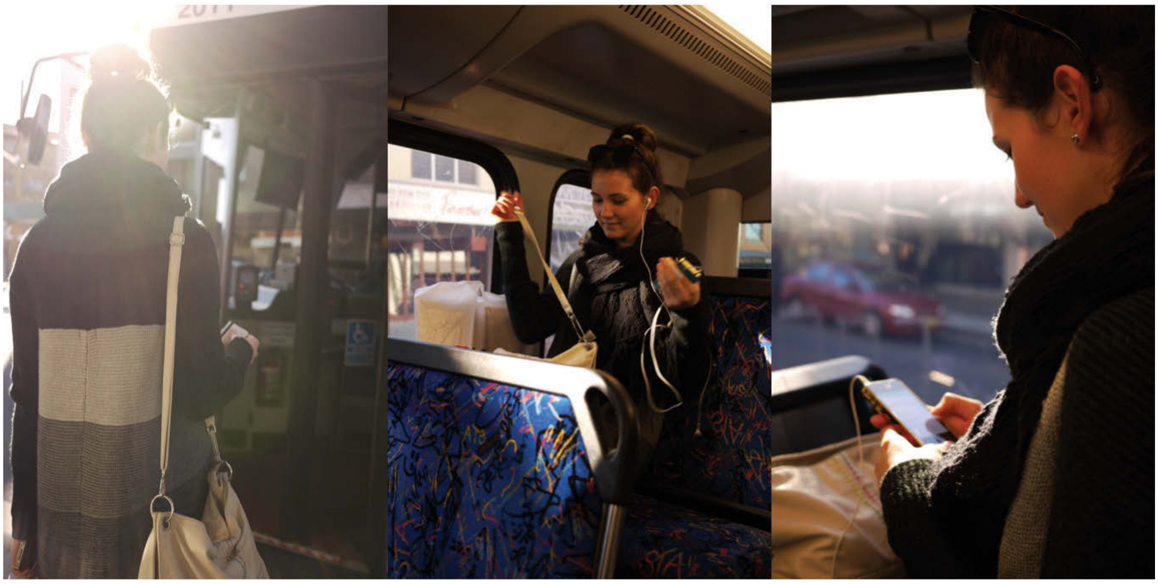


Figure 220: Liya Physical Model Frame 4

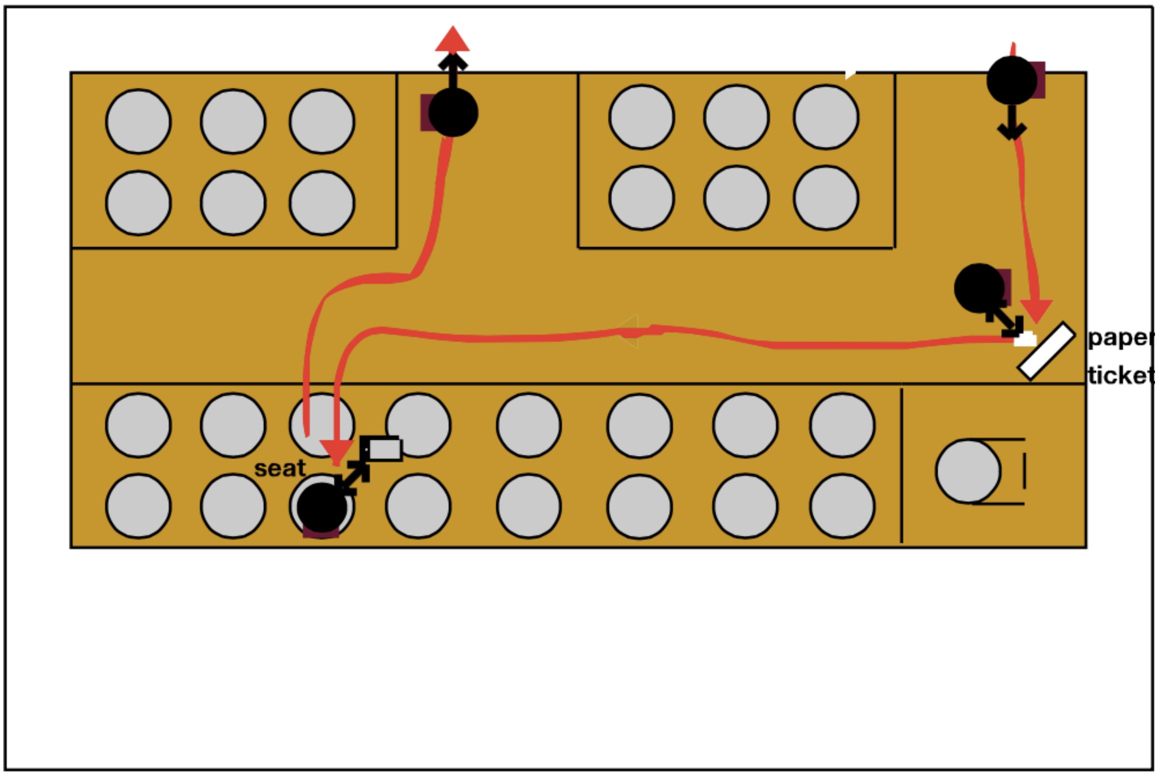


Figure 221: Liya Physical Model Frame 5

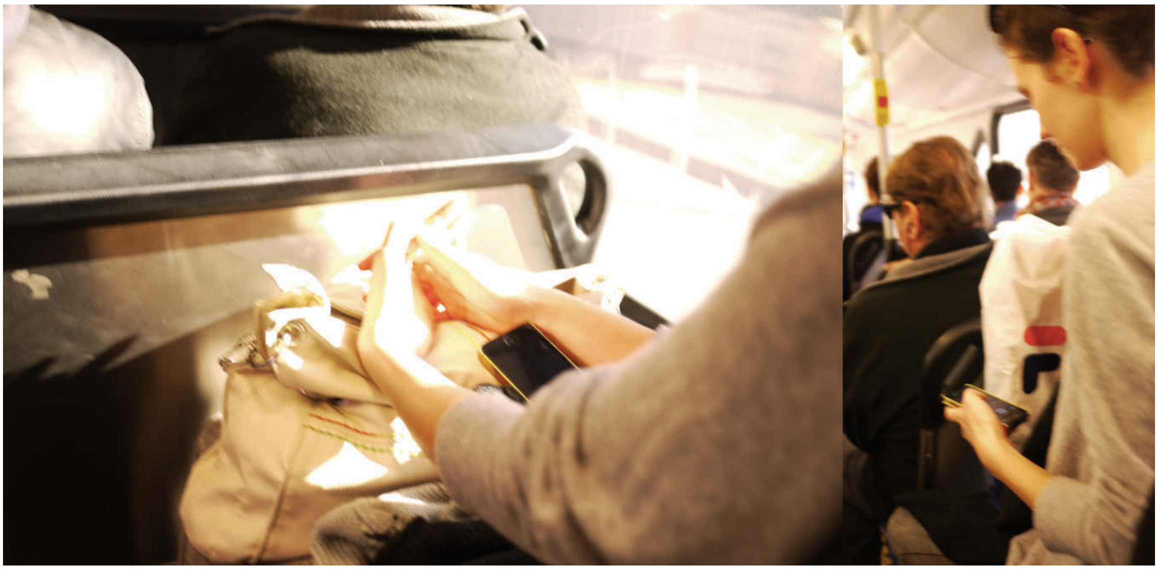


Figure 222: Liya Physical Model Frame 6

She enters the bus, pays with a paper ticket, she doesn't know how to get an Opal card otherwise she would use Opal. She sits down and finishes Snapchatting to a friend since she would find it inappropriate Snapchatting on the bus where others can see the photos. She puts her phone down for a while, then starts sending text messages on WhatsApp.

Figure 223: Liya Physical Model Frame 7

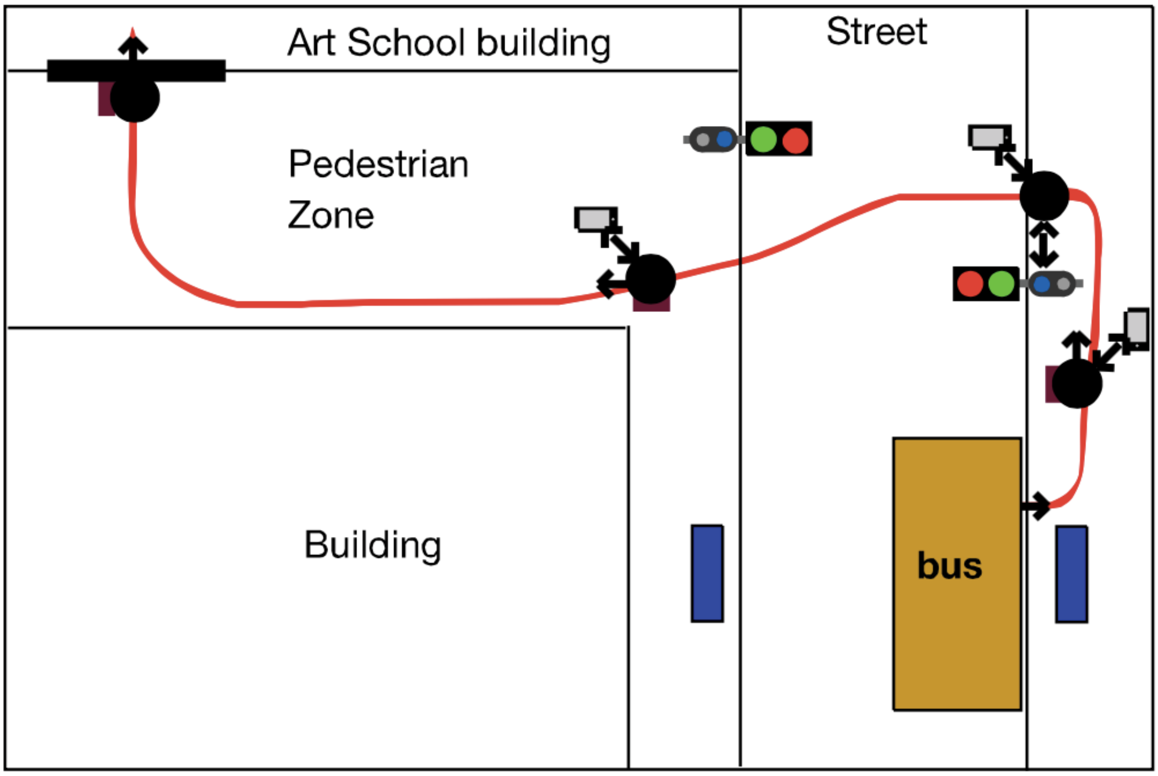


Figure 224: Liya Physical Model Frame 8

Figure 225: Liya Physical Model Frame 9

Liya leaves the bus in Darlinghurst and keeps on texting while walking to her art space. Liya crosses the the street using traffic lights and arrives at her art space.

Figure 226: Liya Physical Model Frame 10

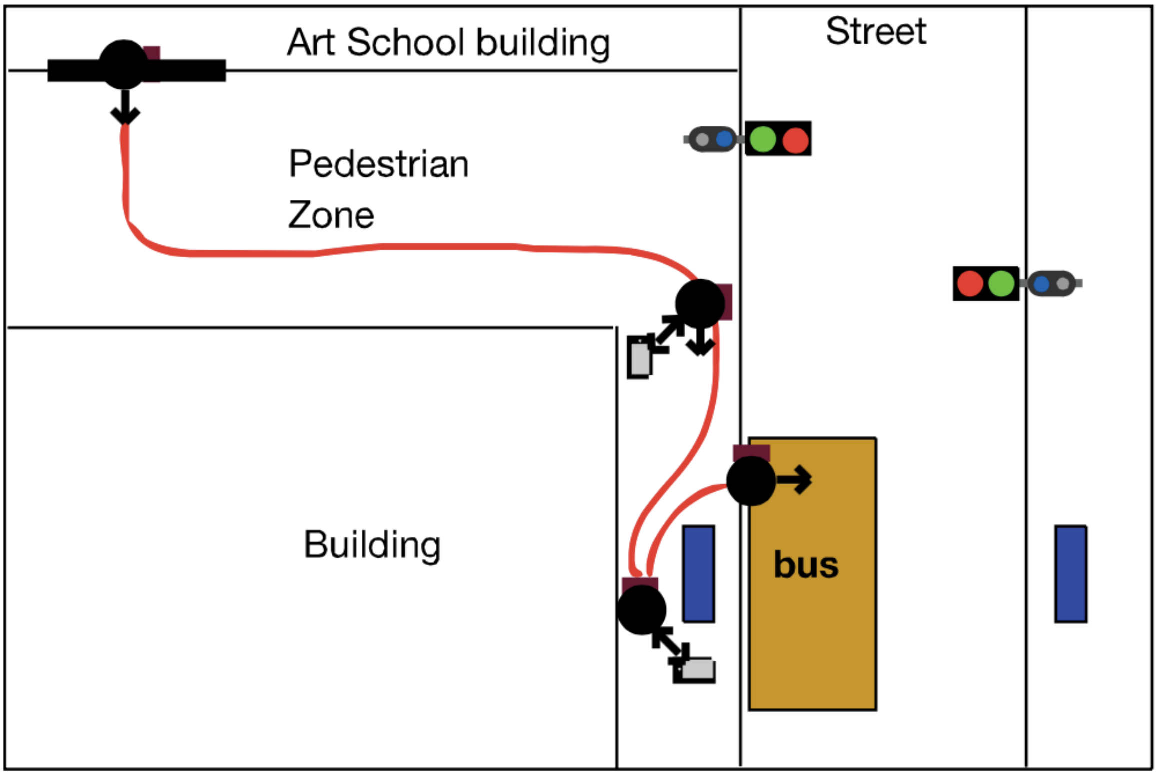


Figure 227: Liya Physical Model Frame 11

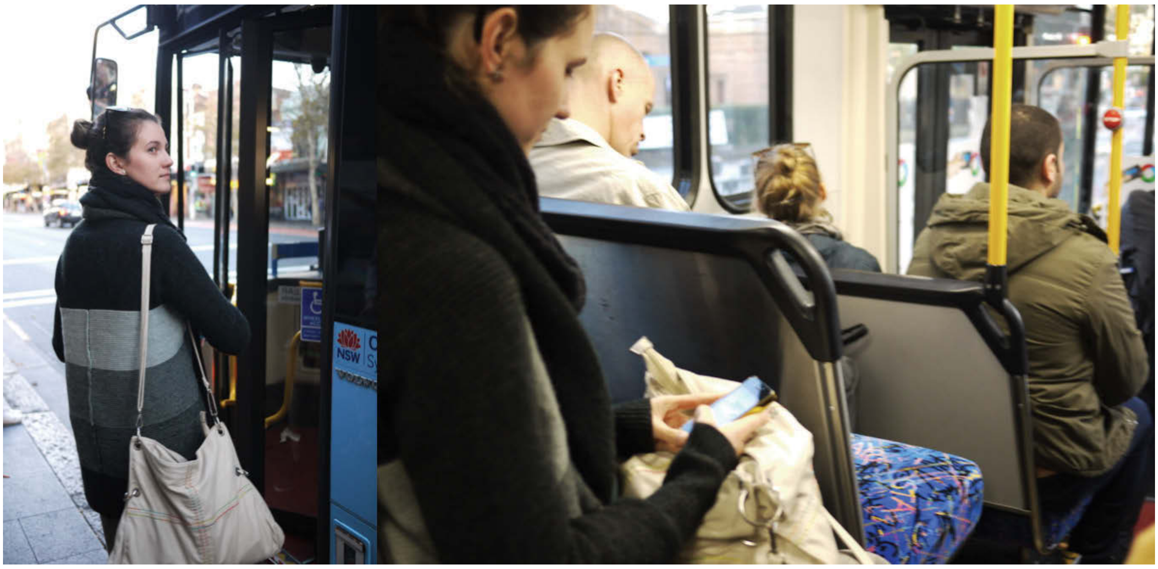


Figure 228: Liya Physical Model Frame 12

Liya leaves her art space and walks back to the bus, while walking she is text messaging with a friend. Liya arrives at the bus stop and waits for the bus, while waiting she keeps on text messaging with her friend. When the bus arrives Liya enters the bus, pays with a paper tick, sits down and continuous texting with her friend.

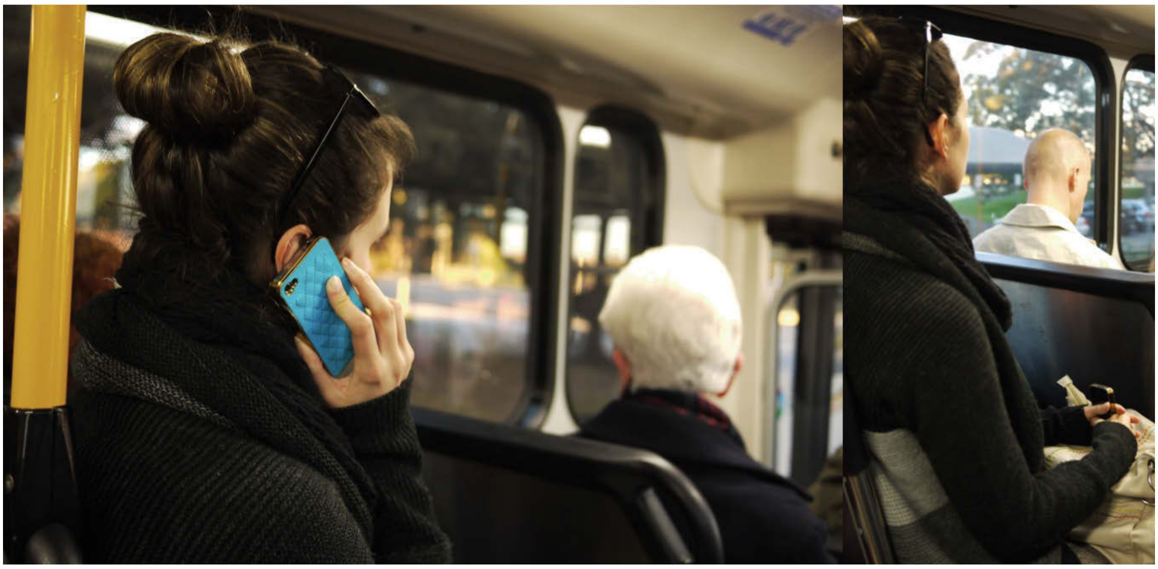


Figure 229: Liya Physical Model Frame 13

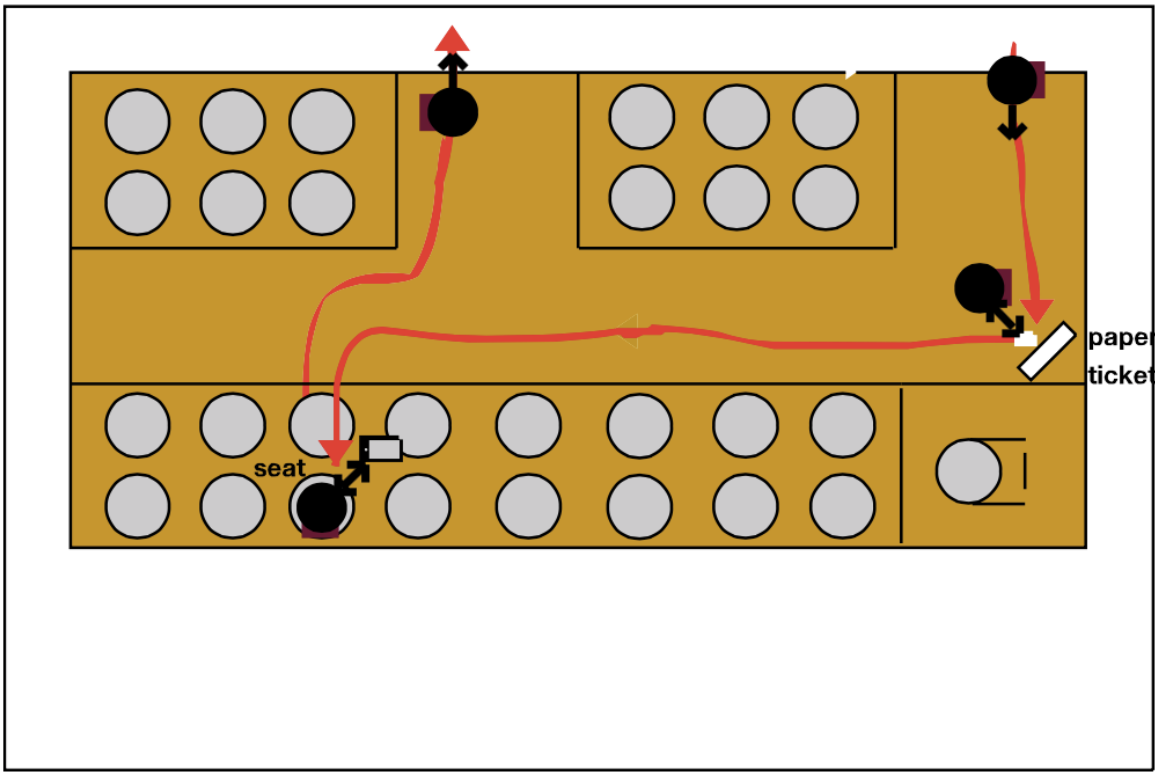


Figure 230: Liya Physical Model Frame 14

Halfway through her bus ride Liya makes a phone call to a friend then puts the phone down for the rest of the trip, but keeps it in her hands.

Figure 231: Liya Physical Model Frame 15

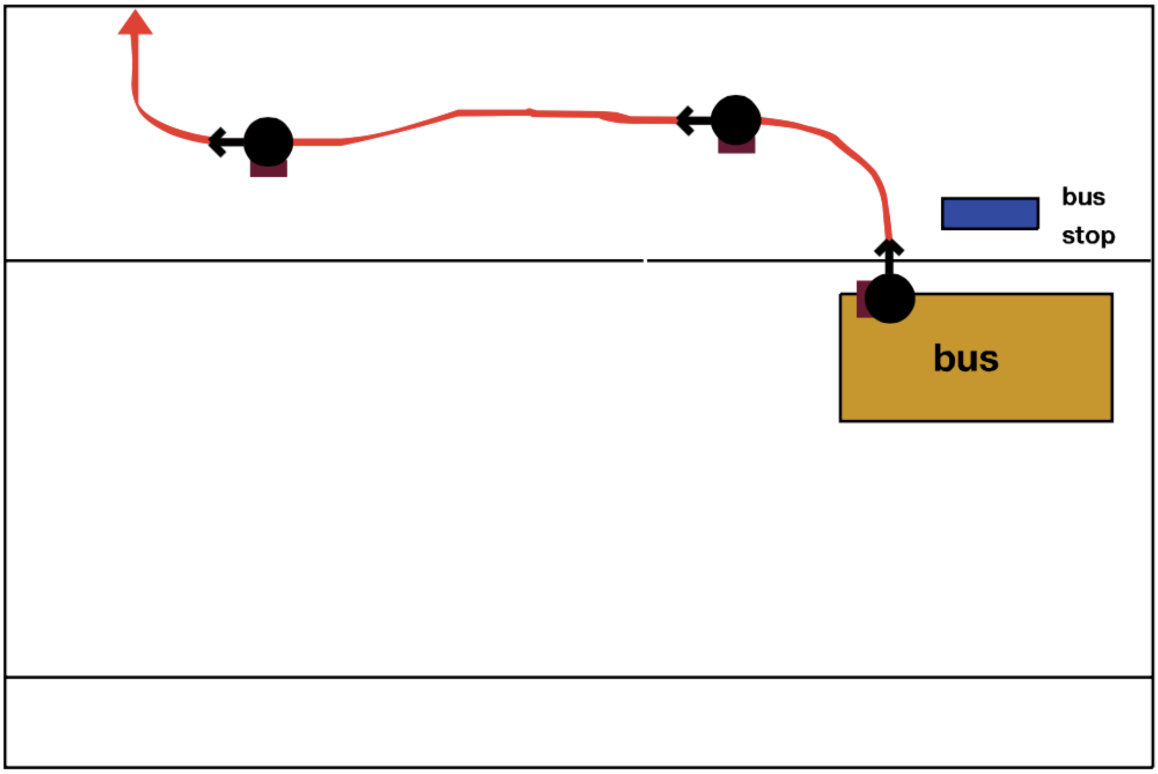


Figure 232: Liya Physical Model Frame 16

Liya leaves the bus, puts her phone in her bag and walks home

Circle Flow Model:

The Circle Flow model is an overview of Liya's data of her everyday interactions.

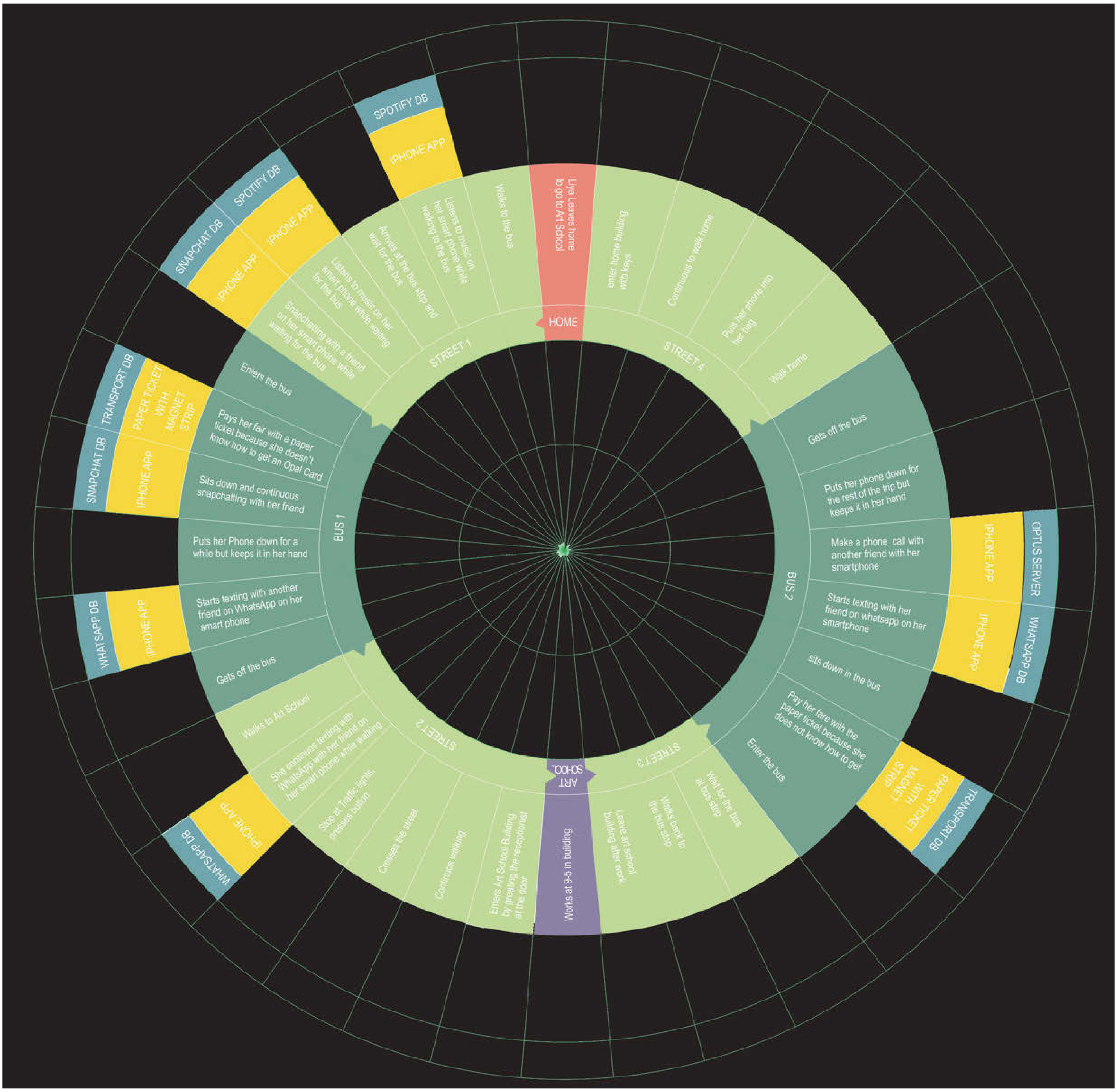


Figure 233: Liya Circle Flow Model

1.2.18 Individual Data Models - Bea (Flexible worker using Private Transport) - Circle Flow & Physical Model

The eight participant researched was Bea who uses private transport and has a flexible job in the neighbourhood of Ultimo in Sydney.

Physical Model:

The physical model show's Bea's interactions situated in the physical environment and within the narrative of her day over time.

Figure 234: Bea Physical Model Frame 1

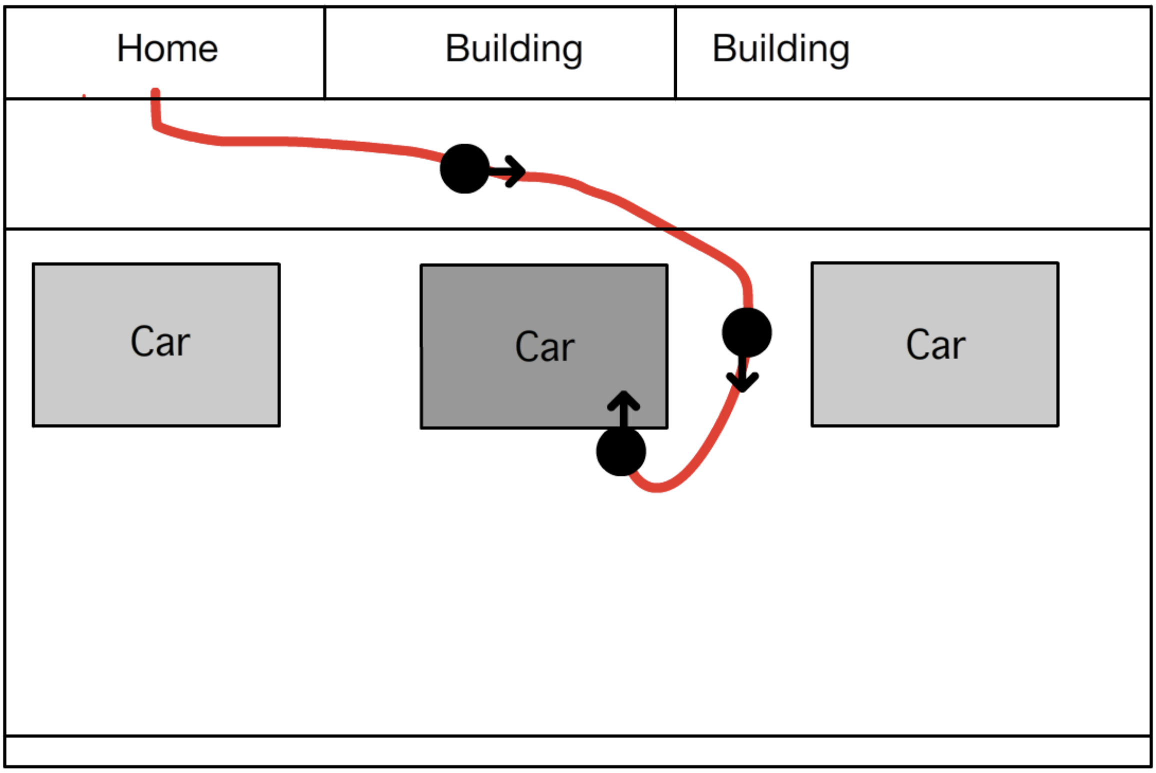


Figure 235: Bea Physical Model Frame 2

Bea leaves her home and walks to her car.

Figure 236: Bea Physical Model Frame 3

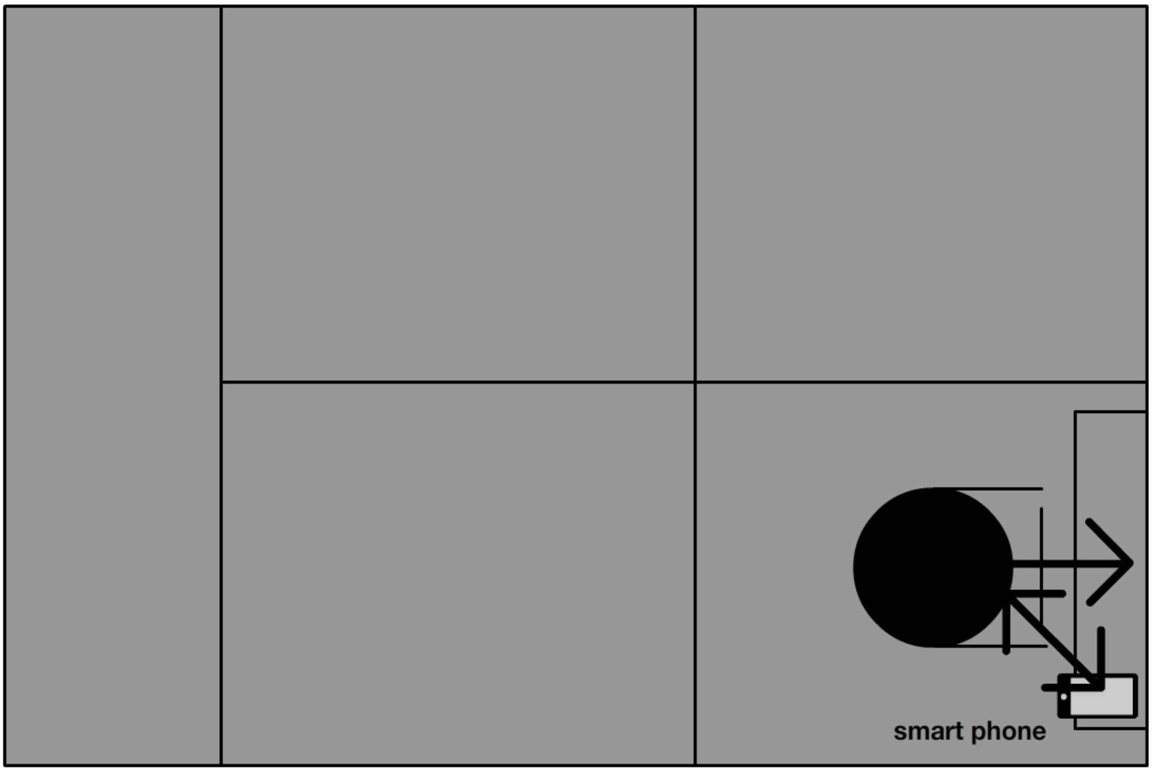


Figure 237: Bea Physical Model Frame 4

Bea opens her car with analog keys, gets in the car and starts driving to work, checks her iPhone for real-estate news since she is looking for a new apartment while she is driving. She is holding her phone in her hand at all times while driving since she does not have a smart phone holder. In particular, at traffic lights she interacts with her iPhone the most. She is also listening to music on her car stereo which is tuned into a radio station an starts playing when she started the car, so she did not have to touch the radio to turn on the music.

Figure 238: Bea Physical Model Frame 5

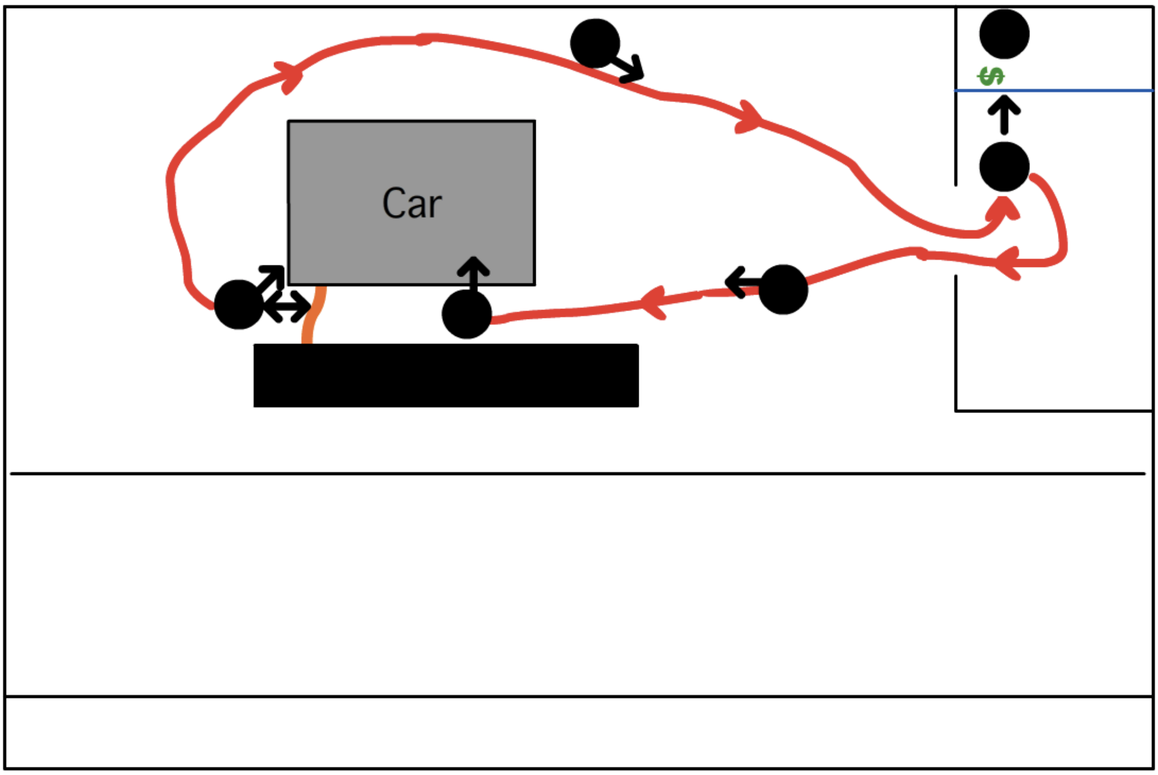


Figure 239: Bea Physical Model Frame 6

Bea stops at a petrol station to get gas. She refills her tank and walks into the station to pay.

Figure 240: Bea Physical Model Frame 7

She pays in cash inside the station then leaves the station and gets back into the car.

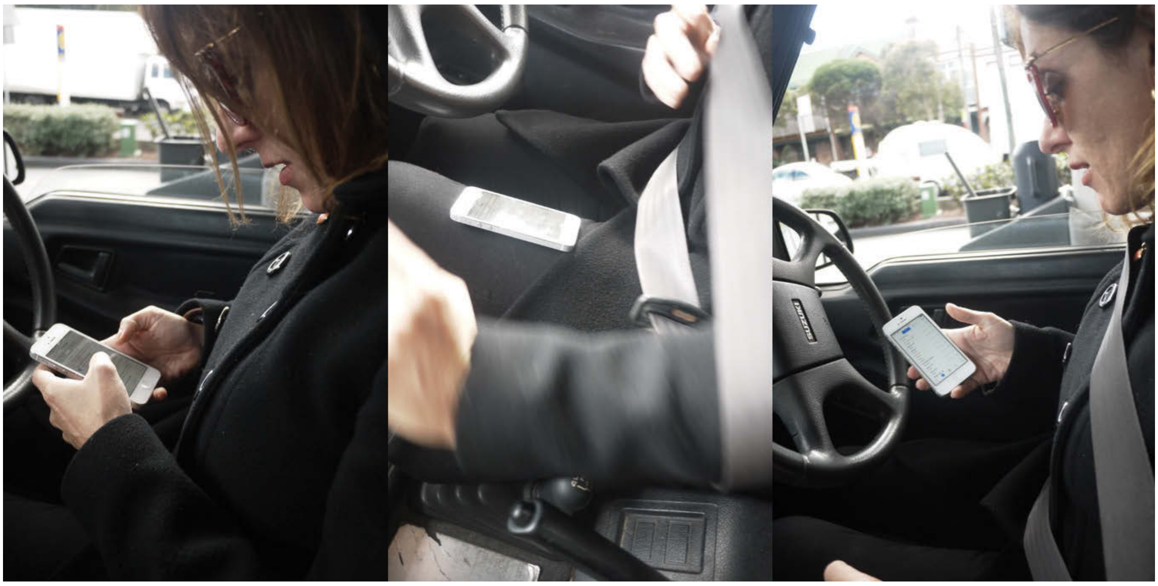


Figure 241: Bea Physical Model Frame 8

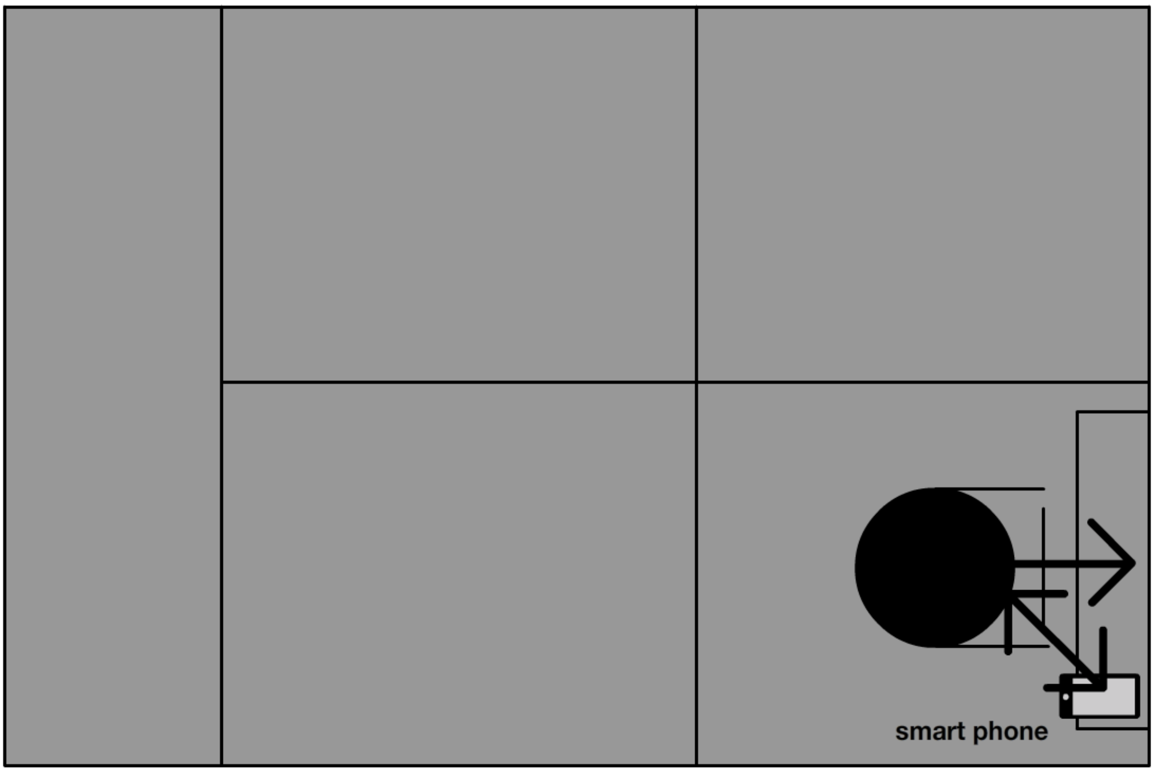


Figure 242: Bea Physical Model Frame 9

Bea checks her iPhone for more real-estate postings while she is putting on the seatbelt and starts driving.

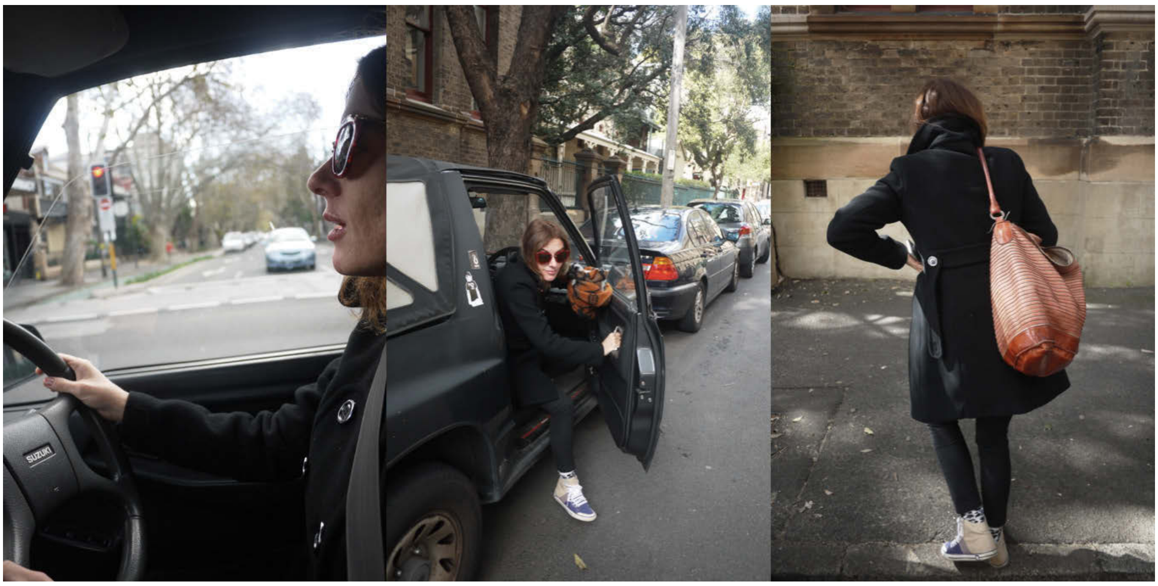


Figure 243: Bea Physical Model Frame 10

She continuous driving to work, parks the car, gets out of the car and continuous walking to work. She doesn't close her car since the back window is open anyway, but she needs to use analog keys to open the car door.

Figure 244: Bea Physical Model Frame 11

While walking she keeps on checking her iPhone for emails and text messages.

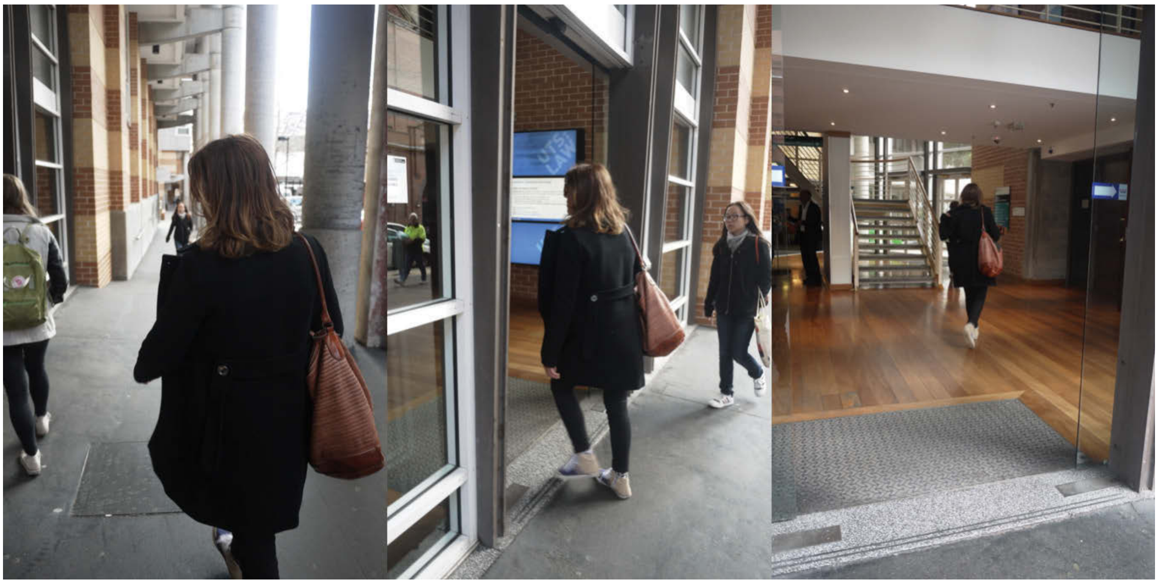


Figure 245: Bea Physical Model Frame 12

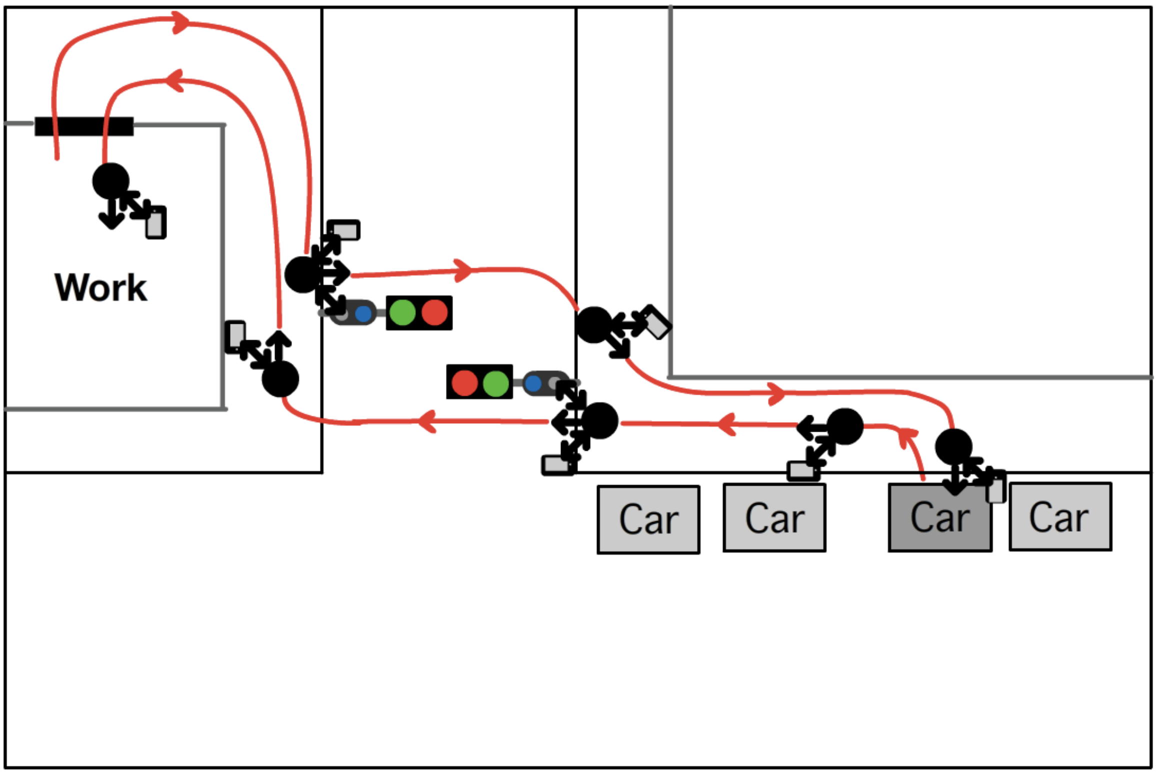


Figure 246: Bea Physical Model Frame 13

She arrives at her work and enters the building and works for four hours.

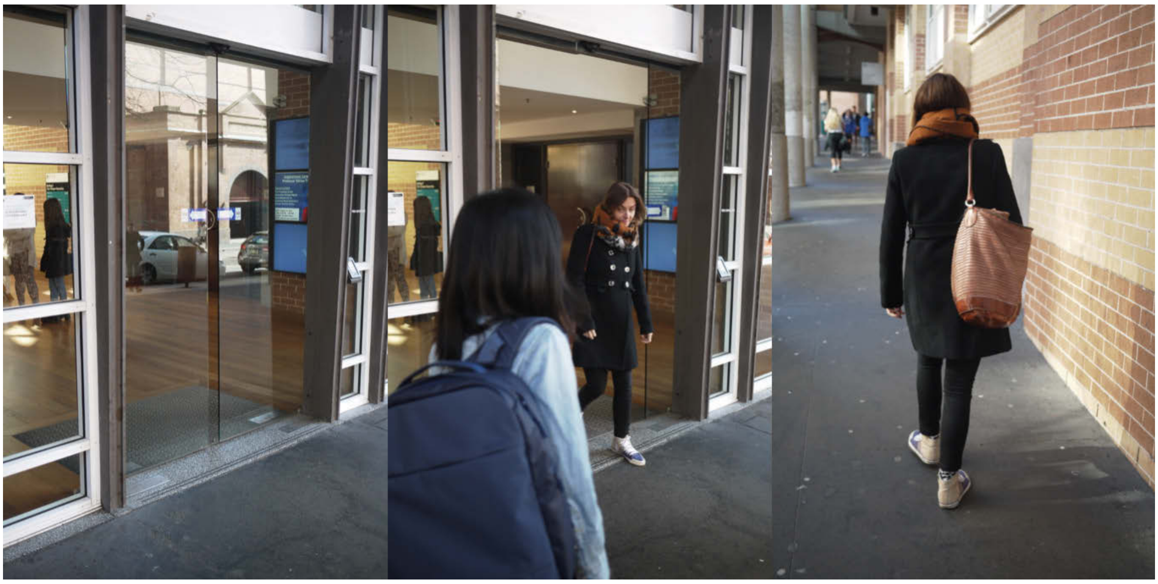


Figure 247: Bea Physical Model Frame 14

She leaves work and walks back to her car.

Figure 248: Bea Physical Model Frame 15

While walking she checks her iPhone again for messages, emails and Real-estate posts.

Figure 249: Bea Physical Model Frame 16

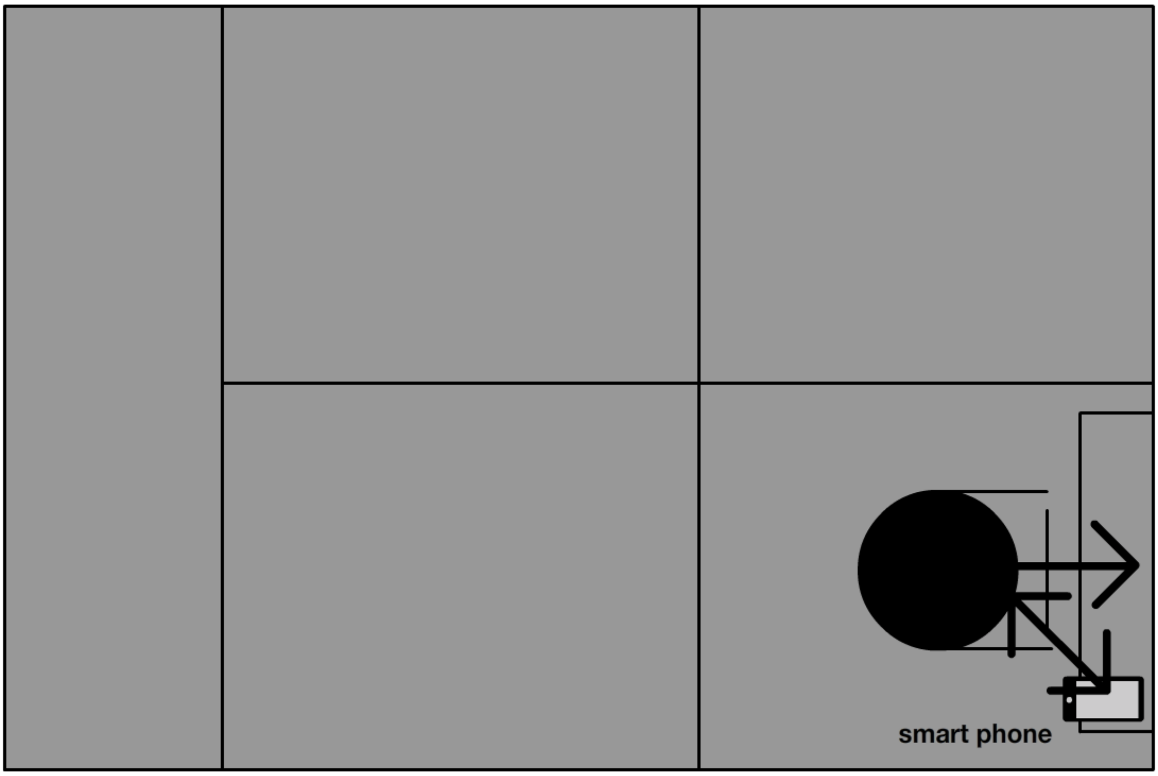


Figure 250: Bea Physical Model Frame 17

She gets in her car using analog keys, starts her car and drives home. She is not using her iPhone while driving back home.

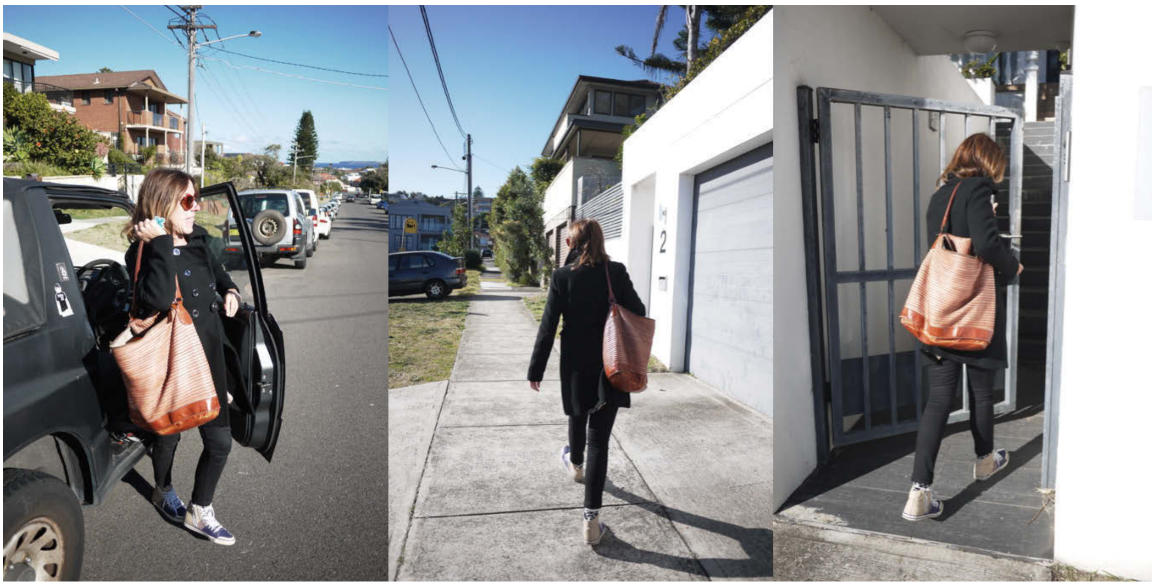


Figure 251: Bea Physical Model Frame 18

She parks her car, gets out of her car and walks home to pick up her dog. She opens her home door using analog keys.

Figure 252: Bea Physical Model Frame 19

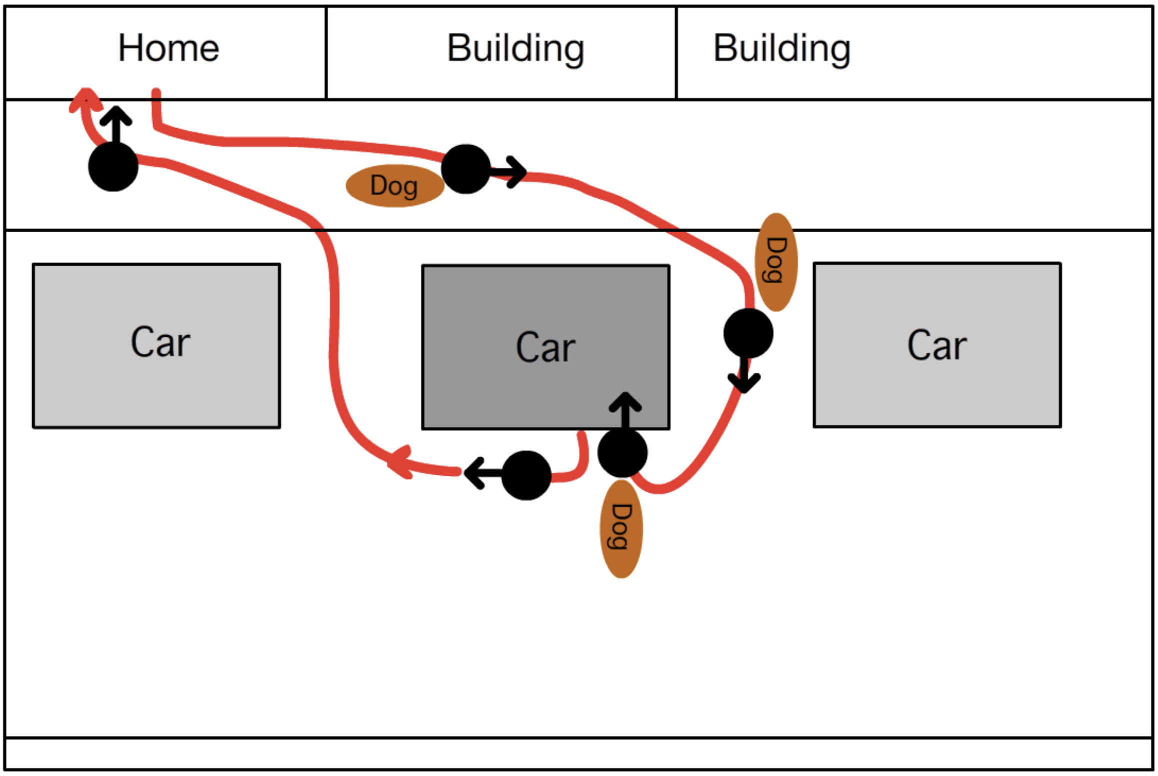


Figure 253: Bea Physical Model Frame 20

She gets her dog, walks back to the car and lets the dog into her car using analog keys.

Figure 254: Bea Physical Model Frame 21

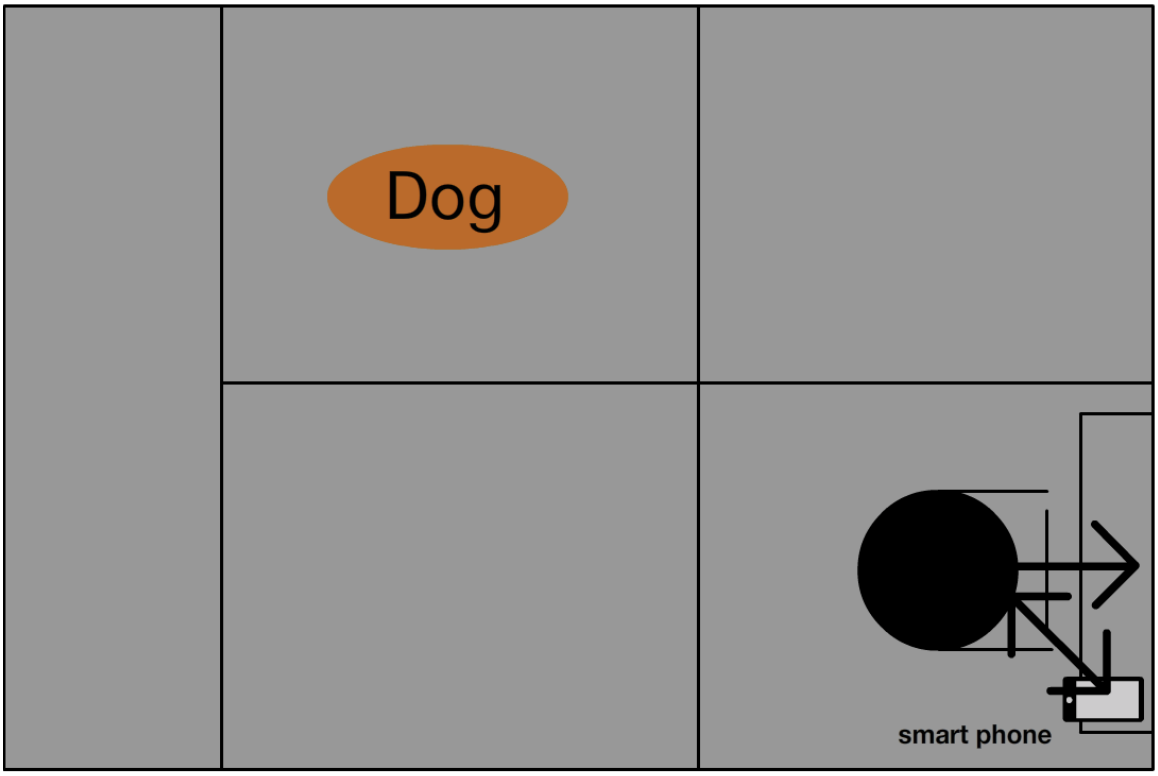


Figure 255: Bea Physical Model Frame 22

She gets into her car and drives to the post office, parks the car and gets out.

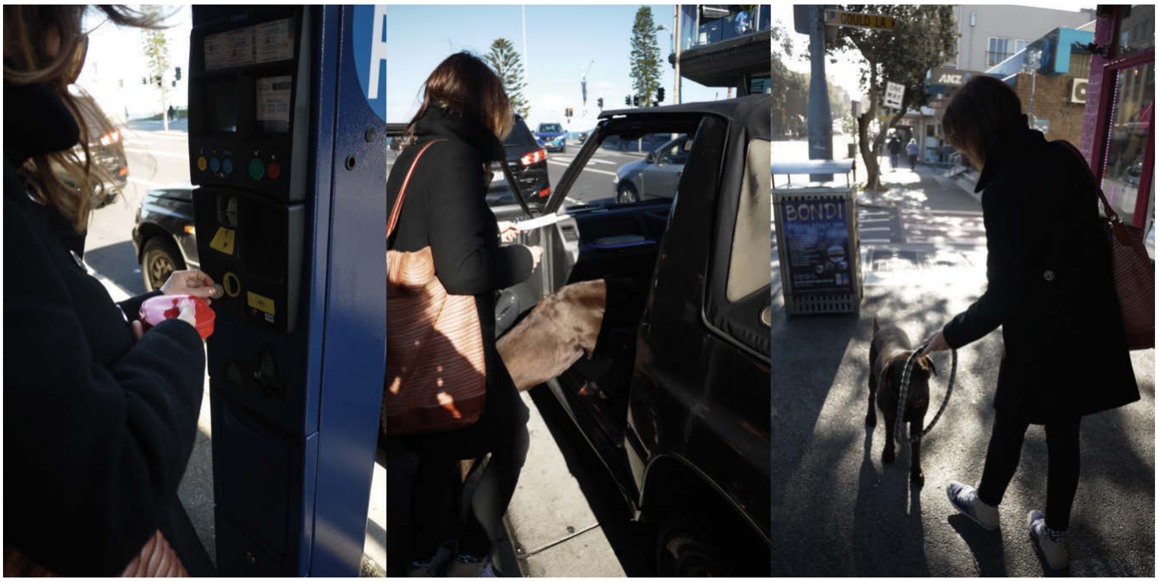


Figure 256: Bea Physical Model Frame 23

She gets a parking ticket from the parking machines, puts the parking ticket back into the car, lets the dog out and puts the dog on the leash.

Figure 257: Bea Physical Model Frame 24

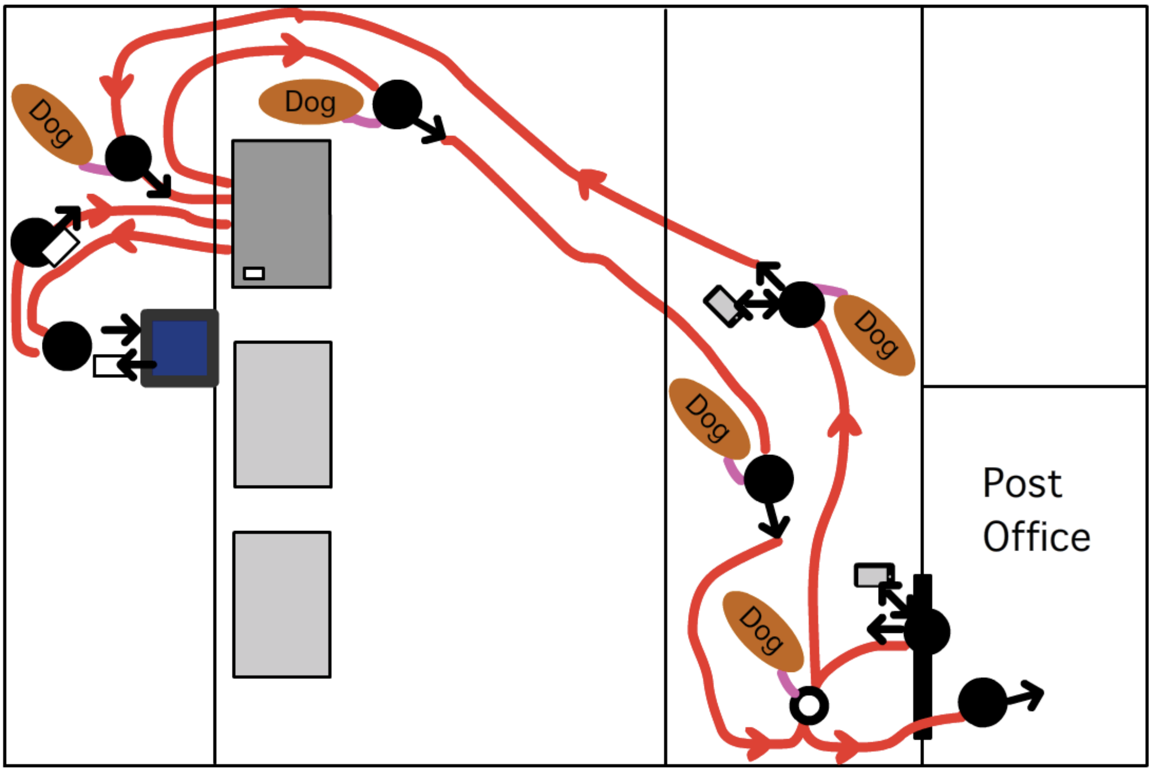


Figure 258: Bea Physical Model Frame 25

She walks with the dog to the post office, while checking more emails on her smart phone. She leaves the dog outside and enters post office.

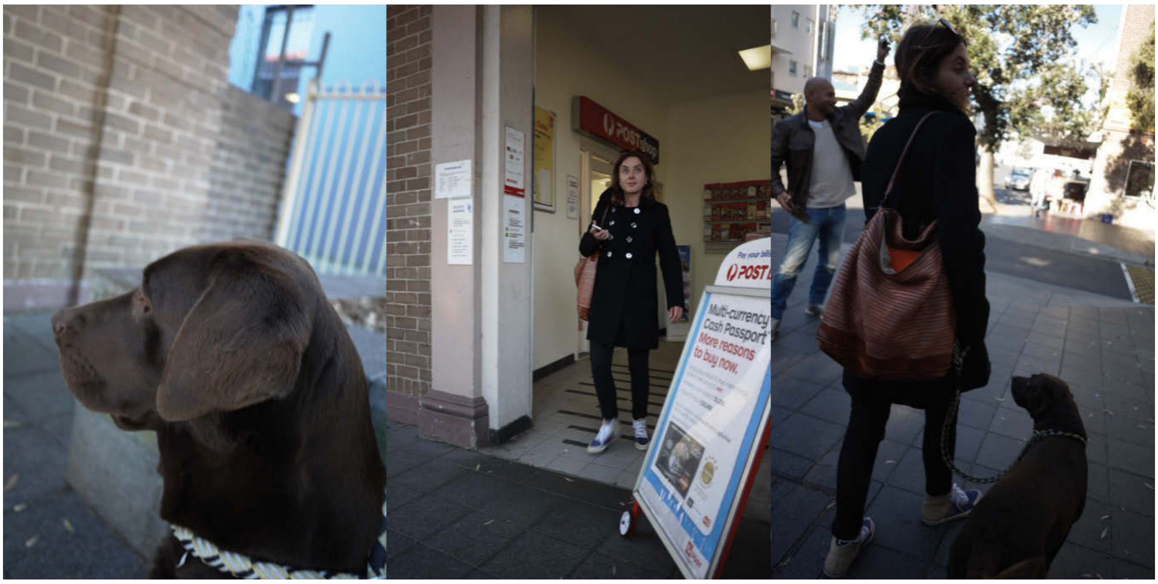


Figure 259: Bea Physical Model Frame 26

The dog waits outside, she comes back out while checking her smart phone for more messages. She picks up her dog and walks back to car.

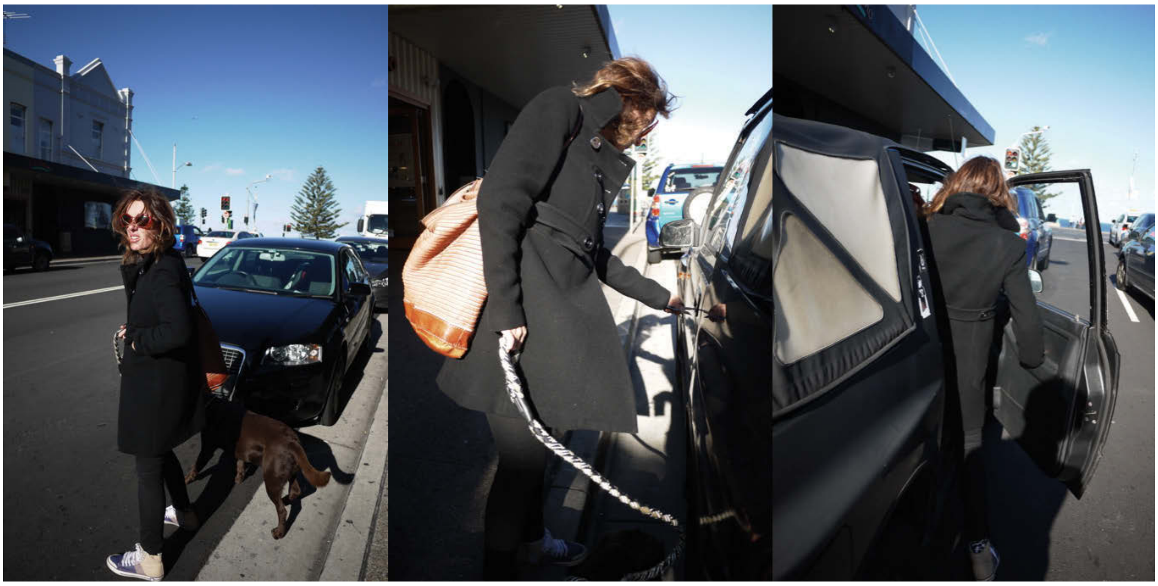


Figure 260: Bea Physical Model Frame 27

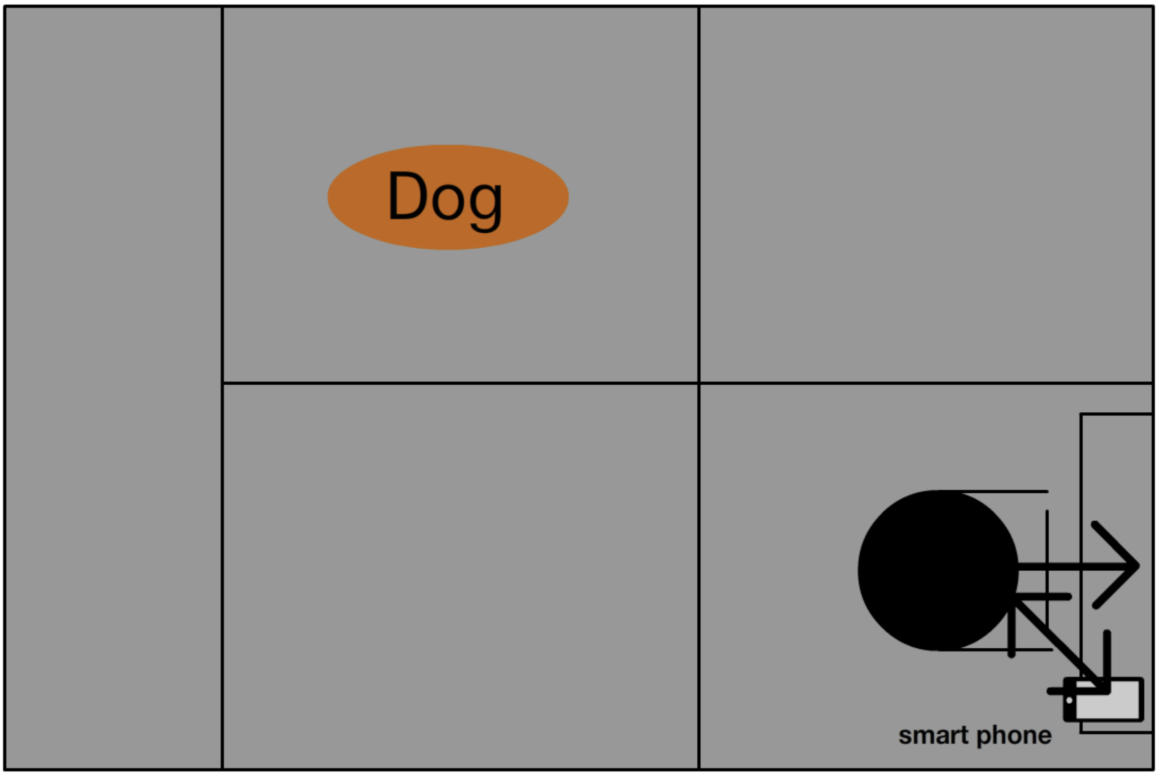


Figure 261: Bea Physical Model Frame 28

She crosses the street, lets the dog back into the car using analog keys and gets back into the car and starts driving to the beach.

Figure 262: Bea Physical Model Frame 29

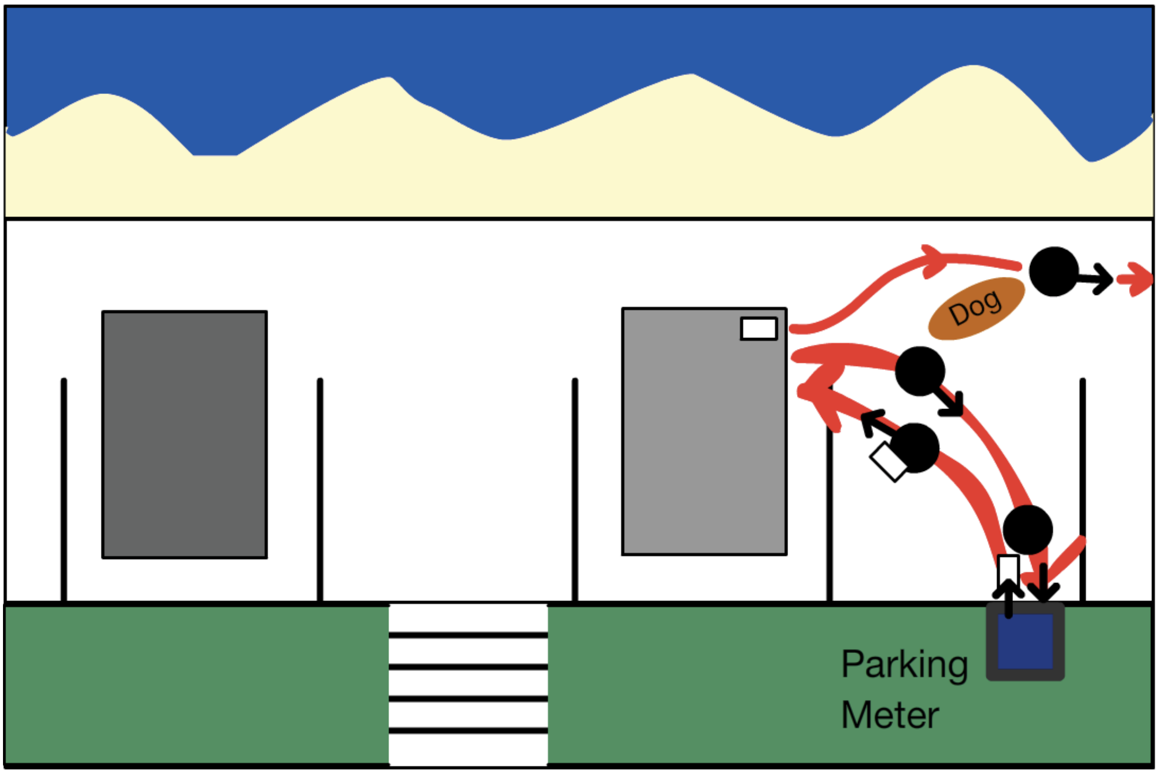


Figure 263: Bea Physical Model Frame 30

She drives to the beach, gets out and lets her dog out of the car.

Figure 264: Bea Physical Model Frame 31

She walks down to the beach, sits down and goes online with her laptop. She tethers the internet from her iPhone because the BondiBeach WiFi is too slow. She writes emails while she it letting her dog go for a walk on the grass.

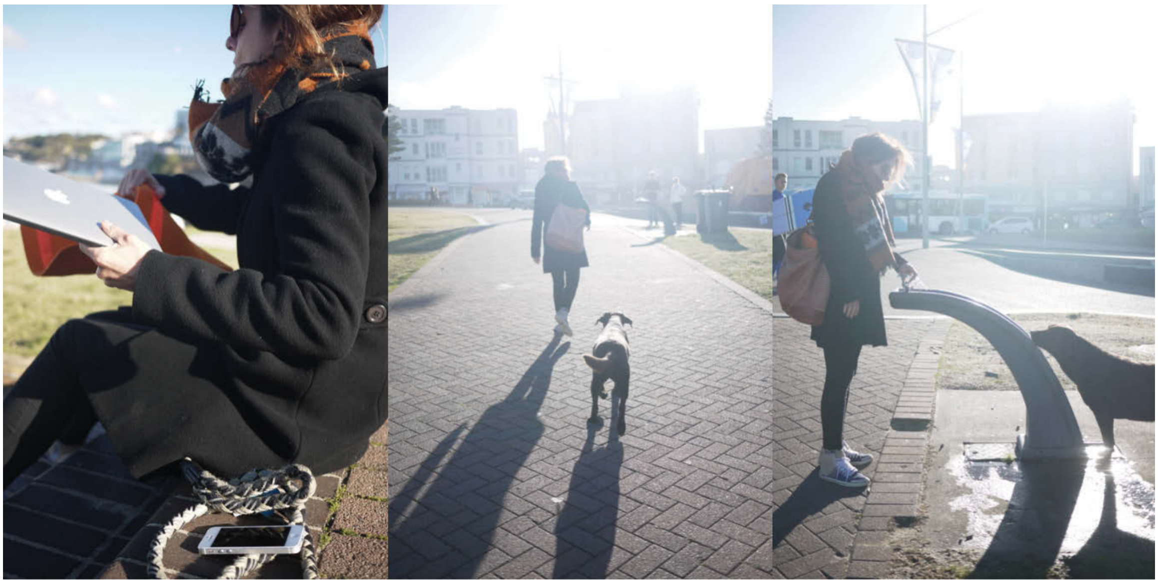


Figure 265: Bea Physical Model Frame 32

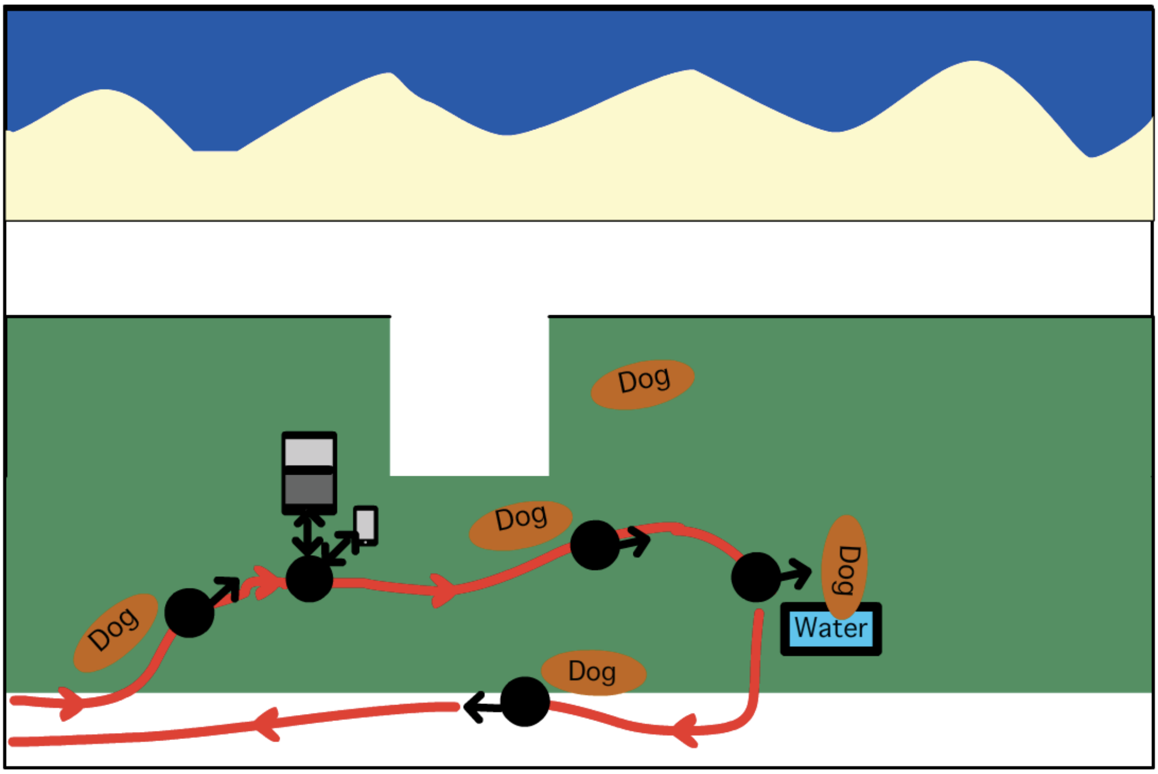


Figure 266: Bea Physical Model Frame 33

When she is done with her Laptop, she wraps up, picks up her dog and walks the dog to the water fountain to give him water to drink.

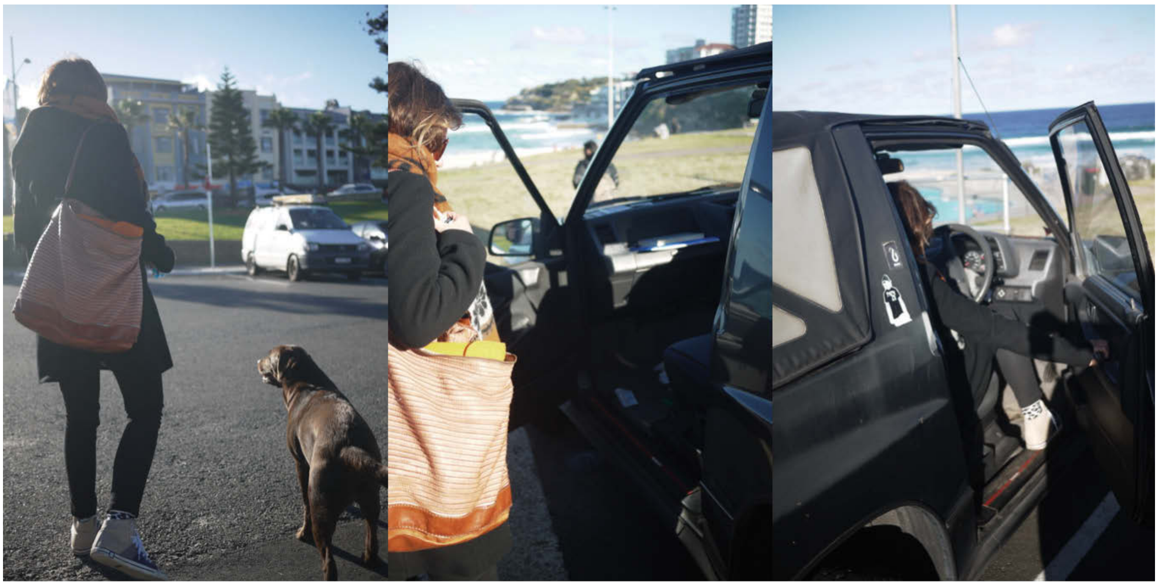


Figure 267: Bea Physical Model Frame 34

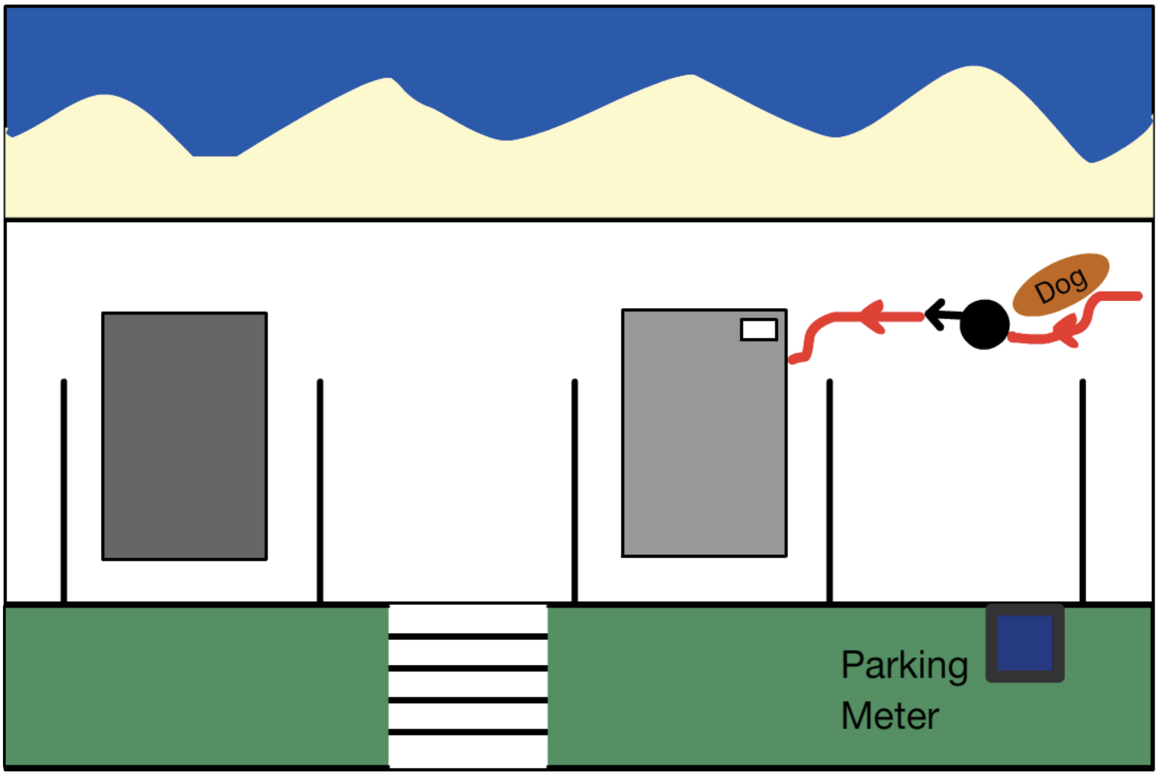


Figure 268: Bea Physical Model Frame 35

She opens the car using analog keys, they both get back into the car.

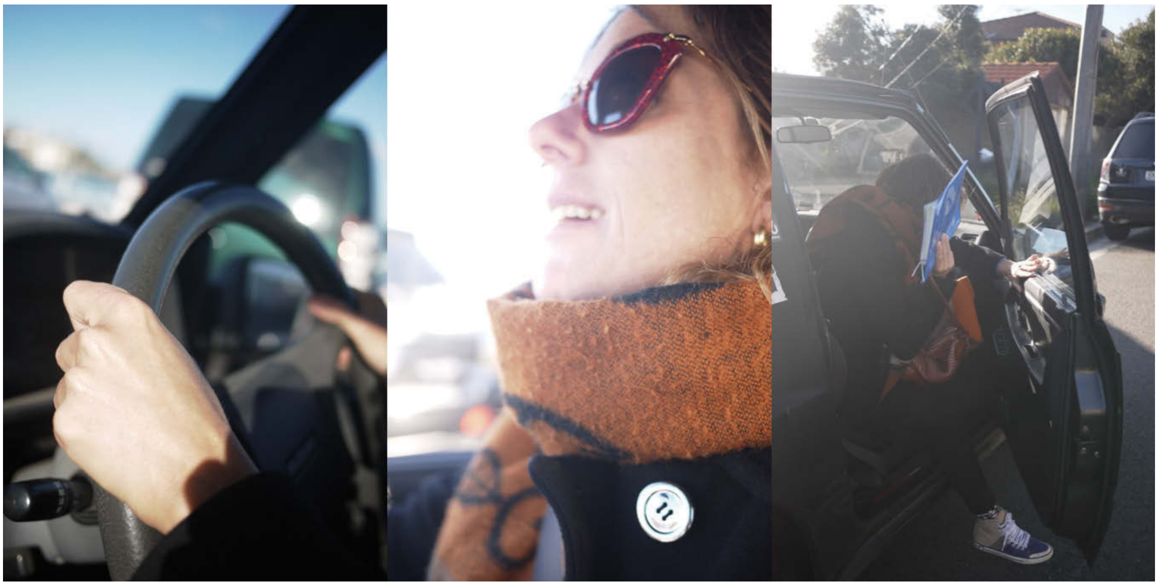


Figure 269: Bea Physical Model Frame 36

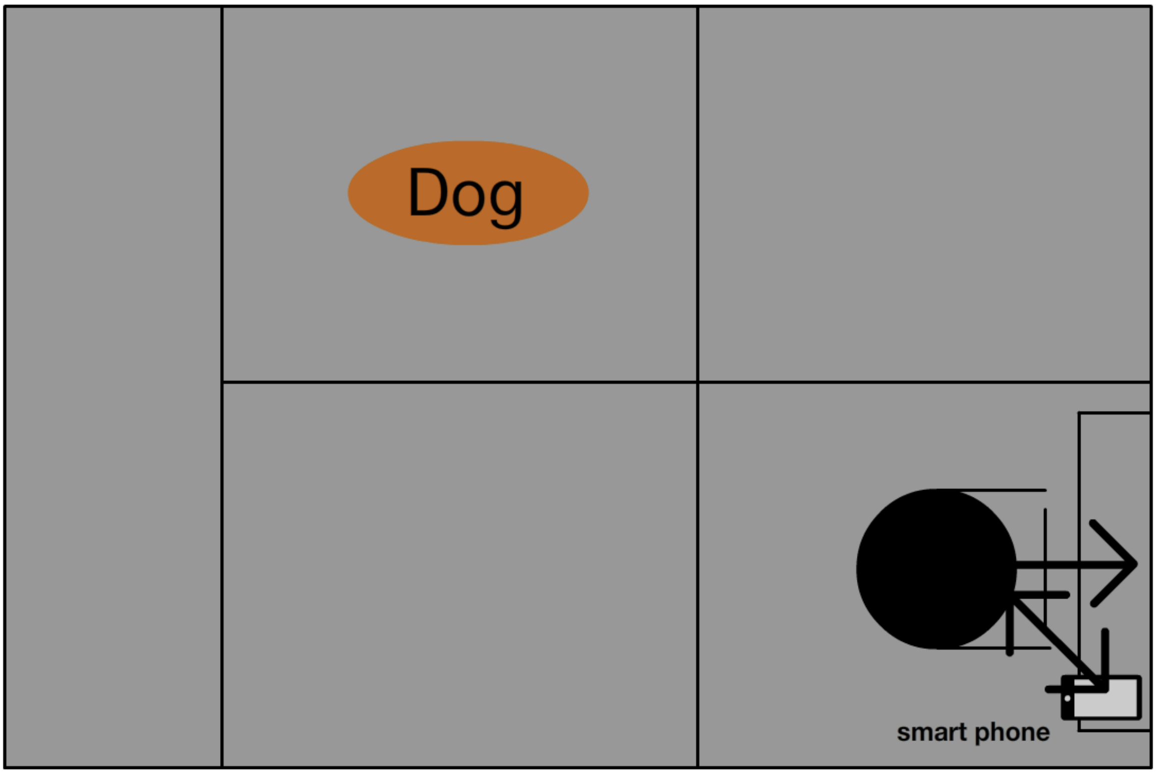


Figure 270: Bea Physical Model Frame 37

She drives back home, parks the car and gets out again.

Figure 271: Bea Physical Model Frame 38

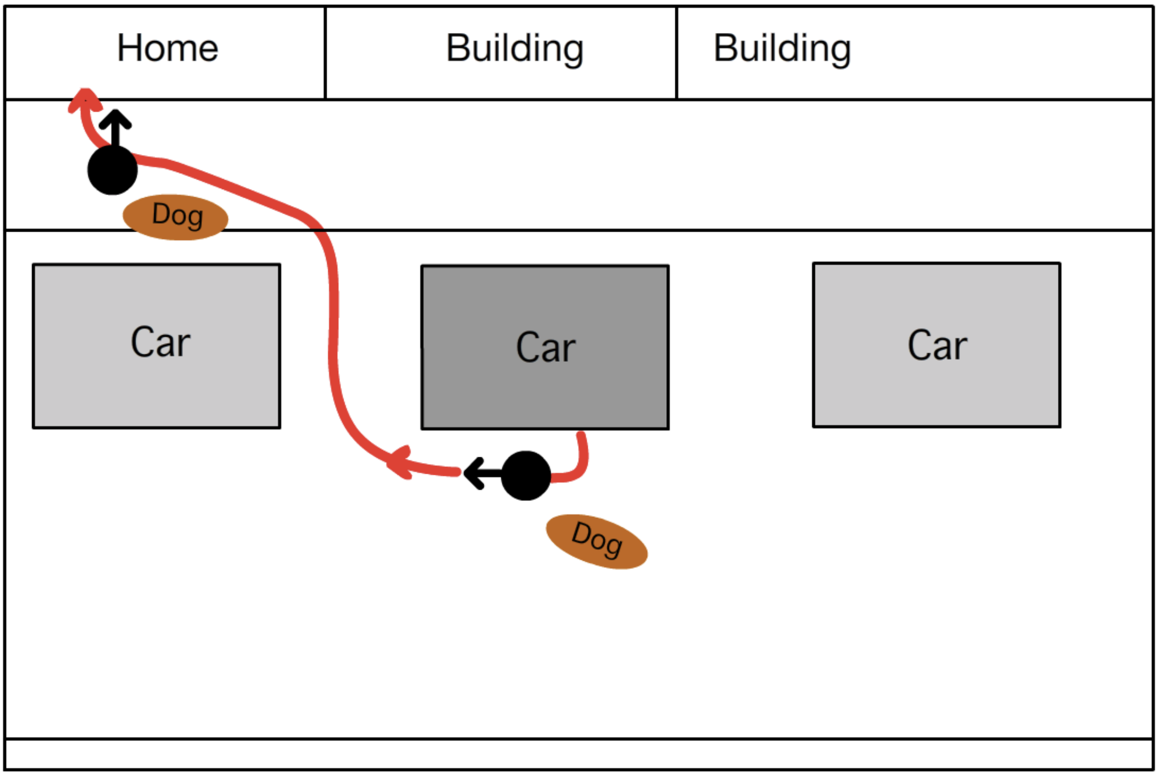


Figure 272: Bea Physical Model Frame 39

She walks back home, checks her mailbox and enters the building.

Circle Flow Model:

The Circle Flow model is an overview of Bea's data of her everyday interactions.

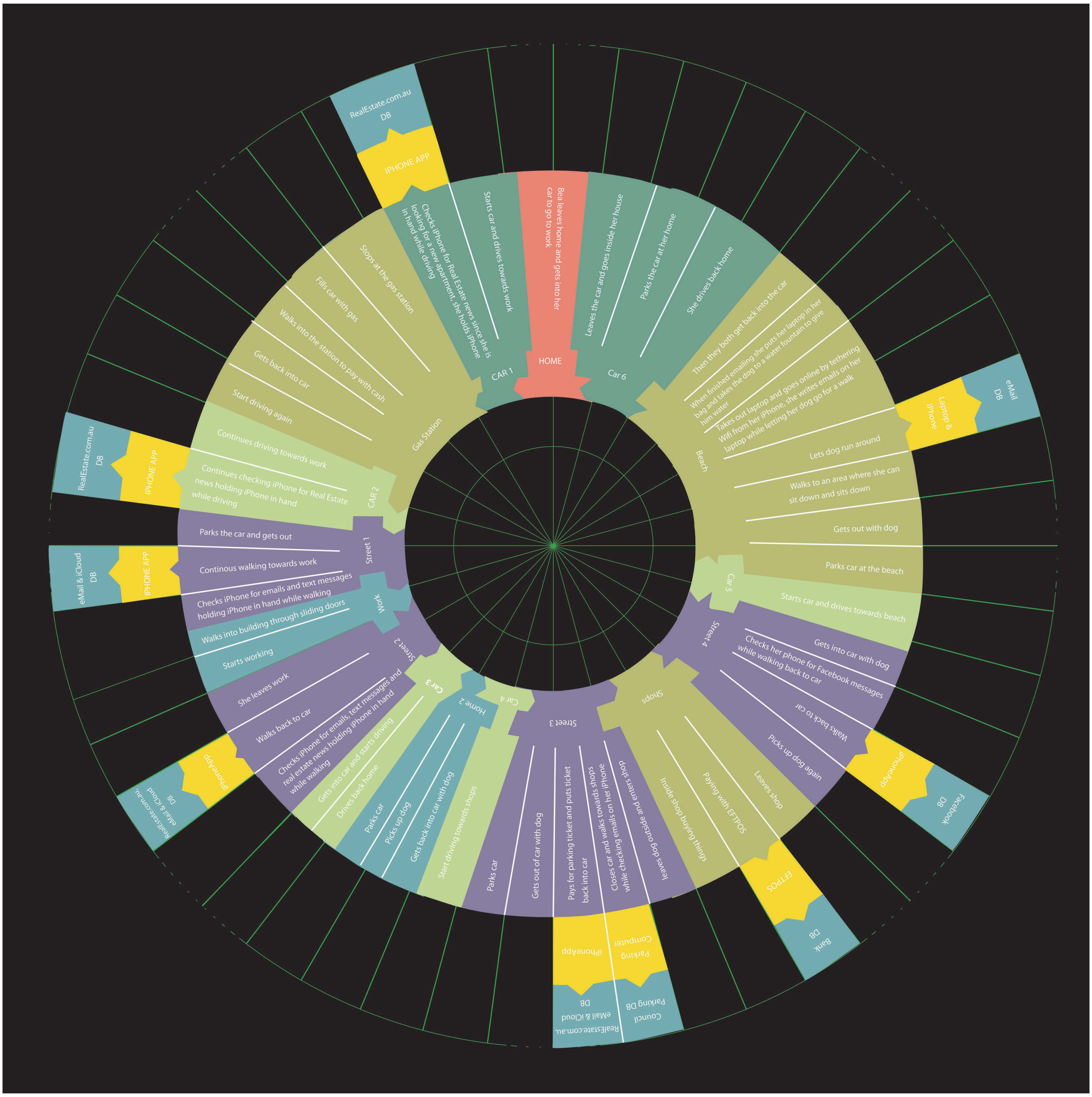


Figure 273: Bea Circle Flow Model

1.2.19 Individual Data Models - Heidi (Flexible worker using Private Transport) - Circle Flow & Physical Model

The ninth participant researched was Heidi who uses private transport and has a flexible job in the neighbourhood of Double Bay in Sydney.

Physical Model:

The physical model show's Heidi's interactions situated in the physical environment and within the narrative of her day over time.

Figure 274: Heidi Physical Model Frame 1

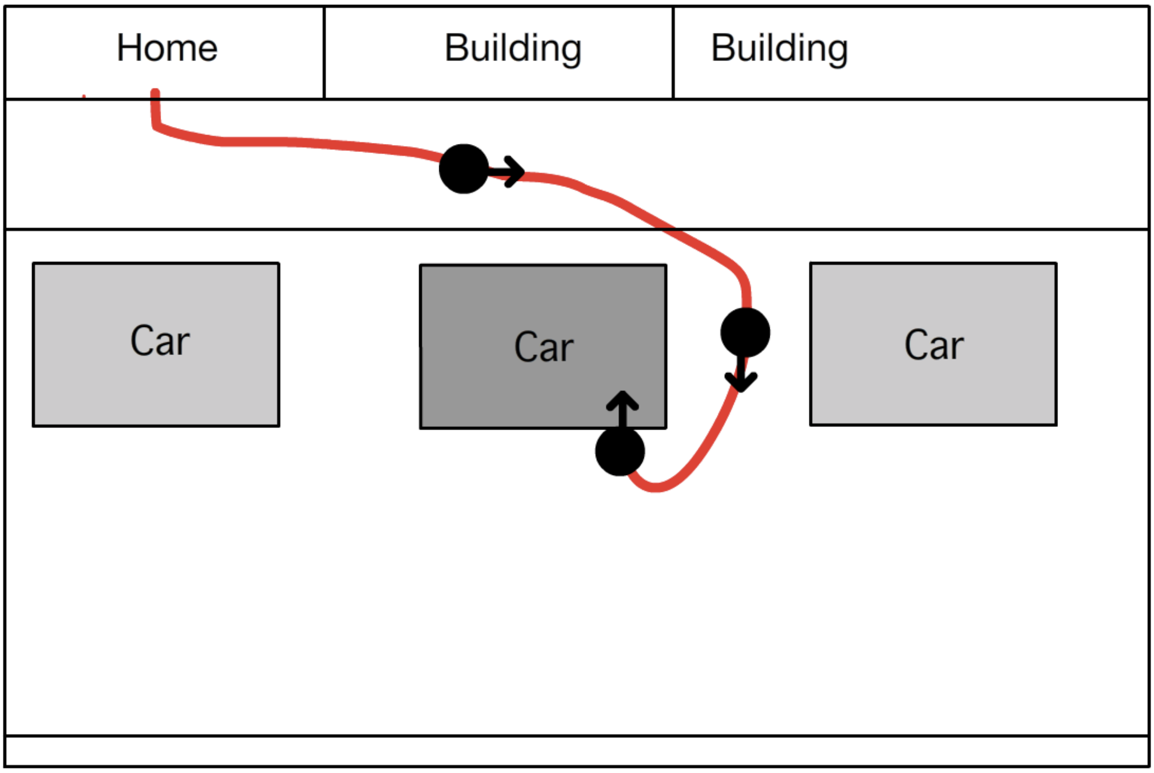


Figure 275: Heidi Physical Model Frame 2

Heidi leaves her home in the morning, checking her mailbox when she leaves the house. Heidi then walks to the car.

Figure 276: Heidi Physical Model Frame 3

She opens car with analog keys and starts the car and then drives to her work location.

Figure 277: Heidi Physical Model Frame 4

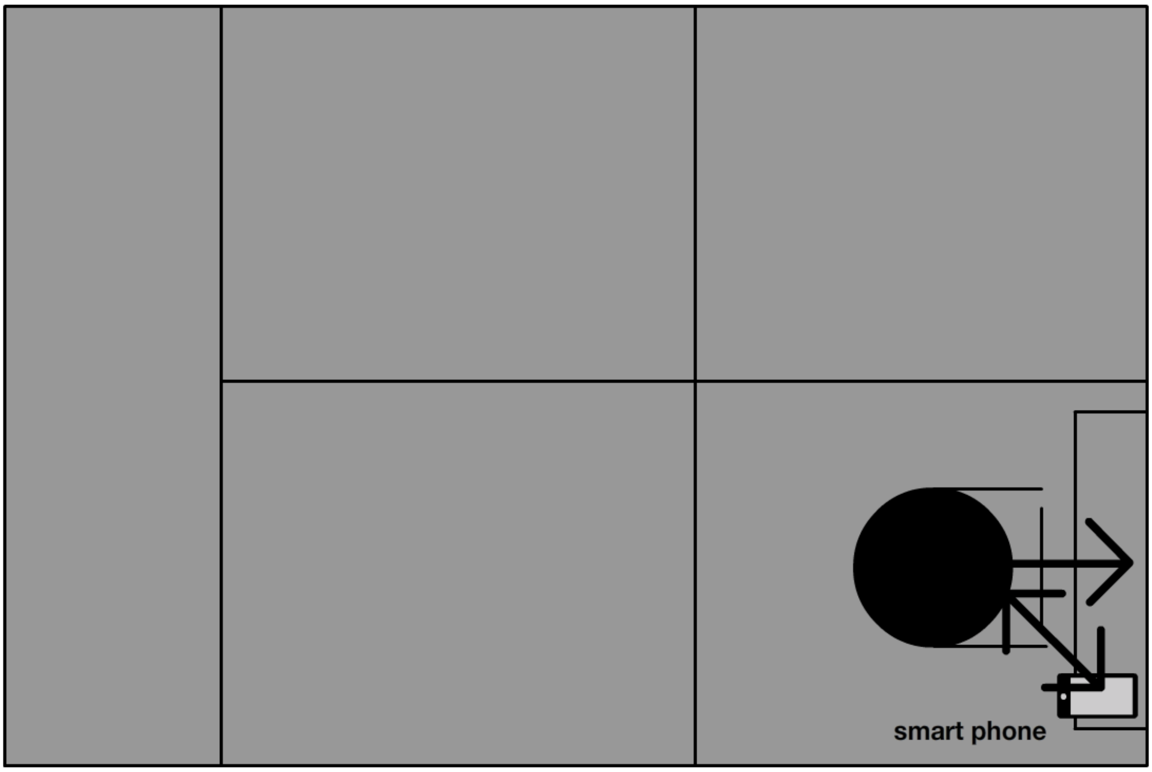


Figure 278: Heidi Physical Model Frame 5

She puts her smart phone in a smart phone holder while driving.

Figure 279: Heidi Physical Model Frame 6

At traffic lights she checks, emails, text messages and Instagram.

Figure 280: Heidi Physical Model Frame 7

She parks her car takes the smart phone out of the holder and gets out of car.

Figure 281: Heidi Physical Model Frame 8

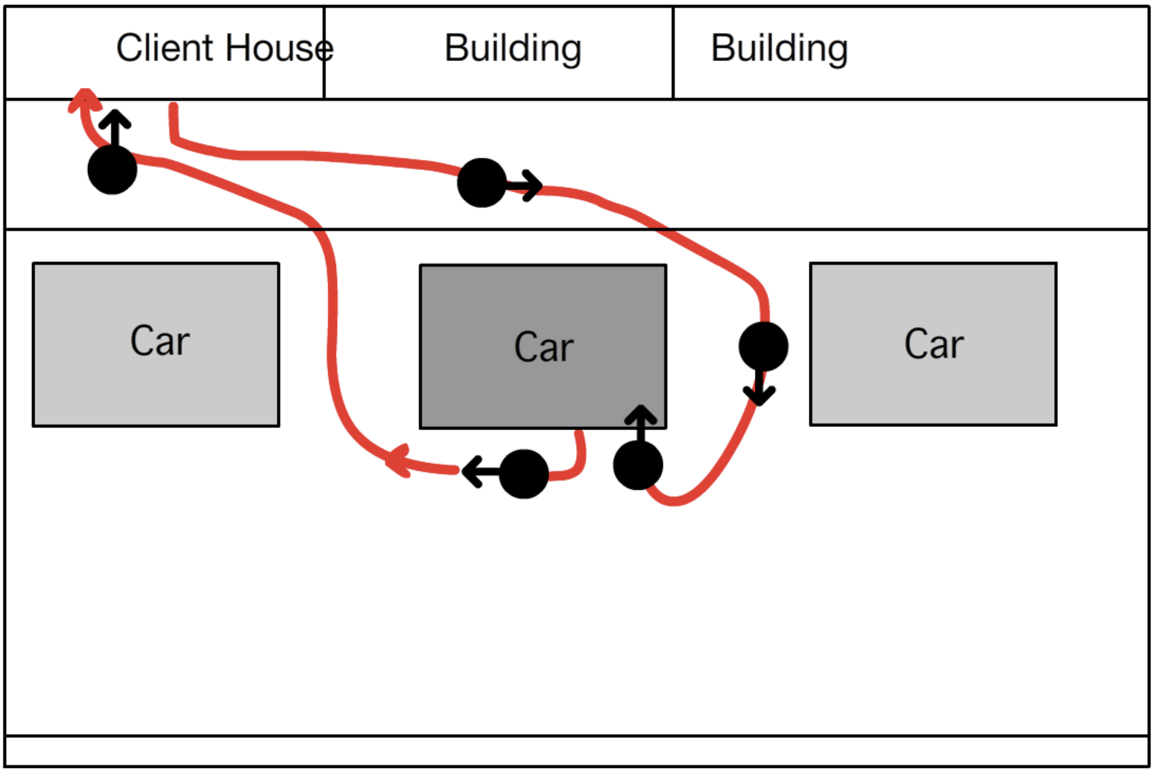


Figure 282: Heidi Physical Model Frame 9

She closes the car with analog keys and visits a client.

Figure 283: Heidi Physical Model Frame 10

When she finishes the client visit she gets back into car using analog keys.

Figure 284: Heidi Physical Model Frame 11

She starts driving and puts her smart phone into the smart phone holder at the next traffic lights.

Figure 285: Heidi Physical Model Frame 12

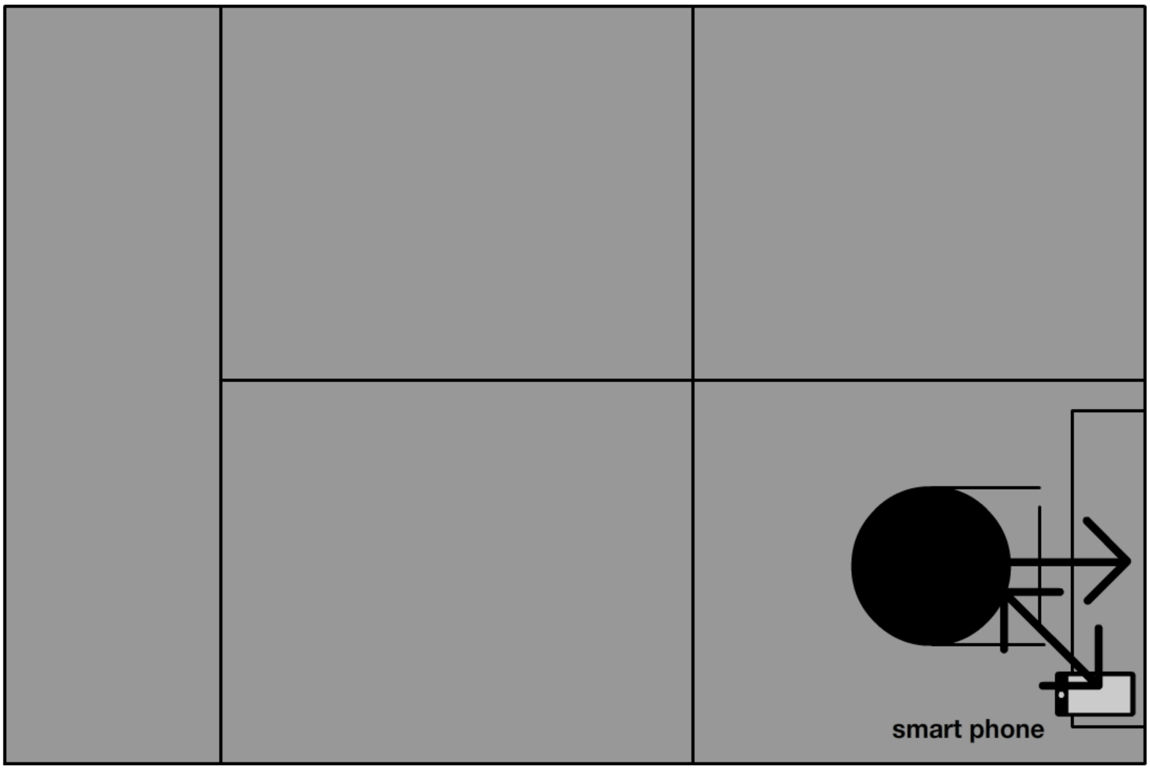


Figure 286: Heidi Physical Model Frame 13

She checks Instagram on her smart phone while driving.

Figure 287: Heidi Physical Model Frame 14

She parks her car at the beach to get lunch and walks to the parking ticket machine.

Figure 288: Heidi Physical Model Frame 15

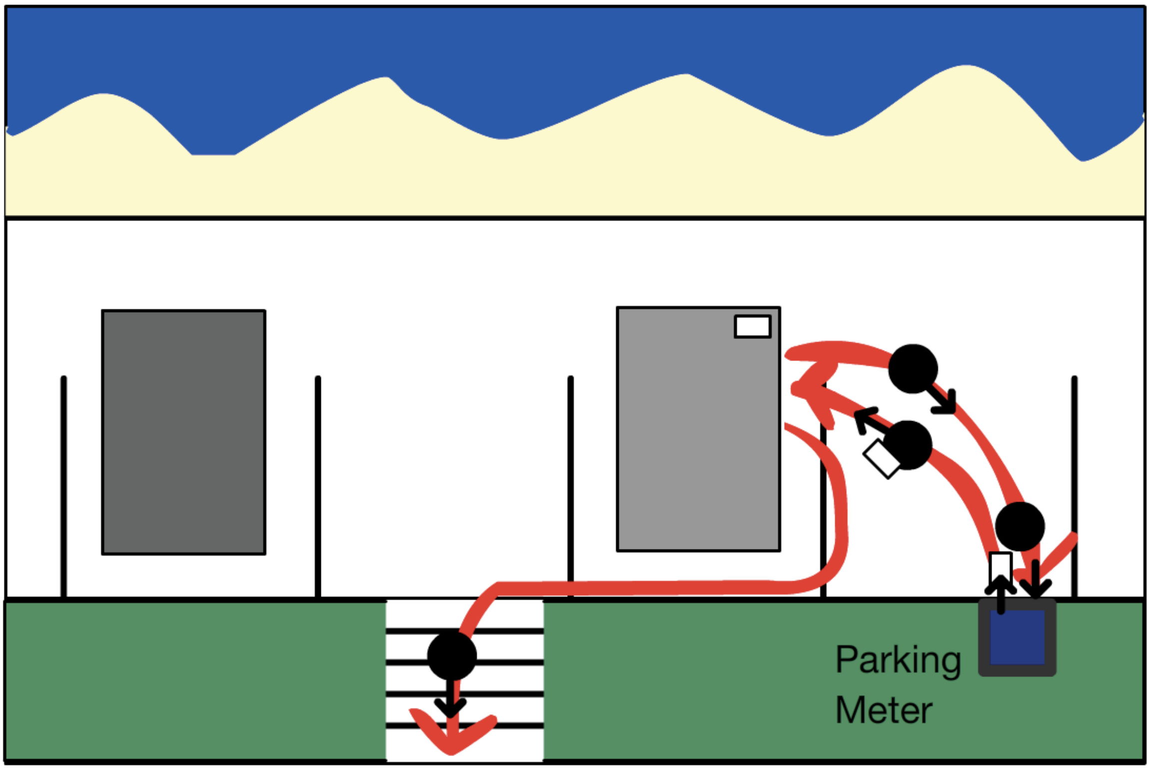


Figure 289: Heidi Physical Model Frame 16

She gets a free parking ticket from parking computer since she has a parking permission. The parking ticket computer checks her parking rights and prints a parking ticket. She takes the parking ticket and walks back to the car.

Figure 290: Heidi Physical Model Frame 17

She puts the parking ticket into car and close the car with analog keys.

Figure 291: Heidi Physical Model Frame 18

She leaves the parking lot and walks towards the shops. She crosses a street using a traffic light.

Figure 292: Heidi Physical Model Frame 19

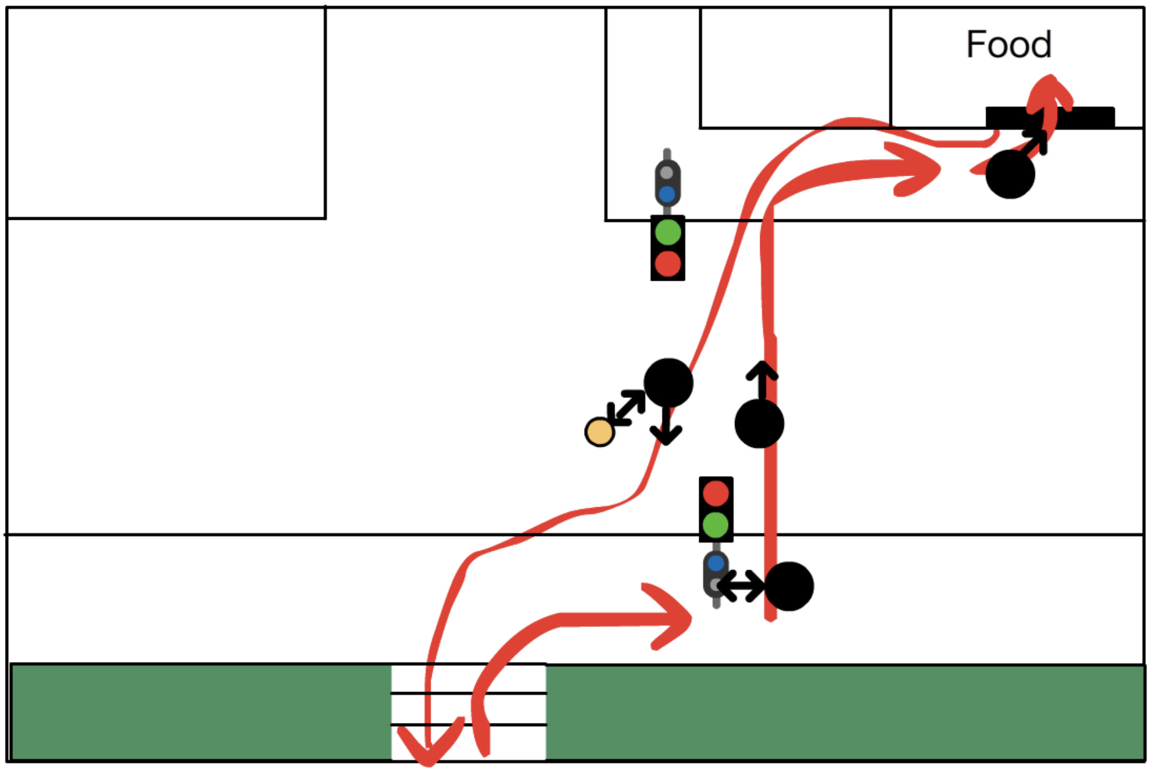


Figure 293: Heidi Physical Model Frame 20

She enters the shop and orders a sandwich.

Figure 294: Heidi Physical Model Frame 21

She pays in cash because the shop does not offer EFTPOS. She leaves the store and goes back to the beach. She again crosses the street using a traffic light.

Figure 295: Heidi Physical Model Frame 22

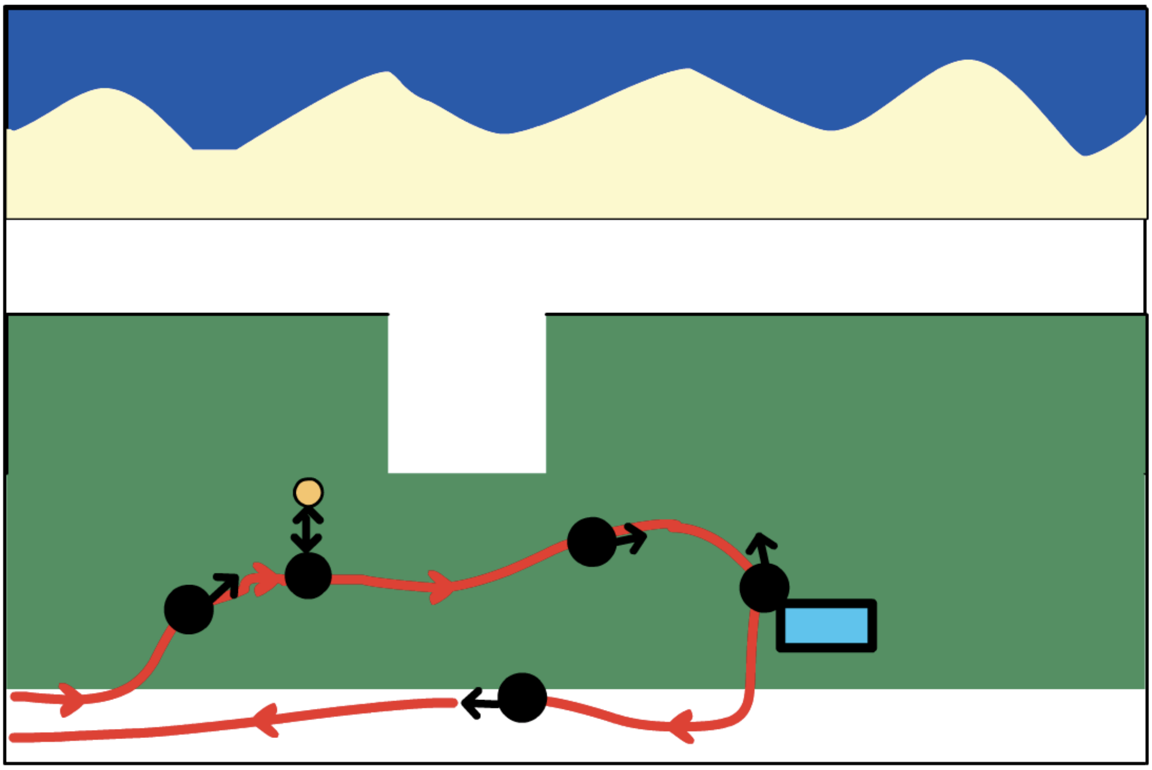


Figure 296: Heidi Physical Model Frame 23

She sits down on the grass at the beach and enjoys her lunch. She leaves her smart phone in her handbag while eating.

Figure 297: Heidi Physical Model Frame 24

She finishes her lunch, bins her leftovers and stays a bit longer on the beach looking at the ocean.

Figure 298: Heidi Physical Model Frame 25

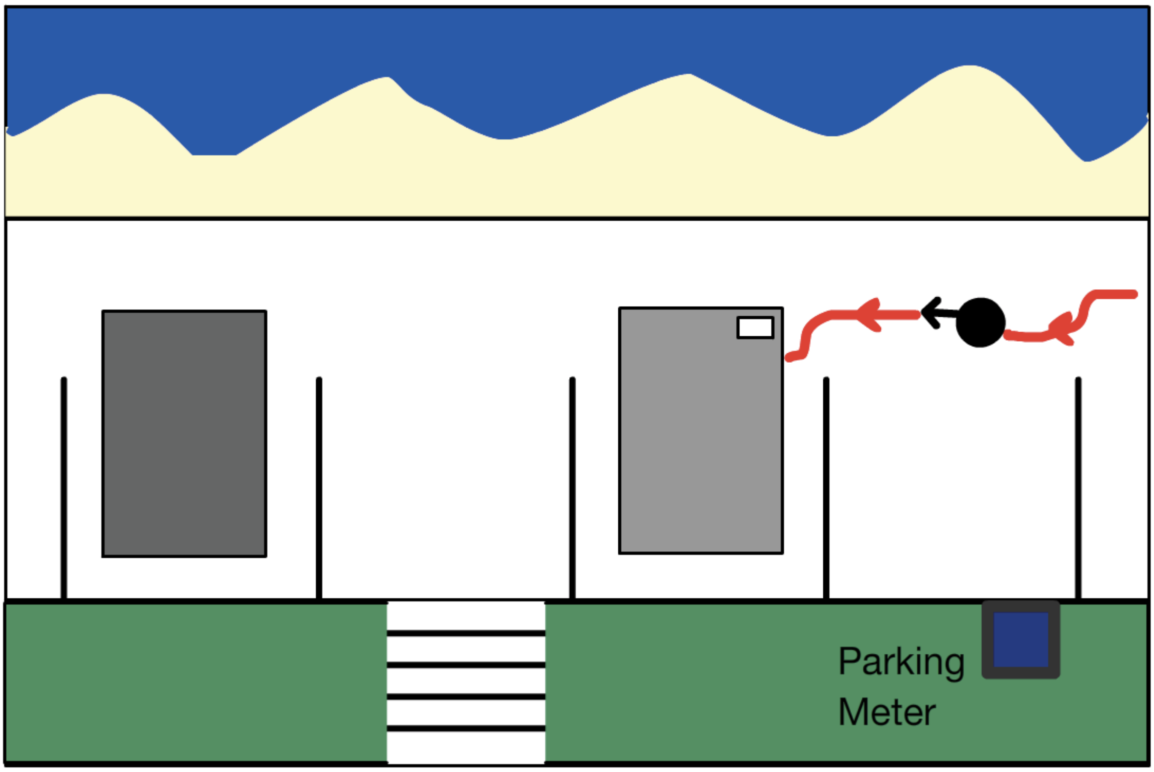


Figure 299: Heidi Physical Model Frame 26

She gets back into her car using analog keys and drives back home to get changed. She is not using her smart phone on this trip.

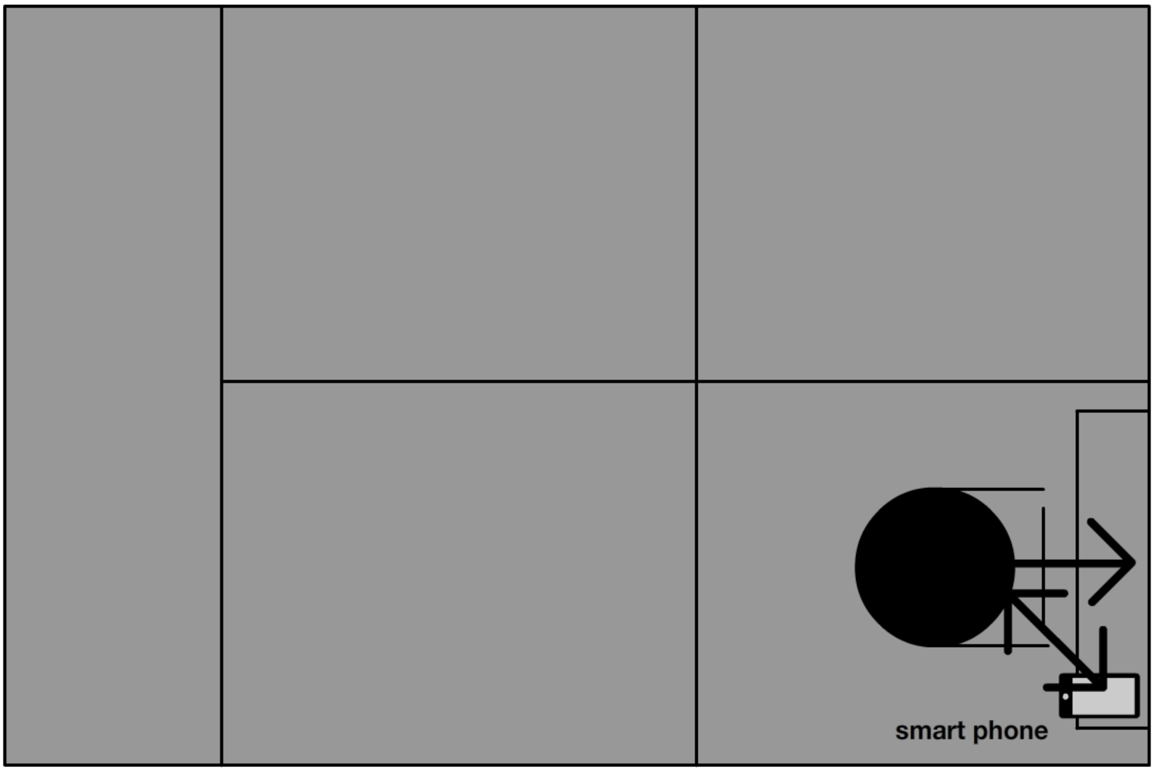


Figure 300: Heidi Physical Model Frame 27

Figure 301: Heidi Physical Model Frame 28

She parks her car, closes the car with analog keys and walks back home.

Figure 302: Heidi Physical Model Frame 29

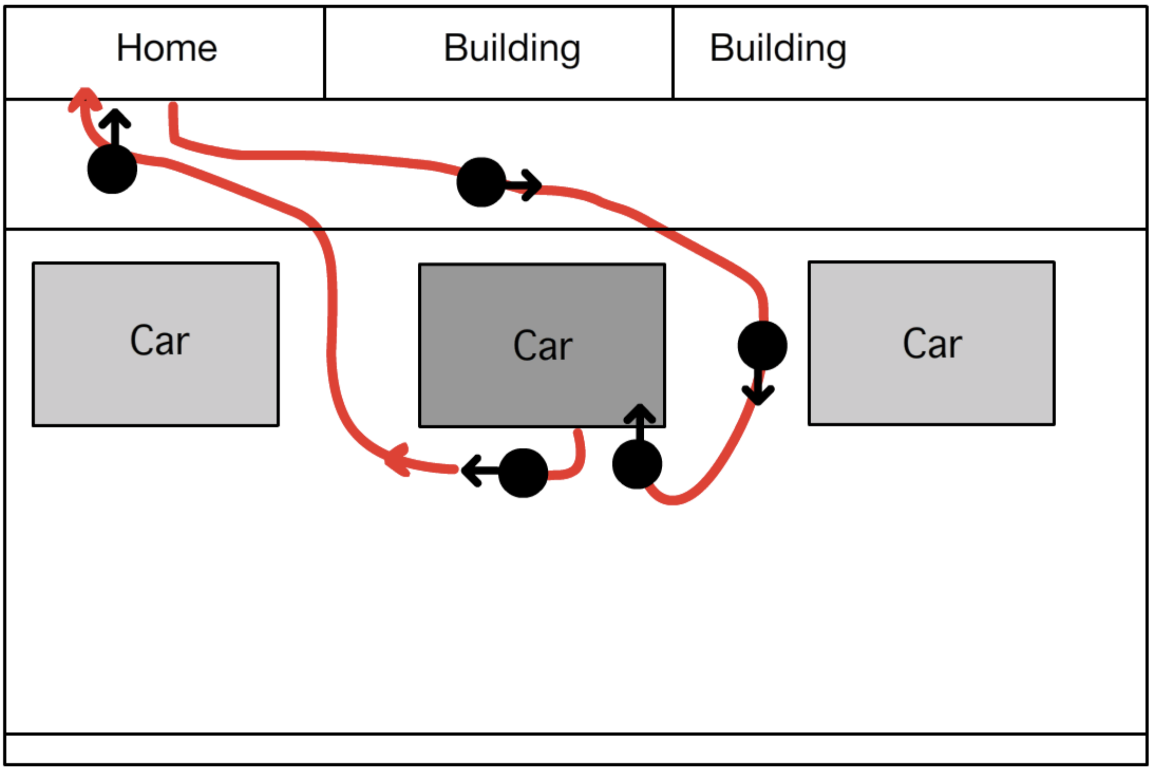


Figure 303: Heidi Physical Model Frame 30

She enters the door with a RFID swipe card.

Figure 304: Heidi Physical Model Frame 31

She leaves the house and walks back to the car.

Figure 305: Heidi Physical Model Frame 32

She gets back into the car using analog keys and checks her smart phone for messages.

Figure 306: Heidi Physical Model Frame 33

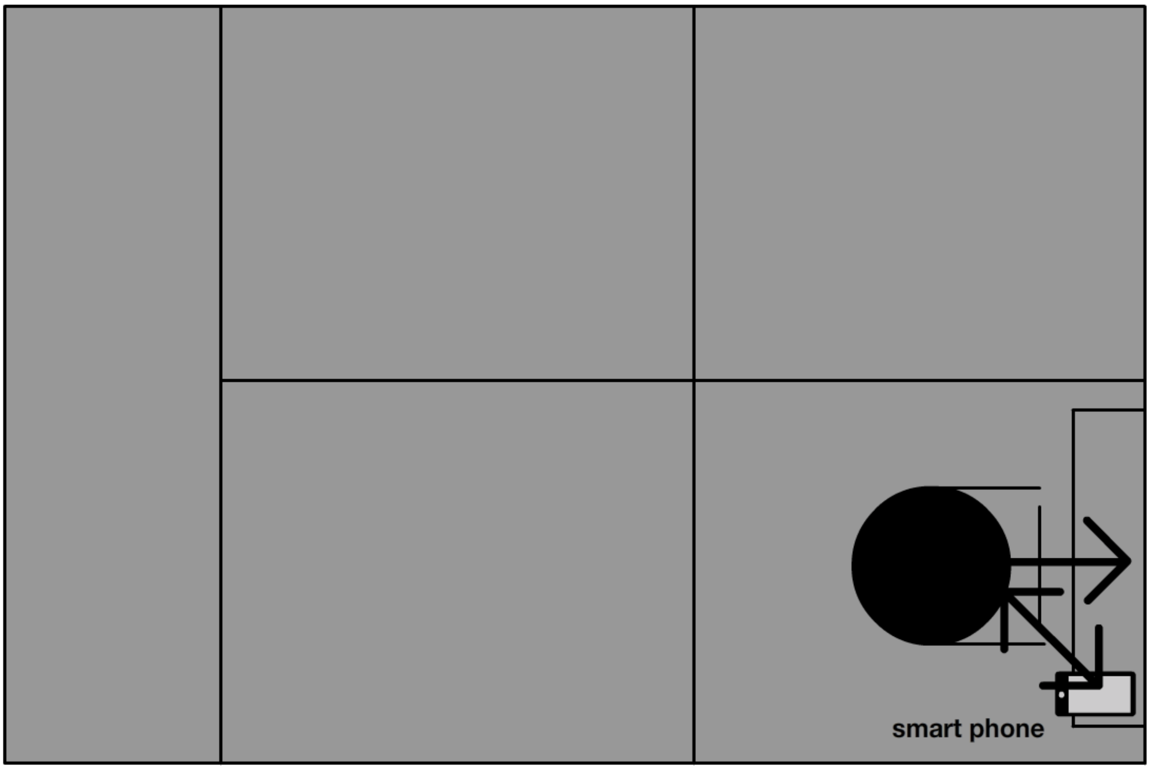


Figure 307: Heidi Physical Model Frame 34

She starts driving and switches on the radio for the first time to listen to music.

Figure 308: Heidi Physical Model Frame 35

She puts on her sunglasses while driving and does not use her smart phone while driving.

Figure 309: Heidi Physical Model Frame 36

She parks her car and gets out.

Figure 310: Heidi Physical Model Frame 37

She locks the car with analog keys and walks to work checking messages and Instagram on her smart phone while walking.

Figure 311: Heidi Physical Model Frame 38

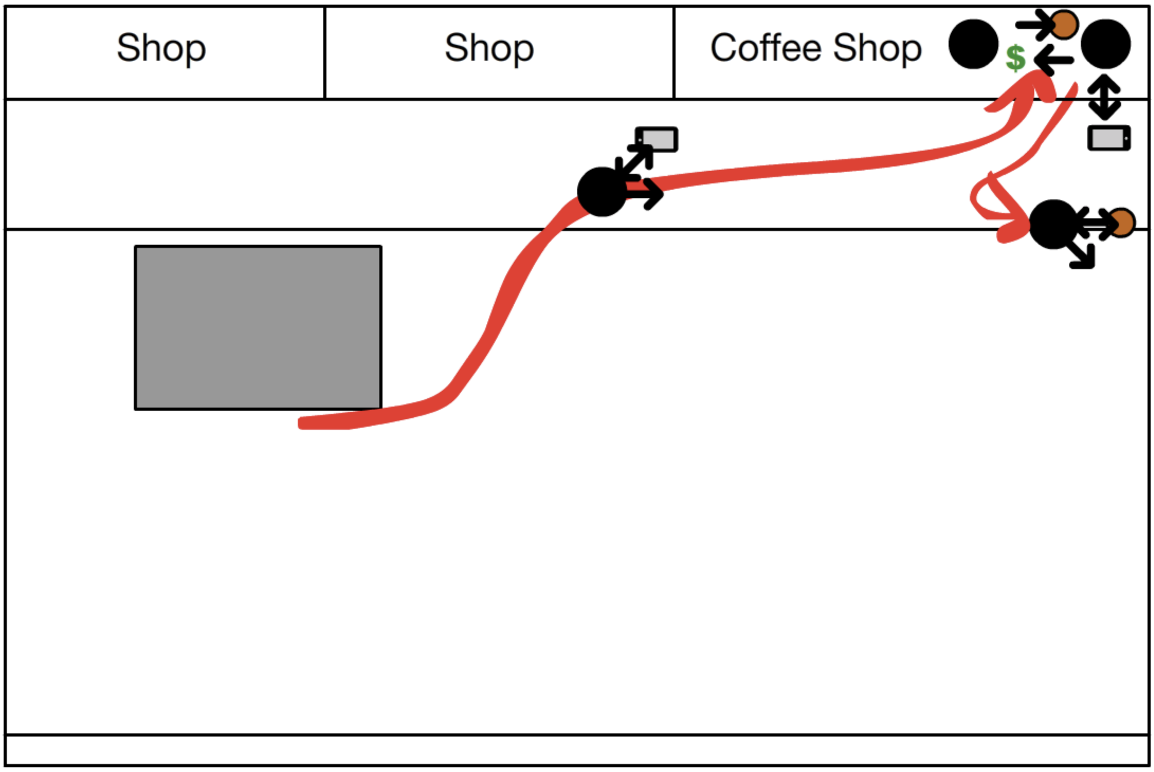


Figure 312: Heidi Physical Model Frame 39

She crosses the street and enters a coffee shop.

Figure 313: Heidi Physical Model Frame 40

She orders a coffee to-go and pays with Paypass on an EFTPOS machine.

Figure 314: Heidi Physical Model Frame 41

While she waits for her coffee she checks emails on her smart phone then picks up the coffee.

Figure 315: Heidi Physical Model Frame 42

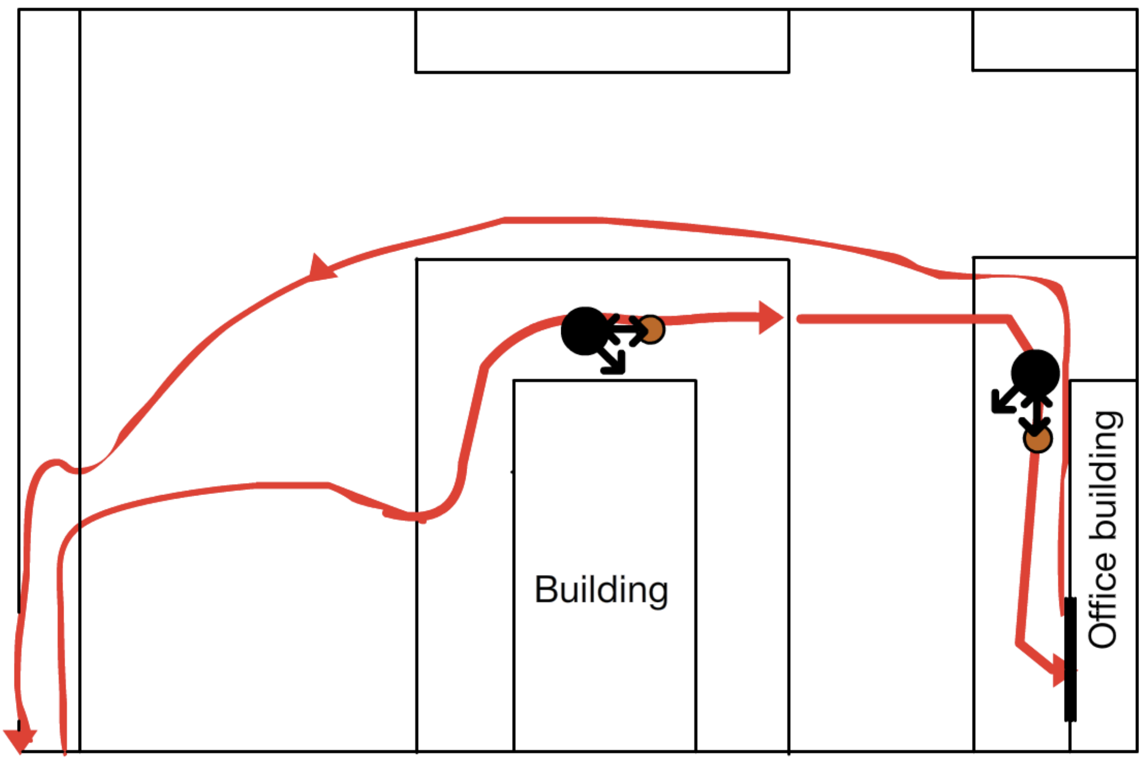


Figure 316: Heidi Physical Model Frame 43

She continuous her way to work, crosses the street and enters her workplace.

Figure 317: Heidi Physical Model Frame 44

She finishes work and closes the door with analog keys.

Figure 318: Heidi Physical Model Frame 45

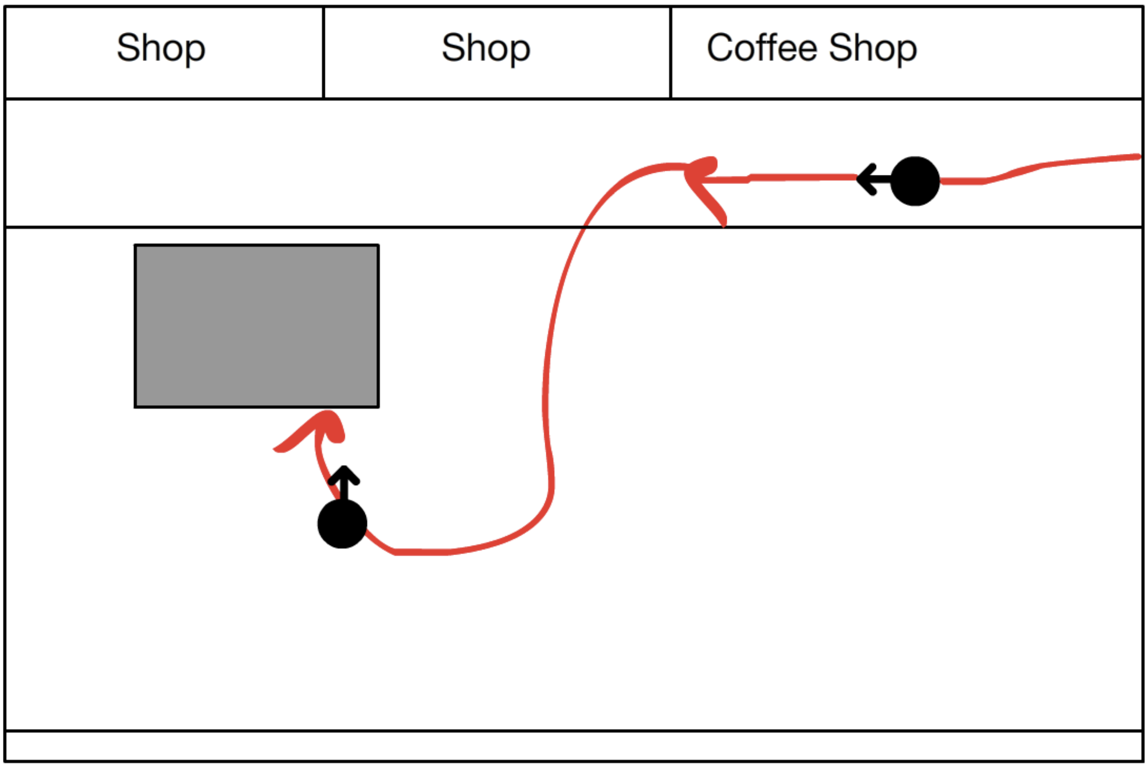


Figure 319: Heidi Physical Model Frame 46

She walks back to her car and opens the car with analog keys and gets into the car.

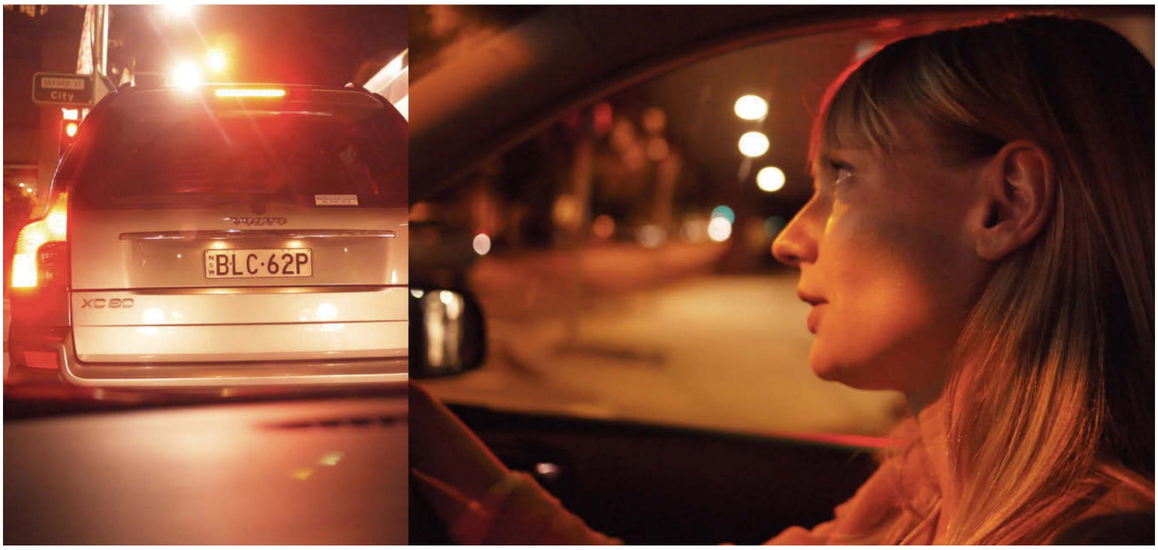


Figure 320: Heidi Physical Model Frame 47

She drives to a restaurant to have dinner. She is not using her smart phone while driving.

Figure 321: Heidi Physical Model Frame 48

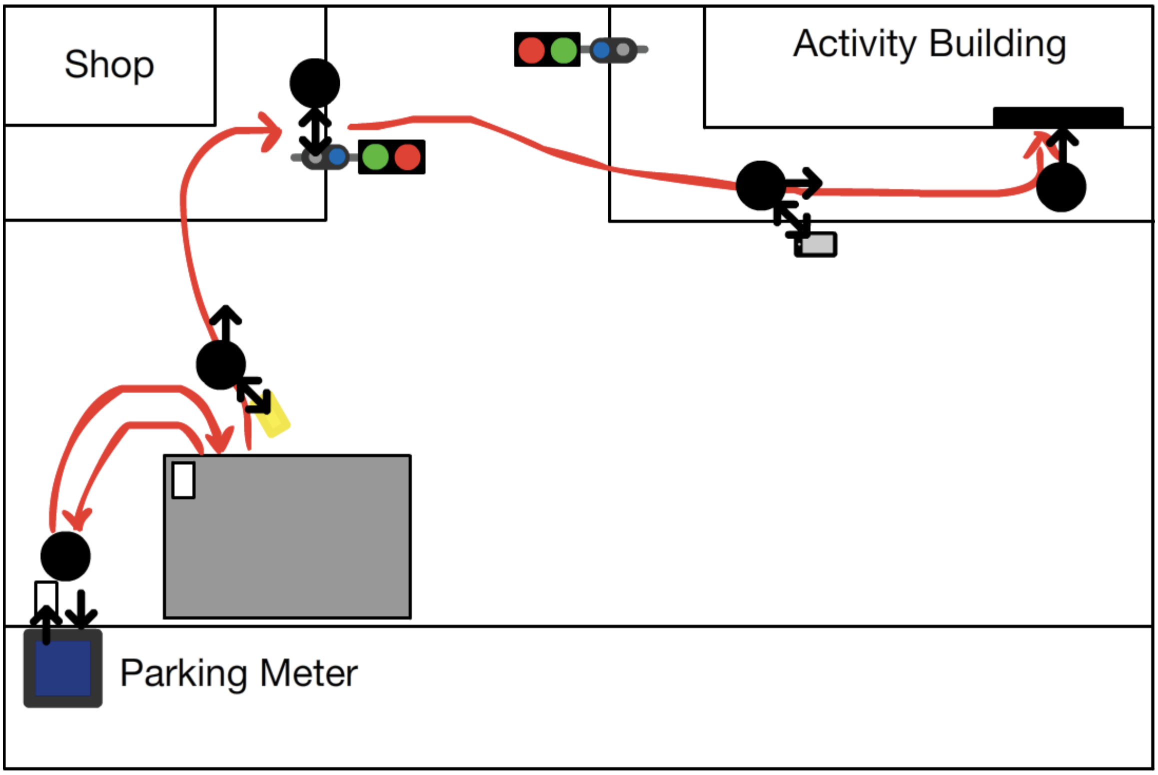


Figure 322: Heidi Physical Model Frame 49

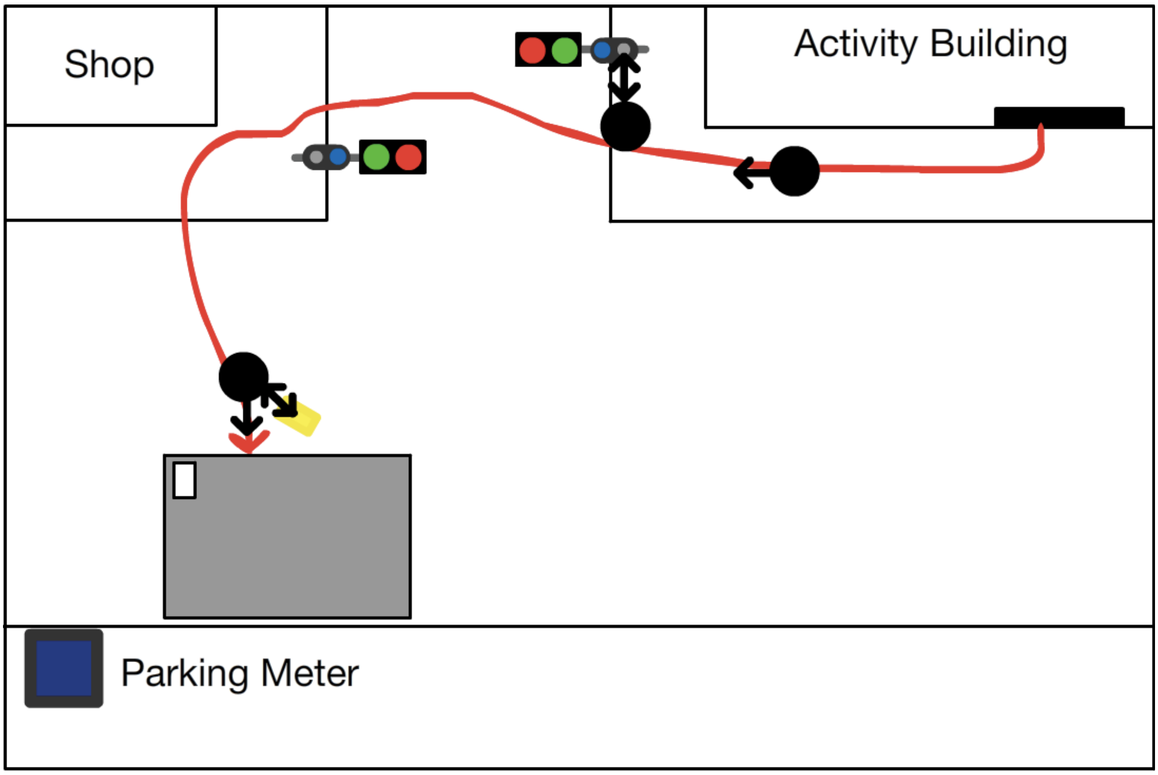


Figure 323: Heidi Physical Model Frame 50

She leaves the car gets a parking ticket from the ticket computer and puts the parking ticket back into the car.

Figure 324: Heidi Physical Model Frame 51

She locks the car and walks to the restaurant checking her messages on the way. She crosses a street using a traffic light.

Figure 325: Heidi Physical Model Frame 52

She texts on the way and stops at a flower shop to look at some flowers but does not buy anything.

Figure 326: Heidi Physical Model Frame 53

She arrives at a Sushi restaurant and waits for a table.

Figure 327: Heidi Physical Model Frame 54

She then eats Sushi.

Figure 328: Heidi Physical Model Frame 55

When finished at the restaurant she walks back to the car. Crosses the street again using a traffic light then arrives at the car and unlocks the car using analog keys.

Figure 329: Heidi Physical Model Frame 56

She gets in the car. Starts the car and drives back home.

Figure 330: Heidi Physical Model Frame 57

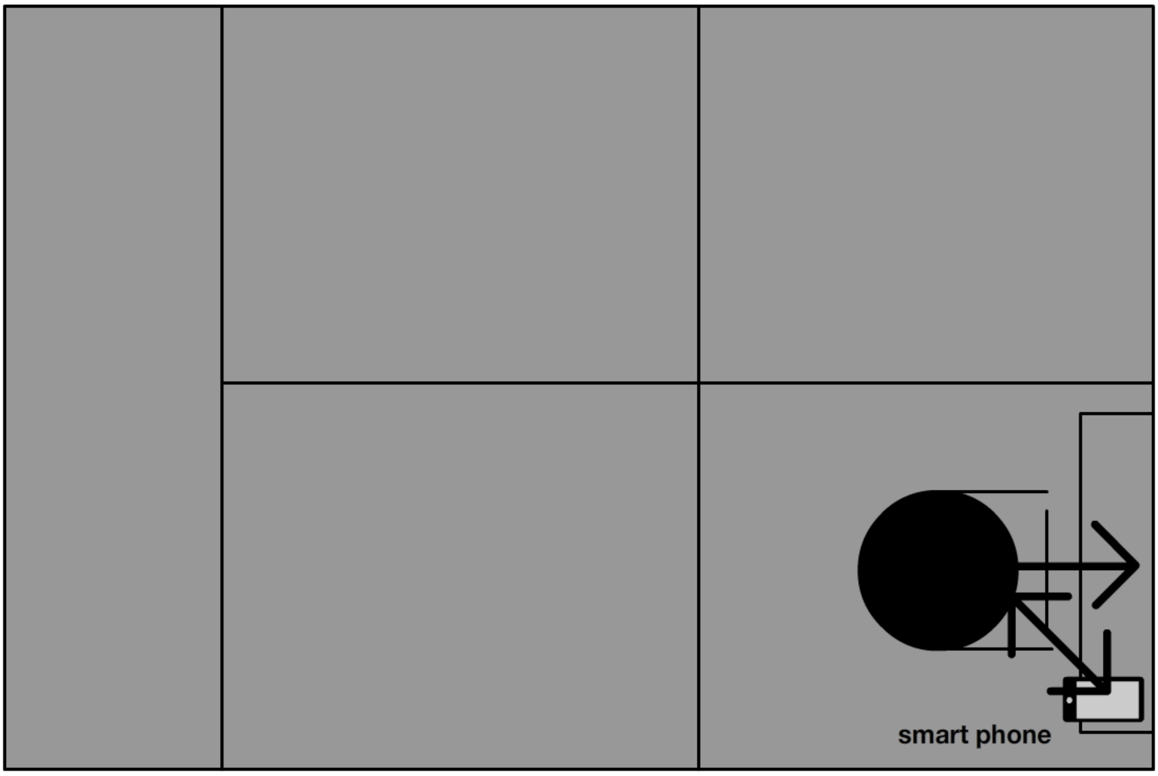


Figure 331: Heidi Physical Model Frame 58

She switches on the radio while driving.

Figure 332: Heidi Physical Model Frame 59

She parks the car and gets out.

Figure 333: Heidi Physical Model Frame 60

She locks the car using analog keys and walks home.

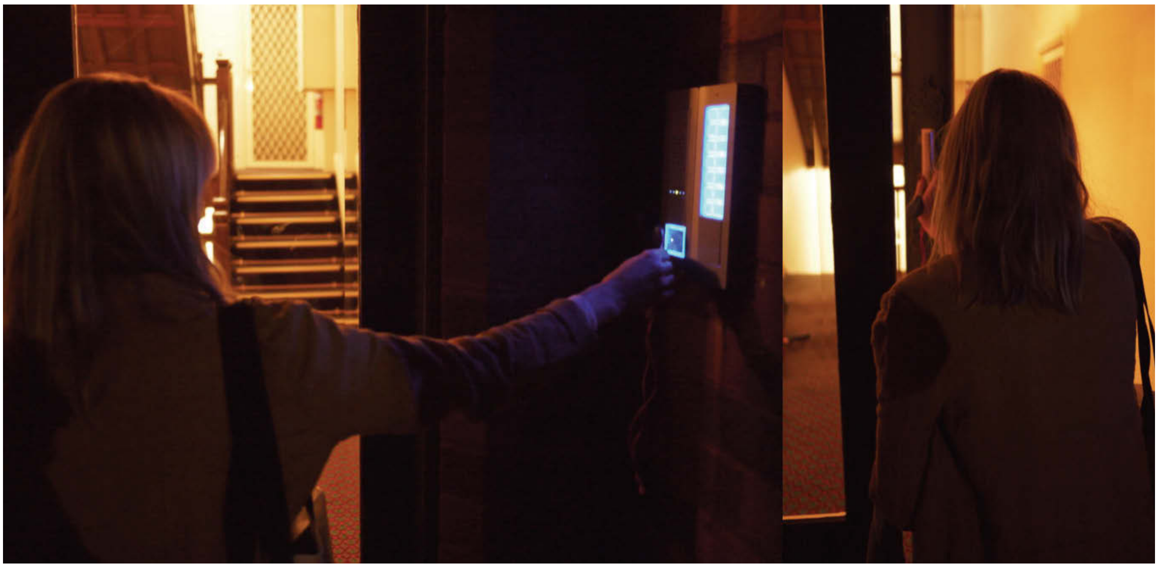


Figure 334: Heidi Physical Model Frame 61

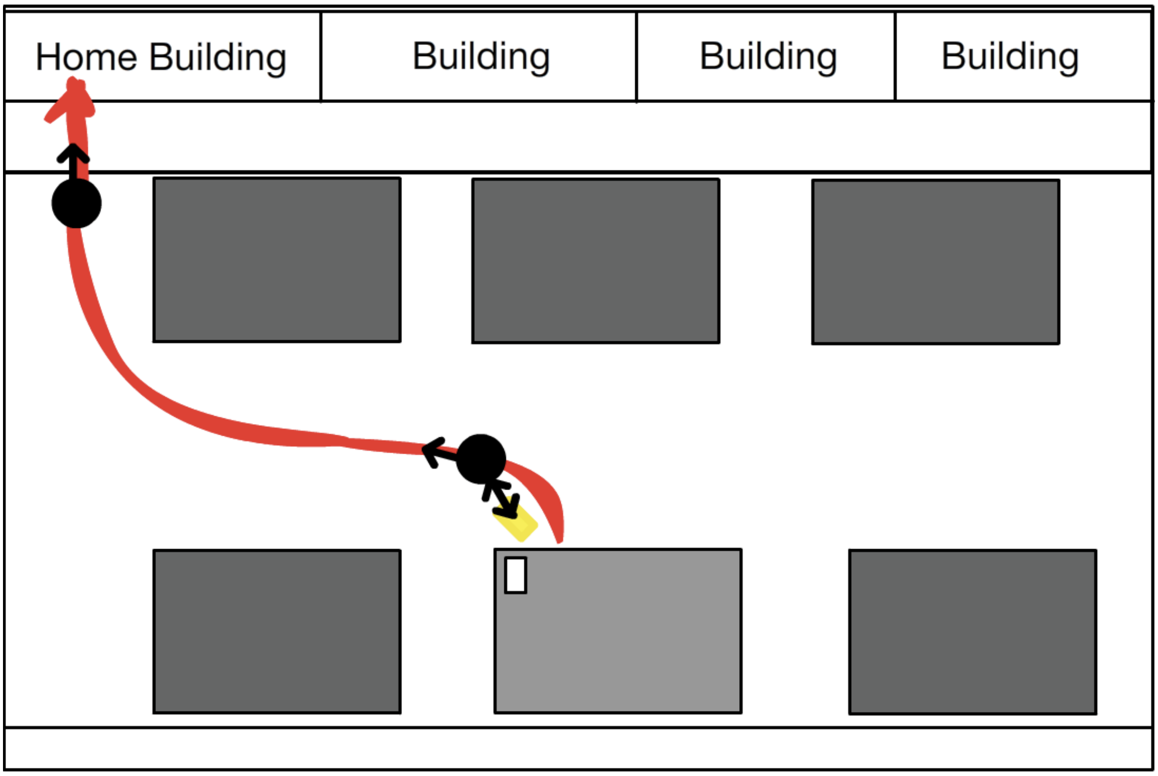


Figure 335: Heidi Physical Model Frame 62

When she arrives at home she unlocks the door with a RFID smart card and enters her home.

Circle Flow Model:

The Circle Flow model is an overview of Heidi's data of her everyday interactions.

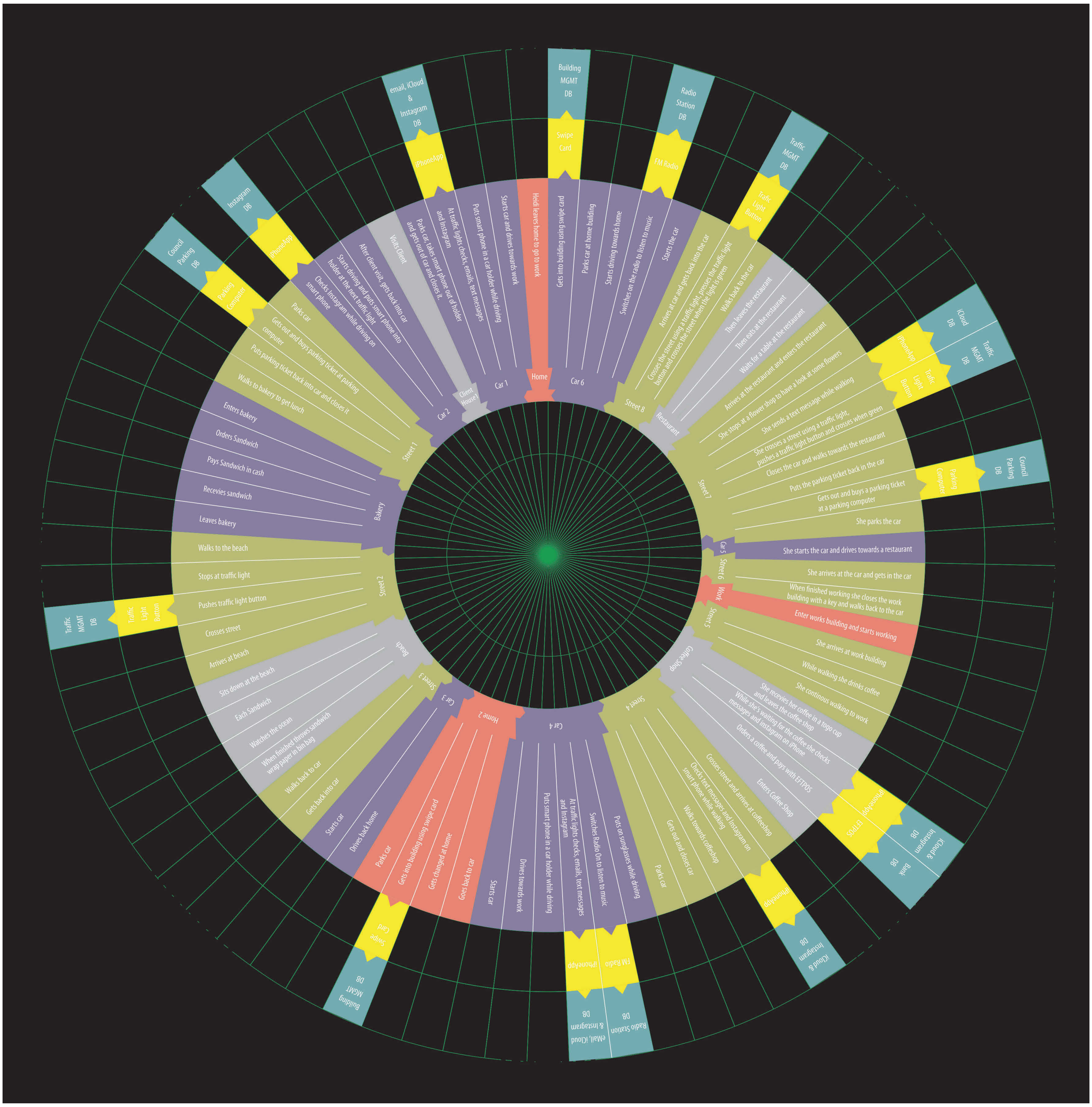


Figure 336: Heidi Circle Flow Model

1.2.20 Individual Data Models - Ralph (Flexible worker using Private Transport)- Circle Flow & Physical Model

The tenth participant researched was Ralph who uses private transport and has a flexible job in the neighbourhood of Bondi Beach in Sydney.

Physical Model:

The physical model show's Ralph's interactions situated in the physical environment and within the narrative of his day over time.

Figure 336: Ralph Physical Model Frame 1

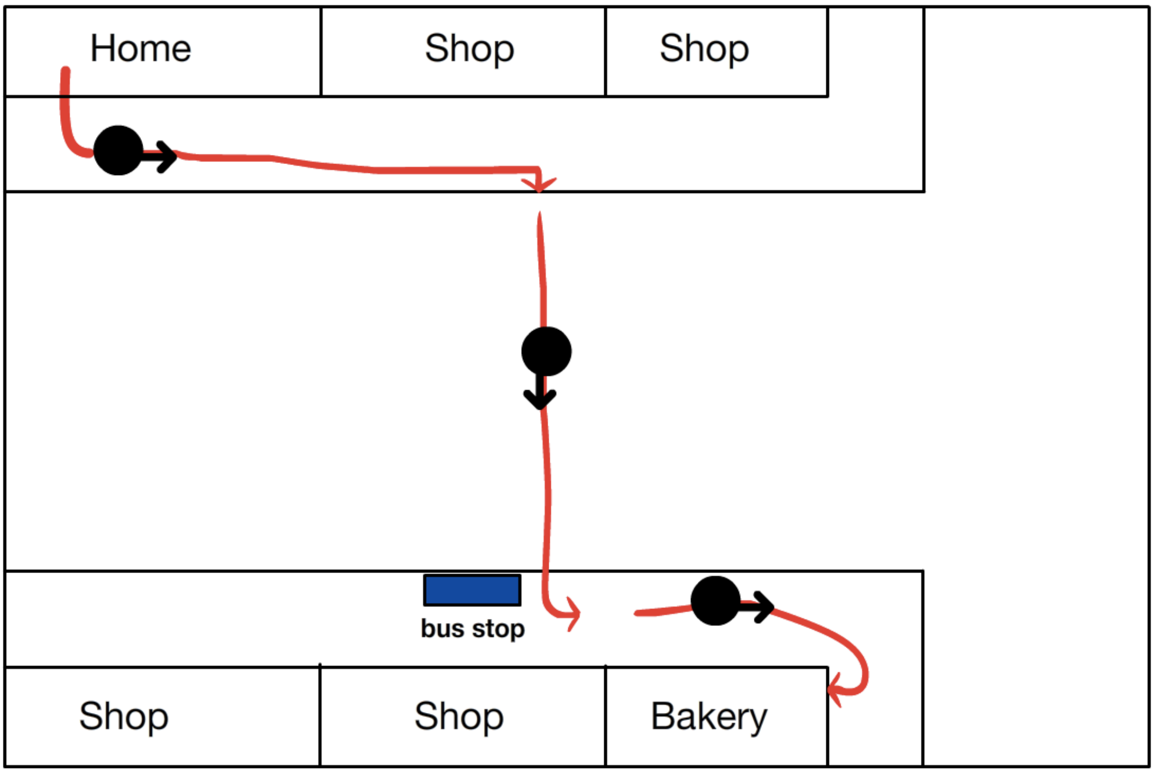


Figure 337: Ralph Physical Model Frame 2

Ralph gets out of his house to get a coffee.

Figure 338: Ralph Physical Model Frame 3

He walks towards a coffee shop through the streets of Bondi.

Figure 339: Ralph Physical Model Frame 4

At the coffee shop he orders a coffee and pays with Paypass using an EFTPOS machine.

Figure 340: Ralph Physical Model Frame 5

He sits down at a window table and reads a paper based street press newspaper while waiting for his coffee. He receives his coffee and puts sugar in.

Figure 341: Ralph Physical Model Frame 6

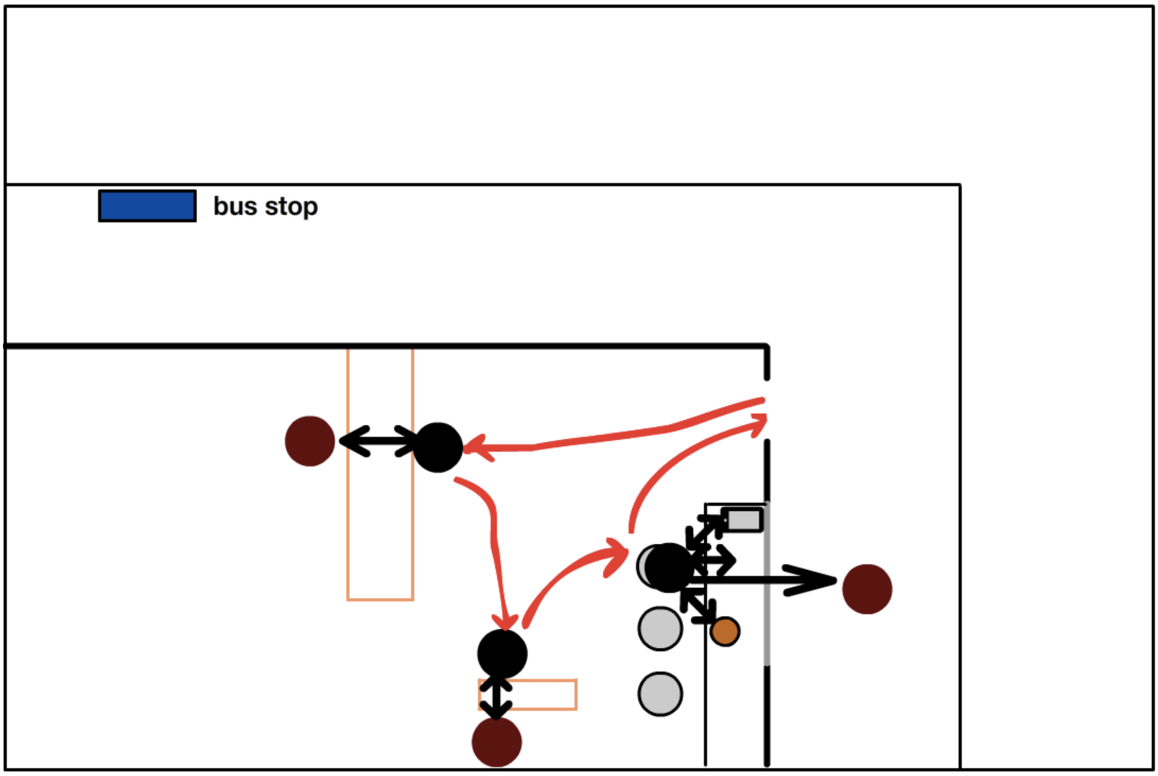


Figure 342: Ralph Physical Model Frame 7

He keeps reading the newspaper, then switches to his iPhone to check and answer some emails, while drinking coffee.

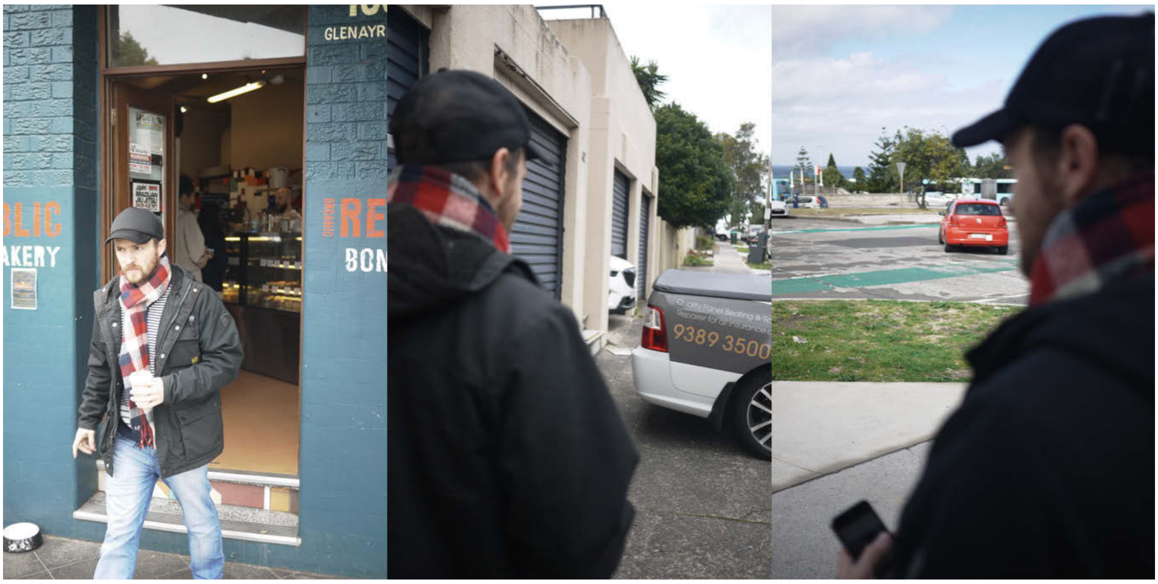


Figure 343: Ralph Physical Model Frame 8

He leaves the coffee shop and walks to the beach to check the waves if he can go surfing. He takes his coffee cup with him.

Figure 344: Ralph Physical Model Frame 9

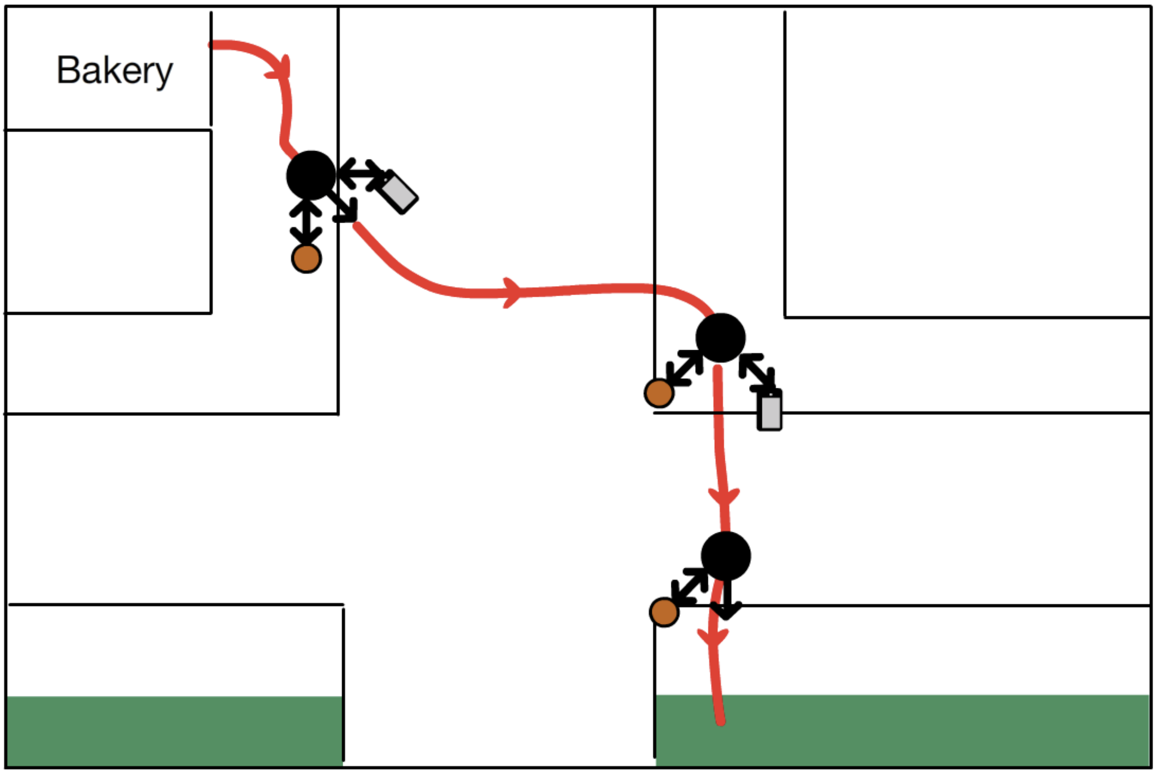


Figure 345: Ralph Physical Model Frame 10

He stops half way to the beach to delete his photos on his iPhone because his phone is too slow and he thinks that if he deletes photos on his iPhone it will be faster again, he stands there for 5 minutes doing that and drinking coffee at the same time.

Figure 346: Ralph Physical Model Frame 11

Once finished deleting he crosses the street and continuous to walk to the beach.

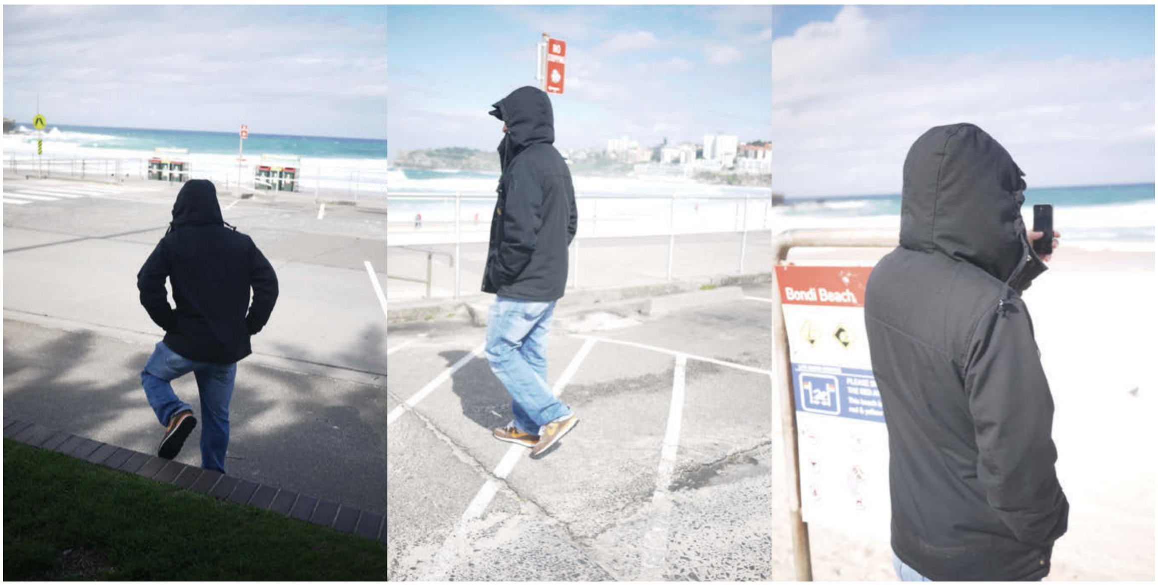


Figure 347: Ralph Physical Model Frame 12

He arrives at the beach, checks the waves and takes a photo of the surf and posts it on Instagram.

Figure 348: Ralph Physical Model Frame 13

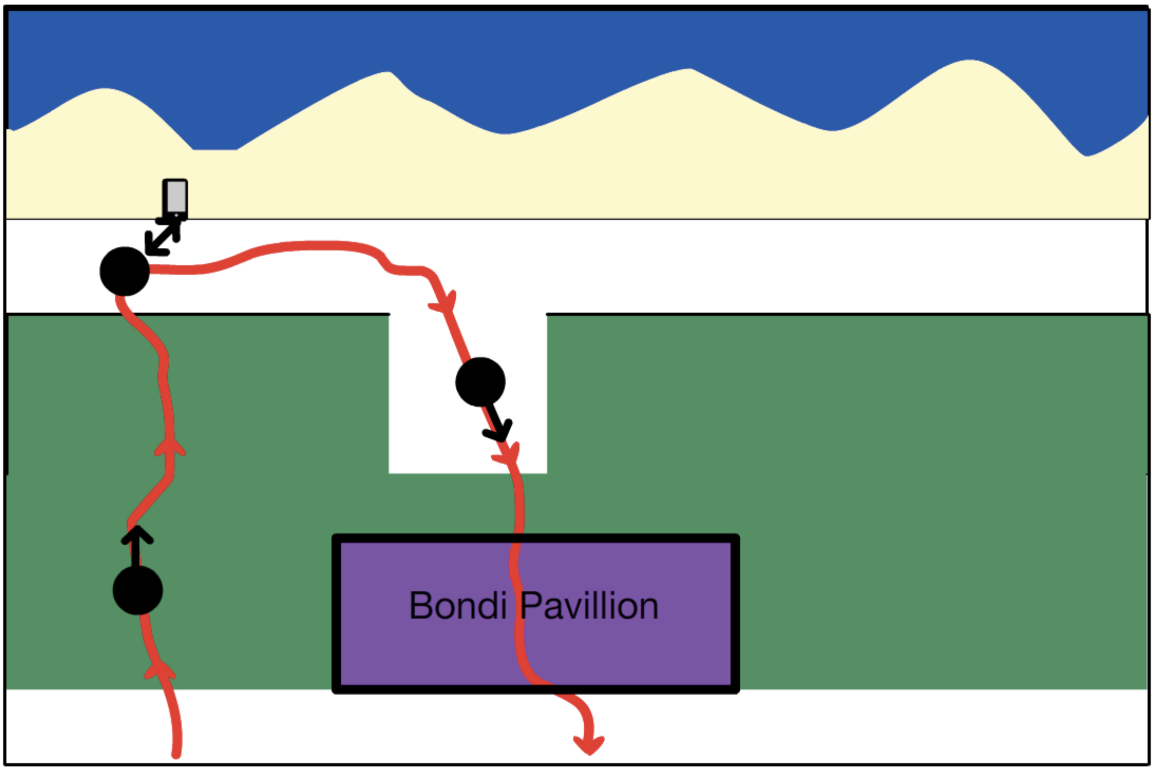


Figure 349: Ralph Physical Model Frame 14

He figures that the tide is too high for surfing and checks when the tide will be low and decides to go later when the tide is lower and walks back home.

Figure 350: Ralph Physical Model Frame 15

He walks through Bondi Pavilion to take a short cut.

Figure 351: Ralph Physical Model Frame 16

He leaves Bondi Pavilion and continues to walk home.

Figure 352: Ralph Physical Model Frame 17

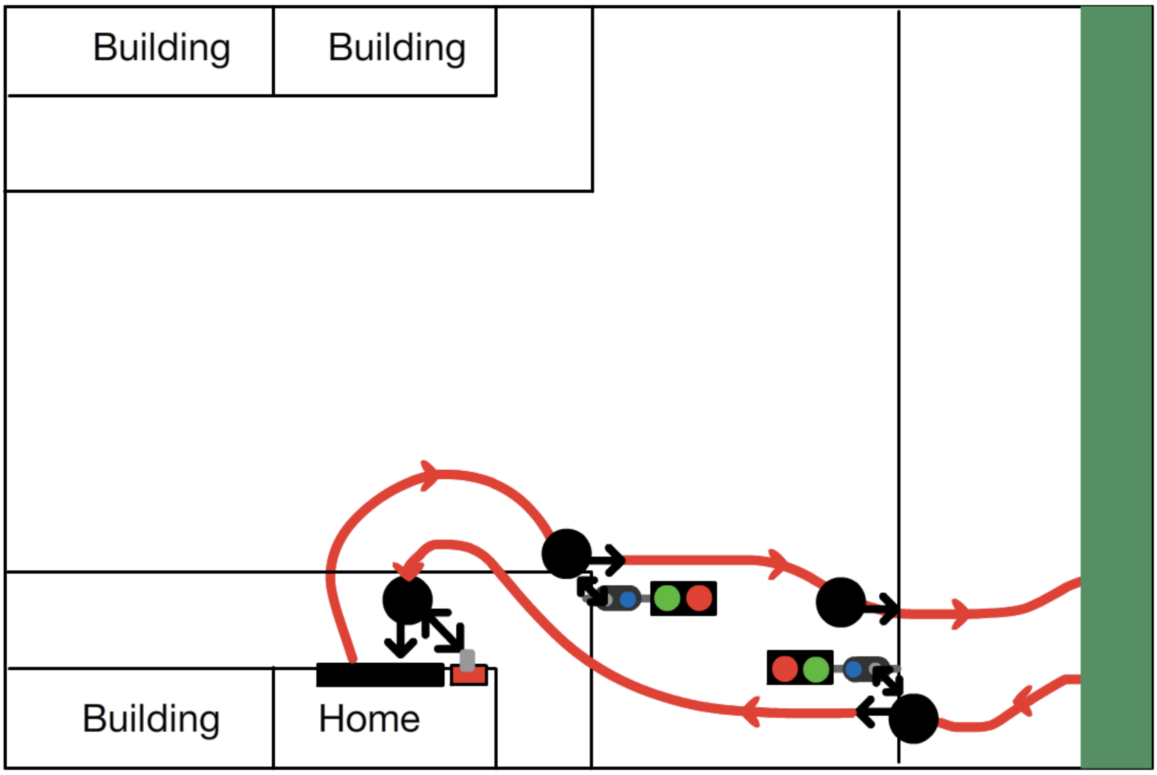


Figure 353: Ralph Physical Model Frame 18

He crosses the street using a traffic light.

Figure 354: Ralph Physical Model Frame 19

When he arrives at home he enters the building with a RFID swipe card.

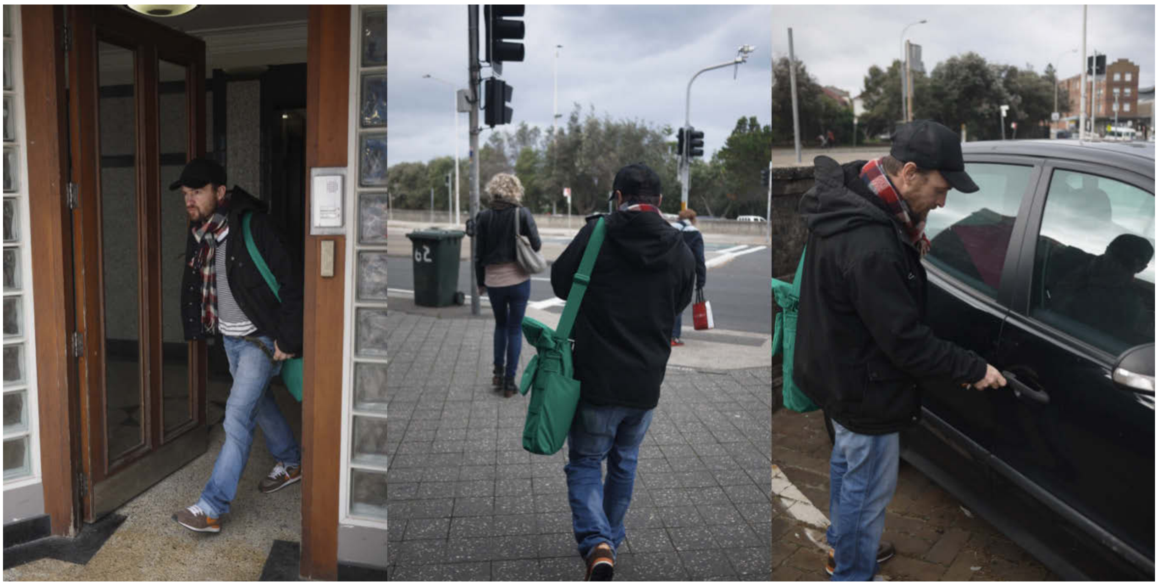


Figure 355: Ralph Physical Model Frame 20

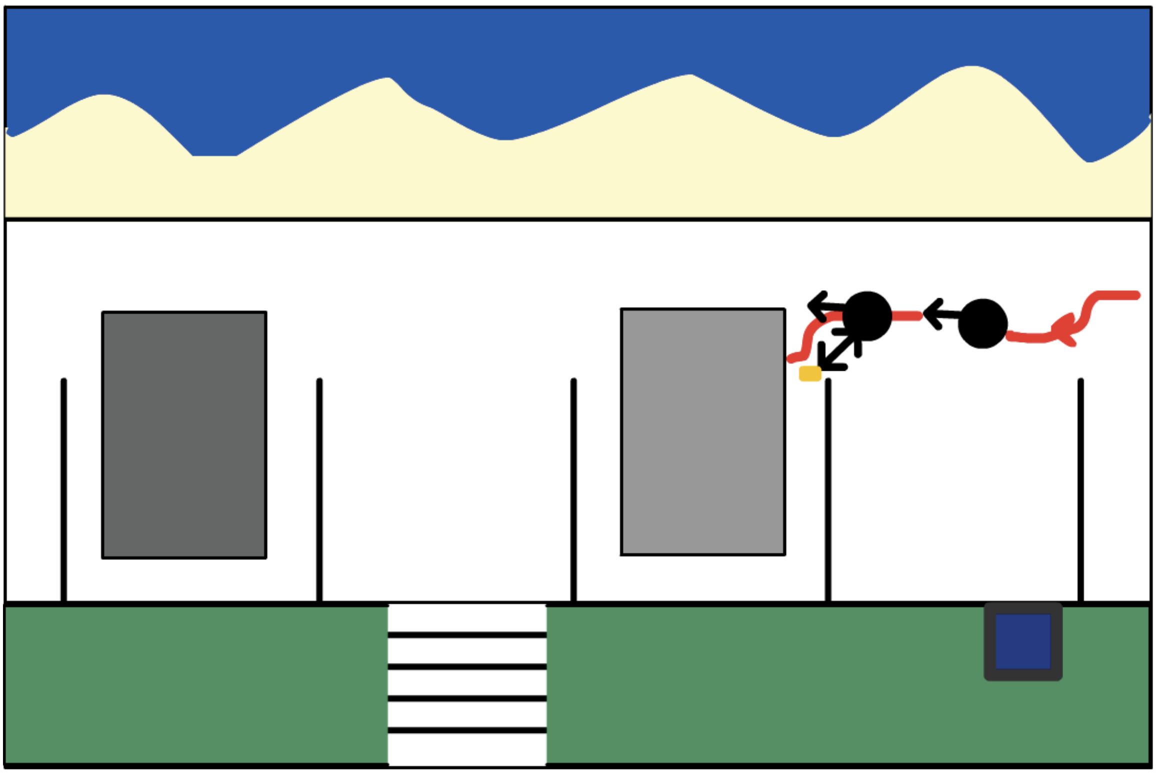


Figure 356: Ralph Physical Model Frame 21

After working for four hours at home he leaves the house again and walks to the car.

Figure 357: Ralph Physical Model Frame 22

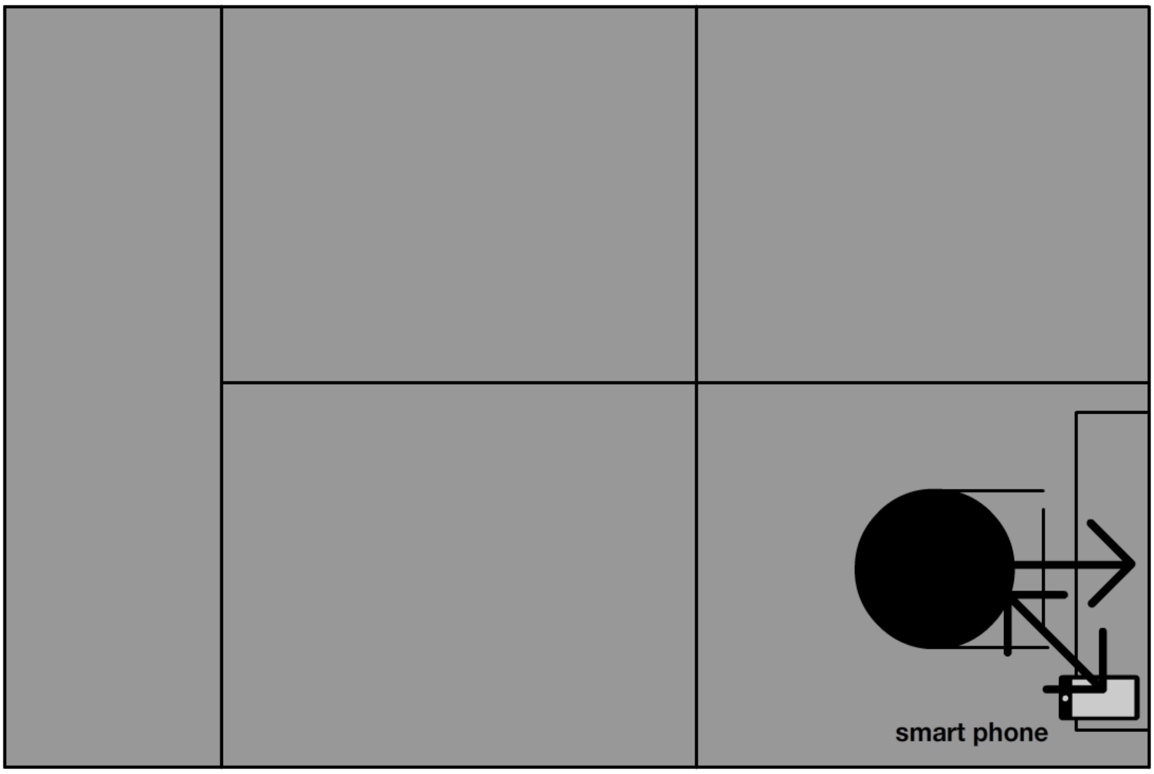


Figure 358: Ralph Physical Model Frame 23

He opens the car with a remote control and gets into the car and drives to the shops. He is eating lollies while driving which he thinks are good for his throat.

Figure 359: Ralph Physical Model Frame 24

Ralph then parks and gets out of car.

Figure 360: Ralph Physical Model Frame 25

He gets a parking ticket at the parking ticket computer.

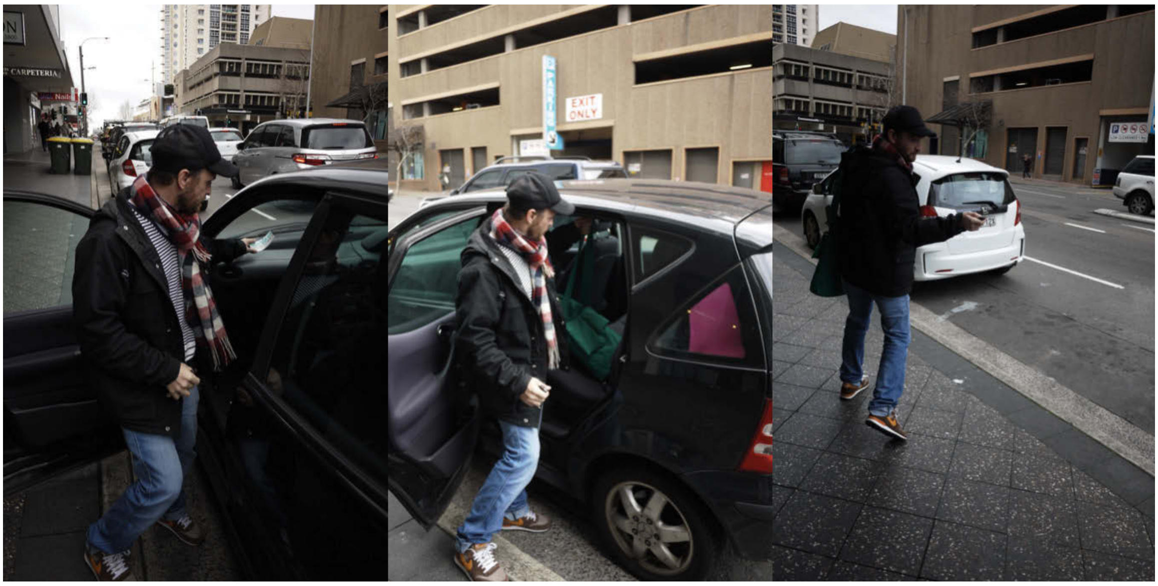


Figure 361: Ralph Physical Model Frame 26

He puts the ticket back into the car, gets his bag out of the car and closes the car with a remote control.

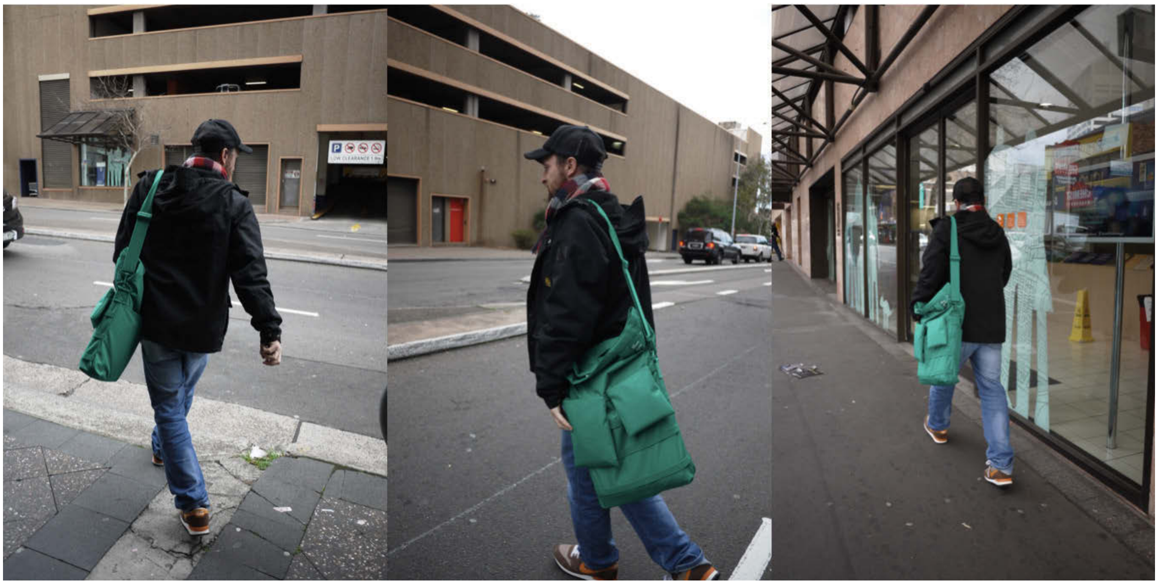


Figure 362: Ralph Physical Model Frame 27

The crosses the street and walks to the Waverly City Council.

Figure 363: Ralph Physical Model Frame 28

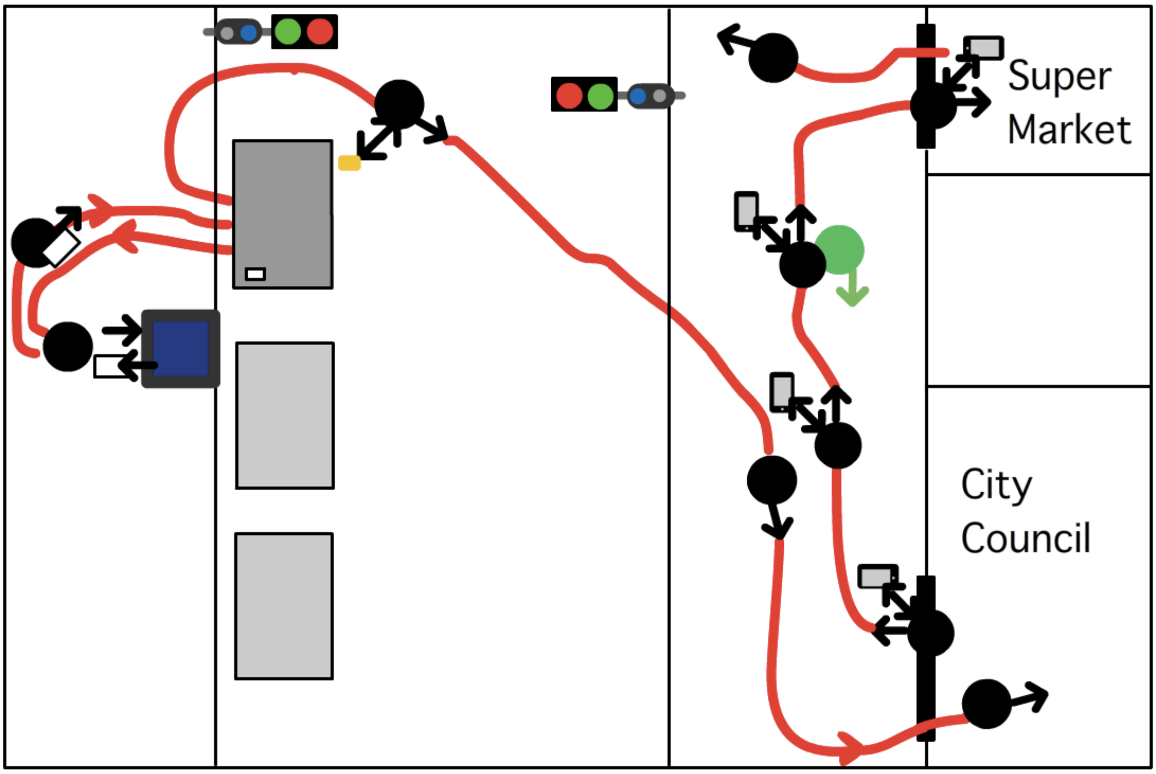


Figure 364: Ralph Physical Model Frame 29

He enters the Waverly City Council through sliding doors.

Figure 365: Ralph Physical Model Frame 30

When finished he leaves Waverly City Council and walks away interacting with his iPhone. He bumps into another person because he is interacting with his iPhone.

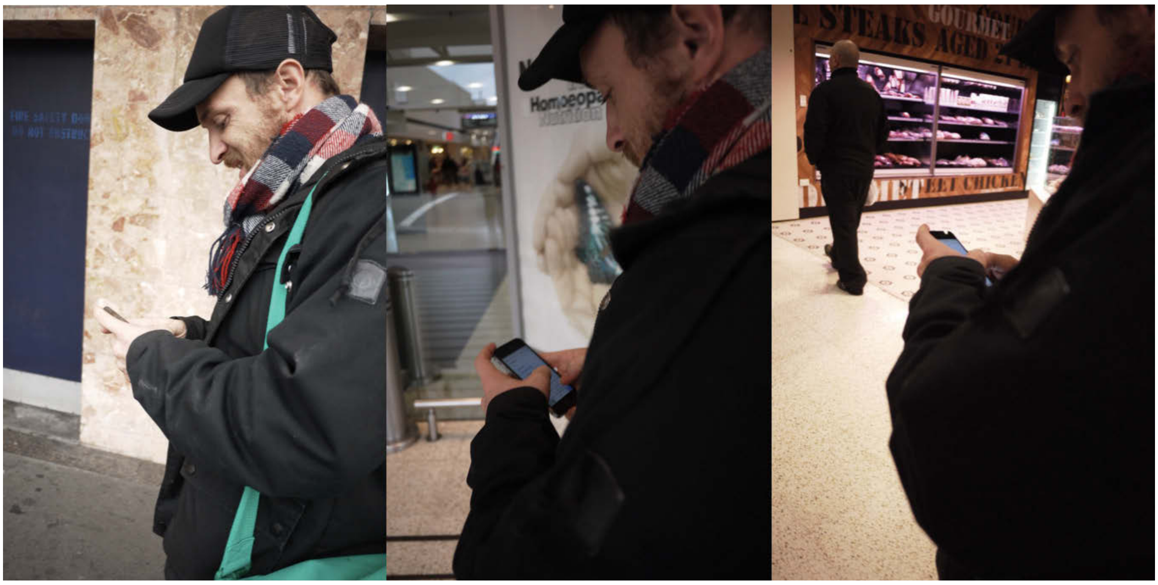


Figure 366: Ralph Physical Model Frame 31

Ralph keeps interacting with his iPhone while walking towards a mall entrance. He enters the mall and supermarket checking on his iPhone what groceries he needs to buy.

Figure 367: Ralph Physical Model Frame 32

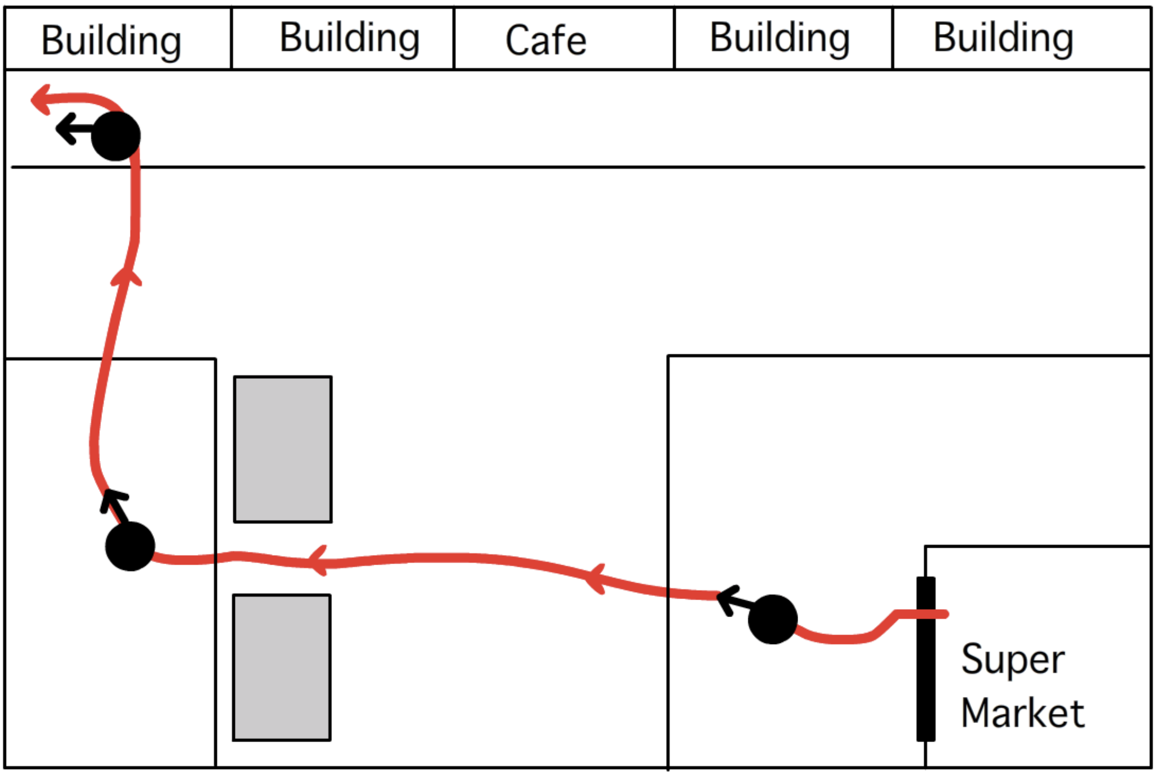


Figure 368: Ralph Physical Model Frame 33

After finishing grocery shopping he leaves the mall and walks towards his bank branch to do some banking.

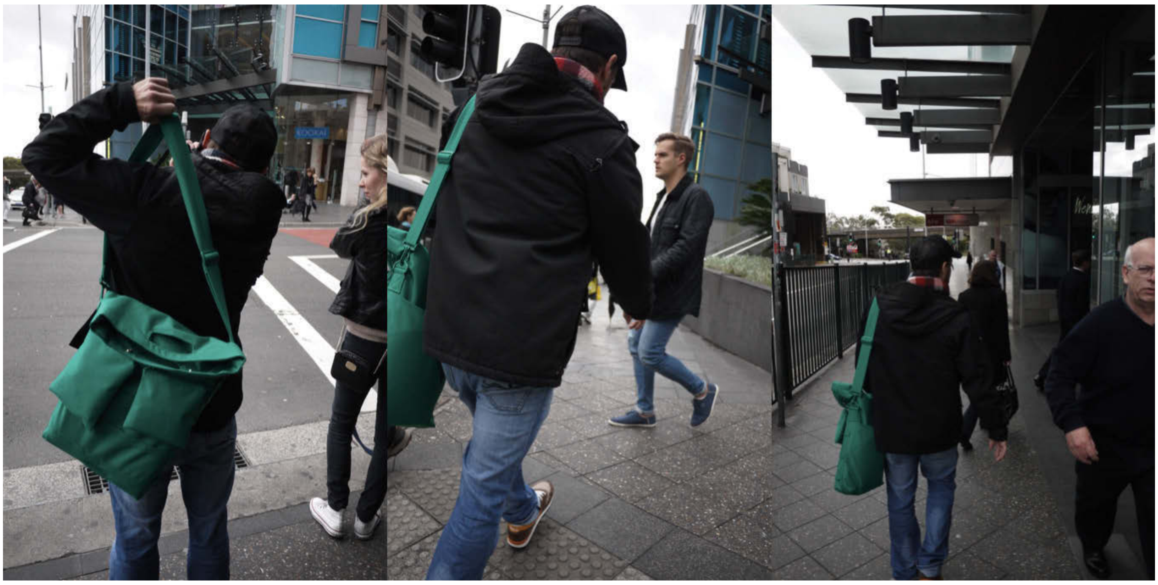


Figure 369: Ralph Physical Model Frame 34

He crosses several streets using traffic lights.

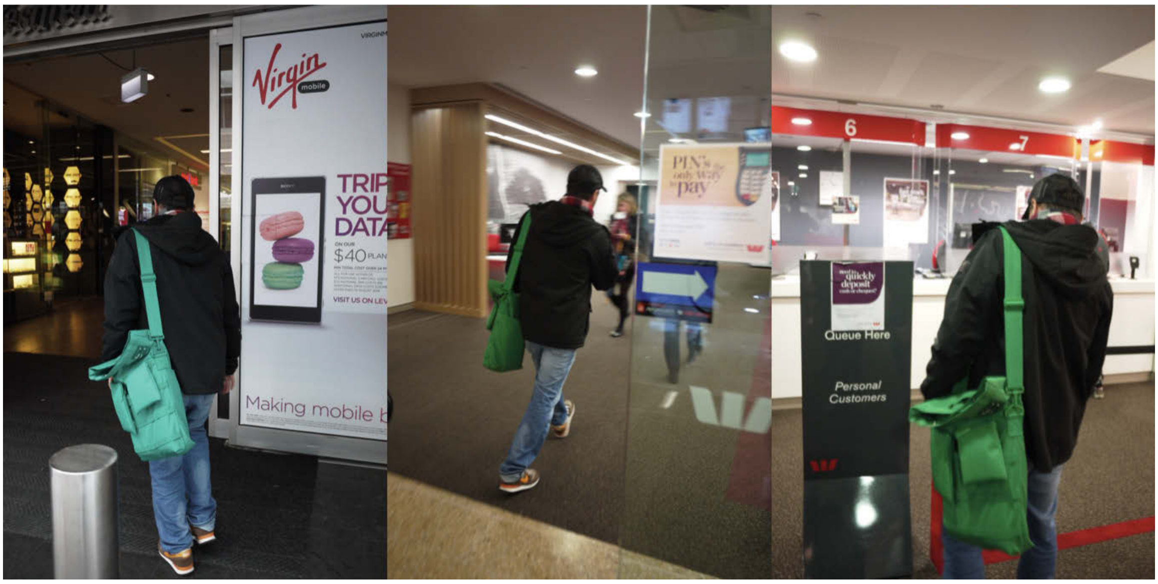


Figure 370: Ralph Physical Model Frame 35

He then enters another mall and walks into his bank branch.

Figure 371: Ralph Physical Model Frame 36

When finished banking he leaves the mall and walks back towards his car crossing a red traffic light.

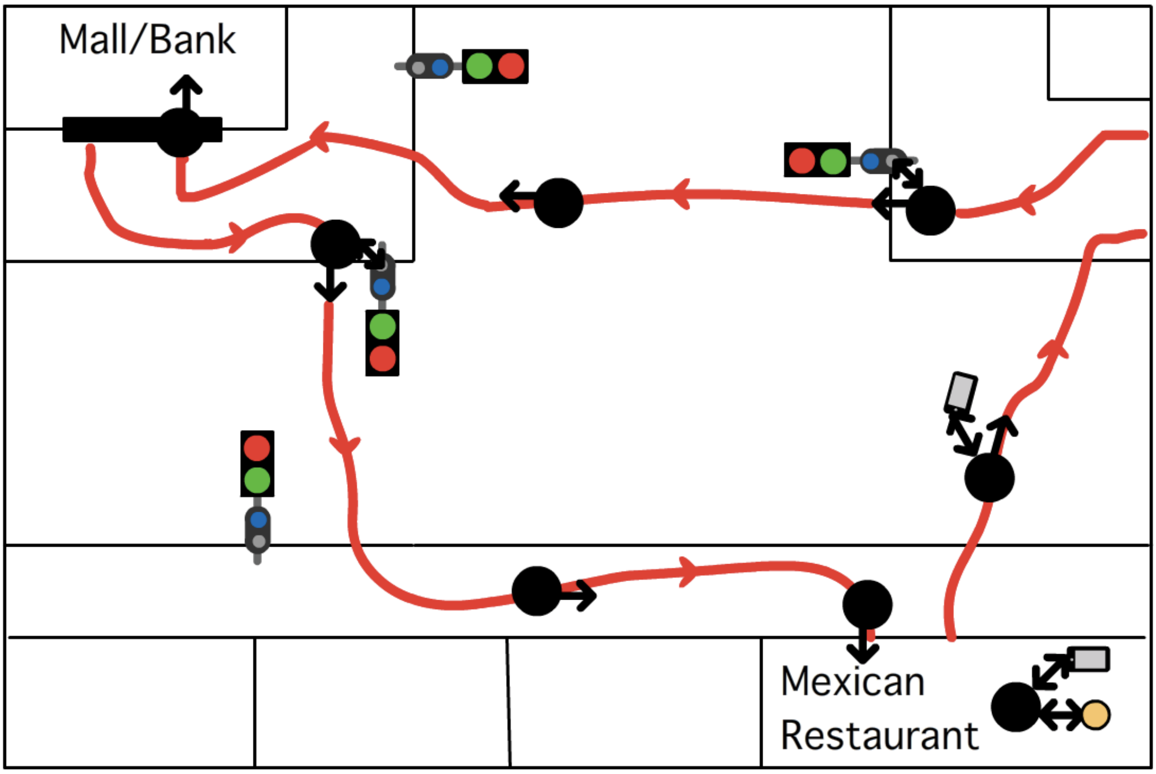


Figure 372: Ralph Physical Model Frame 37

Figure 373: Ralph Physical Model Frame 38

On the way back to his car he stops at a Mexican fast food restaurant to get some lunch. He orders a burrito and a can of soda and pays in cash.

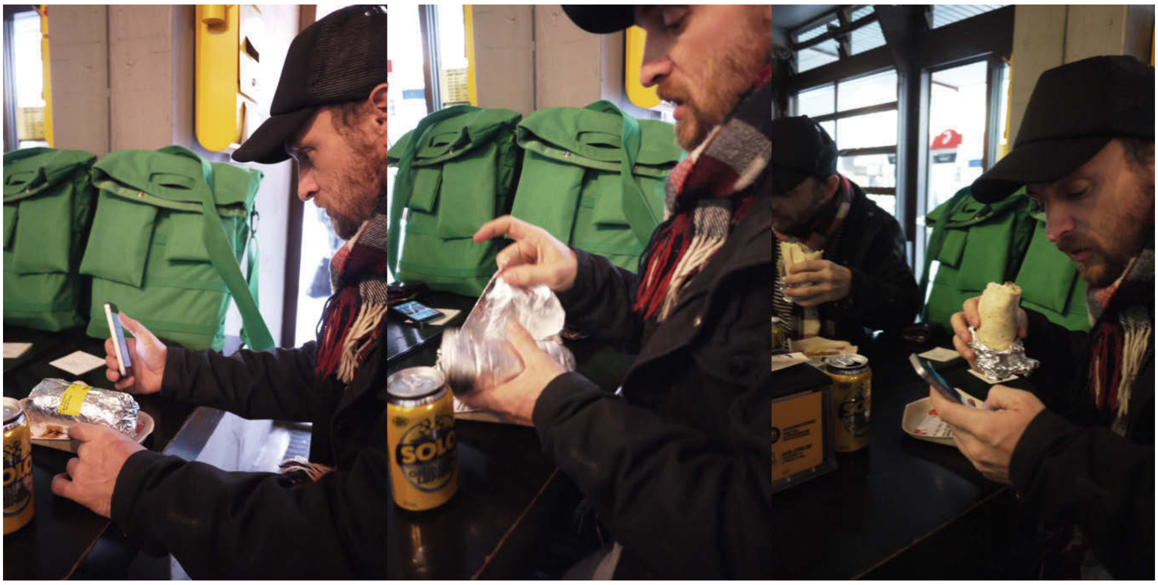


Figure 374: Ralph Physical Model Frame 39

While eating his burrito he keeps on reading emails and replying to them.

Figure 375: Ralph Physical Model Frame 40

When finished eating lunch he leaves the Mexican restaurant and walks back to the car. While walking he keeps on checking his iPhone for messages.

Figure 376: Ralph Physical Model Frame 41

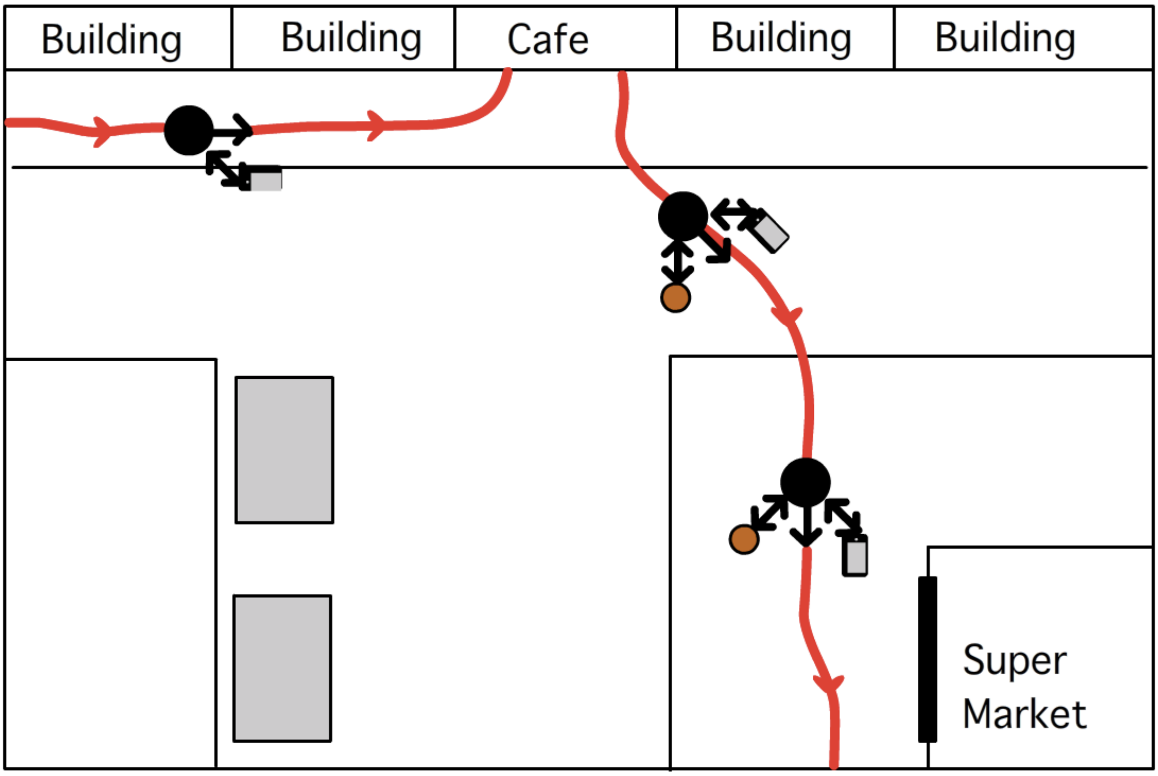


Figure 377: Ralph Physical Model Frame 42

On the way back to his car he stops at another coffee shop to get a coffee. He orders a coffee and pays in cash. While waiting for the coffee he reads more emails. He then receives his coffee and walks back to the car.

Figure 378: Ralph Physical Model Frame 43

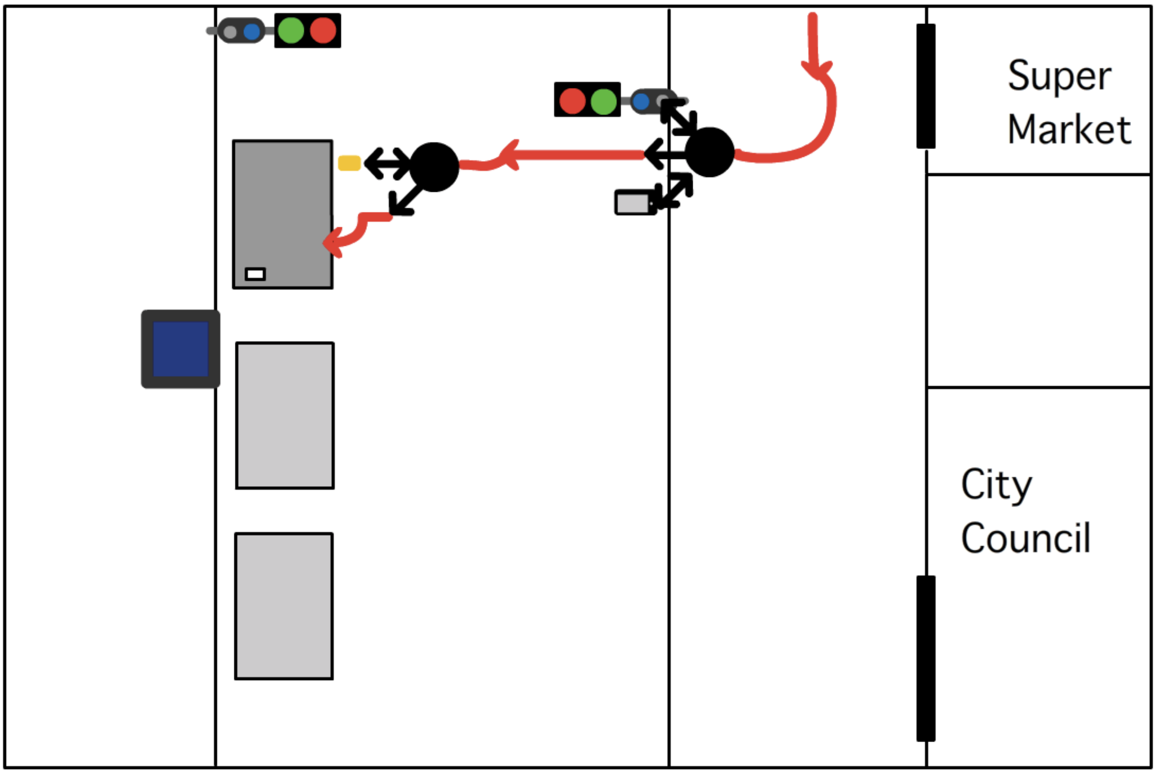


Figure 379: Ralph Physical Model Frame 44

While walking back to the car he drinks his coffee and keeps on using his smart phone to read emails. He also uses another traffic light to cross another street.

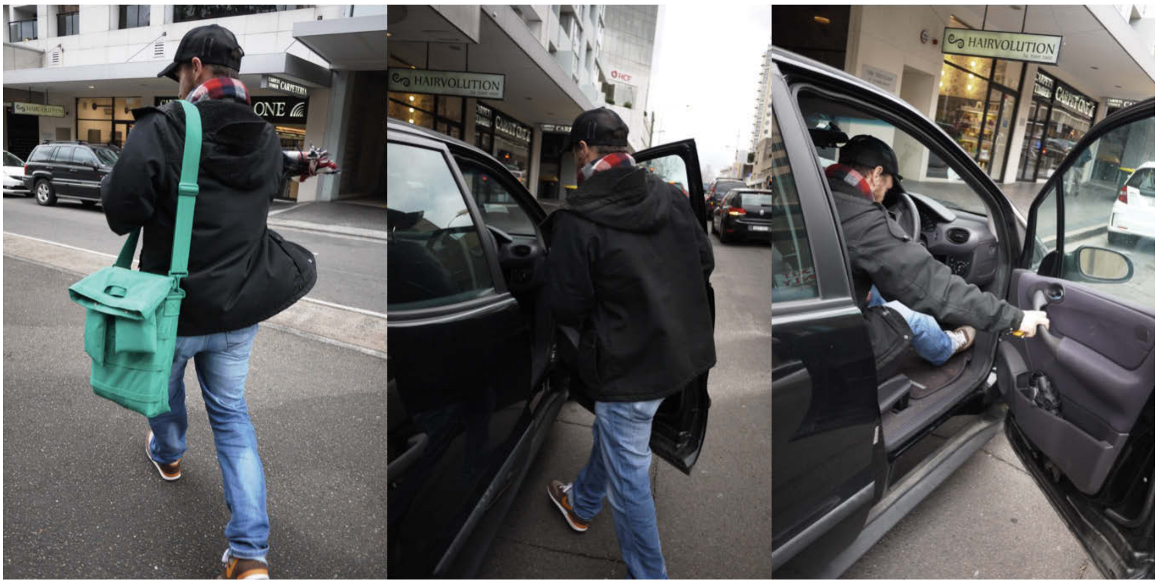


Figure 380: Ralph Physical Model Frame 45

He gets back into the car using a remote control, puts his coffee into a coffee cup holder and starts driving towards another shopping area.

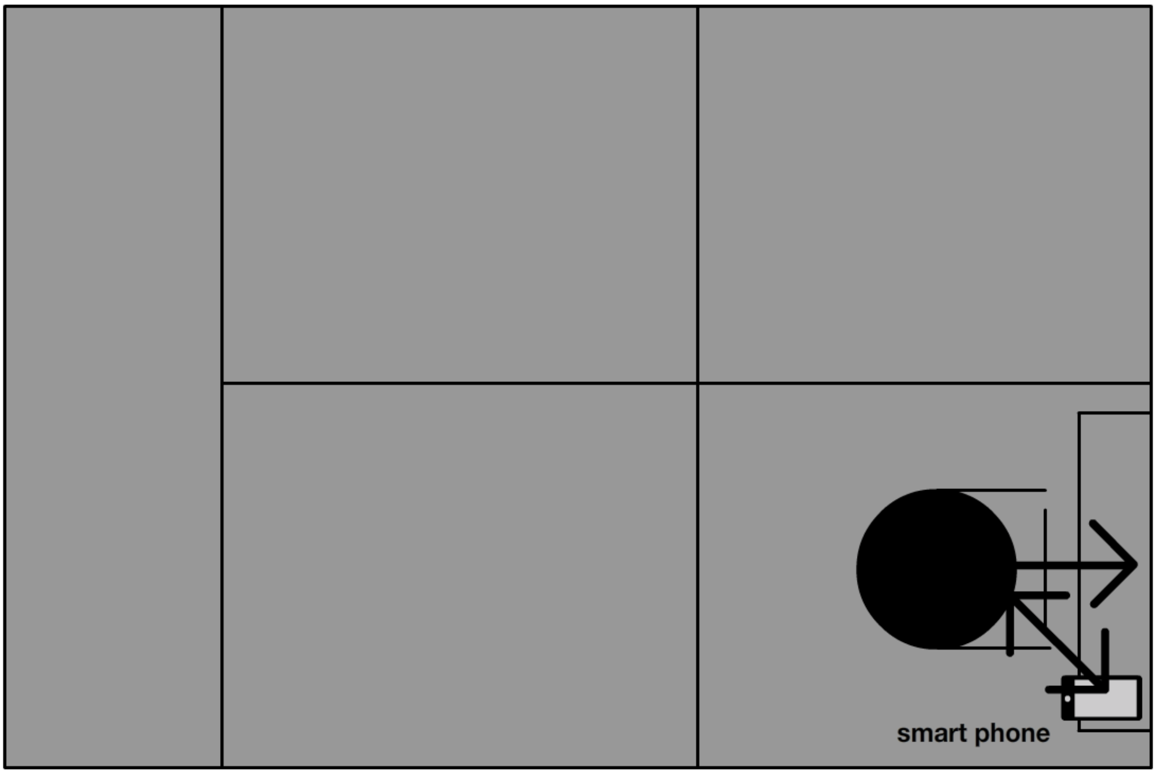


Figure 381: Ralph Physical Model Frame 46

Figure 382: Ralph Physical Model Frame 47

While he is driving he keeps on reading emails at traffic light stops.

Figure 383: Ralph Physical Model Frame 48

He leaves the car and closes the car with a remote control and walks towards the shops.

Figure 384: Ralph Physical Model Frame 49

He enters a pharmacy and buys some medicine.

Figure 385: Ralph Physical Model Frame 50

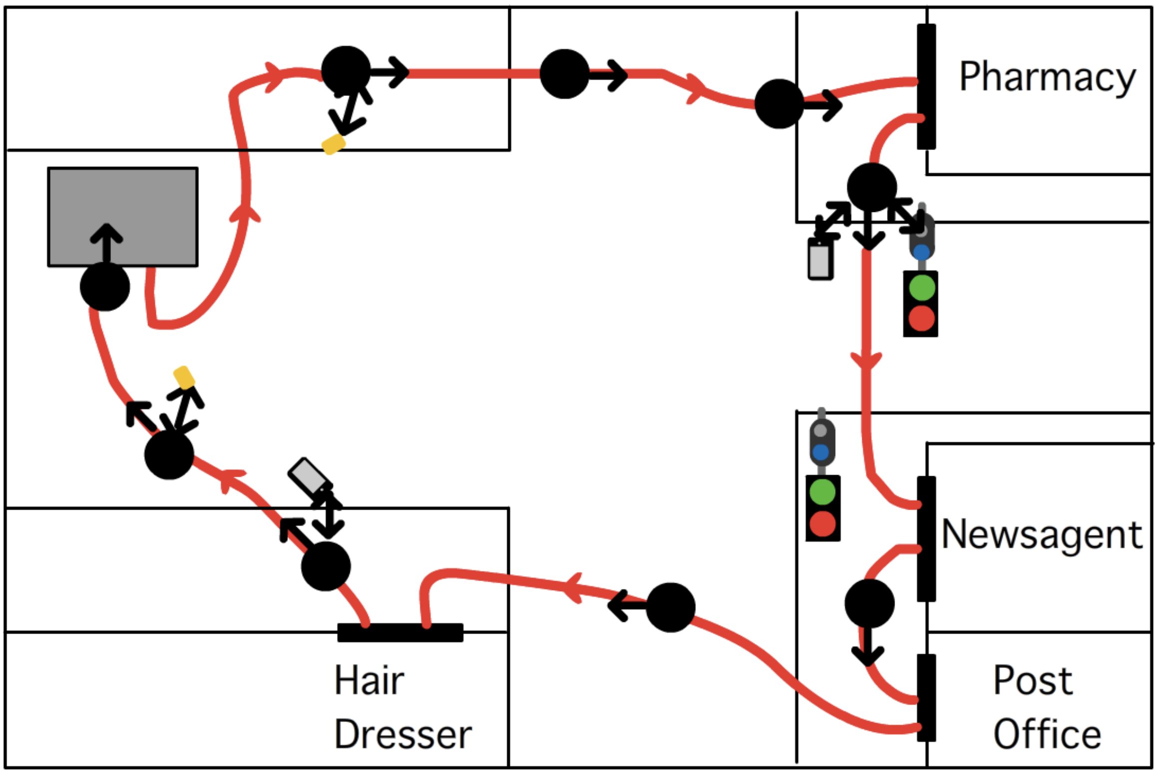


Figure 386: Ralph Physical Model Frame 51

He leaves the pharmacy and walks towards the news agent.

Figure 387: Ralph Physical Model Frame 52

He crosses the street using a traffic light, he pushes a button and waits for the traffic light to switch to green. At the news agent he enters the shop.

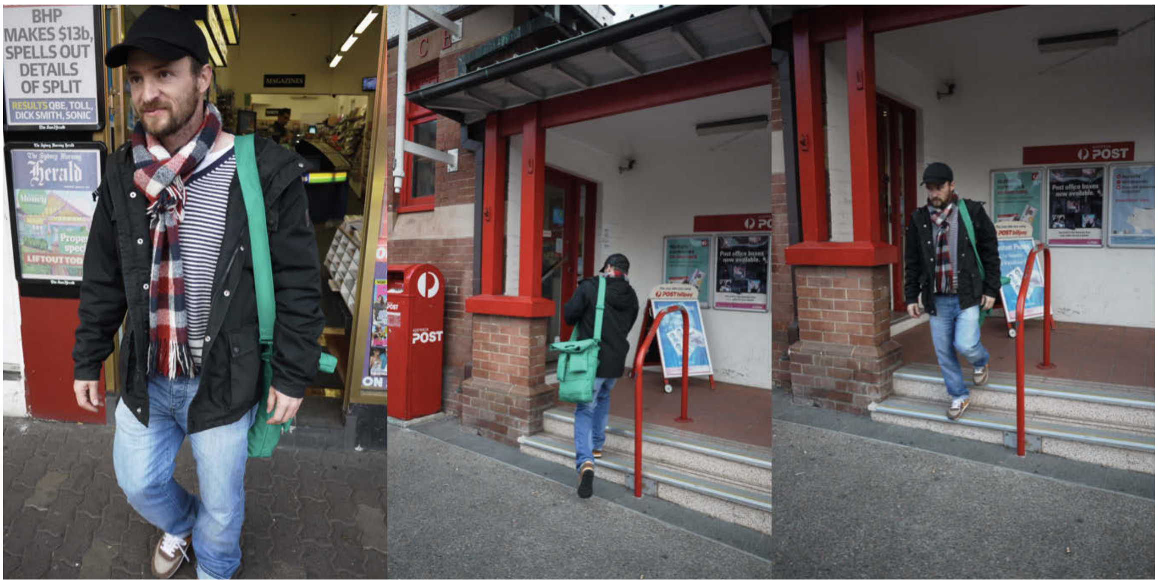


Figure 388: Ralph Physical Model Frame 53

He leaves the newsagent and walks towards the post office. He enters the post office to send some mail. He then leaves the post office and walks towards the hairdresser.

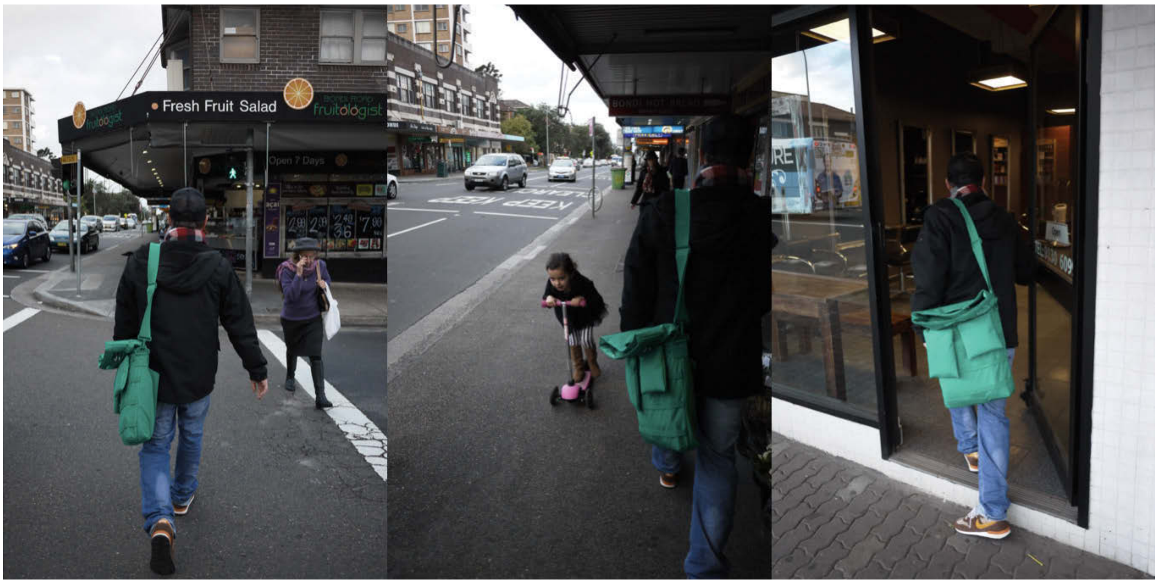


Figure 389: Ralph Physical Model Frame 54

He crosses some streets and enters the hair dresser to get a haircut.

Figure 390: Ralph Physical Model Frame 55

He leaves the hairdresser and walks back to the car. While walking back to the car he his making a phone call with his girlfriend.

Figure 391: Ralph Physical Model Frame 56

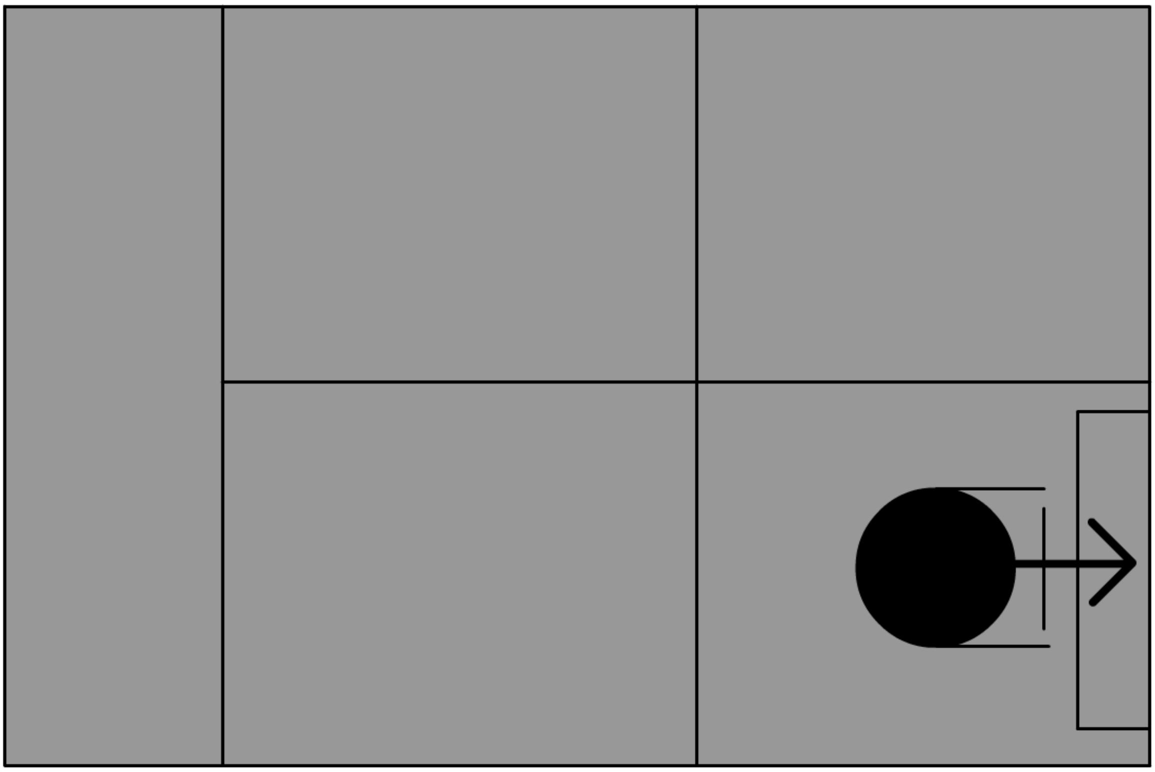


Figure 392: Ralph Physical Model Frame 57

He then arrives at the car and gets back into the car using a remote control.

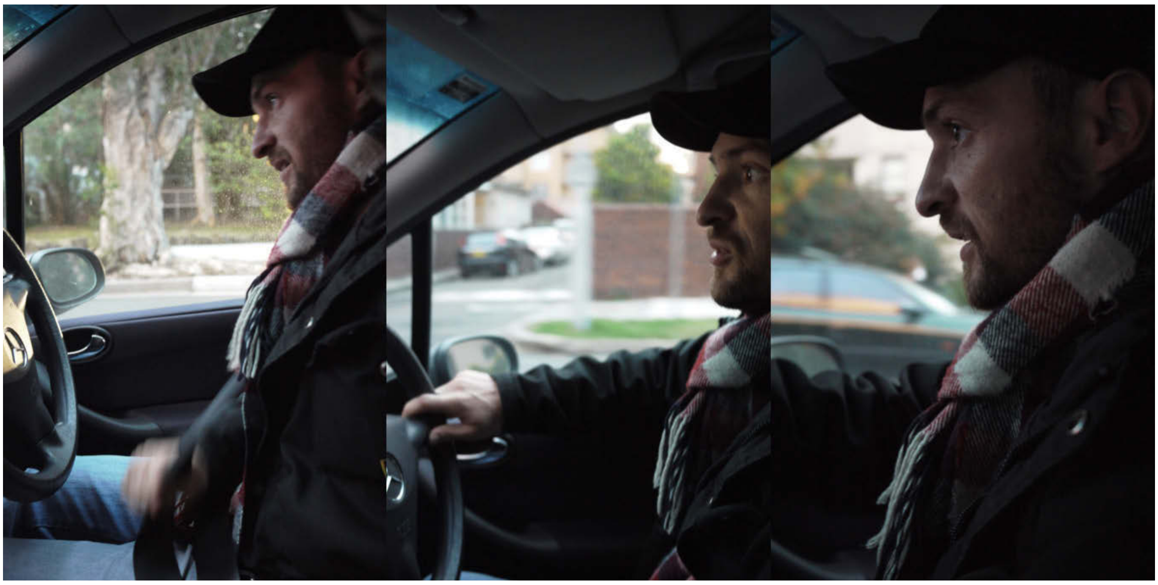


Figure 393: Ralph Physical Model Frame 58

He drives back to his home. While driving he is not using his smart phone.

Figure 394: Ralph Physical Model Frame 59

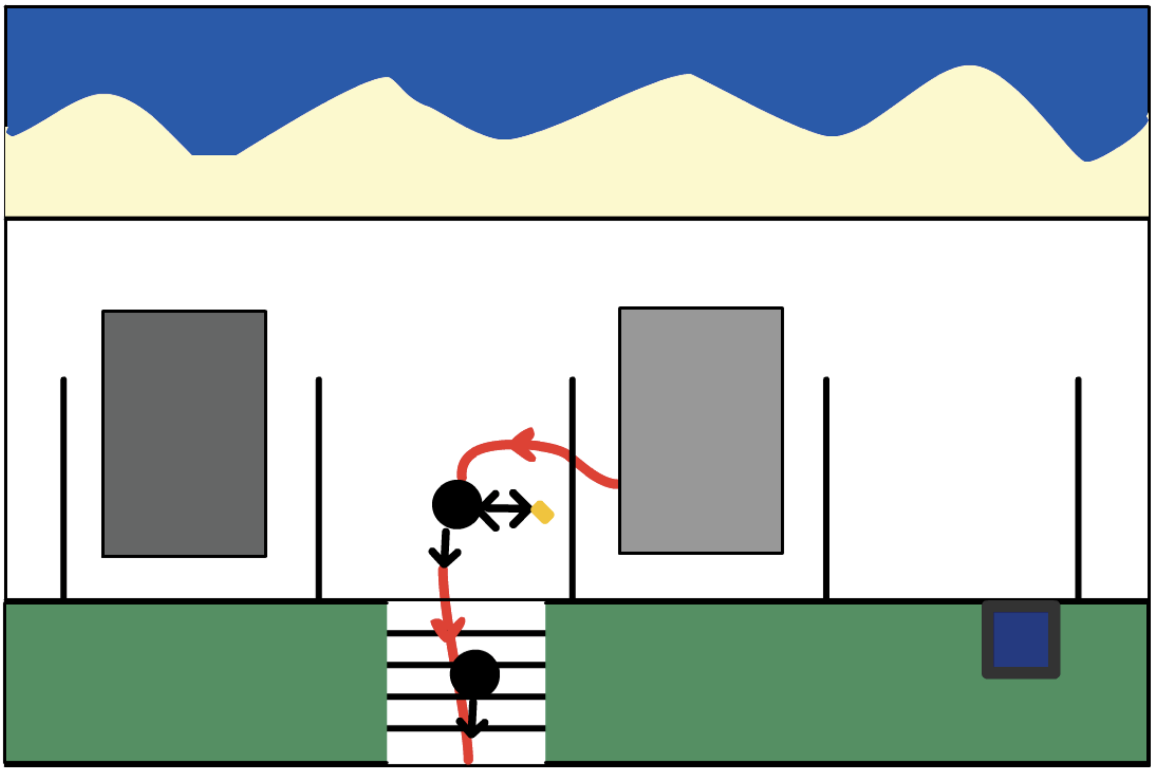


Figure 395: Ralph Physical Model Frame 60

He parks the car, gets out of the car, closes the car with a remote control, crosses the street and arrives at this home.

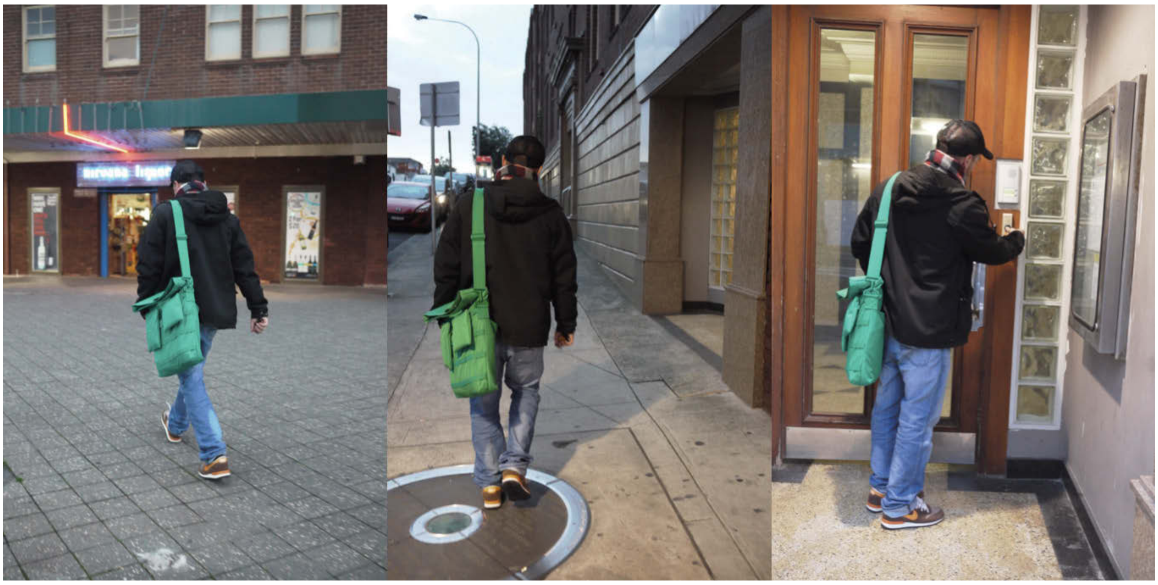


Figure 396: Ralph Physical Model Frame 61

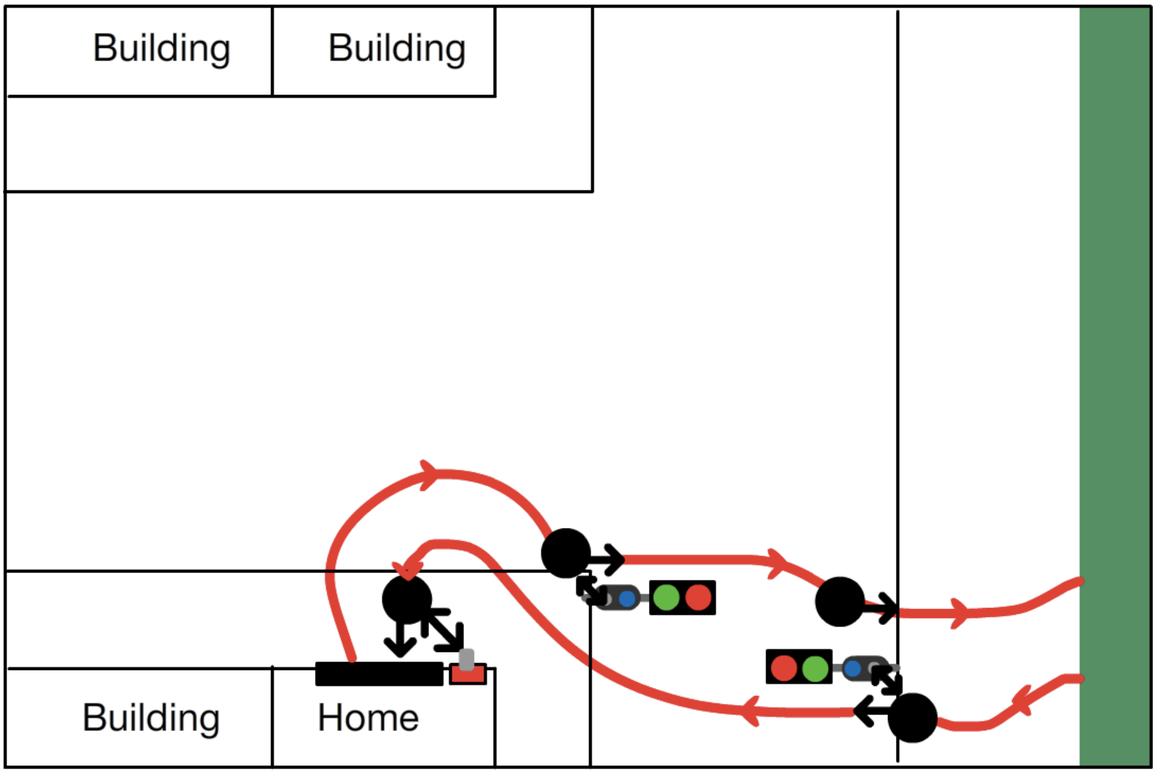


Figure 397: Ralph Physical Model Frame 62

He opens his home door with an RFID based swipe card and enters the building.

Circle Flow Model:

The Circle Flow model is an overview of Ralph's data of his everyday interactions.

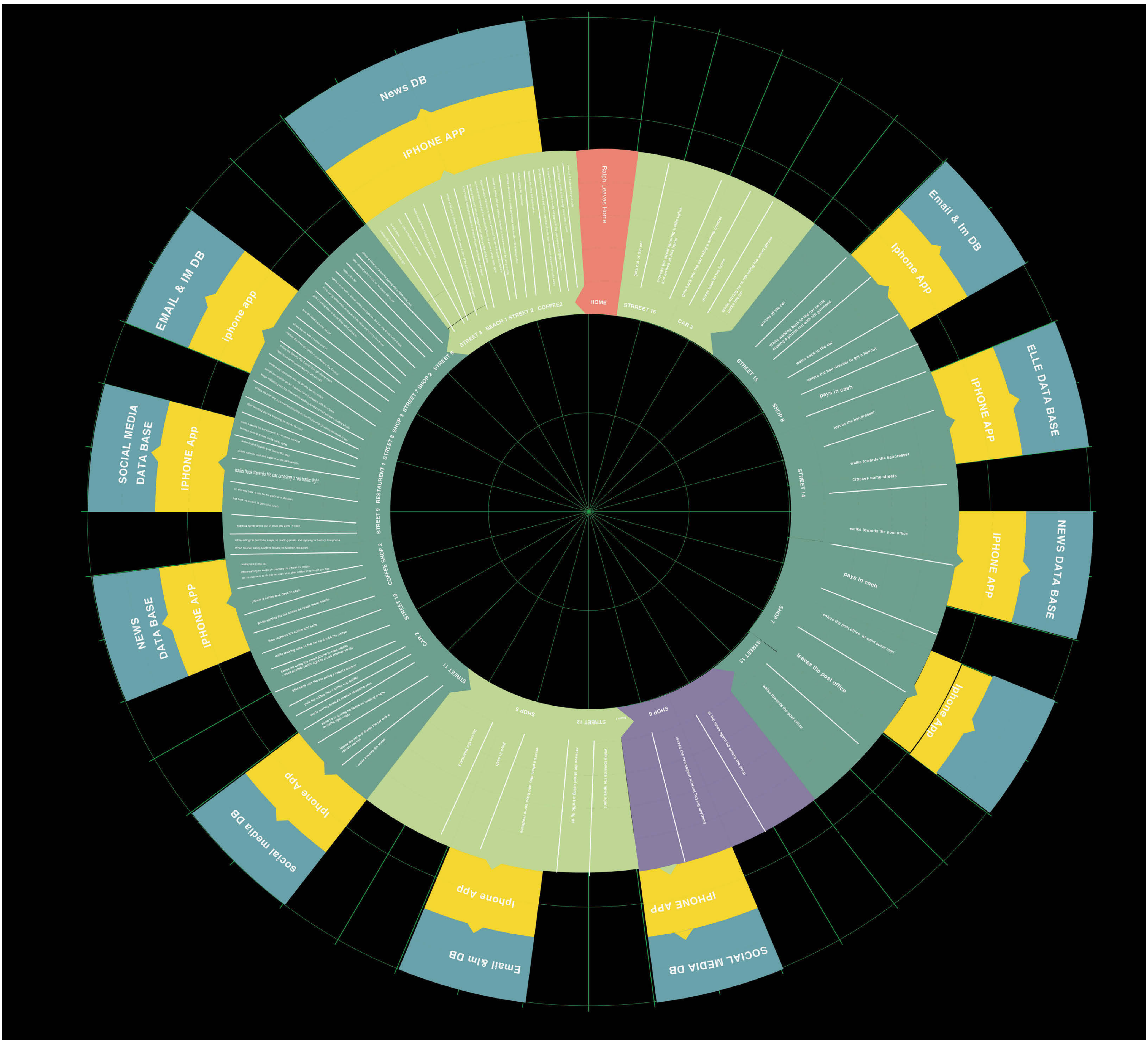


Figure 398: Ralph Circle Flow Model