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The Negative Space of Things

A practice-based research approach to understand the role of objects in the Internet of Things

Duncan Shingleton

Doctor of Philosophy

University of Edinburgh

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Declaration

I declare that this thesis is an original report of my research, has been written by me and has not been submitted for any other degree or professional qualification.

The experimental work contained herein is my own, except where explicitly stated otherwise in the text; the collaborative contributions have been indicated clearly and acknowledged.

Due references have been provided on all supporting literatures and resources.

Duncan Shingleton   UUN: S1155778

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Abstract

This is a practice-based research thesis situated in the research context of the 'Internet of Things', and critiques contemporary theoretical discourse related to the 21st century turn of connecting everyday objects to the World Wide Web. In the last decade we have seen the 'Internet of Things' articulated predominately through three commercial design fictions, each a response to the shift towards pervasive", "ubiquitous" (Weiser 1991), or "context-ware" (Schilit, 1994) computing; where we inhabit spaces with objects capable of sensing, recording and relaying data about themselves and their environments. Through reflecting upon these existing design fictions, through a new combination of theories and practice-based research that embodies them, this thesis proposes a recovery to understanding the role of objects in the 'Internet of Things', which this author believes has been lost since its conception in the mid 2000s.

In 2000, HP Labs presented Cooltown, which addressed what HP identified as the 'convergence of Web technology, wireless networks, and portable client devices provides'. Cooltown's primary discourse was to provide 'new design opportunities for computer/communications systems, through an infrastructure to support "web presence" for people, places and things.' (Anders 1998; Barton & Kindberg 2002). IBM's Smarter Planet followed this in 2008 and shifted importance from the act of connecting objects to understanding the value of data as it flows between these objects in a network (Castells 1996; Sterling 2005; Latour 2005). Finally, Cisco presented The Internet of Everything in 2012 and moved the argument on one stage further, identifying that the importance of connected objects lies in the sum of their communication across silos of networks, where data can provide potential insight from which you can improve services (Bleecker 2006).

Despite these design and theoretical fictions, the affordances of the Internet of Things first proposed in the mid 2000s has regressed from data to product, driven largely by unchanged discourse argued by those designers at its conception and also the enticement of being the next Google acquisition; instead of pigeons reporting on the environmental conditions of a city (Da Costa 2006), we have thermostats controllable from your smartphone (www.scottishpower.co.uk/connect).

Therefore the aim of this thesis is to re-examine the initial potential of the Internet of Things, which is tested through a series of design interventions as research for art and design, (produced as part of my EPSRC funded doctoral studies on the Tales of Things and Electronic Memory research project and also whilst employed as a research assistant on two EPSRC funded research programmes of work Sixth Sense Transport, and The Connected High Street), to understand how we use data to allow an alternative discourse to emerge in order to recover the role of a networked object, rather than producing prototypical systems.

Lay Summary

This thesis critiques contemporary theoretical discourse related to the 21st century turn of connecting everyday objects to the World Wide Web, referred to as the 'Internet of Things'; a future environment, where we inhabit spaces with objects capable of sensing, recording and relaying data about themselves and their environments.

Despite the vision of the Internet of Things first proposed in the mid 2000s, in this author's opinion we have seen the discourse shift from a community of designers, artists and authors who were defining networked objects that articulated the potential in understanding the relationship between thing, network and data, to that of global technology companies defining products, that articulate the benefits that the technologies of the Internet of Things offers, for improving digital interactions. We have seen the Internet of Things regress to an Internet of Smart Products; instead of pigeons reporting on the environmental conditions of a city, we have smart thermostats controllable from your smartphone.

Early debates surrounding the Internet of Things are clearly formed of two arguments. Firstly, contextualising the Internet of Things from a dystopian point of view; a technological platform whose level of data collection can be viewed as a method of control, to infringe upon, or restrict our privacy. A technology which is open to the same issues of data security and trust that we currently experience through our current use of the Intranet. The second contextualisation of the Internet of Things can be from a utopian point a view; that it is a technological platform that speaks to a near future, that offers us the opportunity to be playful in exploring a deeper understanding of the relationship between the digital and physical worlds. Where objects are globally traceable and searchable and can capture and communicate information about themselves and the happenings in their surroundings.

It is the latter which forms the context of this research and the position of this author. The aim of this thesis is not to address how the Internet of Things might be the latest surveillance technology that is an advanced method of data collection that will track our every move, impacting upon issues of power and control over individuals and the wider society. Instead its aim is to explore what the impacts are of creating a technological platform where objects are no longer viewed as inert, but rather as active members of society contributing meaningful insights into the world we occupy, providing new insights into society that drastically alters the Internet as we know it today.

I term this 'Thing centered computing' an 'expanded' Internet able to detect and monitor changes in the physical status of connected things (through sensors and tagging technologies) in real-time, and it is the latest extension of our relationship with technology. Personal computers dealt with the assumption that everything one needed was stored locally. Networked computers built upon that, assuming

everything one needed could be made universally accessible on the Internet. Ubiquitous computing furthered this notion, allowing you to take the Internet with you out into the real world, accessible through mobile devices. As communications become increasingly ubiquitous in everyday life the Internet of Things presents a framework in which computer devices can be embedded in everyday objects, invisibly at work in the environment around us; in which intelligent, intuitive interfaces will make computer devices simple to use and unobtrusive, and in which communication networks will connect these devices together to facilitate anywhere, anytime, always-on communications.

Over the course of the last decade we have seen trajectory articulated through the use of design fictions, that are extensively used by corporate companies to portray of an Internet of Things in reassuring short films; HP Cooltown (2000), IBM Smarter Planet (2010) and Cisco, The Internet of Everything (2012). A design fiction is (1) something that creates a story world, (2) has something being prototyped within that story world, (3) does so in order to create a discursive space. They are tools for thinking about the creation of experiences, whether it be near, or far future scenarios and narratives.

HP Labs in 2000 presented the first Internet of Things design fiction, Cooltown, which addressed what HP identified as the convergence of Web technology, wireless networks, and portable client devices provides; the Connection of Things. Cooltown's primary discourse was to provide "new design opportunities for computer/communications systems, through an infrastructure to support 'web presence' for people, places and things". IBM's Smarter Planet followed this in 2008, shifting the Internet of Things importance from the act of connecting objects, to understanding the value of data as it flows between objects in a network; the Spatiality of Things. Finally, Cisco in 2012 presented The Internet of Everything, and moved the argument on one stage further, identifying that the importance of connected objects lies in the sum of their communication across silos of networks, where data can provide potential insight from which you can improve services; the Emergence of Things.

This thesis is a response to my framing of the Internet of Things through three commercial design fictions and the aim to critique their vision against that which was initially proposed by designers, artists and theorists at the conception of the Internet of Things, and how our understanding has developed to date. Through reflecting upon these visions through a new combination of theories, and practice-based research that embodies them through the use of design interventions, a response to my critique of the use of design fictions, this thesis proposes a recovery to understanding the role of objects in the 'Internet of Things'.

This recovery is articulated through furthering our understanding of the values and meanings of objects when viewed through the affordances of their data, that interconnects across the networks in which they are represented and changes our relationship with physical objects, as we add to society all the facts and the artefacts that make up large sections of our social ties.

Contents

Introduction

Research Context

The Internet of Things (IoT) can be understood as the common term that defines the use of tagging technologies, specifically Radio Frequency Identification (RFID), in conjunction with cloud located databases to provide a framework for understanding Marx Weiser's (1991) vision of ubiquitous networks. The Internet of Things further extends the model of barcoding, into a technological platform capable of providing the microscopic detailed level of information, which facilitates the tracking of objects, through the cradle to grave cycle of manufacture, distribution, consumption and disposal (ITU 2005).

My own research into the Internet of Things began over a decade ago as part of the final year of my undergraduate studies in Digital Art and Technology at the University of Plymouth in 2006. In November of that year I attended a workshop run by Mediamatic in Amsterdam titled 'RFID and the Internet of Things'. It was one of the first gatherings of international speakers to discuss the early technical, social, cultural and political issues that might arise from the connection of everyday objects to the World Wide Web.

> Whether we realize it or not, RFID (radio frequency identification) is an integral part of our life. RFID increases productivity and convenience. RFID is used for hundreds, if not thousands, of applications such as preventing theft of automobiles, collecting tolls without stopping, managing traffic, gaining entrance to buildings, automating parking, controlling access of vehicles to gated communities, corporate campuses and airports, dispensing goods, providing ski lift access, tracking library books, buying hamburgers, and the growing opportunity to track a wealth of assets in supply chain management.'
>
> (Landt 2001)

Melaine Rieback presented the world's first RFID virus, asking Is Your Cat Infected with a Computer Virus? Rieback focused on security issues surrounding the use of RFID and the reasons why artists and designers should care about these issues. She discussed how input data received from individual RFID tags is implicitly trusted, however no one expects an RFID tag to send an SQL injection attack or a buffer overflow. She proposed that designers must therefore build appropriate checks to prevent RFID middleware from suffering all of the well-known vulnerabilities experienced by the Internet.

Rob van Kranenburg introduced the term 'dataclouds', the notion that people will become mere descriptions of the things they are carrying around with them, 'there will be no more public space; there will be no more memory loss and there will be no more people, just 'dataclouds'. His ideas were built around the premise that everything will be tracked, traced and saved which will be the case when RFID readers and tags are everywhere, a trajectory caused by "peoples want for security and cameras".

Kranenburg introduced the idea of the Object Name Service, "the glue that binds the digital to the physical world", and allows for objects to become uniquely traceable throughout the world; "with the data submitted to a central database you will be able to find every object anywhere."

Chris O'Shea, at the time an interactive media artist and researcher, focused on 'creating works that encourage new methods of play and collaboration, challenging our perception of space and physical objects'. From this perspective he asked the question how the Internet of Things can 'focus on hybrids of physical and electronic space' and be used for 'exploration and play, outside of social, economic and privacy issues?'

Arie Altena presentation on 'How the web became social (although it already was)' and the way in which the practice of blogging/publishing research relates to the topic of design for an Internet of Things. Arie noted that the technology of the Internet of Things was still in a state of infancy, and therefore it might turn out to be something people will start using in the same way in which they are using computers right now. He related this to how at the time 'blogging, as a way of using technology, is not scary, it's easy, as opposed to the creating of technology, which still is scary or at least difficult'. In blogging technology, user and software come together; it connects to what people want to do. Altena discussed how personal publishing and its issues for privacy, might have a likewise impact on the Internet of Things.

Finally, Julian Bleecker presented the 'Internet of things, when 1st and 2nd life meet up'; the joining together of 1st life (the human or physical world) and 2nd (the online or digital world). He questioned what it means to create 2nd life experiences through 1st life actions, to go beyond the idea of the network, since it is 'not about the network, it's what you do with it'. He raised the issue of what is an Internet (as a social web), and 'what would the social web look like when more and more network connected things start to participate', and what do people do with these possibilities?

From these early conversations, debates surrounding the Internet of Things are clearly formed of two arguments. Firstly, contextualising the Internet of Things from a dystopian point of view; a technological platform whose level of data collection can be viewed as a method of control, to infringe upon, or restrict our privacy. A technology which is open to the same issues of data security and trust that we currently experience through our current use of the Intranet.

> "Any government that wants to issue a unique identification number to most of the population and then to compile and link information about them, using increasingly powerful technology, bears a heavy onus to justify its case. ... 'Nothing to hide, nothing to fear', directed at each member of the public, should be turned around and directed at government as: 'No legitimate reason to know, no legitimate reason to ask."
>
> Chadwick (2006: 17)

Information and communication technologies, have in some sense, expanded traditional physical space through the creation of 'virtual communication' spaces. The deliberate linkage of the physical world

with the virtual world through the instrumentalisation of our environment, has led to a further 'permeability' between the public and private contexts (Geser, 2002). One of the leading debates surrounding privacy in a ubiquitous Internet of Things, hinges upon an individual's ability to control the blurring boundary between the public and private spheres, and to determine who can access his/her private sphere and under what conditions (Stalder, 2002).

However, this might come at a premium and sacrifice privacy for the sake of convenience. Even though the Internet of Things will provide added convenience for households, for shopping, and for work environments, it will also require the disclosure of more and more private information in order to receive these consumer services. In an ideal world, individuals would be able to make rational decisions on the trade-offs between privacy rights and the value of increased convenience, based on informed consent. Yet, implementing this perfect vision in the world of the Internet of Things might be more difficult than expected. There is the issue of obtaining individual consent for the personal data collection, as with enabling technologies related to the Internet of Things which are embedded in objects, the individual may be unaware of their presence in the environment, making surveillance seamless. As the enabling technologies become more widespread and pervasive, the principle of requesting individual consent every time a person enters into contact with a new data-collecting device becomes out-dated and unrealistic. To avoid being bothered with constant requests, individuals may simply accept the collection of data as a default.

The same companies (including Tesco, Sainsbury's and Asda), that are using RFID tagged products to track consumer spending habits, have also recently deployed technology allowing RFID readers carried by employees to be tracked by managers, effectively introducing the conditions for permanent surveillance. More than 10000 workers have been asked to wear small computers on their wrists, arms and fingers, or in some cases, to put on a vest containing a computer, which instructs them where to go and what to do. The companies say the RFID system makes work practices more efficient, increases the speed of service and reduces theft. However, the employee is unable to do anything without the computer recording and monitoring the employee's behaviour. Internet of Things technology used in this way means the same companies that threaten their consumer's privacy, also threaten their workers' right to privacy (Murray, 2005).

Another source of concern is the implementation of an Internet of Things in the name of national security through the possible misuse of biometric passports and ID cards. Potential dangers associated with electronic identification include, for example, identity theft and illegitimate tracking. These applications of emerging technologies have fostered debate on the trade-offs between national security and personal privacy. In recent years, the fear of terrorism has made the collection of personal identification, profiling and data mining a matter of national policy, prompting increased interest of government agencies in tracking and tagging technologies.

In an effort to strengthen national security, many countries are already implementing projects for the use of RFID tags in national identification cards. The European Union, for instance, is looking into the deployment of electronic ID cards across its 35-nation bloc. Estonia, touted as one of Central Europe's most advanced and tech-savvy nations, is issuing its 1.4 million citizens with an "EstEID", a chip-based ID card that carries the citizen's name, home, address, date and place of birth, digital certificates and email. The card will be valid for travelling to most European countries and for electronic payments, filing tax documents, banking and access to e-government services (CardTechnology, n.d.).

However, users of today's Internet already fill in forms for many information services using false names and addresses, as they are increasingly afraid of revealing personal information when online. A future in which all kinds of applications and objects prompt users for personal identification might exacerbate this climate of distrust. As communications between people, clothes, pens, furniture and applications increase, human beings will have fewer and fewer tedious routine tasks, with computing and processing occurring unnoticed in the background (Bohn et al. 2004). Invisible and constant data exchange between things and people, and between things themselves, will occur unbeknown to those affected.

An Internet of Things technological framework will have an increased capacity to collect and disseminate personal information. The provision of personalized services, such as those offered for smart houses and phones, requires these technologies to collect increasingly sophisticated personal data, from an individual's preferences, to voice patterns, fingerprints and other biometrics such as retina scans. This data collection facilitates personal identification, but at the same time makes it difficult for individuals to maintain control over their personal information and to remain anonymous, when so desired, in the world of the Internet of Things.

By the same token, the combination of tagging technologies and mobile communications may challenge the ability of individuals to be free from interference, particularly from unsolicited advertising and other commercial messaging. The current experience of spam in mobile communications allows us to foresee a future where an increased number of unsolicited messages may be generated not only by other people or business, but also by the objects around us. Ubiquitous communications, along with the collection of information about personal preference, transactions and activities, will provide greater opportunities for organizations to bombard consumers with targeted marketing information.

One of the most worrying factors surrounding the integration of an Internet of Things into our daily lives, are the concerns regarding the incomplete and asymmetric information between data subjects and data collectors. A study conducted by Intel Research in the United States on people living in smart environments, using RFID and sensor technologies, discovered limitations in individual's understanding of the uses and abuses of data collected by these technologies, especially where data can be shared with third parties. According to research by Richard Beckwith (2003), "when people are unaware or badly informed of the surveillance capabilities of technologies, they tend to trust these to be benign". This is

further compounded by the public's lack of knowledge about RFID. Surveys conducted in the United States by the National Consumer Council and Cap Gemini Ernst & Young (2004), underscore the lack of consumer awareness and understanding of RFID's implications for privacy, for example, Cap Gemini Ernst & Young's survey of 1000 people in the United States indicated than 25 per cent of those knew about RFID.

The second contextualisation of the Internet of Things can be from a utopian point a view; that it is a technological platform that speaks to a near future, that offers us the opportunity to be playful (O'Shea, 2006) in exploring a deeper understanding of the relationship between the digital and physical worlds (Anders 1998). Where objects are globally traceable and searchable (Sterling 2005) and can capture and communicate information about themselves and the happenings in their surroundings (Bleecker 2006).

It is the latter which forms the context of this research and the position of this author. The aim of this thesis is not to address how the Internet of Things might be the latest surveillance technology that is an advanced method of data collection that will track our every move, impacting upon issues of power and control over individuals and the wider society. Instead its aim is to explore what the impacts are of creating a technological platform where objects are no longer viewed as inert, but rather as active members of society contributing meaningful insights into the world we occupy, providing new insights into society that drastically alters the Internet as we know it today.

Humanity's approach in trying to understand the world around us has been characterised by a move from simplicity to increasing complexity through various classification systems. The latest of these, the semantic web, is an evolving extension of the World Wide Web. This method of classification means content can be expressed not only in natural language, but also in a form that can be understood, interpreted and used by software agents, thus permitting them to find, share and integrate information more easily (W3C, n.d). The introduction of the descriptive technologies Resource Description Framework (RDF), Web Ontology Language (OWL), and the data-centric, customizable Extensible Markup Language (XML), allows people to add meaning to their content, i.e. to describe the structure of the knowledge we have about that content (Wikipedia, n.d), and is most frequently implemented using tags. By reading the structure of the tags and the classification hierarchy they belong to, a machine can process knowledge itself, instead of text, using processes similar to human deductive reasoning and inference (W3C, n.d). However, this always has to be added by a user, describing what the real-world object is and how the data/content/meaning is associated with it.

As the Internet grows, fuelled by our desire to understand and classify more of our environment, it seems logical that it will need to encompass more and more elements of the real world and therefore the abstraction of the classification has to be more complex. The Internet of Things facilitates communications to become increasingly ubiquitous in daily life; an identification and addressing system that develops a structure for the Internet to more intensely map, or merge, the physical world onto

cyberspace in increasing detail. It will not be simply enough for humans to apply the context of the object and its meaning, instead we will see a real world where objects will become networked, allowing machines to perceive, and objects to know not only what they are, but also the contexts they inhabit and contribute to.

In this context, technological ubiquity and complexity will drive the future communication landscape that is the Internet of Things, with **RFID** being considered one of the main technologies behind this change (W3C, n.d). RFID, however, is not the only technological enabler of the Internet of Things. Sensor technologies, smart technologies and nanotechnology have equal importance, although the technology that enables the Internet of Things is also not addressed in this thesis.

> "RFID is important because it enables machines to perceive. Machine perception is common in science fiction, where sentient robots walk and talk as a matter of course, but it is rare and primitive in everyday life. Airport faucets struggle to sense people impatiently waiting to wash their hands, bar code scanners frequently fail to beep, and home burglar alarms have trouble distinguishing between pets and intruders. During the next few decades, RFID will help change all that. It will usher in a new wave of computing in which devices can effectively sense and interpret the world around them."
>
> Ashton, K (Garfinkel 2006: xxi)

Aims of the Research

Despite the vision of the Internet of Things first proposed in the mid 2000s, in this author's opinion we have seen the discourse shift from a community of designers, artists and authors who were defining networked objects that articulated the potential in understanding the relationship between thing, network and data, to that of global technology companies defining products that articulate the benefits that the technologies of the Internet of Things offers for improving digital interactions.

We have seen the Internet of Things regress to an Internet of Smart Products; instead of pigeons reporting on the environmental conditions of a city (Da Costa, 2006), we have smart thermostats controllable from your smartphone (www.scottishpower.co.uk/connect).

> "Forget about the Internet of Things as Web 2.0, refrigerators connected to grocery stores, and networked Barcaloungers. I want to know how to make the Internet of Things into a platform for World 2.0.; how it can become a framework for creating more habitable worlds, rather than a technical framework for a television talking to a reading lamp"
>
> Bleecker (2006)

In response to the shift away from the initial technical and cultural understanding of the Internet of Things, the aim of this thesis is to answer the following research question:

How can we use practice-based research to examine the current commercial discourse on the Internet of Things, and create design interventions that allow for an alternative discourse to emerge in order to recover the role of a networked object, rather than producing prototypical systems?

In response to this primary research question, the thesis will also aim to answer:

- How can we have a critical discourse on Internet of Things, when it is still largely a near future paradigm and not a ubiquitous framework with which we can interact on a daily basis?
- How do view the locatable, addressable, and readable counterparts to objects in the Internet of Things?
- If agency neither presupposes intentionality nor is assigned to nonhumans, how else might we understand the properties that result from the pattern between objects in a structure?

Practice-based Research

This thesis documents my practice-based research that reflects upon the commercial and theoretical articulations of the Internet of Things which were created over the course of my doctoral studies as a Ph.D. candidate on the Tales of Things and Electronic Memory research grant, my employment as a Research Associate on the Energy/Digital Economy Sixth Sense Transport UK Research Councils grant and the EPSRC Research in the Wild Connected High Street UK Research Council grant, and Lecturer on the Masters in Design Informatics course at the Centre for Design Informatics, University of Edinburgh.

My doctoral studies are practice-based, as the creative artefacts I've produced are the basis of my contribution to knowledge, and this thesis is an original investigation undertaken in order to gain new knowledge by means of practice, and the outcomes of that practice is demonstrated through design interventions (primarily in the form of software) that embody my critical thinking (Candy 2006). As such, it is important to acknowledge the two distinct research contexts in which the artefacts were created:

- New research contexts that are a result of my study into critical thinking - where my practice aims to create new knowledge through an iterative process of reflecting on critical thinking and creating new connections to literature, which are in turn reflected upon through practice. These new research contexts were often used as stimuli in proposals for grant applications, which then became existing research contexts for new practice, where I was the named research associate.

- Existing research contexts as part of a multidisciplinary research team - where the integration of my practice allowed for the communication of the team's knowledge, that I often used as stimuli for new research contexts.

However, through my digital art practice, as a Ph.D. candidate or research associate, collaborative design has been a key foundation to my practice-based research. Collaborative design can be understood of consisting of three building blocks: "knowledge creation, integration between actors from different disciplines, and communication between the actors about both the design content and the design process" (Kleinsmann 2006). Therefore, it is also important to outline my role within the practice, and any corresponding outputs of the research.

Tagged City Play

Created in collaboration with Margarete Jahrmann and Max Moswitzer of the Ludic Society, the work combines their research into 'situated play' with my research into the Internet of Things tagging and locative technologies, to import everyday objects into a game engine. My contribution to the practice included 1) a technological platform that allowed for text and images to be associated with RFID tags retrievable via scanning the tag using a Nokia NFC mobile phone, 2) a Macromedia Flash based graphical interface that represented the gameplay, and 3) bespoke RFID readers used to interface the human players with the game.

Performances
- Tagged City Play (2007), Social Hacking, Plymouth, UK
- An Evening with the Ludic Society (2007) Dutch Electronic Arts Festival, Rotterdam, Netherlands
- Nordicht Blitz Play (2007) Piksel, Bergen, Norway

Papers
- Jahrmann, M., Moswitzer, M., Shingleton, D. (2007), Ludic Society Tagged City Play: Judgement Day for 1st Life Game Figures. a locative REAL PLAY on RFID implants and mobile game maps in a real city, DIGRA Tokyo Japan. 09/07

Additional credits to the wider team: Bauer, R., Rakuschan, F. E., Rusch, C., König, N., Leino, O., Punt, M., and Blassnig, M.

RememberMe and RememberUs

Both projects were created in collaboration with Chris Speed, and the work is situated in the research context of the Tales of Things and Electronic Memory (TOTeM) EPSRC UK Research Councils grant. TOTeM's aim was to explore how attaching a social history and memories to things can alter our

interactions with these objects, and to build a novel platform using the latest technological advancements that could facilitate this. RememberMe was artwork exploring this thinking, that attached donated audio memories to objects in a charity shop, to then be re-played in situ over the shop's speaker system. The work was an extension of my practice where I created RFID readers linked to Arduino to play audio files; a technical platform for an installation at the opening of the Roland Levinsky Building, University of Plymouth in 2007, and subsequently used as teaching material on the Architecture Masters programme at Edinburgh College of Art (2009-2010). I then extended the critical thinking of RememberMe with the work RememberUs. It proposes that stories might also be automatically remotely attached to the objects we buy, unbeknownst to the consumer, and where multiple memories in geographically independent locations could push the balance beyond the one memory for one object relationship; we could outweigh the material with many more immaterial instances.

Performances
- RememberMe (2010), Future Everything, Manchester, UK
- RememberUs (2011), Future Everything, Manchester, UK

Papers
- Shingleton, D., Sutherland, K. (2010), The Memorable: Applying the Internet of Things to small communities, Web Studies Congress, Mexico.
- Speed, C, Gianni, C & Shingleton, D. (2010), Pervasive Memory, Locative Narratives', REM - Research on Education and Media, vol 2, no. 2, pp. 40-47.

Additional credits of the wider TOTeM team: Burke, M., Hudson-Smith, A. Karpovich, A. O'Callaghan, S., Simpson, M., Barthel, R., Blundell, B., De Jode, M., Leder, K., Lee, C., and Macdonald, J.

Mr Seels' Garden App

The work was produced in collaboration with Michelle Bastain as part of The Memories of Mr Seels' Garden, supported by an AHRC Connected Communities UK Research grant. Their research focused on the history of local food production in Liverpool and aimed understand how you can address the concerns of local food-growing in context of a city. The group had already produced a series of artefacts, including a website that overlaid stories onto a map, but where keen to utilise the technology I had developed as part Take Me I'm Yours. The contribution of my practice was to create an App which allowed the public to scan objects only within the geographical area of Liverpool and retrieve a historical piece of information about them. I also took the opportunity to extend their critical thinking by introducing information retrieval based on the dynamic attributes of objects in the Internet of Things.

Performances

- Mr Seel's Garden App (2013), Light Night, Bluecoat Gallery Liverpool, UK
- Mr Seel's Garden App was also available for public download on the Apple Store

Oxfam Logistics

The work was produced for the Sixth Sense Transport, a Digital Economy research projected funded by the UK Research Councils. As a research associate I was part of a team who set out to develop and test a smartphone app designed to combine social networking concepts with asset tracking and monitoring to enhance the visibility of logistics operations within a national UK charity. My contribution to this practice included producing a series of wire frames and storyboards, through an iterative design-consult process, from which I developed the core functionality in an App for the Apple iPhone platform.

Performances
- The app was trialled across three different Oxfam communities of users, over three separate counties in the United Kingdom:
  1. A driver, area manager and three shop managers in Hertfordshire (21/3/13 – 14/6/13)
  2. A driver, area manager and depot manager in Dorset (3/5/13 – 20/9/13)
  3. Two drivers, an area manager and seven shop managers in Cambridgeshire (3/6/13 - 3/9/13)

Papers
- McLeod, F., Cherrett, T., Shingleton, D., Bektas, T., Speed, C., Davies, N., Dickinson, J. & Norgate, S. (2012) Sixth Sense Logistics: Challenges in supporting more flexible, 'human-centric' scheduling in the service sector, Annual Logistics Research Network (LRN) Conference.
- Mcleod, F., Erdogan, G., Cherrett, T., Bektas, T., Davies, N., Shingleton, D., Speed, C., Dickinson, J., & Norgate, S. (2013). Improving collection efficiency through remote monitoring of charity assets. Waste management (New York, N.Y.). 34.
- Dickinson, J., Cherrett, T., Hibbert, J., Winstanley, C., Shingleton, D., Davies, N., Norgate, S., & Speed, C. (2015). Fundamental challenges in designing a collaborative travel app. Transport Policy. 44. 28-36.
- Cherrett, T., Shingleton, D., Norton, B., Mcleod, F., Forey, C., Dickinson, J., Winstanley, C., Davies, N., Speed, C., & Norgate, S. (2015). Developing a smartphone app to enhance Oxfam's supply chain visibility. International Journal of Logistics.

Additional credits go to the wider 6ST team: Cherrett, T., Davies, N., Filimonau, V., Ghali, K., Harding, M., Kubitza, T., Lau, M., Mcleod, F.N., Smith, L., & Speed. C

Internet of Cars

The theory that transport networks could act representations of the Internet of Things was developed in collaboration with Chris Speed. This theory was subsequently explored in the installation Flows, which I developed in collaboration with Mark Kobine.

Performances
- Internet of Cars Demo (2012) MobiSys, Lake District, UK
- Flows (2014) Turner Sims, Southampton, UK
- Flows (2014), Producing Data Symposium, Edinburgh, UK

Papers
- Speed, C., & Shingleton, D. (2012), An Internet of Cars: Connecting the Flow of Things to People, Artefacts, Environments and Businesses, Mobisys 2012: International Workshop Sense Transport '12 Proceedings of the 6th ACM workshop on Next generation mobile computing for dynamic personalised travel planning. pp. 11-12 ACM New York, NY, USA
- Speed, C., Shingleton, D. & Cherrett, T. (2013), An Internet of Cars, 45th Annual UTSG Conference, Oxford, United Kingdom
- Shingleton, D. & Kobine, M., (2014) Flows: Mainofesting CO2 Emissions, in Angus Forbes, Fanny Chevalier, Lauren Thorson. IEEE VIS 2014 Arts Program Exhibition Catalog. Proceedings of VIS Arts Program, Nov 2014, Paris, France.

Additional credits go to the wider 6ST team: Cherrett, T., Davies, N., Filimonau, V., Ghali, K., Harding, M., Kubitza, T., Lau, M., Mcleod, F.N., & Smith, L.

CoGet

CoGet was an extension of Chris Speed work CoMob, and we worked in collaboration to propose a theory that machine learning could be utilised to understand the spatiality of things in a network and use the routines of humans to move them around, which was then embodied in the App I developed.

Performances
- CoGet (2014) Future Everything, Manchester, UK
- CoGet (2014) Car(bon) Mart, Bridport Arts Centre, UK
- CoGet was publicly available for download from the Apple Store

Social Shopping

The work was situated in the context of The Connected High Street project that was supported by an EPSRC Research in the Wild UK Research Council grant. The project explores the potential for reconfiguring the traditional organisation of customer, salesperson, cash register, tangible things and database, allowing shops 'stacks' of both immaterial and material processes to share data that will improve social and economic conditions. Whilst working as a research associate I proposed and explored the theory that agency might lie in the ability for an object to affect a human's understanding of the value of consumer data and explored this through practice in collaboration with Mark Selby and Annika Hupfeld. My contribution was both concept and development of the software that allowed participants to scan their shopping receipts and donate their reward points to a charity of their choosing.

Additional credits to the wider team: Speed, C., Rogers, J., Wallace, J., & Shorter, M.

Take Me I'm Yours

The work was produced in collaboration with Chris Speed, and embodies my research in the agency of things. My contribution was developing the conceptual ideas behind the performances, and the development of an App in response to the critical thinking.

Performances
- Take Me I'm Yours (2012), DIS 2012, Newcastle, UK
- Take Me I'm Yours (2012), Ubicomp 2012, Pittsburgh, USA
- Take Me I'm Yours: Beyond the Supermarket (2013), Expanded Narratives Symposium, Plymouth, UK
- Take Me I'm Yours: Is Your Marmite Watching You? (2014), Fringe Festival, Edinburgh, UK
- The Take Me I'm Yours App was also publicly available for download on the Apple Store

Papers
- Speed, C., Shingleton, D. & Mojsiewicz, K. (2012) Take Me I'm Yours: Workshop Paper, DIS2012: Designing Interactive Systems Conference
- Speed, C. & Shingleton, D. (2012) Take Me I'm Yours: Mimicking Object Agency, Proceedings of the 2012 ACM Conference on Ubiquitous Computing. ACM Association for Computing Machinery, p. 1167-117

Additional credits to the wider team: Macdonald, J., Smith, L., Cunningham, N., Fenn, J.R., Popowich, J, Rosebrock, A., Szczepaniak, A., Trower, A., & Yorke, S.A.

Treasure Trapper

The Travelling Treasures project was a seven-month project developed for EM&G, The Assembly Rooms (AR) and Edinburgh Bus Tours (part of Lothian Buses and Transport for Edinburgh). The work was produced in collaboration with Chris Speed and was interested in better understanding how location-based services and gaming could increase footfall at the many museums and cultural venues. My contribution to the practice was both in the conceptual design of the App, as an embodiment of my theory of relational emergence, and also its development.

Performances
- Developed as a trial for summer 2014, treasure Trapper was publicly available for download from the Apple Store and installed in 7 museum and gallery locations across Edinburgh

Papers
- Speed, C., Shingleton, D. & Dickinson, J. (2014) Using city bus data as a platform for smart tourism, Fifth Annual Digital Economy All Hands Meeting - London, United Kingdom
- Speed, C. & Shingleton, D. (2016) Innovations in Landscape Architecture. Anderson, J. & Ortega, D. (eds.). Toronto: Routledge

Additional credits to the wider team: Macdonald, J., Baxter, R.

Theory

The Internet of Things

> "Society itself is to be rethought from top to bottom once we add to it the facts and the artefacts that make up large sections of our social ties."
>
> (Latour 1992)

More than twenty years ago, in an article for Scientific American, the late Mark Weiser outlined his bold vision of '"ubiquitous computing'; small computers that would be embedded in everyday objects all around us, and using wireless connections would respond to our presence, desires and needs without being actively manipulated. The scenario proposed that computational processing power could be embedded in the world, in places and objects, instead of merely in traditional forms of computers, resulting in a more 'natural' interaction between humans and computers.

> "We are trying to conceive of a new way of thinking about computers in the world, one that takes into account the natural human environment and allows the computers themselves to vanish into the background."
>
> (Weiser 1991)

Ubiquitous computing, also known as ambient, physical, embedded, environmental, tangible or pervasive computing (Greenfield 2006; McCullough 2004), refers to how these individual devices and everyday objects might communicate and process information, creating a world in which things can interact dynamically (Bohn 2004). Weiser explored enhanced computer use through the increasing 'availability' and decreasing 'visibility' of processing power. In other words, in his view, the computer as a dedicated device will 'effectively disappear', whilst its information processing capabilities will increasingly become available throughout our surroundings (Greenfield 2006).

> "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."
>
> (Weiser 1991)

This technological shift is now commonly known as the Internet of Things. The term was first attributed to the Auto-ID research group at MIT in 1999 (Ashton 2009) and later synonymised in the International Telecommunications Union report the Internet of Things in 2005. In the report, the ITU refers to the thickening of connectivity in information networks that presupposes the connecting, and therefore enfolding into the Internet, of a rapidly growing number of everyday objects and devices (ITU 2005). As the Internet grows, we will see it encompass more and more elements of the real world (Landt 2003), "ubiquitous means not merely in every place, but also in everything" (Greenfield 2006). The Internet of Things, through item-based tagging and identification, will take ubiquitous computing,

anytime and anywhere communications, to the next step in networking, 'anything communications'. It builds upon the success of mobile and Internet networks (ITU 2005) by expanding the world's networks even further. What makes this moment like any before, is that the decreasing cost and size of the hardware, and the increasing computational power of software, have converged so that it is now feasible to embed enormously powerful digital intelligence and processing capability into potentially any object or space. The Internet of Things speaks directly to Weiser's vision of ubiquitous computing and communications, a technological framework that will transform the corporate, community and personal spheres that we inhabit.

Personal computers dealt with the assumption that everything one needed was stored locally. Networked computers built upon that, assuming everything one needed could be made universally accessible on the Internet. Ubiquitous computing furthered this notion, allowing you to take the Internet with you out into the real world, accessible through mobile devices. As communications become increasingly ubiquitous in everyday life; "ordinary objects, from coffee cups to raincoats to the paint on the walls, would be reconsidered as sites for the sensing and processing of information" (Greenfield 2006), the Internet of Things presents a framework in which computer devices can be embedded in everyday objects, invisibly at work in the environment around us; in which intelligent, intuitive interfaces will make computer devices simple to use and unobtrusive, and in which communication networks will connect these devices together to facilitate anywhere, anytime, always-on communications (Weiser 1991). I term this 'Thing centered computing' an 'expanded' Internet able to detect and monitor changes in the physical status of connected things (through sensors and tagging technologies) in real-time.

The creation of the Internet of Things will entail the connection of everyday objects and devices to all kinds of networks, e.g. company intranets, peer-to-peer networks and even the global Internet. In this way, the 'virtual world' would 'map' the 'real world', given that everything in our physical environment would have its own identity in virtual cyberspace, enabling communication and interaction between people and things, and things themselves. If humans are the only Internet users of the future, then the total user base might conceivably double, but is unlikely to go beyond two billion active users in the near future (ITU 2005). On the other hand, if 'things' become active Internet users on behalf of humans, then the number of active connections could be measured in terms of tens or hundreds of billions (Sakamura 2005). Embedded intelligence at the edges of the network, in combination with empowering things to detect and monitor their environment though sensors, will enable the network to sense, react and respond to stimuli. The Internet of Things leads us into a new era of ubiquity where humans may become the minority as generators and receivers of traffic, and instead most of the traffic could flow between devices and all kinds of 'things'.

As our objects and our environments are getting smarter, as information processing capacity becomes embedded within and distributed throughout ever-broader regions of space, the artefacts, spaces and

systems we interact with (and through) on a daily basis will collect sand tore information about us, activated by our movements and transactions. Objects and environments, imbued with the capacity to remember correlate, and anticipate a near future capable of reflexively monitoring its environment and our behaviour, becoming an active agent in the organisation of everyday life. Enabled by tiny, inexpensive microprocessors and low-powered wireless sensor networks, processing will become ambient. No longer solely 'virtual', human interaction will be with and through computers, and the Internet of Things promises to be more socially integrated and spatially contingent as everyday objects and spaces become linked through networked computing.

This resulting networking paradigm, will provide a paramount set of opportunities to users, manufacturers, and service providers as data logged in a database can be used to find correlations between owners and applications. We can summarise the Internet of Things as the technical and cultural shift anticipated as society moves towards a ubiquitous form of computing that creates a link between concrete objects and abstract data, producing a hybrid of physical and electronic spaces that enables communication and interaction between people and things, and things themselves. It is an all-encompassing framework to reflect on and design towards more digital connectivity, a system that is local and global, accessible in real-time from any location.

For many of us it is a leap of the imagination to think that embedding microprocessor power in everyday objects can meaningfully affect the interaction we have with them, or them with us. Even though we are at a time when technologies are dematerialising more and more of the world around us (think books – Amazon Kindle, music – Spotify and photographs– Flickr), it is difficult to understand what possible impact connecting objects to the Internet could have on their own materiality.

The leads us to question, how can we have a critical discourse on the Internet of Things, when it is still largely a near future paradigm and not a ubiquitous framework which we can interact with on a daily basis?

Design Fictions

> "Visions of the future are particularly important for designers, because designers have to imagine both the future conditions that will exist when their designs actually come into use and how those conditions will be changed by the creation of their new design".
>
> Elliot and Roy (1978)

Over the course of the last decade we have seen design fictions extensively used by corporate companies to portray of an Internet of Things in reassuring short films; HP Cooltown (2000), IBM Smarter Planet (2010) and Cisco, The Internet of Everything (2012). Each of these have been a response to the shift towards "pervasive", "ubiquitous" (Weiser 1991), or "context-ware" (Schilit 1994) computing; a future

where we will inhabit spaces with objects capable of sensing, recording and relaying data about themselves and their environment.

HP Labs in 2000 presented the first Internet of Things design fiction, Cooltown, which addressed what HP identified as the "convergence of Web technology, wireless networks, and portable client devices provides". Cooltown's primary discourse was to provide "new design opportunities for computer/communications systems, through an infrastructure to support 'web presence' for people, places and things" (Barton & Kindberg 2002, Greenfield 2006). IBM's Smarter Planet followed this in 2008, shifting the Internet of Things importance from the act of connecting objects, to understanding the value of data as it flows between objects in a network (Castells 1996, Latour 2005). Finally, Cisco in 2012 presented The Internet of Everything, and moved the argument on one stage further, identifying that the importance of connected objects lies in the sum of their communication across silos of networks, where data can provide potential insight from which you can improve services (Johnson 2001, DeLanda 2006).

In order to effectively explore these three commercial design fictions of the Internet of Things in more detail, it is important to first discuss what a design fiction is, and how it is an approach by designers to understand these speculative futures.

The notion of design fictions is still taking shape in the discourse of design research (Dunne and Raby 2001; Schmitz, M., Endres, C. and Butz 2008), and the term was first coined by Sterling in his 2005 book Shaping Things, where he described it as something similar to science fiction, but different because it "made more sense". Recently he offered a formal definition, as "the deliberate use of diegetic prototypes to suspend disbelief about change". Julian Bleecker (2008) then further explored design fictions in a presentation given at the Engage Design conference in which he gave a response to an unpublished paper by Paul Dourish and Genevieve Bell entitled Resistance is Futile: Reading Science Fiction Alongside Ubiquitous Computing. In this article, the Dourish and Bell perform parallel analyses of design trends in science fiction television during the period from 1963 to 1989 and developments in ubiquitous computing in the 1980s.

Bleecker concluded that science fiction plays a significant role in shaping the general public's understanding of science fact, exploring how actual design and science as practices, intersect with the imagined futures of science fiction narratives. In a recent ACM interactions article entitled Design Fiction (2009), science fiction author and futurist Bruce Sterling considers how a design perspective can be used to inform the creation of fiction that better engages with the issues of an imagined or desired future.

Design fictions have much in common with other design related activities such as critical design (Dunne and Raby 2007), discursive design (Tharp and Tharp, 2009), design probes (Philips n.d) and speculative

design (Auger 2013). Whilst there is no commonly agreed definition, the commonality across all is that you are using design to create products, services, scenarios that suspend disbelief about change; they remove the commercial constraints that might normally limit the design process through the use of prototypes as the main method of enquiry, and fiction to present alternative futures (Auger 2013). Critical design, speculative design, and design fictions all have their roots in critical thinking, and they do not question whether a presented design is even feasible given politics, economics, culture, environments and technology futures, and in fact the resulting artefacts can often appear subversive and irreverent in nature (Coulton 2016). Instead design fictions get people to concentrate on how they communicate an idea; how they encourage discourse and debate and address challenges and opportunities. Design fictions allow designers to question "how things might be", they can also consider 'alternative presents' to enable them to question "why things are the way they are" (Auger 2013).

So, a design fiction is (1) something that creates a story world, (2) has something being prototyped within that story world, (3) does so in order to create a discursive space (Lindley and Coulton 2015). They are tools for thinking about the creation of experiences, whether it be near, or far future scenarios and narratives; they are "a suspension of disbelief about change that is achieved through the use of diegetic prototypes" (Sterling 2013). David Kirby (2009) uses the term diegetic prototypes to "account for the ways in which cinematic depictions of future technologies demonstrate to large public audiences a technology's need, viability and benevolence". Both Kirby and Bleecker provide the gestural interface from the film Minority Report as an example of a fictional realisation of a technology that went on to broadly inform public opinion (and design practice) about interactive technologies.

Therefore, design fictions can be understood as being used to create a discursive space within which new forms of cultural artefact, or futures, might emerge through the appropriation and manipulation of the cultural forms of design and fiction (Hales 2013). They typically often extrapolate upon the trajectories of current technologies that have not yet reached domestication, to create speculative presents or futures (Coulton 2016). Design fictions can thus be seen as a discipline which deals with practices and processes in order to create preferable future situations, aimed at discovering situations which are changeable and designed (Bonsiepe 2004).

Design Fictions increasing make the use of more complex narrative forms; whereas early scenarios focused on utility, more developed design fictions now also consider the social, psychological and ethical dimensions of technology development. Sterling (n.d) states that design fictions are "a contemporary form of forward thinking intervention, that has been enabled by the current networked media environment", which suggests that they are both a means of representation and a means on intervening. Sterling refers to this as a 'speculative turn' in design practice, that allows us to "think about the future prospectively and critically" (Auger 2013) on the "configuration of an event to come" (Gilles and Guattari 1994). Design fictions are future scenarios (Kirby 2009), which can be used as a participation in theoretical and artistic methodologies to open up design discourse (Sterling 2010). They are motivated

by challenges, opportunities and possibilities, not seen by others, to change something (Krippendorff 2007), and design artefacts that are an entrance point for critical thinking (Dunne 2005).

The Connection of Things

> "There's this place called Cool Town. Today it's a vision of scientists, engineers and other researchers at HP labs. It's a vision of the word where everybody and everything is connected wirelessly through the World Wide Web. People, places and even objects have websites. Beacons beam out their web addresses. People connect through a wide variety of smart, wireless, information appliances that can know who you are, where you are and what's going on around you and it all comes together to provide services people need, when and where they need them."
>
> (HP, Cooltown 2000)

The first of the Internet of Things design fictions, which I term the 'Connection of Things', was outlined by HP Labs in 2000 with their concept 'Cooltown. This was a response to what HP identified as the "convergence of Web technology, wireless networks, and portable client devices provides" (Barton & Kindberg 2002), and for Barton & Kindberg, employees of HP labs, this provided "new design opportunities for computer/communications systems, through an infrastructure to support 'web presence' for people, places and things."

At the time of Barton & Kindberg's writing, much of the information on the World Wide Web simply described the world we physically inhabit, and there were few systematic linkages to real world entities. The Web was largely a virtual space: a space of web 'sites', online 'malls', and chat 'rooms', whose virtual locations had very little correspondence with physical spaces (Barton & Kindberg 2002). Therefore, most of HP's work focused on extending web technology, wireless networks, and portable devices to create a virtual bridge between physical entities (including users) and electronic services. HP articulated this experience as our environment having web hyperlinks at certain physical points, that are captured and presented on to a user's client device and the result of clicking on such a hyperlink would be a web page delivered to the user's screen.

> "We have been pushing web technology into digital 'appliances' or 'things'... enabling users to automatically discover web resources associated with non-electronic things such as CDs, books and printed papers. We have been organising physically related things into web 'places'. We have been exploring ways for people to use new digital communications devices to interact with these places and use the things they find there".
>
> (Barton & Kindberg 2002)

Barton & Kindberg's outlined a design fiction of "applying Web technologies to develop systems that supported the users of wireless, handheld devices for interacting with their environment, anywhere that they may be" (2001). Barton & Kindberg give a vision of a user experience as a mixture of web browsing combined with the manipulation of handheld devices which are automated and enhanced with sensor technologies. These devices are triggered by the user, but more importantly are also triggered automatically "in response to services that are integrated with their physical surroundings, which load

web pages and submit web forms without the user's intervention". They discuss people carrying a multitude of devices on their person, where 'each device, is specialised for certain purposes, that will differ from others in the way it uses web content", the detailed experience of which will "depend upon the device and its application by the user".

> "A user at a conference with a PDA or cellphone device equipped with infrared sensors will approach an infrared 'beacon' at the entrance to the conference hall. Holding the device like a Star Trek 'tricorder' in front of the beacon, the user will see a web page describing the room and its facilities. The user scheduled to speak at the conference would point their web client – a PDA or even something smaller like a watch –at the room's projector and transfer to the projector the URL for their presentation. Here the handheld device has minimal web client function: it only needs to hold URLs. The projector on the other hand is a sensor-enhanced web browser: it senses URLs from users in its environment and displays the corresponding pages."
>
> (Barton and Kindberg 2001)

Barton & Kinberg's own terminology speaks to a science fiction, with their reference to a Star Trek tricorder, however today the ability to download a conference proceeding as an app upon the scanning of a QR code or send a presentation to screen via AirPlay is considered common place. However, the significance at the time was the recognition that handheld devices would mean that content "need not be bound to particular applications of environments", and instead, content delivered at the time and for future interactions. The content would be based upon the current physical context which would incorporate more contextually elaborate information, and which would differ based on "environmentally sensed data".

> "As a mobile user moves into a new area they can carry a device they are comfortable using. In that new area they can download content that corresponds to that area. They can invoke services they did not know existed until just before they used the service."
>
> (Barton and Kindberg 2001)

Cooltown views the role of an object in the Internet of Things as the ability to extend the web to create a virtual bridge between physical entities and electronic services, through the use of sensor-enhanced portable devices; "we can adapt the web user interface through integration with physical artefacts using sensing technologies". Barton & Kindberg (2001) specifically draw reference to the how their model "integrates the physical world with the virtual world of the web", which is achieved by identifying one or more web resources with objects in the physical world, and then placing a 'link' from the object to the resources.

At the same time that Barton & Kindberg were proposing this integration of the physical world with the virtual world of the web, Peters Anders (1997) presented his theory of 'Cybrids'; hybrids of physical and cyberspaces that denote new compositions that integrate real and digital spaces (Anders 1997, 1998, 2001). Anders describes Cybrids as entities which are the result of today's technologies, that offer a new class of symbol, one that while not material, has a presence of bordering on the tangible. Cybrids represent a link between concrete objects and abstract data, which produce a hybrid of physical and

electronic spaces that investigate how cyberspace can work in a way that is native to the ways we think and live with space.

> "Cybrids – a link on the continuum between concrete objects and abstract data. The line that separates data from objects represents a continuum rather than a division. Today there are situation where data and concrete objects work together to create new spatial entities, herein called 'Cybrids'. A Cybrid is a hybrid of physical and electronic spaces."
>
> (Anders 2001)

Anders uses Cybrids to refer to the increasing role computer technology was taking in his practice as an architect. Anders used computer modelling to create sophisticated models that resembled the final designed product. These allowed his clients to experience spaces as beautiful renders to virtual walkthroughs, providing them with the ability to see a building from different angles before it existed as a physical building. Through this design practice, it meant that the object, in this case a building, must first be considered as being all digital or all information. Anders discusses the ability for an object to be a methodology for 'mapping of space and information', and in this context, changes the informational processes into something that is 'spatial in nature' and in 'direct relationship with the physical'. This results in a "virtual and physical world that correspond with each other, comprised of 'entities' that 'cybridize' within that world".

Anders views cyberspace as an electronic extension of cognitive space (Anders 1998) and the connection between the physical object and the symbolic or virtual object must be as tight as possible; when interaction occurs with the physical object it has an effect on the symbolic component and vice versa. In Anders' words they have a "shared component", which is an object's ability to hold or relay information; the examination of a cyberspace object might bring up data on its past, or information about its materials in a spreadsheet. (Anders 1998). Anders talks of a "Cybrid reality", a blurring of distinctions between what needs to be physical and what doesn't, and notes that Cybrids will certainly require some degree of embedded, environmental computing to ensure the coherent merger of these physical and cyberspaces (Anders 2003). Cybrids can easily be interpreted as an early vision of the Internet of Things, in which "I have a physical object here that notes my handling of it and displays its contents to me in this way".

Objects in the Internet of Things that have this 'web presence', the ability to uniquely identify anything immediately via a machine-readable identification, offer the opportunity to intensely map the real world onto cyberspace with increasing detail. Once you have an object with this capacity, you can attach meta information to it, thus creating a digital representation. Adam Greenfield (2006) describes this process as endowing an object with an 'informational shadow' and notes "the significance of technologies like RFID and 2D bar-coding is that they offer a low-impact way to 'import' physical objects into the datasphere". Greenfield's proposal of 'informational shadows' can be viewed as an extension of Alan Westin's term 'data shadows'. Westin refers to the facts or fictions that are implied by the recorded data of people's transactions, the traceable data a person creates by using technologies such as credit

cards, cell phones and the Internet, and Greenfield is arguing the same traceable data can be applied to objects in a network.

Mike Kuniavsky (2010) identifies three key technologies for attaching an informational shadow to an object:

- Inexpensive machine-readable item-level identification technologies uniquely mark every object.
- Wireless networking makes the information shadow of objects accessible to devices in more places.
- Networked information aggregation services create a standard way of accessing information shadows that are produced simultaneously in many places at once.

For Greenfield these key technologies create a "vision of processing power so distributed throughout the environment that computers per se effectively disappear" (Greenfield 2006) Although the aspect of this vision have been called a variety of names, ubiquitous computing, pervasive computing, physical computing, tangible media and so on, Greenfield refers to them as one coherent paradigm of interaction that he calls 'everywhere'.

In 'everywhere', the garment, the room and the street become a site of processing and mediation. Household objects from shower stalls to the coffee pots are reimagined as places where facts about the world can be gathered, considered and acted upon. All the familiar rituals of daily life, things as fundamental as the way we wake up in the morning, get to work, or shop for our groceries, are remade as an intricate dance of information about ourselves, the state of the external world, and the options available to us at any given moment.

The traceable data that is generated by objects in 'everywhere', is part of larger network, or a 'synchronic society' as Westin calls it. The 'synchronic society', is the result of every human or machine consideration generating a small history, and Westin views these histories as 'information resources' that are capable of manipulation in real time. The synchronic society generates trillions of catalogable, searchable, trackable trajectories: patterns of design, manufacturing, distribution and recycling that are maintained in fine-grained detail. These are micro-histories of people with objects: they are the records of made things in their transition from raw material, through to usability, to evanescence, and back again to raw material. From books to frozen peas, parcels, to even people, things move through scanners to update their location; if that location has particular properties, then aspects of its condition complement the data that is associated with the object; "In this way, things carry data about the world around them" (Speed 2010).

Ubiquitous computing is transforming the design and use of the way we move through and interact with space. The Internet of Things, and its associated digital technologies, operate beyond what many of us

long accepted as the traditional site of computing; the desktop or PC. More and more of the everyday objects in our lives are now 'smart'; our phones, our appliances, our running shoes, our cars. We are accustomed to finding advanced technology in places that would otherwise have been unlikely, if not unthinkable, just a couple of years ago.

From a design perspective the Internet of Things provides a hybrid design space that on one hand poses a unique set of methodological, ethical and philosophical design challenges arising from the connection of everyday objects to the Internet, and on the other hand provides opportunities to design new media systems that augment the way we experience our environment. As the data clouds of the twenty first century descends on to the streets, pavements, and driveways, to the front door of our homes and through them, Shepard (2011) questions to what extent are the informatics weather systems becoming "as important, possibly more important" than the formal organisation of space and material in shaping our experience of our environments?

This is a fundamental reconfiguration of physical space; one in which a vast and mostly invisible layer of technology is being embedded into the world around us. Using a wide range of complex technologies and devices, from microprocessors and electronic identification tags to sensors and networked information systems, the landscape and the objects within it, are being transformed and imbued with the capacity to sense, record, process, transmit, and respond to information and activity taking place within and around them.

It is clear that a future Internet will embody a large number of objects that, through standard communication protocols and unique addressing schemes, will provide information and services to the final users; either human or thing. Indeed, billions of objects are expected to take a major active role in the future network, bringing physical world data into the world of digital content services.

As computing leaves the desktop and spills out on to, and into, the things and spaces that make up our everyday lives, we increasingly find information processing capacity embedded within, and distributed throughout, the material fabric of everyday. As the ITU (2005) report argues, in the interest of seamless integration of objects into information networks and databanks, it is crucial to in-scribe objects with a standardised set of markings which will both identify them and allow them to be visibly traced. On any given day, we pass through transportation systems using RFID tags to pay a fare, we coordinate meeting times and places through apps on the run, we cluster in cafes and parks where WIFI is free, and we move in and out of spaces blanketed by CCTV surveillance cameras monitored by computer vision systems. The artefacts and systems we interact with daily, collect, store and process information about us, and are activated by our movements and transactions.

If we instrumentalise the physical world around us with the ability to collect data, process information and take action, what profound changes will this bring about in the shape of the physical space we inhabit and how we exist and co-exist in it?

The Spatiality of Things

> "Our planet is alive with data. It's generated by cars on the freeway, patients in the hospital, electricity in the grid. The more we understand data, the more answers we find. Patterns are easing traffic in over 400 cities, detecting disease faster, reducing energy costs by 10%. On a smarter planet we can analyse all the data we now see, to make the world work better."
>
> (IBM, Smarter Planet 2010)

We must therefore not only consider the ability to attach data to an object, but also the object's place in our networks. This extension of the understanding of an object in the Internet of Things was presented by IBM in 2012, entitled Smart Planet, and is the second design fiction of the Internet of Things that I term the 'Spatiality of Things'.

Cooltown was an articulation of a world that would be increasingly instrumented, with examples ranging from tiny sensors and RFID tags in stand-alone products, accessible through smartphones and location-aware GPS devices, to notebook PCs and embedded systems. Devices that would typically have enough computing power to gather and transmit data which they can communicate directly across local networks or indirectly by way of clouds.

Smarter Planet extends HP's vision of Cooltown, by proposing that the Internet of Things offers up the ability to gather all of the data that is collected by these small, medium, or even large devices, and route that data to where it is best interpreted, allowing us to understand what is happening and respond accordingly. IBM views the of the role of an object in the Internet of Things, as not just its ability to offer web services by becoming instrumented and interconnected, but also for the object to become intelligent. The value lies in the ability to capture information wherever an object exists, move that information from the point of collection to wherever it can be usefully consumed, and then process, analyses and act upon it to derive maximum value and knowledge (Lampkin 2012). Bhumkar (n.d.) refers to how the interconnection of objects and devices results in a world that gets "smaller and "flatter", but also offers a new potential of becoming "smarter" through the ability for intelligence to be embedded into the way the world literally works.

> Smarter Planet's vision explains how a whole new generation of intelligent systems and technologies — more powerful and accessible than ever before — could be put to use for profound impact and to encourage further thinking. Smarter power grids, smarter food systems, smarter water, smarter healthcare, smarter traffic systems. And sophisticated analytics and algorithms that could make sense of it all.
>
> (IBM n.d.)

Smarter Planet is a reflection on what **IBM** saw as the trend in the rise of smart interconnected devices that are capable of measuring, moving and acting upon the information, which would be an extension of the ability of the Internet to connect people to information, or to other people in a network through the bits of data that make up daily life. (Lampkin 2012).

IBM situates the Internet of Things in the context of network and as such shares with another term, locative media, the ability through different location-based technologies to create a data sphere for the Internet, which can offer up new possibilities to locate or 'attach' the digital to objects, space and people. This is the starting point for rethinking our relationship with the physical and material world; we can begin to imagine scenarios where the physical and digital spheres collapse onto each other.

Locative media, as a definition, represents a complex field of different technologies in which boundaries are not strictly defined. Locative technologies include not only specific location-positioning tools like GPS (Global Positioning System) but also wireless communication technologies typical of digital mobility. The wireless cloud around us includes telecommunication system at different geographical scales: global, local and personal.

Bruce Sterling proposed that there are different locative media technologies, the Global Positioning System and Local Positioning System (Wi-Fi, Bluetooth, RFID, ZigBee). The Local Positioning System is defined as being conceived for short-range technologies that could communicate amongst each other, with people and environments. Locative technologies provide a bridge between two worlds, highlighting the tension between the digital world of data and the physical world both on a global scale and on a local one. The implications are, therefore, huge in cultural, social and political terms; by enabling information to be tied to geographical space it allows a new digital morphology to grow overlapping the real one; a data sphere enacted wirelessly by information and communication technologies.

The ability to create a relationship between information and location, is evident through the rise of smartphone apps, which have proved very effective in areas such as user-generated content and the ability to reveal a user's location. This potential is enhanced still further as 'near-field' technologies emerge, allowing users to exchange data with objects and for objects to exchange information with each other as part of an 'Internet of Things'. Smartphone use is starting to soften the traditionally close connection between activity, place and time, affording users a more spontaneous negotiation of meetings and transactions within their daily activity (Wang et al. 2011). Because of their ability to allow connections with everyone in a community all of the time, as a socio technical device, they greatly enhance how users engage with place and time (Wilken 2008) and impact on the spatial and temporal organisation of our activity scheduling and wider social interactions (Campbell & Kwak, 2011; Line, Jain, & Lyons 2011; Neutens, Schwanen, & Witloz 2011). In a personal sense, the smartphone is now enabling more negotiated scheduling of activities to better cater for our dynamic needs and circumstances.

The advances in ubiquitous computing have meant that our society is becoming increasingly connected, and the rapid adoption of mobile technology (Ofcom 2011) has afforded people more visibility and fluidity in their transportation decision making (Ling 2004). Because of their ability to create user relevant contextual awareness, smartphone app development across the travel domain has increased with a proliferation of applications allowing users to visualise transport modes, goods and services in a space and time relevant to their current and future location. Of real interest is the way apps are now enabling travellers to micro manage their itineraries (Wang et al. 2011) through the use of geo-fencing and tagging to obtain alerts to facilities, services and offers.

Most implications of an Internet of Things consist of programs resulting through the convergence of identification and location technologies related to the manufacturing process for consumer goods and their associated logistical systems, such as stock control and product tracking. Bruce Sterling (2005) termed these objects as 'Spimes', an object that can be tracked through space and time, and throughout the lifetime of the object.

Spimes are digital and physical objects "that can link to and swiftly reveal almost everything about themselves" (Sterling, 2004) through referencing rich streams of data and information. The entire existence of these objects can be recorded, archived and searched, from before they were made (its virtual representation), through their manufacture, their ownership history, their physical location, until their eventual obsolescence and breaking-down back into raw material to be used for new instantiations of objects. "[Spimes] are regarded as material instantiations of an immaterial system", they're virtual objects first and actual objects second, which "begin and end as data" (Sterling 2005). Sterling predicts how the presence of 'Spimes' will completely change our relationships with our possessions; "I have an Internet of Things with a search engine. I no longer hunt anxiously for my missing shoes in the morning. I just Google them." (Sterling 2005).

The relationship between Westins 'data shadows' and Sterling's 'Spimes' is clearly evident. "Spimes are manufacture objects whose informational support is so overwhelmingly extensive and rich that they are regarded as material instantiations of an immaterial system. Spimes begin and end as data" (Sterling 2006). As discussed Sterling sees 'Spimes' resulting through the convergence of these emerging technologies, which are specific to constructing the framework that is the Internet of Things, a platform in which every object manufactured will be able to be tracked from cradle to grave, through manufacturer to distributor, to potentially every single person who comes in to contact with it following its purchase. These systems offer the ability for the condition of an object to be recorded in a variety of forms and streamed to databases that can be correlated and mined to ensure that things, for example, are in the right place now or have been in the right place in the past, have been kept at the right temperature and handled by the right people (Speed 2010, Mcfedries 2010). Ubiquitous networked media influences the way in which spaces are used and they provide means to make incremental

adjustments that enable what has been termed the tuning of place (Coyne 2010), resulting in a 'computable city', an environment enabled by remote sensors and networked computation that has significant impact on how we interact with urban spaces (Batty 1997).

We can understand the 'computable city' as the relationship between object, network and place. Information and communication technologies have expanded traditional physical space, through the creation of "virtual communication" spaces. The deliberate linkage of the physical world with the virtual world through RFID tags and sensors, has led to 'permeability' between data contexts (Geser 2002). In a ubiquitous Internet of Things ones sees a blurring boundary between the public and private spheres, accessible under a variety of conditions (Stalder 2002).

Central to computable city is the rise of Web 2.0 technologies and Cloud Computing, which is now the driving force behind many Internet communications and data collection techniques. The term is adapted from O'Reilly Media in 2004 to summarise the rise of services from web-based communities focusing on technologies of social networking, social bookmarking, blogging, Wikis and RSS/XML feeds (Graham 2007). Add into this mix the ability to tag, provide and embed objects with data and you have the potential to change the social and economic value of real world objects and alter our interactions with them. To borrow a term relating to geographic information, the 'MashUp' is changing our information landscape. By linking objects to data and places you can 'MashUp' data with the real world.

The computable city looks at the cloud on a macro/micro scale, a way to create and maintain together a mixed social network through tracking, locating and collecting data of the developing network; physically or virtually, attached to the place, object or body. In an Internet of Things, where each person and object can be identified through standardised networked semantics and has a locatable, addressable, and readable counterpart in the Internet, how will we allow their circulations in time-space to become visible?

Castells (1996) addresses this question in what he terms "the space of flows in the networked society"; a theory to highlight how networks are comprised of organisations, people, things and also data, a structure to sustain the traceability of information as it moves between these nodes of a network.

Castells argues that society is constructed around flows, including flows on information and technology, and these form characteristics of social practices that dominate the shape of the networked society. The networked societies are a material product whose form, function, and social meaning is determined by the social relationships to other material products (people, things, institutions), and is constantly formed through "the purposeful, repetitive, programmable sequences of exchange and interaction between physically disjointed positions held by social actors in the structure of society." (Castells 1996).

The space of flows made up of movement that brings distant elements, things and people, into an interrelationship that is characterised today by being continuous and in real time (Castells 1996, Stadler 2002). Their interaction is in real time, as they are entirely digital, and one of its consequences is that space can expand and contract very quickly. As flows change their volume and direction, the nodes change their characteristics based on their relationship to another node, which are in turn create flows. In other words, function, value and meaning in the space of flows are relational and not absolute. Whether a node "works" or not, then, is not only determined within the node, but emerges from the network of which the node is only a part (Callon & Law 1997). As the network changes, old connections die, and new ones are established, causing a change to meaning, functionality and values as the flows are reorganised through other nodes.

Castells' central argument is that the space of flows is created by the real-time interaction of distributed social actors. The space is comprised of interactions and the material infrastructure that make these interactions possible. It is important to understand that the space of flows is both the real time interaction of people, who can be physically distant from one another, as well as the material infrastructure that makes this possible, in other words, the space of flows has both material and immaterial aspects. As such we can understand the space of flows as being constituted through the combination of at least three layers of material supports; the medium through which things flows, the things that flow, and the nodes among which the flows circulate (Casetells 1996, Stadler 2002). The Internet of Things technological framework consists of these three material layers; tags and readers, data and objects.

How then can the Internet of Things serve as a technological framework that allows us to understand the influence of these new nodes (connected objects) on society through the flow of their informational shadows? In what way does it afford us the ability to visualise both the human and non-human actors that would influence the network participant's decisions?

The Internet of Things therefore can be most closely linked to Actor-Network Theory (ANT), a method for mapping the patterns of techno-science, where networks become the substance out of which both individual identity and social organisation are constructed. Actor-Network Theory can be seen as a tool for exploring and describing how the social is assembled by way of technologies; objects and artefacts (Latour 2005). Its import is one of agency, specifically responsibility that is distributed equally across entities, including a host of nonhuman ones not normally seen as exercising agency at all. (Bijker & Law 1992, Latour 1999).

In the Actor-Network Theory's analytical frame, also known as Sociology of Translation or Structuration Theory, reality is observed through interactions and is considered as the effect of heterogeneous networks; the creation and reproduction of social systems is based on the analysis of both structure and agents (Giddens 1984). As the actors in the network can be both human and non-

human, actor network theorists sometimes use the term actant to refer to such actors. Society, organisations, agents, and machines are all effects of patterned networks generated through the interactions of actor-networks (Law 1992). In other words, they are formed by the relationship between intermediaries - "anything passing between actors, which defines the relationship between them" (Callon 1991), actors and translation - the process of simplification and punctualisation that helps us to understand the complexity of the relationships.

Latour (2005) argues that the observation of the social can only be achieved by tracking the traces it leaves when an association is being produced between elements, and therefore Actor-Network Theory offers an appropriate methodological approach for analysing networked objects in the context of the Internet of Things; objects as actors in the network, considered to have a role within it that extends beyond their material form.

This ability of an object to impart actions within the network is discussed in the final Internet of Things design fiction, that I term the Emergence of Things.

The Emergence of Things

> "What if the next big thing, isn't a thing at all? It's lots of things; all waking up, becoming part of the global phenomenon we call the Internet of Everything. Trees will talk to networks; will talk to scientists about climate change. Cars will talk to road sensors; will talk to traffic lights about traffic efficiency. The ambulance will talk to patient records; will talk to doctors about saving lives. It's going to be amazing, and exciting and maybe, most remarkably, it's not that far away. The next big thing? We're going to wake the world up and watch wide eyed as it gets to work."
> (Cisco, The Internet of Everything 2012)

The third design fiction for an Internet of Things was presented by Cisco in 2012, entitled the Internet of Everything. Cisco defines the Internet of Everything (IoE) as the networked connection of people, process, data, and things. Cisco states that the benefit of their vision of an Internet of Everything, is derived from the compound impact of connecting people, process, data, things, and the value created through the increased connectedness as 'everything' comes online. By comparison, Cisco define the Internet of Things as simply the networked connection of physical objects, and it does not include the 'people', 'process' and 'cross network connection' components of their Internet of Everything.

Evans (2011) discusses the Internet of Things as currently being made up of a loose collection of disparate, purpose-built networks, and believes there is a shift from an Internet of Things to an Internet of Everything when these silos of networks evolve and are connected to one another through added security, analytics, and management capabilities; when the residential building network can 'talk' to the cars network to pre heat its interior before you commute to work.

"Today's cars, for example, have multiple networks to control engine function, safety features, communications systems, and so on. Commercial and residential buildings also have various control systems for heating, venting, and air conditioning (HVAC); telephone service; security; and lighting."

(Evans 2011)

The Internet of Things, or and Internet of Everything, is a starting point for rethinking our relationship with the physical world, were we begin to see scenarios where objects are an interface for data storage and retrieval, and their associated data now have multiple trajectories through space and time, and more importantly they have an 'awareness' of the environment they inhabit. Through adding a whole array of everyday things as nodes of the Internet, new connections arise that lead us to question the composition of a network; a set of nodes or network members that are tied by one or more specific types of relations. By focusing on the key idea of actors and how they are connected, we gain insight into the structure of social interactions.

Lopez and Scott (2000) as cited in Stones (2007) argued that there are two primary ways of conceptualizing structure, both deriving from Durkheim. The first is the relational notion of structure, referring to networks of social relations that tie people together into groups and social systems. George Simmel similarly emphasized relationships, conceiving of society as a dynamic of complex social forms and interactions. These may involve smaller or larger numbers of people, or specific types of association, which structure the way in which agents behave in one another's presence. Norbet Elias's figurational sociology likewise emphasised the webs and networks of relationships within which individual agents do act. The second notion of structure, the institutional, refers to the beliefs, values, symbols, ideas, and expectations that make up the mutual knowledge of the members of society and allow them to communicate with each other. Durkheim (1984) referred to this dimension of structure as a society's 'collective representations'.

Both approaches to structure are compatible with another metaphor routinely associated with structure: pattern. The notion of pattern is often included in the very definition of structure. For example, social structure may be seen as "a system of patterned relationships of actors in their capacity as playing roles relative to one another" (Parsons 1945, cited Stones 2007). The key notion here is the relationship of the actors, therefore it is important to identify what can be considered an agent in the structure.

Agency is a term commonly used when describing the role of a networked object in the Internet of Things. Bleeckers seminal paper, 'A Manifesto for Networked Objects – Cohabiting with Pigeons, Arphids and Aibos in the Internet of Things' (2006) was one of the first attempts to provide a social perspective on networked objects, to what previously had been predominantly the domain of logistical application. In it he terms the phrase blogject "Blogject" is a neologism that's meant to focus attention on the participation of 'objects' and 'things' in the sphere of networked social discourse variously called the blogosphere, or social web". Referring to Sterling's amalgamation of the terms Space and Time to create Spime, an object that is trackable in a system, he combines Blog and Object to differentiate

between an everyday object that exists in the world, and an object that is connected to a network that produces data.

Bleecker distinguishes between 'Things' connected to the Internet from 'Things' participating within the Internet.

> "Blogjects don't just publish, they circulate conversations. Blogjects become first-class a-list producers of conversations in the same way that human bloggers do — by starting, maintaining and being critical attractors in conversations around topics that have relevance and meaning to others who have a stake in that discussion."
>
> (Bleecker 2006).

Bleecker extends Sterling's proposal of a 'Spime' by adding agency to its characteristic. The characteristics of agency involve an ability to be decisive and articulate, to encourage action and a Blogject's intellect is their ability to affect change. Bleecker argues an object's agency is attained through the consequence of their assertions, and through the significant perspective that they contribute to meaningful conversations. In the Internet of Things, this kind of agency happens within the arena of the networked public; streams, feeds, track-backs, permalinks, Wiki inscriptions and blog posts. Things that matter inflect the course of social debate and discussion, that cannot help inflicting local and global change. Bleecker concludes that if an object were able to comment on the world around it, and through that commenting create change, then the agency between subject and object, human and non-human would be completely transformed.

A crucial feature of an agent within a structure is that it can interact; it can pass on informational messages to other agents and act on the basis of what it learns from these messages (Gilbert 2008). Gilbert notes that these messages may represent a dialogue, or a more indirect means of information flow, such as the observation of another agent, or the detection of effects on another agent's actions. Agents are conventionally described as having the following four important features (Wooldridge & Jennings 1995, cited Gilbert 2008).

- Autonomy – there is no global controller dictating what an agent does, i.e. it does whatever it is programmed to do in its current situation.
- Social Ability – they are able to interact with other agents.
- Reactivity – they able react appropriately to stimuli coming from their environment.
- Proactivity – an agent must have a goal or goals that it pursues on its own initiative.

If we can understand a networked object as capable of possessing agency, as a result of an amalgamation of characteristics outlined by Anders, Sterling and Bleecker, then it is important to further deconstruct these features; as without consciousness then it is unlikely an object will ever have autonomy or proactivity due for the need of human intervention to govern these two properties. Therefore, a more

helpful way of describing agency within this context, is to define the following characteristics derived from Gillbert's agent-based modelling (2008).

- Perception – they can perceive their environment, possibly including the presence of other agents.
- Communication – they can send messages to and receive messages from other agents.
- Memory – they have a memory, which records their previous states and actions.
- Policy – they have a set of rules, heuristics, or strategies that determines, given their present situation and their history, what behaviours they will now carry out.

This model of agency is based on theories relating to Actor-Network Theory. Actor-Network Theory insists on the agency of nonhumans, although it is critiqued that the properties outlined by Wooldridge & Jennings relating to autonomy and proactivity, or in other words intentionality, fundamentally distinguish humans from animals or from things. In the context of Actor-Network Theory, agency is located neither in human 'subjects' nor in non-human objects, but in heterogeneous associations of humans and nonhumans.

If Actor-Network Theory's definition of agency neither presupposes intentionality nor is assigned to nonhumans, how else might we understand the properties that result from the pattern between objects in a structure?

> "We make powerful motor cars by suitably assembling items that are not themselves powerful, but we do not do this by 'adding in the power' at the very end of the assembly line; nor, if it comes to that, do we add portions of power along the way. Powerful motor cars are nothing over and above complex arrangements or aggregations of items that are not themselves powerful."
> (Strawson 2006)

Emergence refers to the arising of novel and coherent structures, patterns, behaviours or properties during the process of organisation or interactions in complex systems, which appear differently in different types of systems; whether they occur in physical systems or in computer simulations (Goldstein 1999, De Wolf and Holvoet 2005). Emergence is not to be confused with self-organisation which emphasises the dynamical and adaptive increase in order or structure without external control. Within the context of the Internet of Things this is especially important as without artificial intelligence all output of any system is ultimately traced back to a human's code that arguably exerts control.

Examples of emergence around us are: global pheromone paths that arise from local path- following and pheromone-dropping ants, the swarming movement of a flock of birds, a traffic jam from the interactions of cars. However, one of the best ways to get a feel for emergence is to consider widely cited core examples of apparently emergent phenomena, for example, the liquidity and transparency of water is said to emerge from the properties of oxygen and hydrogen in structure collections of water molecules. Liquidity is not a characteristic of individual $H2O$ molecules, nor is it a characteristic of the

ultimates of which H2O molecules is composed. Yet when you put many H2O molecules together they constitute something liquid (at certain temperatures, at least). So, liquidity is a truly emergent property of certain groups of H2O molecules. There are many chemical and physical systems in which patterns of this sort arise simply from the routine workings of basic physical laws, and such patterns are called 'emergent'. (Bedau and Humphreys 2008; Strawson 2006)

Emergent phenomena share certain interrelated, common properties that identify them as emergent, which include; radical novelty, coherence or correlation, global or macro level, dynamical and ostensive (Goldstein 1999; De Wolf and Holvoet 2005). Within the context of the Internet of Things, we will define emergence as arising through "interacting parts", where the parts of the system need to interact - "parallelism is not enough". Without interactions, interesting macro-level behaviours will never arise. These interactions are "dynamical", or ins a constant state of flow, and emergents arise as the system evolves in time, where new kinds of behaviour become possible only at a certain point in time. Emergent properties can be understood as being radical novel, because the collective behaviour is not readily understood from the behaviour of the parts in isolation; they cannot be studied by physically taking a system apart and looking at the parts. Most importantly emergent properties are relational; they are implicitly contained in the behaviour of the parts if they are studied in the context in which they are found. If emergence is a matter of higher-level phenomena coming from the organisation of lower-level phenomena, what are they emergent properties of an object in the Internet of Things?

The chapter is contextualised the three commercial design fictions of the Internet of Things, in critical thinking that had previously not been joined. In the next chapter I will use practice-based research for art and design to embody this critical thinking to reflect upon the trajectory of object to data, connectiveness to network to emergence. The aim is to understand what are the possible emergent properties of an object in the Internet of Things, when we create dynamic patterns, arrangements or aggregations between or across the data sets of things and apply our own algorithmic laws to them at a given moment in time?

Practice

Research through Design

> "The most distinctive quality of this line of research is that it provokes issues that are unconscious and hidden in people's everyday lives. It means that the design does not aim for a specific solution to a problem, but rather an open-ended discussion that is less predetermined and more unanticipated"
>
> (Kim and DiSalvo 2010)

Research through design (RtD), the practice of using design thinking, processes, and products as an inquiry methodology, has garnered considerable attention in both Human Computer Interaction (HCI) and design discourses (Bardzell 2015), and the term is widely attributed to Frayling's highly influential working paper "Research in Art and Design" (1993). The intent of research through design is widely understood as the method to create new design knowledge by reflecting upon the process that led to the creation of the artefact rather than the artefact itself. Research through design as a practice in itself is knowledge producing (Archer 1995), and so too can the designed object. However, Bardzell (2015) states that a confusion of Fraylings initial definitions has occurred, and what HCI researchers call "research through design" most closely maps onto what Frayling in fact called "research for design" (Frayling cited in Bardzell 2015; Lindley 2015).

- Research into art and design: historical research, aesthetic and perceptual research, and research into theoretical perspectives on art and design (i.e., traditional art historical and critical-humanist approaches to art and design). It represents a pursuit of new knowledge about the practice, as opposed to actually doing the practice; this kind of research is theoretical.
- Research through art and design: materials research (i.e., "customising a piece of technology to do something no one had considered before"), and the explicit and detailed use of an art/design research diary. It refers to the production of knowledge resulting from a design/making process.
- Research for art and design: research "where the end product is an artefact - where the thinking is [...] embodied in the artefact". It refers to a contextual search that is conducted to support the design and production of a design fiction artefact using the and collation of, pre-existing knowledge.

A consequence of this confusion is to ignore art as a mode of knowledge and understanding in which the artist, like the designer and the researcher, is determined to explore and investigate (i.e. research) the world through interrogating, designing, organizing, and making; a practice that is referred to as "art practice as research".

> "Art practice can be seen as a form of intellectual and imaginative inquiry, and as a place where research can be carried out that is robust enough to yield reliable insights that are well grounded and culturally relevant."
>
> (Sullivan 2006)

Due to my practice as a digital artist, it is important to note that the intended output of the practice-based is not research through design, to create products that could be evaluated through quantitative and qualitative research to reflect back upon the process of designing for an Internet of Things. The practice is primarily research for art and design, where each piece allows the audience to experience existing complex theoretical discourses alongside the technological propositions of Internet of Things and produce meaning as part of an aesthetic and cultural exchange or interaction with the viewer.

As such I introduce the term "design intervention" to describe the output of my practice and the methodology used for in my research for art and design. This is a mash up of design fictions and art intervention; a term applied to art designed specifically to interact with an existing structure or situation, be it another artwork, the audience, an institution or in the public domain (Perini 2010, Tate).

Methodology

> "The best way to understand the many difficulties of design fiction is to attempt to create one."
>
> (Sterling n.d.)

Dunne and Raby (2013) argue that design as critique, through practices such as design fictions, can be valuable in the problematisation of technologies. They suggest that by "moving upstream and exploring ideas before they become products...designers can look into the possible consequences of technological applications before they happen".

This thesis uses the perspectives of critical and speculative design, in order to explore an area of near-future/upstream technology that is of substantial interest to both commercial developers and researchers – the "connection of everything" via the deployment of Internet of Things' technologies that instrument multiple aspects of our lives. The following nine design interventions explore how we can assess the critical thinking on Internet of Things discussed in the previous chapter, through practice research that uses design fictions as methodology for enquiry; "doing research is much more like doing design" (Frayling 1993) or design fictions are both 'thinking and doing' (Sterling 2015).

However, when using design fictions as a method of enquiry, we must be wary of its limitations due to the very definition of the word fiction; something that is invented or untrue that describes imaginary events or people. Sterling's (n.d) in his text Design Fiction for Media Philosophers, describes design fictions as ranging "from very simple descriptions of postulated objects and services, to elaborate hoaxes".

Coulton (2016) in his paper on design fictions, argues a key element in any design fiction is that of the notion of plausibility; "an attribute that describes credibility and believability of a concept, as well as its potential to be a truth". Auger (2013) describes this ability to present plausible futures through the combination of informed extrapolations of emerging technologies and the application of techniques borrowed from film, literature, ecology, comedy and psychology. Coulton highlights this tension between speculative design and plausibility, "given that plausibility is a subjective matter and is personal to each person engaging with a design fiction" and states "the field of Human Computer Interaction (HCI) has long used deception, the so-called Wizard of OZ technique, to elicit plausibility."

> "This is in reference to the 1939 Wizard of Oz movie starring Judy Garland in which the Wizard hides behind a curtain and used a voice amplifier and avatar projection to pretend to be 'The Great and Powerful Oz'. In a similar way HCI researchers surreptitiously intercept communications between participant and a computer system to supply the responses and actions, giving the appearance of a functional system, where in fact none exists."
>
> (Coulton 2016)

The plausibility of such fictions comes by achieving the right blend of factual reality from the present when creating diegetic visions of the future (Lindley and Coulton 2014). In order to successfully achieve this blending, it is often useful to draw upon the familiar and mundane elements of everyday life as people have very little experience of what they may encounter in the future as their expectations are usually based upon what they understand today (Evans 2011). As such, design fictions have seen a reliance on short speculative narratives, or value scenarios, as a method for inspiring critical reflection (Nathan et al 2008); short fictional vignettes have long been used to summarise findings from user studies and to illustrate potential technologies (Carroll 1999).

The practice presented in this thesis, aims to draw back the wizard's curtain and instead challenge the notion of plausibility as the majority of case studies presented are functional inventions/artworks, that are both a design fiction and non-fiction at the same time. All the design interventions were working examples that were released to the public, and not illusions of an experience; or in other words the all too often 3-minute video articulating a future scenario. By ensuring that the case studies are fully functional they:

> "have a major rhetorical advantage even over true prototypes: in the fictional world – what film scholars refer to as diegesis – as these technologies exist as real objects that function properly and that people can actually use."
>
> (Kirby 2009)

As the Internet of Things to date is not an all-encompassing framework that we experience daily. Our cogitative model of this technological framework does not exist. We cannot explore a deeper understanding of the relationship between the digital and physical worlds (Anders 1998), where objects are globally traceable and searchable (Sterling 2005) and can capture and communication information about themselves and the happenings in their surroundings (Bleecker 2006).

The nine design interventions created through the methodology of design fictions in the context of practice-based research for art and design, allow for these arguments to be presented to the audience in things rather than in words, where the art of thought is directed to practical action through the persuasiveness of objects (Buchanan 1985), that create debate through the design interventions use.

The Connection of Things Design Interventions

These design interventions reflect upon the early vision of the Internet of Things as proposed by Barton and Kindberg (2002) in their industrial fiction of Cooltown, within the context of ubiquitous computing, which speaks to a vision of small computers that are embedded in everyday objects all around us. The work embodies two supporting theoretical fictions that emerged around the same time, Peters Anders' 'Cybrids' (1998) and Adam Greenfield's 'Informational Shadows' (2006). Both of these speak to how the Internet of Things creates a link between the physical and digital worlds, and the resulting impact on our experience of everyday objects.

Tagged City Play

Tagged City Play is a response to Anders (1998) design fiction of 'Cybrids'; the theory that objects will have a unique digital identity and play a pivotal role in joining the physical world with the digital. Designed at a time before the ubiquity of smartphones, Tagged City Play's aim was to explore what it is like to experience an environment containing networked objects that are designed to respond when they receive a signal, continuously transmitting information to whomever chooses to read it.

```
public void handleEvent(ContactlessEvent e) { if (e.getType() ==
ContactlessEvent.TYPE_READ_DATA) { switch (e.getStatus()) { case
ContactlessEvent.STATUS_OK: screenText.setText(e.getTarget().getCid()); String tagID =
(e.getTarget().getCid()); setTagRFID(tagID); setPlayerID("1"); setDisplay( getAddtagForm() );
break; } } else if (e.getType() == ContactlessEvent.TYPE_CONNECTION_STATUS) { } }
boolean connected = (e.getStatus() == ContactlessEvent.STATUS_CONNECTED); if
(connected) { mul.read(0, 64, false); screenText.setText("Connected"); } else {
screenText.setText("Disconnected"); }
```

Shingleton, D (2007). Tagged City Play, Arduino

'Tagged City Play: Judgement Day for first life game figures', is a multi-player computer game, played in the real cities. The situatedness of this pervasive play is given by the use of mobile and ubiquitous computing devices. RFID tags (Figure 1), both as implant on real players (Figure 2) and on real world objects integrate the so called 'Internet of Things' in a new game format. The situated play introduced within this project shall serve as a case study to analyse what was at the time a new tendency in locative gaming, integrating online geographical information systems, mapping systems, and the act of tagging and assigning value.
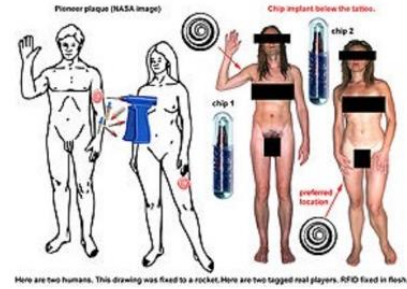
Figure 1: RFID Play Tag

Figure 2: 1st Life Game Figures by Tag/Implant

People were invited to participant through the injection of 'RFID Judgement tag'" under the skin of these 'Real Players' (Figure 3). Through doing so these Real Players are the 1st life persona, who decide to become 2nd life game figures in the Reality Engine, and their bodies become one of the game-interfaces. Each of these Real Player gets a special Quest. First: tag the city with a graffiti stencil to achieve a Full City Tag (the complete city is systematically tagged), through passing judgement by tagging objects, buildings, vehicles, or people. Second: scan tags with the printed circuit board Wunderbäumchens and change the Internet of things into the value Zero. Third: take souvenir photographs and commentary of the play tags, writing on new judgements and values at the games Pit Stop.

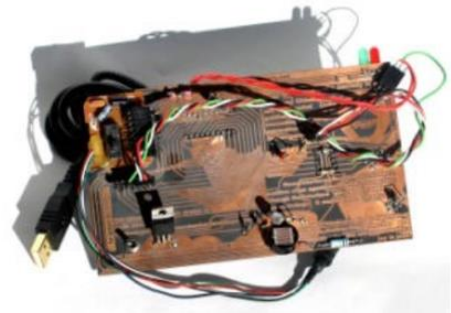Figure 3: Becoming a Real Player through RFID injection

Figure 4: Pit stop's RFID reader interface

Each tagged person appears as a live game figure, and in the local Real Play Pit Stop, a shop in the city centre equipped with a special RFID reader (Figure 4), he information carried by the bodies of game figures is uploaded. The implants of players are scanned to receive an individual play time and graphical display pattern on a satellite map. At the pit stop each player manually sets graphical markers, hot spots in the look of a Wunderbäumchen (the ubiquitous shape of the tree car freshener). Equipped with another sort of Wunderbäumchen, the artisan self-etched, device-art styled RFID reader, he/she uploads a set of ID numbers of objects tagged and names of objects de-tagged.

The Real Players tagging toolbox (Figure 6) contains a variety of tag utensils: graffiti, spray stencils, stickers, RFID stickers and implant injection kits. To tag the city, real world objects are subjectively

chosen as targets to be tagged. The tags are functional but useless (RFID- tags with zero data)! By putting this zero-tag on an object, players de-valuate real world things into virtual play-objects. On the other side players also search for existing tags. The goal of the play is to change the value of tags into the value Zero. To achieve that, Real Players are equipped with 'Wunderbäumchens'. These are technical toys for finding and reading tags and/or emitting a target- oriented EMP (electromagnetic pulse), to kill the tag: Tagging is passing a judgement!

Figure 5: A Borges'ian Psycho-Active 'Pata Play Map

Figure 6: Tagging Toolbox containing Wunderbäumchens

The situated play is visualised through the digital game interface, or the 'psycho active borgesian play map' (Figure 5), which runs in a web browser in real-time and dynamically updates whenever a tagged game player interfaces with it. This game interface was developed using at the time standard Web 2.0 development techniques; Macromedia Flash 8, Processing, PHP, AJAX, JSON and MYSQL. The software enabled you to capture the unique identification number of each low frequency tag from the RFID reader and store all information to do with the tag and its content, which was uploaded by the game player into the collectively played, graphical machine.

The play interface integrates GIS (Geo Information Systems), such as Google Earth and Wikimapia. All real objects of the world, that are marked with tags, can be found via these kinds of maps. Revealed through play, such a map should not perpetuate the impression of a neutral image of reality. From a ludic point of view, it needs a HUD (Heads-Up Display) style, a game-like graphical HUD over the satellite map. The look of the map as game score and display for subjective play data, forms the uncensored on-line map of "the Internet of things". A stencil-style satellite game map unmasks the satellite truth as construction by certain geographical data companies.

It showed the score of each player depending on objects tagged and de-tagged. The scoring function opened a variety of possible game-plays, as 'Last TAG standing' or 'Capture the TA'". Depending on each player RFID-cipher, it generated an individual graphical element to display the routes between tagging actions. The 'signature' element (another kind of tag) of each player is called 'squiggle'. The psycho-active 'pata play' map overlaid all of the squiggles to generate a collective image. It used additive layers to merge the individual route graphs into 2-dimensional graphic. The more players uploaded, the

more the game interface commixed the individual tagging squiggles to generate a collective image of geographically distributed, situated, virtually de-valuated real objects, appeared as a collective naming-ground.

The non-player visitor of the online map, saw an overview of all the sites of city tags (evaluated and de-valuated ones) and could cycle through the different layers of tagging routes. Souvenir photos and additional commentaries in different formats could be viewed at these marked hot spots. The option of adding commentaries or coming to the pit stop with further information about other zero-tags is open to every non-player character, who occasionally would cross or follow the route of the real players in the city.

Tagged City Play was an early reflection on what at the time was still an emerging theoretical debate. It raised questions around the connection of a physical thing with related data through the use of unique identifiers. Invited to participant through the injection of "RFID Judgement tags", Real Players are the 1st life persona, who decide to become 2nd life game figures in the Reality Engine, and their bodies become one of the game's interfaces. Players pass judgement by tagging objects, buildings, vehicles, or people, and in doing so, their trajectories through space are captured and graffitied over a virtual representation city as a game level. As players write new judgements on the everyday objects were share our environment with, they change the value of things in the city, and their actions are captured through souvenir photographs and commentary recorded on the play tags left behind.

> "Walking through the city after a hectic introduction at the Ro Theater, finally the Ludic Society starts to be really ludic and enjoy the play on the street. In the toolbox the tag-team, Führer got the injection kit, a sterilised EM4102 Microchip Syringe Pack to mark people as game characters, and a set of artisan edited tags to mark toy objects. Play tag, equipped with a reality engine goggle and a brand-new RFID pimped mobile phone for Near Field Communication".
> (Jahrmann et al. 2007)

The clearly defined goal of the Tag the City play is de-pricing the networked world of marked things. This is achieved with the help of the flexible tool-kit for the play of tagging the city. The outcome of a tag set on the play-map is open, and the Real Player actions cumulate in a collectively 'Borg-like' constructed 'Borges'-ian psycho-active play -map. Jorge Luis Borges (1941) describes "a map that occurs at a 1:1 scale, as large as the territory that it represents." A Borgesian 'pata-active' map displays a meta-game played 1:1 in the Reality Engine over the city, to blow up the most tagged sites and things with the value Zero. As in the absurd fantasy of Italo Calvino's (1972) invisible city, the game-play of this Real Play focuses on things we don't normally name as play objects. These works prepared the idea of a necessary transgression of 'situatedness', of extending the game zones into the cities (Lacovoni 2005). Furthermore, although it is a locative play with mobile electronic devices, the players come in person to the play's Pit Stop to be refreshed and to be read. With their tagged real bodies, players carry data to the Pit Stop, and as such become data packets within the network.

RememberMe and RememberUs

RememberMe and RememberUs are a response to the potential of emerging Internet of Things technologies, in the context of objects and data at the event-based point of personal exchange.

```
void serialEvent(Serial myPort) { String myRfid = myPort.readString();
readXML(trim(myRfid)); }void readXML(String tagnumber){ xml = new XMLElement(this,
"memories.xml"); int numSites = xml.getChildCount(); for (int i = 0; i < numSites; i++) {
XMLElement kid = xml.getChild(i); String id = kid.getStringAttribute("id"); String search =
kid.getContent(); if (id.equals(tagnumber)){playMemory(search); } } } void playMemory(String
mp3){ song = minim.loadFile("assets/"+mp3); song.play(); }
```
<div align="right">Shingleton, D. (2010), RememberMe, Arduino</div>

The RememberMe and RememberUs design interventions where part of a wider research programme of work, Tales of Things and Electronic Memory (TOTeM), which was designed to allow people to contribute stories and provenance information during the lifecycle of objects. Part of the brief of TOTeM was to build a novel platform, using the latest technological advancements, that could facilitate exploring how attaching social history and memories to things can alter our interactions with these objects. A key goal of TOTeM was to explore the stories attached to everyday objects in scenarios where objects change hands, and where in normal circumstances the history behind the object would be lost as ownership changes. 'Tales of Things', preserved the stories behind everyday objects, which is accessible to the general public (Barthel et al 2013), but which could then also be used as the basis for future data led design interventions. The project developed a system that allowed somebody to not only scan a barcode and 'read' about its history, but also the unique ability to add a further story on to a thing and effectively 'write back' to it (Barthel et al 2010). Furthermore, the Tales of Things allows any other beholder the ability to 'add a tale' to someone else's 'thing'. By scanning a tag through the smartphone App, or by visiting the website, artefacts become 'writeable' and 'open' to further association. This is a critical dimension to the projects politics, that lessons learnt through Web 2.0 should be integral to any Internet of Things (Speed 2011).

Tales of Things offered a simple but novel approach to recording social histories and a playful critique of the tagging culture and was set up to explore how to disrupt the use of printed barcodes. The existing public use of tags (RFID and two-dimensional barcodes) is based upon a 'read only' relationship. Until very recently, the scanning of barcodes on the side of product packaging was restricted to those who had 'red laser' scanners: till operators in supermarket checkouts, stock controllers and staff at airport check-in. The arrival of smart phones has enabled a wealth of software applications that have disrupted this previously exclusive practice. TOTeM as a tagging service allows people to tell stories about objects and places, generating provenance information about the things with which we surround ourselves, as well as offering a place in which unique codes are generated to allow these stories to be associated with the objects.

TOTeM's Tales of Things web application (Figure 7) allows anybody to attach web content (text, image, video and audio) to an artefact through the generation of a unique QR barcode that the owner is encouraged to stick to their thing. When scanned by somebody else using a smart phone, media is launched, and the object can be seen/heard to tell a story about the memories that it is associated with (Figure 8). The application provides an interface to create entries for new objects or to edit the entries of existing objects. A typical entry would have a title, a photo of the object, an optional location and one or more tales (stories) that can be enhanced by linking to multimedia files (or indeed any entity with a public URL). For every new object added, a unique QR code is automatically generated, which can be printed out and attached to the physical object. In addition to the web interface, bespoke mobile applications were developed for the iOS and Android operating systems. The mobile applications ('apps') allowed people to interact with tagged objects 'in the wild' by scanning the QR code. The mobile app allows users to view a scanned object's story and its associated digital media, as well as make their own contribution to the narrative, either as simple text or as a video story using the phone's on-board camera. The mobile app also allows people to create new Tales of Things for objects by scanning unassigned QR codes available from the website.

Figure 7: Tales of Things Website   Figure 8: Tales of Things App

As a result of this participation a 'network of things' is created, capturing the personal memories of users of the application, that explores how the capturing and replaying of stories and memories, and their linking to things via custom developed systems, provide novel ways to engage with past experiences.

The Remember Me and Remember Us design interventions was staged in collaboration with TOTeM and Oxfam as part of the FutureEverything conference and festival in 2010, and 2011. Both projects aimed to create a simple and fast way of embedding donated items with memories, through the use of RFID tags and QR Codes, to explore how attaching memories to objects changes their perceived value to potential customers.

> "What gives houses of our childhood such depth and resonance in memory is clearly the complex structure of interiority, and the objects within it serve for us as boundary markers of the symbolic configuration known as home. In their anthropomorphism the objects that furnish it

become household gods, spatial incarnations of the emotional bonds and the permanence of the family group."

(Baudrillard 1996)

Oxfam is an international charity organisation with 750 stores across the UK, selling books, music, clothes and bric-a-brac. The primary source of the items sold in Oxfam stores is from donations made by members of the public. The shops receive donations of clothes and artefacts from people and sell them on to new owners as second-hand goods. The work wanted to explore the level of relationships between tagged objects and customers, by allowing shoppers to hear the story behind the second-hand objects that they purchase. Specifically, how memories that are attached to objects can affect consumer habits which we examined through participant observation and customer feedback.

"We wanted to investigate how shopping experiences are mediated when provenance information about an object are provided via a digital object memory that is accessible via QR Codes and RFID tags."

(Leder et al 2010)

For both instances of the project, members of the public donating items in the run up to the conferences, at the Oxford Road branch of Oxfam's charity shop in Manchester, were also asked to also 'donate' an associated story by recording a brief audio clip that reflected on, for example where they acquired the item, what memories it brought back, and why it is now for sale. These audio tracks were then uploaded to the Audioboo service (http://www.audioboo.com) and linked to a newly created entry on the Tales of Things website. The stories recorded were varied: for example, a designer shirt given to a person by their mother was donated because the owner didn't like the style ("My Mum, has really bad fashion sense"). Another story related to a large 'Winnie The Pooh' teddy bear that was won by a student at a fair and was donated to Oxfam because it was too big to transport home at the end of term.

Prior to the event, we were conscious of the fact that many shoppers might not have a smartphone and that network coverage can be patchy in a retail environment. Therefore, we constructed bespoke Bluetooth-enabled RFID readers that outputted the tag ID over the Bluetooth Serial Port Profile to a nearby laptop, which then played the appropriate audio clip over loudspeakers in the shop. In addition to tagging every item with Tales of Things QR codes, the donated objects were also tagged with low frequency RFID tags (Figure 9). People browsed the shop using bespoke RFID readers and the Tales of Things iPhone and Android phone-based applications to scan the labels, and once triggered, speakers located in the shop played back the audio stories associated with the label. As a result of the use of Bluetooth, shoppers were able to wander freely around the shop scanning any item's RFID tag and immediately hear the item's story as it was broadcast (Figure 10). The tagged items were sold at the same price as non-tagged objects, in-line with Oxfam's pricing policy and not kept separate or placed to stand out and were only distinguishable by the QR Code on their price tag.

Figure 9: RememberMe Tags

Figure 10: Scanning a memory

RememberMe's emphasis was upon personal stories and not quantitative data such as price, temperature or other logistical data, and offered a rich immaterial dimension to each objects material instantiation. Although the project anticipated an interest in the stories, the project was surprised at how affective the very individual voices were upon visitors to the shop. People browsing the objects and scanning the tagged donated items spoke of the "personal connections" made as artefacts conjured an actual voice that gave the object additional meaning, often describing the effect as "spooky"; the actual sound of somebody's voice associated with an object offered a supernatural extension to handling an artefact. The red silk toiletries bag that had no history or geography was transformed into an object loaded with place and personality as the story of its previous owner described a shopping trip in Bangkok that involved a near death experience in a tuk tuk.

> "Well my item is the little red silk make up toiletries bag its from a place called Narai in Bangkok and it was one of the very first things that I bought when I went to visit my uncle and his wife Noi who lived just outside Bangkok themselves and I believe if this is the shopping trip that I'm thinking of , I believe its also one of the very first times that I got a tuk tuk and nearly fell out, on the middle of the motorway, on the way back which I'm pretty certain it is actually so yeah that's my story and I risked life and limb to get that toiletries bag."
>
> (Red Toiletries bag, Anonymous donor)

For the RememberUs design intervention we wanted to the push the balance beyond the one memory for one object relationship and see if we could outweigh the material with many more immaterial instances. In a network society, as objects are now becoming part of the Internet of Things, we can assume that they will become written upon from many different sources, where every 'thing' becomes part of a vocabulary of exchanges, in which artefacts are increasingly becoming hosts to multiple meanings and values. The consumer doesn't expect a memory, least of all a memory from another place or artefact to be present on their belonging, and therefore in RememberUs we would use the artefact as a 'host' for a re-materialisation; one object for many memories.

As part of the FutureEverything 2011, again in collaboration with Oxfam, we used RememberMe project's 'write back' to see if we couldn't tip the balance between immaterial and material in favour of the former. In RememberUs, the team set up two shops that act as portals to the Internet of Things. Visitors to the Oxfam Emporium (Figure 11). are invited to 'let go' of memories that are associated with

particular things by attaching stories to our memory vessels (Figure 12). Here we created a memory shed where people were invited to leave stories on empty signifiers, objects whose identity had been redacted to encourage people to reminisce about 'thingness' rather than an individual thing.

Figure 11: Oxfam Emporium shop

Figure 12: Memory shed and vessels

Moments later in the Oxfam Originals shop (Figure 13) just down the street, people will 'pick up' the memory and the memories of others when they are associated with another object that they choose to buy. These memories of multiple past owners are loaded on to a QR tag that the shop assistant attaches to the otherwise innocent material object at the point of purchase (Figure 14). Leaving the shop with what may be perceived to be a second-hand item, shoppers would take with them many, many memories that have been associated with their new shoes, trousers or dress. Furthermore, once at home the object would continue to accrue memories long after they had purchased the item; keeping each object open to interpretation.
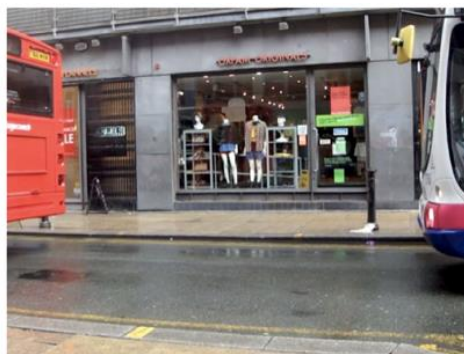

Figure 13: Oxfam Originals shop

Figure 14: QR code attached to a purchased object

As humans, we have complex and intertwined relationships with the objects around us; objects play a unique role in our social networks and have strong ties to identity and memory (Draaisma 2000; Henare et al. 2007; Hoskins 1998; Kwint et al. 1999; Miller 2008; Turkle 2007), space (Baudrillard 1996; Bollas 2009) and value (Appadurai 1986). We shape objects; and objects shape and transform our practices and us in return. (Giaccardi et al, 2016). It has been suggested that people surround themselves with between 1,000 and 5,000 objects. Of those thousands of objects many of them are probably not truly

cared for and end up in rubbish bins or in storage. However, for every owner in almost every household there are a selection of objects that hold significant resonance and will already connect them to an Internet of memory and meaning. An intrinsic human trait is the process of imbuing meaning onto objects so that they provide connections to people, events and environments and objects have the capacity to evoke memories within us, which reveal the complexity of the relationship between human and object. Artefacts across a mantelpiece become conduits between events that happened in the past, to people who will occupy the future. These objects become essential coordinates across families and communities to support the telling of a stories and passing-on knowledge (Speed 2010).

Objects can provoke personal emotions (Turkle 2007): they often constitute part of our identity (Miller 2009) and they mediate our relationship to our memories, acting as intermediaries between past and future (Dijck 2004). Personal and collective memories provide opportunities to learn from the past and to maintain and enrich identity (Sas 2006). More generally, it has been proposed that objects mediate human activity (Leont 1978) and, specifically, that they mediate how we access autobiographical memories (Hoven 2008). Baudrillard (1996) termed these objects 'technemes', items which consider not only their technical function but also the ideas, values, and fetishes connected to them, and he describes them as being in a "perpetual flight from technical structure towards their secondary meanings, from a technological system towards a cultural system."

Like an object's own industrial cradle to grave cycle, from manufacture to consumption and finally disposal, the object's associated memory and meanings are part of a person's own more literal cradle to grave cycle. The advancement of technology has long assisted us in "arming ourselves against the transience implicit in the mortality of memory by developing artificial memories" (Daaisma 2000). The development of writing surfaces, from clay or wax tablets, to parchment and vellum, and later on paper, provided the oldest of memory aids, not only accommodating natural language but also drawings of all kinds. Photography allowed for images to be directly recorded and the invention of cinematography meant moving images could also be captured. The preservation of sound became a reality through Edison's phonograph, and now a day numerous 'artificial' memories from MP3, DVD and computer memories are available to record what the eye and ear take in.

> "Image and sound are transportable in space and time, they are repeatable, reproducible, on a scale that seem inconceivable a century ago… our views of the operation of memory are fuelled by the procedures and techniques we have invented for the preservation and reproduction of information."
>
> (Draaisma 2000)

RememberMe caused customers to become more engaged with the tagged items, in comparison to non-tagged items, and that the intangible memories added 'value'. The attachment of stories meant that every object (approximately 50 in total) was sold, even the types that are notoriously hard for a second-hand shop to sell. (de Jode et al 2012), with Oxfam noting a 50 percent spike in sales during the installation. This builds on the ideology set down by Braunstein (1981) that explicit information should

be seen as a capital asset, knowledge -an important commodity that can be sold and passed from person-to-person, so creating tacit knowledge. Adding information to objects should therefore add value, which may result in higher prices for objects and/or and increase in sales turnover. RememberUs further explored the worth of information, over material objects, by attaching multiple stories to dummy objects in one location, and then related objects were sold with a replica of the same QR Code in a second location.

Both the RememberMe and RememberUs design interventions explored the relationship people have with objects and their willingness to share their stories (or information) with others and aimed to address the material 'turn' by readdressing the balance between the immaterial and material instantiations of the artefact.

Mr Seels' Garden

Mr Seels' Garden is a response to the ubiquitous nature of 'the cloud'. As objects move through the world and data spheres gather around them, how might the information retrievable through them change depending on where they are located in the computable city?

```
function product_has_instructions_date_place($latitude, $longitude, $day, $month){ $uom = 'm';
$sql = "SELECT i.content, i.source, i.gps_distance, s.name, s.latitude, s.longitude FROM
instructions i INNER JOIN sites s ON s.id = i.site_id WHERE i.is_published = 1 AND
i.product_id = 0 AND i.site_id <> 0 AND DAY(i.display_date) = '$day' AND
MONTH(i.display_date) = '$month';"; if( $results = mysql_query( $sql ) ) { while( $r =
mysql_fetch_array( $results ) ) { $a = array( $arr = array();
"content"=>stripslashes($r['content']),"source"=>stripslashes($r['source']),"site_name"=>$r['name'],
"product_distance" => $r['gps_distance'], "my_distance"=> round($this-
>calculateDistanceFromLatLong (array( 'latitude' => floatval($latitude), 'longitude' =>
floatval($longitude)), array(  'latitude' => $r['latitude'],'longitude' => $r['longitude']),$uom)) );
array_push($arr, $a); } $result = $arr; }else{ $result = false;} return $result ; }
```
<div align="right">Shingleton, D., (2010), Mr Seel's Garden, PHP</div>

The aim of the Memories of Mr Seels' Garden project was to engage with the rich and complex history of food across the city of Liverpool through a collaboration between a broad range of partners with a shared interest in time, food and community engagement. The project explored the potential for using community-based heritage projects to intervene into current understandings of the possibilities for developing more sustainable ways of life. The reference to 'Mr Seels' Garden' was drawn from a plaque located in the newLiverpool ONE development, which reproduces an 18th Century map, indicating that on a site now occupied by a chain supermarket, there was once a growing space, owned by the slave trader Mr Thomas Seel. The uncanny juxtaposition of modern and historic food systems, produced by this plaque, has been commented on by a number of Liverpool local food activists, and draws together multiple elements – food, maps, history, time, power, cruelty, memory and the intertwining of the local and the global – to paint a complex picture of changing patterns of connectivity within and between communities.

With all the current interest in growing food locally, including long waiting lists for allotments and many new community 'Growers' groups, we explored the history of local food in Liverpool to see what other surprises might be lurking around Liverpool (Figure 15). Dairies in Chinatown? Pig-farms on Mossley Hill? The project wondered whether knowing more about where we used to get our food from might inspire other radical ideas about where we could grow our food in the future.

A playful part of The Mr. Seels' project involved the 'hacking of food'. It probably sounds more radical than it actually was, but the primary intention was to explore the way in which aspects of our contemporary experiences of food have become anti-social and devoid of any association with place. It wasn't very long ago that people would know where a great deal of their food had come from. Who had grown it, where it had been grown, who had cooked it and where it had been cooked. The Mr Seel's iPhone App lets you discover how we used to grow, make and eat food across Liverpool by scanning food products from the present day. The barcodes on all food packaging are linked to a Universal Product Code database that gives information on what a product is. Supermarkets use these codes to access details about a product including its price. When a product is scanned with the Mr Seel's App it links to the project's own database of memories and historical notes that tell you about how food was grown, cooked and eaten in the past. Just as the local food movement is transforming the global food system, the app seeks to transform Universal Product Codes into Local Memory Codes that uncover our local food heritage.

By scanning the barcode on any food product within the Liverpool area and you will receive a historical fact or story about how we used to grow, make and eat food in the past. The quotes and stories displayed in the app were gathered from local people who have memories about food and from historical archives that tell us how Liverpool used to a centre of local food production.
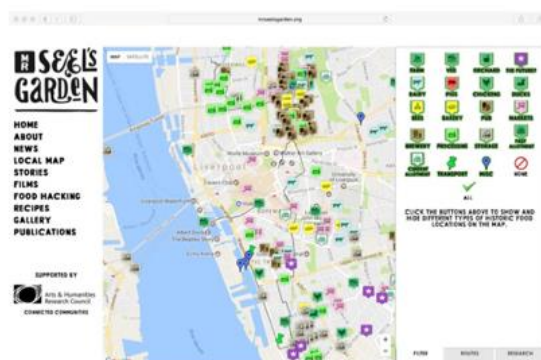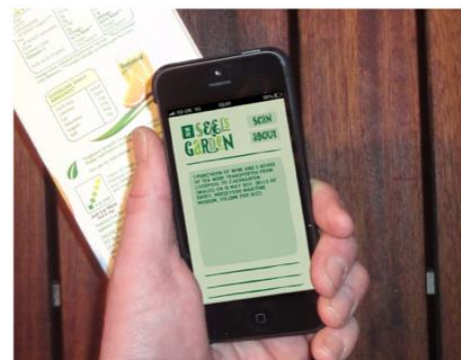

Figure 15: Mr Seels 'Website   Figure 16: Mr Seels' Garden App

Barcodes have come to represent the facelessness of globalisation, where every item, no matter where it is from, or how it was made, can be reduced to a series of numbers and entered into a universal database. The barcodes on all food packaging are linked to a Universal Product Code database that

gives information on what a product is. Supermarkets use these codes to access details about a product including its price. When you scan a product with the Mr Seels' Garden App it links to our database of archive material and stories that were gathered by volunteer researchers and describe how food was grown, cooked and eaten in the past. Just as the local food movement is transforming the global food system, our app transforms Universal Product Codes into Local Memory Codes which uncover our local food heritage.

The Mr Seels' Garden App is a creative tactic produced to engage Liverpudlians with the rich history of local food in the city and to encourage questions about how our food systems might be transformed in the future. Mr Seels' Garden App allows barcodes to be hacked and haunted with the memories of Liverpool's past. By scanning the barcode in the App on any food product within the Liverpool area and you will receive a historical fact or story about how we used to grow, make and eat food in the past. The quotes and stories displayed in the App were gathered from local people who have memories about food and from historical archives that tell us how Liverpool used to a centre of local food production.

> "The computable city uses geographically defined or location-based information in order to create new types of content or services, through their ability to locate, track, map, visualise and attach information to physical location. Locative technologies deal with physical location as well other contextual cues."
>
> (Nova 2004)

The functionality of the Mr Seels Garden App (Figure 16) is extremely simple and drew inspiration from the findings of the Tales of Things and Electronic Memory (TOTeM) project. The user is presented with the ability to scan a barcode, and retrieve a piece of information associated with it, in this case a historical story. However, unlike TOTeM, whose action was a simple scan and retrieve, I wanted to explore the likelihood that as objects move through their environments, the data that is associated with them is likely to be not static, but dynamic; forever changing to the context in which the information is being retrieved. Therefore, the way in object's informational shadow, or as I term it informational cloud, is defined based on an equation consisting of three variables; place, object, and time.

Firstly, the information retrieved for an object can be dependent on where the barcode is scanned; it's spatial cloud.
- City wide - regardless of where the user is stood within a 20 miles radius of Liverpool city centre, or what object's barcode they are scanning, a story is returned. (Figure 17).
- Site specific - a story is returned, regardless of object being scanned, based upon the user's location within a pre-determined geo-locative site or sites, which may or may not overlap. (Figure 17).

• Site locative - a story is returned, regardless of object being scanned, based on a specified radius (or distance) from the centre of a pre-determined geo-locative site. As the user moved closer to, or further from the centre of a site the story returned will change. (Figure 18).
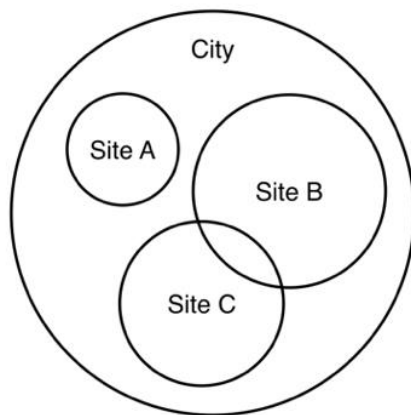
Figure 17: City and site clouds
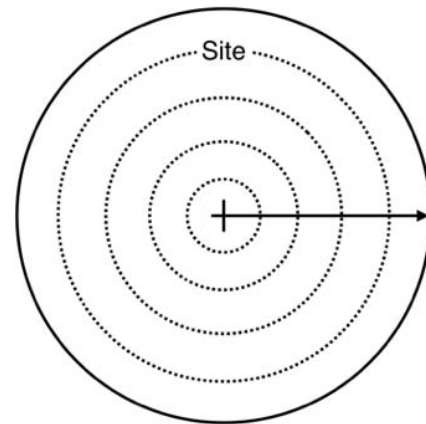
Figure 18: Site locative cloud

Secondly the information retrieved for an object can be dependent on what barcode is being scanned; it's product cloud.

• Product specific - regardless of user location a story is retuned for the specific barcode of the object they are scanning. (Figure 19).
• Product categorization - the same story can be applied to multiple products regardless of the user's location. (Figure 20).

Figure 19: Product specific cloud

Figure 20: Product categorisation cloud
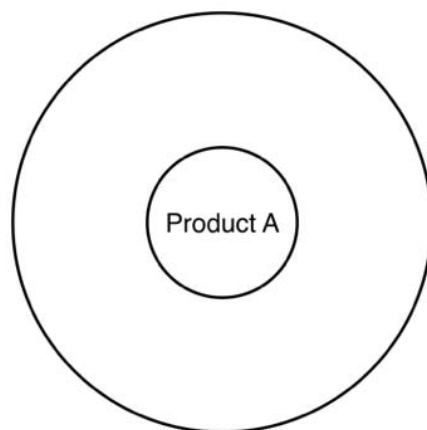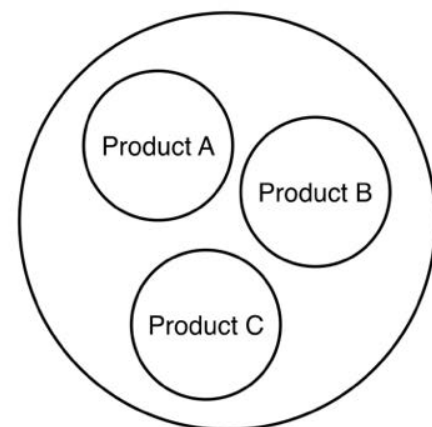
Thirdly the information retrieved for an object can be dependent on when it is being scanned; it's temporal cloud.

• Date specific - for example return a story if today is the 4th April 2016, or 7th July 2018
• Day of month - for example return a story if today is the 20th day of the of the month

- Day of the week - for example return a story if today is a Tuesday.
- Time of the day - for example return a story if the time is between 14.00 and 16.00.

By playing with three variables to place, object and time, we can create extremely complex algorithms for returning a simple piece of information. The more granular the attributes assigned to a story, the higher its precedence are for being returned and displayed in the app when a products barcode is scanned. At the point of scanning the users position is geo-referenced and server-side code determines whether the user is stood with the geofence of a site. If not, a citywide story is returned, however if they are then for each site where a geofence match occurs the distance from the users position to the centre of the site is calculated, with a story from the closest site being returned. For the site we can determine where they are stood and return a story based the changes as they move within in. Stories can be attached directly to a product, or to multiple products, and these stories for the same product can be altered as they move across sites. Furthermore, depending on when the user is scanning the barcode they might retrieve a different story for the same location or object, based on time of day or calendar date in the week, month or year.

> "I uploaded an app to my phone, so that I could scan the barcodes of supermarket food products. Then the phone screen shows a short paragraph telling the history of that particular product, as uncovered by some of the community researchers with the help of the project's museum archivist. (Neatly, laying bare the local within global, the app only works within a 20-mile radius of Liverpool.) Rose's lime cordial, for instance, came to the UK first from the USA on a ship that unloaded at Liverpool docks in 1912."
> (George McKay, Professor of Cultural Studies, University of Salford)

As we learnt from the RememberMe and RememberUs design interventions, it is well understood that the objects can provoke personal emotions (Turkle 2007): they often constitute part of our identity (Miller 2009) and they mediate our relationship to our memories, acting as intermediaries between past and future (Dijck 2004). Furthermore, personal and collective memories provide opportunities to learn from the past and to maintain and enrich identity (Sas 2006). The method implemented with the Mr Seels' Garden App is another example exploring how the capturing and replaying of stories and memories, and their linking to things via custom developed systems, provide novel ways to engage with past experiences. By attaching a social history and memories to things, augmenting them with a digital memory, we can alter our interactions with these objects.

However, the important intervention of the Mr Seels' Garden App is that it attempts to raise a debate around the benefits of 'ubiquity' promised by smart phones (Greenfield 2006). The app set to examine how data, in the case of stories, might change in relation to its place in city, in relation to a thing, and finally in relation to a thing in a specific place. Manufacturers of these phones suggest that users can reach data about anyone, anywhere at any time. By contrast the Mr Seels app allows anybody with an iPhone to receive historical information through the channel of a barcode upon any food product but only within 20 miles of Everton, Liverpool City centre and Sudley House in Mossley Hill. This is an

important intervention that argues for the need to recognise that some knowledge is meaningful because it is connected to particular contexts, and that data, although fluid and liable to leak everywhere, requires architectures to retain the meaningful qualities of this knowledge.

The Spatiality of Things Design Interventions

These design interventions address the second industrial design fiction of the Internet of Things, IBM's Smarter Planet (2010). They proceed to build upon the work discussed in the Connection of Things, by reflecting on how the connecting of everyday objects to the world wide web changes our understanding of the composition of the networks we inhabit.

These design interventions embody the three theories identified that discuss network in the context of the Internet of Things. Sterling's 'Spimes' (2005), the use of tagging and location technologies in order to track objects across time and space (network), Castells' the 'Space of the Flows' (1996), the theory that society is constructed around flows, including flows of information and technology, and finally Latour's 'Actor-Network Theory' (2005), a method for mapping the patterns of techno-science, where networks become the substance out of which both individual identity and social organisation are constructed.

Oxfam Logistics

Oxfam logistics is a response to explore how the Internet of Things can provide a structure to sustain the traceability of information as it moves between the nodes of a network. Its aim was to test a smartphone app designed to combine social networking concepts with asset tracking and monitoring, could enhance the visibility of logistics operations within a national UK charity, Oxfam.

```
- (void)viewDidLoad {[super viewDidLoad]; [self displayHeatmap]; [self removeOverlays];
nviewSlider.frame = CGRectMake(0,600,320,115); } -(void)
viewDidAppear:(BOOL)animated{ OxfamSite *oxfamSite = [OxfamSite oxfamSite]; if
(oxfamSite.myID){ self.myMapView.centerCoordinate = oxfamSite.coordinate;
[self zoomToLocation:oxfamSite.location]; }else{ LocationController *locationController =
[LocationController locationController];  [self zoomToLocation:locationController.location]; }
[self loadSitesPins]; }
```

Shingleton, D. (2013) Oxfam Logistics, Objective-C

Smartphone apps have proved very effective in areas such as user-generated content and the ability to reveal a user's location. This potential is enhanced still further as 'near-field' technologies emerge, allowing users to exchange data with objects and for objects to exchange information with each other as part of an 'Internet of Things'. Smartphone use is starting to soften the traditionally close connection

between activity, place and time, affording users a more spontaneous negotiation of meetings and transactions within their daily activity (Wang et al. 2011). Because of their ability to allow connection with everyone in a community all of the time, as a socio technical device, they greatly enhance how users engage with place and time (Wilken 2008) and impact on the spatial and temporal organisation of our activity scheduling and wider social interactions (Campbell & Kwak, 2011; Line, Jain, & Lyons 2011; Neutens, Schwanen, & Witloz 2011). In a personal sense, the smartphone is now enabling more negotiated scheduling of activities to better cater for our dynamic needs and circumstances.

The advances in ubiquitous computing have meant that our society is becoming increasingly connected, and the rapid adoption of mobile technology (Ofcom 2011) has afforded people more visibility and fluidity in their transportation decision making (Ling 2004). Because of their ability to create user relevant contextual awareness, smartphone app development across the travel domain has increased with a proliferation of applications allowing users to visualise transport modes, goods and services in a space and time relevant to their current and future location. Of real interest is the way apps are now enabling travellers to micro manage their itineraries (Wang et al. 2011) through the use of geo-fencing and tagging to obtain alerts to facilities, services and offers.

Smartphones coupled to social media allow people to be connected to one another continually. Through the rise of Web 2.0, users can easily generate and share photographs, video and blogs at any point in time, creating a rich information environment to improve individual decision making. Social networking principles not only apply to transport users but their individual vehicles, the public transport they utilise and the objects with which they come into contact through what is termed 'the Internet of Things'. This creates new opportunities for shared use of resources, collaboration and sustainable travel with the smartphone being the key information management device in the collection and dissemination of data in the logistics field. The Oxfam Logistics smartphone app was designed to combine social networking concepts with asset tracking and monitoring to enhance the visibility of logistics operations within the national UK charity.

Oxfam has a network of around 650 high street stores and approximately 1300 donation banks across the UK generating books and textiles. The charity operates a complex reverse logistics process across several separate vehicle fleets, servicing these stores and banks. This enables Oxfam to transport goods, primarily second-hand books and textiles, from banks to stores or processing centres, and to move goods between its stores for resale. The logistics operation involves a centralised vehicle fleet serving the whole network and localised 'man-with-van' operations, targeting specific banks and shops. The former feeds recyclate generated by the stores back into recognised commercial recycling streams and provides the take-back of low-grade clothing to a central sorting facility for separation and onward processing. The latter is very region specific where paid and sometimes, volunteer drivers will service certain shops and banks, whilst also undertaking ad-hoc work such as commercial and house collections. The

different transport layers work largely in isolation and there is scope to use information communication technologies (ICTs) to enhance their visibility.

With such a complex, multi-actor supply chain structure, the design challenge lies in i) developing a simplistic data collection, mining and dissemination tool that can be utilised by all the players involved ii) designing it in such a way that it provides enhanced visibility of network performance in time and space, improves temporal decision making and fosters greater collaboration between the players without compromising data protection and privacy obligations. The research focused on using smartphone technology to develop such a tool, given its ability to accurately track users whilst at the same time providing a platform to allow data entry, interpretation and visualisation. The personal smartphone provides an easily accessible platform by which all the parties in the network can engage and participate.

A series of wire frames were produced in response to finding from a focus group and through an iterative design-consult process, the core functionality was developed. The app itself was written in iOS for the Apple iPhone platform which was the base tool used across the apps being developed as part of the 6th Sense Transport project. As Oxfam operates across separate regions, each having an area manager overseeing a series of shops which may or may not use an area van driver and sometimes, volunteer drivers, the app functionality was built around the concept of a community, in which all the players (area manager, shop managers, paid and volunteer drivers) post, share and view information about operations in real-time.

The four main assets represented are donation banks (either textile of book banks), shops (either clothing or book shops), other outlets (either Marks and Spencers, other commercial collections from companies and occasional house clearances) and drivers (either paid or volunteer). The app uses a database of fixed asset locations (the latitude and longitude of each donation bank and shop), grouped by Oxfam region, and represents these on the map as a series of interactive pins, through which the transactions and messages are accessed by users (Figure 26). Each shop and bank acts as a unique bulletin board, allowing users (both drivers and managers) to post/read messages to/from them and access the history of collections/deliveries associated with them in time. Drivers appear in the network as dynamic pins, moving around as their round progresses and have a similar functionality to the banks and shops in that system users can post messages to them and view the transaction activity being undertaken by them as it happens.

Ad-hoc commercial collections of textiles from businesses including Marks and Spencer, and house clearances, pre-booked by members of the public are also significant revenue generating opportunities for Oxfam. These sites are created by the driver in the app as they are undertaken and help provide a record of unique transaction activity in time and space across the region.

The app was designed to have two levels of functionality for two separate user groups; managers and drivers. Drivers act as the core information gatherers in the system, recording for each bank collection (Figure 22) the percentage fill of the bank on arrival, the number of bags of stock generated (the driver typically empties the contents of the bank and places it into 60L hessian sacks to a maximum sack weight of 7.5kg), the stock quality of the bank (a gauge of the general stock quality on a scale of 1 (poor) to 5 (excellent), and the percentage fill of the bank at the end of the collection (which might not be zero if there is stock damage or a capacity issue on the van v) any comments about the collection (this includes text comments and photographs). At each shop, drivers record the numbers of bags transferred as either a delivery of good stock for sale (Figure 23), sourced from either a bank or another shop, or a collection for 'cascade' (where the shop concerned has stock, which for a variety of potential reasons has not been sold but could be at another location). At the site of a commercial collection or a house clearance, the driver 'adds' a new site into the network at that specific geo-location, declaring its name and category, and recording the number of bags/boxes collected by product type along with any comments. To conserve battery life, the app does not continuously track the driver's progress as in a traditional satellite navigation system. Instead, the driver's latitude-longitude location is refreshed whenever the phone is activated in anyway, or the driver passes between cell stations of the phone's network provider.

Each time a stock collection is made from a donation bank, or from a shop in the form of a cascade, the other members of the community are notified via a push notification from the app to their iPhone or iPad giving the site origin and message 'stock collected available for cascade' (Figure 24). Push notifications alert the community of all transactions and messages as they are entered into the system by the respective user, regardless of whether the app is on or off.

Figure 21: View of shops (S) and banks (B) and drivers (D) in the network
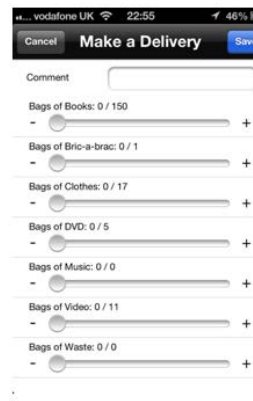
Figure 22: Donation bank stock collection screen

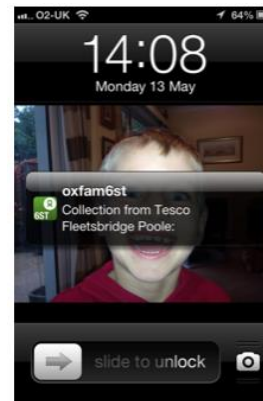Figure 23. Shop delivery screen

Figure 24. Push message notification being received from a book bank

These act as a temporal reference point for all members of the community, with managers able to view a driver's current position, and then visualise where he or she should be in hour intervals during the rest

of that day, using a continuously updating geo-location history logged by the system. This feature was designed to allow managers to understand the driver's likely movements, in the event of a re-scheduling decision being warranted when house/commercial clearance requests are received. The 'heat map' produced (Figure 25) is a visualisation of the intensity of driver transaction activity (latitude and longitude points where transactions were logged in time) with areas of higher intensity coloured red, moving through green to blue, indicating lower intensity visitation. With each day's round, more location histories are added to the heat map so that patterns of activity by hour and day can be understood.

A key feature of the app is the messaging system which allows the members of the community, and assets within it to message each other with requests and notifications. The messaging platform works on the principal that members of the community represent a specific location or asset and these entities act as the bulletin boards to which messages are attached (Figure 26). In the case of shops, each manager is registered under their shop and messages are posted to that location address in the network. This approach was taken rather than using named individuals because the personnel running the shop and potentially using the app vary from day-to-day and having a general shop bulletin board was considered more flexible. Drivers have messages attached to their map icon by users as they move around the network. Drivers also have the ability to take and post photographs at each bank/shop site which are then added to the message and transaction history of that location (Figure 27)

As well as being able to view the contents of the drivers van in terms of the stock held at any point in time, and the transactions as they occur at banks, shops and other locations, managers can also view the collection/delivery history of each asset in the system. For donation banks equipped with Smartbin sensors, this allows managers to receive percentage fill readings twice per day and utilise the information to make better collection scheduling decisions (McLeod et al., 2012). Figure 28 shows that the Sainsbury's clothing donation bank at March was only 28% full on the morning of the 5th June 2013 and did not warrant a collection due to the bank being under 50% full. The app allows this information to be shared by the members of the community where in the case of 'shop adopted banks', the shop manager can make a better-informed decision as to whether a volunteer needs to visit a bank to prevent it from over flowing.
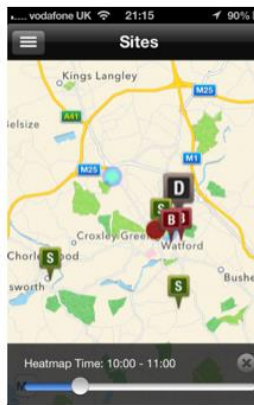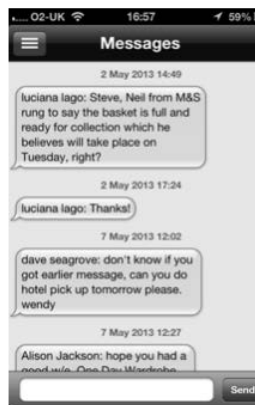
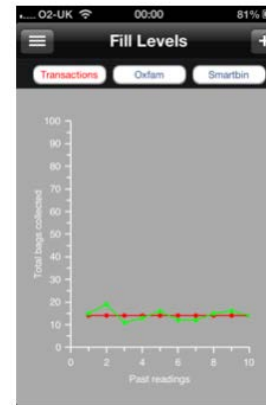| Figure 25: Driver location heat map | Figure 26: Driver information bulletin board | Figure 27: Photographs linked to a specific donation bank site | Figure 28: donation bank collection history. |

The app was trialled across three separate communities in Hertfordshire, Dorset and Cambridge involving 4 drivers, 10 shop managers, 3 area managers and a depot manager. In the trials, the app has identified donation bank sites that are being serviced too often and new service schedules have been developed. It has also helped shop managers better communicate stock availability and transfer.

The depot manager in Dorset commented on the ability to know exactly where the driver was at any time, and should be in the immediate future, had an immediate impact on the way the round was conducted. "Like today, I can see where he is in relation to Shaftesbury because he needs to go there before it shuts, and he was on his way back from Keynesham and if he's not going to make it back in time I can call the Shaftesbury shop and let them know".

The Dorset Area Manager also found this feature very useful for better planning rounds, because for the first time, live van fill level data are available which helps pinpoint spare capacity during the day's activity. "Knowing where the driver is and where he is likely to be is enabling us to re-organise the route because we can see where there is spare capacity in the round. We can now see what is in the van in real-time and get updates on where he is in the network through the notification messages. Knowledge of how time is used in the business has improved. The driver is going out earlier since we started with the app and seems to be producing more". In this specific case, the information provided through the app showed additional capacity on a specific day which lead to a re-organisation of the round and the addition of a shop service. "This is solely due to the real-time information and being able to get the notifications of round transactions to build up a picture of time use". Previously, the transport operated very much on an 'allotted time per task' basis. "The visibility of where he [the driver] is and where he is likely to be is very helpful in planning activity. We are using real information instead of thinking – he might be, he might be".

The Oxfam Logistics app is designed to improve the visibility of transport options and facilitate collaboration between Oxfam shop managers, area managers and drivers (paid and volunteer) at the local level. The app allows Oxfam's local communities to better engage and visualise the state of clothing and book donation banks and the location of transport both in the present and into the immediate future. In a dynamic and continually evolving business setting, this can help make better commercial decisions (e.g. where a lucrative house clearance can be scheduled in place of servicing a donation bank which may not have reached an optimal fill level, or where valuable donated goods can be notified to the community and an appropriate sales outlet identified and transport arranged).

The Oxfam design intervention highlights how networks are comprised of organisations, people, things and also data, a structure to sustain the traceability of information as it moves between these nodes of a network and is addressed by Castells (1996) in what he terms 'the space of flows in the networked society'.

Internet of Cars

The Internet of Cars is a response to explores how cars in a transport network could have potential to act as packets of data, a manifestation of the flow of information across social networks.

```
boolean getLatestData(String macAddr, uint8_t &red, uint8_t &green, uint8_t &blue, uint8_t
&fan1, uint8_t &fan2) { String jStr; char jsonStr[MAX_JSON_STR]; HttpClient client; String
url = "http://192.168.0.100/flows/flow.php?site=" + macAddr; client.get(url); if
(!client.available()) { return false; } while (client.available()) { char c = client.read(); jStr +=
String(c); } jStr.getBytes((byte *)jsonStr, MAX_JSON_STR); if (!jStr.startsWith("{\"results\":")) {
return false; } aJsonObject* root; root = aJson.parse(jsonStr); aJsonObject* results =
aJson.getObjectItem(root, "results");
```

Shingleton, D., () Internet of Cars, Javascript

In his 2004 paper, Nigel Thrift explored the potential for digital systems to extend the social negotiation with a space through the car, through identifying digital technologies as offering a more complex substrate for enabling communications to become part of a negotiation with space (Thrift 2004). The car complimented with satellite navigation, air conditioning, musical soundtracks and a figure-hugging seat provides a very personal interface with a city, one that predisposes the driver to allow the car to become an extension of his/her body. Once driving, we find ourselves expressing a series of characteristics that indicate a deep embodiment of the car including: the charged emotional state in which we engage with others, communication techniques using lights and movement, and the 'tactics' that allow us to navigate spaces by reading the 'gestures' and actions of others (Katz 2000).

> "The advent of a mixture of geographical information systems, global positioning and wireless communications means that getting lost will no longer be an option and, equally, that increasingly it will be possible to track all cars, wherever they may be. The result is that both surveying and being surveyed will increasingly become a norm: it is even possible that, through the new informational and communicational conduits that are now being opened up, some of the social

cues that have been missing from the experience of driving will be re-inserted (for example, who is driving a particular car), making the whole process more akin to walking again, but with a new informationally boosted hybrid body, a new incarnation."

<div align="right">(Thrift 2004)</div>

The Internet of Cars as design fiction aims to capitalise on the connection between car and smartphone and offer an integrated platform that links the transport network with social networking. Despite describing the transport infrastructure as a 'network', most road and transport users see little similarity between the 'transport network' and the internet. The work suggests that overcoming this difference is key to a new paradigm of transport in which connections, flow and sharing are synonymous with both social networking and travel behaviour. The experimental and speculative platform combined data gathered from Automatic Number Plate Recognition (ANPR) cameras and a smart phone application that allows participants to use cars as a form of internet. It was developed as a creative approach to conceiving cars as data packets through the use of their license registration plate and offering a playful platform that allows users to engage with them as though they were part of social media and situates the experimental use of cars as a manifestation of flow across social networks.

The vision of an Internet of Cars is located within 'The Internet of Things' and proposes that by adopting the 'habits' that consumers are currently developing to scan shopping items to access network data, may overcome the technically determinist vision of tags and codes appears to be obscuring an opportunity to fold existing 'things' into an internet for traffic. Cars are the single most visual form of actual moving data that we know and yet they are wholly overlooked as packets of data that interface with humans, businesses and the environment. The vision within this work introduces the principle that car registration plates can be used as unique identifiers in the same way as barcodes and offer a platform for people to store data on to them, use them as interfaces to social networks, pass messages between people, and connect to environmental data. The authors speculate that the primary barrier is one of habit. The public do not identify the registration plate on a car as a portal to the internet in the same way that QR codes (quick response barcodes) or RFID are beginning to offer.

The objective of the work was identifying cars as things within an Internet of Things that have the potential to link people, services, artefacts and places, whilst challenging the barrier of the public identification of cars as packets of data. In Sixth Sense transport (Davies et al 2011) we are looking to provide travellers with many forms of interface to enable them to 'see' the flow of traffic and begin to anticipate new travel opportunities. Part of this work involves developing visualisations of future transport options as well as mobile applications that support sharing. Considering cars as extensions of social media is one way that we are exploring how to alter people's perceptions of automobiles and offer them new models akin to the fluidity of email, social networking and file sharing, systems that are part of the paradigm that Castells describes as the Network Society (1996).

The Internet of Cars, explores the potential for registration plates to act as information carriers. Dynamic, fluid and representing individual packets of information within a UK wide network, cars could be critical components within the emerging phenomenon known as the Internet of Things. Each one tagged with a unique identifier that is scannable with smart phones, as well as the highly sophisticated roadside cameras, cars with their number plates have been the equivalent of barcodes on supermarkets products for many years. However, they remain woefully overlooked. This vision explores a commercial and social platform for turning cars into networked artefacts that will provide the missing link in connecting the flow of things to people, artefacts environments and businesses. Visible in the street, cars that are linked through a common web platform offer a fluid interface to the Internet of Things that will make visible the flow of products and services that could change the way we inhabit cities in the 21st Century. Able to 'see' where things have come from and where they are going, cars have the potential to become the next web browser.

Cars offer a local and dynamic interpretation of social activity: where people go, what their habits are. Lift sharing, moving things such as shopping, postal items and messages suddenly transforms the opportunities for an Internet that we can 'see'. In contrast is the static life of things such as barcoded products bought from supermarkets which only appear 'on the grid' when they are scanned at the point of manufacture, in the warehouse, and finally at the point of sale (Sterling 2005). We know that as individuals or as families we move 'things' around in bags and cars, but these things are hidden and therefore are offline during transit preventing them from connecting to other people and services. We wouldn't dream of scanning a tin of baked beans in someone else's supermarket plastic bag. But cars are in the public domain and they offer an open platform upon which things in flow can suddenly be made accessible. Cars offer a local and dynamic interpretation of social activity: where people go, what their habits are. Lift sharing, moving things such as shopping, postal items and messages suddenly transforms the opportunities for an Internet that we can 'see'. In contrast is the static life of things such as barcoded products bought from supermarkets which only appear 'on the grid' when they are scanned at the point of manufacture, in the warehouse, and finally at the point of sale (Sterling 2005), cars are in the public domain and they offer an open platform upon which things in flow can suddenly be made accessible.

The ability to tag a vehicle's registration plate with information to allow others to read at various points in the future offers a potentially new way of disseminating not only traffic information (journey times, congestion/incident hotspots), but data on weather/road conditions, special events, and user relevant offers. In terms of using vehicle registration plates as information carriers, it is important to understand the returning habits of vehicles within a network, what defines a 'regular' vehicle in terms of the variability in its arrival times, and the proportions of unique vehicles that may not be 'familiar' with the local area.

The success of the Remember Me/Us TOTeM project and its impact upon second hand clothing culture by disrupting a traditional technology such as barcodes and its associated habits, offered a transferable method for this project to disrupt the assumptions surrounding the role of car number plates. The primary convergence scenario for the Internet of Cars projects are the thousands of cars that travel around the roads between the English towns and cities of Weymouth, Dorchester and Southampton, in particular during the tourist seasons. The A35 Dorset corridor linking Weymouth to Bournemouth and connects the historic towns to the beaches and coast line of the south of England is no different to any other in its reliance upon the car as a conduit for moving people and things to support personal, social and commercial needs. At present though, there are no connections between people and the things (cars). Through correlating the data accrued by the roadside traffic cameras with social data that is mined at each location and data that is associated with specific cars, the research team are developing a platform that will reveal the car as a point of network inquiry for tourists. In short, cars that move around the area, being scanned by the ANPR system (Figure 30) will carry with them up-to-date data about the area that is submitted by fellow car drivers who associate data with their car number plate.

Figure 30: ANPR data set from the A38

The Internet of Cars is a public platform that enables car registration data gathered from the traffic cameras to be complemented by crowd sourced data. The promotion of free smart phone apps that

allows residents and visitors to scan cars will provide further data that will contribute to an image of the cities social, economic and environmental flows. At present two initiatives are planned to encourage the use of the system: the first uses the car as a place to store photographs and text to share with others through the mobile scanning of the number plate, the second extends the reach of this data by sharing location specific information via APNR cameras. These two design fictions are described below through cartoons that explain the context and user experiences for both initiatives:
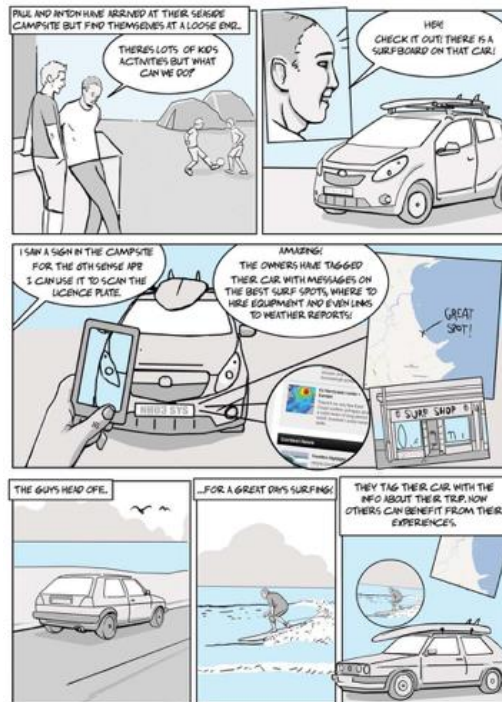
Design Fiction 1: The car holds the memory.

Design Fiction 2: The memories are spread through the use of roadside ANPR's.

Preliminary research has explored the topic during in-depth interviews with 15 participants at a campsite in Dorset (Filimonau et al 2013) who were introduced to the car tagging idea illustrated in case study 1. Participants found the idea interesting but had some initial problems grasping the concept given they largely fail to appreciate the car as a node within a network. For instance, within the campsite environment, people felt they would probably talk directly to other visitors. On the other hand, the car provides an intermediary in the social exchange process which, for some people, overcomes barriers imposed by social interaction. Within a campsite community, visitors have 'weak ties' (Nahapiet and Ghostal 1998). In this setting the car has potential as a portal for exchange of information linked to visual clues about the occupants such as their equipment or children's age. It removes some of the problems associated with social exchange such as reciprocation (Burke et al 2011). For example, some campsite visitors were very reluctant to ask other visitors directly for help as this embeds them into a reciprocation arrangement that might impose subsequent costs they might be unwilling to provide. In this context, car tagging may extend 'network capital', that is people's access to the coordination systems

that facilitate access to services and opportunities (Urry 2012). This, in turn, extends social capital (Larsen et al 2007).

On the other hand, given the highly personal associations with cars, participants expressed some concerns about privacy. People understand that car number plates can be traced directly to owner's details and this introduced some reticence as participants were not sure what type of information might be retrieved. There were also concerns about 'who' might be allowed to tag details onto 'their' number plate and 'what' information might be left for others to read. For instance, someone could leave a rude or highly personal message that other users could retrieve unbeknown to the car owner. This relates to trust, one of the core components of social capital (Burke et al 2011). Participants troubled by this aspect showed a preference for face-to-face interactions which they felt provided an opportunity to appraise the individual and the consequent value of their information.

Participants who grasped the concept were excited by the opportunity and experienced a moment of realisation when they visualised the potential; one woman likening the car to her Facebook page and her 'wall' where others can write comments. Potential users were comfortable so long as they maintained control, as in a Facebook page, and had the ability to delete and edit contributions. The surfing scenario in case study 1 developed, in part, from an early interview in which a participant described the potential for linking up with likeminded people who would be able to see he is a windsurfer from paraphernalia on his car.

Thrifts explored the potential for digital systems to extend the social negotiation with a space through the car. Published in 2004, eight years later the wide spread adoption of smart phones means that pedestrians now match and extend the technology that Thrift identified in the car. The Internet of Cars work for the Sixth Sense Project aims to capitalise on the connection between car and smart phone to offer a connection between transport network and social networking. Latour's model of the social through Actor Network Theory provides a vocabulary for acknowledging car's as 'actants' within a network, vital elements that contribute to the performance of agents and meaning. As the car becomes a node within an internet it has the potential to gain a form of agency and become party to the needs of a system.

> "Society is not the whole 'in which' everything is embedded, but what travels 'through' everything, calibrating connections and offering every entity it reaches some possibility of commensurability. We should now learn to 'hook up' social channels like we do cable for our televisions."
>
> (Latour 2005)

As the Internet of Things begins to manifest itself in different forms, there is no doubt that as objects become connected to the internet, that they will begin to change the way that we go about transforming age old practices. From scanning second hand good to find out who formally owned them, to scanning

cars to find out what the weather is like where we plan to go today, the connectivity of things is going to offer new opportunities for how we relate to the things that are around us.

Even though we describe the transport infrastructure as a 'network', most road and transport users see little similarities between the 'transport network' and the internet. With the opportunities that the scale of real-time data derived from the ANPR data is providing, coupled with the reticence of our preliminary users who struggle to connect their social media practices with that of driving their car, the project offers a critical exploratory platform upon which we can begin to ameliorate the disconnection between a transport network and a social network.

As the reading and writing to objects through tags becomes more and more ubiquitous, an Internet of Cars offers an open platform as a critical and socio/technical critique of current instances of the Internet of Things It is hoped that through this design intervention, opportunities for connections that are otherwise invisible to current users (e.g. sharing information about the local area) affords participants the potential, in this case, to re-think decision making processes about travel and adopt social networking methods.

Despite representing an extraordinary number of nodes within a system, of the 31,035,791 registered cars on UK roads accounted for in 2009, very few remain actually represented in most networks. In direct contrast is the precedent of 50 million users of mobile social networking worldwide. Not only does this build and reinforce social ties distributed over time and space, it also permits real-time data stream aggregates to inform network participants of new recommendations (e.g. new books on Amazon, 'second guessing' new contacts in the industrial networking tool LinkedIn) and the scope to establish new network nodes. This difference between the rich semantic networking facilitated by social networking technologies and the low-level communications capabilities often associated with vehicle networks represents the primary motive for the Internet of Cars project. As a speculative platform, it is a creative approach to conceiving cars as data packets through the use of their license registration plate and offering a playful platform that allows users to engage with them as though they were part of social media.

CoGet

GoGet is a response to the potential for ubiquitous computing technologies to connect people and 'things', and it allows for physical artefacts to gain mobility, to move through social networks to help aid the flow of the city.

```
function bearingTo($point){ $lat1 = $this->toRad($this->_lat); $lat2 = $point->toRad($point-
>_lat); $dLon = $this->toRad($point->_lon-$this->_lon); $y =sin($dLon) * cos($lat2); $x =
cos($lat1) * sin($lat2) - sin($lat1) * cos($lat2) * cos($dLon); $brng = atan2($y, $x); return
round(($this->toDeg($brng)+360),2) ; } function destinationPoint($brng, $dist){ $dist =
```

```
$dist/$this->_radius; $brng = $this->toRad($brng); $lat1 = $this->toRad($this->_lat); $lon1 = $this-
>toRad($this->_lon); $lat2 = asin(sin($lat1) * cos($dist) + cos($lat1) * sin($dist) * cos($brng) );
$lon2 = $lon1 + atan2( (sin($brng) * sin($dist) * cos($lat1)) , (cos($dist)- sin($lat1) * sin($lat2)) );
$return = new LatLon; $return->_lat = round($this->toDeg($lat2),5); $return->_lon =
round($this->toDeg($lon2),5); return $return; }
```

Shingleton, D., (2014), Co Get, PHP

Our lives are governed by 'fixed' time schedules with activities aligned to school and work start/end times, public transport schedules, facility opening hours and deadlines. The rise of the 'anytime' 24-hour society has led to increased consumption of goods and services, the take-up of non-standard work schedules (e.g., rotating shifts), and a more dynamic approach to activity planning, leading to the constant 'hectic' pace of life many of us feel. Coupled to this is how laptops, smart phones and PDAs, linked to 'social networking' have revolutionised when, where and how people communicate in work and at home, softening 'time' and 'space', allowing social relationships to revolve around the appreciation of the relativity of friends and colleagues in personal time.

The findings from the Oxfam Sixth Sense trial allowed us to understand the extent to which behavioural change in transport habits and practices can be facilitated through the creation of a new form of 'transport network', based on extending social networking principles to transport users and their individual vehicles. The development of an innovative, open, extensible technical platform that can help to provide users with new ways of understanding the relationships between their own future transport plans and those of others, by using social networking principles to create 'visibility' of potential transport options in time and space. If we are better able to visualise the activity of people and things (cars, buses, lorries, even items within a lorry) relative to their immediate and future time schedules, and crucially, the conditions under which people and other 'things' might be willing to liaise and adapt, we might be able to realise more opportunistic and collaborative uses for transport resources. Through the novel use of smart phone and tagging technology to provide data feeds on activity and availability, monitored through a Platform that will anticipate opportunities for connections that are then made visible to users in the social network, we can extrapolate a deep understanding of how the increasingly multiple forms of temporality and spatiality influence travel mode choices and the ways in which people and 'things' might be willing to share certain personal travel information.

In March 2014 I was part of team that ran a series of workshops at the Future Everything festival in Manchester to better understand what it might be like to allow objects to 'piggy back' the urban routines that we perform on a daily basis so that they may move across the city. The CoGet platform adopted a given space and dispersed a collection of physical artefacts across it, and the CoGet platform through knowing where these artefacts are at all times, throughout the festival, requested people to move them to places where they could be part of useful applications. For example: somebody is making tea but needs a teacup. Close by a teacup has recently been used to hold some screws whilst somebody repairs a chair. The teacup alerts passers-by through Bluetooth and via a screen display and asks if somebody wouldn't mind moving it (the teacup) to the person who is making the tea. CoGet uses humans to move objects

around. These objects want to be somewhere else and humans pick up them and move them for them (Figure 31).

Figure 31: In this picture a beach ball can be seen taking humans to where it wants to go.

Figure 32: Participants exchanging a fictional object.

The CoGet software and experiments reveals where things want to go and asks the public to move them on their behalf. Connected to the net, and able to read the social complexity of a local area, CoGet lets objects control people's movements by predicting where they need to be and borrowing the legs of a human to move them (Figure 32).

> "Across the connected city small things play a large part in sustaining the flow between people and places. Cups of tea, bottles of water, books, four way plug adaptors, bicycles, computers and many more objects are the 'things' that support the meeting of people and the jobs that they do. However sometimes these things aren't where we need them, and flow is halted. If things knew where they were likely to be needed, perhaps they could ask passers-by to move them there."
>
> (CoGet Workshop, Future Everything, 2014)

The iPhone app requires a critical mass of people running the application which shares the speed and bearing of individuals to a map, allowing everyone to see the direction of where people are going (Figure 33). The app uses the principles of big data and machine learning to, record analyse and predict which users in the network are most likely to following the object's desired path and recommend which users should participant in moving the item.
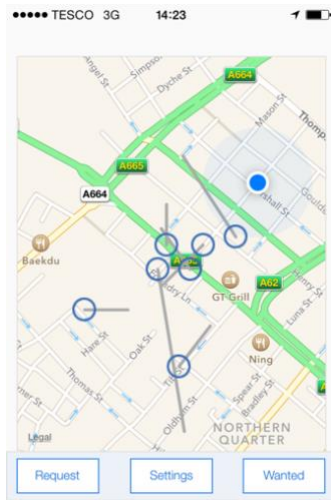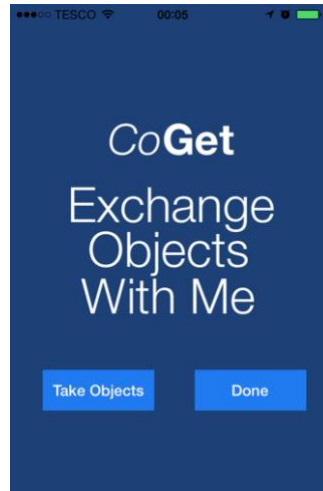
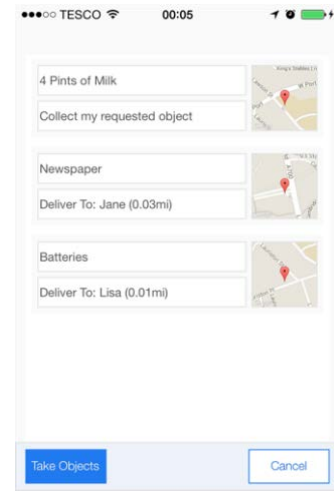| Figure 33. Bearing of participants | Figure 34. Exchange prompt | Figure 35. Requested objects |

At any point somebody in the network can request something (Figure 35) and members can choose to accept to 'Take the object" along a part of its journey (Figure 34). In actual fact the object can remain with anyone person until someone offers to take it a little further toward the person who requested. But for the sake of participants and to foster a dynamic sense of flow the workshops at Future Everything tried to move things across an area within 20 minutes.

Following the 20/30 minute workshops, we explored the experiences with a handful of participants. In discussing the experience of collaborating with people in the street Susan, Dan, Mark and we explored some of the tensions and opportunities:

Sue: "It was comforting to know at different times that you were still in it, in the system, so you were aware where the other dots where"

Dan: "There is an element of security knowing that, but the reality is you don't know whether they are friend or foe"

Mark: "I think it would be quite exciting with a large number of people, because if it's all very spaced out it's a bit isolating, but if there's loads of things moving all of the time I think you'd get a real sense of being part of something flowing, so I think it's a numbers game really"

Sue: "except if it was on a day to day routine [sic], just thinking about that walk to work which is what you were talking about it would actually be quite nice to meet a stranger that you would normally walk past in the street every day to actually stop now and again and say hello purposefully on your journey to work – that would be quite a nice social"

Mark: "but that would require quite exact timing for everybody which is the thing... I wonder what happens because it's going to be different every day, sometimes you want to finish your coffee – you're a bit there and a bit there"

Interviewer: "that's where the machine might learn where you are on a sliding scale of being early this morning or late"

Sue: "I suppose it depends on how many people are working on that route and what the object of the hand over is"

Interviewer: "you might get more friends, 'Oh it's you this morning'"

Mark: "yeah, it could be really interesting, I'd like to try it on a big scale
In exploring the problems of not knowing the area and handling a new app that places a cognitive load on watching a screen and watching out for people Mary, James and Peter discussed:

Mary: "I think because, first of all, you're focussing on where you're going your minds kind of on 'that' rather than 'that', but I think if you're doing it regularly so once it gets into that zone it just becomes automatic, so I think once your focus has gone off that and getting from there, you would just kinda go 'here you are'"

James: "Yeah because I'm not from Manchester so don't know the area or anything, so it was a bit of me thinking 'am I even in the right place at all, and looking at street signs, I might have been more aware of other people trying to pass objects if I did know where I was. But it's about routine this, so you would, you'd be really familiar, and you'd be really open"

Peter: "I'm really familiar with these streets and even I felt quite confused walking the streets with this task in hand and so even being from here it still confuses you in some ways and it's quite disorientating in away, but it's a lot of fun."

In an exchange around the feelings of passing an object to a stranger:

Simon: "I was happy to actually find someone and do the exchange, and I was also happy that he was with us [a workshop helper] because otherwise I wouldn't have known if I'd have to press done because it was buzzing before, but yeah it felt good, actually good."

Interviewer: "Did you feel that you were relating to people in a different way?"

Mike: "I felt that I was looking out more, and looking more at people as I went along, but I also realised quite quickly that searching for other people who were peering at their iPhones whilst wandering around is not going to get you anywhere in the Northern Quarter!"

Gareth: "I quite liked coming across people, I think maybe we crossed paths [looking at another participant] and it's kind of nice that you're in this little team."

Interviewer: "So even though there wasn't a gift to exchange there was a..."

Gareth: "Yeah yeah there's still something there"

Mike: "I did feel a bit of anticipation as well, so it felt like it would spice up the walk a little – am I going to get an exchange or something?"

Susan: "I missed my exchanges which I actually feel a bit bad about, I think I missed three exchanges."

CoGet makes a further leap toward a future in which objects borrow our daily routines to move themselves around. Based upon the research from the Sixth Sense Transport project that combined social networking with locative media to support collaborative travel practices, the project investigates the potential for ubiquitous computing technologies to soften the rigidity of time and connect people and 'things' to ease the flow of traffic and save energy, through using smart phones apps the CoGet project manifests a future context in which physical artefacts gain mobility and move through social networks to aid the flow of the city.

It was clear that using a new app in the urban landscape (familiar or unfamiliar) presents a significant cognitive load, however participants understood the need for many more users to fully experience the power of the network, but the workshop allowed them to anticipate it's potential as an exchange platform. The phenomenon of exchanging objects with strangers is tantalising and interesting in transforming daily routines. The experiences of participants seem to suggest that a connected landscape, that was made up of data points, reconfigured the street in to a space of potential rather than a space of traditional social behaviour that was passive and less networked. Ultimately the work forecasts the potential of objects to become animated within an Internet of Things and represents a fiction that is beyond the current obsession with worrying about the barriers toward interoperability; it makes real a context in which objects as humans to do things for them.

The Emergence of Things Design Interventions

These works focus on the third commercial design fiction of the Internet of Things, The Internet of Everything, as proposed by Cisco (2012), and work explores a connected objects ability to influence other parts of the network. Actor-Network theory, and Julian Bleecker's theory of 'Blogjects', deem this an object's ability to have agency. The final critical theory explored is 'emergence' which addresses their question, what happens when "lots of things are all waking up"?

Social Shopping

Social shopping reflects upon the potential agency of consumer data within the established practice of shopping.

```
<h1>Campaigns</h1> <table> <thead> <tr> <th>Name</th> <th>Company</th> <th>Target</th>
<th>Total Donations</th> <th>Percentage Donated</th> </tr> </thead> <tbody> <%
@campaigns.each do |campaign| %> <tr> <td><%= campaign.name %></td> <td><%=
campaign.company %></td> <td><%= campaign.target %></td> <td><%=
campaign.rewards_donated %></td> <td><%= campaign.percentage_donated %>%</td> </tr> <%
end %> </tbody>
```

Shingleton, D. (2014) Social Shopping, HTML5

The extraordinary number of products available in a typical high street at any one time is a material manifestation of the big databases and shop inventories that are connected to each thing. Making visible the scale of the goods in the high street to the shopper, through patterns, correlations and recommendations is a critical step in developing a more connected high street. Through a better understanding of how this data can support the shopper and the salesperson to connect 'things that want to be together', new models of shopping will emerge and reinvigorate the role of things, people and architectures. This Internet of Things design intervention is firmly located within the tenet that the re-thinking of things, data and people might unpack and actions and established practices. (Figure 36).

Figure 36: Proposed design fictions by the Connected High Street project.

The purpose of this practice research was to explore the potential for reconfiguring the traditional organisation of customer, salesperson, cash register, things (tangible commodities) and database, to allow shops that represent 'stacks' of both immaterial and material processes to share data that will improve social and economic conditions. The design intervention builds on research and innovation that have initiated in response to the advent of ubiquitous computing in which every shopper now carries a cash register in the form of a smart phone. Equipped with a suite of applications, shoppers are able to make purchases, compare prices, track goods, acquire vouchers and group together with friends or strangers to get better deals, all contributing to the consumers range of tactics to make the most from the high street. This project aims to use this sophisticated user knowledge to inform new models of interaction with physical artefacts and their connected data to improve the high street experience and recover cultural values and relationships that are core to shopping.

> "To strengthen the high street, we need to increase the number of mutual connections between the nodes or network participants (retail, services, local government, job centres and all others). The more mutual connections, the more adaptive the high street network becomes in response to changes in the success of individuals shops and services."
>
> (Grimsey 2013)

The technical design prototype aims to breakdown the existing shops data silos to connect people (shoppers and salespeople) with meaningful data through the interaction with 'things' (available goods). It aims to use a combination of product design and design informatics to explore the potentials for opening up the databases that currently exist within the silos along the high street; 'things' in shop have always existed in two places: as material (physical artefacts) and as immaterial (data within shop inventories).

We are already experiencing the clues to how shops are changing as shoppers equipped with smart phones are developing tactics that disrupt traditional store processes such as "showrooming", where shoppers are likely to walk into stores, test out a product by examining its size, weight, texture and in some cases performance, and use their Amazon app to order a cheaper version online (Campbell 2013). The high street is actively moving towards a frictionless shopping (Brynjofsson and Smith 2000) experience, a condition in which the buyer experiences little or no resistance in the purchase of a product (fictionalised by IBM in this IoT commercial: http://www.youtube.com/watch?v=44f5A8PCWiU). It is also the case that two people will pay different prices for the same item at the checkout because vouchers, the influence of loyalty card schemes, based on personal data that was volunteered by each shopper, and special deals have made the price of shopping far more complex.

UK high street shoppers are inundated with company loyalty cards, 95% of the British population holding one (Christie 2014). The numbers of cardholders in the UK indicate that loyalty cards are hugely popular among consumers and profitable to the businesses. Yet, loyalty schemes are not uncontroversial. As customers collect points, retailers collect personal data, including demographic data, name, age, gender, postcode, etc, and individual level purchase data, who bought what, where, when, and at what price (Kumar and Shar 2004). This data enables retailers to build a customer database, to profile their customers, to target them with tailored incentives, and thus to maximise the profitability of their promotional and pricing strategies (Pauler and Dick 2005). In sharing their personal data, users thus create economic value through their on-going shopping activities, only a fraction of which is passed back to the user in the form of discounts (Arnett 2013). Intelligent in their design, they offer the illusion of paying us for a brand loyalty, when in fact the value offered on the piece of paper is truly a virtual currency. Only redeemable at the store that issued it, it has no real value until it is claimed, with all money being retained with the issuing parties' ecosystem.

There is an estimated £billions of issued reward card points being unused every year, with an average £28.60 of points on each reward card in the UK (Grimsey 2012; Christie 2014). This could be because the value of the reward is often so minimal i.e. save £0.16 of your next shop, the time period of use is not immediate with redeemable vouchers often being valid for the next day, and finally the perceived value of the reward points can be very abstracted, i.e. you have been rewarded 23 points for this transaction. Although the stores advertise what each point is worth, in the case of Tesco 150 points are

worth £1.50, there is possibly a break in the cognitive connection between points and value can account for such a gap between the total financial worth of rewards being issued and those being redeemed. Boots, however, print on their receipts the amount that transaction is worth in pence; you now have in your hand a piece of paper whose value explicitly expressed in a recognisable currency amount. As a shopper you have a printed record of the value of your consumer data in the transaction, or more accurately the amount Boots are prepared to pay you to mine your consumer habits (Figure 37).

- Tesco one point per £1 spent and 150 points are worth £1.50
- Boots four points per £1 spent and each point is worth a penny
- Sainsburys (Nectar) two points per £1 spent 500 Nectar points are worth £2.50
- John Lewis one point per £1 spent and 500 points are worth £5
- Waitrose one point per £1 spent and 500 points are worth £5
- Superdrug one point per £1 spent and 100 points are with £1
- Waterstones three points per £1 spent and each point is worth 1p
- Costa five points per £1 and each point is worth 1p
- Game 2% of purchase value is given in points and every 400 points is worth £1

Figure 37: Examples of retailers using loyalty cards and they value they pay their consumer for their transaction data

Dave McCarthy, an analyst at HSBC, estimates that Clubcard costs Tesco £500m a year (Ruddick 2014), comprised of vouchers issued valued at upward of £200m, the cost of each physical card approximately 11p per card, and the loyalty letters sent to 10m Clubcard homes four times a year, that receive no subsidies from Royal Mail. (Humby et al. 2008; Guardian 2003). However, Tesco recuperates some of its costs through selling anonymous customer data to its suppliers, with Dunnhumby generating £53 million in profits for Tesco in 2012. (Platt et al 2014). Tesco works with its Dunnhumby business unit to build a big-data business that analyses millions of customer transactions and sells the resulting insights about shopping behaviour (but not customer-level data) to major manufacturers, including Unilever, Nestlé, and Heinz. The anonymous data can pinpoint spending habits down to the level of postal area, identifying which groups of residents buy, for example, the most wine, chocolate, or organic food. Dunnhumby's website (http://www.dunnhumby.com) states: 'We have access to the shopping behaviour of 13million households, with item-level purchase data from Tesco Clubcard. This helps manufacturers to understand the purchase decisions and habits of customers better than anyone else.' Dunnhumby uses this anonymous data to develop insight into how customers shop, and it is this insight, not individual customer data, which they market to Tesco's suppliers. The Clubcard data also helps Tesco run its business more efficiently. Tracking Clubcard purchases helped uncover price elasticities and set promotional schedules saving over £280 million, because the Clubcard information allows it to only stock products that will sell in vast quantities (Kotler 2009).

At the same time that £billions is being wasted on the high street in unclaimed reward points, 13 million people (1 in 5) live below the poverty line in the UK. The Trussell Trust (2014) in their report identify that many families hit crisis and cannot afford food and today people are going hungry in their own homes. Rising food and fuel prices, static incomes, high unemployment and changes to benefits are causing many families to struggle to put food on the table. The economic downturn and its aftermath have seen the need for food banks soar nationwide. New food banks are opening at the rate of two a week and numbers of people given three days' emergency food by Trussell Trust food banks rose from almost 350,000 in 2012/13 to over 900,000 in 2013/14.

The main way that food is donated is though 'Supermarket Collections'. These collections engage the public at supermarkets where they are met by volunteers who give them a 'food bank's shopping list' and ask them to buy an extra item with their shop, which is then donated to the food bank. Schools, churches, businesses and individuals also donate non-perishable, in-date food to the food bank. All food given out by food banks is donated. Once collected, volunteers sort the food and check that it's in date and then pack it into boxes ready to be given to people in need. Frontline professionals then identify people in need, with care professionals such as doctors, health visitors, social workers, Citizens Advice Bureau staff, welfare officers, the police and probation officers amongst others identify people in crisis and issue them with a food bank voucher. Food bank clients bring their voucher to a food bank centre where it can be exchanged for three days' supply of emergency food. Volunteers meet clients over a cup of tea or free hot meal and are able to signpost people to agencies able to solve the longer- term problem.

Social shopping is a smart phone application, and accompanying website, which allows shoppers to donate their supermarket reward points to food banks. It is a playful take on the high streets tendency to collect data from their customers in exchange for money off their next shop. However, be linking the supermarkets reward database with that of local foodbank's funding requirements, it challenges how much "value" does the customer put on their own data; are the willing to give away the "reward" they receive for being profiled?

Figure 38: Social Shopping prototype, showing till receipt printer and donation booth.

At the point of checkout an additional till receipt is printed, which has a unique barcode. This barcode identifies the merchant, rewards account number, and transaction reward value. The use of unique barcodes on till receipts in conjunction with redeemable offers is already commonplace in the supermarkets. After a one-time setup of their customer details within the application, the shopper would be able to scan the barcode, and then allocate those points to a food bank of their choosing. The transaction would then be validated against the supermarkets records and the reward points reassigned from the shoppers account to the food banks.

The use of a till receipt automatically acts as publicity material for those unaware of the project. It also allows the shopper to have the choice as to whether they want that particular transaction's reward points to be donated or not. For instance, the shopper may wish to keep the points for a high value transaction where the gain for them is significant but would equally be happy reassigning a minimal number of points from a low value transaction.

All food banks would be listed on a website, that displays the total level of donation, current need, and feedbacks to the community the quantity of people being assisted with emergency food parcels. Shopper donations could automatically be pushed to social media to help the project gain traction.

Yunus (2009) describes the idea of a 'Social Business', creating a business not for the traditional purpose of making money, but for solving social challenges. The high street is slowly adopting this business model and reacting to the consumer's desire to choosing socially responsible shopping experiences. After all shopping can be a highly social activity in which friends, family, and indeed strangers, share experiences through engaging with 'things' (Miller 2005), which social contexts will only be further capitalised upon, through increased visibility offered by ubiquitous computing (Ng 2012).

Social Bite (www.socialbite.co.uk) offers 'Suspended Coffee and Food', which means that their customers can pay in advance for a coffee or any item of food from their menu, and a local homeless person can come into their shop to claim it. They currently provide nutritious food and hot drinks to over 30 homeless people in each of their four shop locations, who visit them on a daily basis and get a filing sandwich, hot bowl of soup or a coffee as a direct consequence of the public's kindness. As part of their Christmas campaign Social bite offered a £5 by a homeless person Christmas lunch ITISON deal (Figure 1). The target was initially set at 800 meals but by its conclusion, after trending on Twitter and Facebook, saw more than 36000 meals sold. Waitrose, Community Matters provides their customer, at the end point of checkout, with a token to place in the box of the good cause they'd like to support. The more tokens a cause gets, the bigger the donation they receive. Each month every Waitrose branch donates £1,000 (£500 in Convenience shops) between 3 local good causes chosen by their customers. This is also replicated online at Waitrose.com 3 national causes share a donation of £25,000 voted on after the customer checkouts, and since its launch in 2008, the scheme has donated £14 million to local charities. A similar scheme also runs in Asda's stores.

The design intervention aimed to ask whether we increase the public perception of the value of collective consumer datasets by decreasing the friction in donating to food banks? Social Shopping was a design intervention that could be used as a starting point for a conversation with the participants to enable them to derive greater value from the data they produce and share, and whether an object could act as a proxy to facilitate their understanding.

After using the Social Shopping app, we conducted a series of one-on-one semi-structured interviews in order to elicit the participants' current uses of their loyalty cards, including their adoption, as well as the collecting and redeeming of loyalty rewards. In addition, we were interested in participants' understanding of and attitudes towards retailers' uses of their shopping data.

From a user perspective, loyalty cards are first and foremost a means of adding value to the everyday, and thus often necessary, practice of shopping. From a business perspective, however, loyalty cards are primarily a means of collecting demographic and shopping data about their customers. So, every time a user collects points, the company collects data. Our participants were aware that companies ran loyalty schemes for their own profit. More specifically, they thought businesses offered loyalty schemes: to lure people into the store, to get more customers, to keep people coming back, to give them an incentive to spend, and to get them to spend more money. It was further clear to them that companies collected shopping data through loyalty cards and that this data was used for customer profiling and marketing purposes. How exactly their data was used, however, was less clear: "They've got your preferences, but I'm not sure what they do with it then".

The project highlighted that value creation is very much embedded in a cardholder's everyday shopping practices and guided by an individual's orientations towards privacy and the particular affordances of a loyalty scheme, however a cardholders' key concerns were less with privacy than with value creation, only some of which was economic. The lack of transparency at the stage of data collection, processing, and use turns data producers into users with little stake in the value generation process and offer implications for designers of human-data interactions.

Take Me I'm Yours

Take Me I'm Yours reflects upon the agency of objects, by extending the current continuum of personal barcode scanning software that is currently limited to two modes, reading and writing, and adding a further dimension, actions.

```
- (void) readerView: (ZBarReaderView*) view didReadSymbols: (ZBarSymbolSet*) syms
fromImage: (UIImage*) img { NSString *barcode = [[NSString alloc] init]; for(ZBarSymbol
*sym in syms) {barcode = sym.data; break;} Play *play = [Play play]; ServerConnection
*serverConnection = [ServerConnection serverConnection]; self.serverEngine = [[serverEngine
```

```
alloc] initWithHostName:serverConnection.url customHeaderFields:nil];
NSMutableDictionary *postParams = [NSMutableDictionary dictionaryWithObjectsAndKeys:
play.myID, @"act_id", [DeviceUniqID getDeviceID], @"uuid", barcode, @"barcode", nil];
NSString *path = [[NSString alloc] initWithFormat:@"%@instruction/user.php",
serverConnection.path]; self.networkOperation = [self.serverEngine
postDataToServer:postParams path:path];
__block typeof(self) bself = self; [networkOperation
addCompletionHandler:^(MKNetworkOperation *operation) { NSArray *json = [operation
responseJSON];  if ([json count] != 0){ play.line = [NSString stringWithFormat:@"%@", [[json
objectAtIndex:0] objectForKey:@"content"]];} [bself
performSegueWithIdentifier:@"displayLine" sender:bself]; }
errorHandler:^(MKNetworkOperation *errorOp, NSError* error) {}]; [self.serverEngine
enqueueOperation:self.networkOperation ]; }
```

<div align="right">Shingleton, D., (2012), Take Me I'm Yours, Objective-C</div>

Users of smart phone-based barcode scanning applications are familiar with reading both one and two-dimensional barcodes to link to internet-based materials. As explored in the design interventions that respond to the Connection of Things, it has also been possible to introduce a 'write-back' function that allows users to attach messages and stories to objects. Take Me I'm Yours however, speculates a near future scenario where object databases may begin to identify associations and propose 'actions' to a user.

> "Ordinary objects which have long been used by one master rake on a sort of personality, their own face, I could almost say a soul ... awakened by their contact, [they] take on their own life and autonomous activities, a sort of latent and fantastic wilfulness."

<div align="right">(Claudel 1965)</div>

In way this design intervention offers an opportunity to experience a sense of what it may feel like in the future for objects to begin telling us what to do (Figure 39).

Figure 39: A representation of a future context in which objects will begin telling us what to do.

Take Me I'm Yours responds to the adoption of barcode scanning software that has become available for smart phones. Previously restricted to use at supermarket checkouts, and connected to local and closed databases, the traditional barcodes that are attached to consumer products have become useable

by smart phone users. Software such as Red-Laser, Food Scanner and ShopSavvy available for Android, iPhone and Blackberry smartphones allows users to access data associated with barcodes. Companies such as Google Merchant and Amazon support connections between the two barcodes models: UPC (US and Canada) and EAN (Europe, Australia, South America, Africa), and make it possible for the public to link to common product information. Scanning a product with a barcode reader allows users to compare prices across a range of stores, check availability in second hand stores and even give location-based information about where the nearest store may be in order to purchase the same product. Barcode scanners in supermarket checkouts, or near-field scanners used to check passports at airports, devices 'read' tags and codes and recall data upon that item from a networked database. We can refer to this as the first generation of Internet of Things where the technologies simply recall immaterial data that is associated with an artefact when it is scanned; they are Read Only.

More recently applications such as Tales of Things allow users of smart phones the facility to scan a product code and attach their own media to it. Short text stories, a photograph or video can be posted to the database and is made available for others to read when scanned again using the same software. Turning the barcode into a media channel, mobile phone camera scanners offer companies and individuals a conduit through social data can be attached. Not only can we add this data across product lines, but we can also offer the public a chance to create new codes for unlabelled items, and tag them with memories, stories and media content. This affords individuals to pick a single item, attach social data to it through a website that then generates a unique barcode for them so that others who come across the object can retrieve that data. These systems are aimed at encouraging the public to record personal stories onto objects, allowing some objects that are moving through the world to not only contain quantitative data to ensure product integrity and 'freshness', but also to contain qualitative data that is intended to affect how users interpret and use physical objects. We can refer to this as the second-generation Internet of Things technologies that, allow consumers and owners of artefacts to 'write' information back to a tag allowing others to recall and further comment; they are Read and Write.

The third generation of Internet of Things developed as part of Take Me I'm Yours involves not only the reading and writing of/to tags, but the passage of instructions and actions through objects to facilitate their movement through space/place; they are Read, Write and Act. The tendency for the first two generations of Internet of Things is that objects are not shared in the actual world, only the immaterial data that they are associated with. Reflecting upon the development of the consumer experience from 'reading' codes, to beginning to 'write on' to codes, Take Me I'm Yours involves not only the reading and writing of/to tags, but the passage of instructions and actions through objects to facilitate their movement through space/place; a hypothesis of the next user experience in which objects begin to talk back. Take Me I'm Yours idea speculates a scenario in which 'things' may begin to gain a level of agency and start to demand actions of us. The cultural and technical phenomenon in which all objects are connected across networks, and branded as the Internet of Things, is largely framed as a relationship between scanners, tags and databases. Take Me I'm Yours anticipates a context in which

connections between databases may lead to emergent characteristics including assumptions to be made about the needs of a user, or even the needs of an artefact itself. Take Me I'm Yours is a design fiction in some respects, as the development of a digital system from which emergence can be experienced requires resources beyond the reach of the current technology and thus mean we must develop a platform that simulates the experience.

Take Me I'm Yours is an iPhone app that allows users to read a traditional barcode that is associated with everyday consumer items. Upon scanning a code, the user is prompted with an action to do something with the artefact: "Give me to your neighbour", or "Take me to work with you". Through actions that correspond with 'real world' contexts 'Take Me I'm Yours' encourages the movement of things through people, places and circumstances to provoke new histories and question the perceived function and value of artefacts. When the Cornflakes packet is browsed at home by a family and it says, "Turn me inside out and design your own packet", the artefact is given a voice that provokes a self-transformative action.

The first performance of Take Me I'm Yours was demonstrated in Newcastle during DIS 2012. The demonstration included a shelf containing 30 packets of Scottish porridge oats, with each barcode associated an instruction or action that could be recalled upon scanning the barcode (Figure 40). Visitors to the demonstration where invited to use their own smart phone to scan artefacts and listen to and follow the instructions from their phone. For this performance the instructions remained relatively simple, such as "Place me behind you", "Stack me with my friends", and "Balance me on my edge", and participants of the demonstration obliging followed the instructions creating what can only be described as a 'Jenga' tower.

Figure 40. An audience member scanning an action using their smartphone

The second performance titled, Take Me I'm Yours: Mimicking Object Agency was presented at the DOMe-IoT Workshop at Ubicomp 2012 in Pittsburgh. Twenty products bought from a local supermarket were scripted to ask human participants to help organise them into different groups (Figure 41). Participants used the Take Me I'm Yours iPhone app to listen to what each object wanted by

scanning its barcode. The workshop took the form of three acts. The first act was to organise the objects in to local recipes, with instructions such as "Please take me to my friend the cucumber", "Now, I'd like to be with the pepper", "Leave me with the butter" and "Looks like we're going to be a Pittsburgh Perogie". In the second act the objects requested to be put into their political parties, with instructions such as "I want to stay with the bacon thanks", "Let's make a party with the salt", and "Hey we're the socialist party of Pittsburgh". The final act consisted of the workshop participants, moving the objects into a line, with instructions such as "Let's make a line and I want to be the leader" "I want to be seventh in the line" and "Oi put me next to the onions!".

Figure 41. Products instructing the audience to organise them into receipes

The third performance, Take Me I'm Yours: Beyond the Supermarket, was performed at the Expanded Narratives Symposium in 2013, and was a show that featured supermarket goods as actors. Using the publicly available smart phone app Take Me I'm Yours, a human actor interacts on stage with local products that are usually found in the cupboards and fridges of our kitchens. Beyond the Supermarket introduced theatre goers to the secret lives and opinions of Marmite, sugar cubes and steel wool, as the humorous and disturbing tale changed the way that audience members perceived how they might in future pick up products and encourages them to listen to what they have to say.

The piece was performed twice and involved an actor using an iPhone extend a relationship with 8 physical objects on stage. The set up was simple, a troupe of actors has failed to turn up for a performance leaving the script writer with no show. Handed an iPhone the distraught professor turns to the objects for help. What follows is a shared audience / actor experience in which neither are entirely sure what the objects have in mind as the script unfolds revealing the personalities of the objects. The iPhone was connected to a data projector to display the live messages that are spoken back to the actor and allows the audience to share in the emergence of a meta-narrative (Figure 42).
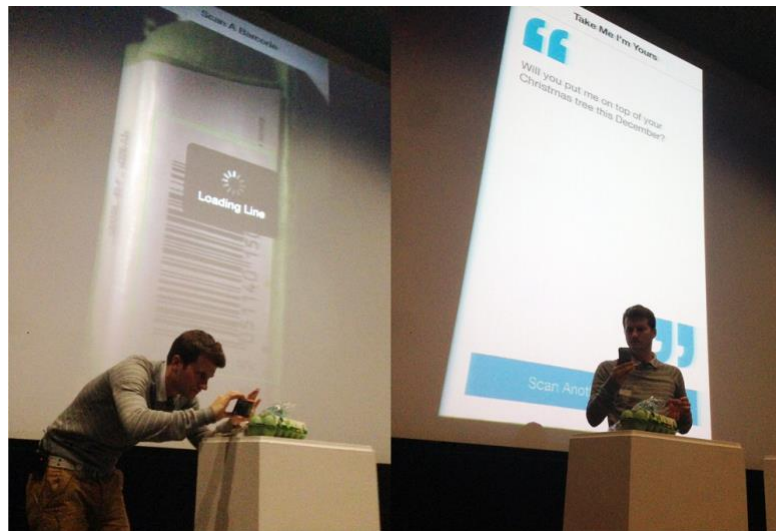
Figure 42. Actor Chris Roberts scans fellow actors (objects) and considers how to respond to their thoughts as the performance unfolds.

Below is a sample of script, written by Lytton Smith, Nijah Cunningham, J.R. Fenn, Jamie Popowich, Abby Rosebrock, and Angela Szczepaniak;

Marmite	Love me or hate me. Love me love me love me hate me hate me. Love me hate me.
Gunderman	Ha. That's quite funny. Because people either love or hate Marmite. Yes. Okay, I get it, the joke's on me. Okay, okay. Who's responsible for this? Is it my Intro to Objectification students? You've all failed the course. Laugh about that now.
Marmite	My father was German. He bottled brewer's yeast and ate it. But my name is French, you know, for earthenware pot.
	Gunderman is tickled that he gets responses from the objects. He keeps scanning.
Marmite	A man took me off the shelf 1 day and put me on toast.
Marmite	Always toast. Toast again. No one drinks me anymore.
Gunderman	That is quite clever, though. (To the audience) Isn't that ingenious? It's a neat little demonstration, really, of the ways-
Marmite	Make a nice hot drink outta me.
Gunderman	Anyone have a kettle handy? Some boiling water?
Marmite	Give me to someone to eat, served on an icecube of white sugar.

Gunderman looks mischievous; he is something of a bully. He gets a sugar cube out of the pack, uses his keys to spread marmite on the sugar, tries to get audience members to eat.

Sugar   Pretend I'm cocaine.

Gunderman   I think that might get me fired. I'd have to check with my Union rep.

Sugar   Recent credits include the role of cocaine in numerous student films

Sugar   As set dressing in The Nutcracker I felt ashamed by the Mouse King's theft of sugarplums and marzipan from little ones at his rock bottom.

Gunderman   Ooh, a celebrity. Well, at least we've finally got an actor in the house. Don't tell me they've gotten lost – or stuck in the revolving doors! You know, we've got an English lecturer who once got stuck in the revolving doors? You can't push them, see; they tell you that, in big letters on them: Don't Touch! But he touched them, and they stopped revolving. And the more he pushed, the more they wouldn't move. Relatively speaking.

Sugar   Do you know how important I am to French Fry recipes?

Gunderman   Well listen to her. Who knew sugar was so self-aggrandizing?

Sugar   Go ahead, call me Sugar in the workplace.

Gunderman   Sugar with a political bent. I like it.

Sugar   Make tea for someone with me.

Gunderman   Nope, still no boiling water. Or actors.

Sugar   Put me on someone's collar as if they've got terrible dandruff

Gunderman   I might have been able to pull that one of if you hadn't just told everyone the plan out loud.

Sugar   When you see me, think of Baltimore, and call someone you know from there.

Gunderman	A reference to The Wire! Very intertextual. How droll.
	Well, why not – we've time to kill, haven't we
	Gunderman gets out his phone, makes a call.
Gunderman	Emily? Hey, Emily-
	Well, yes, ah, okay, it is half-three in the morning in L.A.-
	No, no, nothing's wrong. It's just that this box of sugar told
	me to call someone from Baltimore.
	Yes – a box of sugar. It said to call someone from Baltimore.

The final instalment of Take Me I'm Yours took part at the Edinburgh Fringe 2014 with the Beltane Public Engagement Network (Figure 43). It showed a new and improved version of which we had previously shown at the Expanded Narrative Symposium and at Ubicomp. Is Your Marmite Watching You? the show explored a world where everyday objects around us, including food items, can communicate with each other and us.

Figure 43. Alison Trower performing Is Your Marmite Watching You? written by Stephen Alan Yorke.

Take Me I'm Yours is an extension of the trajectory of taking objects online. From watches to chairs to jars of marmite, anything that can be assigned an IP address will have the potential to wirelessly transfer data over a network and therefore communicate. Take Me I'm Yours introduces a lineage for our relationship with objects from 1. Read Only, 2. Read and Write and 3. Read, Write and Act. The work proceeds to establish the conditions for a third generation of Internet of Things by articulating the nature of networks (Lopez and Scott, 2000), their structure (Durkheim 2984) and their capacity to support the principles of Actor-Network Theory which may lead to a condition in which objects may take on a form of agency (Wooldridge & Jennings 1995, cited Gilbert 2008:21)

"In between the somewhat surreal comedy the show raised valuable questions over the benefits and potential risks associated with this new technology. Smart packaging on food items can tell us when food has gone off and point out the nearest food recycling centre helping to reduce food waste. Sensors in street lamps can feed back information on air quality, weather conditions and UV radiation...New technology is being designed to 'nudge' us, to send some kind of physical reminder (noise, vibration etc.) for us to act in some way. For example, if we haven't reached our exercise target for that day, we can be 'nudged' to encourage us to keep going until we have. This technology is being designed to change our behaviour in a good way but who decides what is good or bad? Who sets up the value data frame?"

<div align="right">(Stafford 2014)</div>

The most noticeable observations we're evident at the second performance during the workshop at Ubicomp. Watch people actively listen to products for what must have been over 30 minutes was surprising on a number of counts.

- Watching how loyal the people are listening to, and obeying the products
- Each script was part of a series of steps in fulfilling a larger task – organising things into the correct collection for a specific recipe. However, the scripts were pretty linear and could easily have gotten muddled up if people scanned a product too many times, but people always figured it out.
- Even when our scripting wasn't perfect people were still determined to organise the things according to what they requested. In the final act scripting error messed up the actual order, but some participants were determined to keep the 'things' happy and continued to move the objects despite being stuck in an obvious 'loop'.

Over the course of the four performances the works speculates, through a design demonstration, upon a future context in which objects will begin to talk to us and even give us instruction or begin to gain agency (Bleecker 2006). The value of this working 'design fiction' is to frame the history of users' relationships with barcodes as they have moved from closed supermarket systems to more open internet-based experiences. It anticipates a time when objects themselves will be used to impart 'new' knowledge back to us.

Treasure Trapper

Treasure Trapper explore the theory of emergence through developing user experiences that rely upon an interoperability between different city databases and location-based data.

```
SettingsSingleton *settingsSingleton = [SettingsSingleton settingsSingleton]; NSDictionary *dict
= settingsSingleton.arrvials; NSString *busstop_id = [dict objectForKey:@"id"]; NSArray
*arrivals = [dict objectForKey:@"arrivals"]; for (int i = 0; i < 1; i++){ self.object_name.text
=[[arrivals objectAtIndex:i] objectForKey:@"object_name"]; NSString * imgLocation =
[NSString stringWithFormat:@"http://fields.ace.ed.ac.uk/tt/uploads/%@", [[arrivals
objectAtIndex:i] objectForKey:@"object_image"]]; NSURL *imgUrl = [NSURL
URLWithString:[imgLocation
```

```
stringByAddingPercentEscapesUsingEncoding:NSUTF8StringEncoding]]; UIImage *pin =
[UIImage imageWithData: [NSData dataWithContentsOfURL:imgUrl]];
self.object_image.image = pin; NSString *secondDatestring = [[NSString alloc]
initWithFormat:@"%@ %@:00", MyString2,
[[arrivals objectAtIndex:i] objectForKey:@"time"]]; NSDate *date1 = [df
dateFromString:MyString]; NSDate *date2 = [df
dateFromString:secondDatestring];NSTimeInterval distanceBetweenDates = [date2
timeIntervalSinceDate:date1]; MZTimerLabel *timer3 = [[MZTimerLabel alloc]
initWithLabel:object_timer andTimerType:MZTimerLabelTypeTimer];[timer3
setCountDownTime:distanceBetweenDates]; [timer3 start]; }
```

<div align="right">Shingleton, D., Treasure Trapper, Objective-C</div>

The tourist's city is defined by two extremes: the static cultural centres, including museums and galleries, and the dynamic flow of people and traffic. Digital technology has the potential to connect the flow of traffic that passes cultural centres with the tourists who are interested in seeking out all that a city has to offer. Treasure Trapper is a locative-media-platform that integrates Lothian Buses API providing time/GPS of Tourist buses travelling across the city, with artefacts from Edinburgh Museums & Galleries and Assembly Rooms. Tourists and locals are able to use a smart phone app to follow objects across the city, capture them and return them to venues boosting tourist footfall. Treasure Trapper uses Edinburgh's city bus data as a platform for smart tourism.

As a popular tourist destination, Edinburgh's museums are of particular interest, however the large National museums and galleries dominate the tourist trails eclipsing the smaller venues, leaving the smaller venues with a smaller proportion of the market. The top 3 most popular attractions listed, through a visitor survey by Edinburgh Tourist Attraction Group, are currently Edinburgh Castle (72%), National Museum of Scotland (32%) and National Gallery of Scotland (30%). Although City of Edinburgh Museums & Galleries Service manage 8 visitor attractions across the city, including the iconic Scott Monument and the home to the capital's history, Museum of Edinburgh, the only venue mentioned through in a recent survey was the Museum of Childhood (10%). Edinburgh Museums & Galleries have a wealth of stories, objects, collections, events and authentic experiences to offer the visitors and residents of Edinburgh that can be lost in the shadow of their complementary counterparts listed above.

The solution, to make these overshadowed cultural venues more 'visible', was to develop a game that would mobilise these otherwise hidden treasures by bringing them out of the museums and galleries. Interested in the opportunities of correlating different data sets that are available in places such as cities the authors struck upon the idea of using the flow of buses that passed by museums to move objects around the city (Figure 44). In response we developed a game in the form of mobile applications for iOS and Android platforms that integrated data derived from the Lothian Buses open API which describes the time of arrival of buses to bus stops across the city with cultural information about artefacts held within the museum collections.

Figure 44: Participants in the Treasure Trapper game. At this point the players are picking up a virtual artefact dropped by the bus.

The applications integrate data to form a simple but compelling game. Simply put, as the tourist buses that are operated by Lothian Buses pass by a registered museum or cultural venue, they 'steal' an object from the museum's collections. The buses drop the objects off at bus stops around the city; the app associates the GPS coordinates of the bus stop with virtual object for three minutes. This provided the user with a small window of opportunity to 'catch' the virtual object and make it part of their collection. The smart phone app would be aware of the users GPS coordinates making it impossible to 'cheat' the app, and thus heightening the gaming qualities. The user is able to catch 12 objects in their collection before having to return the objects to the museum to receive a prize. Prizes range from badges at the early levels and discounts in the shop for higher levels. On returning the objects by scanning a QR code at a venue the next level of objects is unlocked, and the player can return to the city streets to capture the next series of objects for higher value prizes (Figure 45).

Figure 45. Treasure Trapper iOS interface.

What appears to be unique about the Treasure Trapper application was the achievement in combining new web services with existing ones.

> "The Treasure Trapper app has created a fantastic opportunity to make staff, right across the EMG spectrum work together on something truly innovative and exciting. Frontline staff were asked to nominate the objects they believed would create greatest attraction for young people,

then the curators from the History, Art and Collections Teams all worked on writing descriptors for these nominated objects in a manner that would capture the interest and imagination of young people. Finally, the EMG development team (retail and outreach) play a part in engaging with the young people when they come to the point of claiming their rewards."

(Edinburgh Museum and Galleries 2015)

Beyond the development of a server-side gaming platform and a client-side app, the interrogation of Lothian Bus data meant that the project was rare in its building upon existing city services. The project demonstrates the potential for using moving vehicles as carriers of data for localised services. Few platforms have managed to build games on top of existing city-wide databases and the feat of pulling three together: Edinburgh Museums and Galleries, Assembly Rooms and Lothian Buses is quite an achievement. Particularly given that the iOS and Android apps were made publicly available.

Conclusion

Discussion

This thesis initially proposed the question, how can we use practice-based research to examine the current commercial discourse on the Internet of Things, and create design interventions that allow for an alternative discourse to emerge in order to recover the role of a networked object, rather than producing prototypical systems?

It is clear that objects already play a unique role in our social networks and have strong ties to identity and memory (Draaisma 2000; Henare et al. 2007; Hoskins 1998; Kwint et al. 1999; Miller 2008; Turkle 2007), space (Baudrillard 1996; Bollas 2009) and value (Appadurai 1986). Through my framing of the Internet of Things in the three commercial design fictions, it provides a context against which we can ask how each of design fictions' proposed attribute an object's 'connectiveness', will affect our understanding of this existing role.

The research introduced term 'design interventions', a mash up of 'design fictions' and 'art interventions', a response to the what this author views as the shortcomings through the use of design fictions; namely this issue of plausibility (Coulton 2016). Design fictions enable designers to question "how things might be", they can also consider "alternative presents" to enable them to question "why things are the way they are" (Auger 2013), but they are a tool for a designer to reflect upon the production of knowledge resulting from a design/making process (Fraylings 1993). In my opinion they require you to already have a cognitive model of your subject matter/context for the prototypical output to have meaning; which is typically only consumable within the community that produced it.

Here in lies the challenge for producing design fictions the for Internet of Things. If I have no mental model of ubiquitous technological environments, as they do not currently exist, how can I understand the technological, philosophical, sociological and cultural theories that address the Internet of Things potential?

Design interventions offer a recovery to plausibility because they draw upon the principles of art interventions, which means they are working instances of Internet of Things technologies, that allow the audience, institution or public domain to interact with the associated concept presented. They allow the designer to move closer to non-fiction by embodying both technology and theory in a working example, which allow the audience to understand first the technology, thus providing the cognitive model for them to then engage with a complex theory, second.

The design interventions presented in the thesis are used as a method for conducting research for art and design/art practice as creative artefects aimed to question, respond and challenge how we can understanding of the role of an object in the Internet of Things. Design interventions provide the tool to allow us to answer the question how can we critique discourse on Internet of Things when it is still largely a near future paradigm and not ubiquitous framework which we interact with on a daily basis?

The research began by examining the early vision of the Internet of Things as proposed by Barton and Kindberg (2002) in their industrial fiction, Cooltown. I introduced the term the Connection of Things, and situated this within the context of ubiquitous computing, which speaks to a vision of small computers that are embedded in everyday objects all around us (Weiser 1991). The connection of everyday objects to the Internet of Things is next stage in the evolution of how we access information; from 'personal computers' that were local, to 'networked computers' that makes information available on the Internet, to 'ubiquitous computing' that allow you to take information out into your environment, and finally to the arrival of what I have termed 'thing centred computing', the ability to access information through our environment.

Cooltown was critiqued against two theories, Peters Anders' Cybrids (1998) and Adam Greenfield's Informational Shadows (2006). Both of which speak to how the Internet of Things creates a link between the physical and digital worlds, and the resulting impact on our experience of everyday objects.

Anders Cybrids were embodied through the design intervention Tagged City Play! which used tagging technologies to take real world objects and convert them into game play objects; a pervasive play given by the use of mobile and ubiquitous computing devices. The work addressed what it feels like to experience an environment where objects are capable of communicating information, resulting in data being layered on top of the real world. The importance of the Tagged City Play! is it was one of the earliest developments of a technological platform that allowed you to not only read information from a RFID tag, which to date was just its serial number, but also to write meta information in the form of text and images. Although the complexity of that information has evolved over the later work presented, for example to include GPS coordinates or video in TOTeM, in essence they all follow the same principle of interaction.

Greenfield's Information Shadows were embodied through RememberMe and RememberUs design interventions, the aim of which was to investigate the experience of attaching data to an object, and how it might affect our handling of them. Finally, the design intervention, The Memories of Mr Seels Garden, expanded the theory to consider not only the object, but also how its relationship to time and space might affect the data related to it. The importance of research output from Mr Seels Garden is that it challenged the notion the data associated with an object is static. By this I mean even if an object is capable of having multiple types of information (data) associated with it, regardless where or when you scan the object, the information shadow you retrieve would always have the same context; as in

RememberMe and RememberUs. In fact, Mr Seels Garden shows us that an object's data can be dynamic and constituted not only by its product categorisation (its taxonomy), but also spatiality and temporally. Through the practice of an object's data being structured in time and place, perhaps it has the potential to produce specific social patterns and relationships (Lefebvre 1974)?

This ability for a connected object to reveal insight into the network in which it is situated, was then investigated through the second commercial design fiction of the Internet of Things, IBM's Smarter Planet (2010). It built upon the previous research, by reflecting on how the connecting of everyday objects to the world wide web (thus turning it from a connected object to a networked object) changes our understanding of the composition of the networks which we inhabit and introduced the term the Spatiality of Things.

The Spatiality of Things examined through Sterling's Spimes (2005), a term which describes the use of tagging and location technologies in the manufacturing process to track objects across time and space (network). This theory was investigated through the design intervention Oxfam Logistics, a project that connected the fill level of charities donation banks to their network, providing their staff with the visibility of stock inventory as it moved from bank, to van, to shop.

Secondly, I built upon the debate for the Internet of Things to act as a technological framework for visualising the structure of networks, by exploring Castells' theory of the Space of the Flows (1996). The design intervention the Internet of Cars, looked at the ability for cars to act as vehicular packets of data in a transport network consisting of automatic number plate readers. The work reflected upon Castell's proposition of how society is constructed around flows of information and technology.

Lastly, I considered Latour's (2005) Actor-Network Theory, a method for mapping the patterns of techno-science, where networks become the substance out of which both individual identity and social organisation are constructed. This theory was explored through the design intervention CoGet, which asked what happens when things move people around, where objects 'piggy back' the urban routines that we perform on a daily basis and request people to move them to places where they could be part of useful applications. The project used the power of machine learning to predict where a person would be in time and space, and the object acted upon that person to transport itself to its end destination, using the person's journey.

The ability of a connected object to impart actions within a network was addressed in the final commercial design fiction, Cisco's the Internet of Everything (2012), which I term the Emergence of Things. I began by examining Julian Bleecker's theory of Blogjects, which reflects upon a networked object's ability to have agency, and this was explored through the two design interventions, Social Shopping and Take Me I'm Yours.

Social Shopping reflected on the agency of consumer data, and the ability to re-appropriate it for social change. Through the increased visibility offered by ubiquitous computing (Ng 2012), I explored the value of a person's data, by asking at the point of checkout whether they wished to donate the data value of their shopping basket to charitable causes. This built upon Yunus (2009) idea of a 'Social Business', were we can view the high street reacting to the consumer's desire to choose socially responsible shopping experiences. It was designed as a proxy that could be used as a starting point for a conversation with the participants, which may enable them to derive greater understanding of the value of the data they produce and share.

Take Me I'm Yours reflected on the agency of objects. The design intervention aimed to extend the current continuum of personal barcode scanning software for smart phones that is currently limited to two modes, reading (first generation) and writing (second generation, and add a further dimension, actions (third generation). Take Me I'm Yours involves not only the reading and writing of/to tags, but the passage of instructions and actions through objects to facilitate their movement through space/place.

Finally, by reflecting upon CISCO's view of the Internet of Things, which addresses their question of what happens when "lots of things are all waking up", I extended the critical thinking to date, and introduced the term 'relational emergence'. This is a critique of Bleecker's theory that agency is the defining property of a connected object and proposes that the role of an object lies in the properties that might emerge when you begin to connect across databases; which I term the Emergence of Things.

This proposition was explored through the design intervention Treasure Trapper, a smartphone game that investigates what happens when you begin to 'lace' together city data services. What was unique about the Treasure Trapper application was the achievement in combining new web services with existing ones, building a game on top of existing city-wide databases: Edinburgh Museums and Galleries, Assembly Rooms and Lothian Buses.

Contribution to Knowledge

Over the duration of my practice-based research for art and design, I have identified a new combination of critical thinking and critiqued their application to the Internet of Things through the use of design interventions. As such, it is the opinion of this author that this thesis' contribution of knowledge lies in its framing of the Internet of Things as the understanding of an object's trajectory from digital connectiveness, to network situatedness, to the potentiality for relational emergence as a result of its data creating associations across databases. In light of this new thinking, perhaps a better research question to ask is:

What affordances will an object have when our understanding pivots from that which is primarily material, to those that are inmaterial; when we view an object from the perspective of its data first, and its physicality second?

As previously discussed, the Internet of Things has been articulated through three commercial design fictions. First Cooltown, which addressed the "convergence of Web technology, wireless networks, and portable client devices provides", that offer "new design opportunities for computer/communications systems, through an infrastructure to support the 'web presenc'" for people, places and things" (Anders 1998; Barton and Kindberg 2002). Second Smarter Planet, which shifts the importance from the act of connecting objects, to understanding the value of data as it flows between these objects in a network (Castells 1996; Latour 2005; Sterling 2005). Finally, the Internet of Everything, where importance of a networked object lies in the sum of its communications across silos of databases, and whose data can provide potential insight (Bleecker 2006).

The examination of these three Internet of Things design fictions and critical thinking, articulates objects through their trajectory from thing to data; a 'Dematerialiation of Things'. However, in this author's opinion this is not the current understanding of objects that are being designed as part of the Internet of Things. Instead we see instantiations of objects regress to back their materiality; we have an 'Internet of Smart Products';

> New smart objects are already beginning to become part of our habitual routines ... bedside table lamps that are connected to friends and families, to thermostats that tell you that you've left your heating on ... are transforming the relationship between people and objects.
> (Oberlander, J., Speed, C. (2014), Manifesto for the Centre of Design Informatics)

Here Oberlander and Speed are referring to two products that are widely considered Internet of Things objects. Firstly, the Good Night Lamp (Figure 46) which is an internet connected family of lamps. Each family is made up of a Big Lamp and a Number of Little Lamps. Whenever you turn on your Big Lamp, any Little Lamps connected to it will turn on wherever they are in the world. This project, by Alexandra Deschamps-Sonsino, seeks to communicate the act of coming home to loved ones, making use of an object as simple as a lamp. When one gets home and turns on the lamp, a signal is sent to other similar devices remotely connected to the emitter, and the light of these receptors is simultaneously lit. This way one can tell when he/she is 'connected'. The remote lamps, with their lights on, show that one person turned on his/her lamp, which by convention indicates their presence at home.
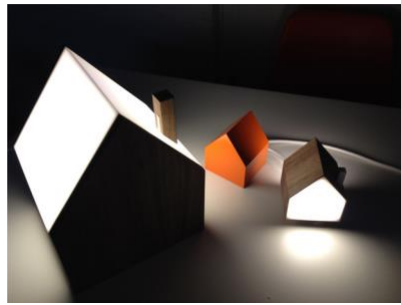
Figure 46: The GoodNight Lamp

Figure 47: ScottishPower Connect wireless thermostat system

Secondly, they reference the rise in smart thermostats, that let you remotely control your home's temperature via a tablet, smartphone or desktop for greater control over your central heating. An example of this is Scottish Power Connect (Figure 47) which allows users to control their heating remotely and create a daily schedule, or simply turn it off when they go on holiday. The app also enables users to 'boost' their heating if they need it to be warm in a short space of time or put their current schedule on 'hold' should something change; if for example, you were to miss your train home, you can simply pause the schedule to avoid heating up an empty home.

As it stands, the transformation of the relationship between people and objects as Oberland and Speed discuss, is not one that arises from the understanding of an object's relationship to network and data, but to products that articulate the new capability of local or remote digital interactions. Internet of Things objects are still being designed where the focus is weighted on product (material) first and data (immaterial) second. When we reflect upon the initial question of this thesis, herein lies the opportunity to recover our understanding of the role of objects in the Internet of Things.

The Internet of Things is leading us into a new era of ubiquity, where the 'users' of the Internet will be counted in billions and where humans will most likely become the minority as generators and receivers of traffic, and instead most of the traffic will flow between devices and all kinds of 'things'. As the Internet grows, we have, and we will see it encompass more and more elements of the real world; as "ordinary objects, from coffee cups to raincoats to the paint on the walls, would be reconsidered as sites for the sensing and processing of information...where ubiquitous means not merely in every place, but also in everything" (Greenfield 2006). The significance of the Internet of Things is, that through tagging technologies like radio frequency identification and two-dimensional barcodes, it offers a low-impact way to 'import' physical objects into the data-sphere and endow them with an informational shadow (Greenfield 2006).

If an informational shadow is created for every object connected as a node in the Internet of Things, what does the shadow look like and what is its effect on an object?

Most implications of an Internet of Things consist of programs resulting through the convergence of identification and location technologies related to the manufacturing process for consumer goods and their associated logistical systems, such as stock control and product tracking. These systems offer the ability for the condition of an object to be recorded in a variety of forms and streamed to databases that can be correlated and mined to ensure that things, for example, are in the right place now or have been in the right place in the past, have been kept at the right temperature and handled by the right people (Speed 2010). Sterling terms these objects 'Spimes'; objects that can be tracked through space and time, and throughout their lifetime. Spimes are regarded as "material instantiations of an immaterial system, they're virtual objects first and actual objects second", which "begin and end as data" (Sterling 2005). From books to frozen peas, parcels, to even people, things move through scanners to update their location; if that location has particular properties, then aspects of its condition complement the data that is associated with the object. "In this way, things carry data about the world around them" (Speed 2010).

The ubiquity of smartphones and online platforms offers individuals the ability to re-appropriate previously closed channels and tag physical objects with memories, stories and media content. Anders (2001) discusses the ability of an object to be the methodology for the mapping of space and information, a 'cybrid reality'; "I have a physical object here that notes my handling of it and displays its contents to me in this way". The change in informational processes become spatial in nature and in direct relationship with the physical, resulting in a virtual and physical world that correspond with each other, comprised of entities that 'cybridize' within that world.

However, when we are discussing the attachment of data to objects, whether it's labelled 'Spimes' or 'Cybrids', I question whether Greenfield's 'Informational Shadow' is the right analogy to use. The term shadow by its definition implies that it is the object that casts the information; we are still primarily considering its physicality first and that data must be read from it. In contrast, the Internet of Things can provide a technological framework for data to be written onto objects, in situ or remotely, allowing the data to cast its own shadow on to objects that are either present in the real world, or more importantly have never existed, or no longer exist due to having been lost or destroyed.

As discussed earlier the Internet of Things offers the opportunity to intensely map the real world onto cyberspace with increasing detail, through the ability to uniquely identify anything immediately via a machine-readable identification method such as RFID or a high-density visual code. Once you have this capability, you can attach meta information to it and create a digital representation. Therefore, when we examine an object as part of the Internet of Things we must consider the data attached to it, as well as its physical form. A networked object provides additional affordances to those objects that are offline or simply 'connected' or 'smart'.

The study of the affordances of objects is not a new concept, exploring the psychology of materials and thing. Psychologist James J. Gibson originally introduced the term in his 1977 article "The Theory of Affordances" and explored it more fully in his book The Ecological Approach to Visual Perception. The term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could be used (Norman 1988).

> "An affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective–objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behaviour. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer."
>
> (Gibson 1977)

Affordances provide strong clues to the operation of things. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing. When affordances are taken advantage of, the user knows what to do just by looking (Norman 1988). Affordances are those qualities that emerge from a quality of an object in the environment, to a quality of an agent using that object (Ortmann & Kuhn 2010). An affordance is neither agent or object but rather their combination; affordances are dyadic relations (Chemero 2003; Nye and Silverman 2012). Affordances are the possibilities of action called forth by these relations to a perceiving subject (Gibson 1977; Gibson 1979; Weeks and Fayard 2007). The affordances of a physical object therefore reside both in its visibility and feedback, the part that is visible whose action has an immediate and obvious effect (Figure 48).
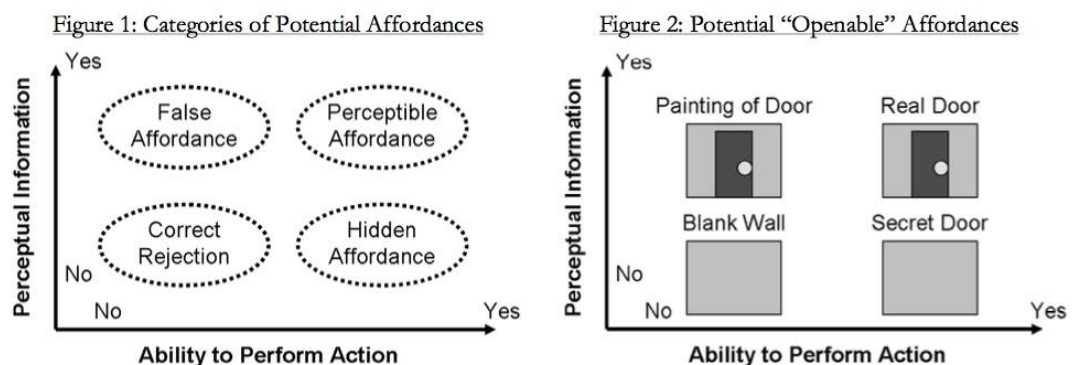

Figure 48: Affordances (Nye and Silverman 2012)

However, if an object's affordances lie in the relations of its data, how can we perceive the qualities that emerge when data is immaterial and whose visibility and feedback power might be wholly unrecognisable by the human eye?

In artistic practice, negative space (Figure 49) is used to refer to the space around or between the subject(s) of an image, and not the subject itself. The surrounding space is used to artistic effect as the 'real' subject of the image and is used to form an interesting or artistically relevant shape. The importance here is that it is the immaterial space that is used to define the method of viewing the

representation of the object for the audience. Another way of understanding this thinking is Heidegger's example of a handmade ceramic jug; an object that has function and form and is made of a particular material. Heidegger (1971) states these qualities are all derived from a fundamental 'thingness', however he views the jug as constituted fundamentally by the void inside of inside of it; 'the vessel's thingness does not lie at all in the material of which it consists, but in the void' (Heidegger 1971; Harman 2010)
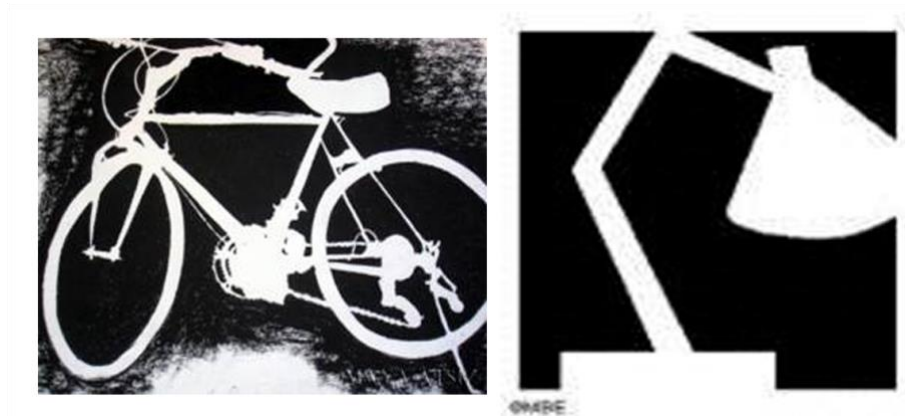

Figure 49: The artistic practice of negative space.

In the same way, objects in the Internet of Things become abstracted manifestations of their data whose immaterial representation may differ from their physical form. When we stop examining the physical object, and instead start seeing the immaterial data that surrounds it, the form of the object begins to disappear. By concentrating on what doesn't exist, the negative space, we can more accurately define the boundaries of what does exist; "all objects relate to their own visible and invisible qualities" (Harman 2010) When we view an object in the Internet of Things, foremost we are viewing its data. Its forms, and its potential intentionality for action lies in the negative space created by the associations/relations between databases tables and indexes.

This I term this the 'Negative Space of Things'. It is the method by which we can begin to understand the immaterial affordances of an object and leads us to ask what happens when an object's negative space begins to interconnect across the networks in which it is represented?

Ubiquitous digital devices are built into the world of everyday life, of social relations, places and things (Coyne 2010), and the Internet of Things is evolving into a "conceptual framework for understanding how physical objects, once networked and imbued with informatic capabilities, will occupy space and occupy themselves" (Bleecker, 2006). Like humans, objects, practices and things never exist in a vacuum but are always situated in particular temporal and spatial contexts. As such, things themselves are positional and relational, and their uses, values and meanings may change significantly from context to context (Appadurai 1986; Harman 2009; Kopytoff 1986). The Internet of Things provides a technological paradigm under which we can manifest the new forms of spatial arrangements; where objects also form networks, communicate and even perform tasks (Kuijer and Giaccardi 2015).

Through an enormous quantity of the new associations being generated via thing to thing and thing to people communication, The Internet of Things allows us to see a whole set of patterns and relationships that were previously not visible in our networks; "society itself is to be rethought from top to bottom once we add to it the facts and the artefacts that make up large sections of our social ties" (Latour 1992). Society, organisations, agents and machines are all effects of patterned networks generated through the interactions of actor-networks, the observation of which can only be achieved by tracking the traces left when relationships, or associations, are being produced between intermediaries (Law 1992; Latour 2005). Social networks are comprised of the patterns of casual interconnection and interdependence among agents and their actions, as well as the positions they occupy (Lopez & Scott, 2000). In other words, their relational structure is the sum total of all the social relationships of all the agents at a given moment in time.

Attributing agency to objects is not a new concept. Actor network theorists discuss the ontological symmetry of humans and nonhumans, in which material forms take on the characteristics of humans: they judge, form networks, speak and work performatively (Engeström and Blackler 2005). Actor-Network Theory can be seen as a tool for exploring and describing how the social is assembled by way of technologies, objects and artefacts, "and its import is one of agency, specifically the responsibility that is distributed equally across entities, including a host of nonhuman ones not normally seen as exercising agency at all." (Latour 2005).

Actor-Network Theory proposes that the structure of networks consists of nodes, both human and non-human, where associations between the nodes exist in a continuous space of flow (Castells 1996); it is more interested in the infrastructure of Actor-Networks, how they are formed, maintained and how they can fall apart. Networks, according to Actor-Network Theory, are understood as relationships of heterogeneous actors – social, technical, textual, naturally occurring etc, – brought together into more or less stable associations or alliances (Law 1991). In short, an Actor Network is the act linked together with all of its influenced factors (which in turn are linked), producing a network between technical and non-technical elements (Monteiro 1998). The term 'actor' can therefore be used to refer to a person, a plant, a machine, a weather system or a germ (Whittle & Spicer 2008); 'they need not be human characters they can be anything' (Latour 1988).

The essential characteristic of actor-network theory is the equitable analysis of human and nonhuman actors, referred to as the 'missing masses' (Latour 1992), which are esteemed as equal actors in networks that want to achieve a common purpose. Actor-Network Theory's commitment to 'radical symmetry' involves viewing the power of humans and non-humans as equally uncertain, ambiguous and disputable (Callon 1986), with no agential priority is accorded to the institutional, conceptual, natural or material (Callon and Latour, 1992). A machine can therefore be thought of as having, in principle, the same degree of agency as a person. Law claims that their patterned network of heterogeneous materials

defines people. "If you took away my computer, my colleagues, my office, my books, my desk, my telephone I wouldn't be a sociologist writing papers, delivering lectures, and producing 'knowledge'. I'd be something quite other" (Law 1992).

Actor-Network Theory incorporates what is known as a principle of generalised symmetry; that is, what is human and non-human (e.g. artefacts, organisation structures) should be integrated into the same conceptual framework and assigned equal amounts of agency (Barad 2003; Bennett 2010; Latour 1988; 1992; Murphy 2013). An actor is not the source of action but the moving target of a vast array of entities swarming towards it, and action should be felt as a set of agencies or translations between mediators that may generate traceable associations. (Latour 2005). In the Internet of Things, "agency happens with the ecology of networked publics –streams, feeds, trackbacks, permalinks, Wiki inscriptions and blog posts" (Bleecker, 2006). In other words, the agency lies in the flow of data between connected objects.

The Space of Flows is Castels' (1996) theory relating to network society and technologies role in a new type of space; made up of movement that brings distant elements – things and people – into an interrelationship through synchronous, real-time interaction. Network societies are made from the interaction between a set of interconnected nodes, organised in and around a given social structure (Webster 1995). This social structure is formed by the flows between relationships of production and consumption; social practices ordered across space and time (Giddens 1984) Meaning is constantly produced and reproduced through symbolic interaction between actors framed by this social structure. Therefore, flows are understood by the purposeful, repetitive, programmable sequences of exchange and interaction between physically disjointed positions held by social actors in the economic, political and symbolic structures of society (Castells 1996). The Space of Flow is defined as consisting of three elements – "The medium through which things flows, the things that flow, and the nodes among which the flows circulate" (Stalder 2001). The Internet of Things can be understood in terms of these three elements – tag/reader, data and objects.

Through contextualising the Internet of Things through Actor-Network Theory and the Space of Flows we can conclude that an object's agency, meaning, functionality and value is deduced from the relationship created by its negative space when inserted as an actor into an intersection of a flow in a network. Immaterial flows of data are extremely malleable, and out of changes, new relationships arise; things are less defined by their intrinsic qualities but more by their relational position to one another (Latour cited Stalder 2003).

How does this affect our relationship with physical objects?

If we take it seriously that things, and people, are less defined by their intrinsic qualities but more by their relational position to one another, then the unit of analysis, and action, can no longer be the single element, an individual person, a product or a company (Latour 1993, 1999). McLuhan (1972) states the

"meaning of meaning is relationship", and by this he meant that there is no content without context and that the importance of a piece of information, its real meaning, changes depending on what it is related to. The difference between data, information, and knowledge is the amount of relationships that are contained within it. Leibniz argues that space is created between things; objects create space which is constituted by the relationships among these objects (Leibniz cited Khamara 1993). In other words, function, value and meaning in the space of flows are relational and not absolute. As the network changes, as old connections die, and new ones are established, as the flows are reorganised through other nodes (Stalder 2003), a node's agency, meaning, functionality and value changes too. From a relationship, meaning emerges, and objects in the Internet of Things cannot help but allow us to view the world in terms of unseen relationships where the things-in-motion illuminate their social context.

What if we try to understand the world from the perspective of a 'thing' that is situated within relationships with other entities, and that has the potential to influence the existence of those other entities?

The Internet of Things offers a technological framework for this theory, connecting everyday objects to networks and providing them with a rudimentary knowledge about what they are and the environments they inhabit; given the fact that an object through a tag/reader can query a database to discover associations about itself, and any other object within its vicinity. The Internet of Things blends the distinctions between subjects and objects (Law, 1991), and between ideality and materiality (Engeström and Blackler 2005), as objects acquire perspective and agency through the data they collect, the stories they reveal, and the interventions they make in the lives of the people that use them (McVeigh-Schultz et al., 2012). As such objects, will have their own temporal and spatial systems and rhythms that, in turn, affect and shape other elements in the world around them (Bachelard 1994; Amato 2013). However, agency can only be determined in terms of intentions, "for an item of behaviour to count as action, whoever perpetrates it must intend to do so, or else the behaviour in question is just a reactive response" (Giddens 1984).

As objects in the Internet of Things are not sentient, as there is currently no supporting technological framework of artificial intelligence, then is Bleecker's proposal that the defining character is one of agency correct?

Closely linked to the theory of agency, emergence refers to the arising of novel and coherent structures, patterns, behaviours or properties during the process of organisation or interactions in complex systems; the behaviour of a large number of individuals to exert action. (Goldstein, 1999; De Wolf and Holvoet, 2005; Bedau and Humphreys 2008). For example, the pattern of traffic flow may be the product of many rational choices by car drivers (human or automated), each of whom have the desire to get home quickly and safely and have no intention of producing a delays and traffic jams. However, these patterns of delays and traffic jams emerge from the rational decisions by individual drivers, with knowledge of the

context, or network, in which they are situated (Strawson 2006; Barnes 2000). Interactions at an individual level affect the network as a whole. The Internet of Things offers the affordance of a radically increased number of nodes of networks, all of whom are creating interactions through the streaming data. It provides the technological framework that supports emergent phenomena as it is composed of 'interacting parts', that are 'dynamical', where the relationship between the connected objects, that are context and temporally specific, allows it be 'radically novel' (Goldstein 1999; De Wolf and Holvoet 2005).

The Internet of Things will dramatically increase the number nodes(object) in our networks, all of whom will be creating interactions through the streaming of data at a given moment in time. However, the databases to which the send data is currently sent are often dealt with in silos; I retrieve a piece of information upon scanning this object, which may differ depending on the software I am using to instigate the scan. If emergence is a matter of higher-level phenomena coming from the organisation of lower-level phenomena (Johnson 2001), the interacting nodes, what emergent properties arise for an object in the Internet of Things, when we create dynamic patterns, arrangements or aggregations between or across the data sets of things, and apply our own algorithmic laws to them at a given moment in time?

The primary contribution to knowledge of this thesis is the understanding that an object in the Internet of Things is on a trajectory from materiality to immateriality, and as a consequence will have the characteristics of emergence (not agency) as result of its negative space; the interconnection of an object's data across networks will determine the relational effect they have on the world at that given moment in time. I term this the relational Emergence of Things. "Networks distend, establishing more and more connections, while the folding of flow upon flow heightens the complexity of both the system as a whole and the nodes through which the system is interlaced with itself" (Doel 2000). The organisation of a synchronous real-time relationship between the nodes of a network, gives the network as a whole the ability to exert a causal influence. "Agents residing on one scale start producing behaviour that lies one scale above them: ants create colonies; urbanites create neighbourhoods; simple pattern-recognition software learns how to recommend new books. The movement from low-level rules to higher-level sophistication is what we call emergence" (Johnson, 2001). The source of relational emergence is the organisation of nodes, and the maintenance of a set of substantial relations between the nodes that constitute them into a particular kind of whole at a particular moment in time, and thus allows a node to produce causal impact in its own right (Elder-Vass 2010; DeLanda 2006).

Social structures are constantly changing and until now, people have been primarily responsible for these changes. People create cultures, values, aesthetics, politics, economics and more, and each of these affects and shapes places (Fouberg et al 2010).

However, what happens when we add connected objects into this equation?

The structure of a network, the relations among network members, and the location of a member within a network are critical factors in understanding social behaviour. Complex, dynamic social systems are analysed in terms of stabilising and destabilising mechanisms, and traditionally it is only human agents who play strategic roles in these processes. Institutions and cultural formations of society are carried by, transmitted, and reformed through individual and collective actions and interactions. These social structures help to create and recreate themselves in an on-going developmental process in which collective agents play constructive as well as destructive and transformative roles in the context of complex sociocultural arrangements. These arrangements of social life involve time, space and place as constitutive factors in the construction and reconstruction of what people do and in the way in which they do things together, as active agents with their distinctive characteristics, motivations, and powers contributing to the reproduction and transformation of our networks. In other words, societies are composed of the relations between people, and the ramifications and latticework of those relations constitute the structure of society.

Of the many design fictions that are being written and portrayed for an Internet of Things, few offer a method with which to anticipate and prepare for its societal impact. Companies will promote the benefits of a network of artefacts in the hope that we subscribe to their platform, whilst writers and designers will develop design fictions that offer dystopian and utopian futures, more increasingly based on smart objects whose affordances lie in digital interactions, rather than understanding an object's negative space.

However, the Internet of Things offers the affordance of an increased number of nodes of networks, all of whom are creating interactions through the streaming of data at a moment in time. It provides a technological framework for an object's negative space, allowing emergent properties to form when we create dynamic patterns, arrangements or aggregations between or across the data sets of things and apply our own algorithmic laws to them at a given moment in time. Emergent properties will arise for the interconnection of an object's negative space, which differ depending on the context in which it is viewed; its assemblages (Deleuze cited DeLanda 2006).

Through re-contextualising the Internet of Things from a relational emergentist methodology, within the context of Actor-Network Theory and the Space of Flows, it raises questions about how our social networks will be constructed, destructed and transformed by the interactions represented when people to people, people to things, and things themselves are interconnected? The behaviour of the relations between the nodes of a network in particular temporal and spatial contexts defines the behaviour of the network as a whole. Data is turned to information through context (Harman 2010) through the process of relating it to other data; two pieces of data need to be different enough so that when related to one another, a difference can be seen (Bateson 1972).

This is a proposition of a future that is not intended to be a science fiction but a plausible parallel given the trajectory of contemporary research as explored through the new composition of existing theory and the subsequent design interventions. This trajectory is an opportunity for further research, as we begin to understand how connecting objects means we could possibly gain new insights into how we make places, how we organise space and society, how we interact with each other in places and across space and time, and how we make sense of others and ourselves in our locality, region, and world.

As objects are treated like code, the messages they encode will emerge from the pattern of social relations being expressed. An objects role in the Internet of Things is to provide the meta-data that enables clusters of data to self-organise in the synchronic society, assembled out of an unthinkable number of associations created by agents both human and non-human.

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