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INTERNET OF PROPS. A PERFORMATIVE ONTOLOGY AND DESIGN FRAMEWORK FOR THE INTERNET OF THINGS

by

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At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Sub-Committee.

Work submitted for this research degree at the Plymouth University has not formed part of any other degree either at Plymouth University or at another establishment.

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Relevant scientific seminars and conferences were regularly attended at which work was often presented; several papers prepared for publication.

Below a list of the most recent ones:

Presentation and Conferences Attended in the last part of the research:

- ML 2014, Mobile Learning, 28 February – 3 March 2014, Madrid - Spain
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A SDCard is also included that contains further documentation of projects described in chapter 6.

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ABSTRACT

Set in the relatively new and fast developing field of investigation known as Internet of Things (IoT), this research starts by looking at the lack of critical and conceptual reflection on the area. With a main research question that challenges the underlying concepts of the IoT, the study develops a performative design framework to critique the field of investigation. The main corpus consists of:

1. speculative inquiry into the ontological dualisms of 'objects' and 'things' and the emerging social dimension of humans and non-humans;
2. the identification of an ontological-performative model based on the idea of Props;
3. the entanglement of theory and practice to construct a performative design framework, called the Internet of Props, which includes: an enabling platform (Smarter Planet Lab) and a set of design strategies (Transactional Props) to demonstrate and evaluate this model and framework;
4. a combined-evaluation conversational analysis methodology that assesses the performativity of the setting and the Props, through linguistic and socio-behavioural studies.

Inspired by the concepts of ontological theatre, the entanglement of humans and non-humans, and the Internet of People; the IoT is imagined and performed in a theory-driven, practice-based investigation of the Internet of Props, which aims to bring new theoretical and practical knowledge for the future of the IoT.

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CHAPTER ONE: Introduction

> *The Internet of Things is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology.* (ITU, 2005: 9)

In its 2005 report, the International Telecommunication Union (ITU) announced the emergence of the Internet of Things (IoT) as the next technological revolution. This PhD takes issue with the IoT and should be seen in the context of the overstated, revolutionary claim (in line with the technological determinism) characterising the discussion on all new technology and media. The IoT is the latest definition in the explosion of terminologies that technological determinism has produced since the last century, and since technology has become a matter of relevance in society, economy, culture and education in general.

Manovich's, "The Poetics of Augmented Space" (2002) lists novel terminologies that have been introduced to catch new technological paradigms. This includes at least ten different definitions dealing with similar approaches: ubiquitous computing, augmented reality, tangible media, wearable computing, intelligent buildings, intelligent spaces, context-aware computing, smart objects, wireless location services, sensor networks and E-paper. These terms are like monikers;

they attempt to catch an evolving reality, while pointing out key aspects, new features and characteristics of the emergent technical or scientific field. They highlight the challenges many disciplines might have to face; not only those with direct technological dependencies, but also across design, human sciences and the humanities. Whilst these terms are useful tools, they easily become obsolete, and disappear quickly. In fact, Bruce Sterling, the *Wired* design columnist, calls them, "archaeologism - the neologism of the past" (Sterling, 2006). The quick appearance and disappearance of these terminologies highlight, on one hand, the need to understand an emerging phenomenon whose impacts could extend beyond the technological borders, and, on the other hand, the search for a vocabulary commensurate to the new vision of the world that they carry with them. The IoT is not in the list, but its predecessors are, and they are all connected to contemporary discussions around the IoT, i.e. ubiquitous computing and smart objects. Regardless of the fact that, "the origin of the Internet of Things is a logistic-driven idea", it has, nonetheless, become a recognised and accredited term in the last fifteen years, including outside the logistic field and across many fields and disciplines (Kranenburg, 2011: 8). This terminology appears confusing though, as it uses the word, "things" – a term loaded with philosophical implications. Unfortunately, so far, IoT has not dealt with this fundamental discourse in depth, i.e. the distinction between things and object that is so essential in western thought and for the implication it has for social and design disciplines. The term IoT is an emergent moniker in great need of clarification and better definition.

The IoT has gained relevance in many sectors (industry, academia, government etc.) and is establishing itself as a field of investigation well beyond its technological aspects. There is a growing global interest in public and private sectors for research within the IoT. Funding bodies are supporting research and innovation ideas in this field, as attested by the roadmap of innovation established in UK by the Technology Strategy Board (TSB),[1] Innovate UK and by the increasing number of calls for grants from the UK research councils in many disciplines, from Science to Social Science and Art. The Arts and Humanities Research Council (AHRC) and the Engineering and Physical Sciences Research Council (EPSRC) have grant calls with strands in the IoT field. The Arts Council of England does too, in particular through its digital fund for arts called NESTA. This shows also the need and urgency for a multidisciplinary and interdisciplinary discussion to happen.

Art and design conferences, such as ISEA (International Symposium on Electronic Art), ACM CHI (Annual Conference Meeting on Computer Human Interaction) on Human Factors in Computer Systems, ACM DIS (Annual Conference Meeting on Designing Interactive Systems); or more strictly Computing and Engineering ones, such as UBICOMP, the IEEE IoT conference series; and international events on technological creativity, such as South by

[1] The Technology Strategy Board is an executive non-departmental public body (NDPB), established by the Government in 2007 and sponsored by the Department for Business, Innovation and Skills (BIS).

South West (SXSW), have focussed on the IoT over the last few years. One of the reasons the IoT is receiving this attention, is due to the fact that it can be seen as a direct descendent of the well-established field of Ubiquitous Computing and as having the potential to extend beyond it.

Nowadays, inside the HCI and Interaction Design (ID) research environment, Ubiquitous Computing is the point of reference, for its history, its conceptual and theoretical background and for its established design and research methodologies and applications. Twenty-four years ago in an article in the journal *Scientific American*, Mark Weiser (1991), a former Xerox research Lab director, outlined the Ubiquitous Computing vision in the following way:

> *Ubiquitous computing names the third wave in computing, just now beginning. First were mainframes, each shared by lots of people. Now we are in the personal computing era, person and machine staring uneasily at each other across the desktop. Next comes ubiquitous computing, or the age of calm technology, when technology recedes into the background of our lives.* (Weiser, 1991: 94)

The Ubiquitous Computing paradigm not only changes the approach to technology, but also ultimately it redefines the relationship with the material world around us - the environment and our social interactions - in a way that reveals its impact on our everyday lives.

> *Small computers 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 (Want, 2008).*

Being a direct descendant of Ubiquitous Computing, the IoT carries some of its limits, as shown in the overall design and theoretical approach. Whilst IoT has gained much relevance, its relevancy has been overshadowed by the need to establish a clear vocabulary. This requires interaction designers to participate and so there is an underlying question of,

> *how digital technologies can fit more neatly around our lives is a question of how we can facilitate meaningful opportunities for communication and interaction.* (Giaccardi, 2015: 27-28)

This PhD uses this question as its starting point, embracing the history of Ubiquitous Computing, its embodied vision (Dourish, 2004), and bringing it into the context of the IoT from an ID perspective. This research attempts to address this gap right at the beginning and follow the implications through to their design consequences. Finally, it works to deal with them via the practical element and its reflexive synthesis.

Clarifying the field of the IoT implies the questioning of the first part of the definition, specifically as related to the Internet. Inscribing the IoT into the evolution of the Internet is a means of looking at the trajectory of the Internet and the World Wide Web as a medium. As the medium of the digital revolution, the Internet has pervaded most aspects of our daily lives, giving a presence to digital interactions and to the world of bits. The Internet is a complex medium that involves network infrastructure, digital devices, the World Wide Web with hyperlinks, and all the services and applications that developed since the invention of TCP/IP and the WWW. The Internet started in the sixties as a network of a few computers connected between research centres to share information, expanding to a global, publically-accessible network with scale through the implementation of the World Wide Web. It developed quickly on the surfaces of computer screens, which led to a point in the nineties where Virtual Reality (VR) seemed to represent the future of the World Wide Web, due to its simulation and representational potential and capabilities. It was, however, the Social Internet, Web 2.0 (social networks, peer-to-peer and user-generated content), the Internet of People (Nold & Kranenburg, 2012), together with the mobile web that made the Internet into an essential and pervasive medium. The Internet moved slowly away from interaction on the computer screen to the portable and 'wearable' mobile screen of the modern smartphone, and is now ready to move into the physical environment.

Due to its name and its relevance, the IoT is part of this history and also part of the future; a future detached from its original platform (the computer) and, in particular, the screen-based model that followed the ubiquitous shift. The move to the ubiquitous paradigm for the medium also means a departure from the representation and simulation vision of the world, into reality and materiality. Within the IoT vision through the interconnected things, the physical world is the new territory where the Internet is extending its pervasiveness. The interplay between the two worlds, one of bits and one of atoms, between digital and physical interaction, is the challenge designers have to embrace. The cultural scaffolding needed to embrace this challenge is insufficient, as a lot of questions are left unresolved. Questions then arise about the liminal spaces between humans and non-humans, subject and object, matter and information, and their relationships. Answering these questions is essential for a proper design-discourse to happen inside this emerging field.

In the paper "Thing Theory" (2001), Bill Brown, stated that 'things' become urgent every time a new medium (computer, cinema) appears. In other words, 'things' change their status and condition, meaning and value, anytime humans develop a new means of communication. Thus, according to Brown, every new medium implies a redefinition of our notions of 'things', and this is even more stringent for the IoT, as 'things' are its key constituent element.

> *The internet of people is 1 billion strong. Almost one third of the world's population will be on the web by 2011.*[2]
>
> *The Internet of things—cars, appliances, cameras, roadways, pipeline, pharmaceuticals and even livestock—is headed to 1 trillion.*[3]

The real-time overlapping of digital and physical layers challenges our model of interaction and conceptual knowledge, requiring a response. Moving away from the representational approach towards a more performative one, is in itself an ontological shift. The performative turn to interaction refers to a vision

[2] 1 Sam Palmisano speech, IBM ex CEO, November 12, 2008

[3] IBM offical presentation on the Smarter Planet, 11 December 2011

of the world, which implies a definition of reality as something, "in the making" (James, 1907).

Within the IoT vision, the 'things' have their own Internet, which means that Internet has reached deeper into our lives, pervading the physical environment. Neil Gershenfeld, the director of the Centre for Bit and Atoms at MIT, wondered about this in 1999:

> *What happens when the digital world merges with the physical world?* (Gershenfeld, 1999: 14).

After more than fifteen years, maybe the question is not so much about 'what' but about 'how'. This could motivate research, not only from a theoretical standpoint, but also critically, and from a design-practice perspective.

The significance and scale of the shift IoT could represent, culturally and socially, is just starting to be discussed outside its visible technological and economic impact. This thesis is also grounded in a discourse about a new vision for the Internet as a medium. Pragmatically, this research joins concepts from media studies and performance, tangible or ubiquitous design concerns and social issues. This research goes through a theoretical and speculative exploration of an ontological model, which is then enacted in practice through the design of an enabling platform and the setting of a series of design workshops. The aim of the workshops and the platform is to intertwine theory and practice to construct a theoretical and design framework. The entanglement of humans and non-humans, the mangling of the Internet of People and the IoT thereby becomes what this research defines as the, “Internet of Props”. The Internet of Props uses performance and performativity aspects as a way of interpreting the everyday condition typical of the context of the IoT.

My personal interests over the last fifteen years have contributed to developing what became central to this research. My initial works and research into locative media allowed me to explore how the digital information overlaps the physical space and how the interplay between digital interaction and physical one. My history and background as an artist, practitioner and researcher in the digital domain has produced works like *Remote Risonanze* (1998) and *Quixote* (2004). *Remote Risonanze* was a sound installation that used network technology and VR technology in their early stage of development to create a connection between online and offline spaces over the Internet. This project gave me the chance to design a participatory art-installation, whereby the final outcome of the soundscape was produced by the intervention of remote users. The setting was a newly-refurbished theatre. *Quixote* was a locative performance; it used the mobile phone to collect stories through a participatory storytelling-process about a puppet, “Quixote”, that was passed from hand-to-hand. The journey of the puppet was tracked by a GPS device in real-time, and the public could follow both the stories and the physical trip on the Internet. This project provided me with an insight into locative technology and the interaction between the physical and the digital when they start to overlap.

Once we are located in a world, the door is opened to social interactions among shared things in that world. (Weiser, 1995: 5)

This project also anticipated the social dimension and interaction that Twitter later on manifested and facilitated. My interest in the theatre and use of performative practice have been important background experience that, in the case of this current research, also contributed to the study approach and outcome. A further, underlying research-aspect in both projects is the social and connected dimension between digital and physical, the overlapping of everyday flow with digital dynamics being remote interactions or some sort of artistic, disruptive technological-objects. Moreover, both projects and most of the theoretical research undertaken relates to the public space, the dimension of the everyday, which is typical of the IoT. Finally, an essential source of inspiration constituent in my background was work done with the Digital Art and Technology group at Plymouth University and its closeness to art and media pioneer, Roy Ascott. Ascott's works and pioneering writing on cybernetics, media and art have been essential to the development of the overall approach and to the role of my art-practice in research. Moreover, Ascott's work has the speculative and artistic qualities that the ontological performative framework defined in this thesis attempts to achieve. The elements above represent the background and the motivations to pursue the investigation of this doctoral thesis.

In his book *Smart Things*, Mike Kuniavski, who is also the founder of ThingM, one of the first interaction design firm to create projects for the IoT, asked what the role is for designers in the ubiquitous computing challenge, writing: "Who is responsible for this user experience?" (2010: 13). In order to answer this question, Kuniavski provided an overview of all the professional figures in charge of designing smart things: industrial-, identity-, packaging- and marketing-designers, and pointed out that a hybrid of physical and informational matter must be considered. The profile of the interaction designer within ubiquitous computing is that of a user-experience designer using technology with the goal of, "making life as productive, meaningful and pleasurable as possible" (Kuniavski, 2010: 288). In relation to this, designers are already at work, things are getting smarter, and there are some examples of products already on the market or prototypes that have being launched, such as the Ambient Orb by Ambient Devices, Mir:ror by Violet, the Adidas_1 shoe and the WineM by ThingM. At the time of writing this thesis, the commercial success of these products has not been great (although most of them have had media attention for their novelty and innovation). They did not break through as expected, possibly because they did not resolve the tension between things and objects, and between the connected element of daily-life practices, experiences and situations. Such products tend to think of objects as a separate entity or as a solution to a problem, but one that has to be addressed by an independent entity, the smart object. They do not engage with daily performative-practice and how these are interwoven with other daily activities or experiences. This is something this thesis will look into and that the design framework will attempt to deal with.

The motivations that are developing the field of IoT, as a revolution or an evolution following the 2005 ITU vision, have the following as their main concerns: technical/engineering issues (data-management, scalability, standards and communication), economical issues (new products, efficiency, etc.) and optimisation aspects (managing processes better, typically increasing efficiency and reducing costs) (Mattern & Floerkemeier, 2010). The vision of a ubiquitous society is driven only partially by the evolution of technology (communication and information), however, as most of the enabling solutions are already there and the costs are increasingly diminished. The revolution is driven by economical and engineering needs, in the first instance, with the promise to, "deliver substantial economic and social benefits" (Mattern & Floerkemeier, 2010: 108). There are, however, other underlying promises attached to the IoT's rhetoric, such as the idea of sustainability as an ecological issue that can be delegated to things to resolve (like, for example, in transportation and traffic control). At the moment, the factors behind IoT development are mainly industrial and institutional. Following the suggestion of the author of the Hammersmith report, "some problems could be addressed with technology others could be addressed with design" (Valhouli, 2010: 2). The design decisions and interventions have, so far, been originated inside limited conceptual frameworks; limited because they always only operated in confined context and not in the connected everyday dimension and limited because they do not deal with fundamental questions the IoT asks about the distinction between 'objects' and 'things'. To show how limited the vision behind the development of the IoT is, within the field of engineering field, the IoT is usually referred to as machine-to-machine (M2M) communications. It is etymologically and conceptually difficult to swap one for the other as if interchangeable or synonymous. This is a signal of how a purely technological vision could compromise the evolution of it at the very start of its evolution. Moreover, the concept of machine as an alternative to things carries connotations that are not insignificant and can affect the design process. Machines are apparatus that perform specific tasks, like agents they act on behalf to execute a function and in this sense they are perceived as having some sort of agency. The concept of agency as 'acting on behalf' could be very much misleading as ITU itself warns; something we will come back to later in the thesis. It puts the human and the non-human on the same level, when they are not the same. Recognising the distinction between the human and the non-human, even in a connected and distributed manner, is not just a superficial etymological disquisition. This is something that needs addressing, and it will be addressed in the following chapters, in particular in Chapter Four.

The IoT has the potential, not only to connect objects and to make them communicate, but also to connect them to the Internet, intended as the network of people, the social web, which represents a much broader and richer scenario than the one of the machine and agency. Most of the research in the IoT roadmap has focussed its attention on concepts like agency as a human property that can be passed over to previously inert entities.

> *We surely know that hurricanes and volcanoes are not controllable but nevertheless, we have the idea of our primacy of agency as givers of meaning in this world. (Kranenburgh, 2010: 13)*

The issue of agency is recurrent and it seems to be the major concern for scholars involved in the theoretical discussion about the IoT from a media, technical or cultural perspective (see Latour, 1996; Ingold, 2013). But what if the issue of agency is just a red herring? This research will try to steer away as much as possible from this matter, as the direction in this study attempts to be more primary and foundational in order to envision a more-seamless integration between physical and digital interaction. This means philosophically grounding the field of the IoT by focussing on cultural and social aspects (such as value and meaning) instead of focusing on agency. Agency is a problematic concept on its own because it does not deal with the issue of what a thing is and leaves open or unresolved the classical dualisms between subject and object, human and non-human by suggesting the handover of human abilities to the non-human. Moreover, agency almost implies things are tools, machines or artificial systems that replicate human faculties, abilities and skills, instead of looking at how the things are and perform already, or how humans interact with them.

While trying to avoid conventional theoretical approaches that look at the 'problem' of agency (Ingold, 2013) and a re-definition of a principle of symmetry between human and non-human (Latour, 1996), the research questions leave aspects of the IoT unexplored, i.e. the distinction between things and objects in the design discussion around the field in order to identify new visions and possible design frameworks. The rapid expansion of the industrial market for the IoT has left many aspects of its development as a research domain unresolved. Even agreed definitions of the IoT are problematic, which may have unforeseen consequences on design processes and future development of the field. To address these issues, this research considers a more grounded analysis that challenges the shallower definitions of the IoT, starting with its vocabulary and the distorted definition of, "object" and, "things". The research then proceeds to explore how this ecosystem can be redefined on the basis of contemporary socio-cultural and technical visions. This PhD challenges these initial theoretical aspects in order to reframe all of the actors in play across the Internet, including non-human ones. To explore the design implications, this PhD uses a practical component to propose a new framework - defined as the 'Internet of Props' - to respond to the initial questioning. Pragmatically, the research also looks at putting this framework into practice and to test its validity as a new design toolkit for the IoT. This would eventually help the IoT field to establish itself as a more coherent and sustainable media and design-research domain. The research question that emerges responds to the appearance of the IoT and the consequences and implications of this potential revolution.

Research questions

Given the ID and HCI context, the motivation, and background described above in this chapter and the need to find novel approaches that account for performance and performativity, the main research question is:

> Can the underlying concepts of the Internet of Things be critiqued through performative design?

In order to exploit the significance of performative design, the existing IoT landscape needs to be understood. In mapping the landscape, a further question can be asked:

> Is the existing discourse on the IoT adequate and what are the gaps and omissions in this discourse?

A particular interest in this discourse is to shift the technological determinism intrinsic to IoT into a more cultural and philosophical debate. The question that arises at this stage is, therefore:

> What is the significance of the difference between 'objects' and 'things' and what are the ontological consequences of this debate?

In order to address these issues, the thesis identifies the Prop as bridge between the technological and the philosophical, and asks:

> Can props be used as a performative device to expand and critique the way that the IoT is conceptualised?

In order to explore the potential of the Prop as a theoretical and practical device:

> What is the necessary infrastructure to enable the Prop to be enacted in the world?

and, subsequently:

> How can this performative design-framework be evaluated?

Answering these questions is seen by this thesis as key in setting the ground for development in the IoT field, but it is also an attempt to open new models for ID in general. In fact, if the initial interest for clarifying the vocabulary around the IoT helps to unpack unresolved aspects of IoT both philosophically and conceptually, like the ontological distinction between objects and things that implies, it also allows (as we will see) a new definition of our concept of the social. Moreover, approaching IoT as a medium in the trajectory of the evolution of the Internet extends this vision into social and cultural discussions on aspects not yet fully considered or understood, such as meaning and value. Finally, the performative aspects of everyday life are brought into the discussion and key design questions that have an impact on the field of ID are broadened.

Methodology

> *The recent emergence of ubiquitous and tangible computing moves the stage of interaction from the virtuality of the screen to the physical environment.* (Jacucci, 2006: 942)

The context of IoT is a highly-mediated one, whereby user-experience happens by means of complex interaction, which includes technology embedded into the physical environment and that tends to disappear into the fabric of the world (Weiser, 1995), and of unpredictable behaviours. Among the major methodological challenges faced by this emerging field are approaches for capturing contingent processes like everyday situations. Art installation or live-performance are used to engage with this ephemeral condition, that refers to multimodal interactions with object, space, body, language and participative processes. Those configurations are events that are difficult to capture, "as the contingency resides in particular and personal configuration" (Jacucci, 2005: 23).

In an Art and Design context, practice-based research is commonly understood as a research methodology that creates new knowledge in the material culture of making and doing (Archer, 1979, 1995) or to summarise, in the practice. This research incorporates a mixed methodology that includes a significant practice-based element, whereby the theory is put into action to be tested and evaluated.

The research starts by problematising the field, then by drawing on theories derived from various disciplines to shape new concepts. These new concepts are then practically tested through a design approach that embeds elements of artistic (cybernetic art and performance) and speculative, embodied design-practice. At the end the outcomes are evaluated by means of a combined methodology that involves quantitative, qualitative and hermeneutical techniques. This is a similar approach to other recent experience-design has used as a research method: a significant practice-based element embedded into a theory-driven design-process (Hassenzahl, 2010). The practical components are complementary and integral to the theoretical elements; together they represent the mixed methodology for this research that comprises of:

- speculative inquiry into the ontological challenge of 'objects' and 'things' and their distiction and the emerging social dimension;
- the identification of an ontological-performative model based on the idea of Props;
- the entanglement of theory and practice to construct a performative design-framework, called the Internet of Props;
- The testing of the performative design framework through:
    - codesigning and implementing the enabling platform, defined as the Smarter Planet Lab;
    - prototyping the Prop as a speculative and technological probe;
    - defining, planning running a design workshops (including an intervention named Transactional Props, inspired by Ascott's 1971 cybernetic artwork *Transaction Set*);
- evaluating the outcome of the workshops through conversational analysis.

In applying a performative paradigm to design, the investigation establishes a mixed methodology as a framework. This integrates more established ID techniques, such as: Participatory Design (Greenbaum & Kyng, 1991); Experience Design (McCarthy & Wright, Hassenzahl, 2010) and Embodied Interaction (body-storming and embedded-storming) (Schleicher et al., 2010). These are then combined with more abstract and open-ended, performative approaches derived from the latest social and anthropological theories (i.e. Actor Network Theory, Meshwork and entanglement), from the Philosophy of Science, Cybernetics, Cybernetic Art and Digital Art. This thesis describes this mixed methodology as a performative design framework, which it names the, "Internet of Props".

HCI (and so ID) has always been a field of a highly-interdisciplinary nature. Its history is characterised by interdisciplinary experimentation that incorporates various disciplines (i.e. Psychology, Cognitive Sciences, Social Science and Anthropology). Drawing on this methodological heritage, this research, has developed both a design methodology and an evaluation process. Brenda Laurel (1992) was the first to make the connection between the worlds of computer bits and performance, and describe the former as a performative activity. More recently, Spence (2016) noticed that Performance Studies and HCI have been being taking tentative steps towards one another for a while. "Performance" is a word that has been associated with all sorts of experiences and events outside of its original dramaturgical context. It is now such that, philosophically and semantically, it sits apart from the theatrical domain it used to belong to. Significant in this respect is the performance and dance work of Wakkary, Schiphorst & Budd (2004), and digital art of Jacucci (2005) and Giaccardi (2012). As per the studies mentioned above, the aim is to find a design process that avoids to, "represent reality", to respond to a, "post-task world" (Jacucci, 2006: 953 & 952). In this sense, the toolkit and strategies to be implemented in this research need to facilitate the emerging of new levels of behaviour and communication among the participants, being human or non-humans. To mirror the, "everydayness" (Benford et al. 2013) condition typical of the new field of IoT, the research has to aim at outcomes that are as open-ended as possible. In order to get closer to the complexity of everyday experience and to exploit the potential of designing activities for the field of IoT, "the only way to find out what happens is to try or to watch other" *trying* (Spence, 2016: 2). The 'performative' aspect, not only ties into the background and motivation for this investigation, but is also a fundamental element of the theoretical approach. The everyday dimension typical of IoT is in fact populated by practices, that are intrinsically performative at different levels, as philosophers (James, 1907; Pickering, 2007) and sociologists (Turner, 1966; Goffman, 1957) have pointed out. The term, "performative" has become a transdisciplinary idiom to define a shift in ways of interacting and investigating the world. This research is inscribed in this line of thought and tries to catalyse the theory and the design practice around a holistic 'performative' approach. This novel framework is then evaluated through a Conversational Analysis (CA) method that attempts to catch the multimodal aspects represented by the cultural and performative approach of the research. CA has been chosen because it is a common methodology in the qualitative study of social interaction, allowing the catching of the ubiquitous quality of structured and unstructured communications processes. In the analysis, both verbal and nonverbal aspects of interaction processes will be accounted for, combining techniques developed to catch social behaviour and performative qualities between humans and things. The evaluation will, therefore, mix techniques from CA; usually linguistic in the case of the verbal (Austin, 1962; Searle, 1969), and socio-behavioural for the non-verbal, derived from social psychology in the study of small group interaction and dyadic interactions (Goodwin, Knapp & Hall, 2002; Scherer & Ekman, 1982).

To inquire into critical aspects of IoT and help in imagining its future, the research will introduce a novel, performative class of entities, using the Prop, as a technological and speculative probe. Props act as an open framework to include participation in the interaction; to engage users in a design process. These are instruments for thinking about, performing with and through, the 'things' of the IoT and, at the same time, they become part of a new dialogue with humans. The new concept of the Internet of Props is methodological, both in a theoretical and practical sense, as it responds to the vocabulary's need and also aligns itself to the performative and cultural approach that the design framework wants to follow, implement and test. The intention of this research is to identify critical, cultural and social aspects, and bridge the knowledge and design gaps inside the emergent field of the IoT, both theoretically and practically. The lack of this critical engagement is already limiting and reducing the possibilities and the potential of design achievements in this emerging field. By addressing this gap, so the objective for the framework also becomes a contribution to the design areas, of HCI and ID.

The corpus of the thesis will be comprised of five core chapters, beginning with this introduction, which tried to set out an overview and a guide for the practice-based study, and ending with a conclusion where a reflection upon the findings is undertaken. The first chapter has set the research context and outlined the issue that will be addressed, the two following chapters outline critical deficiencies and provide the background of the problematising of the field, the fourth proposes a new solution and the fifth tests and validates it. A breakdown of the structure of the thesis chapter by chapter follows.

Chapter Two starts by mapping the territory, tracing the history and by identifying the origins and the progenitors of the IoT (in particular Ubiquitous Computing, the most established and enduring technical and interactive paradigm related to the field). It also reviews terminology used in different contexts to describe the phenomenon of the IoT. The chapter then presents evidence of the Things of the IoT and practical predecessors; describing and analysing them, highlighting their relevance for the discussion. Towards the end of the chapter the discussion is directed towards identifying the tension and the forces that are recognised as part of the development of the field. The chapter ends by introducing the argument around one of the contested vocabulary aspects of the field: the distinction between objects and things

In **Chapter Three** a literature review is undertaken to frame the speculative enquiry about 'things' and 'objects', and to establish their differences, similarities and implications. Through this discussion, the chapter will enter into an ontological challenge between 'objects' and 'things', the research will explain that this is due to a conflation between the two words. There is a common habit of referencing them as interchangeable, which in the case of the IoT acquires new relevance and value. In fact, within the IoT the name itself establishes the difference and implicitly the question. The lack of discussion on this matter is seen as major deficiency; in particular, when it comes to designing new interactive experiences. Here, it ensues the recovery of scholars' recurring question throughout the history of Western thought, the distinction between 'object' and 'thing'. The review of discussions in this area also takes into account recent studies within areas such as material culture, anthropology and archaeology.

Chapter Four starts by looking at the consequences of establishing a distinction between 'things' and 'objects' and the impact on the social dimension and human/non-human relationships that this distinction has. The new, emerging social-dimension will be explored through a review of social and anthropological theories, models and ideas that look at extending the concept of the social to human and non-human interactions too. This third chapter runs in parallel to and supports the second one in establishing the key theoretical framework. It also aims to pose questions about the common assumptions on how this social dimension is made, i.e. heterogeneous entities.

Also in this case the chapter will undergo a literature review on selected social and anthropological theories, in particular, those of Bruno Latour (1996) and Tim Ingold (2013). Theories from these scholars are analysed and compared to help support a conceptual framework for the IoT. This chapter together (with the second chapter) constitutes another grounding for the research.

In **Chapter Five** the research takes a performative turn to identify new possible design models in the conceptual framework depicted in the previous chapters. This is the pivotal chapter where other practice-based theories, like cybernetics, are recovered to inform new design routes. This chapter draws the basis for a proposition to resolve the deficiencies highlighted in the previous sections of the thesis. Inspired by sociologist Erving Goffman's *Presentation of the Self in Everyday Life* and philosopher Anthony Pickering's *The Cybernetic Brain,* the theatrical metaphor of the Prop emerges. The concept of Props is introduced to play out our relationship with things and between things. Fundamental questions are at the core of this chapter: Can the Prop be a useful term or concept to help us recover the difference between 'thing' and 'object', which have lately become conflated? Can the Prop be a useful design concept? The idea of Props is also measured against other contemporary HCI or ID devices, i.e. cultural probes. In this context, the idea of the 'Internet of Props' emerges as a 'performative', ontological design-framework, and a design toolkit.

Chapter Six describes the entanglement of theory and practice that generates the design framework defined as the, "Internet of Props". The Internet of Props comprises of two elements: a platform and a practice-based intervention/experiment to perform the framework. At the core of this final chapter is the description of, and reflection on, a project aimed to test and validate the overall conceptual- and design-framework. The project aims to critically validate the design framework, which could then inform future practice of interaction design in the field of the IoT. This section gives detailed descriptions and demonstrations of the concepts, technologies and theories contributing to the project and practical aspects of the research. The practice was undertaken in different experiments with participants. The results were gleaned by undertaking a conversational analysis to identify recurrences and patterns emerging from the behaviour of both the participants and the Props. The practical findings in this chapter feed into the conclusion that follows.

Chapter Seven represents the conclusion. It summarises all the trajectories of this thesis and key aspects that have informed the origin and the development of the present research. The theoretical and practical findings come to a synthesis through recursive interaction between practice and theory, and by pointing out the key aspects of the design and theoretical framework. The conclusion also draws attention to elements of the discussion that could inform the future development of this research.

CHAPTER TWO: Mapping out the Internet of Things

Chapter Introduction

This chapter presents and defines the technological area known as the, "Internet of Things" (IoT). It analyses new terminology and vocabulary, the rhetoric and nature of the IoT, by means of key theoretical references and practical-project examples. It concludes by defining the domain and matters of investigation. By looking into the broader research and disciplinary context from which the IoT originated - Ubiquitous Computing - key matters and issues will be identified to critique the new field of the IoT. Referencing the works of influential scholars, in particular interaction designers, this chapter will establish the interdisciplinary nature of the field. New entities, such as the 'spime', the 'blogject', the 'tweetject', 'networked objects' and 'Smart things' will be presented and analysed as examples of inhabitants of the IoT. The final part of this chapter will tease out how each of these has established the context for addressing the philosophical discussion around the distinction between 'objects' and 'things'. From this discussion and its implications, the research question is identified. This exposes the IoT's lack of a critical foundational theory and cultural and social reflection.

2.1 The new domain

Tracking the origin of the IoT requires going back more than fifteen years. In 1999, Kevin Ashton, a young manager at Propter and Gamble, was preparing a presentation for a group of senior executives in his company. The central idea of the presentation was to create and develop a connection between the RFID chips used in the logistics of goods and the Internet. Ashton wanted to catch the executive's attention, so he called this new idea the, "Internet of Things". [4] This is now generally accepted as the point in time that marked the birth of a new vision for the future of the Internet. As Ashton himself reported in 2009, a new terminology and a new research field were started with little awareness of the future importance that this terminology and general concept would gain.[5] In this moment, the Internet was translated from a domain of people, to a domain of things and objects within the material world. In 1999, the Internet was in its infancy as a network of information and of communication, among people and among organisations on a global scale. Its potential to become intrinsically interwoven with so many aspects of our economy, education and life in general was only foreseen by a few. The Social Web or Web 2.0 was not yet imagined at that stage. Ashton's definition was an intuition, a fortunate combination of words for a terminology, that now, ten years later, represents the convergence of many interests, and draws increasing attention from industry, academia and governmental institutions. From the industrial context where it originated, the

[4] RFID journal [online] Available at http://www.rfidjournal.com/articles/view?4986. [Access on 05/06/2011]
[5] RFID journal [online] Available at http://www.rfidjournal.com/articles/view?4986. [Access on 05/06/2011]

term migrated quickly into the academic field through the AUTO-ID lab at MIT in Boston (of which Ashton was a co-founder). Nowadays, the Auto-ID Labs are a well-established network of research laboratories across the globe.[6] From Auto-ID, the IoT went from a logistical driven idea, to a field of academic research.

Since that time, the IoT has grown far beyond the Web 2.0 in terms of pervasiveness and scale. The scope can be accounted to the fact that the IoT is of great potential economic worth, a point that the *Wall Street Journal* technology columnist, Walt Mossberg, in his 2013 prediction of what would be the most prominent technologies in the year ahead, included:

> *[A]n expansion of apps and devices that let people wirelessly control many everyday objects, from light bulbs to appliances, using low-powered networks and smartphones or tablets. And we'll likely see more smart devices with such intelligence built in, similar to the Nest intelligent thermostat, which is Wi-Fi powered.*[7]

This assessment has been demonstrated to be true, but why is the IoT important and why has it gained so much traction as an idea? Perhaps it is due to its vision of the future that is made up of intelligent devices and Smart Objects inter-connected to the Internet. In this vision, the 'smartness' of the things of the IoT will assist us to resolve real-world issues, such as environmental sustainability, energy efficiency and home assistance; an altogether attractive

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[6] www.autoidlabs.org/. Nowadays these labs are everywhere in the world; connected in a network of companies and academic research centres. The AUTO-ID lab started as a consortium of companies and universities interested in the development of the Radio Frequency technology and it's now a network of academic research laboratories in the field of networked RFID.
[7] allthingsd.com, Jan 1st 2013

vision of a potential future. Another answer could be because it has to do with 'the everyday', the common dimension that everybody shares and has to deal with. It could also be the scale that has struck a chord and its pervasiveness:

> *By 2015, more people will access the Internet from mobile devices than from conventional PCs. A year later, in 2016, 19 billion devices and gizmos will be connected to the mobile Internet -- not just your smartphone and tablet, but your washing machine, cars and clothes will be connected too.* (Goldmann, 2012)[8]

Why is it, then, that such a simple and niche idea had such a massive impact on society? As Sherry Turkle, a prominent MIT psychologist and technology scholar, pointed out, "We live our life in the middle of things" (2007: 6). Things are pivotal to our life, humans have learned to survive and evolve through them. Evidence of this reliance on things is perhaps most memorably played out in Kubrick's *2001: A Space Odyssey* (1968) during the early pre-human savannah scenes. The bone of the slaughtered bovine becomes a transformative object, not only shaping the physical environment and becoming a social tool of power, but also triggering a transformation in the consciousness of primates. This ultimately leads, through a punctuated equilibrium to the evolution of Homo sapiens. It is not, however, just the ape that is transformed, the object itself undergoes a change; it transforms from a bone to a weapon. *"Objects can be transformed in the course of an activity; they are not immutable structures" (Nardi, 1996: 74).*

[8] Cisco's new, smarter network for the Internet of things: money.cnn.com/2012/06/05/technology/cisco-smart-network/ (accessed on 30 Jan 2013)

The IoT is a symptom and a result of this transformation; a transformation that the physical world, nature and man-made entities, are now undertaking. The IoT is a technological revolution that involves a large number of fields (e.g. wireless network, sensors, nanotechnologies, microcontrollers etc.); it is a new dynamic network of networks that is based on a vision of network ubiquity. The IoT emerged through an awareness of an increased significance of 'smart' objects within our culture. "It is the move from anytime, any place connectivity for anyone, we will now have connectivity for anything" (ITU, 2005: 2). "[The] Internet of Things is a "global concept" … a concept that is evolving" (IERC, Cluster Book, 2012: 26).

According to Kuniavski's vision of the IoT, the things now have their own Internet: "The IoT suggests a world in which digitally identifiable physical objects relate to each others in a way that is analogous to how purely digital information is originated on the Internet (specifically, the Web)" (2012: 5). Enhanced with sensors, they can communicate to each other and with us too. In other words, they no longer need to rely on people, as things are gathering information about their own environment and us, and sharing it in their own network and with the network of people as well.

The future depicted by ITU's 2005 vision and rhetoric is innovative, futuristic, economically prosperous, sustainable and decisive:

> *The advent of the Internet of Things will create a plethora of innovative applications and services, which will enhance quality of life and reduce inequalities whilst providing new revenue opportunities for a host of enterprising businesses.* (ITU, 2005: 13)

Written from a more personal and socially-orientated perspective, the promise is that the IoT will make our lives better. This is the beginning of the era of immaterial information overlapped with, and woven into, every aspect of the fabric of the real world. The approach taken by those developing the IoT has, thus far, been very technological and based around logistics, however the IoT is not a specific technology; it is more an ecosystem of hybrid analogous and digital technologies (sensors, wireless and a distributed communication system with some kind of computational capabilities). "Ubiquitous computing, by contrast, encompasses a wide range of disparate technological areas brought together by a focus upon a common vision" (Bell & Dourish, 2006: 1).

There is no doubt that the applications of the IoT are going to be broad. A quick tally of some them already includes, "medical diagnosis and treatment, cleaner water, improved sanitation, energy production, the export of commodities and food security" (ITU, 2005: 10). According to a survey run by the IoT-I in 2012, 65 scenarios grouped in 14 domains are identified as the main areas of development and growth: "Transportation, Smart Home, Smart City, Lifestyle, Retail, Agriculture, Smart Factory, Supply chain, Emergency, Health care, User interaction, Culture and tourism, Environment and Energy" (IERC, Cluster Book, 2012: 35). These scenarios include a Smart City as an example, including:

Smart Parking,[9] Noise Urban Maps,[10] Traffic Congestion,[11] Smart Lightning,[12] Waste Management[13] and Intelligent Transportation Systems.[14]

The European Community has also identified the IoT as an Emergent Digital future and has included it in many research programmes, such as: the IoT-I part of the EU Seventh Framework Programme, the UK RC national research institution, the ITU regulatory body, and in universities (MIT, AUTO-ID networks). These demonstrate that the relevance of the IoT is for institutions as well as companies. Taking into account all of the research so far, the pace of change and the institutions that are taking notice, it would appear that the IoT could have the capacity to have as large an impact on our lives as the Internet did (and still does).

2.2 Ubiquitous Computing: The noble paradigm

"The concept of the Internet of Things (IoT) builds upon Weiser's vision of ubiquitous computing whereby physical objects have a representation in the on-line world" (Blackstock et al., 2010: 1). The term, "Ubiquitous Computing" is now synonymous with many different things: 'smart' objects, big data and networked communications-devices, pervasive and mobile computing.

[9] Monitoring of parking spaces availability in the city. Structural health: Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.
[10] Sound monitoring in bar areas and centric zones in real time.
[11] Monitoring of vehicles and pedestrian levels to optimize driving and walking routes.
[12] Intelligent and weather adaptive lighting in street lights.
[13] Detection of rubbish levels in containers to optimise the trash collection routes.
[14] Smart Roads and Intelligent Highways with warning messages and diversions according to climate conditions and unexpected events, like accidents or traffic jams.

Nonetheless, it has not lost its relevance and it has established itself as having strong currency in industry, institutions and universities, as the noble paradigm behind many other definitions. In 1991, Mark Weiser, Chief Technology Officer at Xerox's Palo Alto Research Centre (PARC), coined the term, "Ubicomp",[15] short for Ubiquitous Computing. Later, in his seminal and much-referenced article, "The Computer for the 21st century" (*1999)* published in the journal *Scientific American*, Weiser talked about information embedded in the environment, in objects and in bodies, as what he defined as the 'third wave' of computing. In this article, Weiser revealed to the world what he and some of his colleagues at Xerox PARK were working on: the next computational paradigm, the ubiquity of computation. The aim of these researchers was to find alternatives to the established computing paradigms (mainframe and personal computer), and develop the emerging discipline of HCI. Xerox PARK was a special research environment in the late eighties. Here, Weiser and his colleagues were able to extend the discussions around computing to other disciplines (sociology, anthropology, philosophy and psychology) and saw an opportunity for an interdisciplinary field to be established. Their wide contributions were vital to the development of HCI discourse and in particular to addressing and informing technology from a cultural, philosophical and cognitive angle. Two of Weiser's papers were the starting point of this move, "Designing Calm Technology" (1995) and, "The Computer for the 21st century"

[15] The term is now also a well-know annual conference on pervasive and ubiquitous computing (ubicomp.org/ubicomp2017/index.html), thus the full term will be used in this thesis.

(*1999)*. The concept of, "calm technology from a philosophical point of view" is a reference to the Heideggerian concept of 'ready at hand' as a tool or technology that disappears into the background of our life (Weiser, 1995). The research undertaken at Xerox Park was a moment when the focus of computer scientists moved from the device (i.e. computers) to more abstract concepts, like computation, information and communication. This brought the vision of embedding computational and communicational power into our physical environment. It was not just in a single object or device, it instead allowed for the physical and cognitive digital-processes to disappear into the periphery of our attention. The idea here was to seamlessly interact with the digital world and the one we were used to in a new ubiquitous environment, one that aimed to deal with complexity of the world (for and with us) in real-time. In this respect, Ubiquitous Computing has been compared to other technologies in the history of humanity. Following cultural anthropologists, like Ong (1982) and Goody (1977), the history of mankind can be divided in three eras of information and communications technologies: the oral, the written and the computational. The common denominator is, that at some point they all started to operate in the background of our lives, and this is, in effect, was what Weiser foresaw for Ubiquitous Computing. This is in line with the tradition of media and cultural studies, like in the case of Jay David Bolter's (2000) *remediation* concept (all new media will inherit characteristic of the previous ones that they are going to replace) or Silverston's (1996) concept of *domestication* as an effect of the acquisition of technological innovation into everyday life. The

domestication of technologies is a phenomenon that appears when the media 'disappears' inside our lives, becoming embedded in the everyday.
This paradigm changes the approach to technology, and ultimately, it redefines how humans relate to the material world.

As already pointed out, "Ubiquitous Computing" has become a blanket term for studies and research in ambient intelligence, wearable, pervasive and mobile computing, home automation, robotics and more recently the IoT. This has, however, compromised the original conception of Ubiquitous Computing. The original vision was initially so broad and open that it allowed for others to be incorporated within it. This is possibly the reason behind the longevity that Ubiquitous Computing has achieved.

Publications and papers (such as those by Lucy Suchman, former Principal Scientist and Manager of the Work Practice and Technology laboratory at PARC, and Paul Dourish, computer scientist) helped immensely in creating the conceptual framework behind Ubiquitous Computing. The paradigmatic shift and its socio-cultural implications have been conceptualised through the embodied virtuality, something anticipated by Weiser as being synonymous with the Ubiquitous Computing vision. (Although the word, "virtuality" is now considered out of fashion, it still has value in relation to the digital dimension.)

Dourish, in the first instance, and others (Greenfield (2006); McCullough (2004)), have contributed greatly to the definition of the epistemological foundation of the paradigmatic shift anticipated by the appearance of Ubiquitous Computing in the early nineties, which is now evident and inherited by the IoT.

2.2.1 The new deal

> *Through digital interaction, we have become ubiquitous.* (Giaccardi, 2015: 2)

Since 2004, the vision of Ubiquitous Computing has attracted the attention of numerous scholars with different backgrounds. The full multidisciplinary potential of the subject is evident in the broad spectrum of disciplines involved in the discussion around Ubiquitous Computing, from architects to designers and media experts. Their aim has been to open up the discussion on a recognised shift in technology, by removing the hype from the technical drivers of innovation and placing the discussion into others domains, i.e. the socio-cultural. In that sense, Ubiquitous Computing operates like an open framework, available to different disciplines also in search of a redefinition. Books on the subject, have mainly originated inside the academic environment. They have tracked the story of Ubiquitous Computing and, in the more recent ones, connected it to the IoT as a first massive implementation of Ubiquitous Computing. These are some of the key titles: *Digital Ground: Architecture, Pervasive Computing, and Environmental Knowing* (2004) by Malcolm McCullough; *Shaping Things* (2005) by Bruce Sterling; *Everyware: The dawning* *age of ubiquitous computing* (2006) by Adam Greenfield, *Smart Things: Ubiquitous Computing User Experience Design* (2010) by Mike Kuniavski, and *Sentient City: Ubiquitous computing, architecture, and the future of urban space* (2011) by Mark Shepard. The writers' backgrounds reveal the perspective involved: Greenfield is a new-media entrepreneur, McCullough and Shepard are architects, Sterling is a design journalist and sci-fi writer, and Kuniavski is an interaction designer. *Divining a Digital Future. Mess and Mythology in Ubiquitous Computing* (2011) by Dourish (a computer scientist) and Bell (a cultural anthropologist) is closest to the topic.

Dourish & Bell's (2011) book revisits Ubiquitous Computing concepts and their relevance twenty years after the subject was first announced outside the PARK's borders. *Divining a Digital Future* traces the origins of the myth of Weiser's vision, but it also looks in new directions where Ubiquitous Computing is actually being implemented and becoming reality. This is defined as being in the messiness of everyday life, where many examples of its presence can be found, although not in the neat, systematic manner that Weiser might have predicted. The book is a review of Ubiquitous Computing, it traces back to the initial definition by Weiser, and the authors retrospectively assess what it has become in the time it was envisioned for. Weiser's (1989) paper established the new terminology via a research report on things already happening and a manifesto written in future tense. Ubiquitous Computing is about a proximate future, a factor of social relationships, social order and changes to everyday life, eventually leading to new opportunities both economically and culturally.

Ultimately, the aim of Dourish & Bell's (2011) book was to: check the state of Ubiquitous Computing and verify if the time of Ubiquitous Computing has come, and if so, whether in a different shape; and to imagine alternative configurations for Ubiquitous Computing to continue. In particular, the authors looked at the multidisciplinary qualities of the field claimed by Weiser. Initially, the vision of Ubiquitous Computing gave computer scientists the opportunity to widen their viewpoints, although some of the issues were not new for HCI. Following the socio-cultural approach of other researchers at PARC (like Suchman), the approach suggested a focus on human–human (not human-machine) communication. The modalities and methodologies were very practical and typical of the research field; highly-mediated interaction, through experiments, test beds and prototypes. Other industrial players were also going in similar direction: IBM had a pervasive and mobile agenda, while Phillips had, "ambient intelligence". For Dourish & Bell, three factors have contributed to Ubiquitous Computing's success: 1.) the relevance of the Internet, 2.) technological development and 3.) the proliferation of digital devices and the challenges created by this.

Initial HCI concerns were for natural interfaces, then for context-aware applications, and later for everyday computing. This was a big challenge as everyday situations are very different from work situations. There has already been two recognised shifts in Ubiquitous Computing: "a shift in Ubiquitous Computing away from the workplace application and towards those in the domestic spaces" and, "the next shift, still on-going, the move into everyday life environment" (Dourish & Bell, 2011: 18).

The traditional HCI approach was based on a triad: people, activity and technology, and the original Ubiquitous Computing vision was very technological. According to the Dourish & Bell (writing in 2011), Ubiquitous Computing is happening right now, and just not in the way imagined by Weiser, it is happening in a very messy way, particularly from the aspect of connectivity. The two real large-scale examples discussed and analysed in the book are: Singapore and South Korea, which both have a level of infrastructure and connectivity of services that make them unique. Even in this set up, however, Ubiquitous Computing is not seamless and is instead a messy configuration of connectivity and services. Dourish & Bell's proposal for new configurations for the future Ubiquitous Computing, are:

- to make better use of scientific areas that have contributed to the development;
- to interlink them into a complete interdisciplinary environment;
- to depart from the traditional model: people, activity and technology.

The authors are clear that, on its own, Ubiquitous Computing is already a socio-cultural object and this is evident and notable both in its artefacts, and in its practices. For these reasons, their technological visions are not just about technology, they are also about Ubiquitous Computing having a cultural relevance. As a cultural object, Critical Studies, Anthropology and Sociology need to inform the new developments of Ubiquitous Computing. What happened previously, according to the authors, was that Ubiquitous Computing borrowed methodologies from other disciplines. Now, they suggest, it seems the time to embed them as an intrinsic matter for design. This again is a relatively new shift in design that uses a generative account of culture, instead of the former taxonomic one based on ethnographical and social studies. This maps out an idea of culture as a generative process of creating meaning, in other words as a, "Cultural practice both performative and active" (ibid.: 54). By doing so, experiments, prototypes, test-beds in Ubiquitous Computing are not simply technological projects, but theory objects; embodiments of socio-cultural theories.[16] The authors insist that, in order to incorporate (generative and performative) everyday practices, Ubiquitous Computing needs to be able to both acknowledge any emergent technology (including open source), and incorporate real cultural-processes, as the oral-culture approach does. This formula has a clear reference in the work and theories of the American anthropologist Walter Ong and to his (1982) concept of mind/cognitive technologies, i.e. writing and media. Following this school of thought, it is

[16] The concept of a theory object is also something key to the design practice and methodology in this PhD thesis - see Chapter Five.

possible to draw a parallel between oral culture and the computing one.[17] The conclusion drawn by Dourish & Bell (2011) was an open call to think of a new research agenda for Ubiquitous Computing, similar to the attempt carried out previously, by people like Greenfield, McCullough and Sterling. According to all these authors, the main obstacle to the development of a full interdisciplinary agenda is the internal driver of Ubiquitous Computing: the computer science community and its methodology. Perhaps as a linguistic and political attempt to overtake this 'obstacle', new related terminologies have emerged over the years, i.e. "Everyware" (Greenfield, 2006) and "Spime" (Sterling, 2003). Debating the proper terminology is a common way for researchers to think around the past and to prepare the future.

2.3 Everyware

Everyware, as a neologism, is the contraction of, "everything, everywhere" and, "hardware" (meaning *tools, machinery, and other durable equipment).* Adam Greenfield coined the term in 2006, but for him, Everyware is not exactly synonymous with Ubiquitous Computing (although it does deal with the appearance of ubiquitous technologies). "Everyware" stands for all previous interactive paradigms that have since been developed, such as 'tangible', 'mobile', 'pervasive' and 'mobile computing'. To summarise, Ubiquitous Computing is the era of no-PC, and it is the era of computation. As a new

[17] An idea that will be recovered and expanded in later stages of this thesis – see Chapter Four.

unified paradigm, the Everyware concept was designed to allow us to understand the relevance and the implications of this, better than any single technology or previous technological paradigms. For Greenfield, the IoT is another extension of the concept, an extension introduced to include the network aspect between objects, an element that is not so central in the other concepts.

Greenfield (2006) discusses what actually happens outside the workspace, in everyday life. This highlights an issue in Weiser's original vision, the fact that it was tied to an office/workspace environment (as most of PARK projects were). Interacting with daily objects means that humans, "redefine [their] relationship with such things, [we] find our daily experience of the world altered in innumerable ways, some obvious some harder to discern" (Greenfield, 2006: 23). Everyware is, therefore, used by Greenfield to denote a process of digital mediation in and of our everyday lives, the way people experience the real world in particular when artefacts, "such as clothing, furniture, walls and doorways become platform for computation" (ibid.: 19). Greenfield's vision of Everyware does not go further than Weiser in terms of objects sensing, processing or networking, but it does extend it towards the idea of situation. Everyware is a situation in the sense of, "information processing dissolving in behaviour" (ibid.: 32). Here, the words, "situation" and, "behaviour" express dynamic and evolving conditions.

Although the author admits, "such interaction can't meaningfully be constructed as a task-driven", implicitly criticising one of the Ubiquitous Computing methods (ibid.: 38), he then somehow falls into the same trap as Weiser when he says that the glue that keeps situation and behaviour together is a scenario or, in general terms, is a narrative. (Scenarios are one of the key methods for HCI and interaction design that will be questioned later in this thesis, because they are usually a closed system that could develop into something very complex, but are ultimately deterministic.) To escape this deterministic result, Greenfield's proposition is to divide the day into operations and then let Everyware augment it, but without recognising that operation and task are almost synonymous. Everyware has the advantage of being a new unified approach, which points out that the dimension that matters is the everyday. Everyware also shares other important aspects, like environmental sustainability, technological innovation, economic development, and overall a better quality of life and wellbeing, similar concepts to the IBM Smarter Planet.

2.4 IBM Smarter Planet

The Internet of Things (2010), a video curated by IBM Social Media group, attempted to explain IBM's particular framing of the IoT as the 'Smarter Planet':

> *Over the past century but accelerating over the past couple of decades we seen the emergence of a global data fields…The planet itself, natural system human system,*

physical objects have always generated an enormous amount of data but we didn't be used to be able to hear it, see it, to capture it but now we can because all of that stuff is now instrumented and it's all interconnected so we can actually have access to it…So in effect the planet has grown a central neural system…More than two billion people are expected to be connected in the next few years but there will be even more things networked to the Internet.[18]

In this vision, the interconnection of people and things in the same social space of the Internet is not a challenge to be left to engineers only. It is something that redefines our relationship with the social and material world and the way digital and physical interaction interplay in our daily lives, in our cities and in every sector of our society. The narrative IBM developed for the IoT goes under the name of *Smarter Planet*. Smarter Planet is a scenario, a large-scale scenario for 'smarter' cities, 'smarter' health, 'smarter' transportation, etc. that touches upon almost every aspect of our lives. This scenario is needed because of food wastage, road congestion, energy wastage, air over-pollution, and food mileage. There is a clear issue of sustainability and a need for efficiency that underpins this vision (that, alternatively, is a commercial one). The Smarter Planet idea contemplates the presence of digital devices of any size embedded in things like cars or places. IBM's vision provides a more systematic conceptualisation of the IoT on a scale that involves cities, big organisations and institutions. The dimensions of the system can grow as you connect more contexts to it:

What this means is that the digital and physical infrastructures of the world are converging. Computational power is being put into things we wouldn't recognize as computers. Indeed, almost anything—any person, any object, any process or any

[18] www.youtube.com/watch?v=sfEbMV295Kk

service, for any organisation, large or small—can become digitally aware and networked.[19]

The technological essence of the Smarter Planet builds upon three elements: instrumented-ness, interconnectedness and intelligence ('the three Is').[20] "Instrumented" refers to the ability of sensing in real-time the physical properties of the environment (objects, places and people) around. This is already happening in particular in sectors, such as supply chains, healthcare, transportations and even in the natural environment (protected parks, etc.): "Today, there are 1 billion transistors for each person on the planet…By 2010, 30 billion RFID tags will be embedded into our world and across entire ecosystems".[21]

"Interconnected" alludes to the ability of new smart entities (people, devices and objects in a broader sense) of communicating and interacting with each other through different, wireless and mesh networks:

> *The Internet of People is 1 billion strong. Almost one third of the world's population will be on the web by 2011; there will be nearly 4 billion mobile phone subscribers worldwide by the end of 2008; the Internet of things—cars, appliances, cameras, roadways, pipeline, pharmaceuticals and even livestock—is headed to 1 trillion.*[22]

The last one, "intelligence", in this context, refers to the ability to respond to events, in real-time, quicker and more accurately, but also to predict future events. "Every day, 15 petabytes of new information are being generated. This

[19] Sam Palmisano, 2008. www.ibm.com/ibm/ideasfromibm/us/smartplanet/20081106/sjp_speech.shtml)
[20] Sam Palmisano, 2008. www.ibm.com/ibm/ideasfromibm/us/smartplanet/20081106/sjp_speech.shtml)
[21] Sam Palmisano speech, November 12, 2008
[22] Sam Palmisano speech, November 12, 2008

is 8x more than the information in all U.S. libraries; an average company with 1,000 employees spends $5.3 million a year to find information stored on its servers".[23] The way to reach this scenario is envisioned to be through automated systems, big data, centralised intelligence based on advanced analytics and new information visualisation models to immediately grasp the sense of events and act upon it. The main aims (and main selling-points) of the Smarter Planet are: "*more transparent, more efficient, more accessible, more equitable, more resilient.*"[24].

This new, smart ecosystem is global, just as the Internet is: "Every natural system and man-made system s becoming interconnected, instrumented and intelligent" (IBM presentation, 2009, Smarter Planet & Smarter Cities). Natural and man-made systems merge into one, global, hybrid ecosystem, with real-time capabilities of sensing, sharing and acting on any given situation, be it a natural event, a traffic jam or in health monitoring, assistance and hospital-bed management. The Smarter Planet vision covers novel technologies, such as smart systems, smart metering and monitoring systems; sensors and identification technologies (like RFID), wireless communication networks (such as Zigbee and Wifi), big data, software analytics and real-time visualisation systems. These technologies are very similar to the ones that Ubiquitous

[23] New Intelligence White Paper from ThinkForward website
[24] Sam Palmisano IBM CEO AND CHAIRMAN "Welcome to the Decade of Smart," remarks presented at Chatham House, London. January 12, 2010

Computing (in first instance, and now the IoT) are implementing and developing.

IoT and Smarter Planet did not emerge out of nowhere. From a research point of view, they can be inscribed (both technologically and historically) in the broader and well-established area of Computer Science and HCI, and in an area of research that has, so far, endured for more than twenty-five years: Ubiquitous Computing.

2.5 Tracing the inhabitants

As discussed, a plethora of new terminologies have emerged to describe and classify the overall context of Ubiquitous Computing and the IoT. Just as Dourish & Bell (2011) did for Ubiquitous Computing, this part of the thesis attempts to identify new entities (signals of the appearance of the IoT vision discussed so far). In this section, the terminology, the invention of a new vocabulary, the etymology of the archeologisms and the meanings defined by their authors is reviewed, presented and commented upon. The vocabulary is symptomatic - the naming itself represents the attempt to frame the novelties facing our society - and by looking into it, the new territory is revealed, such that it can be explored and appropriated.

Researchers and theorists have coined different terminology to describe and to define the Things of the IoT. The inhabitants of the new digital ecosystem (that emerged through the ubiquitous move anticipated by Weiser) are: tweetjects, smart things, blogjects, networked objects, sentient objects, cybrids, spimes and wearables. Although most of them describe similar concepts, they have key differences and point out new qualities and suggest new implications. A presentation and analysis of each of these is, therefore, central to fully comprehending the extension of this new domain of the IoT.

2.5.1 Tweetject

The first fully-industrialised version of the IoT encountered is the one promoted by IBM under the vision of Smarter Planet. In a Smarter Planet scenario, Things are little agents that act on our behalf; buses talking to bus stops, house appliances deciding the right time to be turned on for overall energy management, and so on. Smarter Things populate the Smarter Planet, of course:

> *Smart "things" will be able to perform: for instance, devices will be able to direct their transport, adapt to their respective environments, self-configure, self-maintain, self-repair, and eventually even play an active role in their own disposal.* (*IoT in 2020*, 2008: 3)

The *House that tweets* is a project that was started by IBM inventor, Andy Stanford-Clark in 2008. He set up his house on the Isle of White to be constantly monitored with sensors that send tweets. The twitter account Andy's House describes the house as a, "tweetject". Doors, windows and water are all monitored, and as energy and water consumption values reach a certain threshold, the house will tweet, keeping the owner (and also a community of twitter followers) informed in real-time about the condition of the house. This system uses a peer-communication network (MQTT and PUBSUB messaging broker) developed specifically for this project, where all the publishers/receivers are equals entities on the networks.

This project shows (on a basic level) the possibilities of home automation systems, but also how an inanimate thing, like a house, can become a producer of social-media content, similar to that of the many people who tweet daily. The technologies used for this project are all open-source and relatively low-budget. Similar to what in the early nineties pushed in the revolution of the Internet through HTML, now Arduino, MQTT and Twitter have the potential to invent new media types. The house, so far, has 18 followers and it has published 23 thousands tweets.[25]

> *It is therefore expected that the Internet of things will become a reality over the next 20 years…to improve the quality of our lives and consistently reducing the ecological impact of mankind on the planet... (IoT in 2020, 2008, 3)*

The tweetject also shows that in our social-media worlds there are already spaces for new kinds of entities; not just humans, but objects too.

[25] checked on 01/02/13 on https://twitter.com/andy_house

2.5.2 Smart things

It is not just IBM that has explored the design and development of 'smart' Things. Whirlpool brought out the first 'Smart fridge' in 2014, Adidas the *Adidas_1 shoes* in 2005, and, from Sony to Samsung to Apple, new 'smart watches' have recently flooded the market. These products represent the first generation of physical objects enhanced by the technologies of the IoT, by embedding sensors and communication and computation devices into their fabric.

Adidas_1 shoes is an example of an enhanced everyday object. They sense shocks during the running and then adjust themselves to guarantee the optimal cushioning level for a smooth run. The Smart fridge is another example. An LCD screen, a digital connection to the internet, sensors and microchips are physically embedded, so it is able to compile a food shopping-list and to fill an e-cart with food missing from its contents, based on the owner's diet. The Smart fridge is almost the holy grail of digital smartness, but somehow it never quite delivered. One reason for this, is perhaps its high price tag, another is in a misunderstanding of the everyday condition, our activities and how we are connected with the things around us.

The next example, the 2010 *Prayer Companion,* is not necessarily a Smart Thing, but in terms of its overall conceptual and practical approach, it is appropriate to mention it in this particular context:

> *The Prayer Companion is a small device designed to serve as a resource to the prayer activity of group of cloistered nuns living in a convent in a northern English city. A text display set in a raised enclosure presents a stream of headlines from online RSS news feeds interleaved with excerpts of text drawn from social networking websites. This information is updated frequently, so the result is an on-going reminder of contemporary events and concerns potentially relevant to the nuns' prayers.* (Gaver et al., 2010: 1)

While it is hard to fully count this an example of an IoT project as it doesn't connect more then one device, it does have element of design practice that is of value for this research. Through its design approach the university research project ended with the implementation of a device that, in a seamless way, 'disappeared' into the daily life of the nuns. According to its designers, its key design qualities were openness (as, "design that leaves ample room for its users' own interpretations and appropriations") and materiality (which, "can have strong effects on how computational artefacts are understood and used".[26]

2.5.3 Sentient Object

Although Rheingold's book *Smart Mobs: The Next Social Revolution* (2003) precedes the IoT, there is a full chapter dedicated to, "The Era of Sentient Things". What he discussed here is very similar to the examples addressed in this part of the thesis (it is not by chance that the chapter begins with a quote from Weiser).

Rheingold, both as a media journalist and a sociologist, is sharply observant of all the technological ferments happening around the world. His books

[26] www.researchgate.net/publication/221513653_The_prayer_companion_Openness_and_specificity_materiality_and_spirituality

document visits to research centres and interviews with researchers whose works have had a potentially-broad impact on our lives. The chapter reports on a mix of different projects and visions in the ubiquitous computing area at the early stage of it and somehow confirm the thesis by Dourish & Bell (2011) that the Ubiquitous Computing era is already upon us. Rheingold gathered very heterogeneous technologies together under the term, "sentient things", including: "[A]ugmented reality, wearable computing, tangible bits, information in places, smart rooms and digital cities…Sentient Things means physical objects with the ability to compute and communicate (2003: 145). In another passage of the same chapter he writes: "Used together, wireless network, portable computer and barcode scanner have the power to create new applications which have the potential to change the nature of products, of places and of social agency" (ibid.: 169).

Before turning to the next terminology, it is useful to state the elements pointed out by Rheingold, as they are useful for future discussion in the current research, these are:

- heterogeneity of technologies;
- a new kind of social agency;
- impact on the physical reality around us.

2.5.4 Blogject and networked objects

Julian Bleecker, the founder of the Near Future Lab and a researcher for Nokia, moved further and proposed alternative qualities to the concept of Smart

Things as described in his *Manifesto for Networked objects*: "To distinguish the instrumental character of 'things' connected to the Internet from 'things' participating within the Internet of social networks, I use the neologism 'Blogject' — 'objects that blog'" (2006: 2). The term, "Blogject" points out the element of participation in the network of networks, including by things in our social networks and also suggests their active role, or agency. "Blogjects always have some form of agency — they can foment action and participate; they have an assertive voice within the social web" (ibid.: 6). Two projects that can be used as examples of blogjects are *The Pigeon that blogs*[27] and *Air*[28], both by Beatrice da Costa.

The Pigeon that Blogs (2009) is a flock of pigeons equipped with environmental sensors, GPS/GSM technologies that find and track levels of toxic pollution in the air. According to da Costa, in acting as a sensor, the pigeon becomes a form of citizen that participate[s] actively in the environmental-ecological discourse. Data is collected during the flight of the pigeons in a specific city and at a specific time, charts of which are then formed and uploaded to the website of the project. The pigeons have been released in many different cities, helping to monitor the presence of carbon monoxide in the environment.

[27] www.pigeonblog.mapyourcity.net/index.php
[28] www.beatrizdacosta.net/air.php

Da Costa's *Air* (2006) provided similar outcomes but through different agents (using humans instead of pigeons). "AIR is a public, social experiment in which people are invited to use Pre-emptive Media's portable air monitoring devices to explore their neighbourhoods and urban environments for pollution and fossil fuel burning hotspots".[29] Its portable device (that looks like a big necklace) is carried by the participants and works similarly to the equipment described in *The Pigeons that Blog*. It tackles an ecological problem that seems distant from our responsibility and makes it very close. Eventually *Air* motivates the participant through a real awareness of our impact on the public domain of environmental policy. For Bleecker, such objects (ones always connected to the Internet, "will become first-class citizens of our world: and "Things" in the pervasive Internet, will become first-class citizens with which we will interact and communicate" (ibid.: 2). The sense is that they have an agency, a voice in the public domain of environmental issues, therefore they may have citizenship and, moreover, be examples of the beginning of 'an interspecies' dialogue. In Bleecker's sense, i-DAT's Ecoids could perhaps be seen as having this potential:

> *The ecoids are ecological agents, part of the Ecological Operating System. The intention with the Eco-OS, Ecological Operating System is to make the data generated by human and ecological activity tangible and readily available to the public, artists, engineers and scientists. (Phillips and Speed, 2009)*

Eco-OS collects data from a specific environment through a network of ecoids and provides the public, artists, engineers and scientists with a real-time model of the environment that then becomes material for artistic production. The

[29] www.pm-air.net/

ecoids can be built to gather data vital to the biosphere of influences that it is subject to (the influx of anthropogenic CO_2 and pollutants, deforestation, harmful land-management, etc.). There are reasons to consider the well-known changes in global parameters (in terms of atmospheric CO_2 concentration, temperature, distribution of precipitation, soil erosion, etc.) as the result of these influences.

These objects have gone, "well beyond the working setting" and they are tangible participants of a public debate (Dourish & Bell 2011: 19). This could be the function of new ubiquitous objects, in other words:

> *[U]biquitous computing when it withdraws into the periphery fails to create the kinds of expansive, playful and engaging experiences that promote human participation in new domains. […] …an emancipatory and democratic information technology, such as technology that involves people in public debates around issues of science and governance concerning climate change, environmental pollution, and health care, while simultaneously drawing on research in the social sciences about learning, participation, motivation, and behaviour change.* (ibid.: 19)

The ecoids have been used in environmental projects that involved artists and schools children within the North Devon Biosphere. Each ecoid will publish its data to an online database. From this data, artists will work with i-DAT to create artwork/scientific-research/public awareness about the environment around us. There is also a great opportunity to share the technology and data with other biospheres across the globe.

2.5.5 Spime

The human-object relationship has been discussed by Sterling in his pamphlet, *Shaping Things*, possibly the most adventurous and ground-breaking book written on the topic back in 2005. The style is unconventional and it brought together the approaches of design amateur and journalist, futurologist and science-fiction writer. It is about understanding a synchronic line that connects the world of things so far and in the world as it is going to be in 2070. In addressing the reader, Sterling points out the, lack of historical precedent to the changes observed and, the obsolescence of the production method in terms of sustainability (2005). In his writing, Sterling appears to wants to contribute to the overall discourse on the IoT, by inserting an historical perspective about things and objects and our relation with them. Ultimately, it aims to bring this contribution back into the production line to inform design methods to apply to the new reality. The book gravitates around the neologism of, "spime", short for Space and Time. According to Sterling, a spime is, "a set of relationships first and always, an object now and then and also a spime is an historical entity with an accessible, precise trajectory through space and time" *(2005: 77).* Furthermore, "[the] spime begins and ends with data … [It] is, by definition, the protagonist of a documented process. It is an historical entity with an accessible, precise trajectory through space and time" (2005: *11 and* 77). The example used by Sterling is a bottle of Sangiovese wine, as an exemplification of an early-stage spime-actualisation. Through its labels the bottle tells you about its content, the production process and origin, the best way to consume it and what to do with the bottle when it is empty. Furthermore, it allows you to connect to an immaterial system of information through a website where you can get more info, possibly become a member of the producer's special member club and maybe get in contact with other people that, like you, have bought this type of wine. He writes:

> *They are designed on the screens, fabricated by digital means, and precisely tracked through space and time throughout their earthly sojourn…Spimes are sustainable, enhanced, uniquely identifiable and made of substances that can and will be folded back into the production streams of future spimes.* (2005: 11)

Clearly through that instance, the object bottle, you become part of a long history of wine-making, you will be able to appreciate what you have at hand, you will know how to keep it sustainable through the right recycling process. Ultimately, it becomes a relational broker, as it will help you to get in contact with many more wine lovers. The bottle of wine is only a point in space and time but it is also all these layers of information and communication that are built on top and activated by the physical object. The spime will survive its life-span, the drinking, discharging and recycling. The value given to information over the physical entity and the relational element become the new properties of the object and, as the author says, the basis for the interplay between objects and people. These aspects of spimes highlighted go over a simple design matter and it requires a deeper discussion on the relationship between human and non-human to avoid reducing the issue to a production level only.

Sterling ties humans and things in a historical pathway of coevolution. The taxonomy of objects/human co-evolution that he generates shows the traces of a techno-cultural, techno-social and techno-economical relationship. He sees interspecies progress as part of the history of humankind as phases of the co-evolution of species (human and objects). At the beginning there were artefacts, now is the time of gizmos, ultimately the future of spimes and biots is arriving, according to Sterling. "Every one of these transactions – artefacts to machine to product to gizmo – involves an expansion of information. It enables a deeper, more intimate, more multiplex interaction between humans and objects" (2005: 17).

Given the relational aspect as granted, there are two elements worth research attention in relation to the concept of the spime. Firstly, the object's space and time's trajectory compared to the human one; secondly the informational/physical nature of this new entity. The spime has to deal with the physical world as it is a, "manufactured object[s] although richer in its digital technological elements as they are regarded as material instantiations of an immaterial system" (ibid.: 11). As a manufactured object, a spime is part of material system and the sustainable material can be folded back into the production line, but what is it that the bottle is not actually doing? While the bottle is an activator of a new social network, the bottle itself, the physical instance of the spime is not relational on a single species level. In the state of a spime, the entity might connect humans to humans, but in this example it is not connected object-to-object. From a relational point of view there is a clear imbalance.

A more advanced IoT example of a spime could be considered within the project *Remember me* (2010) by Chris Speed.

> *Remember me project, developed in collaboration with the Oxfam charity shop in the student quarter of Manchester, is a creative/technical intervention explored how memories that are attached to objects can affect consumer habits. […] A research associate worked for one week in the Oxfam shop in Manchester and asked people that dropped things off to tell a brief story about the object into a microphone e.g. where they acquired it, what memories it brings back and any associated stories. These audio tracks were then uploaded and linked to newly created stories on the Tales of Things website[30]. One week later, with the permission of people involved, this audio track was linked to two-dimensional barcodes and RFID tags that were attached to the objects in the shop with a custom Remember Me label. Two dimensional barcodes, commonly known as QR codes (Quick Response) are a printed paper barcode that is able to contain an internet address, and like RFID Tags can easily be associated with information or data files.*
>
> *People browsed the shop used bespoke RFID readers and the Tales of Things iPhone and Android phone based applications to scan the labels. Once triggered, speakers located in the shop played back the audio stories associated with the label.* [31]

The protagonists of *Remember me* are particular kinds of objects that have stories: any second-hand items. A second-hand object is a very particular kind of spime, as it is the kind of thing that does not turn itself in to the junkyard (as Sterling predicted for the spime), but at the same time it cannot go back into the production line. Its recycling process happens by means of new ownership

[30] http://www.talesofthings.com/
[31] http://chrisspeed.net/?page_id=351

instead. This is a very relevant example of a spime; it stresses many aspects involved with the IoT, and also approaches it from a more cultural perspective.

This early work demonstrates the potential of the IoT to be embedded into the objects of our daily lives, as a way of establishing emotional connections on a different level and specifically through digital interaction. It shows how digital elements can be inserted into the material world, but still marks a division as a mobile phone is still needed. This is a limit to a more performative level of interaction. The project takes into account the physical qualities of the objects and leaves the question of how to make the digital and physical interaction more seamless unresolved. There is no evidence of object-to-object communication, therefore as an example of the IoT, it leaves out a key component for the discussion: the relational dimension.[32]

2.5.6 Cybrid

Finally, "cybrid" is a term originated in the architectural field in 2001. It represents the link between concrete objects and abstract data, producing a hybrid of physical and electronic spaces. Greenfield would say that it adds a 'digital shadow' on the top of the physical elements of objects, buildings or places. According to its originator, Anders:

> *Cybrids are the interactive union of physical and electronic spaces and objects. Incorporating the concept into our definitions of space results in three different types*

[32] There is also a minor design question that this project raises: considering the material aspect of the QRcode, what happens if the code deteriorates or is removed from the object itself?

> *of spatial entities; only the second two are examples of cybrids. The first, not a cybrid, shows a complete separation between the physical and electronic environments – a typical example would be an office with a computer network. The second is a partial cybrid entity – an example being an office with a teleconferencing facility. The last would be a complete overlap, i.e. the entity would exist almost entirely in both physical and cyberspaces. A typical example would be a building security or operating system that could be accessed both physically and electronically.* (2001: 61)

Arguably, the Portland Square Building on the Plymouth University Campus can be seen as an example of a cybrid. The overlap between the physical and the digital is manifest through the digital system called Arch-OS.

> ***Arch-OS*** *represents an evolution in intelligent architecture, interactive art and ubiquitous computing. An 'Operating System' for contemporary architecture (Arch-OS, 'software for buildings') has been developed to manifest the life of a building and provide artists, engineers and scientists with a unique environment for developing transdisciplinary work and new public art.*
>
> ***The Arch-OS experience*** *combines a rich mix of the physical and virtual by incorporating the technology of 'smart' buildings into new dynamic virtual architectures.*[33]

Arch-OS anticipated a lot of the discussion on Smart Things and Smart Buildings. Digital technologies are seamlessly embedded into the fabric of the building and interact with the inhabitants in many ways, such as via sound, robotic movement and energy visualisations. In an architectural context (and for the field Architecture) Arch-Os represents a breakthrough and a way of showing how the inner life of a building can generate data and information that can be meaningfully communicated back to the inhabitants of the environment. It shows a deep connection between the environment and its inhabitants, and

[33] www.arch-os.com/

also how the inhabitants can reveal their presence in the traces of their daily experience in the space they live in. The limits of Arch-OS are that it was built as close system and is not connected to other, similar things; it does not extend beyond the building, although it does allow us to perceive it differently. From a design point of view, however, it does allow other kinds of interaction to take place that do not involve interfaces other than the actual fabric of the building itself.

All the terminologies presented here highlight the transformation undergoing in the material world and the transfer of human skills to objects that makes them somehow more human: they have agency, the ability to communicate, to remember and to learn. It is an anthropomorphic transformation of the material world people inhabit. "In a world increasingly mediated by technology, we must ensure that the human core to our activities remains untouched" (ITU, 2005: 13). But how can this be ensured? At the moment, this is mainly done by means of regulation, ethical and privacy legislation, but this task is, in its first instance, one for designers. The perspective is cultural and social, but most importantly (and as this thesis will point out) also ontological.

2.5.7 Wearable objects

Wearable technology is a big topic connected to the history of Ubiquitous Computing. Without getting into too much depth on history of the wearable, a couple of examples, *the Head* (2004-2007) and *Seven Miles boots* (2003-2004) from artist Laura Beloff, can help to point out its relevance and legacy for the present discussion.

> *The Head is a piece with process-like, participatory and mobile approach to art practice. It is dealing with a view of contemporary, mobile and technologised society. The Head is a wearable sculpture with connection to internet and public access via mobile phone/SMS. The Head is available for adoption for the public. When someone adopts the piece they become responsible for it. The head contains a mobile phone, which is embedded in such a way that the camera of the phone functions as an eye of the head-sculpture. The public can access the Head via their mobile phones by sending an SMS-message. When the Head receives the SMS-message it responds by capturing an image and recording a short sound file simultaneously. This image with sound is sent back as a reply to the sender. The images are also automatically uploaded to the public site in Flickr.com. The dedicated Flickr-site can be thought as the mind of the Head-sculpture with continuous accretion of memories.*[34]

> *The project SEVEN MILE BOOTS is a pair of interactive shoes with audio. One can wear the boots, walk around as a flaneur simultaneously in the physical world and in the literal world of the internet. By walking in the physical world one may suddenly encounter a group of people chatting in real time in the virtual world. The chats are heard as a spoken text coming from the boots. Wherever you are with the boots, the physical and the virtual worlds will merge together.*[35]

Beloff's works find space in this discussion, as connected wearable objects are part of how digital interaction slides into the fabric of our daily existence.[36] The work has performative qualities and it attempts to become part of daily experience. It has also Thing qualities, not only because it is connected to the Internet, but also because it attempts to create a relationship between the objects and the people wearing them (or remotely connects to them by sharing picture and sounds, and by building up a memory of this linkage). *The Head* is still an

[34] www.realitydisfunction.org/head/

[35] randomseed.org/sevenmileboots/

[36] They can also fit into the categories of blogject or spime, but they have been given a separate section for their wearable nature. They have a role on their own as objects close to our body without being a fully-digital device (like the mobile phone or the Smart watches), but more as an enhanced or extended thing.

extraneous object in itself, and its anthropomorphism as an object brings concerns about surveillance from a conceptual standpoint. From a design perspective, its anthropomorphism affects its 'thingness' by resembling the human, instead of maintaining its own identity. It suggests mimicking the subject through some sort of agency passed over to the object. The boots are different in this respect, and more pertinent somehow to the present argument. As final remark on Beloff's works, the object-to-object or social aspects of the Thing relationship is not explored or questioned, which is a critical limit in the context of the IoT.

2.6 Tensions, forces, issues and futures

According to the EU there are three barriers to the development and the widespread adoption of the IoT: governance, privacy and security, and sustainability (European Commission and EPoSS, 2008). There are also industrial concerns, mainly in the realm of efficiency, energy saving and profitability. No doubt these are real issues, relevant and crucial to the development of the IoT, but there are others equally important (if not fundamental) aspects to address. As seen earlier in the chapter, our understanding of the IoT is limited and this could impact upon the design outcomes. As Dourish & Bell recognised: "Any description of technology is always already social and cultural, as social and cultural are already thoroughly implicated in how technology is imagined and designed" (2003:12). Thus, the limitations of technology are implicated in its social and cultural foundation. With this in mind, if the drivers of IoT development are left only as technological efficiency and profit, the design will be deeply affected. In that sense, HCI and Ubiquitous Computing both have an old model of framing the world.

Reflections on the social and cultural implications of a specific technology or set of technologies are the groundwork and the foundation to imagining new design models, new paradigms or new visions of reality. These need to be established in order to provide new perspectives to the IoT. Alternative configurations of the field need to be based on different perspectives and are the only ones able to address fundamentally social and cultural issues. The global scale of the IoT, its size and dimension and the process of mediating the entire, physical environment should be seen as urgent for all of the design community. The IoT is a process of transforming the reality into a medium. As McLuhan *stated in 1967, "[a]ll media are extensions of some human faculty - psychic or physical".* How designers respond to this is a matter for the new performative ontological framework, as:

> *The medium, or process, of our time - electric technology is reshaping and restructuring patterns of social interdependence and every aspect of our personal life. It is forcing us to reconsider and re-evaluate practically every thought, every action, and every institution formerly taken for granted…Everything is changing: you, your family, your education, your neighbourhood, your job, your government, your relation to "the others. And they're changing dramatically.* (Ibid.: 31)

The extension of the transformation of any media technology was already anticipated by McLuhan's socio-cultural analysis and put the responsibility for this in the hands of those developing the technologies. This need for a socio-cultural conceptual framework able to operate in a design context is reflected in what has been done in Ubiquitous Computing. At this precise moment, the IoT is seriously lacking a foundational paradigm, as it has been borrowing from the broader field of Ubiquitous Computing to fill the void. So far, the IoT has been subsidiary, a bi-product of Ubiquitous Computing (at least in terms of theory and design models), but this subsidiary framework works only up to a point, and it is limiting to compress the potential of the IoT into this old framework.

The IoT can inherit the epistemological foundation from Ubiquitous Computing, this is certainly an option to consider to start with, however, the IoT has the potential to develop and extend the discussion broader than its initial definition. It has been already pointed out that the IoT (as a terminology) is a moniker, which could be very instrumental in explaining and driving the development of a new emerging socio-cultural and technical condition. It is now time to give to the IoT the status that it deserves and extend the boundaries in which it has been constrained. Just as the Internet is not just about HTML or PHP, the Internet of Things is not just about RFID or QRcodes, temperature sensors or Arduinos. As a new domain, the IoT is in need of a foundation, probably more ontological than and epistemological, but similar to what Dourish did in the context of Ubiquitous Computing. Regardless of the IoT's growing relevance in society; its economic impact; the huge sums of public money (Future Cities) going into developing new smarter solutions for urban areas all across the world; the legislators, academic research centres, national and supranational institutions and frameworks (ESRC, EPSRC, TBS, EU Institutions – Framework) that are taking it as their focus, the IoT is still missing a conceptual framework that is not strictly technologically-, engineering- or computationally-based. The following chapters in this thesis will look at filling this gap and provide a framework for the IoT that contextualises it into a design field, an Interaction Design one. Where should the project of filling this gap start? The direction is, although it might sound trivial, the full understanding and clarification of the terminology, in particular, the capital of the word, "things". In fact, it is not clear, if the IoT definition is used, whether this implies objects or Things. Is it the Internet of Objects or the Internet of Things? Do designers design for the Internet of Objects or the Internet of Things?

> *The semantic origin of the expression is composed by two words and concepts: "Internet" and "Thing", where "Internet" can be defined as "The world-wide network of interconnected computer networks, based on a standard communication protocol, the Internet suite (TCP/IP)", while "Thing" is "an object not precisely identifiable" Therefore, semantically, "Internet of Things" means "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols".* (*IoT in 2020*, 2008: 4)

To understand and clarify this as a starting point, as not just semantics but as a longstanding philosophical-ontological concern: the differences between an object and a Thing need to be addressed. The two words, "object" and "thing", are frequently used interchangeably, as synonymous, but they are not. There is considerable confusion across all related disciplines and practices, around the role, function and differences between the Thing and object. They are frequently interchanged and the entomological and philosophical context ignored. In two key references for this field, *Everyware* and *Smart Things,* the authors both avoid dealing with the fundamental question of the difference between the two entities. Few have really questioned the matter. This research will make a start from there. Things and objects are not the same, etymologically, and, most importantly, are a matter of discussion for Western thought. Redefining the distinction might help the rest of research to better inform their design processes and strategies for the future. Thus, to clarify this point is, not only legitimate, but also potentially necessary, in order to make a real breakthrough into new design paradigms and perspectives. Whether we are able to frame the difference and follow its implication will have a significant impact on future design practices. Other disciplines like Anthropology and Archaeology have already looked into differences to establish a meaningful definition (Ingold & Hodder, 2011 and 2012). This has an increasingly important implication for the field of design and will also be addressed in the following chapter.

Finally, to establish the domain, a clarification about who is contributing to it should be provided. An interdisciplinary nature is certainly another aspect shared with Ubiquitous Computing, and this thesis makes a claim to orientate the IoT agenda, not just in technological terms, as it is cutting across many disciplines (Architecture, Media, Design, Health, etc) Compared to Ubiquitous Computing, the IoT is free from a very specific computer-science history; hence, it can represent an opportunity to address key interdisciplinary and foundational questions without the historical bias that Ubiquitous Computing is carrying. In the founding of Ubiquitous Computing as an interdisciplinary design-practice, social science and philosophy (Dourish, Greenfield and McCullough etc.) provided the theoretical framework and the epistemology that support its methodologies; this thesis makes a claim for the IoT to now enjoy a similar treatment.

As Dourish & Bell suggested, embedding cultural twists give active and performative roles to culture, because it becomes a design process via a generative account, not just as an evaluation or analysis tool: “Our focus is not on culture as an object, but on culture as a practice, as both active and performative” (2005: 10). In this case, cultural practices are not used as a methodological tool (a clear limitation of HCI methodologies) but rather as design framework in action. This move represents a big departure from traditional HCI, CHI and even ID. Questioning traditional HCI design methods (like scenarios and personas) as something that are neither active nor performative is a strategy for this research. The outcome is very uncertain but something to look at. There is an urgency to address these questions, as they are predefining the design process. Thus, the following are the catalysts for the discussion and for the definition of the field: 1) a clear differentiation and clarity about the distinction between object and thing; and 2.) an understanding of the new relational, social dimension that is intrinsic to the IoT. By exploring this initial lack of critical and cultural discussion for IoT, this research aims to extend the opportunities of development for the field. By identifying and engaging with this groundwork, new design opportunities should then emerge. There is a recovery to be made, because, while the IoT is gaining more relevance and traction in society, its conceptual and theoretical limitations are getting more evident and problematic.

Chapter summary

The aim of this chapter has been to map out the ground in which this research is set, in particular connecting the IoT to its historical context, setting the link with the field of Ubiquitous Computing as a precedent and something to inform future developments (linking back to its origins and at the same time looking at questions arising for the area). The research uses a similar strategy to the one used in Ubiquitous Computing to define the new field. In this chapter, as well as tracking the history of the IoT and Ubiquitous Computing, unresolved matters that this thesis will deal with were highlighted. The works of prominent voices in the field of Ubiquitous Computing and the IoT were reviewed to show the extent, size and dimension of the domain. At the end of the chapter, the driving question was identified. Moving forward to the next two chapters, this is where a strategy for setting the new conceptual framework will be suggested.

CHAPTER THREE: Things matter, a matter of things

Chapter Introduction

The third chapter starts by looking at one elementary aspect of the IoT: why, "things" and not, "objects"? What is the consequence of the ontological debate over the difference between objects and things? In Ubiquitous Computing, and generally, the two words, "object" and, "thing" are used interchangeably. Frequently, they are synonymous; unaware of the history they carry. The distinction, and the etymological and semantic connotations become even more relevant in the case of the IoT, right from the name. This chapter deals with the difference between, "objects" and, "things", attending to the definition of the nature of each entity. This is a matter for ontological investigation (not semantic disquisition). Broadening the discussion also gives the opportunity to open up the dialectic of object and thing, to the Western-dualistic conflicts of object and subject, and the separation between human and non-human. This chapter organises a literature review of scholars who have engaged the philosophical discussion, showing that, at present, it has various implications in the technological disciplines in a time when they are altering the established notions of reality.

This literature review aims to reveal a lineage of thought from scholars that have questioned the problem from different perspectives. In the previous chapter, new kinds of things were encountered: spimes, networked objects, Smart things, sentient objects and blogjects. This digitisation is a process that is becoming more pervasive and seems irreversible, especially if approached from the angle of the emergence of the IoT. This might be one reason why the definition of the IoT is gaining more relevance than it did in the context in which it originated. The process and relevance might be symptoms of profound impact (the world experiencing the dawn of a technological revolution aiming to intervene on the materiality of the physical world). For this reason, scholars are generally readdressing their concerns about things, objects, our relationship with them and the distinction between the human and the non-human. These neologisms use the words, "objects" and, "things" indistinctively. This is due to common use, but some semantic or etymological explanation of the differences should be provided.

Is a Smart thing the same as a Smart object? Are the two terminologies interchangeable? Is the spime an object, a thing or neither? Are networked objects really objects? Even when the definition is unpacked, authors pay little attention to the implication of the distinction. The bottle of wine with a barcode and a website, the ecoids, the pigeons that blog, the iShoes; what are they, objects or things? "Things" and "objects" do not seem to oppose each other; on the contrary, they seem to co-exist in the same entities, sometimes even at the same time. They are more like conditions or states of the entity, however, they are not the same, and, in this new techno-social landscape and scenario, it becomes a matter for investigation. It is legitimate to ask if the Internet of Things is really the Internet of Objects. Looking at industrial/commercial cases and academic-artistic research in the field of the IoT, the design paradigm that is central seems to be modelled around the idea that the IoT is made of objects more that it is of 'things'.

Would knowing the difference between an object and a thing in advance have influenced or improved the design of the IoT? The attempt here is to resolve the dilemma and check the impact of this distinction on the development of the field from a design perspective. What is to follow is a review of the very essence of the question, undertaken with the idea of scaffolding the IoT field and providing solid foundations for new design approaches. As has been pointed out earlier in this thesis, the IoT is still missing a constituent of fundamental, critical groundwork and it is still borrowing the Ubiquitous Computing epistemology established by Dourish (2001) and Suchman (2007) through their work at Xerox. Nowadays, the IoT claims to reshape the physical reality of things, their relationships and our relationship with them. It seems, therefore, that a foundation other than the one borrowed from Ubiquitous Computing is needed, to establish the IoT's autonomy. What makes this aim so essential, is that it will bring both a cultural perspective and an ontological clarification to the IoT. Philosophers, anthropologists, archaeologists, sociologists, geographers, art historians and computer scientists have endeavoured at defining the essence and nature of what is meant by the words, “object” and, “thing”. Some of these efforts will be presented and reviewed here. The ultimate aim of this quest is the definition of an ontology (of things) for the IoT, in order to inform a design framework for it.

Among the many who have undertaken this endeavour, key scholars for this research are: Richard Coyne, Professor of Architectural Computing at The University of Edinburgh; Daniel Miller, Professor of Anthropology at UCL London; Sherry Turkle, Professor of the Social Studies of Science and Technology at MIT; Ian Hodder, Professor of Anthropology at Stanford University; Tim Ingold, Chair in Social Anthropology at the University of Aberdeen; Bruno Latour, Professor and vice-president for research and director of the Master of experimentation in arts and politics at Sciences Po, Paris; Graham Harman, Professor of philosophy at the American University in Cairo and, as a recurrent echo throughout this review, the late work of the philosopher Martin Heidegger.

3.1 Ontological groundwork.

Richard Coyne’s blog post, “No-Thing as it seems” (April 23th, 2011) was a critical attempt to acknowledge the problem coming from someone inside the digital debate. This is both a title and a statement that sets the ontological question about the nature of things, a matter that philosophy is well-acquainted with, but something that had in the context of the IoT (for a while) been put aside. The post implicitly questioned and called for a deeper look into the matter of a thing and what this is thought to be. For Coyne, the thing has something hidden, is unique, is always connected to a situation or a place and, he seems to suggest, has some sort of narrative or connecting story. Sensing that addressing the friction between object and thing is essential, he set himself to do so. Coyne did not mention any technological element, he simply echoed it, opting instead to follow a very theoretical route based on a philosophical understanding of the thing as part of the material culture inhabited by humans. At this time (2011), it was clear that the physical and the digital were starting to dissolve into a new sort of hybrid nature or ecosystem, which is why the question of how to distinguish between object and thing needed (and still needs) to be addressed. Coyne tracked the discussion back to its philosophical ground, quoting Heidegger and his etymological remarks on the original meaning of the word, "thing" in the old German, "thing means a gathering, and specifically a gathering to deliberate on a matter under discussion, a contested matter" (1971/2009: 174). Things are relational entities, while this suggests that objects are not: "Whatever things are, they are individual, situated, contextual, and born of unresolved contest. No thing is quite as it seems, or perhaps more as it seems than we think" (Coyne, 2011). Embracing things and understating the difference is the paradigmatic shift here. Such shifts, "from discourse on environment to landscape, from space to place from time to temporality"

(Hodder, 2012: 10) often emerge from outside a specific field. Likewise, a place or a thing is a cultural instance made of meaning, history and memories. The place is something filtered through the culture, while the space is an analytical activity (Ibid.). Things have been used in the history of thought to solve the dialectical dualism between object and subject, therefore at a very simple level they play an instrument in founding a new ontology of the world (Ibid.). Viewing the materiality and the external world through the lens of, "things" instead of, "objects" represented a break-through for philosophy in the twentieth century.[37]

This is just an initial approach to the topic, putting aside easy generalisation and simplification, it is essential to dig deeper. First, a review is undertaken of how the terms have raised interest in different disciplines and then we will look at reviewing works that have attempted a definition of each word ("object" and, "thing").

In his book, *Entangled* (2012), Hodder, summarised the many studies on the relationship between humans and things, which are mainly of interest of in four disciplines and are key references for both this and the next chapter: Philosophy, Sociology, Material Culture studies, branches of Anthropology and Archaeology, and the Cognitive Sciences. Recent times have witnessed a return

[37] This is a line of no return whose impact will be even more clear in the next chapter when ideas of the relationship between human and non humans will be introduced and reviewed.

to the use of, "things", not only in subjects that, historically, have dealt with it (like, Social Science, Material Culture, Anthropology and Archaeology), but also in Design and Cognitive Science. Let us now turn to these, one at a time, starting with, Cognitive Science.

3.1.1 Cognitive Science

There was a child went forth everyday;

And the first he look'd upon, that object he became. (Walt Whitman, 1855)

Sherry Turkle is well-known for her studies on technologies and the self; their effects and interactions. In 2007, she edited a book called *Evocative Objects: Things We Think With,* aiming to show how objects play a central role in human existence, both emotionally and cognitively. With an underlying distributed cognition approach, the book attempted to find evidence of the role objects have on shaping our thinking, knowledge and feelings. The work is organised as a collection of short anecdotes, where each contributor remembers a key moment of their life linked to a specific object. The objects vary from a cello to a train. The object becomes the emblematic symbol of that experience or of a specific life change; a sort of objectification of the life through what Turkle calls, "evocative objects". This book reinforces the awareness around the significance of objects and the material reality, in a time when information and technology started to be embedded into the material world.[38] Here, it is not ideas, but things that are key. She asserted that, by documenting the autobiographies of objects and persons, she could attempt to show the, "power of concrete, contextual reasoning" (2007: 7). Furthermore, she highlighted the relevance of the direct experience that involves the material culture, over the abstract reasoning that Western thinking keeps (wrongly) considering to be the only accountable way of knowledge. *Evocative Objects* is an account of active roles and the nuances of objects in human life, and it is also an account of the many dimensions an object or a thing can get. The underlying theorem is that objects are connected to the subjects, and these stories demonstrate the personal ties each author had with objects.

The particular form of the book also stresses other aspects: the personification of the object into a character and the placing of it on a stage, transforms it in the light of a specific narrative and making it into a prop.[39] Turkle's collection of texts aspires to echo the insights of Vannevar Bush's *As We May Think (1945),* in terms of an awareness of a new human connectivity: an extra-cranium networked-connectivity rather than an internal-organisational connectivity. The objects connect people to other people and to ideas.

[38] This is a time when the reality is directly mediated through the retroactive fitting of digital technologies on the physical environment.

[39] Chapter Four will re-address this matter, as this is a key shifting point.

It is also interesting that Turkle made a short taxonomy out of the objects described in the book. Among others, she accounted for: natural objects (an apple), artefacts (a train), ready-mades (The World Book Encyclopaedia), bespoke objects made by the author (a knot). The book highlights that these objects are part of an experience, in the sense of an entanglement of objects, people and ideas; in effect, the new context for the everyday connectedness of the IoT and Ubiquitous Computing, through their cognitive and performative roles (Dourish & Bell, 2011).

3.1.2 Material Culture

As a field of study, Material Culture sits as part of the broader anthropological and archaeological context. It is a relatively recent area of investigation that emerged as a subset of both disciplines.

> *The terms 'material culture' and 'material culture studies' emerged, one after another, during the twentieth century in the disciplines of archaeology and socio-cultural anthropology, and especially in the place of intersection between the two: anthropological archaeology.* (Hicks, 2010: 25)

The relationship between artefacts and their socio-cultural environment is the main concern for the field, and with, "distinctive contributions to make to the interdisciplinary study of material things in the social sciences" (Ibid.: 26). This (eventually epistemological) status that the field acquired, attracted many scholars towards the theoretical discussions that involves materiality, culture and the social.

> *[Material Culture] it was deployed to solve a number of quite specific, long- standing archaeological and anthropological problems. These related to the idea of relationships between the 'social'/'cultural' and the 'material'. It is in relation to these problems that the field came to acquire during the 1990s a kind of paradigmatic status.* (Ibid.: 26)

As a recent area, Material Culture literature is rich in theoretical framing, and frequently considered of philosophical interest too. Its youth means it has had to define itself and matter of investigation. It is in this field, therefore, that the most recent contribution to a 'theory of things' and an epistemology of how 'things' relate to each other is happening (although in a very analogue way). Of key interest for the scholars in the field are: the life and biographies of objects, their values and meaning, and their social roles.

Although the technological element is missing in their analysis, the field gives a significant contribution to the discussion due to their insight into the material world and our cultural, psychosocial relationship with it.

Daniel Miller is one of the most influential voices in Material Culture studies today. His publications have represented important steps for the development of the area, and the attention gained around his findings has helped him gain his reputation. A notable idea in Miller is a two-fold definition of materiality: one very mundane, whereby material means artefact, and one more sophisticated, whereby it is part of a larger conceptualisation of culture. The idea of materiality, in the last instance, claims to transcend the dualism of subject and objects. In the introduction of *Materiality*, a collection of essays edited by Miller in 2005, he dealt with the key foundational issue of the, "world confronting us as material culture and continu[ing] to evolve through us, through a reiterative process of objectification and alienation" (2005: 8).

In relation to the fundamental question, 'what is a thing?', Miller stated that it is impossible to answer the question from inside the field; there is no way of defining the thingness of the thing, as this is a matter for philosophy. Having said that, it is possible to have a theory of objects if it is approached from the perspective of artefacts. Ingold (as addressed later) insists on the same point.
According to Miller, things tend to disappear into the background of our lives, what he calls, "the humility of things" (ibid.: 85). Through education, he added, they become normative orders of a society, of an economy, of a culture and disappear from the perception. This disappearance is also a process of alienation of the things from human perception, understanding and capacity to isolate and reflect upon them. Humans alienate themselves from the things made by them, but in an endless movement they keep producing them through the process of objectification: "A novel reification of people and a new personification of things" (Brown, 2001: 10), or in Grosz's terms: "The thing is what we make of the world rather that simply what we find in the word" (Brown, 2004: 126). In one way, this happens by applying, "the concept of agency once sacralised as the essential and defining property of persons, and

apply[ing] this concept to the non-human world" (Miller, 2005: 11). Through this idea, Miller recalls Gell's natural anthropomorphism; a synonymous concept of personification already encountered via Turkle. On one side, the objects are moving towards a process of personification, while on the other side, it might happen that humans are increasingly moving towards a process of objectification of themselves.

3.2 Objects: a definition

The object, "stands before, over against, opposite us"; an object is, "what stands forth us" (Heidegger, 1971/2009: 115). The Merrier-Webster dictionary provides a starting point to cast some light into the differing meanings of the word; an object is: "something material that may be perceived by the senses". Following this definition, an object has properties and qualities that are perceivable by our sensorial system (sight, hearing, etc.) and it implies that those properties are ultimately measurable (i.e. dimension, colour, temperature, speed, etc.). Lastly, an object is made of some kind of matter that provides it with a physical presence (Ibid.). This is pretty obvious, but still an essential step for the discussion. Let us now move now to some more in-depth definition through a recent work by Ian Hodder.

Hodder is the author of *Entangled: An archaeology of relationship between humans and things* (2012). Although the agenda of this book is mainly archaeological, the initial chapters' focus is on a review of the most recent theories about things and humans. By doing so, the author deals with more general concerns analysed from the perspective of the objects and things. For Hodder, the definition of object, "derives from the idea of throwing in the way" (2012: 7); an object stands against our thumb or our senses, as in the initial dictionary definition. "An object is something we contemplate as distant from us and set up against us" (Ibid.: 8). This way of framing the object, again highlights the sensorial, perceptual and physical element, but it also is a place to start to remark upon the differences, in terms of physical distance, presence and otherness. Furthermore, in another passage of the book Hodder states; "We are more likely to use the word object for things that are relatively stable in form" (Ibid.: 7). This idea of 'being stable in form' is referring to the matter element *as per* the initial definition.[40]

By looking into the meaning and relevance of objects, the book attempts to understand and define the ways the two elements (human and non-human) come together and depend on each other, via a social approach. As Hodder writes: "We can look at entities as 'things" that assemble humans and non-humans, or as 'objects" that are thrown in front of our thought, that oppose us" (Ibid.: 14). Regardless of the fact that Hodder's interest appears to be in how humans and non-humans are tied together, he also remarks on the connotation

[40] The introduction of the aspect of form becomes important for a design context whereby form is an essential aspect, i.e. following ergonomic principle or an aesthetical one. This aspect will be picked it up again at a later stage.

of the word, "object" as something distinct from us. The subject is something that stands in front of us: "The term 'object' is very tied up in a long history which opposes subject and object, mind and matter, self and other" (Ibid.: 7).

Continuing this literature review, in *The Object Reader* edited by Candlin & Guins (2010), a selection of key essays and extracts around the topic under discussion here, documents the multidisciplinary and long standing interest around it. The reader is given a comprehensive account of historical multidisciplinary writings (from Anthropology, Philosophy, Sociology, Semiology, Psychology, Media and others) and also an insight into more recent contributions from emerging areas (Material Culture, HCI or ID). This creates a good platform to allow a dialogue. The more contemporary essays are contributions from people like Bleecker and his blogject/networked objects. These are given as examples of the IoT's things, demonstrating an awareness that IoT is gaining in reaching a core discussion in the tradition of Western thought.

The first part of the book is related to objects, and hosts a range of contributions from numerous established scholars including: Mauss, Lukas, Barthes, Baudrillard, Winnicott, Ingold and Du Bois. The section does not engage with unravelling the fundamental question of what is an object. It instead focuses on presenting perspectives on value and the meaning of objects from a cultural, socio-economical, sexual and political point of view (by editor's admission, this section is more epistemological). Out of the contributions for this part, three are very relevant for the present discussion: Mauss, Barthes and Ingold.

Marcell Mauss' interest was in the gift culture among the Samoan population. In the 1970s, he studied the spiritual power (*hua*) and social power of objects in this culture. For the Samoans, objects are the centre of a complex social and a significant system organised around the idea of contractual gifts. The reputation of a person, *man*a – authority and wealth - is based on the kind of object he/she presents and on the obligation to return the gift that the receiver feels: "The objects retains a magical and spiritual hold over the recipients, the thing given is not inert is alive. It is alive and often personified" (1974/2009: 23). For Mauss too, the object was not inert and tended to personify or mirror human qualities. The element of personification, the personhood, of the objects shows that in society outside of Western tradition the subject is not necessarily understood as entirely distinct from the object; Mauss describes the phenomenon as a second-hand agency. Something imposed on the object by the subject, but that somehow gives a level of autonomy to the object in the social realm (Ibid.).[41] Furthermore, the object has a magic hold that can survive the giver and the recipient (Ibid.).

Its spiritual power is another dimension quite far from our understanding of the material culture, although it can show similarities with religious traditions.

[41] This is another aspect to factor in and consider for the design implications it could possibly have. Later in the thesis this will be addressed more extensively.

In his 1970s essay on, "Toys", Barthes looked at contemporary childhood objects as, "a microcosm of the adult world" *(1972/2009: 38)*. Whereas the abstract and geometric set of wooden blocks of the author's childhood allowed the child to perform actions, "he creates life, not property" (Ibid.: 39). These toys represent a model of society and prepare the child for a normative life.

Contemporary toys are made of material like plastic, which avoids the sharpness, coldness and warmness of traditional materials, separating the child from the real world (Ibid.).[42] Here, once again, the object has a meaning and significance, immaterial in its substance, but intrinsically linked to material aspect and fabric. Value, meaning and significance are part of a cultural, social and political structure, but so are the objects' material manifestations (matter and form) (Ibid.).

3.2.1 Artefacts

In his essay, "On Weaving a Basket" in *The Object Reader* (2009), Ingold articulated epistemology of artefacts. The common-knowledge view is that an artefact is a product of a making-process that involves a manufacturer, thus is a distinctly human intervention. Usually, artefacts are considered artistic products or artisan craft products. In both cases, they are made and are part of a particular cultural setting or environment. Artefacts can be assimilated to

[42] This accent on the matter of the object and how the matter relates again to a model of the world, is a critical characteristic to consider for further discussion, and we will see in Ingold how this is related to design.

objects for their physical state, as they are an instantiation of a thing. They are produced and made by a skilled artisan or an artist. In the discourse about object and things, introducing artefacts may look a diversion or a too specific instantiation to be accounted for in the overall theoretical analysis. This is not actually true, in fact, Ingold treated artefact as more of a thing than an object, in particular referring to the making aspect and in the way matter, form and substance are accounted for, are related to the maker, and ultimately are brought back into the theoretical idea of things as a relational entity. In this paper, Ingold talked about organisms, artefacts, form, surface, weaving and making. By doing so, he stressed all of the key aspects relevant for this thesis chapter and anticipated the discussion in the next (on the social roles of things and objects). Ingold makes clear in his text, that the artefact is a particular class of objects or things. Although not helping to unravel the division, his analysis does help to point out other aspects critical to this thesis (like the aspect of making, which is useful from a design angle).

Artefacts, in Ingold's view, are not objects or things, and cannot be made; they 'grow' like an organism. He gives the example of a spiral basket and how it is made. The weaving, the repetitive movement and application of forces on the matter by the skilled artisan are generative acts. The act of weaving is like the growth of a natural organism, like a shell. Both the shell and the basket have substance (organic for the shell and material for the basket) and both have a form. The form reaches a state of stability, so the result is that there is an organism and an artefact. In nature, this happens through genetic specification, while in the case of the basket, this happens through cultural specification. This specification, like the gene, is not imposed from outside, but rather, generated from within. In design terms, this is a shift. The design is not a process imposed on the material through a predefined project idea, but is generated culturally, and it could be said it is performed from within the matter itself. This is an example of Dourish's concept of a new generative account of culture in design.

Ingold described the growing of an artefact as, "a process of autopoiesis, that is, the self-transformation over time of the system of relations within which an organism or artefact comes into being" (Ibid.: 87). The process of autopoiesis is natural and substantial, as the producer of the artefact, "works from within the world, not upon it" (Ibid.: 89). This notion of autopoiesis unifies a system of relationships that works from within to generate the static form of the artefact or the organism. The system of relationships is the context from which the artefacts originate. The turn that Ingold gives to culture and design is based on a rediscovery of a key role played by matter. The matter and cultural imagination are part of the same system of forces that generate the artefact through the action of the artisan. Here, humans are inside a web of elements, but it does not look like a network in Latour's terms, it is more like a field of forces. This idea of a performative culture, of autopoiesis, of system of relationships and of design as a generative process within the matter is useful for this thesis and will be discussed further in Chapter Four.

In conclusion, Ingold's weaving concept is not a process of making, but is the making itself; exactly like for Heidegger (1971), where the dwelling is the building. For this reason, in Ingold, the term, "material culture" acquires a very specific connotation, in terms of how the materiality is taken into account and how it is interwoven with culture.

3.3 Things, a definition

Heidegger's, "What is a thing?" (1968) was the first text to really address this question. The essay is a complex argument about the nature of the thing and the difference between the thing and the object. Here, Heidegger deals with the many aspects of the thing, in search of the, "thingness". The initial straight answer to the question is, "The jug is a thing" (Ibid.: 177). The explanation of what makes a jug a thing is articulated and it develops in the attempt to define the thingness of the jug, which is stated as jug being *qua* vassel. This is an ontological answer based on considering the jug as made of earthy matter, of being able to be independent and self-supporting, having sides and a bottom that can contain. It is also based on the void, the negative space where the liquid is actually poured; the void that holds the wine or water. A thing, by dictionary definition is, "a matter of concern, the concrete entity as distinguished from its appearances, a product of work or activity, an inanimate object distinguished from a living being"[43]. The definition of a thing, according to the dictionary, is much broader than the definition of an object. "Thing" can denote:

- a thought, a problem, immaterial in short;
- something real but not alive, a non-organism;
- an artefact as the product of craft;
- or what is defined as a real model or instantiations.

The dictionary definition reveals a complexity of dimensions, including some quite mundane and common sense. The immaterial aspect of the thing is (for now) excluded, as the focus is the material. As an artefact and an inanimate being, this definition might be confused with that of an object. This last definition is not self-explanatory and deserves more care in its unpacking. It seems to suggest a kind of metaphysical distinction between things and instantiation, although it says it is concrete: "that the inhabited world is compromised not of objects but of things" (Ingold, 2008: 3). In Heidegger though, there is a sort of permeability between object and things: "An independent, self supporting thing may become an object if we place it before us" (1971/2009: 114).

To some extent (and in one direction) Coyne's hierarchy between object and things also contemplates a permeability or co-presence, by which a thing is

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[43] Anon, (2013). In: 1st ed. [online] Available at: http://www2.merriam-webster.com/cgi-bin/mwdictsn?book=Dictionary&va=thing [Accessed 10 Aug. 2013].

never a mere thing, but could be a mere object. You can treat things as 'mere objects', but things cannot be 'mere things', here is the difference. "Mere" is used by Coyne as a reductionist adjective that recalls the physical reality. Objects are simpler entities compared to things, as things carry values that could be personal or have meaning shared across communities. "Thing already carries connotations of significance, history, meaning, memory" (Coyne, 2011*)*. Hodder (2012) reviewed (in the first instance) much of the theory around things (as he did for objects). To summarise his point of view, a thing is, "an entity that has presence by which I mean it has a configuration that endures (Ibid.: 7). As an entity, the thing has its stable form or unity of any kind; it could be an organism or man-made artefact like a jug or bottle of wine. Its configuration is made to last over a certain life-span. It is constituted of matter and somehow its presence resembles the 'objectness 'of the standing before us, in front of us or simply that it suggests an idea of space and time.

According to Hodder (2012), the core characteristics of things are summarised in the following five properties:

- **not inert** - things are in constant transformation, they are not inert. Even the solid rock, says Hodder, erodes (quoting Deleuze and Guattari (1980), and Ingold things are flows of matter, energy and information);
- **forgetness –** things embed histories and places that are connected to them as part of the production process or as part of their way of functioning, and there is human inclination to forget or not knowing this;
- **non-isolated** - Even without humans, things are part of a inter-related ecosystem; hence they are not in isolation, they are interconnected;
- **endurance over temporalities** – they last, most of the time longer than humans but it is just a question of different temporalities;

- **disappearance** – they disappear in the background of our attention as a frame around a picture or as an iPad.

Hence a thing is a heterogeneous bundle**.** In the author's view, "things are just temporary bundles of matter, energy and information", "Things assemble (Ibid.: 8-9). On this matter, Hodder's argument follows the etymological origin of the word, "things", as expressed by Heidegger. This notion of bundle and assemble, and the meaning of putting together is a peculiar quality of the thing. Although sometimes in the argument, it is easy to slip into the indistinct use of, "object", "thing" or even, "entity", this quality is unique for the, "thing". For Heidegger, things assemble (as it will be shown) and so do humans, God earth and sky.

This concept of gathering has been pivotal and recurrent in many scholars' works (i.e. Latour, Coyne), and it is still orientating contemporary discussion on the matter. Latour remarked that a thing, "designated originally a certain type of archaic assembly" (Hodder: 160). Further on in his review, Hodder pointed out the key aspects of the distinction that the move from object to things allows leaving the dialectic for the relational (2012, 33). In his essay, "From Realpolitik to Dingpolitik" (2004), Latour wrote a section entitled, "From objects to things", where he recalled an event as an example of this relational shift, and of the fact that things are an assemblage.

In the same fatal month of February 2003, another stunning example of the shift from object to things was demonstrated by the explosion of the shuttle Columbia.

> *"Assembly drawing" is how engineers call the invention of the blueprint. But the word assembly sounds odd once the shuttle has exploded and its debris has been gathered in a huge hall where inquirers from a special design commission are trying to discover what happened to the shuttle. They are now provided with the exploded view of a highly complex technical object. But what has exploded is our capacity to understand what objects are when they have become.* (2004: 161-162)

The old meaning of the word, "thing" reveals a relational and contextual entity, recovering the etymological sense of gathering: the thing is part of a network, a web of relations. A thing gathers other aspects from outside of its physical appearance. There is a level of intimacy in the thing that is totally extraneous to the object. The object, in this sense, can become a thing in the moment when it starts to gather stories, memories, emotions, knowledge and histories. A thing is identifiable (if not in a unique absolute way, at least relatively) through traces left by the owner or elements identifiable by the owner themselves. As a bundle, it is hard to see how they can be individual; it not possible to box the thing into a unity; just as a thing cannot be a, "mere thing" (Coyne, 2011). If there is no unity, the ontological entity cannot exist *per se*, and so it cannot be described by the way it is represented by the subject. Thus, as a bundle and gathering, they join; they do not oppose the binary division between object and subject. This represents a departure, "a break away from the subject-object dualism" and an argument for, "a symmetrical approach to humans and non-humans" (Hodder, 2012: 1).

Bill Brown (an anthropologist) provided a good map of the history of the dialectic of object and thing, and has discussed the relevance this topic has taken in recent years. In particular, he pointed out their relational essence when it comes to the subject. In his essay entitled, “The thing”, Brown said, “the way things perform, in their rearticulation of the subject-object relation, shows the exhaustion of objects when they are assigned the responsibility of being our social receptacles” *(2010: 10).* Brown continued his research on the subject in “Thing Theory” (2001), remarking again on the distinction between object and thing, in favour of thing. In fact, by mean of things the boundaries between human and non-human can appear much more permeable:

> *The story of objects asserting themselves as things, then, is the story of a changed relation to the human subject and thus the story of how the thing really names less an object than a particular subject-object relation.* (Ibid.: 4)

Furthermore, Brown considered the return to the thing as a way for art and culture to rediscover the dimensions of the everyday. He pointed out how things can grab our attention on film; and that they do so because they have become, “not just objects, but actions” (Ibid.: 16). Being an action means being part of a narrative in relation to other elements of the story. This concept of action can be extended even further to incorporate ideas like experience (in particular in relation to something highly-interactive). Both of these concepts are useful for the discussion and they will be carried over in the following chapters.

Hodder's original idea was that objects and things co-exist with their differences and dependencies, and with humans between them, as they are entangled. From identifying the paradigmatic shift - the move to things - the next chapter will proceed by looking at its relational aspects. In Hodder's terminology, entanglement becomes the bridging concept. Latour adopted this perspective as well and developed it into the idea of extended society through the Actor Network Theory. The next chapter will be where this matter is explained. As the thing cannot be understood as a separate entity, Miller suggested following Levi Strauss on the road of, "consider[ing] things only as defined by the relationship that constitute them" (2005: 6), which is something already known from Heidegger's idea of gathering.

Chapter summary

This chapter aimed to give a solid cultural and philosophical background to the research by looking into the definition of objects and things and putting together a comprehensive literature review. It has also included an ontological quest through the review of anthropological and philosophical texts back to the most influential thinker of the previous century, Heidegger. This quest has been central to the cultural framing of the field of the IoT.

The next chapter will start from the departure, the shift from the dualistic division between subject and object, looking at how things help to reconcile it. Having established the thing as (among the other definitions) a relational entity, the next chapter will bring the discussion into the domain of the social by looking at three approaches in particular:

- *Latour's and Law's Actor Network Theory;*
- *Ingold's 'Spider approach';*
- *Hodder's Entanglement concept.*

This aspect is the key to the philosophical and ontological quest, and also in relation to the topic of this research. As highlighted earlier, "object", is, as a term, biased on a dualistic entity; something opposed to other entities, in particular the subject. Unpacking this difference between object and thing and the consequent 'return to thing' for Hodder opens the notion of entanglement. This is the attempt to bridge the two entities (object and subject). The next chapter will expand on this more extensively, and *in relation to its impact on the discussion about the Things of the IoT, where a thing is part of a real flow of life with history, meaning, value and memory, energy, matter and information.*

CHAPTER FOUR: Social: the net, the mesh, the constellation

Chapter Introduction

After establishing a Thing as a relational entity in the previous chapter, this chapter deals with the new social dimension that is formed of human and non-humans. This emerging sociality seems to characterise the IoT, as the IoT gives space for non-humans to play a role. It is also something that resembles what Latour and Law anticipated inside the Sociological and Anthropological traditions, under the definition of Actor-network Theory, the re-assemblage of society.

Building on concepts established and introduced in the previous chapter, this chapter presents and analyses the final output of the ontological and relational turn: the departure from the dualistic division between subject and object through Things, and the opening up to a reconciling of the human and the non-human. Seeing the relational nature of a thing is instrumental for this shift; a shift that could substantiate the new development of the field of the IoT.

This chapter reviews concepts and theories whose aim is to overcome traditional social concepts like agency and structure, and look to other more cultural aspects like value and meaning. The five main ones are: Actor-network Theory (Latour and Law);

meshwork (Ingold); humans-things entanglement (Hodder); and contextual archetypes and value constellation (Ng).

These have commonalities; they look at the social using a relational approach that is not standard in social theory (it has mutated from other sciences, in particular, biology). Here, "Things are their relations" and, "there is nothing intrinsically wrong in blurring the distinction between social actors and objects" (Ingold, 2011: 70; Latour, 1994: 795). Through a reading of these theories, this chapter attempts to devise a set of concepts to allow a broader understanding of the IoT and an interdisciplinary approach to defining a new ontology for the design of the IoT.

4.1 Relation and interaction: behind the dualisms

An object has properties and attributes, whereas a Thing has relations. It might sound oversimplified, but this is where the discussion left off at the end of the previous chapter. For the argument to move from the specific to the abstract, a closer look at philosophical concerns is of help. In classical philosophical and social doctrines, an object could be everything in the outside world, as opposed to the subject. Thus, it is their opposition that defines the subject and the object; the boundaries that separate each and their dichotomy. Descartes and Kant established the dualism that is the basis of Western philosophy. It is only in the last century that this distinction, subject and object, has been reconciled (as shown in the last chapter), with the notion of the Thing being instrumental to the reconciliation. The consequences of this are the 'opening up' of society into entities and a broadening of the investigations of other polarities, like the human and the non-human, mind and body, the material world and nature. This reconciliation could eventually turn into an extended concept of society, as in Latour. The elements of these dialects have urged many disciplines to re-discuss the foundational aspects of their fields; in particular, Sociology, Anthropology, Archaeology and Cultural Studies.

These are only few of the dualistic tensions to overcome. There are others. Typical of the sociological field, are the binary tensions between agency and structure, individuals and society, the local and the global, matter and culture, thing and history. People like Latour, Ingold and Hodder have been trying to move away from this tension, and they have different imperatives and in doing so. They, not only question their disciplines, but also ask more fundamental questions. Latour's and Ingold's theories are not the same, but they do bring forth dynamic flows of concepts that (over time) may build into a consistent body of ideas, and eventually emerge as structured and coherent thinking.

What follows is a review of some of the key social theories developed in recent years dealing with this new social landscape. The theories and concepts presented and analysed are: Actor-network Theory, Meshwork, Entanglement, Constellation and Contextual Archetypes.

4.2 Actor-network Theory

Actor-network Theory (ANT) has fascinated and influenced generations of researchers in many different fields. At the same time, it is also controversial, due to its openness and ambiguity.

ANT was introduced as a sociological model, although the scholars who created it, referred to it more in the sense of a method or ontology (Callon, 1999). From its field of origin, it soon reached a level of abstraction and conceptualisation that freed it from its specific disciplinary boundaries and made it into an interdisciplinary framework. ANT started in Paris in the 1980s by a group of scholars, including John Law, John Hassard, Michael Gallon, and led by Bruno Latour. Latour's work has influenced many fields, from Art and Design to Politics and Economics, and, of course, Social Science and Philosophy (Harmnan, 2009). The review undertaken here takes into account a comprehensive range resources, but keeps the focus on two main references: *Reassembling the social: An introduction to Actor-Network-Theory* by Latour (2005) and *Actor Network Theory and after* by Law & Hassard (1999). It attempts to present and analyse the core of ANT, and the aspects of the theory that are relevant to this thesis' argument. According to Latour, "ANT aims at accounting for the very essence of society and nature" (1998: 2). The theory evolved over a number of years and through many revisions and critiques.[44] All of the works discussed have an underlying agenda: moving away from the Western dualistic thought and bridging the human and non-human. By attempting this, most of them put their discipline on ontological trial; in particular, addressing foundational questions related to the condition of living, to the social and the material. In *Reassembling the social,* Latour's task is to, "redefine the notion of the social", a social made, not of stabilised matter, but of relations, thus the social becomes, "a very peculiar movement of association and reassembling" (2005: 1 & 7).

[44] This review is very much interested in the core aspects of the original theory, however, some critical discussions coming from different fields will be included (i.e. Harman, from a philosophical perspective, Ingold from anthropology and Hodder from archaeology.).

What is immediately clear from these initial quotes is that the social (as a concept) is not a contraposition of entities, but a relational state. This relational state enables the composition of society and societies to be redefined by means of associative connective forces. Primarily, then, ANT can be considered a sociological theory about relations, although it always had the ambition to become something more (a network-like ontology - Latour, 1990). As it has been claimed to be many things let us first say what it is not. It is not a sociological method that uses networks; this is one of the major misunderstandings of ANT. "It does not wish to add social networks to social theory but to rebuild social theory out of networks" (Latour, 1990: 2).

In order to clarify why ANT is not a social methodology, an explanation of the terms that makes the acronym is needed; starting from the word, "network", the most critical and commonly misunderstood element of the theory.[45] The idea of the network in ANT theory is not, that of a technological engineered, stable and structured network. (It is not the Internet, with its architecture and infrastructure made out of routers and servers. The Internet could be an instantiation of it, but not the whole of it.) Furthermore, it not a social network, nor (in a broader sense) the quantitative social-network methodology that looks at the relationships in organisation and information (Latour, 1990). ANT is also not about tracking social relationships, their frequency of connection, their

[45] A misunderstanding that originated a lot of the secondary literature on the subject.

proximity, value and so on. What is the real meaning of, "network" in this context then, and why the confusion? Latour himself clarified where the misunderstanding originated. The original terminology used by Latour and his colleagues at the outset of the theory was, "acteur-réseau". The French word, "réseau" (a word that Latour borrowed from Diderot) is translated into English as, "network", but the connotation that the English word took was not the one the French word intended. Semantically, the French word, "réseau" is like the word, "rhizome", used in English translations of Deleuze and Guattari (1980). It carries the sense of an "alternative topological system", but without the connotation of a specific structure (as in the word, "rhizome", it does not imply a particular geometrical shape, schematic diagram or blueprint) (Law, 1999: 6). In this sense, it has nothing to do with any technical, defined and well-organised network. In ANT, the size or scale of networks is irrelevant; ANT deals with the micro and the macro in the same way. The réseau concept can be used to map an organisation like a university or a disease caused by bacteria. In these, the micro and macro levels are all made of relationships, but these are not ones of an infinite regression or like that of a Russian doll. These are mooted in the sense of, "the small is being unconnected, the big one is to be attached". Instead, the topology reveals itself in something that can be considered less stable. The paths of the network are not predefined and the network is made of interconnected nodes drawn during the process of creating new associations. This should be kept in mind and will be the sense in which the word, "network" will be used in the following discussion of ANT.

The term, "actor" should also be clarified. In ANT, actors are entities; humans and non-humans, natural and organic or inert and inorganic, material and immaterial, Latour does not differentiate between them. From a social point of view, this vision assembles the human and the 'unhuman', as Latour calls it, and considers both as part of social forces. This is a turning point for social sciences; it accounts (in the definition of the social) for entities that were not accounted for before. This has consequences for Western thinking too, as it moves away from the anthropocentric vision at the very basis of the Western ontological and epistemological understanding of the world. This shift brings social science and philosophy, towards concepts of an extended society (Latour, 2005). From a philosophical point of view, it represents a significant turn, because it attempts to remove the dualistic friction that animates our traditional thinking and transforms everything into a node, in quite a symmetrical and horizontal way. Every entity is seen and understood as relational, both in itself and in its nature. This relational model originates from heterogeneous mixes of entities, which removes the orthodox dualistic division that has kept Western thought locked in a similar position for centuries. With this shift, the polarities between mind and body, subject and object become absorbed in the relational nature of the réseau, overcoming distinctions that kept the entities separate until now. In this sense, the difference between object and thing becomes irrelevant, but without rushing to this extreme, this symmetry does not automatically mean a reset of all differences, i.e. that things and humans are now the same thing. Frequently, Latour's approach has been described a vision of humans and things as on the same level, or inside the network and with the same relevance. For Latour, however, this is not the case: "ANT is not, I repeat is not, the establishment of some absurd symmetry between humans and non-humans" (2005: 76). Latour is actually looking at the dissolution of both. In a more general sense, the theory is an*, "enquiry about the agency of all sort of objects" (*Ibid.*)*. Vulgarising Latour on an abstract level simplifies things and omits the real matter: that from now, on humans and things are both actors and actants. In other words, that, "the role attributed to non-human in the description of action, is precisely one of the strength of ANT (Callon, 1999: 181). Latour granted agency to all sort of objects (documents, technologies, machines, artefacts and humans). In this way, *"the range of agents able to participate in the course of action extend prodigiously"* (Ibid.: 77). This is a remarkable point, as it again states the inner nature of ANT, as something not anthropocentric and also not socio-centric. If this is the case, where then is agency and what is an actant? Quoting Latour, "An Actor, in ANT is a semiotic definition – an actant - that is, something that act or to which activity is granted by others" (1990: 7). Moreover, "an actant can literally be anything provided it is granted to be the source of an action" (Ibid.: 7).

The actant can be any sort of entity, including a political organisation. It is the initiator; the entity that ignites action and starts the network as well. The actant has agency in a primary sense (as a conscious deliberate act) and also as a secondary agency, dependent on others. As long as action and agency is no longer just a human prerogative, ANT's shift decouples orthodox dichotomies, and decouples action and agency from language. Latour is not, therefore, trivially interested in the distinction between objects and things from a material point of view.[46]

The other open question in the theory is about the relevance and the real meaning of agency. It has been said (by Ingold) that the overcoming of the dualistic distinction cannot be reduced solely to the indistinct granting of agency to all entities. There is a more cultural and less political view to be pursued here. The implications are multi-faceted. The number actors engaged in agency increase dramatically, as they can provide any kind of agency from languages to other means of communication (e.g. visual or not codified and evolved languages).

Objects, humans, animals, concepts, corporations, even nations, are actors and the relations are established in every possible way. This vision allows for the inclusion of technologies in the sense of tools (as in Heidegger) and in cognitive terms (e.g. language and writing). It also connects the concept of agency to a line of thought initiated by Goody (1977) and Ong (1982), of materialising non-material technologies. Walter Ong rewrote the history of evolution from a

[46] Although, this is a matter that the IoT has to deal with and could deal with better if it was properly channelled into a design model.

cultural perspective in his book *Orality and Literacy* (1982). Ong's theory is based on what he called the, "technology of mind". Ong identified three phases as milestones in the developments of culture and knowledge, described according to three cultural technologies used to transmit information: orality, by means of the spoken word, chirography, by means of the written word, and typography, by means of the printed word. This cultural approach accounts for the technological too, and is one of the inspirations for this research; in particular, for its performative aspect typical of the oral culture, which Ong compares for similarities to the digital culture.

In conclusion, a few aspects of the theory can be highlighted as constituent and uniquely identifiable:

- the topology of the network as precarious transformation, expanding; collapsing and generative by the means of the tension;
- the performative undefined qualities of entities;
- a critique of agency granted symmetrically to humans and non-humans;
- size and scale being independent;
- the decoupling of traditional Western dualism like subject and object; agent and structure, actor and society, local and global;
- a relational essence.

ANT theory as stated earlier is in substance a topology, a flat vision (as Latour always asserted); but it is not a structured form. The challenge of ANT theory in this context is, as Latour stated, that it is not about making, it is more the work of a geographer: "it is an ontological definition, and not a piece of matter in the hands of others, especially of human planners or designers" (1990: 7).

4.3 Ingold's meshwork and SPIDER

Ingold's ideas are radical and eclectic, with a broad set of references that includes views far away from the traditional historical and cultural Western tradition of thought.[47] Some interesting concepts in Ingold's ideas take shape around a critical review of ANT and in particular of Latour (as the main representative character of ANT theory). The book that collects Ingold's vision is *Being Alive*: *Essays on movement, knowledge and description* (2011). Two chapters of this book are dedicated to a comparative discussion with Latour and develop two alternative concepts in comparison: 1.) meshwork, and 2.) SPIDER. To summarise, the notion of meshwork is similar and an alternative to that of Latour's network (réseau), and SPIDER is similar and an alternative to that of the Actor in ANT.

The word, "meshwork" is borrowed from Lefebvre's *Representation of Space* (1991), where it was used to define the lines of paths that people invisibly leave or follow when they move freely within real space. These lines are compared to the text lines on a printed page, but understood as a texture and not as a text. The other source of inspiration for Ingold is Darwin's description of the entanglement of vegetation on the edge of a bank: "the plants and the bushes

[47] Animism is one such idea. An account of this is outside the scope of this research. Another preliminary annotation that should be made here is about the complexity of summarising Ingold's thoughts at this stage, as his writings do not currently look like a unified coherent corpus. His ideas are very much still in evolution and fluid, but there are a few concepts that have solidified over the years and are now associated with him.

clothing an entangled bank (1859: 64). By means of meshwork, Ingold defines a complex geometrical system of how things interrelate as, “a texture of interwoven threads” (2011: xii). With this word, “meshwork”, Ingold attempted to identify a metaphor for society made up of, on one hand, the generative process of a network of relationships (a kind of relationship that is evolutionary and immanent), and on the other side, a settlement or nature of the meshwork (as made of lines instead of connected points). Starting with this last element, the idea of the meshwork and its difference from network is in its nature: an entanglement of interaction (as in Darwin’s metaphor, not as in the connections of separate entities). In this way, Ingold overcomes the dualism and antithesis found in the forces that rule the interactions and in the emergent topography of the meshwork.

The similarities between Ingold’s meshwork and Latour’s réseau are both visual and topographical. Ingold and Latour were both careful to clarify this possible source of confusion, by interpreting the topographical metaphor as a social structure. From a topological point of view, and according to Ingold, the meshwork is made of lines and not points. Which raises the question, is the meshwork relational or interactional? It looks more interactional, in the sense of something that is happening in-between and not between two entities. The meshwork allows for flows and actions to happen, as there are no defined entities, only flows and energies. As a consequence agency and action do not emerge in the interaction of different entities, neither they are distributed across the network. So, where is action then? “Action and agency emerges in the interplay of forces that are conducted along the lines of the meshwork” (Ingold, 2011: 92).

To fully understand the matter of agency in Ingold, Chapter 7 of *Being Alive* (2011), entitled, “When ANT meets SPIDER: social theory for arthropods” is invaluable. Here, SPIDER is used as a narrative and rhetorical way to directly challenge Latour’s ANT. The acronym SPIDER stands for Skilled Practice Involves Developmentally Embodied Responsiveness. This entomological acronym is a kind of role-play game with Latour’s ANT theory, whereby the two arthropods explain their similarities and differences through a dialogue. The two notions are not so distant conceptually, however it is difficult to nail down single elements to clearly compare them. The two concepts keep evolving and the differences seem very slight. On one side, they evolve towards a more consistent conceptualised system, and on the other side, they undertake continuous adjustments in response to critique and new context. In regards to the name, SPIDER is about the coupling of embodiment and agency. The essence of agency is also what differentiates living organisms from inert matter. The asymmetry of different agents gives the opportunity to develop or extend the model to include many entities in the meshwork.

But what is the nature of the Actor(s) in SPIDER? How do they interact or relate? It appears that the same symmetry between humans and non-humans that it is possible to find in ANT is also in SPIDER, although in the latter, the agency seems embodied or embedded in the web of lines:

> *The 'problem of agency' is thus one that they have created for themselves, born of the attempt to re-animate a world already rendered lifeless by an exclusive focus on the 'objectness' of things. There is a world not of things that exist in the throwing, but in which the die is already cast. It is indeed striking that the more theorists have to say about agency, the less they seem to have to say about life. To rewrite the life of things as the agency of objects is to effect a double reduction, of things to objects, and of life to agency.* (Ingold, 2011: 215)

The move from the material to the cultural can be seen in the skilled manipulation or gesture of the artisan (as seen in Chapter Three) and in the embodiment of a developmental process. The SPIDER model recognises that cognitive, conscious and embodied processes are the essence of agency: "the close coupling of bodily movement and perception" (Ibid.: 94). Agency becomes a dynamic skill that humans embody and it is what qualifies an agent over an actor (in Latour's sense). Here, there is a connection between Ingold and the cognitive theorist James J. Gibson. The Gibsonian ecological model (1979) sets ideas of perception and action opposed to representation of reality (the dominant model which, in many fields is seen nowadays, is seen as something to overcome in order to enable paradigmatic shifts).[48]

As mentioned earlier, Ingold's theory moves from meshwork to SPIDER to the idea of web (possibly because of the initial use of the word, "spider"). This

[48] This model of perception and action can be also defined as a performative one, as opposed to representational. This might be the way to take it into a relation to the new model for the IoT, a point that will be returned to later when performative model is drawn.

move can be applied directly to the material world of artefacts and supports a production/design theory. The web is, in fact, exemplified by the weaving example: "The web is not an entity. That is to say, it is not a closed-in, self-contained object that is set over against other objects with which it may then be juxtaposed or conjoined. It is rather a bundle or tissue of strand" (Ibid.: 91). This tissue is the meshwork and it is not made of pieces and bits, but tangles and pathways.

Ingold then states, "the web is in short the very condition of my agency. But it is not, in itself, an agent" (Ibid.: 93), and here is Ingold's turn, the meshwork is not a network of lines, but a web.

As a web, it has is own 'materiality', i.e. the web of the spider, of Skilled Practice Involves Developmentally Embodied Responsiveness, like the weaving of the artisan. As mentioned in other of his writings,[49] Ingold has translated the abstract concept into a more practical and 'applied' model. In this theory, he refers to a specific class of object: artefacts. Artefacts are products of skilled artisans and of an embodied knowledge: "Producers, both human and non-human, do not so much transform the world, impressing their preconceived design upon the material substrate of nature, as play their part from within in the world's transformation of itself. Growing into the world, the world grows in

[49] In particular, his theory of production inspired by and based on the act of weaving a basket, as discussed in the previous chapter.

them" (Ibid.: 6). This production idea resembles that of the Dwelling in Heidegger's, "Building Dwelling Thinking" (1971), but translated from architecture to a design context. The production of artefacts (as seen in Chapter 2) is made by the act of weaving. For Ingold, production (form-giving) is more than making or as designing, it is the organic dialogue of interwoven forces. It is, as in artist Paul Klee's sense, "movement, action. "form-giving is life" (1973: 269).

The sense of form-giving as an act of life brings Ingold to an extreme in his thinking: a vision of the world similar to that of some pre-civilised society, an idea of life as animistic. A final note (although it might appear marginal) on Ingold's writings, is that there is no reference to digital or connected technology; this could represent a challenge if the task is to translate his ideas into the highly-technological context of the IoT.

4.4 Entanglement: dependence and dependency

As an archaeologist, Ian Hodder's work involves dealing with matter, debris, fragments of objects, ruins, shadows of the past recovered through the materiality of a culture or of a society in a time gone by. He is presumably used to questioning objects and things, in order to reconstruct the world of humans, by 'reverse engineering' the culture they had belonged to and the processes that produced them. Perhaps for this reason, Hodder's book *Entangled. Archaeology* *of the Relationships between Humans and Things* (2012) has a peculiarity, compared to the previous theories and models: it is written from the perspective of things. In some ways, this sits in opposition to the common view within the social and humanist sciences that the subject is always central. Furthermore, compared to Latour and Ingold, his model is simpler and more empirical.

Looking at relationships and interactions between humans and things, subject and objects, Hodder's relational models follow two rather hierarchical concepts in relation to that of entanglement: the concept of dependence and the concept of dependency.

The distinction between the latter two is not just semantic; it is substantial: "Human beings depend on things, both in the sense of relying on things and in the sense of being contingent on the particular things relied upon" (Ibid.: 17). In this sense, the relation can express a tension/potential, i.e. when someone says 'it depends', and it can means a relationship that represents constraint: "Human become involved in various dependencies that limit their abilities to develop, as societies or as individuals" (Ibid.: 18). In the latter case, particularly, the connotation can be negative. (Think of the example of the bureaucratic system of a state, on one hand, it helps the institution to operate as a system, but, on the other hand, it limits the growing and development of the institutions, because it perpetuates the status quo.) "There is thus a dialectic relationship between dependence, often productive and enabling, and dependency often constraining and limiting" (Ibid.: 88), and in his view, the human relationship with things frequently alternates between these two states.

Hodder then moves on to analysing the different kinds of dependence in more general terms, to create a sort of taxonomy of humans-things relationships. The taxonomy identifies four different states for a complex model of dependencies:

- when human depends on things, shortly (HT);
- when things depends on other things, shortly (TT);
- when Things depends on Humans (TH);
- when Humans depend on Humans (HH).

All together, the dependencies generate the condition for entanglement. "Entanglement at one level is simply the addition of this four sets of dependences and dependencies" (Ibid.: 88), which are summarised by Hodder in the formula: Entanglement = HT + TT + TH + HH.

In its mathematical simplicity, the formula reveals also its limits. The abstract and schematic form of it hardly seems able to represent the messiness of humans and things and their mutual relationship in everyday life. If, "entanglement can thus be defined as the dialectic of dependence and dependency", then are both humans and things trapped in this condition due to their limits and constraints, and their relations? (Ibid.: 88). It seems to suggest a condition of no evolution; where tension instead of polarity is the ruling force.[50]

[50] This point will be developed later.

By looking at the semantics, many of the meanings of, "entanglement" are on the negative spectrum.[51] In his acceptance of this, Hodder's definition of, "entanglement" is different to that involved in the paradigms of network and meshwork previously discussed here (a point that will be further addressed later in this thesis). Nevertheless, Hodder's view represents another possibility for the approach to entanglement and also a critical view in regards to more established theories that relate.[52]

Hodder supported the idea of interspecies dialogue (extolled by Bleecker), and pushed it further, to an independent level where things can develop their own systems (despite whatever Latour might have thought).[53] When he said that, "things depend on things", Hodder was somehow legitimating a separate level of society, independent from the human one. Based on the fact that things 'have their own lives' (they break, they change, they decay, and etc.), they are not subsidiary in Hodder's vision, and the entanglement is, therefore, "a dialectical

[51] The dictionary definition of entanglement is: *the action or fact of entangling or being entangled: many dolphins die from entanglement in fishing nets; a complicated or compromising relationship or situation: romantic entanglements; an extensive barrier, typically made of interlaced barbed wire and stakes, erected to impede enemy soldiers or vehicles: the attackers were caught up on wire entanglements.*

[52] Including: distributed personhood or enchainment (Strathern); mutualism & symbiosis between humans, plants & environment (Darwin); co-evolution and symbiosis (Darwin); material engagement (Renfrew); equipmental totality (Heidegger); Chaîne opératoire – operational sequence (Leroi-Gourhan); behavioural chain from procurement to discard (Shiffer).

[53] "Objects are never assembled together to form some other realm anyhow" (Latour, 2005: 85).

tension" (2012: 94)[54] The conditions of co-dependences are of a different kind: material or immaterial and in most cases both. These co-dependences are also heterogeneous. "Our dependence on things often seems to involve trying to escape from them as much as it involves identifying with them" (Ibid.: 21). He also identified different forms of entanglements: historical, social, religious, ideological' semiotic' phenomenological and so on. The historical one is an important aspect, both for the difference in duration between things and humans, and for the diachronic and synchronic dependencies of each contingent relationship.

For Hodder, entanglements also have different degrees that can be accounted for in the tautness of the web. "The degree to which human and things are entangled partly relates to length of connected but often invisible links that are involved" (Ibid.: 106). The, "aspect of invisibilities" is connected to the non-reflexive level at which humans interact with things (Ibid.: 106). The example of driving a car is quite revealing in this respect. The act of driving happens regardless of our knowledge of all of the components involved in the process, and regardless of the knowledge of all the interactions between the engine and the transmission etc. "Humans get caught in a double blind in relation to things since they both rely on things (dependence) and have to reproduce things they have made (dependency)" (Ibid.: 112).

[54] Hodder used many examples to demonstrate and support his dependencies concept, such as sailing a boat, riding a bicycle and others related to an archaeological context.

Hodder's empirical angle is novel in the understanding of the relationship between humans and things: "material objectiveness of things tend to trap humans into specific form of co-dependency" (Ibid.: 95). This element of co-dependency can be interpreted as a sort of primary agency of things, to be distinguished by the secondary agency (the one given by humans). Certainly the different aspects of dependences represent limitations, but the opportunities for the relationship between human and things, as these, "specific flows of matter, energy and information" are, "provisional, worked out in practice, temporary and partial" (Ibid.: 110 & 105).

4.6 Value constellation maps and context archetypes

> *The market is an institution, which mixes human and non-human and controls their relations.* (Callon, 1999: 182).

Thus far in the relationship between humans and things, the focus has been mainly upon the social and cultural aspects, however in the economic field (within market configurations) there are also some interesting concepts and frameworks to exploit the new technological context of the IoT. Unlike the previous theories discussed in this thesis, Irene Ng (economist working at the University of Warwick) has actualised the discussion in the latest technological context. Regardless of the final outcomes, the relationship between humans and products here show some interesting insight for the matter under discussion.

In her book *Value and Worth* (2013), Ng set the ground for new perspectives in exploitation of the relation between human and things in the context of the IoT. Within a business context, things are called products. Ng's argument starts by pointing out that the traditional business model of selling a product is not effective anymore, given that the digitisation of the economy has transformed everything into a service. Services engage the flow of everyday life and situations: profiling the customer, and defining patterns and habits is a major concern for industry, but they still have little idea on how to engage with the flow of everyday life and its real-time dimension. Hence, a different approach is needed.

The basis of providing a service is knowledge within a context, a very different matter than producing and selling a product. It means knowing location, space and time, dealing with complex settings and many subjective perspectives, and keeping in contact with customers and knowing the market. This is the potential that Ng sees in Ubiquitous Computing, and even more clearly in the IoT. Her research interests here relate to the concept of value and how new technologies influence value in dynamic and transforming markets of products and business. She writes:

> *On this journey, I spent some time with sociology where I considered the human agency, identity and practices to create value; systems thinking, for a holistic view of value creation; business models, in terms of capturing, proposing and creating value;*

and information and communications technology (ICT), which I felt would inform future contexts for value creation. (2012: 141-144/4715)

Her work responds to recent technological changes in the IoT and their impacts upon an economy based on products, commodities and services. It does this without losing the focus of economical aspects and avoiding technological determinism. Her major contribution has been to define a model for applying abstract theories into a market context or practice.

It is clear that Ng thinks the field of IoT is still building on a vision borrowed from Ubiquitous Computing, and needs better theorisation (a premise of this research). Similarly to Hodder, Ng turns to objects. In fact, she says that a context of a family breakfast can be told from the father's perspective, from the mother's, the son's/daughter's, but what it is usually not considered, is the object's perspective. This is exactly the perspective she directs us to for a new radical and disruptive business model. Her method and model takes the perspective of things as central. Ng's economic model has two core concepts: value constellation maps and context archetypes.

4.6.1 Value constellation map

The idea of constellation is very much tied to the market, where context and value creation is essential to the success of the business, but, "every context has a, "value constellation'" (Ibid.: 2810-2811/4715). Inspired by astronomical metaphor, the constellation is a pattern formed by prominent stars within apparent proximity to one another on Earth's night sky; Ng's use of the term is strictly confined to the business field and related to the creation of economic value. The map organises all the entities or in business terms stakeholders (products, consumers) in a flat way, and then draws connections between the elements to show how and where value and worth can emerge. The value constellation map resonates other metaphors, such as réseau, meshwork and entanglement: "A value constellation map is a map of all the entities within contextual archetypes" (Ibid.: 3187-3188/4715).

4.6.2 Contextual archetypes

The common understanding of the meaning of, "archetype" is as an original thing, i.e. a situation, an idea or a physical object which for implicit or explicit consensus is generally understood as a symbol or prototype. The word has Greek origins; etymologically it means primitive and model, or the original model. An archetype presents behaviours that are recurrent and patterned, and characteristics that are common elements. Sometimes its origins are so entangled with history and people that is not possible to track where or how it has originated. The archetype is useful to reveal and understand everyday situations, in particular those that have a shared value or worth: "[E]ven if we are completely unique people, our actions and activities in the contexts of experiencing things (products) are often very similar across many people. I call these contextual invariances or context archetypes" (Ibid.: 402-404/4715).

To explain the nature of contextual invariances or of context archetypes, Ng referred to everyday situations; including the example of having a tea with friends. This is a very ordinary circumstance that everybody has experienced and knows very well. It is clear what is involved in terms of objects, the procedures involved, and the roles and convention. In this situation, attention is not concentrated on the setting, because given it is a much repeated one; humans have learned it and are used to it. There is, however, an entanglement of human and non-human in making the tea that is rich and complex and culturally biased, that is only revealed when the situation starts or the making emerges. As Ng puts it: "these contexts are messy, dynamic and may involve millions of interactions which makes it hard to understand and draw insights from" (Ibid.: 414/4715). ID or HCI disciplines have scarcely accounted for situations like Ng's contextual archetypes, and have real difficulty in grasping knowledge of the everyday dimension through conventional HCI or ID techniques and methods, but, "these contexts are rich in meaning and reveal how we want to live our lives" (Ibid.: 412/4715). A tea-making situation is today not usually considered a technological setting and has little interest from a Ubiquitous Computing perspective, as it is not a work-related activity and it does not deal with complex systems. It does, however, represent everyday life, the IoT territory into which little or no insight has been reached so far, and must be unravelled to show its rich complexity, meaning and value. NG makes clear that, although, "these may be mundane day-to-day activities … it is in the mundane that is embedded our tacit cultural values"(Ibid.: 2401-2402/4715).

Dourish & Bell (2012) also recognised that life and everyday situations are mundane, messy and unordered, nonetheless they are where most of our lives' value and meaning is created and experienced.

Ng's business perspective reveals new and previously neglected contexts, and introduces the technological domain of the IoT into the equation. In addition, her work shows that the discussion in designing the IoT and within the IoT in general can be shifted from just a question of agency, to a question of experience, meaning and value. The value is created through the interaction in everyday contexts that, in most cases, could be considered archetypical, and so, "the experience/interaction is the enactment of our social and cultural values" (Ibid.: 747/4715). In Ng's description, contextual archetypes are mainly tested in the economics field, but those same archetypes might also have cultural and social values to be exploited, as, "we participate in many value-creating contexts in our day-to-day lives" (Ibid.: 2397-2398/4715). In its addressing of the everyday, Ng's model of contextual archetypes becomes relevant for the present study, because it can be assimilated to meaning and value in a cultural domain. Contextual archetypes can also be understood in terms of meshwork or ANT and entanglement, as a force that keeps the tangle together and develops it.

4.6.2.1 No agency but value

Ng suggested two main ways to look at the history of value: one atomistic and one phenomenological. Plato discussed the atomistic vision of value over 2,000 years ago, when he saw value as something inscribed in the object itself; as part of its essence. This atomistic idea of value distinguished two aspects: intrinsic and extrinsic. Below is how Ng summarised the distinction between the two: “Intrinsic value is like an emotional dimension of value, whilst extrinsic value could have practical and logical dimensions” (Ibid.: 573-574/4715).

Looking at a real example is helpful to clarify the meaning of the distinction of value. We can use the example of a mug. A mug has a functional value for an individual when it comes to drinking; a mug is needed to hold the water and to easily drink it, and this represents its extrinsic, practical and logical value. The intrinsic value refers to more ephemeral qualities of the mug like colour or form. Someone might like or dislike these qualities (no matter what they are) and these qualities can create an emotional link with the individuals. Similarly, in *Affective Design* (1986), Don Norman talked about the intrinsic value that an object has, giving the example of three different teapots. From a personal perspective, he explained why the three teapots were not the same and why people had different attachments to each of them. The different values that he personally had for these ordinary objects were the reason behind his attachments; therefore value becomes an important relational force (Ingold’s and Latour’s sense). The intrinsic meaning is that it is good as subjective perception of it. The extrinsic meaning comes from the fact that the subject can do something with it.

Long after Plato, philosophers like Husserl and Heidegger conveyed that inner values could change depending on context and situation. As suggested by the term, the phenomenological approach proposed by Husserl and Heidegger, refers to what happens and to the experiential dimension of the world, "that individuals conceive objects through their experiences of it i.e. the interaction between the object and the individual" (Ibid.: 588-589/4715). In this view, the value is not in the object, not even as it is perceived differently in various situations, but instead the value is created when the object is experienced: "The value of an object such as a mug arises from a person's experience, interaction or relationship with that mug. It is not the essence of the mug that is of value. Value is created only when the mug is experienced in some way" (Ibid.: 589-591/4715).

Participation and co-development between humans and objects is needed to create value. "The value is emergent and experienced between the object and yourself […] in the former the value is created when the object is created. In the latter, value is created only when the object is experienced (used)" (Ibid.: 778/4715). The value is seen as a generative phenomenon, and the experience is what entangles humans and objects together (although in this case it might be more appropriate to say, "things") (Ibid.).

In some ways, the same route that brought us from the object to the thing, and from the thing to the new social dimension is now linked to the contextual pattern. Although Ng's practical business view seems reductive, it is indeed the first, successful attempt to translate the abstract discussions about the new social dimensions of things (réseau, meshwork, entanglement) into a reality. Borrowing computing terminology, her model can be described as a 'middleware theory for the ubiquitous world tailored to the business technological context of the IoT'. Worth and value shows one way to translate the abstract sociocultural-anthropological theories into practical business scenarios, and this model could inspire methodologies and techniques for applications in other fields. In trying to find a way to contest the agency model (and at the same time provide a conceptual tool for designers), Ng's constellation map has emerged as the first[55] practical and applicable example set in the field of the IoT.

In this chapter, different approaches were presented that have dealt with the consequence of the shift from object to things. Synthesising the differences between these is a challenging, but essential task for the development of this research. From this point onward, the thesis will explore the context of the IoT and aspects of design, in order to identify its contribution to the field. This will prepare the ground for the introduction of the notion of the 'Prop' and the 'Internet of Props'. This chapter has pulled together lines of thought from the more theoretical and ontological approaches of Latour, Hodder and Ingold, to

[55] To the best of this author's knowledge.

the empirical view of Ingold and Hodder, and concluded with the technological context of Ng. These theories, in particular Latour and Ingold, outline the interaction process as, not a connection of separate entities (human or nonhuman), but rather, as an emerging and dynamic meshwork or entanglement of entities (human, nonhuman and informational). Thus, if the interaction is a process of entanglement (Hodder) or meshwork (Ingold), then the IoT, as a new territory, needs to enable the, "flow of matter, energy and information" (Deleuze and Guattari 2004: 377). Equally, designers need to understand and observe what happens in this new context and how to respond to it. Latour's initial decoupling of orthodox dichotomies and his firm opposition to grant agency or the simple migration of human qualities to things helps to swipe the idea of a mundane shortcut that limits the development of the IoT as a testing bed for a new vision of an extended society. In this context, Latour introduced, the concept of the Actor. Although still in its embryonic form, this usefully prepares the ground for a performative vision of reality. Ingold and Hodder shifted the discussion from the social and political element of agency into a more cultural and performative model. Here, agency is dismissed in favour of the embodiment of skill and other qualities, and the entanglements or interactions of matter, energy and information; a vision, that allows designers to find a role in the discussion.

Finally, freed from the frame of agency, other aspects are left free to emerge, such as Ng's 2012 concept of value. Her economical perspective already contextualises the concept of value creation into new markets generated by the appearance of the IoT. Observing the creation of value of any kind (emotional, ephemeral and the practical logical and functional) and performing the phenomenological value, seems to be an essential step for designers to open a new vision for interaction in the IoT. Ng (2012) highlighted mundane aspects of daily life and raised them from their trivial and empirical level to a new conceptual level, by means of contextual archetypes. I argue that this helps to give to these contexts a place in the creation of IoT scenarios. If this is the case, then mapping the constellations formed by the contextual archetypes becomes a useful technique or tool for designers interested in the entanglement of daily interactions as a new context for the IoT. Similarly, the idea of an extended social (Latour) or a network of dynamic relationships or a meshwork (Ingold) is one that fits with the agenda of developing the theoretical basis of the IoT, and paves the way for the development of a more suitable and comprehensive design approach.

Chapter summary

We have seen in this this chapter that overcoming traditional polarities and dichotomies is one way of avoiding the emergence of new forms of segregated and hierarchical subjectivity, a subjectivity of objects, out of the new context represented by IoT. After all, do we want to build two separate networks: one of People (i.e. Facebook) and one of Things ('Thingbook')? This is a point where, by critiquing the concept of agency and its relevance for the discussion, we could help in shaping the IoT differently. If we see agency as like value or meaning (as a force internal to the network, instead of embedded into a single entity) this is another step forward, towards and understanding interaction as a negotiated, fluid and dynamic process inside a network (or meshwork or in an entanglement) instead of between entities (objects and subjects). Rephrasing the matter of energy and flow from agency to value and meaning (as Ng does) shifts the discussion from power to trading. This is a much more open-ended and cultural approach, integral in new interactive-and communication-processes and open for participation and reconfiguration. This approach, named for the purpose of this research as "performative ontology", challenges traditional thinking and culture (and more broadly than the technological context of IoT, which is already urging a different model from the one borrowed from Ubiquitous Computing). In accordance with Dourish's account of culture as a generative and not taxonomic process that informed the development of Ubiquitous Computing, this investigation proposes a performative ontological approach to inform the development of the IoT. This could conceivably become a quality or, in computing terms, a requirement for the system underpinning the IoT.

The next chapter will argue for the manifestation of this approach within the definition of the Prop.

CHAPTER FIVE: The Internet of Props.

Chapter Introduction

This chapter builds on the theories reviewed in the previous two chapters. It deals with some of the critical aspects highlighted and attempts to distil from them, a foundational and coherent conceptual-approach for the IoT. Subsequently, it moves to translating the foundation into a design framework for the next IoT generation. To do so, it comes to terms with the deficiencies and critical aspects of the IoT presented previously.

In general, this section reflects upon the elements of our daily lives through a performative approach influenced by the work of various sociologists (Erving Goffman, in particular) and by the Philosopher of Science, Andrew Pickering. One particular concept will be considered as a model for human and non-human interactions: ontological theatre, an interpretation of cybernetics. Following the broadening of the IoT into a new ontological-performative foundation, this chapter will then introduce a new notion: the Prop, as a new condition of the entity. It will tackle one key sub-question in relation to this: can props be used as a performative devices to expand and critique the way that IoT is conceptualised?

The performative element of props will be presented, analysed and developed in a schema to widen the deficiencies and limits of the vision of the IoT. Next, Props are established as a critical, contextual and relational tool, in order to understand (in the *first instance) the new ecosystem originated by the advent of the IoT. From a theoretical approach, the argument will proceed to establishing a performative design-framework, under the name of the Internet of Props.*

5.1 From theoretical foundation to design framework

In the previous two chapters, a body of theoretical work has been consolidated. Now, the purpose is to translate these theories into a new vision for the changing socio-technical and cultural landscape represented by the IoT, and to define a design framework for it. There are two driving forces that inform this turning of theory to practice:

- the need to take into account the considerations exposed in previous chapters and deal with the conceptual consequences for the vision of the IoT;
- the need to give a practical answer to the fields of HCI and Interaction Design that are still ruled by old methodologies around the appearance of a new technological and design context, the IoT.

Dourish & Bell's advice sets the agenda: "Cultural questions […] are prior to, not consequent to, design practice" (2007: 11). The cultural concepts carried forward from previous discussions in this thesis, are:

- the departure from object as a dualistic paradigm that creates a division with the subject;
- the establishment of Things (instead of objects) for their relational nature (so that Things become an alternative to canonical dualistic distinction between object and subject and a way to connect the matter with the mind);
- new social dimensions and topologies defined as meshwork (Ingold) and entanglements (Hodder), and network (Latour) and the consequence of the previous move to a more open and relational social model between humans and non humans;
- a new social ecosystem for the everyday dimension.

These concepts are critical for any discussion involving the material world and the subject today, but what are the implications of this as the discourse for the IoT?

To comprehend the implications, a parallel example from different disciplines is helpful. Architecture had a similar paradigm change when the distinction between space and place was being established, and Art went through a similar shift from artefact to concept and processes. My claim is that this object to Thing shift is as relevant as the one undertaken by Architecture and Art. In this respect, by embracing the definition of a new ontology based on the establishment of Things as social and cultural entities, this shift did as much for the IoT, as Architecture did with the move to place. By doing so, a difference has been established according to which Things are relational, social and cultural; while objects are analytical entities (as much as space is for Architecture). The Internet (as it stands, and in terms of its evolution so far) can be considered as the Internet of People (Kranenburg and Nolan, 2010) with spaces like Facebook and social media; while the IoT exemplifies machine-to-machine networks (M2M). In order to broaden our vision of the IoT, it is not enough to simply juxtapose the Internet of people, i.e. Facebook and Twitter with M2M, as today the IoT is understood, designed and developed, in particular, by industry. Think of the IoT as a sort of 'Thingbook', the social network of Things by assonance with Facebook, the social network of people. The equation is not simply adding (linking together) Facebook and Thingbook, although it is a simpler point to start with. In that sense, and originating from a technical-deterministic angle, there is already technological evidence of the convergence of Thingbook with Facebook. What is driving the technological development might not follow the same principles that emerge here, but it looks like the engineering innovation is implicitly pushing in the same direction as the theoretical evolution imagined in the present study. In August 2012, Facebook was redeveloping its mobile software and adopted the network protocol MQTT as part of its new infrastructure. This moment marks the beginning of the convergence of Thingbook and Facebook. In a simple way, this could be considered as the genesis of the entanglement of humans and non-humans, the meshwork of human and things. James Governor, popular blogger of the online *Redmonk* web magazine, reported and welcomed the new change in this 'colourful' way.

> *Facebook's new native iOS client – a kingmaker for MQTT. IBM + Facebook = No Shit?" […] Last year I wrote a post about a* World Made of Messages, *which examined how lightweight asynchronous messaging is becoming increasingly important in Web and Internet of Things.*[56]

Governor's enthusiasm shows the relevance of this move both for Facebook and for the network of machines and things. MQTT is very light protocol developed by IBM for M2M communication. It is open-source and freely-available online.[57] The integration of MQTT (Message Queuing Telemetry Transport) into the Facebook mobile application, used by humans, creates the condition for a conversation to happen by the use of a common protocol of communication between humans and non-humans.

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[56] redmonk.com/jgovernor/2012/08/24/facebooks-new-native-ios-client-a-kingmaker-for-mqtt-ibm-facebook-no-shit/ (accessed 03 March 2013)

[57] In the next chapter, this will be presented more extensively as it is at the core of the Smarter Planet Lab, the platform developed at Plymouth University in collaboration with IBM as a test bed for the IoT.

At this point, the next step is to connect the emerging topology and social dimension to the practice of designing, developing and implementing the IoT; bridging the theories illustrated earlier to practice. This can be interpreted as an interspecies dialogue as in the, "Manifesto for networked objects", as Bleecker defined it, although the interaction does not involve two human-beings but, rather, humans and non-humans or only non-humans. The interspecies terminology shows a connection among different entities, and denotes the difference and the distinction. The properties of human beings are transferred to the other species; the networked objects that have now the ability to sense, communicate and act between other entities of the same species and with human beings. A little yellow canary is the example given by the author (the bird used by Cornish miners as a way of alerting them of the presence of an immaterial hazard, a lethal gas).

A certain area of contemporary sociology connected with design or technology is also looking at the interspecies dialogue as a sort of new animism. While animism is still an abstract concept, here, bridging concepts models and ideas need to be sought. Here, the research's trajectory stumbles upon the transdisciplinary science of cybernetics, which shares the same ontological premise and is empowered by a performative model.

5.2 ID techniques and methods

Looking at design methodologies that inform the development of the field of ID, there are strategies to support participation (tactics to put the user at the centre of the design process and to deal with the everyday dimension of people's lives), but they are all based on static techniques. Most of them, especially the common ones (scenarios, personas, storyboarding etc.) do not engage in a generative account of culture and social life. Thus far, these design techniques have predominantly used the narrative metaphor (scenarios, personas, etc.), which are static predetermined and representational models of reality. This research proposes the use of an approach that actively involves participants but is not representative; is performative, behavioural and evolutionary both in process and outcome, and, thus, constitutive of reality. Let us first review current ID techniques.

5.2.1 Scenarios

Scenarios is one of the most established and common interaction design techniques. "Scenarios are informal stories about user task and activities. Scenarios can be used to model existing working situations, but they are more commonly used for expressing proposed or imagined situations to help in the conceptual design" (Preece et al., 2015: 409). A scenario is a fictional situation, like a short story, that imagines and describes a possible future, a new context where a new technology comes into place. It serves, "both to generate design ideas and communicate the results" (Dunne, 2005: 92). Scenarios are usually closed narratives, sometimes very complex, but generally closed. They are usually task-driven and created for specific well-defined contexts (workspaces, entertainment places, home environments, etc.). They set goals and construct a narrative to achieve a task and, in most cases, technological determinism is implicit in the fiction:

> *Usually scenarios have a conservative role, predicting patterns of behaviour in relation to technological developments. They draw from what we already know about people, and so weave new ideas into existing realities. These scenarios extend pre-existent reality into future and so reinforce the status quo rather than challenging it.* (Ibid.: 92)

Dunne criticised aspects of this popular method, identifying the implicit limitation that then affects the design and the final outcome. Typical contexts for traditional ID/HCI scenarios are office spaces or laboratories. Everyday life is not accounted for, as it is not a static reality; it is in a constant state of flux and therefore difficult to deal with. Scenarios frame reality in a static way; they do not perform it. Thus, scenarios are like still images of reality (a future based on the present). This can be a great limitation, especially when it comes to deal with the everyday dimension, which is difficult to frame in terms of task and activities. Greenfield's (2006) proposition, the Ubiquitous Everyday Scenario, divides the day into operations and then lets everyware augment it. This does not help, as it just fragments or pixelates the situation.

Another issue, is that scenarios share the same task-based approach of Weiser and his colleagues at Xerox, the same epistemological approach as HCI and UX, in the early generation of Ubiquitous Computing and the same technocratic approach that pushes the development of any new technology. Although scenarios can be a rich tool accounting for social dynamics, cognitive processes and emotional responses, as Dourish & Bell (2014) pointed out, scenarios share the same premise: a dualistic epistemology of the world. An epistemology that differentiates and opposes, subject and object, matter and mind, could represent another conceptual limit in the current (ontological) research context.

5.2.2 Personas and Storyboards.

Personas are another ID tool that helps designers to profile the user. They are: "[..]rich description of typical users of the product under development that the designers can focus on and design the product for design (Preece et al., 2015: 357). Usually more than one description or personas is needed for the design process. Again, as in the case of scenarios, personas (although realistic) are static views of the users. Thus, although they might be helpful in designing products, they become obsolete if applied to design dynamic processes and experiences embedded in the everyday flow of time and space.

5.2.3 Participatory design

Participatory design aims to involve the final user into the design process. It was originated in Scandinavia in the late sixties as a democratic process for involving members of the union in the definition of their work (Preece, 2014). In itself, it could be a challenging process to involve the user, because of their differences (cultural, social, technological, etc.), especially if the final attempt is to come out with a full specification for a system. This kind of participatory process has been used in particular for projects that relate to community or groups.

5.2.4 Bodystorming and embodied storming

The mode of participatory design known as 'bodystorming' is often considered a form of prototyping in context. Since embodied storming engages participation at a physical level of experience, the process enables the expression and exchange of tacit knowing, which is knowing more than we can tell. It is also a way to allow people to be people by working together in tight 'Generate–Do–Learn' cycles, to engage one another in simulating experiences and processes through joint acting and improvisation. Bodystorming takes advantage of the enactive approach to cognition and engagement in the world, described by Francisco Varela as, "perceptually guided action" (1995). Contrasting the information-processing view of the world with an enactive view, Varela shows how people, as fully engaged perceivers, essentially 'act first' and learn (in rapid cycles of action and perceptive feedback) from their actions. Human perception is constrained by our embodiment — we only learn to perceive physical objects by interacting with them. We must act first to know reality. But because bodystorming is done as a group, there is 'communication' that occurs at the level of body language, kinesics, gesturing and proxemics. It is high-context group communication. The result is faster and better collaboration with participants.

5.2.5 Experience prototyping

Experience prototyping is an approach that attempts to understand the experience of interacting with an artefact, system, or a service (Buchenau & Fulton Suri, 2000). This approach is similar to bodystorming, in that it tries to replicate an existing situation or construct a new one, in which participants can understand, in an embodied way, what it feels like to interact with something. Buchenau & Fulton Suri (2000) also showed how information about goals and needs were introduced to the participants of the prototype to produce certain behaviours and test certain aspects of the experience. This requires a measure of roleplaying from the participants, something that is not always experienced as easy or natural (Oulasvirta, Kurvinen & Kankainen, 2003; Brandt & Grunnet, 2000). Role-playing, drama and games are popular techniques used in design to explore interactions and facilitate communication between stakeholders (see e.g. Brandt & Grunnet, 2000). Key in role-play situations are the props and setting, affecting the potential for the participants to understand the situation, make relevant choices and take action. Then it started to reveal how this can be used to create a networked situation breaking the boundaries between the subject and the object.

5.2.6 Cultural probe

The cultural probe represents a more recent and interdisciplinary method for ID. This is a design and ethnographic technique used to document the process of an activity; a way of researching from inside the context of use. As part of a European Project aimed to facilitate an insight into design contexts, Bill Gaver, Anthony Dunne and Elena Pacenti, developed cultural probes via the adoption of specific devic333es and design strategies. Visually, the first Cultural Probes looked like boxes filled with a set of objects, like cameras, block notes, pens and other either digital or analogue devices useful to record or document a process. Gaver, Dunne & Pacenti explained it in terms of a practice, technique and part of a participatory methodology for designers: "The cultural probes - these package of maps, postcard, and other materials – were designed to provoke inspirational responses from elderly people in diverse community. […] The probes were part of a strategy of pursuing experimental design in a responsive way" (1999: 2).

Probes are an ethnographic design method, a way of gathering information about context, audience and target users. They usually serve to record and document in a broader sense. They can be critical objects, but they are not the final product; they are part of the method that contributes to the final design. Any kind of object can become a cultural probe if it is designed to stimulate a response and feedbacks. As a method they are used to richly inspire and inform the final design of applications or interactive devices. In this sense cultural probes vary from situation to situation and each time, it is up to the designer and researcher to define the content of the box and the strategies used. As a method it is very flexible and it allows the designers to have a deep insight (to see the world through the eyes of the users) without being directly involved. Every new design context, situation and audience requires a different cultural probe. They could be as low tech as a pen and paper, or as high tech as an iPhone app. As a research tool on user's habits they can contribute to the definition of the IoP framework.

5.2.7 Theory Object

Along the line of new design strategies for the changing ubiquitous panorama, both Dourish/Bell and Bleecker proposed the Theory Object. The Theory Object is situated more in the semantic realm than in the design one. Their purpose was to critically frame an emerging vision of the world and by means of its semantic meaning to inspire new designers. "A Theory Object is a concept that's accreting attention, and generating visible, searchable, rankable, trackable trails of attention" (Sterling, 2006). At first sight, it can look like just a linguistic endeavour, but it can become an inspiring tool, a tool to both test the new reality and to imagine it: "The term theory object is itself a kind of a theory object. Any real theory object has probably got trackback. Links. Pictures. Maybe a PowerPoint. A website. An FAQ. Maybe some Flash animation. Maybe it's got a database layer and user-centric graphic web apps..." (Ibid.).

Spimes or blogjects can be considered Theory Objects. Not in their practical tangible application but, rather, in their conceptual sphere where they belong. "Theory Object" refers to multiple interactions and multiple media.[58]

[58] Later in this chapter it will be used again (although it has limitations, in that it lies at the conceptual level and does not address practice).

5.2.8 Critical/Speculative Probes

Antony Dunne exemplified critical and conceptual design by a series of objects (such as the *Technological Dreams Series,* 2007) that he and his colleague Raby exhibited around the world. In his book *Hertizian Tales* (2005) Dunne outlines his original approach, of putting into action, performing and materially objectifying a critical take on society by means of product design practices.[59] By reflecting on existing values and practices in culture, economy and consumerist society, as well as in the way people socialise and behave, Dunne & Raby created critical objects (a materialisation of Theory Objects) that challenged established values by embodying that critique. For them, "conceptual design object is to be used as a prop in a scenario that works in a critical, transformative way" (2005: 96). The artefacts are for exhibition, they do not respond to any functional logic, although they are designed through established practice and craftsmanship that is typical of product design. They are not meant for end-users and are instead created to test how the end-user will react to the object and its critical dimension. They are not testing any usability aspect but are instead looking at adoption within the everyday. This introduces a level of domestication, not seen as an embodied technology but instead as a critical device to perform concepts related to our daily life.

5.2.9 Technology probes

Another inspirational element for the Prop is in terms of design methodologies, technological probes. Technological probes were introduced in 2003 by

[59] The terminology is a clear reference to the Frankfurt School of Critical Studies.

Hutchinson as an extension of Gaver's cultural probes and the Speculative Probes by Dunne. Compared to the Gaver probes, the technological ones have trifold aims: social, engineering and design:

> *Technology probes are simple, flexible, adaptable technologies with three interdisciplinary goals: the social science goal of understanding the needs and desires of users in a real-world setting, the engineering goal of field- testing the technology, and the design goal of inspiring users and researchers to think about new technologies.* (Hutchinson, 2003: 1)

Technological probes are relevant here, because they are a response to objectives that crossover with those of this present research, the definition of: "new participatory design strategies in which family members can actively participate in the design of new technology" (Ibid.: 2). From a design perspective, this technological probe is a hybrid of the cultural probe by Gaver and the Speculative probes by Raby & Dunne. What is original is the technological aspect: "Our technology probes involve installing a technology into a real use context, watching how it is used over a period of time, and then reflecting on this use to gather information about the users and inspire ideas for new technologies" (Ibid.: 2). As an IoT design tool, Props aim to incorporate technological aspects in a way that is similar to that of technological probes. The table below is this study summary of those HCI and ID techniques for the purpose of this study.

Type	Qualities	Limits
Scenarios	Informal Explorative Inspirational Communicative Structured Speculative Predictive Narrative	Static Deterministic Close Exclusive Task driven Contingent Dualistic
Personas and Storyboards.	User centred Descriptive Narrative Explorative	Static Deterministic Not inclusive No relational Contingent
Participatory design	Processual User centred Analytical Iterative Responsive Inclusive	Critical Speculative Functional
Cultural Probe	Experimental Responsive Iterative Inspirational Ethnographic Functional (as a tool)	Contingent Instrumental Technology agnostic
Theory Object	Semantic Experimental Critical Speculative	Material Deterministic 1.
Critical/Speculative Probes	Experimental Critical Performative	Technology agnostic Speculative 2.
Technological Probe	Experimental Responsive Technological Inspirational Ethnographic tool	Contingent Instrumental Dualistic

Table 1: Summary of qualities and limits of HCI/ID methods and techniques

5.3 [PROP]osition: establishing the props

This section starts to draw and to develop a new proposition to inform the design of the IoT, and then it moves on to considering alternative design strategies (artistic, performative and social) that respond to the conceptual arguments. By doing so, a novel proposition will start to emerge that could be used as the basis of a performative evolutionary framework for ID in the field of the IoT.

In the previous section, two necessities were pointed out: the overcoming of the limitation of traditional ID techniques and the development of new tools and techniques to respond to new needs. In order to make further steps in the design of the IoT, there are new routes that need to be tried and some turns that need to be taken. The first is informed by a transdisciplinary science, cybernetics. Cybernetics (the study of networks of dynamic relationships[60]) and, in particular, the work of Andrew Pickering, offers a way to understand how dynamic relationships between human and non-humans can work in the new context of the IoT.

The second route is a performative one. It is a consequence of the first, but also driven by the need to find new dynamic models for ID and in a broader sense,

[60] Elena Crippa from Roy Ascott: Teaching change (http://www.tate.org.uk/context-comment/blogs/roy-ascott-teaching-change Accessed on 14/04/2015)

novel philosophical approaches to reality. An introduction to both approaches should allow us to reach the target of a proposition by the end of the section.

5.3.1 Cybernetic turn

> *[…] the world —human and nonhuman— is a lively place of performatively interacting and endlessly emergent systems (of which we humans are just one sort). This gets us back to cybernetics.* (Pickering, 2007: 2)

It sounds like cybernetics shares the same premise as this study. Cybernetics emerged in the fifties through the work of the mathematician Norbert Weiner as, "the scientific study of control and communication in the animal and the machine (1948: 221). Since then, cybernetics has influenced many fields of human activities: art, pedagogy, management and politics, and has evolved in levels that are defined as orders. The history of cybernetics is very rich and its vision had an impact in many fields of human activities, but it has never been fully-embraced by the academic world. In his book *The Cybernetic Brain* (2011), Pickering retraced the origin and evolution of the English history of cybernetics. The book presents cybernetic projects alongside the theory and shows how the two are synergetic within the field.

The relevance of cybernetics for this research is multiple. In the first instance, it is a transdisciplinary science of information and communication. In addition, it has a vision of the Human-Non-human relationship: "stages for us a non modern ontology in which people and things are not so different after all" (Pickering, 2010: 18). In this, practical aspects are embedded into the theory.

Since its advent, it has produced a theory and real projects, artefacts and machines. It is a science that engages with the world by making and designing. Pickering discussed what emerged (via the work of early cybernetician Ashby):

> *[…] a distinctly notion of design very different from that more familiar in modern science and engineering. If your usual notion of design entails the formulation of a plan which is then imposed upon matter, the cybernetic approach entailed instead a continuing interaction with materials, human and non-human, to explore what might be achieved – what one might call an evolutionary approach to design, that necessarily entailed a degree of respect for the other.* (Ibid.: 32)

It is not the purpose of this study to provide a comprehensive history of cybernetics. Instead, this research will utilise an alterative definition of cybernetics: ontological theatre, that Pickering recovered from an early cybernetician, Gordon Pask.

5.3.1.1 Ontological Theatre

Ontological theatre is a concept that Pickering (2011) used to describe how cybernetics has developed into, "a certain vision of what the world is like, what being in the world is like for us and everything else".[61] The meaning of the term has to do with the qualities recognised in cybernetics whereby: "ontology is the foundational upstaging Western dualism that constrains our thought in static contra posed dichotomies"[62]. In this sense, it goes along with Latour's idea of modernity, setting cybernetics as 'non-modern'. In this context, theatre (counter-intuitively) means the making of a reality, instead of representing it. Gordon Pask referred to this in his work on theatre, *Ontological Theatre* (2011),

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[61] Sistemas Sociales, (2014) Sketches of Another Future an Interview with Andrew Pickering (video interview) Retrieved from https://www.youtube.com/watch?v=juGIXi6Lyek)

[62] Sistemas Sociales, (2014) Sketches of Another Future an Interview with Andrew Pickering (video interview) Retrieved from https://www.youtube.com/watch?v=juGIXi6Lyek)

where he gave examples of how one might go on in the world if one espoused that ontology. Pickering supported the ontological approach as an alternative to the epistemological and the metaphysical in science.

> *The word epistemology comes easily to the tongue of cyberneticians, especially perhaps to readers of a journal, which features human knowing in its title—cybernetics as a distinctive way of knowing the world. The word ontology – which I take to refer to a sense of what the world is like: what sorts of things there are in the world, and how they relate to one another – in contrast, is seldom uttered and, when it is, usually in a sense that differs from this quick and straightforward definition.* (2007: 2)

In this respect, in its attempt to find a philosophical foundation, HCI also turned to epistemology (Dourish, 2004). Ontology is an alternative to the epistemological definition of knowledge and understanding of the world as something measurable and understandable.[63] In the first instance, it appears that the phenomenal has, of course, more relevance for technological science (being that it deals with what is measurable), however, for the cybernetician (and as the social scientist has long recognised[64]), it is a shared vision and the ontological approach has a lot to say in the scientific domain.

Until now, Dourish's epistemological approach remains the cornerstone of theory in the field of Ubiquitous Computing, which is, thus far, also the main formalised reference for the IoT. Pickering recognised, however, that the primacy of ontology over epistemology (in the context of something that has

[63] The classical definition refers back to the Kantian distinction between, "noumenon" (ontological) and, "phenomenal" (epistemological), where the noumenon is not definable by our senses, while the phenomenal is.
[64] https://prabash78.wordpress.com/2012/03/14/interpretivism-and-postivism-ontological-and-epistemological-perspectives/

the potential to redefine reality and the material world), is what is expected to happen with the IoT. Moreover, the ontological approach proposed in this research allows for the emergence of meanings at a cultural and social level over and above that of agency. The idea of ontological theatre adds to this, by giving primacy to the performative aspect and allows the translation theoretical concepts in practice.

5.3.2 Performative turn

Many scholars have undertaken a performative turn. The ones cited in this study, are Erving Goffman (sociology) and William James (philosophy). In *The presentation of the self in everyday life* (1956), Goffman borrowed the notions of stage and backstage from theatre to explain human interactions in everyday situations. In his performative approach, Goffman used the idea of the world as a stage (Shakespeare's trope), where people perform daily roles according to a non-written script, but based on established social rules, showing and hiding aspects of themselves according to different contexts and audiences. Goffman was the first sociologist to use the metaphor of theatre to explain real situations in everyday conditions, by showing how reality is a sequence of 'stages' and differing 'plays'. It is the contention of this thesis, that the idea of an ontological theatre has the potential to bring new creative perspectives for design, by bringing together an abstract level of a vision of the world and a stage to play it out on. It is evident that the IoT context is the daily condition; and here the performance concept has already been tested out and applied.

The performative turn that Pickering unravelled in cybernetics is a shift in the philosophical paradigm into a performative understanding of discourse opposed to the longstanding and established representational tradition. Representational thinking works around the dualistic separation of mind and matter, object and subject and the reality as a projection. This is a line of thinking that has greatly influenced science, art and Western culture in general. Performative thinking, instead implies something that does something; the term, "performative"; identifies the reality as something in the making (James, 1907) and the 'being' as something constantly performed. Inspired by these two turns, a proposition emerges around the idea of Props.

5.3.3 Props

The theories presented in the earlier two chapters referred the redefinition of form of social identified as (network) réseau, meshwork or entanglement. These theories, except entanglement, also account for immaterial entities like thoughts, ideas or even like institutions or nations. For the purpose of his study, the Things accounted for are the material ones, as the immaterial ones are not central to the discourse. The scope of the present practice-based research is the material world. It will be focused on entities that have (or could now have through the IoT) a dimension of the material. In the polarity of Things and Objects, the IoT (as a factor of a changing of reality) cannot be grasped by using the elements already known; there are missing factors to consider (mediated, experiential, symbolic and narrative). Thus, the research introduces the proposition of a new element, Props, as a new class of entities.

Props respond to a design need and the new conceptual aspects within the landscape of the IoT. In this respect, Props should be seen as a design tool to be utilised for bodystorming about the IoT, as they allow for practitioners to incorporate elements that lie outside of the object and things ('subject' and 'object' dichotomy) and participants/end users and the audience to mould the design specification.

Before entering into the design discussion, it is important to introduce and explain the word Prop: its origin, etymology, context and meaning. The word, "prop" has different meanings in different contexts. Most commonly, perhaps, a prop is known to be: "an object which supports another"(OED).[65] In a theatrical context, "prop" is an abbreviation of, "property", denoting: "a portable object other than furniture or costumes used on the set of a play or film"(Ibid.). Iconic props in theatre history include those used by Shakespeare: Hamlet's skull and Othello's handkerchief. The handkerchief is a good example for this thesis, as it is a common mundane everyday object, but in the play it has a symbolic and narrative function, and it is very strategic for the plot as an element of tension and forces. The handkerchief plays many roles, it is an actant of many situations in the drama, in fact, it is:

[65] https://en.oxforddictionaries.com/definition/prop

- a present from Othello to Desdemona;
- a token for Desdemona, to represent his love for her;
- an item of evidence that Iago uses to trick Othello. [66]

The example of the handkerchief reveals many aspects (simultaneity, value, etc.) of the prop that will become very useful for continuing the discussion.

By placing an object onto the stage, its value changes and also does its condition or status too. The stage transforms the symbolic value and function when props become part of a narrative or a plot. Out of stage and out of narrative context, props return to their previous conditions: as objects. As Walter Benjamin (1936) said, their value, meaning and agency is transformed by the context where they are placed being on a stage or set, or even a new dimension in the everyday life flow, like in the Happening tradition.[67] Props are not specific categories of objects, they represent a condition that any material entity can enter into, at the same level as objects and things do. The conditions could happen simultaneously, as they are not mutually exclusive like objects and things are not mutually exclusive in the first instance. Props emerged in a cultural context and maintain that connotation based on meaning and value, i.e. symbolic and narrative.[68] Thus, props are also found in a ritual context in relation to religious practices. In both theatre and religious rituals, props 'have plot' and they are

[66] MacGuffin" is a term that emerged via the director Alfred Hitchcock, it is used to describe a goal or motivation that serves as the driving force behind the action. It can be a concept as elusive as hope or an object as tangible as a ring. See Brown (2009) for more on cinematic props.
[67] Happenings is discussed in detail later in this chapter (p.180).

[68] For more on this, see: Gell, A. (1998) *Art and Agency*

part of an experience.[69] For example, in the Catholic Church props are commonly used as part of the liturgy, i.e. as part of the ritual of the Mass.[70] Thus, they generate a new class of entities through their own performative narrative qualities. The simple condition of being on a stage (or set) during a performance confers a unique status to props, making them universal, symbolic, archetypical, narrative and, ultimately, performative. They carry no script, no context, no network on their own; they are just objects with their form and material qualities, and all these other qualities emerge as contextual and relational.[71]

This being the case, this thesis contends that the idea of props allows for the definition of a new status in terms of the move from objects to Things: a way to perceive and interact with entities differently. The characteristics of props are many-fold; they are symbolic, discreet, self-contained and narrative, relational systemic and performative.[72] A key characteristic of Things and objects is that they can be simultaneously different for users, even when they share the same context. In the conception proposed by this these, objects, Things and Props are not interchangeable alternatives, but rather, conditions or specific functions of a physical entity. This proposition claims that each entity belongs to the material

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[69] Previously discussed in relation to cybernetics in Brenda Laurel's, "Design and animism" (2009)

[70] Spiritual rituals use objects as part of a coded narrative; here props are a symbolic material-embodiment of a spiritual element, e.g. the sacred host or wine used during Mass to signify the body and the blood of Christ.

[71] The term, "prop" is not new to the context of ID. In, "'Resistance is Futile': Reading Science Fiction Alongside Ubiquitous Computing" (2007), Dourish & Bell (2007) talked about how TV and movie props have influenced 'today's' interaction designers. Designers have long been inspired by futuristic fiction, movies and TV series. This is not, however, the definition and use of Prop intended in the present research.

[72] It should be noted here, that in a performance context props are imbued with a predetermined meaning (communicated to the audience via players) within the over-arching narrative, rather than being 'simultaneously different for users'.

world and could have three states/functions/conditions: interchangeable, negotiable and contextual. The three conditions could be simultaneously present in any physical entities, human or non-human.

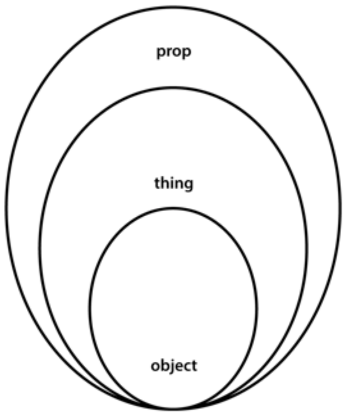

Figure 1: the three states of entities of IoT

These conditions need not be satisfied all together. Likewise, they need not happen for each of us at the same time. This means that their condition is constantly re-negotiated and redefined; they are phenomenological conditions, experiential and contextual. Each of these conditions has its own, “ness”, intended as a set of properties/qualities and roles characterising the different states: objectness, Thingness and Propness. Ontologically and semantically, the difference between objectness and the Thingness has been dealt with previously, now it is time to explain the Propness. Propness transforms an ordinary object into a symbol, but out of a specific negotiated context. When the Propness is lost, the entity returns to its objectness or to its Thingness. Propness helps to evidence the symbolic, narrative, relational systemic and performative properties of Things and objects. Let us follow the line in which the Propness emerges in entities and in social exchange, and link that to the new technological context of the IoT. Props have creative connotations, as they represent the objectification of the cultural and imaginative, participatory work. The function or role that they can play in a performance varies from a symbol, to a narrative expedient, to a sort of actor. All these functions can be considered archetypical when they become part of what French call the *mise-en-scène*, the presentation on a stage through the material form of an idea, concept or narrative. As Things, Props are also relational, but their definition in this context allows us to extend the network of non-humans to the network of humans. The tension existing among objects/Things/Props together (with the coexistence of the three states in the same entity) is key to understanding the model of this investigation.

Here, the role of props is active, performative and not as the final product. "Devices are props that carry out those scripts" (Kuniavsky, 2010: 39), and Props, like devices, are participants of the performance, of the embedded scripts and form part of the forces that keep all the participants tied together. The network relationships are activated when the action starts and they are performed together. In this sense the script, structures and relations cannot be predefined.

In the present research, Props, (like probes) are intended as: "an instrument that is deployed to find out about the unknown – to hopefully return with useful or interesting data" (Hutchinson, 2003: 2). Props, are working tools; the prop is a device, is a function of the Thing. "The use of physical objects, such as wands and batons, can also facilitate coordination. Group members can use them as external thinking props to explain a principle, an idea, or a plan to the others" (Brereton & McGarry, 2000: 119). As a term, "Prop" operates beyond this performance context. Props become, therefore, a state of the entity from a philosophical perspective and a new design tool to model the IoT (through a design framework that it will be discussed in the next section).[73] In this sense, Props, are closely related to critical design artefacts. The introduction of props as symbolic performative entities is part of a shared context, and the Internet is new extended ecosystem of humans and things. In this context, Props are open works, prototyping tools, negotiated constructs that perform multiple functions, they bring forward participation in the creative process, and users' engagement is bought into the definition of the design process. Props allow to experiment on various IoT sets in an open ended, open sourced, research and design tool. The new technological stage and the context for these free experiments to happen are defined as the Internet of Props.

5.4 The performative design framework: Internet of Props.

> *As for artificial intelligence design methods work from the idea that design proceed from a problem statement to a solution with well-articulated methods as the means to*

[7373] There, the idea of props will be placed into a broader context, on one side conceptually related to the ontological performative dimension and on the other in the technological dimension of the Internet of Things, with the objective to broaden our vision of the IoT and ultimately inform new design strategies.

reach the desire end. The method approach is rationalistic insofar as it threats a problem statement as objective; sees means as separable from ends; assumes that understanding can be articulated in formulas, diagrams and charts; and assumes a privileged relationships between these representation of knowledge and thinking. Finally, empirical studies that threat complex behaviour as reducible to measurable variables, means as separate from ends, and experimenter's values as irrelevant are also realistic. To turn to practice comes about because rationalism had created an obstacle to thinking about technology by reifying technological artefact as object of study a part from their making and use. (McCarthy & Wright, 2004: 24-25)

The turn to practice discussed by McCarthy & Wright looks at placing technological artefact (in this case Props) back into their context, but on a more abstract, radical and speculative level. This level is where there are still reminiscences of the ordinary context.

Through the practical notion of Props, with its intrinsically performative nature, the argument draws upon the definition of Internet of Props as a design framework based on practice. The practice is to be intended here in its original Latin etymology of, "praxis", a word that means process, but also practical implementation. The framework pursues the translation of the theories discussed in Chapters Three and Four into practice. In this, it aims to design the IoT from unexplored angles, and show connections with a stronger conceptual background. The Internet of Props framework is, therefore, a practical implementation, but it does not aim to be the end product or a real-life design project. It is an instance that 'performs' the IoT, demonstrates the ontological framework and the sociological theories (meshwork and network); but is also a process, and in that sense is evolutionary and adaptive. The idea of making is intrinsic to the implementation of this framework. The Internet of Props pulls together ideas that belong to different fields (in particular, performance and performativity) and share a common vision (that has been explored up to this point within this research). "A framework is a set of interrelated concepts and/or a set of specific questions that is intended to inform a particular domain area" (Rogers, 2012: 4). The Internet of Props is a culturally- and performance-driven toolkit, a framework and a testing bed for the IoT, in the sense that it puts in place a new participatory embodied cultural and performative ontology for the IoT. "The Paskian idea of a dynamically evolving performative relation between the human and the nonhuman" (Pickering, 2007: 10). The Internet of Props looks at exploring the interconnection of humans and non-humans in the design context of the IoT. The practical notion of Props avoids the objectification and the reification of the technological artefact. The Props of the Internet of Props are entities that perform; 'thinking tools', speculative probes and technological probes used to explore the entanglement of humans and non-humans at the convergence of the Internet of People and the Internet of Things. "The cybernetic approach entailed instead a continuing interaction with materials, human and nonhuman, to explore what might be achieved – what one might call an evolutionary approach to design" (Ibid.: 32). The Internet of Props, like the cybernetic approach is introduced in the context of the IoT as a catalyst of change, it tests behaviour, it provokes new design ideas with the same practical and evolutionary philosophy cybernetics had. Through this view the Internet of Props has the potential to broaden the IoT under the condition that the ontological performative turn is accepted and embedded into practice. "Designers create a theatre stage and provide props, but people create their own drama and meanings" (Kuniavski, 2010: 290).

The Internet of Props is a framework (conceptual and practical) that fills the gap revealed by the lack of theoretical foundation of IoT projects; whose consequences can be seen on the number of standardised outcomes that come out from using the traditional methodologies of Ubiquitous Computing in the context of the IoT, i.e. transportation projects and smart objects, etc. like the smart bin. The Internet of Props does not use scenarios, as these tend to reinforce the status quo, and Internet of Props tools are meant to be evolutionary and performative. The performativity of all the elements involved in the interaction or the Props connected together are one of the values that the Internet of Props is interested in. This is not as an alternative to the IoT, but as a performing, performed framework and a method for it. In the context of the Internet of Props, the Props are technological entities, as well as material artefacts. At a very basic level, they are common enhanced objects shifted into a more radical, provocative and speculative context to liberate them from the functional, productive and logical restriction of usual ID and HCI scenarios. They are liberated from the constrictions of the daily context and shifted into a more experimental and provocative context, while still maintaining their physical qualities. The intrinsic value of the Props (as referred in Chapter Four) is changed, but the Internet of Props framework enhances the extrinsic value. This is key, because this study is looking at potentially extending that to the emerging meshwork/network during the intervention.

The experimental practice Happenings worked was an inspiration for the framework too. The term, "Happening" was coined by artist and lecturer Allan Kaprow in the sixties to describe an experimental performance-art practice. One characteristic of the Happening (as an art form) is that it relies on active participation. It calls for the active role of everybody who wants to get involved with a priority on the physical aspect. The participation is what makes the Happening happen.

Another characteristic of this form of performance, and one that is relevant for this study and the definition of the framework is that it deals with the everyday dimension. "A Happening, unlike a stage play, may occur at a supermarket, driving along a highway, under a pile of rags, and in a friend's kitchen, either at once or sequentially. […] It is art but seems closer to life" (Kaprow, 1966: 5). It does so, as a disruptive practice of the daily experience and for this reason it becomes a test-bed for other visions of the world. The closeness to life and the flow of daily life makes the Happening an interesting reference for the framework of the Internet of Props, as it is experiencing the different ontological states or conditions that reality can 'take' simultaneously. It suggests how reality can have multiple instances, and how you 'make things happen'. "A happening is for those who happen in this world, for those who don't want to stand off and just look. […] You've got to be involved physically. […] But happeners have a plan and go ahead and carry it out. To use an old expression, they don't merely dig the scene, they make it" (Ibid.: 5).

5.4.1 Everyday dimension

The dimension of the everyday is complex and difficult to predict. As recognised by Dourish & Bell, everyday situations are, "messy" and "fluid" (2011). From a design point-of-view, there are few models to deal with it, however there are a few. Greenfield proposed one, who suggested dividing the day into set of actions and situations and to create multiple scenarios and then reassemble them into discreet tasks. This, however, continues to rely on scenarios and is, therefore, limited in its scope as they are representational and simulation design tools. A state of continuous transition characterises the everyday condition whereby no situation is ever stable and every element of the system has the potential to be constantly renegotiated and redefined. The evolution is unpredictable and constantly dependant from how the entities engaged in the performance negotiate. The entities are not static and predefined and therefore the meshwork is performed at the time of the action. An engineer responds to the messiness and complexity by automating the everyday. This is a popular trend within the IoT, but is not the answer, as it fails to deal with the complexity and it delegates to the material world, decision-making and action in the name of efficiency and sustainability.

5.4.2 A toolkit for the Internet of Props

The methodology that underlines and supports the framework is a mix of performative, speculative and artistic design tools. The toolkit aims to define tools that can be used as a test bed and to experiment with the IoT in line with the conceptual framework described as the Internet of Props. From the abstract philosophical level, through the design theory the research moves towards a more practical definition and into the practice, by means of the toolkit and the design practice of the workshop. The toolkit is defined below (the next chapter will document the implementation). The toolset accounts for three key components that were instrumental in the design workshop described in the next chapter:

- the Smarter Planet as a platform for interspecies interconnectivity, things and people;
- the Props as speculative and technological probes;
- the Transactional Props as a set for critical and behavioural processes to emerge.

The platform takes care of the connectivity aspects and it is mapped onto the social qualities elicited from the concepts presented in previous chapters. “Platforms determine the interfaces between elements and how sub-systems work together” (Ng, 2012: 3138/4715). As speculative objects, they do not dispatch a function; they are not absolving any specific role other than provoking responses. Props are there to generate behaviour and value. Through the recording of all the social encounters and interactions, Props also act as a research tool to give us more insight into this new digital ecosystem and emerging social dynamics. The performative design level is similar to that in Ascott's metaform, where the form was greater than the particular. Props are a metavalue where the value of a Thing is greater than the particular. As in Ascott's works, Transactional Props also take,

> *banal situations like 'wardrobe' or 'supermarket' or 'bathtub' and introducing into this kind of benign everyday theatre a particular metaform or assortment of metaforms, which upon contact will then animate themselves and their contexts together, charging both with new meanings.* (Dault, 1972: 167)

The metaforms or metavalues are the Props; strategic artefacts to establish relationships, which are ultimately meant to generate meanings or value. In defining the Props, there were two elements to take into consideration. The first was the materiality of the Prop itself. The second was the enhancing of the Prop by technological means.

Regarding the first aspect, the ready-made, Props are ordinary and common objects, "an ordinary object elevated to the dignity of a work of art by the mere choice of an artist" (Breton & Éluard, 1938: 23). Duchamp established and explored the concept of the ready-made, elevating common objects to the status of artistic products by shifting their function and context and, in so doing, changing their meaning and value. This simple action showed how meaning and value could be altered regardless of physical qualities or materiality. In Ng's terms, the reference is to the combination of atomistic intrinsic value and phenomenological value. The shifting in context of the object in this artistic act can also be interpreted as a shift in its relations and social dimension, as the object becomes part of a different and more substantial history: the historical narrative of art (as shown in art galleries to artistic audiences). If the Props have to be linked to Ascott's conceptual artistic framework (instead of being a metaforms), then, as in Ascott's work, they become metavalue entities.

For economic value in Ng, "value creation is essentially conducted and controlled by customers, but the firm has a role in helping facilitate it" (Ng, 2012: 2799-2800/4715). Similarly, in the Internet of Props, the value is in the hands of the participants and the designer can only facilitate it. The practice looks into specific speculative and provocative sets, and building Props as technological and speculative probes in order to use them for an intervention or experiment that call for participation (as in a Happening). Thus, the technological and the design need to be adaptive, scalable and open to respond to participants and to evolve through the interaction.

Chapter summary

This chapter began with a conceptual exploration. It started by contextualising the distinction between Things and objects, and then explored the search for alternatives route to the social dimension. This chapter then moved back to the topical centre of the thesis: the IoT and the design approaches for it. It summarised the concepts explored in the literature review to scaffold and an analysis of case studies in the field of the IoT, and then moved on to present some strategies for the design of the IoT, proposing two interwoven routes: 1.) design, implementations, methodologies in the Internet of Props framework; and 2.) a toolkit based on a Theory Object: Props. The framework insists on performative properties, in order that both theory and practice can be brought into the design process. The proposal is that the framework can intercept everyday situations, using tactics originated in different fields.

The next chapter will take the framework and apply it through both the implementation of the technological platform, the design workshop and intervention. From that point it will move to the analysis of the findings through a qualitative strategy: conversation analysis.

CHAPTER SIX. Performing the Internet of Props

Chapter introduction

> *Through technology, socialness is shared with nonhumans in an almost promiscuous way, autonomous being endowed with some sort of primitive speech, intelligence, foresight, self-control, discipline. They have no rights, to be sure, as in the eleventh meaning, but they are much more than material entities: they are complicated organisations.* (Latour, 1994: 798)

In this chapter, all of the concepts previously introduced are brought together to inform the design praxis, in recognition of a mixed-design approach that utilises the theory, and situates it into the practice. The practice originates from the design method introduced at the end of the previous chapter: the Internet of Props. The Internet of Props is a device for questioning and critiquing ideas around the IoT, and a way to put the theoretical findings of this thesis into action and in context. In this chapter, the Internet of Props is implemented, demonstrated, performed and, finally, analysed through a conversational analysis methodology. The beginning of the chapter also accounts for the technological specificity, digital fabric, of the IoT, as it is a matter not dealt with yet. Following this, there is an account of two practical aspects of the research:

1. *designing and installing the Smarter Planet Lab as the enabling platform;*

2. *Transactional props, an Internet of Props intervention and actualisation of the design framework based on a re-interpretation of Roy Ascot's Transaction Set (1971).*

The initial task undertaken in the practice was the co-design of the enabling network's architecture infrastructure, actualising (from a network engineering perspective) a specific vision of the IoT. The latter one was the application of the design framework developed through an integrated technological strategy of workshops, experiments and design methodologies. This integrated-technological strategy was intended to represent a sort of design toolkit; a way of showing the potential and the possibilities of the IoT.

After documenting the workshop and intervention, this chapter will evaluate the data collected in four different reiterations of the Transactional Props to evaluate the framework. This will open the conclusive discussion of the thesis.

6.1 The enabling platform – Smarter Planet Lab, Plymouth University

In presenting this new phenomenon, it is useful to keep in mind that the IoT is not a specific technology, but rather a system of technologies; way of interconnecting devices, objects, databases, sensors, communication chips, micro-controllers and displays. As for Ubiquitous Computing, the IoT needs an integrated environment and the design of system architecture in order to be able to operate and to support designers in testing their ideas. To respond to the research question about the necessity of an enabling infostructure and in the absence of specific integrated-platform for experimentation, the research had to undertake the definition and deployment of an integrated architecture.

As the practice compromised of two elements, we begin first with the definition of the platform. This took the name of Smarter Planet Lab and it was the first essential element of the design practice complementing this study. In order to perform cultural aspects of the IoT, it was necessary to have a device that embedded cultural principles and approaches. Being as the IoT is a system of technologies, integrating these technologies was the first step to be able to operate. Enabling the interconnectivity between objects, and between objects and people, without any distinction was the core reason to have a specific platform. This needed to be an open system that responded to the ontological setting, whereby everything and everybody were essentially Things of the network regardless of their nature. The requirements needed to set up the platform were identified as:

- an appropriate network protocol;
- architecture that links together all the elements of the system;
- devices (arduino, particle, etc.) to be connected to the platform;
- software to control the interconnection between all the elements in the lab with the network outside the lab, Internet through API and in particular the social media like Facebook and Twitter.

These guided me (as a lead architect) in establishing a relationship with IBM and designing the Smarter Planet lab. Since its establishment in 2010, this enabling platform has been used to support this research, but it has also worked as an educational resource (for the students of Plymouth University Digital Art and Technology UG and PG programmes) to allow the quick prototyping of IoT design projects and systems. Key qualities of the platform are: the **flexibility** to allow 'plug and play' solutions to open source hardware (i.e. Arduino, sensors, actuators, etc.); **connectivity**, fully-networked input/output and connected to the Internet,[74] so forming a decentralised architecture for the IoT based on a relational ontology;[75] and **openness,** as in open-source and adaptable (to allow interdisciplinary design-based activities to happen, with the development focus on creative and innovative (instead of technological) potential).

The aim was to create an open architecture of integrated and interconnected analogue and digital technologies to rapidly prototype the emerging IoT system.

[74] Meaning each device can send and receive with others in a 'many to many' communication architecture as the IoT should be.
[75] As per the conceptual guidelines developed over the course of this research thesis.

The design and set up of the IoT platform began with my researching of a network protocol to implement an architecture of interconnected technologies. This involved initiating discussions with Brian Innes (IBM engineer at Hursley IBM Research Centre) and Nick Marshall (a DAT placement student at Hursley) in 2010 (facilitated by an industrial placement).[76] Having worked with open-source physical-computing platforms (like Arduino and its predecessors) for many years, it was clear to me that, to be able to experiment in the field of Ubiquitous Computing and in the emerging field of the IoT, an integrated architecture was needed. In 2010, it was harder to make more than one micro-controller connect with another microcontroller, and impossible to do it directly and wirelessly (MIDI was still the protocol used in most interactive and physical installation). Thus, there was the necessity of finding other protocols (possibly open-source) to enable this interconnectivity. The students, designers and researchers in the locale were also in need of a flexible, interconnected and open platform to creatively experiment with an integrated set of technology. The platform, and consequently the Lab, responded to this need.[77] The Lab was to create an architecture to interconnect people and Things in the same system. This means to see the resulting network as a *unicum* of entangled entities, humans and non-humans. The MQTT protocol represents the first real bridge between the Internet of People and the Internet of Things, of the same relevance

[76] Andy Stanford-Clark and Brian Innes introduced and demonstrated a new open-source telemetry protocol (MQTT). This was key in my ability to set up the Lab. They also gave important input into how to create an integrated platform with the required characteristics.

[77] The lab set-up was also guided by the need to reflect the philosophy of an horizontal communication between objects and people (an extended social dimension provided by the way communication was managed in the platform through the MQTT protocol).

of IP for Internet. The underlying risk was that would I develop digital communication restricted to in-species' boundaries: non-humans talking to non-humans (M2M communication) or humans talking to humans (Internet communication).

6.1.1 Personal contribution

My role was the 'lead architect' of the overall project, which included the design, the coordination of the implementation in collaboration with the engineer at IBM Hursley and the technical department at Plymouth University. The design consisted in the selection of the different technologies (network and computational) that constituted the architecture of the system, defining the model of interconnectivity between of all them and way of integrating all the components involved. This constituted the requirements for the system for the implementation, which was carried out by the IBM engineer and the technical department in Plymouth. As lead architect, I supervised all of the phases of the implementation, resourcing and coordinating of the entire component. Known as the Smarter Planet Lab, it has since been used by the researchers in the i-DAT Research Group and by the students on the undergraduate and postgraduate programmes in Digital Art and Technology (DAT) at the University of Plymouth.

Figure 2: Smarter Planet Lab launch event, Plymouth University, 2010

6.1.2 Implementation

The design of the Lab was mainly focused on the definition of two fundamental aspects: 1) the network architecture in terms of protocols and communication; and 2.) the Integration between platforms and devices such as micro-controllers, mobile phones, computers and sensors. At the time of the design of the Lab, IBM had already released some technologies to the open-source community. Others were then developed for this specific project and later released as open-source.

The key component was the network protocol called MQTT[78] (formerly Message Queue Telemetry Transport). It was identified at the time as one of the few with the potential to become a standard and also one that intrinsically embedded the overall philosophical and social approach at the root of the approach explained in this thesis (as it allows for a many-to-many communication regardless of the source). Below is how IBM inventor Andy Stanford-Clark described MQTT:

> *MQTT stands for Message Queuing Telemetry Transport. It is a publish/subscribe, extremely simple and lightweight messaging protocol, designed for constrained devices and low-bandwidth, high-latency or unreliable networks. The design principles are to minimise network bandwidth and device resource requirements whilst also attempting to ensure reliability and some degree of assurance of delivery. These principles also turn out to make the protocol ideal of the emerging "machine-to-machine" (M2M) or "Internet of Things" world of connected devices, and for mobile applications where bandwidth and battery power are at a premium.*

[78] http://www.mqtt.org

The Publish-Subscribe messaging pattern requires a message broker. The broker is responsible for distributing messages to interested clients based on the topic of a message. The broker is responsible for distributing messages to interested clients based on the topic of a message. Andy Stanford-Clark and Arlen Nipper of Cirrus Link Solutions authored the first version of the protocol in 1999.[79]

The MQTT telemetry protocol guarantees the connectivity between all the devices in the labs: computers, smart phones, and small digital-devices (i.e. Arduino, Photon).

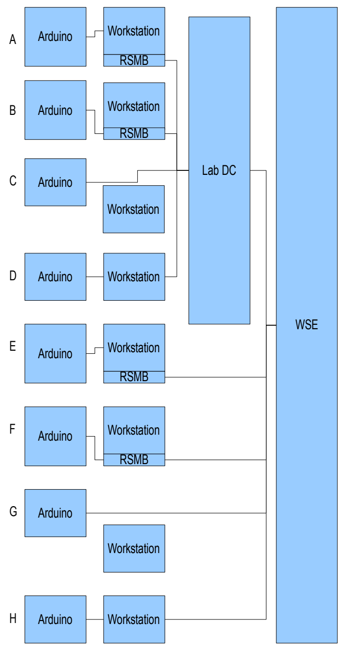

Figure 3: Blueprint for connecting Arduino to IBM Web Sphere Sensor

MQTT is similar to Bluetooth, but because it is very light and compact it can be uploaded onto almost any device with a chip on board. MQTT seemed to have all the qualities (open-source, lightness and horizontal interconnectivity) to become, not only the perfect solution for the Lab, but also (in the long term) a standard for broad IoT implementations. The protocol uses a simple broker

[79] http://www.mqtt.org

software to publish and receive short messages (i.e. SMS length) from all the devices connected to a local network or to the Internet. This broker was another 'brick' in the Lab implementation. The figure below shows all the technologies (hardware and software integrated in the Lab).

Figure 4 – The final setup of the platform installed in the Smarter Planet Lab

The Lab, as a system, integrates various open-source technologies now standard in the IoT (but not at the time of the first implementation) in a way that makes it easy to operate and access for students and practitioners. It implements an integration of open source hardware and software solutions, of which the main components are:

- Arduino boards;
- Arduino Wireless shields, to connect Arduino Boards to the Internet via a Wireless network;
- Wireless routers, for different network configuration WAN or Internet;
- MQTT lightweight telemetry protocol;
- RSMB, the broker that allow devices to publish and receive.

The project was carefully designed with an open-source approach, which it is understood as integral to the development of the IoT and to its vision. Although the collaboration was with an industrial partner (IBM, a giant software company whose business model is based on software licencing) all the software involved in the platform were open-source licensed.

The following table shows the various scenarios envisioned for the Lab architecture:

Scenario			Description
A	WSE is not exposed directly to the student workstations or Arduino. (Lab Wireless LAN doesn't need to route to WSE)	Arduino to RSMB	Arduino connects using the serial connection to a workstation. The workstation runs the MQTT protocol bridge to Ethernet. A local instance of RSMB runs on the workstation and the student connects the Arduino to the local RSBM, which bridges to other student RSMBs and/or the Lab DC
B			A local instance of RSMB runs on the workstation and the student connects the Arduino via Lab wireless LAN to the workstation RSMB. The RSMB is bridged to other student RSMBs and/or the Lab DC
C		Arduino to Lab DC. No local RSMB	The student connects the Arduino to the Lab DC via the Lab wireless LAN.
D			Arduino connects using the serial connection to a workstation. The workstation runs the MQTT protocol bridge to Ethernet. The student connects the Arduino to the Lab DC over the serial protocol bridge.
E	WSE is directly exposed to student workstations and Arduino. (WSE must be accessible on Lab Wireless LAN)	Arduino to RSMB	Arduino connects using the serial connection to a workstation. The workstation runs the MQTT protocol bridge to Ethernet. A local instance of RSMB runs on the workstation and the student connects the Arduino to the local RSBM, which bridges to other student RSMBs and/or WSE
F			A local instance of RSMB runs on the workstation and the student connects the Arduino via Lab wireless LAN to the workstation RSMB. The RSMB is bridged to other student RSMBs and/or WSE
G		Arduino to WSE. No local RSMB	The student connects the Arduino to WSE via the Lab wireless LAN.
H			Arduino connects using the serial connection to a workstation. The workstation runs the MQTT protocol bridge to Ethernet. The student connects the Arduino to WSE over the serial protocol bridge.

Figure 5 – Scenarios of development and further development (2010)

The architecture of the Smarter Planet Lab has the potential of being an Intranet of Things (local network) or an Internet of Things (global network) according to the set up. It can operate as a private isolated network or it can be open and publically-accessible from and to the outside world.

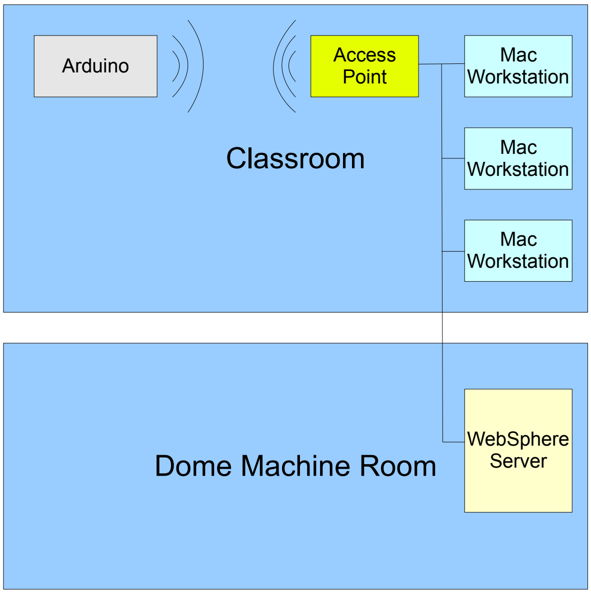

Figure 6 – Draft Configuration of the Smarter Planet Lab (2010)

The above diagram shows the networking connections required through the Wireless Arduino shield into the access point to the Plymouth University network and towards the rest of Internet.

After this first deployment and setting the Lab has been improved and updated over the years. New devices have been connected to the overall architecture, like Raspberry PIs and Spark Cores, and the broker software is now in the cloud, running from a centralised server that all the students can access. Recently, another element has been integrated: the JavaScript based IDE for the IoT called Node-RED, "a tool for wiring together hardware devices, APIs and online services in new and interesting ways".[80] This addition has been important, as it adds another brick to the overall platform and is a visual tool to connect and

[80] http://nodered.org/ (latest access on 30/04/15)

configure the IoT. Node-RED (like MQTT) has been developed at IBM Hursley and it is open-sourced. Node-RED is available to all the machines within the Lab.

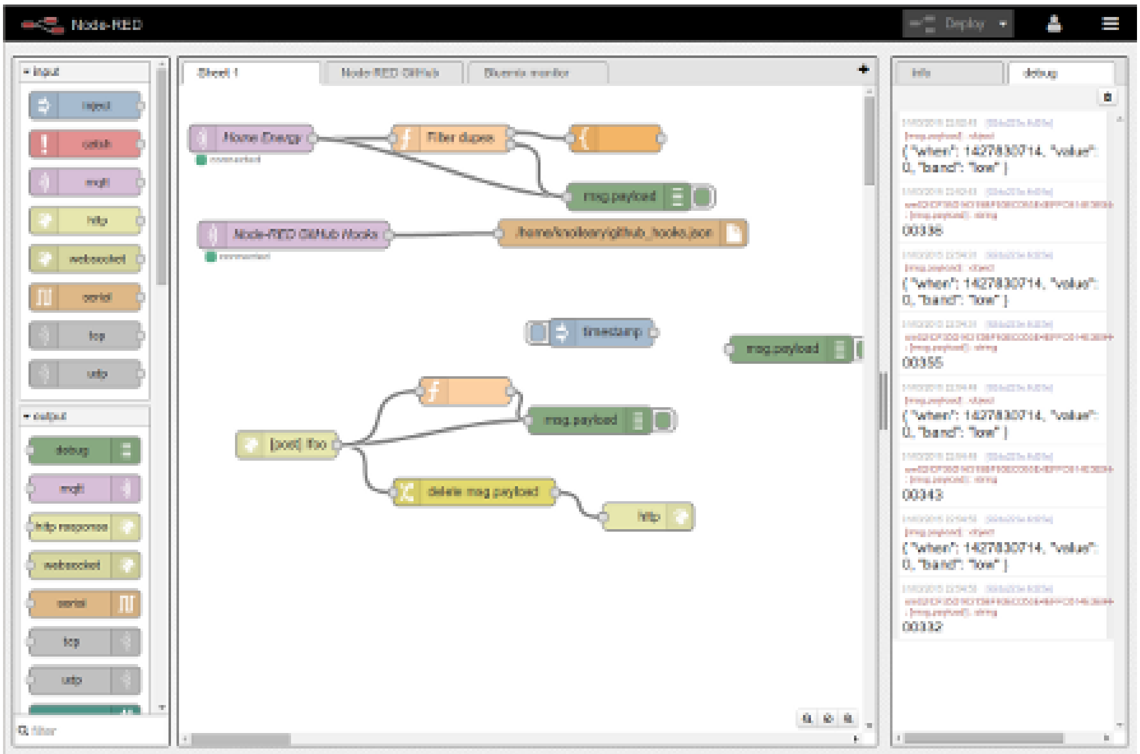

Figure 7 - Node red visual IDE interface

6.1.2.1 Platform outcomes

The relevance of the Lab to this thesis lies in the configuration and setup of the system as an open instantiation of the IoT. This confirmed in the initial ideal of the need for a configuration that supports the development of IoT and how the configuration is culturally-biased and not a neutral assemblage of pre-existing technologies. In fact, the IoT is (as Ubiquitous Computing is for Dourish & Bell) a set of very heterogeneous technologies that can be configured and connected in unpredictable, expandable and adaptable ways. "The lesson of the real world of ubiquitous computing, then, is that we will always be assembling heterogeneous technologies to achieve individual and collective effects" (Dourish & Bell, 2006: 7).

6.1.3 Lab as pedagogical resource

At the time of its opening (2010), the Lab was the first of its kind in the UK. Over the years, it has proven itself as a key resource for collaborative interdisciplinary activities in the field of the IoT with students, researchers from different disciplines (Architecture, Product Design, Health and Social Care) and external bodies. Since its establishment, the Lab has been a permanent resource for undergraduate and postgraduate DAT courses, and embedded into the delivery of teaching. The pedagogical approach has been shaped around how the Lab has been designed. The project has been presented multiple times, and has used as an example of a new pedagogical approach for designers and digital artists. It has been invited to be shown at International Conferences, such as: CHI 2014 (May 2014) in Toronto, Transdisciplinary Imaging Conference in Istanbul 2014 (June 2014) and the Mobile Learning Conference in Madrid in 2014 (March 2014).

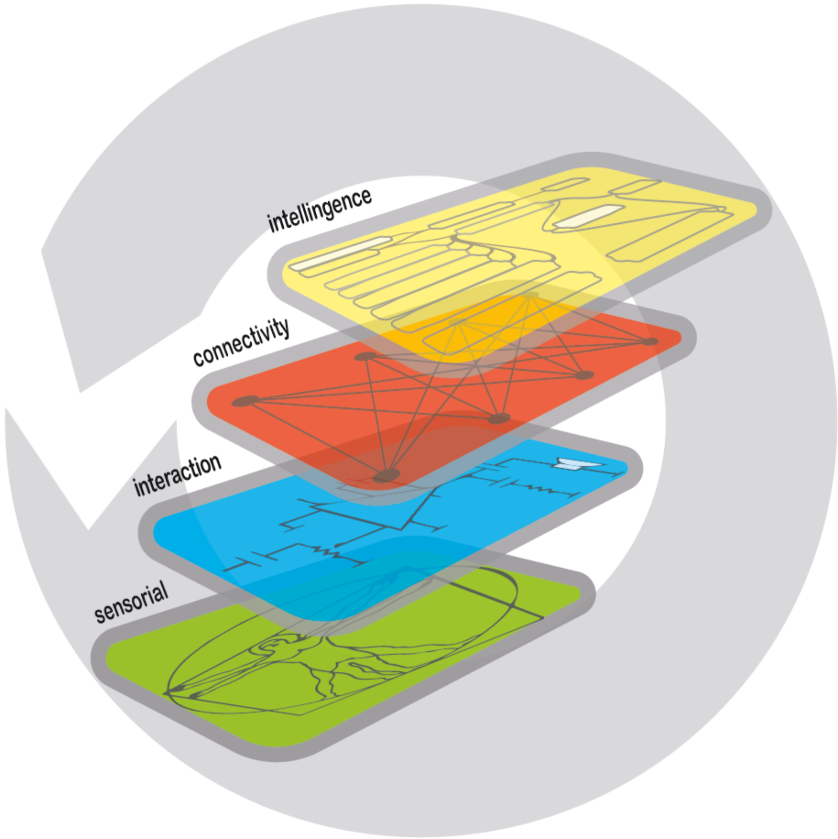

Figure 8 – Aspects of Smarter Planet Lab

6.1.3.1 New knowledge, the human and non-human

The Lab has a special configuration and architecture, in that it connects humans through their Smartphones or wearable devices, as well as micro-controllers of the ubiquitous environment, like Arduino Spark Core, etc., and mini computers (Raspberry Pi, etc.) and sensors. This makes it a unique facility for IoT development. The architecture of the system mirrors the interaction model previously discussed in this thesis. Most of the prototyping, platform and system are, by default, a single point-to-point communication system, and the Lab (through the MQTT, broker and devices created this meshwork architecture) allows a many-to-many communication and uses a flat system (as all the devices, objects, places and human interactions are treated equally and symmetrically by the platform). The human and non-human platform is, therefore, a communication whereby human subjects can use the same system as the non-human objects to communicate. Unpacking the concepts that drove the development of the platform helps to explain theories essential to the understanding of the IoT. From here, it is easier for students and researchers to use the platform with a different design attitude. Finally, and linked to this last concept, the Lab is an excellent exemplification of a performative ontology that treats all communication equally.[81] The design of the Lab predates Facebook's adoption of the MQTT telecommunication protocol for the Facebook Messenger mobile-app. This is more than serendipity and coincidence. The intrinsic engineering-quality that technically incorporates the ontological vision of IoT that this study describes is embedded into the design of MQTT protocol. My role as an architect of the overall system was to recognise this quality and its potential in the interconnection with the other components of the platform. Similar to what HTTP represented for the Internet of People, for its relational nature and implementation, the MQTT can be considered as representing for the IoT. Here, the Internet of People meets the Internet of Things, and here also originates the Internet of Props.

The platform represented by the Smarter Planet Lab is the cornerstone of the design-framework of this thesis. It is aligned to the research question, as it

[81] Through the Lab students and researchers can experience the translation of ontology into the technology used.

designs and develops a horizontal communication system between humans and non-humans, and therefore there are no boundaries between the Internet of People and the Internet of Things.[82] In addition, it is an adaptable and open-open technical substrate that can be reconfigured in real-time to enable and to responds to the performative nature of the IoP. In its openness, it incorporates the theoretical (ontological and sociological) principles and provides an easy platform for experimentation into the design of the IoT for digital artists and product designers, computing students and others. Having accomplished (through the Smarter Planet Lab) the essential infostructure necessary to enable the experimentation, the research moved to applying the design principle of the Internet of Props framework into a design workshop and intervention called Transactional Props.

6.2 *Transactional Props*: the Internet of Props in action

The instantiation of the Internet of Props is a set of interventions called Transactional Props, the first of which includes a design workshop. What follows is the description of the implementation, documentation of the intervention and an evaluation, analysis and study of the Internet of Props via a Conversational Analysis (CA) methodology. The intervention, Transactional Props, operates in a multifaceted way, as a cybernetic art installation, a design

[82] This reflects the new ontological model drawn for the Internet of Props in terms of the interconnectivity between Props, and between Props and people.

experiment and a social study. Both the name and concept are inspired by one of Roy Ascott's famous art installations: *Transaction Set* (1971).

6.2.1 Inspiration: Roy Ascott

Transactional Props is an homage to Roy Ascott's work; a re-enactment of one of his artistic interventions in a new technological context. Ascott's *Transaction Set* (1971) is a version of a project that has been exhibited with different titles since the sixties: *Plastic Transactions*, *Table top Strategies*, sometimes they are collective *Transactional Pieces*.

Figure 9 - Roy Ascott's *Transaction Set* (1971) has been removed due to Copyright restrictions.

At that time (the 1970s), Ascott became interested in the table as an interactive object. This led him to use the table-top as a horizontal platform for a series of art pieces. For Ascott, the horizontal dimension of the table was (conceptually, politically and aesthetically) as fundamental as it was for Duchamp, who inspired his work[83]. It embedded aspects of divination; biographical and symbolic significance[84]. The table-top project was emblematic of Ascott's cybernetic vision that he applied in art and education.[85] It is a sort of material

[83] Ascott, R. (2013) Interstitial Creativity [online] Available at www.cost.eu/download/44615 [Accessed on 15/05/2014]

[84] Ascott, R. (2003) Telematic Embrace: visionary theories of art, technology, and consciousness Available online at https://zaklynsky.files.wordpress.com/2013/10/telematic-embrace-visionary-theories-of-art-technology-and-consciousness-by-roy-ascott.pdf

[85] Ascott, R. (2003) Telematic Embrace: visionary theories of art, technology, and consciousness Available online at https://zaklynsky.files.wordpress.com/2013/10/telematic-embrace-visionary-theories-of-art-technology-and-consciousness-by-roy-ascott.pdf

manifesto of cybernetic art. For Ascott, cybernetics is the substrate, a systemic and holistic vision of the world, an ontological understanding of reality (as discussed in the previous chapter by Pickering).

Transaction Set is a very analogue work that uses simple elements: a table and some very common pieces of plastic kitchenware. These 'table-top" pieces (everyday objects with no special qualities or value or meaning) respond to the cybernetic concept of system, network and interaction. There are no rules and nothing happens until some people sit down and start to play or interact. The only clues or context given to the participants are the everyday objects left on the table, on a sink mat that resembles a chess grid (which might vaguely reminds the participants of logic or structure). The playfulness and openness of the table-top reflects a concept of art as a process of seeding, where the artwork is constantly negotiated among the participants who define rules, roles, meanings. In Ascott's words:

> *Table-top behaviour enables us to invent and rehearse alternatives, to exploit the fecund ambiguity of new relationships and the dynamic uncertainty of movements of meanings. The table-top not only encourages interaction between observers attending it but focuses into this mediating plane all the psychic energies of the individuals involved.* (1975: 173)

Conceptually though, ordinary kitchenware has a strong power, as kitchen objects shape material reality, i.e. the glass with water and the pastry cutter with dough:

Unlike classical 'found objects' (Duchamp's, for example, had to do with criticism) these readymades of Ascott's are quite literally visual ideas; they act as tools in the transactions, which occur when they are manipulated. The transactional process of two people pulling up chairs, sitting down and arranging generalized, familiar, but strangely evocative objects in new and surprising ways, this game-playing is of course an analogue for the way things get themselves discovered in science, in art, and in administration of all kinds; indeed, the process of playing with these things is a useful analogue for the contemporary administrative process. (Dault, 1972: 168)

The transactional pieces are very interactive and performative. They embed the cybernetic ontological view shared by the Internet of Props, in terms of "inventing and rehearsing alternatives, exploiting the fecund ambiguity of new relationships and the dynamic uncertainty of movements of meanings" (Ascott, 2003: 173). As stated in Chapter One (p.20), interactive performative behaviour pre-empts the origin of a new relationship of things and people. The inspiration for the actualisation of the IoP framework came from this cybernetic art-installation; both as an example of cybernetic art and an illustration of the cybernetic theory.

6.2.2 Designing, prototyping workshop and interventions

The design workshop and interventions, Transactional Props, is designed as an actualisation of the Internet of Props design framework and toolkit, and a hands-on design practice. Transactional Props makes use of the platform (Smarter Planet Lab) and the technological probes: Props.

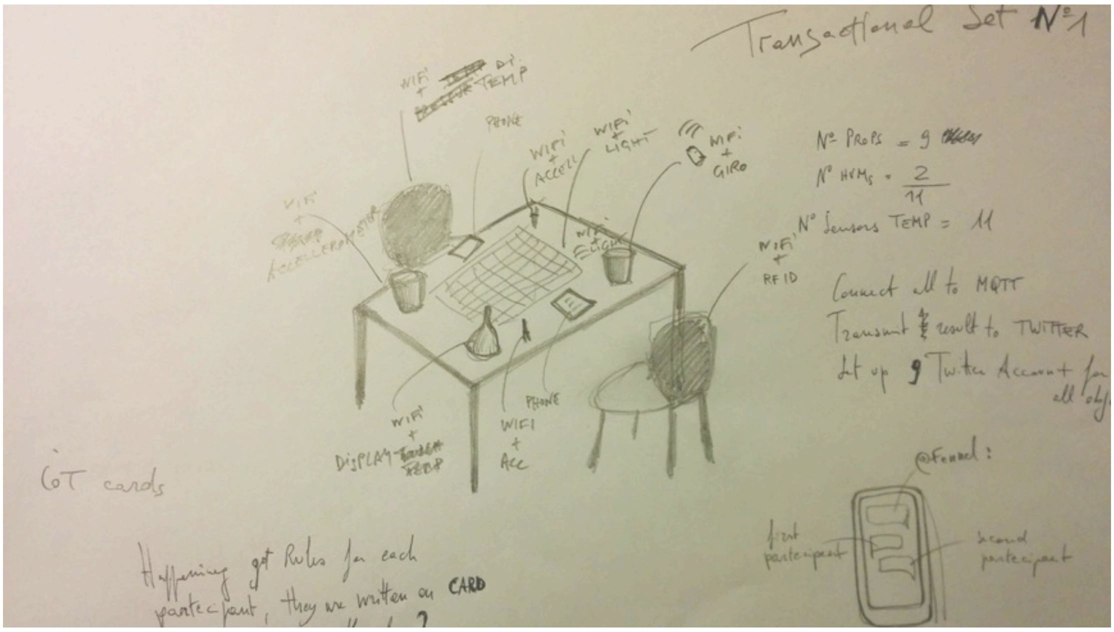

Figure 10 – One of the initial sketches (2015)

The first element of the setting, the Lab, has been already presented. Now the Props will be introduced. Unlike the majority of design workshops (where objects used during the workshop are not technological) this workshop made use of Props that are technological artefacts. The participants did not need to be technologically savvy, however, and they could be technologically agnostic. The Props required a good deal effort in terms of pre-workshop planning and preparation. They needed to be designed, developed and programmed in order to be able to operate in the Transactional Props setting. The necessary ethical approval for running the workshop and the interventions was sought from, and granted by, the University of Plymouth Ethical Committee (See Appendix 1 for the forms). All the participants were fully-informed and participated in Transactional Props on a voluntary basis. The consent form, signed by all participants, granted permission for audio and video recording to be used and studied (see Appendix 1). Before the experiment, each participant received a paper with a short description of the Transactional Props project, with explanation of objectives and outputs of the research. After the workshop the video was transcribed into English using a conversational Analysis methodology to include both verbal and non-verbal communication. Transcripts are attached in the Appendix 4.

The next section contains a detailed account of how the Props were designed and implemented. After this, the workshops strategy and methodology is introduced to show the Props work in context.

6.2.2.1 The technological and speculative probe: the Props

In the implementation of the practice, the Props moved from being just a theoretical object, a Theory Object (Sterling, 2006), to becoming a performative design-artefact acting as a technological probe (Hutchinson, 2003) and a speculative probe (Dunne & Raby, 2005). As a technological probe they embedded the key technologies typical of the IoT (microcontroller, sensors, etc.) and some of the essential logic of IoT system (responsiveness, intelligence and autonomy).

Figure 11. Prop: green cutter

Figure 12. Prop: pink glass.

Implementation involved multiple tasks: electronics assemblage (sensor, microchip, battery power and optimisation of the circuit.); coding for the microcontroller; creation of a Twitter account; and visual coding of the Node-RED logic, supported by a Research Assistant. This phase was key to the success of the workshop itself and required my undertaking lot of engineering work, coding and testing before the final version of each Prop was ready.

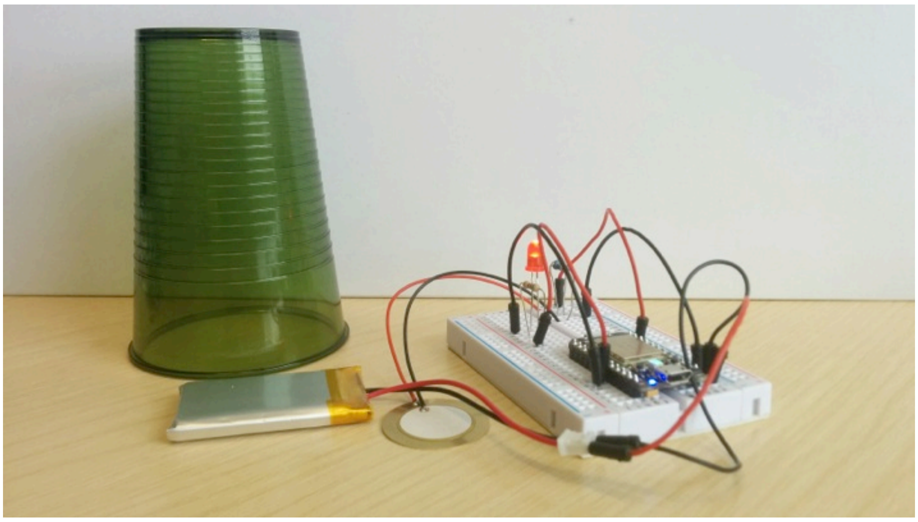

Figure 13. Early Prop prototype

Each Prop was a different piece of kitchenware that had been equipped with:

Spark Core microcontroller and a WiFi chip, Lipo Battery and a Sensor. Three main software modules underlying Transactional Props were enabled via the technology of the Smarter Planet Lab: Node-RED (Visual IDE programming interface for the IoT); MQTT telemetry protocol for communication; a broker for publishing and receiving messages; and Arduino/Wiring [86] (partially implemented) for the Spark Core microcontroller. The Props were connected through the Spark Core IDE to the cloud and via MQTT they were sending sensor data through to Twitter, each Prop has its own Twitter account (See Appendix 1 for list of accounts, p. 261).

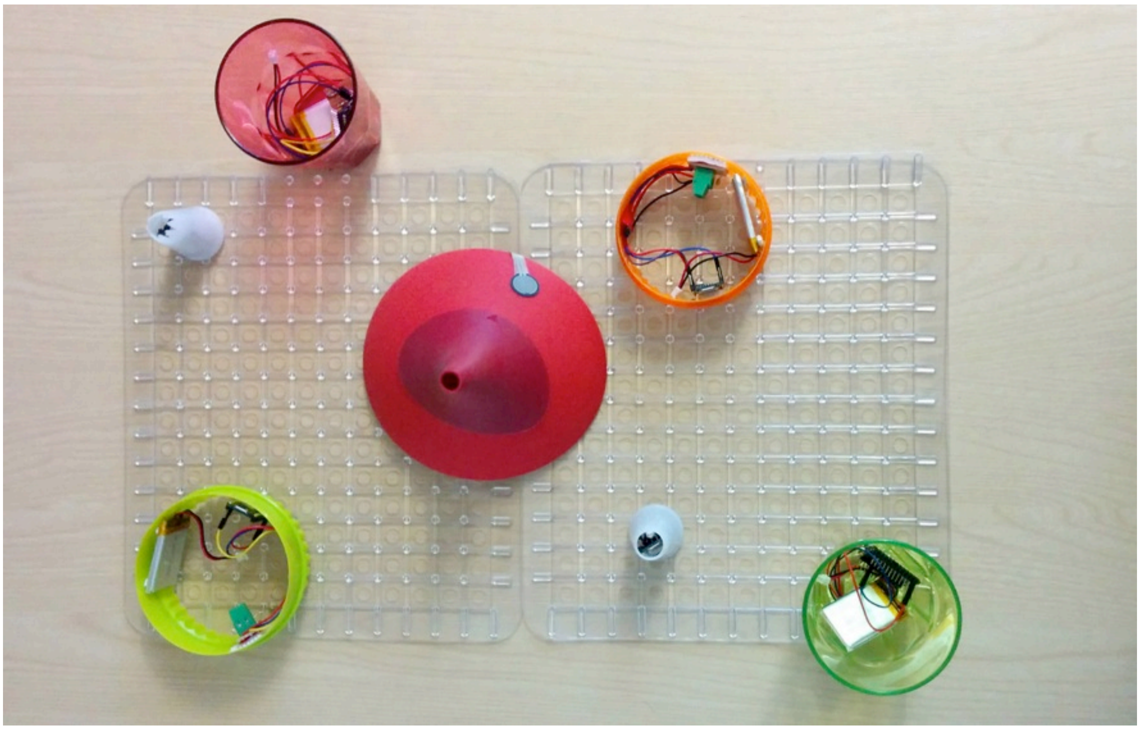

Figure 14. Transactional Props set, top view)

[86] Wiring is the 'programming language' that Arduino uses, and is commonly described as the Arduino programming language because of this.

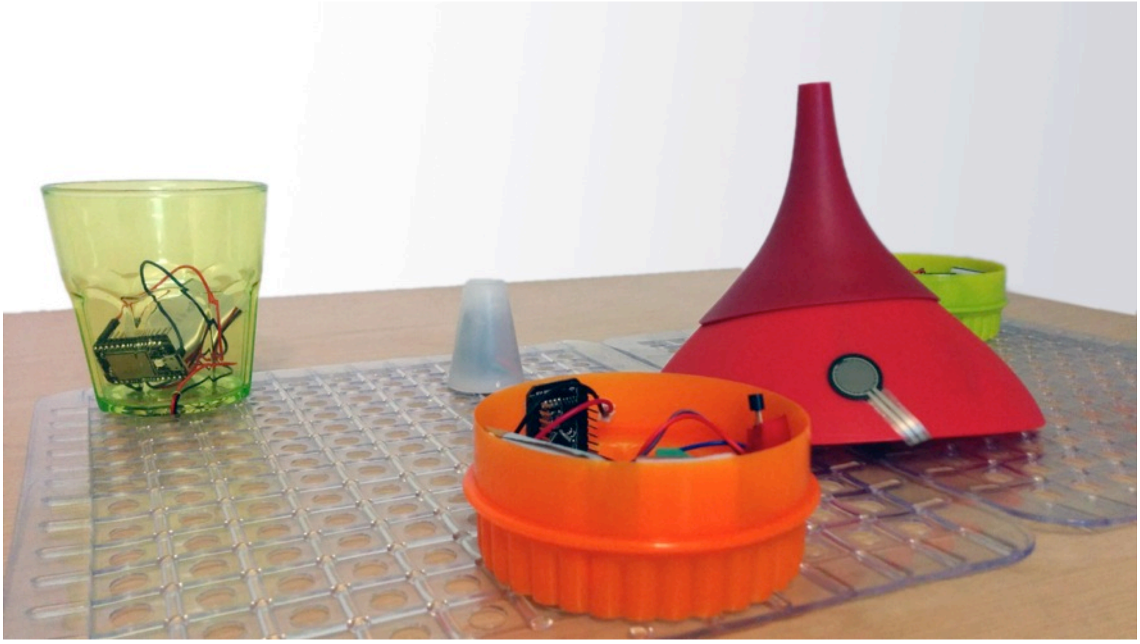

Figure 15. Transactional Props set, side view

When activated, each Prop posted the data coming from the sensors attached to it, via a tweet to its own Twitter account, using the #transactinalprops hashtag. This meant that all the conversation happening during the workshop could be followed and recorded. Below is a table with the list of Props and the sensors and actuators they were coupled with.

Props	Sensor	Actuator
green glass	Piezo sensor	
pink glass		Vibro motor
orange cutter	Temperature sensor	
green cutter	Light sensor	
flat nozzle		RGB LED
spiky nozzle	Tilt sensor	
Funnel	Pressure sensor	

Table 2. Props, technological coupling

The coupling of sensors and Props was quite casual; either inspired by their function and form or, in some cases, left to chance. The coupling provided the Props with simple set of behaviours that represented some of the behaviours objects have in the IoT. In this context, the Props are not neutral. They behaved in a simple way at the beginning, but all differently. This was designed to:

- bring the humans out their comfort zone (their habits of interaction);
- initiate a dialogue that involved non-humans;
- activate role-playing between humans and non-humans;
- investigate the physical and digital qualities of the artefacts: props.

Spark.io was chosen as a microcontroller for its dimension and because its programming language is the same as the Arduino's. Nowadays, Spark.io is the smallest microcontroller on the market that embeds a WiFi antenna. Spark.io is not, however, fully open-source, as the hardware is locked to a proprietary hardware and software configuration (the hardware is not open-source and the software configuration depends on the centralised cloud architecture). It was possible to connect it to the MQTT and IBM pre-existing infrastructure, however. The code uploaded on each Prop was very basic to start with, but the Node-RED visual script had been set up to allow easy reconfiguration during the intervention and experiment to respond to the design process. In a broader sense, everything and everybody was a Prop in this set: humans and non-humans. On the table, there was one additional object that was not digitally-enhanced, but was well part of the system: a sink mat. This is taken directly from Ascott, where the grid-like mat on the table was an illustration of his cybernetic vision of the world, a metaphor of semantic structure that helps to decode and to interpret the world. My feeling was that on a basic level, this chess-like grid would help the interaction by reminding the participants of ideas of games and logic.

6.2.2.2 Planning the workshops

The workshop's setup resembled a participatory design workshop whereby participants shared ideas and brainstormed over a topic, a design concern, but in this case the participants were also part of the design experiment and an integral part of the outcome of the workshop. The approach was not the canonical participatory-design one, but rather a mixture of strategies and techniques typical of ID, HCI or CSCW (Computer Supported Collaborative Work), together with inputs from art and performance. "Art, clearly established in our present culture as a form of behaviour (rather than a simple array of images or objects), now takes on the quality of a transaction. Art aspires to the condition of exchange" (Ascott, 1975/2003: 172-3).

In terms of the present research, it is this behavioural and exchange dimension that is of interest here. In the workshop the participants were given an introduction to the overall theoretical framework first, presented with the Transactional Props setting and then invited to freely experiment and engage with it. The interaction with the Transactional Props setting and toolkit was planned in stages for the workshop.[87] Following this, the workshop plan was scheduled into following sequence of activities:

1. a short presentation of IoP and workshop's brief;
2. a performative interaction with props and concepts in action (Stage 1 and 2);
3. writing design cards;
4. break;
5. a performative interaction with props and concepts in action (Stage 3);
6. final discussion.

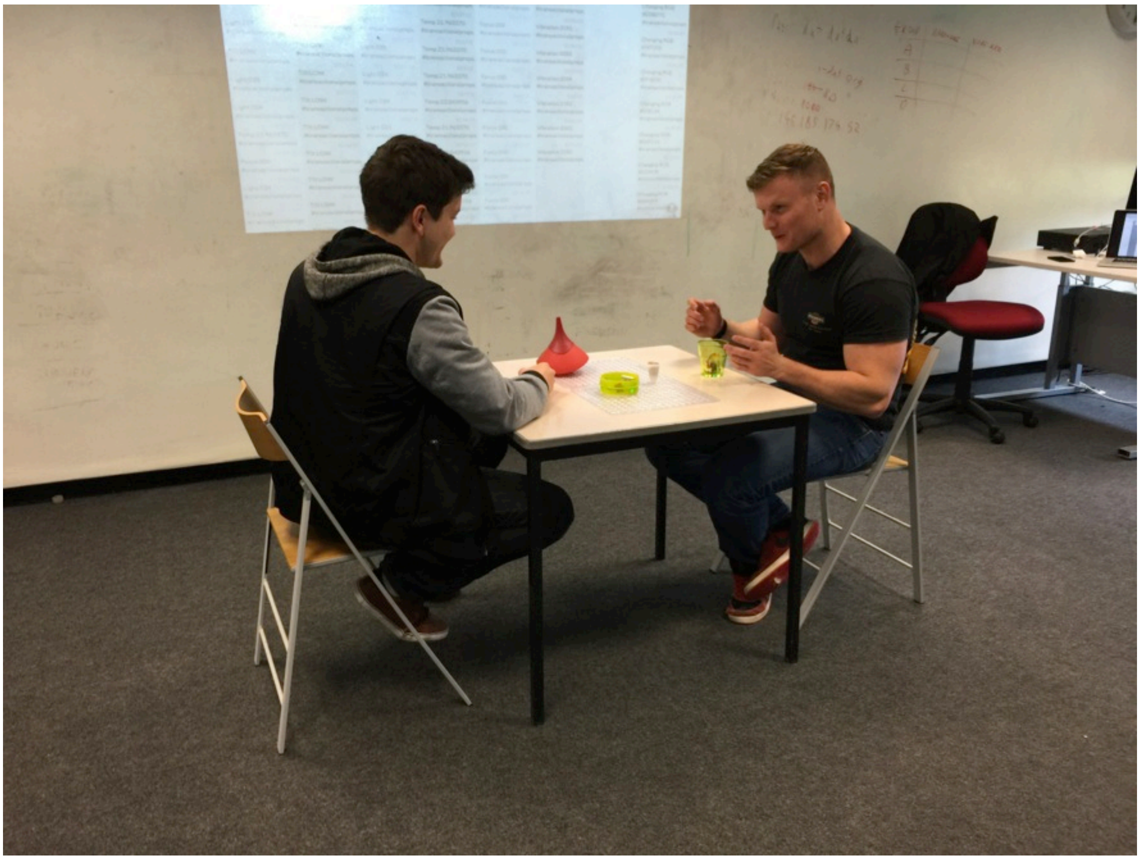

Figure 16 - Transactional Props Media City 15 intervention – Vicktor and Luke

As mentioned previously, each Prop involved in the workshop had its individual Twitter account, where all the data was archived. During the workshop, no biological data was recorded and there was no automatic link

[87] An account of the stages is given further on in this chapter.

between the Twitter accounts of the participants and their accounts of the objects. These activities were designed to try to elicit configuration of the Internet of Props by observing the performativity of all entities (human and non-human) involved in the interaction. It also aimed to empathise with the multiple configurations of the system, to investigate the possibilities the system could perform. The objective was to gain insight into the performative framework and tacit knowledge about a way of interacting between humans and non-humans through the observation of the people's engagement (verbal and non verbal). Ascott's interest was also in behaviour, in allowing behaviours to emerge and show the process; "when art is a form of behaviour, software predominates over hardware in the creative sphere. Process replaces product in importance, just as system supersedes structure. Consider the art object in its total process: a behaviourable in its history, a futurible in its structure, a trigger in its effect (Ascott, 1967/2002: 158). Ascott was interested in the sensory system outside of the orthodox one, what he calls the, "extended sensorium" (Ascott, 2014)[88]. The idea of the sensory system and behaviour is something rather contemporary in the discussion about the IoT.[89]

[88] Roy Ascott, Kappatos Athens Art Residency, [online] Available at http://athensartresidency.org/index.php/in-resindence/roy-ascott/ [accessed on 15/04/2014]

[89] This is because the market and industrial imperatives want to constrain the vision of the IoT to enhancing reality by retrofitting a sensory system to the so-called inanimate world of Things and objects **https://www.wired.com/insights/2014/11/the-internet-of-things-bigger/**

6.2.3 Testing the Internet of Props, *Transactional Props*

The first workshop ran publicly on the May 1st 2015 as part of the Conference Media City 2015 held in Plymouth (UK). The workshop's location was within the Smarter Planet Lab in the Babbage Building (room 213). What follows is an account of the preparatory work and a documentation of the event.

6.2.3.1 MediaCity (Session one)

> *The table-top supports an open system, in which only the intervention of observers can generate meaning and value. Art, then, resides not on a surface or within material objects alone, but between the behaviours of all parts of the system.* (Ascott, 1975, 2003: 173)

The workshop aimed to put in place and explore the conceptual and design framework defined as the Internet of Props in the context of IoT. The IoT, itself, has evolved as a conceptual framework for understanding how physical objects and places linked to the Internet will tell us something about the world around them, about themselves and about us. If indeed the IoT changes the way people cohabit the physical space with Things, then Things themselves can contribute to the making of it. The workshop explored the entanglement of humans and non-humans and the convergence of the Internet of People and the Internet of Things. The Internet of Props is 'performed' through the workshop, by exploring the novel network architecture of the Smarter Planet Lab, (developed in conjunction with IBM) as a way of interconnecting the Things and the People.

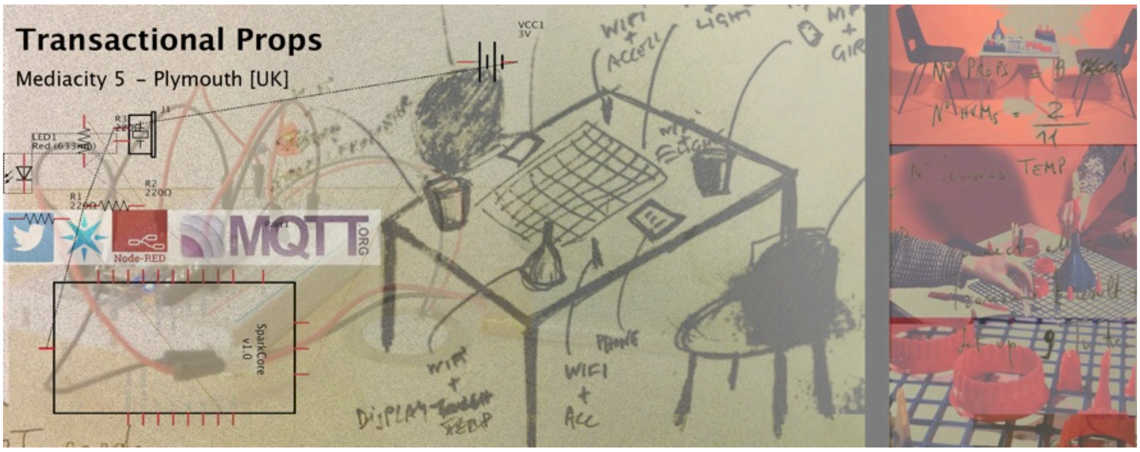

Figure 17. Poster for the MediaCity 15 workshop, Plymouth, 2015

The pre-production phase of the whole workshop and intervention Transactional Props included the preparation of the Props and the scheduling of activities, discussion and performance/exhibition. All stages required the participation of the people and all conversations were video recorded for further investigation and analysis.

Figure 18 - Transactional Props intervention - Media City 2015 Conference, Plymouth, 2015

The stages were systems on their own, in the cybernetic sense. The interactions happening during the workshop explored the potential of the Props, by means of performative actions. The stages were an open platform to perform the new context of the Internet of Props. Participants were working in groups for the first part, and then they experimented with the Transactional Props in couples.

Each group had the opportunity to go through the interaction in different stages and at different levels of interactions.

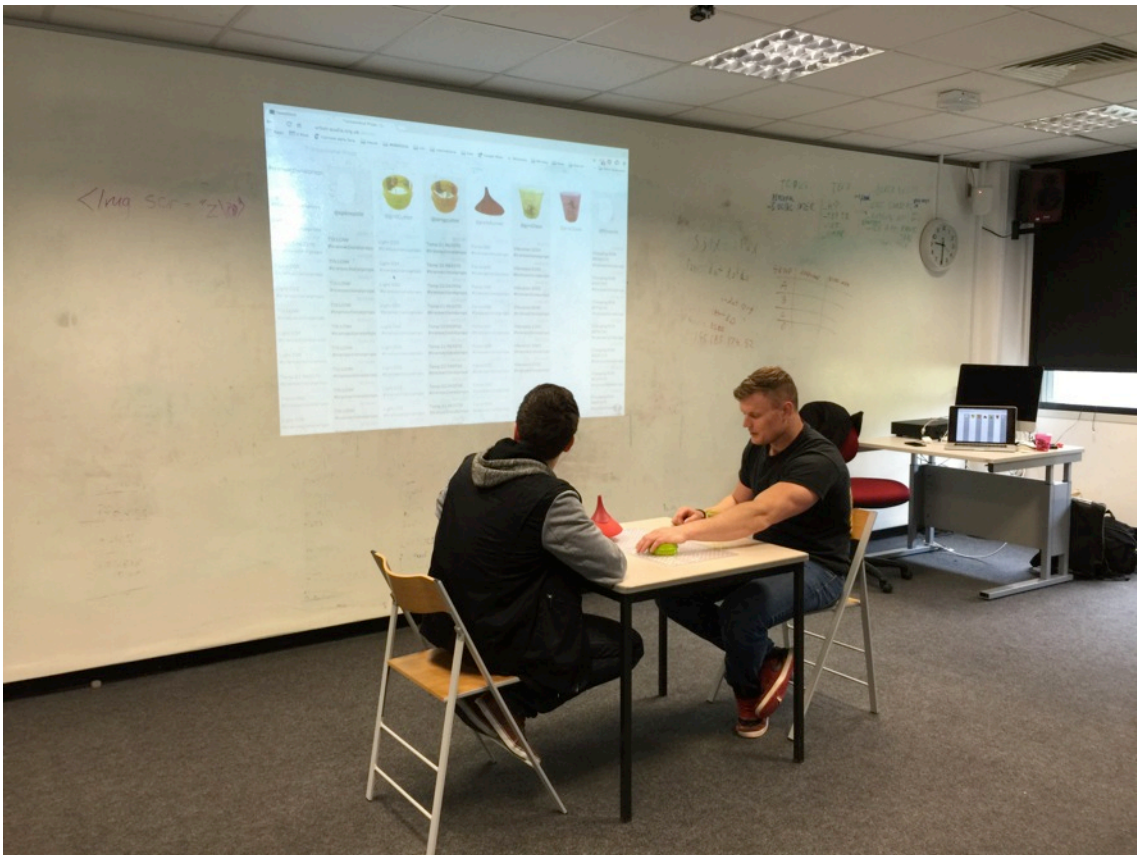

Figure 19 - Transactional Props intervention - Vicktor and Luke, Media City 2015 Conference, Plymouth, 2015

Figure 20 - Transactional Props intervention - Vicktor and Luke, Media City 2015 Conference, Plymouth, 2015

The number of participants that took part in the workshop was higher than the number that actually engaged with the Props in the various stages. 12 people engaged in the overall workshop activities and 6 people actively took part in the interaction. The interaction was done in pairs with one participant sitting on each side of the table. Not all the pairs took part in all of the stages. Again, this was part of the openness of the system and the ethical condition of the workshop. The workshop lasted about 4 hours in total and was well-attended overall. The people that were not directly involved in the interaction assisted as the audience, sometimes suggested actions to the participants. The following is an account of the stages of the workshop.

6.2.3.1.1 Stage one: Free interaction

People sat at the table and started to figure it out what to do. In this stage the props were present, but none of them had any logic. There was no time restriction in any of the stages. All the data received from the Props was published on a webpage that shows each individual feed and the whole conversation through the #transactionalprops.

Figure 21 - collective workshop during Media City 15 Conference, Plymouth, 2015.

6.2.3.1.2 Stage two

Each 'set' was made up of a table with common plastic objects that had been propped up with sensors, a couple of chairs and a screen or projection to visualise the tweets. Here is when actuators were introduced on the table, together with their coupled sensors. The participants had, again, the opportunity to freely play for however long they wished.

Figure 22 – Transactional Props intervention - Vicktor and Luke, Media City 2015 Conference, Plymouth, 2015

6.2.3.1.3 Stage three

Stage three was anticipated by some more-standard design-practices. Each participant was asked to pick up an object and assign behaviours (one or more again no limits) to it by using the design card. The design cards were prepared with three sections, ready to be filled by the participants as the figure below shows.

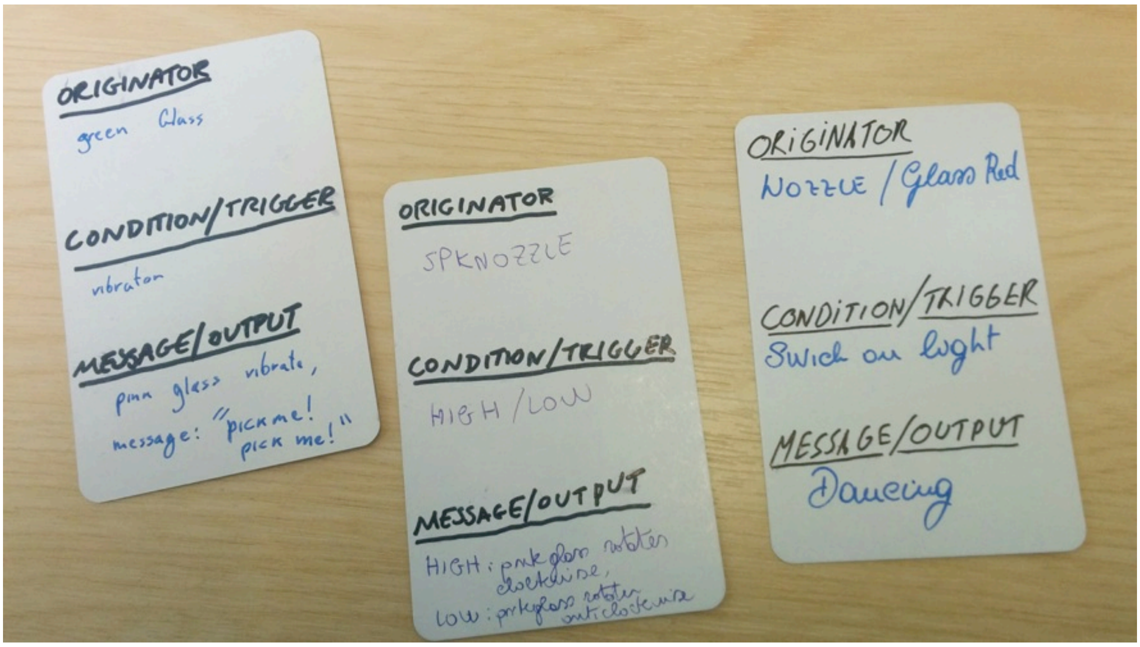

Figure 23. Design Card filled by the workshop/experiment participants

Each card had three fields:

- Originator - where to insert the Prop that originated the new condition;
- Condition/trigger - the data or value that triggered an event;
- Message/input - what happens after an event has been triggered and what Prop is affected (eventually).

The cards were then collected and (through Node-RED) 'programmed' into the Props while all the participants took a break. On their return, the participants would play with the Props again, but at this stage each Prop would behave according to the actions specified by the participants earlier on.

This stage could be reiterated as many times as required. In fact in the experiments carried out after the workshop this phase were repeated incrementally, to observe, not only the reaction, but also what kind of incremental behaviour could be ('evolutionarily) 'developed.

Figure 24 – Collective workshop during Media City 15 Conference, Plymouth, 2015

Figure 25 – Transactional Props Exhibition at Media City 15, Conference, Plymouth, 2015

6.2.3.2 Subsequent interventions (Session 2 and 3)

Based on the first debut of the Transactional Props workshop, a series of further design workshops were organised using the toolkit as an experimental tool.[90] The workshops that happened after the debut workshop adopted some slightly different strategies. The participants undertook more compact and focussed interactions. The Transactional Props setting with the table interaction maintained consistent, but was tested in different environments (such as a home context, a lab and an office space) in a series of four different sessions. In this series of sessions, the timing and the scheduling of design task were accurately controlled and each session lasted a maximum of 30 minutes. The participants assigned to the participants were of two and in sequence: Interaction in Transactional Props (Stages 2 and 3), and reconfiguration of the Props, through the design cards with personal redefinition of sensors and response settings. This second element was necessary to show how on IoT system should be open to 'almost realtime' and seamless reconfiguration by the users. The openness of the system is an essential design requirement and a performative quality of the Props enabled by the platform, the Smarter Planet lab.

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[90] A version of the Transactional Props workshop was also exhibited at the 2015 Media City Conference Exhibition (2015). The Conference audience were able to interact with the Props and also to discuss the overall design framework highlighted in a poster.

Figure 26 - Second intervention with Elena and Davide, Plymouth, 2015

These interventions were repeated twice with three different couples. Here, the participants became part of the system by imagining multiple levels of interactions between humans and non-humans through the behaviour during the interaction and the role assigned to the Props via the design cards. This second set of interactions took place over two days, the first one on May the 9th 2015 (where there were two participants) and the second on May 15th (where there were six participants). In both cases, people were introduced to the project, briefed about the openness of the system and the fact that there were no rules, and then left free to interact with the Props for up to a maximum of 20 minutes. I was not involved in the interaction, but I was present for the whole duration to film, time, organise the sequence of the tasks, supervise the platform and reconfigure the Props in the pause between the workshops.

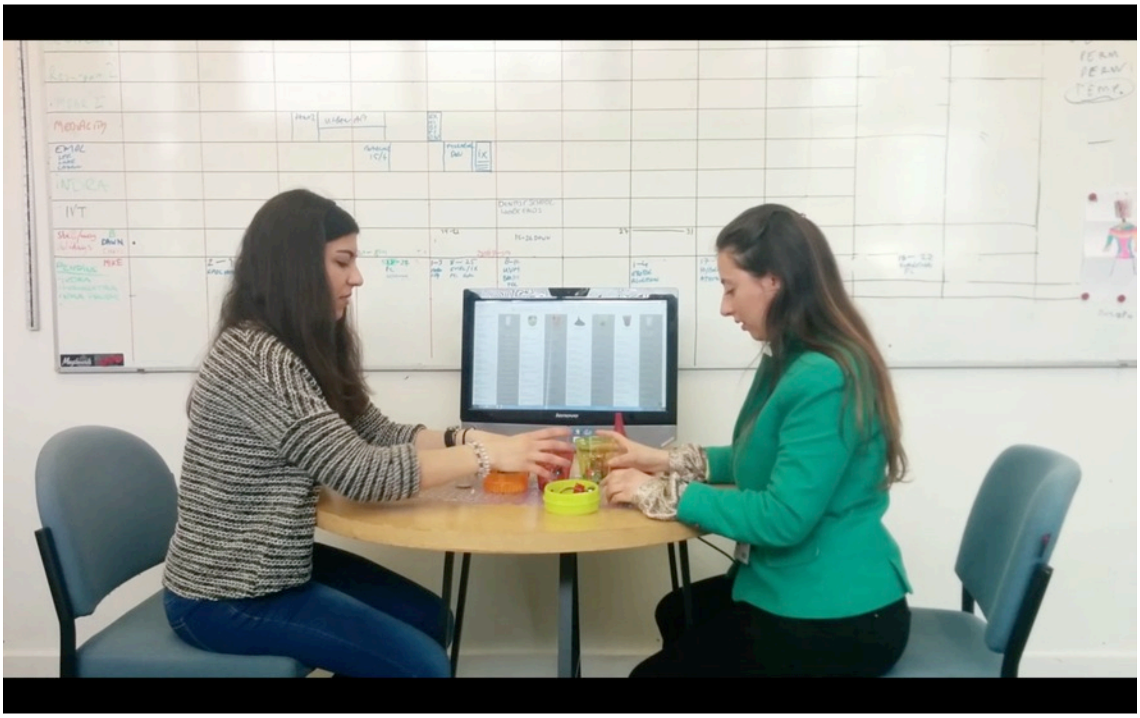

Figure 27 - Third intervention with Inge and Valentina, Plymouth, 2015

Compared to the initial MediaCity workshop and intervention, another difference was the fact that no audience was present at the interventions, allowing the participants to be fully free from external conditioning.

Figure 28 – Fourth intervention with Alessandro and Daniela, Plymouth, 2015.

6.2.4 Evaluating the Internet of Props: methodology and analysis

The questions asked at the beginning of this thesis (p. 30) reflected on how a performative design-framework can be evaluated and on the Props as a performative device, in relation to the major ontological stand that this research has taken. This section will expand on and detail techniques and strategies, mostly within CA, that have been used for this purpose. These strategies inform and are applied in the analysis, which comes later in this section. Overall, the framework attempts to give insight into multimodal way of interaction among humans and non-humans and, in particular, it aims to gain experiential information of the new ontological dimensions that are intrinsic issues to the IoT. As a toolkit, the Internet of Props comprises of the Smarter Planet Lab and the Props. The platform (Smarter Planet Lab) is not evaluated in this section as the cultural and theoretical issues are already embedded into the definition of the technical requirement and it is implicitly assessed through the analysis that follows. The workshop, interventions and the Props will, therefore, be the focus of this evaluation.

Given that the interaction in Transactional Props provided a context for unifying different design techniques: bodystorming, role-playing, technological props, it required an evaluation that accounted for the complexity of multimodal-communication. It also required the evaluation of performativity as a fundamental design-tool and locus (not using performativity to evaluate design-tools or practices).

To summarise, the design process involved: a platform as a cultural tool; a design framework (the Internet of Props); and a toolkit (workshop, intervention, Props). In the workshop, participants found themselves in an unfamiliar context dealing with a setting that involved: a table, 2 chairs and the speculative and technological probes: the Props. There were no predefined rules of communication and interaction to start with and everything needed to be negotiated in the making. The workshop and the intervention were run with a group of Undergraduate final year and PhD students at Plymouth University. The intervention was then repeated for other 3 times with the involvement of researchers and PhD students at Plymouth University. The demographic of the participants was adults (aged 18 to 45) at different level of education. 12 people in total participated in the workshop: 4 were female, 8 were male; and they teamed up in the couples:

- 3 only male;
- 2 mix male and female;
- 1 only female.

The tables below show the participants across all sessions of the Transactional Props, individually and in teams.

Name	Age	Gender	Profession	IoT knowledge	Technology adopter
Inge	26-30	Female	Student	No	Laggards
Valentina	26-30	Female	Student	No	Laggards
Daniela	26-30	Female	Researcher	No	Late majority
Alessandro	26-30	Male	Researcher	Yes	Early Majority
Robert	18-25	Male	Student	Yes	Early Adopter
William	18-25	Male	Student	Yes	Early adopter
Luke	18-25	Male	Student	Yes	Early adopter
Vicktor	18-25	Male	Student	Yes	Early Adopter
Gerrit	18-25	Male	Student	Yes	Early adopter
Chris	18-25	Male	Student	Yes	Early Majority
Elena	36-40	Female	Researcher	No	Late Majority
Davide	36-40	Male	Professor	Yes	Early Adopter

Table 3: List of all Transactional Props' participants and personal information, presented according to the dyads structure

The setting of the intervention is hybrid in that it is neither in the field nor in the laboratory, in a sense we can consider it as just unfamiliar setting to provide an unfamiliar experience. "Unusual and extraordinary experience can have qualities of everydayness" (Benford et al. 2013: 6)

In accordance with CA analysis, the study had to observe the natural behaviour of the participants with no interference from the researcher. The objects of observation are the participants in dyads (small group settings). The length of the interaction was up to the participants for a maximum of 30 minutes. None of them exhausted the full length. In that sense, the participants were left free from the beginning to decide the duration of their engagement. The duration data were collected and are part of the overall set of information that is counted.

The workshops were a difficult set of events to capture, as they were contingent and relied on social and, "personal configurations" (Jacucci, 2005: 23). In order to catch these configurations, the study implemented a series of strategies and tools to provide data analysis (via CA and other techniques): video-recording; transcripts with coding of both verbal and non verbal communication;[91]direct observation, for a qualitative and holistic evaluation; Props sensors data; and design cards.

The research sessions were recorded through audio-visual devices, in accordance with Conversational Analysis method for the analysis of dynamic interactions (verbal and non verbal) in everyday situations: "[…] The visual aspects of the interaction, a special argument for using video over audio applies to those settings in which core aspects of the action relate to the physical environment, the use of object, technological artefacts, and/or the body or bodies of one or more of the participants" (quoted by Have, 1999/2003: 72). Video recording is one of the most common techniques used in Conversation analysis as it allows a full account of what happened and not just the verbal communication: "Video recording provides a wealth of contextual information […] [Recording] should catch 'natural interaction' as fully and faithfully as is practically possible" (Ibid.: 72 and 68). I was absent from the recording, but present at the sessions to operate the camera and as an external observer for more holistic and qualitative analysis. The video recording was used as an

[91] For notation syntax consult the Appendix; the transcriptions followed Have's guidelines (2003).

unobtrusive technique to allow the participants to freely interact without the need of any cumbersome tracking devices (i.e. eye tracking headset). The material recorded by the video camera has been then transcribed using a conversation analysis transcript notation convention (see Appendix 3 for notation conventions); the information collected from the participants on the design cards was also transcribed (see Appendix 4 for Card Transcript).

The main transcript from the video was labelled (Action and Rules) for automatic analysis and then processed through one of the standard conversational analysis software, Nvivo. Part of the research was, therefore, run automatically and part was run manually. To give a more holistic view, the results were then cross-referenced with other data collected and the observations of the researcher.

6.2.4.1 Plotting the analysis, linguistic and non verbal behaviour

Conversational analysis was implemented with two main targets in mind: the emergence of performative aspects in the interaction; and the roles and entanglements of the participants with the Props. In exploring the data collected during the workshop and the interventions, different levels of social interactions and different levels of conversation were put under observation via the observation of verbal (semantic, both linguistic and informational) and non-verbal communication (gesture and addressing). The analysis looks for various cues: linguistic, visual and acoustic to understand the interplays occurred on the sets of the intervention. The verbal evaluation assesses the performative aspects looking at the text to find out the performative qualities of the dialogue between the participants. In linguistic terms, these can be found in what the theory defines as, "performative utterances" (Austin, 1962); sentences, which do not aim to describe a given reality, but in describing the reality, change the social reality as well (the phrase, "I promise" is a good example of this). This linguistic evidence is used to study conversation and social interaction in particular in small group-settings, which was the setting of the Internet of Props. The analysis focused on identifying the presence and recurrence of performative utterances: "the usual verb with the noun 'action': it indicates that the issuing of the utterance is the performing of an action – it is not normally thought of as just saying something"(Austin, 1962: 6-7). As, Austin claimed, in order to perform an act, utterances need to respond to certain conditions:

- *they are utterances which belong to the grammatical category of 'statement';*
- *grammatically, they occur in the first-person-singular present-indicative active;*
- *they are utterances which do not 'describe', 'report' or constate anything; and which cannot undergo a 'true or false' categorisation;*
- *the uttering of the 'statement' carries out the act named by the verb, that is, it implies something more than just saying some words.* (Alvarez, **2005:686**)

Evidence of a performative utterance is identified in its performative verbs (e.g. the word, "promise" in, "I promise"; in saying the phrase, an act – that of promising - is undertaken). Austin provided categorisations and taxonomies of performative verbs and the utterances that they produce: verdictives, exercitives, commissives, behabitives and expositives).

The exercitives, as a way of exercising of powers, rights or influence (i.e. appointing, voting, ordering, urging, advising, warning, etc.) (Ibid.: 151) can be applied in this case. In addition, the research would concentrate on finding evidence of directives, which are attempts by the speaker to get the addressee to do something (paradigm cases: requesting, questioning). Also, the use of the passive is possible, with, "the verb in the second or third person (singular or plural), and the verb in the passive voice" (Ibid.: 57). This part of the analysis was carried out manually, through a 'qualitative hermeneutic linguistic' evaluation of the transcript, sampling one of the interactions (Luke and Vicktor).

The other question of the relevance of the Props in the performative design framework follows an analysis of what Goffman called, "focused interaction": "the kind of interaction that occurs when persons [small groups of 2 or 3] gather close together and openly cooperate to sustain a single focus of attention" (1963: 24). In the workshop, the small group was comprised of humans and non-humans, a dyadic setting with two participants and a number of Props. The use of Props was investigated through the non-verbal account of dyadic interaction by manually looking at non-verbal cues related to body gesture and facial poses (smiling, gazing, nodding, laughing, smiling, etc.). It involved observation and interpretation of body and facial cues, through the analysis of the video recording, a standard practice in research methodologies of non-verbal communication (Scherer & Ekman, 1982). According to the non verbal analysis review conducted by Gatica-Perez (2009): "Conversational patterns exist at multiple time scales, ranging from addressing (i.e., who speaks to whom), to a large variety of turn-taking patterns of longer temporal support including floor control mechanisms, discussion types, etc." (2009: 1777). The scope, in this case, was to highlight pattern of behaviour in the multimodal interaction that might show the emerging entanglement of humans and non-humans. In this configuration, the gaze or the head pose was significant to understand what, in the social psychology literature in particular in non verbal behaviour and non verbal communication in human interaction (Knapp & Hall, Scherer & Ekman), is known as, "addressing", as these identify who talks, to whom and when **(**Scherer & Ekman, 1982**)**. Gesture, as in any visible bodily action by which, "meaning is given voluntary expression" (Kendon, 1983: 13), was also considered, by sampling one specific video (Luke and Victor). As well as direct observation, a wordcloud was generated from the transcripts for both verbal and non-verbal communication analysis. The Design card transcript was also analysed to look for behavioural patterns in the role-playing aspect of the Props. Finally, a statistical test was carried out to check the T Value of the consistency and validity between verbal and non-verbal data. These were the strategies used to explore the data and information collected during the workshop and the interventions. They are not purely analytical and require a hermeneutic effort in the study.

6.2.4.1 Analysis

A preliminary examination of the data and the material collected (video and transcript) helped me to familiarise myself with the materials collected. In the initial planning of the workshop and interventions it was presumed that three stages of interaction would allow the study of an evolutionary conversation and would create more awareness of the behaviour of the Props. In practice, this was not possible, due to the timing and the low quality of the material collected. The material available covered two sessions in two cases and in the reminder only one. For consistency, it was then decided to use only one session for each dyad. The sessions selected were the ones that had the same setting for all the interventions, in order to provide comparable data.

The first relevant task was to import the data from the transcript into the software for CA qualitative analysis, Nvivo, and to label them according. The following factors were tagged in the entire set of transcripts as significant information for the investigation: participants: to weight and differentiate the contribution of each participants; and theme (to weight, identify and compare key factors of the interaction: Rule, Data and Action).

During the coding phase it was noticed that (predominantly) the non-verbal elements corresponded to the Action Theme. This convergence served both purposes: labelling the non-verbal elements and categorising any action that happened during the intervention. The table below summarises this dataset.

All Session	A : Non Verbal	B : Verbal	Rules	Data
1 : ChrisGerritTranscript	17	39	4	0
2 : LukeVicktorE2Transcript	40	76	7	8
3 : RobWillTranscript	28	56	3	13
6 :ElenaDavideTranscriptForVideo2	33	123	1	2
7 : AlessaandroDanielaTranscript	36	45	1	2
8 : IngeValentinaTranscript	57	145	9	0

Table 4: Full summary of Nvivo data for the interaction

The key parameters for the study were related to differentiate the verbal and non-verbal communication. The table below highlights the predominance of verbal compared to the non-verbal. A T-Test was run on those data in order to empirically and statistically verify the how significant the predominance of the verbal communication in the interaction was over the non-verbal, and to validate the dataset. The p value obtained was 0.0289 below the threshold of 0.05, the number that defines statistical inconsistency in the set of data. This proved that the values were consistent and that the verbal analysis would have represented an essential part of the evaluation of the framework towards the final findings.

After verifying these quantitative elements, the research proceeded to the linguistic grammatical interpretation by analysing the transcript in order to identify the performativity conditions specified in the previous section. This was carried out in accordance with Austin's categorisation of performative utterances. It was done on one sample transcript, as during the direct observation it was noticed that the interactions followed similar pattern across all the iterations of interventions. Below are extracts of the conversation between Luke and Vicktor that reveal the presence performative utterance.

Vicktor: Make that move.
Luke: But, You've got to, Okay, ***well I'm going, I'm going*** *()*
Luke: ***I'm going, I'm going to go with force****,*
((Luke stands force piece up))
Luke: ***I'll put it*** *in that corner*
((Luke moves orange playing piece to the corner nearest Vicktor))
Luke: ***We're making rules***
*Vicktor: [Basically****, I can't] touch*** *your sensors and you can't touch mine*
Vicktor: I don't understand the rules
((Luke moves prop onto board))
Vicktor: See, now you can't touch that.
Vicktor:=and ***I can't steal yours****.*
((Luke points to screen))
Vicktor: ***I win(h)***

It is possible to observe that, the conditions identified by Austin (first-person, verb at the indicative present, and exercitives or directive performative verbs) are in the dialogue and characterise the conversation. In general, these utterances were most often associated with the definition of a new rule in the negotiation of the interactive process.

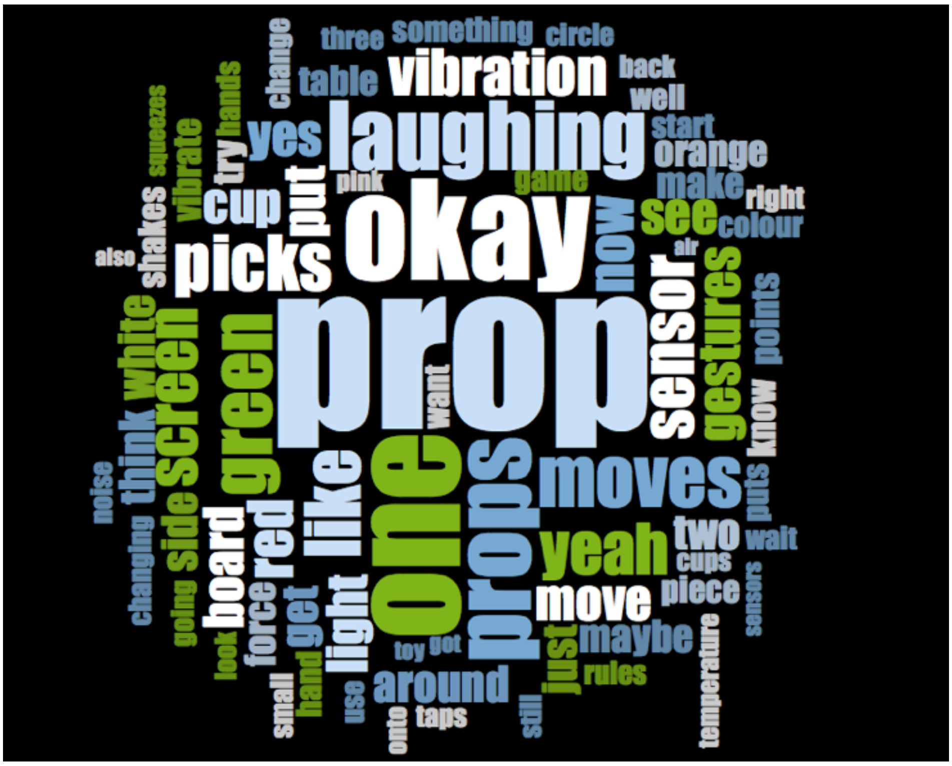

Figure 29. Wordcloud of ALL interventions

Through the Nvivo visual reporting features, a wordcloud of all the interaction was generated. The wordcloud above visualises the word frequency, weighting the most popular ones with bold and big fonts, similarly to a tag cloud. Among the most frequent words it is notable the recurrence of generalised acknowledgement ("Okay", "Yeah"). These were intended as signals of agreement between the participants, and by rephrasing them into an explicit format, they correspond to the performative utterance, "I agree" (Austin, 1962). Moreover, according to Zimmermann, they also serve, "to show participation and continuous engagement" (1982: 530).

The visual observation of the video-recording produced data related to the presence and recurrence of visual clues of non-verbal behaviour, such as head pose/gesture and contact. This was carried out by selecting a sample (MediaCity_VL_Stage2_front_low) as being a more significant and clearer example of the interaction, and usefully segmented in two parts: 2) initial exploration and 2.) definition of rules. In fact, the interaction was richer and more intense in the first segment and more structured in the second (when rules of interaction were negotiated, agreed and implemented by the participants). The first segment lasted 4'07" on an overall duration of 11'13". From the video segment, a series of time markers was produced to show when the event started and when it ended; following that the duration of each event was calculated. The head pose and the gesture were marked, by looking at the interaction between each participant and the Props, both as signals of the involvement of the Props in the conversation. In particular, the head pose is a parameter used in behavioural methodologies to identify addressing, an aspect of small group interaction that identifies the speakers' focus of attention.

Luke Head Pose			Vicktor Head Pose		
Start	End	Duration	Start	End	Duration
00:20	00:23	00:03	00:00	00:02	0.02
00:35	00:56	00:21	00:13	00:15	0.02
01:14	01:17	00:03	00:19	00:20	0.01
01:18	01:19	00:01	00:23	00:28	0.05
01:22	01:24	00:02	00:36	00:39	0.16
01:25	01:26	00:01	00:50	00:56	0.06
01:30	01:36	00:06	00:59	01:30	0.71
01:37	01:43	00:06	01:31	01:50	0.19
01:43	01:45	00:02	02:00	02:10	0.10
01:47	01:58	00:11	02:15	02:17	0.02
01:59	02:11	00:12	02:20	02:21	0.01

02:13	02:23	00:10	02:25	02:28	0.03
02:25	02:26	00:01	02:29	02:50	0.21
02:28	02:51	00:23	02:54	02:55	0.01
02:52	02:57	00:05	02:56	02:57	0.01
02:58	02:59	00:01	03:01	03:07	0.06
03:01	03:02	00:01	03:30	03:34	0.04
03:05	03:07	00:02	03:36	03:37	0.01
03:08	03:10	00:02	03:42	03:45	0.03
03:11	03:30	00:19	03:48	04:00	0.52
03:35	03:38	00:03	04:03	04:07	0.04
03:39	03:43	00:04			
03:58	03:59	00:01			
		02:20			**2.31**

Table 5 – Timing of the eye contact (head pose) between participants and props

Luke Gesture			Vicktor Gesture		
Start	**End**	**Duration**	**Start**	**End**	**Duration**
0.00	0.19	0.19	0.00	0.43	0.43
0.21	0.41	0.20	0.47	0.48	0.01
0.46	0.48	0.02	0.50	0.52	0.02
0.53	1.47	0.94	1.00	1.01	0.01
1.48	2.01	0.53	1.02	1.23	0.21
2.05	2.29	0.24	1.24	1.28	0.04
2.30	2.31	0.01	1.32	1.37	0.05
2.35	2.42	0.07	1.38	1.55	0.17
2.46	2.50	0.04	2.00	2.15	0.15
3.02	3.05	0.03	2.30	2.45	0.15
3.10	3.31	0.21	2.46	3.05	0.59
			3.08	3.35	0.27
			3.37	4.01	0.64
		02:48			**2.74**

Table 6 - Timing of the hand contact (gesture) between participants and props

In a segment of the video from Victor and Luke's interaction, over a period of 4'.07", Victor 's gaze was directed towards the Props for 2'.18", a similar value compared to Luke, 2'.20". This shows a prolonged addressing of both participants' attention toward the Props. The engagement of the participants with the Props was even more evident in the duration of hand-Prop contact and associated hand-gestures, which in the case of Victor lasted 3'.14" and for Luke 2'.48".[92] Overall, they all had a prolonged interaction with the settings as the table below shows, the average time of one stage interaction was 8'.11".

All Session	Duration
1 : ChrisGerritTranscript	03:50
2 : LukeVicktorE2Transcript	11:33
3 : RobWillTranscript	03:33
6 : ElenaDavideTranscriptForVideo2	10:44
7 : AlessaandroDanielaTranscript	09:11
8 : IngeValentinaTranscript	10:19

Table 7 – Overall duration of all interventions

The direct observation helped to point out that engagement with the settings was positive and proceeded at an intense pace, however, the participants without previous IoT knowledge mainly used the Props for their physical qualities, e.g. "to fly in the air and not to throw like fireworks". This is observable in a comparison of Tables 2 and 3. In Inge and Valentina's interaction there was no use of sensor data. The participants with previous knowledge of the IoT paid particular attention to the data generated by the Props, and some of them were actually able to use the data to establish a communication with and through the Props in a meaningful way during the

[92] None of the participants seemed intimidated by the Props; once sat around the table, the interaction started almost immediately, and once it was clear that rules needed to be negotiated the conversation started to flow.

interaction. The sensor data was embedded into the conversation to the extent that it formed game and a winner was celebrated at the end of the interaction.

((Will shakes the vibration sensor))
Will: 4000
((laughing))
Will: 1 2 3 4 5 6, Yeah(h)::
((Will raises both hands in air in celebration))
Will: I win
((Rob gives little sensor to Will as a trophy and will places the piece on his head))
Will: I am the king
((laughing))
((Will poses for pictures))

The interaction was rich and developed some interesting strategies related to combining the Props according to their colour and shape. Combinatory strategies emerged in the interaction as appeared in this action:

((holds RGB LED against the red prop))

The strategies (both physical and digital) were then turned into rules and when that happened, it was observed that the interaction flowed in a more structured manner. Below is an extract from the interaction between Valentina and Inge.

Inge: So you can have the green glass-
((Hand green prop to Valentina and the vibration sounds))
Inge: So(.)mmh:: (.) do you want to start?
Valentina: Yes(.) okay
((They begin to move props around the table, taking it in turns))
Valentina: on you! ((Laughs))
Inge: I don't know
Valentina: Mine, Mine ((Valentina points to green cup prop and green circle prop))
Inge: ( )
Valentina: No (.) One, two, three I won, I put this in here

Finally, the analysis looked into the card transcripts; the role-playing element of the workshop. It was noticed that the participants (almost naturally) tended to project human agency onto (personify) the non-human Props. The personification and the projection of human feelings and emotions onto Props, e.g. "I'm happy", was standard in the participants' 're-programming' of the Props, carried out through the Design Cards. (The bodily-interaction established in the first round of workshops was more significant, because no subjectivity was pushed into the props.) The implementation of behaviour in the Props through the design cards did not create any particular notable change in the interaction. In most of the cases, the participants did not seem to be particularly interested in the digital information generated by the Props and they paid more attention to their own physical responses or behaviour. This ends the analysis and the findings that have been produced, the thesis will move now towards its conclusion.

Chapter summary

The aim of this chapter has been to present how it would be possible to design IoT systems with sensors, networks and other distributed computational devices. The practical methodology comprised of:

- *a platform;*
- *a performative design framework called IoP;*
- *and a toolkit: Smarter Planet Lab, Props and Transactional Props.*

The framework was practiced through a workshop and some interventions under the name of Transactional Props. Transactional Props extended Ascott's original work in a continuum that links the first cybernetic and telecommunication art to the latest IoT experiments. It looked at a performative pathway of communication between humans and non-humans. There are aspects of being in the world (of humans and of non-humans) that are not cognitive, not representational. To think about these, we need to use different paradigms, such as performative ones. This chapter has given a detailed account and description of the practice element of this study and its contributing theories.

A conversational analysis explored a dataset produced via the workshops. This data was interpreted as empirical evidence for the great richness in the interaction that could emerge from the open framework of the Internet of Props. The Props proved to be a useful, creative tool to opening design possibilities that could account for verbal and non-verbal strategies and the open-source IoT platform implemented at Plymouth University was apt for engaging in this sort of experiment.

This chapter described and analysed the design framework and the practical implementation of the conceptual model, the ontological performative model defined as the Internet of Props. In this part, the theory and the practice were connected in the study (as an overarching research methodology, the outcome of which be presented in the conclusion). The conceptual model here responds to the origin and emergence of the IoT. It has been defined through ontological and philosophical engagement; and the practical elements described, documented and evaluated here elicit the theoretical knowledge as situated and performed. This practice - the enabling platform and the definition of a design workshop and intervention - is an original contribution to the overall research agenda of the IoT field and goes under the definition of the Internet of Props. The practice elements[93] *embed the performative-ontological approach that has characterised the research so far.*

In the final chapter, the ways in which the conceptual and practical framework presented here, respond to the limitations in theory and design for the emerging field of the IoT, will be discussed. As we will see, the performative and the relational concepts of this ontology are a way of interpreting the new reality of the IoT, and a substrate for the design framework.[94]

[93] Following, is a list of these components and the actions undertaken as part of the research:

- Co-designing and implementing the enabling platform, defined as Smarter Planet Lab;
- designing and prototyping of the Props as an interactive speculative and technological probe;
- planning and defining the workshop and intervention named Transactional Props and inspired by Roy Ascott' cybernetic art work Transaction Set (1971);
- evaluating the outcome of the IoP via a conversational analysis.

[94] As in Ascott's cybernetics, they inform the definition of the platform as well the design of the interventions.

CHAPTER SEVEN. Conclusion

Chapter Introduction

This section will conclude the study by summarising the fundamental achievements, and by reflecting on the findings that could open further investigation (either deeper into the line of thinking or following into novel trajectories). The research started by questioning the very basic element of the new technological field known as the Internet of Things – in particular the ontological essence of the word, "things". This initial speculative interest developed into some foundational discussion, which was then interwoven with design theory and practice. From a practical point of view, this was aimed at the definition of a platform that embedded the ontological theoretical approach, a design framework called the Internet of Props and a design practice called the Transactional Props. The final part of thesis saw the documentation and analysis of an instantiation of the framework: a practice-based series of interventions.

The objectives of this chapter are to reflect on the design framework and toolkit, and to point out the contribution to knowledge that the study and practice brought to the field and to contemporary discussion about the IoT. Through the definition of the original (performative-design) approach, the research also broadened the discussion of the IoT into ID and HCI. In doing so, this study makes a significant contribution.

7.1 Development of an argument, by chapters

A summary of each individual chapter constituting the body of this investigation is provided at this point, in order to synthesise the route followed and the key aspects the study dealt with. This summary should help to review the argument carried out from the theoretical discussion to the development of the practice, and from the practice to the final evaluation. The aim is to prove its consistency and to show the validity of the methods undertaken throughout the research. The mixed-method approach taken was informed by a broad set of disciplines, and involved:

- conceptual scaffolding through the investigation of a new vocabulary (this also brought in the definition of a new ontological-performative social-dimension);
- translation into design theory through the identification of a performative approach;
- definition of the Internet of Props as a performative design-framework and a toolkit that proposes a test-bed platform for critiquing the IoT;
- experimentation through a design series of interventions that enacted the theory and looked at the responsiveness of the framework and the emerging interaction dynamics;
- evaluation undertaken through a conversational analysis that observed the performative and behavioural quality of verbal and non-verbal interaction.

Chapter One started by establishing the research field and introducing the IoT. The IoT was there set into the broader context of investigation in the trajectory of the more established Ubiquitous Computing, by presenting initiatives and projects in industry and within institutions. Furthermore, the first chapter reveals something of the impact of the IoT on society as a whole (at the time of writing) and the initial attempts of researchers and practitioners to explore the

IoT's potential and define a vision for it. As a result of this exploration, deficiencies and issues emerged that were instrumental to setting the argument and defining the methodology for the thesis. This led to a **Chapter Two** that dealt with the matter of the difference between, "things" and, "objects" in relation to the IoT. This matter was left virtually unquestioned at the time of this thesis' initial theoretical investigation (2010/11). It is a difference that is, however, at the heart of Western thinking, and established within the basic dualistic concepts that oppose subject and object, human and non-human. In **Chapter Three**, it was explained how the polarity between subject and object found a resolution in Philosophy. Through the attempt to overcome this division, Philosophy has established an ontology of things and the social, as a novel vision of the world. Thus, this thesis contends, in the context of the IoT, Things can be introduced as a relational entity. (It was through this subtle, speculative vocabulary change that the basis for the development of an argument was found, by following the consequences of the distinction throughout the social dimension of Things.) **Chapter Four** moved towards an exploration of the social dimension as anticipated by the shift from the dualistic approach to the relational. After establishing the Thing as a relational entity, the chapter reviewed social and anthropological theories that have looked at extending our concept and notion of the social, to include non-human entities. This emerging model is a dynamic topography that has previously been defined in various (almost synonymous) ways: as a meshwork, a réseau (network) or an entanglement of different entities, material and immaterial, human and non-human. The implications of this paradigmatic shift into a new social-dimension are still not understood and many human domains (including Computing and Design) are just at the beginning of a process of dealing with them. A review of these highlighted some theories (Actor-network Theory, entanglement and meshwork) that provided elements that contributed to the move into a practice mode in **Chapter Five**. In turning abstract concepts into a design framework,[95] Chapter Five took on-board the speculation of the previous two chapters and made a move into the design and technological realm via two turns: one ontological and one performative. Both turns found a synthesis in the approach of Cybernetics, which is in its essence a practice-based theory. The chapter continued by defining a new class of entity - the Prop - that embodies both the performative and the ontological dimension in line with the cybernetic vision. From the notion of Props, the chapter developed the Internet of Props, as a design framework for the IoT. **Chapter Six** dealt with the Internet of Props as a toolkit, and the notion of Props as a technological probe and a speculative design tool. The IoT was translated into practice through Transactional Props, an IoT version of the cybernetic intervention by Ascott's *Transaction Sets*. The practice incorporated the elements highlighted in the figure below.

[95] Here, Ng's model of value-creating and the constellation map provided a good example of a translation of abstract theory into a real design-model.

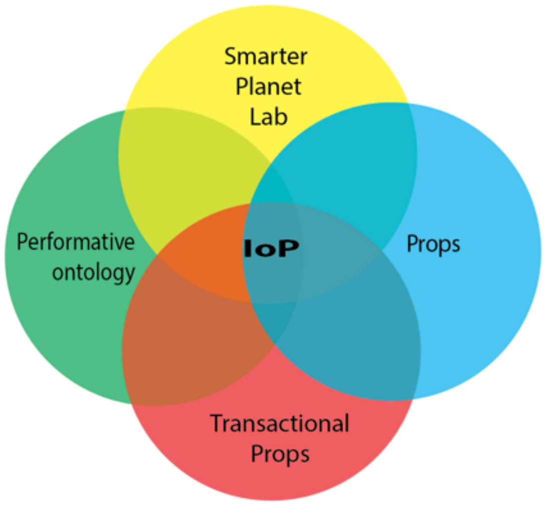

Figure 30 - Overview of the key components of IoP framework

The platform was the instrumentation needed for the Internet of Props to operate. The workshop Transactional Props was where the new extended society of the IoT was enacted. After the workshop and interventions, the study undertook a conversational analysis to qualitatively and quantitatively study the outcomes and point out patterns of behaviour in the interaction between humans and non-humans.

The next section will reiterate the research questions set at the start of this thesis and assess how they how well they have been answered.

7.2 Smarter Planet, Props, Internet of Props & Transactional Props

The thesis set a major question at the beginning of the study:

> **Can the underlying concepts of the Internet of Things be critiqued through performative design?**

In order to answer this question, the research has taken a very interdisciplinary approach: a theory-driven practice-based investigation, which integrated existing knowledge from various disciplines and mixed-methodologies (the table below summarises a combination of the strategies, both theoretical and practical).

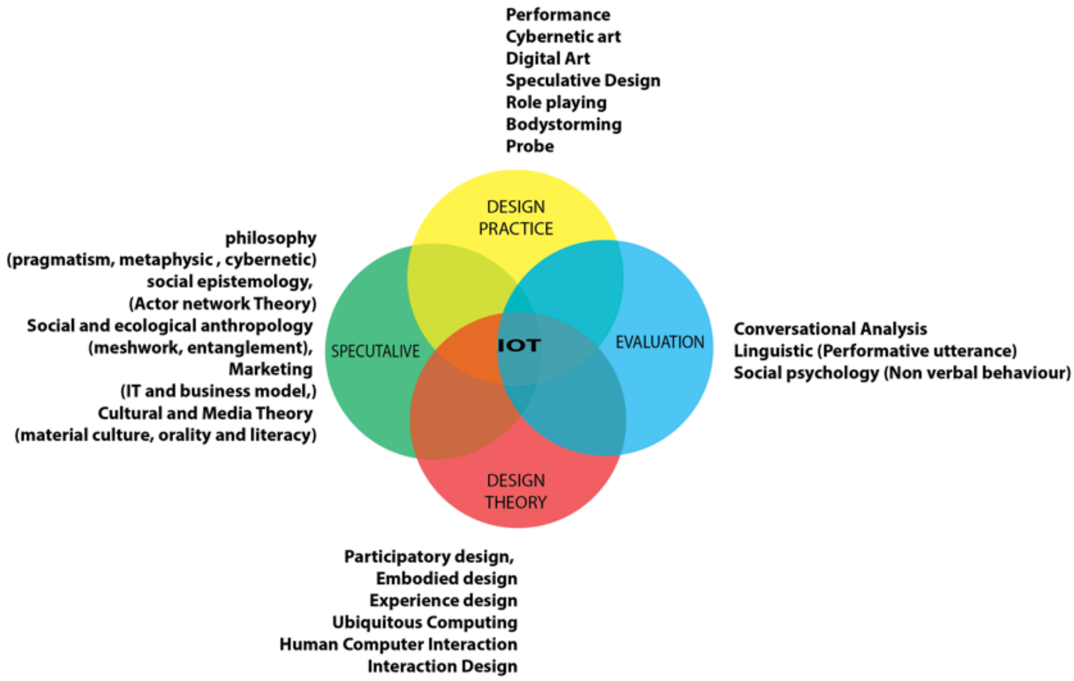

Figure 31 - Summary of theoretical and practical strategies employed in the research.

The theoretical stand taken throughout the research was informed by a performative-ontological approach, showing that theory can guide practice if reality is considered as, "in the making" (James, 1907: 123). The sub-questions that were deemed by this thesis as key to the resolution of the main question are reiterated and addressed below.

A) Is the existing discourse in IoT adequate and what are the gaps and omissions in this discourse?

The thesis started by providing a wide snapshot of the new IoT landscape, its predecessors (Ubiquitous Computing) and the various declinations and instantiations available in the academic and industrial domains at the time (up to and including 2010). This revealed a fast-growing, fragmented field, driven mainly by economical and technological factors, and informed by obsolete design models and methodologies derived mainly from Ubiquitous Computing. The inadequacy of these models, methods and techniques was identified as a fundamental omission in the discussion around the IoT. At the time of writing, HCI and ID (the other possible lead for the IoT) had moved away from task-driven thinking and embraced a more-embodied approach, but their outcomes were still culturally and philosophically contradicting their premises. The reason behind this was identified as a lack of adequate frameworks and techniques.

B) What is the significance of the difference between objects and Things and what are the ontological consequences of this debate?

In questioning why the IoT refers to Things and not to objects, the research uncovered the IoT's philosophical heritage; a longstanding discussion whose implications are even more urgent today in the light of this new technological change. The dualistic polarities of object and subject, which have long framed Western science and thought, have proved insufficient in responding to the changes in the physical reality around us. The shift from the representational to the performative idiom is not reflected in how the reality (the computational, informational and communicational) is shaped. Unpacking the dualities revealed a new social dimension, based on Things as relational entities. The entanglement, the meshwork or the réseau, with their energies, flow and information (rather than the agency of the separated entities), became prominent in the discourse of this study. The thesis followed these lines of thoughts across various disciplines, before finding a synthesis through cybernetics and ontological theatre (Pickering, 2014), and then defining its own performative-ontological framework. It is possible to say that that cybernetics, as a practice-based theory, provided the research with both conceptual and practical inspiration.

C) Can props be used as a performative device to expand and critique the way that the IoT is conceptualised?

Props, as an ontological device (a Theory Object), were placed at the intersection of the Internet of People and the IoT, of Facebook and 'Thingbook', to experiment with the interplay. Props were defined as a new class of entity and the Internet of Props was constructed around these, to enable the emergence of new dynamic interactions (as the ubiquitous, social dimension of IoT requires). After the set up of the Lab, exposing participants to Props was the next practice act in the research. The Props familiarity (as kitchenware) was made unfamiliar by the intervention setting and by the permutation of common everyday-objects made into an IoT Thing. Moving theory into practice, the Props became a real physical Theory Object (Sterling, 2006). The Props were designed as a speculative, provocative technological probe to capture and instigate changes in behaviour. Props (in a theatre and ritual context) are performative entities. In this new (Internet of Props) context, it was hoped that they would challenge the idea of perceptions, the boundaries of material and the immaterial, become potential instances of the IoT. The Props in the Internet of Props are constructs, built on uncertainty and ambiguity that allows meaning to emerge with interpretation, participation and interaction. They were developed to embody both Latour's and Ingold's ideas, to operate as a generator of meaning, and as such, they played a role as activators of social dynamics, as noticed by the rich interactions during the interventions. The Props were instrumental in establishing a high level of interaction between participants; and the richness of the social interactions was revealed through the strategies and rules that the participants established during the sessions.

D) What is the necessary infrastructure to enable the Prop to be enacted in the world?

As Benford et al. pointed out, it is problematic to translate theory into practice, and to do this, "we truly need tools and platforms that embody these mechanisms to the level of code" (2013: 16). By embedding the critical (hence cultural) elements from the ontological discussion, the platform created here enabled a communication network where all elements were treated at the same level (with no distinction being human or non-humans). This network was instrumental in supporting the framework, the Props and many other projects that have been developed since the Smarter Planet Lab was established at Plymouth University in 2010.

The definition and development of the Smarter Planet Lab filled a essential technological and cultural gap in the IoT, and provided designers with a tool for rapid and agile experimentation and prototyping. This research outcome involved co-designing, prototyping and implementing a platform that embedded the cultural and ontological principles omitted in the common understanding of the IoT of the time (pre-2010).

The workshops helped raise questions, such as how to support an open-ended design-process through a platform, and how to improve requirements in the definition of an open-ended design-process.

E) How can this performative design-framework be evaluated?

What are, "the results, the sign, and the reward of that interaction of organism and environment which, when it is carried to the full, is a transformation of interaction into participation and communication[?]" (Dewey, 2005: 22). Installations and performances are experiences that share qualities with daily-life events (ephemerality, physicality, interactivity etc.). In this sense they can be used as a kind of parallel with the IoT context. Conversational analysis evaluation techniques derived from social psychology and linguistics proved to be an effective method to study naturally occurring interactions in this context.

This research has shown that the design framework (bodystorming, Props etc.) enabled rich interaction. Direct observation, video-recording combined with linguistic, communication and behavioural study-methods helped in describing the structure of this particular (Internet of Props) interaction and providing experimental evidence. A wealth of information was conveyed verbally and non-verbally. The linguistic method was effective in highlighting the presence of performative qualities, while the observation of body movements (head pose and gesture) showed a significant engagement of the participants with the Props. This last aspect also revealed the need for computational tools to map behaviour beyond video recording, in order to be able to increase the sampling in the analysis and give more universality to the findings. The results also showed that the Props activate a performative process and, in the way they are involved in the interaction, they show how there is an entanglement between the human and non-human in the IoT instantiation. Overall, this research has provided a valid opportunity to define ways of identifying and studying communication patterns in the organisation of interaction in the context of IoT.

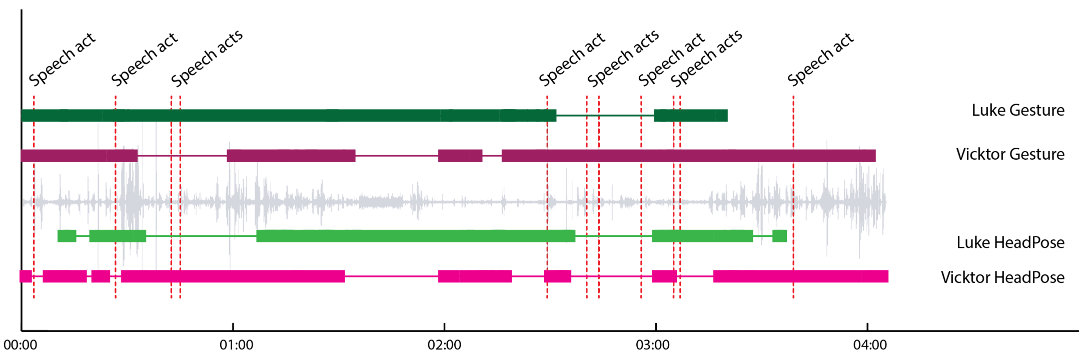

Figure 32 – The cross-referenced summary of all interactions (verbal and non-verbal)

In my view, the level of embodied behaviour and performative utterance is significant. The repeated physical contact between the participants and the Props during the former's performative utterances could conceivably be interpreted as a performative entanglement between the object and the subject, revealing a new-networked social-dynamic, in which the entities dissolve themselves in the interaction process.

These findings confirm the overall research question and the theoretical approach that was taken to inform the design framework, as a way of critiquing the underlying approach in the design of IoT project, products, applications and systems. The practice helped to highlight these aspects without necessarily resolving them. It was however, observed that participants did not like to be distracted by screens or projections, and they were looking for a consistency of experience between the digital interactions and the physical ones (between the online and offline). By allowing 'acting before understanding', Transactional Props enacted a tangible understanding and provided an insight into the entanglements of human and non-human in possible IoT scenarios.

In my view, Props and the Transactional Props set up help to dissolve the established relationship between subjects and objects to encompass a more creative entanglement situation and a more dynamic set of relationships; setting a new context for the evolution of the IoT. I contend that the practice challenged fundamental aspects of the IoT. The Internet of Props implicitly required all the participants to question their understanding of how humans relate, both to each other and to non-human entities, and how humans develop meaning and value out of this interaction. At the same time, the participants engaged in a process of making new realities by enacting them around a table, which worked as a kind of 'design-divining' tool. The analysis shows how the link between objects, identifiers and sensors is the key to the new materiality of the IoT. Considering that (in most cases) this is done by retrofitting sensors or actuators, the project also shows how essential an open configuration is to this process.

The research has contributed by broadening the IoT knowledge-base by adopting a performative approach. Since the completion of the majority of this research, scholars in the field have regained interest in combining ID and performativity. A new emerging method goes under the title Performative Experience Design (see Spence, 2016). This research could, therefore, be considered an early contribution to this 'new' view in HCI and ID.

7.3 Impact on HCI and ID

The framework presented in this research is an attempt to overcome the limitations of more established ID methods, like participatory design and embodied interaction, in order to respond to the rapid advent of the IoT that accelerated the move to a ubiquitous world of technology. The framework and the practice also highlighted the need to rethink some of the standard HCI and

ID methodologies (such as scenarios or persona) and replace them with something more in line with the overall conceptual grounding. This is where the Internet of Props comes in, as a performative toolkit based on Props instead of Things or objects, and on flexible set-ups instead of scenarios. Scenarios are fixed in time, while the Internet of Props set-up is designed to be a negotiated context where rules are created and are dynamic, and are agreed among the participants in real-time. Thus, in the Internet of Props system it is, therefore, reconfigured as it plays out. Performativity describes our complicity in shaping reality; a performative task is a way in which reality is changed. The Internet of Props has a role in making things 'become'. When ID and HCI move their territory out of predefined environments and activities into the flow of life, they encounter a great challenge. Here, discussion about experience; participation, processes and behaviour, become central. The IoT offers this territory to the traditional context of ID and HCI, as it is fast becoming part of the everyday. Its a pervasive and, some would say, fully-mediated everyday-condition that, as this thesis has argued, has a lot in common with the ready-made, the Happening and cybernetic arts. Establishing the Props has also been important. Props have a performative dimension and they can be enriched with a semantic, narrative and symbolic level. The Internet of Props aims to establish itself as a design space for exchange of expertise between designers and participants as an, "embodiment of known expertise" (Wakkari, 2009: 302).

Furthermore, while dealing with the context of the IoT, this research attempted to address some methodological matters within HCI and ID and to design a framework that is drawn from a different hypothesis, and could, ultimately, challenge more-established ones. The framework developed through the practice could well inspire ID and HCI designers and IoT engineers in future studies. Suggestions for further study are outlined below (Section 7.5).

7.4 Challenges and limitations

> *Bringing things to life, then, is a matter not of adding to them a sprinkling of agency but of restoring them to the generative fluxes of the world of materials in which they came into being and continue to subsist.* (Ingold, 2011: 29)

The research had an underlying, very speculative and broad aspiration, which (as the quote above helps to put into perspective) was a major challenge. The issue of agency (agency in general, and the kind of agency objects are gaining in the new technological context) as fundamental to any discussion on the IoT was questioned from the start. This study and the line of thought that it has acknowledged (i.e. Latour, Ingold, Pickering) looked beyond this to other key issues[96], but it must be acknowledged that agency is, however, a critical concern that is part of the IoT discussion.

[96] Including, the everyday dimension as the context that the IoT deals with; its relational essence and the scale of the impact the IoT could potentially have on our lives.

This research was strongly guided by an approach that differed from the traditional representational/dualistic Western line of thought. According to this, Props were situated as 'against objectification'; as 'performative entities' that do not simulate, but are instead instigators of processes (just as they are themselves made of processes). They were designed to be a speculative provocation to induce a level of dynamism into systems; something that is difficult to gauge the success of. In a similar vein, In terms of the combined methodologies used to capture contingent processes; the issues of studying ubiquitous experiences are well known (Crabtree et al., 2006). The mixed-method analyses carried out to evaluate the framework here, have shown the challenges of the rigorous study of the ephemeral flow of live interaction, and of new dynamic-interactions between humans and non-humans. (Further work could be done in this direction, and non-intrusive computational technology could help to study these interaction sets.)

7.5 Concluding remarks and suggestion for further development

This research has developed a wide set of tools and methods: from the technological to the philosophical, and from the design to analysis. They all contribute knowledge to the field of the IoT. The Internet of Props is not meant to be a real life incarnation of the IoT. In the workshop and interventions, it is primarily meant to enable reflection upon, and the imagining of, the IoT. Transactional Props, put a framework into action, and provided with a method to validate and evaluate the outcomes. At the end of the study, the Internet of Props emerged, both as a conceptual toolset and an applied toolkit with space for development. In my view, it clearly establishes, "an underlying philosophical grounding that is appropriate to design" (Wakkari, 2009: 34).

There were underlying critical and practical aspects that it was not possible to deal with completely in this research, i.e. a full account of all non-representational theories and overcoming the technical limitations of Twitter (which cuts out feeds over certain range of frequency). The research has, however, created a comprehensive and integral body of knowledge around the topic in discussion. It has engaged with practical issues, shifting them to a more abstract level, in line with the discussions the IoT requires. This enabled a solidification of the conceptual foundation of the field (in particular, in dealing with the philosophical matters of dualism and in looking outside the traditional Western (representational) mode of philosophical thinking).

Future work could address the critical or undeveloped aspects that emerged during the investigation. Below are some suggestions for prospective studies:

- further development of the Smarter Planet lab as a platform for the Internet of Props, to allow for extendable open and reconfigurable settings (this could extend its use as a technological design toolkit);
- the exploration and translation of Performing Arts methods and techniques in relation to the Prop could help in informing new (practice-based) approaches to design practice;

- the implementation (as part of the Smarter Planet lab) of a non-verbal social-sensing platform to automatically record non-verbal communication (by identifying visual and vocal cues in a non-intrusive manner);

- exploration of the notion that each object has its own social-media presence, looking at questions of how interactions should be, happen and how this should be orchestrated;

- developing the constellation as a design technique might be a way to map everyday interaction and dynamically configure the network of connected elements;[97]

- The Props operated in a very specific situation, staged for the duration of the workshops and experiments. Observations of the behaviour of Props in the temporal flow of daily life in different settings could be further investigated;[98]

- this research looked at a specific example of value and meaning in an economical context, so identifying key indicators in values and meanings generation in cultural and social contexts could bring new insight into ID.

In conclusion, to be truly performative the IoT should stay open and adaptable to support the co-evolution and entanglement of humans and non-humans, something the Internet of Props brings a step closer.

[97] The constellation (via Ng) could be an effective working tool for the Internet of Props. As a working metaphor, it represents dynamism and, etymologically, it is linked to the creation of meaning and value in many cultural traditions.

[98] Testing the Props following the constellation map approach could also be explored, in order to evaluate how change of context influences interaction.

APPENDIX 1

LIST of Twitter Accounts created for each Props:

- @pnkGlass – A pink glass that vibrated depending on the movement by the green glass.
- @plstkFunnel – A plastic funnel that had a pressure sensor built in that passed the data through to Twitter.
- @grnGlass – A green glass that activated pink glass through a piezo sensor.
- @grnCutter – A green cutter that had a light sensor within it.
- @orngCutter – An orange cutter that detected the temperature.
- @fltNozzle – A flat nozzle that illuminated an LED light based upon random time and color values generated by the system.
- @spkNozzle – A spiky nozzle that had a tilt sensor within it.

APPENDIX 2

Information form for Ethical Disclaimer

The project is part of the PhD research (Internet of Props. A Performative Ontology for the Internet of Things).

The aim of the research is the identification of performative design model for the development of Internet of Things projects and intervention called the Internet of Props.

This research is a speculative inquiry into the ontological challenge between 'objects' and 'things' and the emerging social dimension in the context of the Internet of Things.

The aim of the research is the identification of performative design model for the development of Internet of Things projects and intervention called the Internet of Props.

The props are used to inquire into the critical aspects of IoT and also help to imagine and perform the future of IoT. Props act as an open framework to include participation in the creative act, to engage users in the definition of the design process. These are instruments for thinking about performing with and through the 'things' of IoT.

> *The term "Internet of Things" has come to describe a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects. (IoT 2008, International conference, Zurich, March 26-28, 2008)*

The practical experiment will explore the entanglement of humans and non-humans (i.e. objects) and the convergence of the Internet of People and the Internet of Things.

The participants will be exposed to a IoT platform made of a table and common plastic objects (i.e. funnel, nozzle tips, etc) digitally enhanced with sensing (i.e. force, vibration, temperature, light) and communication technologies (wi-fi connection). Each object has a Twitter account and will tweet the data generated by the sensors attached to it.

The participants will interact with the objects and then they are invited to reconfigure the behaviour of the objects and the content of the tweets during the experiment via Design Cards.

Participants will work in couple.

Consent form

PhD research. Internet of Props.

PLYMOUTH UNIVERSITY
FACULTY OF ARTS AND HUMANITIES

Consent Form

CONSENT TO PARICIPATE IN RESEARCH STUDY

Name of Principal Investigator: Gianni Corino

Title of Research: Internet of Props. A Performative Ontology for the Internet of Things

---

Brief statement of purpose of work:
This research is a speculative inquiry into the ontological challenge between ‘objects’ and ‘things’ and the emerging social dimension in the context of the Internet of Things.
The aim of the research is the identification of performative design model for the development of Internet of Things projects and intervention called the Internet of Props.

The objectives of this research have been explained to me.
I understand that I will be participating in Internet of Props research and I have been informed that my involvement consists of taking part in an experiment with props and non-invasive sensors with the involvement of another participant. The experiment will be recorded by video camera, cameras and recording of non-invasive sensors data attached to the props.

I understand that I am free to withdraw from the research at any stage, and ask for my data to be destroyed if I wish.
I understand that my anonymity is guaranteed, unless I expressly state otherwise.

I understand that the Principal Investigator of this work will have attempted, as far as possible, to avoid any risks, and that safety and health risks will have been separately assessed by appropriate authorities (e.g. under COSHH regulations).

Under these circumstances, I agree to participate in the research.

Name: ……………………………………….
Age 18-25 ☐ 26-30 ☐ 31-35 ☐ 36-40 ☐ 41-51 ☐

Gender: Male ☐ Female ☐

Profession: ……………………………………….

Have you heard of Internet of Things before? Yes ☐ No ☐

Signature: ....…………….. Date: ....…………..

I am granting permission for the researcher to use a tape or video recorder.
I am happy with my video clips or extracts of them being shown in scientific publications (e.g. conferences, papers, etc.).

Name: ……………………………………….

Signature: ....…………….. Date: ....…………..

APPENDIX 3

Transcript guidelines

Transcriber's doubts and comment

( ) Empty parentheses indicate the transcriber's inability to hear what was said. The length of the parenthesised space indicates the length of the un-transcribed talk. In the speaker designation column, the empty parenthesis indicate inability to identify a speaker.

(word) Parenthesised words are especially dubious hearing or speaker identification.

(( )) Double parentheses contain transcriber's description rather than, or in addition to, transcriptions.

Time interval

(0.0) Numbers in parentheses indicate elapsed time in silence by tenth of seconds, so (7.1) is the pause of 7 seconds and one-tenth of a second.

(.) A dot in parentheses indicates a tiny 'gap' within or between utterance.

Characteristics of speech production

<u>word</u> Underscoring indicates some form of stress, via pitch and/or amplitude; and alternative method is to print the stressed part in *italics.*

w(h)ord A parenthesized h, or a row of hs within a word, indicates breathiness, as in laughter, crying, etc.

:: Colons indicate prolongation of the immediately prior sound. Multiple colons indicate a more prolonged sound.

Sequencing

[*A single left bracket* indicates the point of overlap onset

] *A single right bracket* indicates the point at which an utterance or utterance-part terminates vis-à-vis another.

= *Equal signs*, one at the end of one line and one at the beginning of a next, indicate no 'gap' between the two lines. This is often called *latching.*

This notation is also used to differentiate between verbal and nonverbal communication.

APPENDIX 4

Design Card Transcript

Legenda:

O = Originator

C = Condition/Trigger

M = Message/Output

SESSION 1 - User 1

O: shout & pound the table

C: pink glass > vibrate Tilt go down

M: All off

O: take light of random props

C: green cutter > vibrator pink glass

M: Tweeter you find the way

SESSION 1 - User 2

O: vibration sensor

C: vibration over 3000

M: Pull me down

O: orange nozzle

C: below 10

M: pink shiver

O: temp sensor

C: temperature duration > 3

M: shaking

O: light sensor

C: under 200

M: turn the light on LED bright

O: Red cup

C: vibration

M: Do a star jump if current player

O: Till sensor > LED

C: falling down

M: LED RED > Green

SET 1 User 3

O: Green cup

C: is above 300

M: red cup vibrate

O: Light sensor

C: is above 2600

M: cup vibrate Message 404 sen cdone sound

SESSION 1 - User 4

O: Time

C: Every 60 seconds change color of the flat nozzle

M: Different color that switch RED-Green

O: Green Cutter

C: if light 7500

M: Vibrate red cup

———————————————————————————

SESSION 2 - ELENA

O: orange cutter

C: 20 C (equal or sea water above)

M: I am a jelly fish

O: Orange Cutter

C: 20 C (under) sea water

M: I'm a Salmon

O: Green Glass

C: 5 hits

M: say to pink go away, danger

O: Pink Glass

C: 3 vibration

M: skis to nozzle to alert the herd

O: pink glass

C: 1 vibration

M: says to nozzle about the behavior of an enemy

O: Green Glass

C: 1 hit

M: said to pink do not come it is aggressive

SESSION 2 - DAVIDE

O: funnel

C: val > 1000

M: I'm squize

O: green cutter

C: value>200

M: Too bright Turn me

O: Funnel

C: val > 100

M: Put me down

SESSION 3 - DANIELA

O: orange cutter

C: I'm rolling

M: switch on light

O: nozzle/glass red

C: switch on light

M: dancing

O: Funnel

C: Pressure

M: Help me please

SESSION 3 - ALESSANDRO

O: Green Cut

C: light on

M: Pink glass vibrates

O: spiky nozzle

C: tilt

M: pink glass vibrates

O: green glass

C: pick up/pick down

M: with on flat nozzle/switch off flat nozzle

O: Funnel

C: Pressure

M: Ouch

SESSION 3 - INGE

O: Orange cutter

C: to move around

M: to move like a wheel

O: pink glass

C: to turn around itself

M: to move around like a cup at the fun fair

O: flat nozzle

C: to fly

M: to fly in the air a not to throw like fireworks

SESSION 3 - VALENTINA

O: green glass

C: turn around

M: I'm happy

O: red glass

C: Build the pyramid

M: I'm excited

O: spiky nozzle

C: to jump

M: I want to do sport and gym

O: Green cutter

C: To throw

M: Funny Day

APPENDIX 5

Video Recording Transcripts

Session 1– Stage 1: Plymouth 01/05/15

Video Source: MediaCity_VL_Stage1_Front_low.mov,

MediaCity_VL_Stage1_low.mov

Participants: Vicktor and Luke

Duration: 9′ 40′′

Luke: ((Laughing))::

Vicktor: It's like, yeah, play this game, but there's no rules

Luke: =And you don't know what the game is

((Laughing))

Someone off-screen: It's called the game of ()

Luke: ((Moves his hand to touch a playing piece but instead places hand on chin))

Vicktor: ((Also places hand on chin))

Luke: No(h) (.) I can't

Vicktor: What's that? ((Vicktor moves the red playing piece))

Luke: Oh(h)

Vicktor: Make that move.

Luke: But, You've got to, Okay, well I'm going, I'm going ()

Luke: I'm going, I'm going to go with force,

((Luke stands force piece up))

Luke: It's small but mighty

Victor: [It's still low]

Luke: [It's still low]

Vicktor: It's still too low

((Vicktor moves green circle piece onto board))

Luke: Is that another version

Vicktor: it's one two three light

Luke: Maybe if you -

((Luke places hand over green piece and watches numbers change))

Luke: Oh Boom

((Laughing))

Luke: I think that outplays his one

((Vicktor turns piece upside down))

Vicktor: Should get, upside down, damn it

Luke: This one?

Luke: I'll put it in that corner

((Luke moves orange playing piece to the corner nearest Vicktor))

(.)

((Vicktor moves a playing piece on top of another playing piece))

Luke: But now you've put a prop on a prop

Vicktor: Go on then.

Luke: I think I should take my hand off now

((Luke removes hand from green prop))

Luke: We're making rules

Victor: I don't know what the rules are(h)

((Laughing))

((Luke picks up a green prop in a cup))

Luke: What's this one, uh, This is the green lamp, vibration sensor

((Luke repeatedly taps the prop on the table))

Luke: Oh(h)

((Luke moves the prop onto the board))

Vicktor: Did you break it

Luke: No(h) vibration sensor

Luke: I'm pretty sure I won that

Vicktor: That depends on what the rules are

Luke: I think, if you start with equal amount of pieces, each piece should have two conditions of it

Vicktor: Okay [But (   )]

((Luke gives pieces out again))

Luke: [And then] you put us involved as well

((Luke and Vicktor both look very confused and concerned))

Off-screen: There is no rules

((Laughing))

Off-screen: You decide the rules

Luke: I think we made a few, there's one, this one, you start with equal amounts (.) of pieces, but then we're two systems as well, so that's seven.

Vicktor: For the rules, I try and say, you have to try and make them use less of their sensors, somehow

(.)

Luke: Yeah

Vicktor: Yeah?

Luke: Or get the lowest readings [you can get]

Vicktor: [Basically, I can't] touch your sensors and you can't touch mine

Luke: Do you have to use less of them?

Vicktor: So for instance if I was to move that there, and you to put that ((Points to the red prop)) on that, I can't use that, because there's no way, I can't(.) I can't

((Luke picks up force prop))

Luke: What happens if I put this in there?

Vicktor: You can still use it, because it's in there

Luke: [Oh(h)]

Vicktor: [Oh]

Luke: So what happens if you put this one ((gestures to a prop)) I could go like that.

Luke: But then I can't touch that, because it's already in your prop ((Puts both hand in the air))

Vicktor: Is it in it? Because I managed to take it straight out again ((Vicktor removes a prop from on top of the force prop)) But

((Both laughing))

((Luke puts head in hands))

((Luke picks up red prop to look underneath))

Vicktor: <u>I don't</u> <u>understand</u> the rules

((Luke moves prop onto board))

Vicktor: See, now you can't touch that.

Vicktor:=and I can't steal yours.

((Luke points to screen))

Luke: Maybe if you get the force over a certain amount, then you almost like, unlock it

((Luke squeezes red prop))

Luke: So it makes

((Luke points to screen))

Luke: See what I mean, (   )

Vicktor: But there needs to be rules, otherwise I don't understand, uh::

Luke: What happens if you put these on their side, what does that mean?

((Luke places green prop onside))

Luke: Then we've got two (side) props there

((Luke moves force piece on the board))

Vicktor: Ah(h)

((Luke moves props around to the side of the board))

Luke: Chris, tilt is always low, there we go.

Luke: Maybe it should be a race?

Luke: From this side of the board to that side of the board, each one having a different condition

((Both are silent))

Vicktor: But we don't have any conditions(.) yet

(.)(5.7)

((Luke moves props off the board))

Luke: Maybe they should all be off the board at the beginning and you have to work on that point and that point

((Luke gestures are two spaces on the board))

Vicktor: But how (.) What enables you to move?

Luke: They're all online

(.)(2.5)

Off-screen: Think about the shape, what you getting as data, you might want to[( )]so if you press the force, then you can make two move

Luke: [Yeah], So say you get this one, you have to start on this one, you have to get the force to like, 3000, which is pretty difficult, but appears to have stopped

[( )]

Vicktor: Check if it's connected on the bottom

Luke: Oh the bottom ((looks underneath prop)) Yeah(h)

Off-screen: Disconnected?

Luke: Fair enough ((Reconnects prop and tests it))

Luke: So, and then these ones [(   )]

[((People talking))]

Luke: You have to get it up to [(12000)] ((Gestures to ceiling))

((Vicktor picks up prop and points it up toward ceiling))

Luke: No that's cheating

Vicktor: what? How's that cheating?

((Vicktor holds prop up again, stands up and gets close to the light))

Luke: Yeah, and then you can move it onto the board

((Vicktor sits back down)

Luke: And this one, you have to get the force up

((Luke uses the red prop))

Luke: Oh, it's really, ((readjusts and squeezes the prop harder, laughs and moves the prop to the side))

Vicktor: What about the heat thing?

Luke: You have to get that heat above [(   )] don't break them

[People talking]

Vicktor: Is it on(.) oh(h) [here we go]

Luke: [It's coming through]

((Luke picks up the vibration sensor and taps it on the desk four times))

(.)(7.2)

Luke: Maybe 25, yeah.

((Luke taps the vibration sensor on the desk))

Luke: I don't want to break it

((Laughing))

Luke: Should I just do it quickly ((taps the vibration sensor on the desk))

(.) ((Luke gestures to the screen))

Luke: There we go, then this one that I've got.

((Picks up the white prop))

Vicktor: This is the tilt it, you need to find out which direction it tilts

Luke: Yeah, ((Moves prop from side to side in his fingers))

Off-screen: That is a bit (   )

Vicktor: No it's not, when you tilt it, you can feel the ball

((Luke moves the prop more and shakes it))(3.5)

Vicktor: [That,]

Luke: [Oh(h)] that's quite exciting, I don't know, it's gone

Vicktor: Okay, so we allowed to only use our props?

Luke: No, you can use any prop but (.)(0.3) if you do, you have to (.)(0.3)

Vicktor: Beat the previous

Luke: Score

((Vicktor sighs))

Luke: We need arbitrary scores Chris, we need a score board

Off-screen: Well you can make the props interact with each other ,[(.)], the sensor can affect each other

Luke: [Yeah] Oh yeah, so you can start with three and my sensors could affect your sensors, so we could change them

((Phone rings))

Vicktor: Nice

((Laughing))(9.8)

Vicktor: Yeah, you mean like

((Vicktor moves prop))

Vicktor: So that's (mine) now, what you going to do about that(h) (.) what the-

Luke: I still say you have to go from this side of the board to this side of the board

((Luke gestures to two points on the board))

Vicktor: But how?

Luke: I don't know but I think we should play a part

((Vicktor moves the red prop from one side of the board to the other))

Vicktor: I win(h)

Luke: There should be, (.) you need like, a trigger

((Luke moves red prop back to the original side of the board))

Vicktor: We're basically going to make your game, for you

((laughing))

Luke: Does anyone else want a go?

Off-screen: Does anyone else want a go?

The video ends here

Session 1 – Stage 2: Plymouth 01/05/15

Video Source: MediaCity_VL_Stage2_Front_low.mov

MediaCity_VL_Stage2ab_low.mov

Participants: Vicktor and Luke

Duration: 11′ 33′′

(   )::

Luke: Can we put some triggers in?

Luke: Because I think every time it vibrates, we should have to do some, like expressive dance

((Luke waves hands in the air))

((Luke picks up the vibration sensor prop and taps it on the table))

((The new prop begins to vibrate on the desk))

((Luke repeats this movement a few times))

Vicktor: So why do you get to make it vibrate (.) Why don't I get to make it vibrate, does every single make it vibrate?

((Vicktor picks up the red prop and squeezes it))

Vicktor: Pressure, come on, <u>pressure</u>

Luke: No, I think it's because vibration is a bit stuck

((Vicktor picks up a small white prop and shakes it from side to side))

Vicktor: Wahoo::

((Luke taps the vibration sensor prop again and the pink cup starts to vibrate))

Vicktor: Not fair

((laughing))

Vicktor: I want to make it vibrate

Luke: Maybe, maybe a rule should be if you can get it not to vibrate when moving that, (.) but you have to lift it up to a certain height, and then you have to put it down, and not get that to vibrate, see if you can do it

((Vicktor lifts up the vibration sensor and places it back down gently, the prop does not vibrate))

Vicktor: Ohh(h), ahh

Luke: Try it again, this time faster.

((Luke looks at his watch whilst Vicktor picks up the prop faster and puts it down gently, the prop does not vibrate))

Vicktor: [(so)] good

((The prop vibrates))

Luke: Ahh ((points at Vicktor))

((Laughing))

Vicktor: It's because you hit the table, ((Vicktor points towards Luke side of the table))

((Luke hits the table hard and the prop vibrates))

Vicktor: You see.

((Luke shrugs and everyone laughs))

((Luke picks up the prop and puts it back down gently, the prop doesn't vibrate and Luke receives and approving noise from Vicktor))

((Luke picks up the vibration sensor and drops it, the pink cup vibrates, Luke then does this again))

Vicktor: Okay, urhm::

((Laughing))

((Luke picks up a white prop and begins to shake it vigorously))

((Vicktor picks up the other small white prop))

Vicktor: What's this one do?

Luke: (Fat) nozzle? Changing RGB

Vicktor: Due to?

Luke: So it has a changing RGB in it, due to what?

Vicktor: Just curious, what makes it change?

Luke: Light? Let's try light?

((Luke moves props around))

Vicktor: Ah, I think it's just a loop, like an RGB colour loop. Okay, (.) I'll blind you, then I'll win

((laughing))

Luke: It's changing (   )

Off-Screen: See what happens now?

Vicktor: It's getting warm?

Luke: Wait, maybe it's a vibrator?

((Luke taps the vibration sensor on the table, making the pink cup vibrate and changing the light in the RGB led))

Luke: It changed to green

Vicktor: Do it again

Luke: [Ah(h)]

Vicktor: [Oh(h)]

Luke: Christopher, you wizard

((laughing))

((Luke taps the vibration sensor on the table, the cup vibrates but the light does not change))

Luke: Oh, it didn't change that time

((Luke taps the vibration sensor on the table, the cup vibrates))

Luke: Oh, it changed that time

((They both set the props to one side))

Vicktor: Okay, Okay so, I say these need (bystander things), these are props that we (use)

((Vicktor moves props around))

Luke: You need more outputs, you need more outputs really, because you have the vibration, but you should have like, sound

((Vicktor shakes the vibration sensor vigorously))

Luke: So maybe the sound could be the human, so like, every time light goes over 3000 you have to like, squawk like a (bee)

((Vicktor is still shaking the vibration sensor))

Luke: Will the vibrator shut up

((Vicktor is still shaking the sensor))

Vicktor: [ ]

[((Group talking))]

((Vicktor moves props around and moves the green circle towards his hand and back again a few times))

Luke: I don't know what you just did, I'm confused.

Vicktor: I think all the elements change the colour

((They both inspect the two cups))

Vicktor: Ah(h) so that's what it does, it picks up feeds from everything else, and then changes colour when something changes

Luke: We think

Vicktor: I think

((Moving props and picking up red prop))

Vicktor: So pressure

Luke: Which ones this? ((Picks up orange prop)) temperature. ((Heats prop up with breath))

Vicktor: It's more of an experimental game (.)(0.8) No-

Luke: No, it's not going over 28 ((places orange prop down))

Vicktor: Okay, so let's make some sort of game out of this ((moves props around))

Vicktor: So there's the vibration sensor

((Moves props off the board to the side and starts placing them on top of each other))

Luke: Woh woh woh ((moves the props onto their own areas))

Vicktor: Okay so what shall we do

Luke: You have to get the inputs to certain levels, remember.

Vicktor: Okay

Luke: So in which case, light has to go above 5000,

((Picks up orange sensor))

Luke: temperature needs to go about 30, to start playing on the board

Vicktor: Okay, okay.

Luke: force needs to go about 3000

((Luke breaths heavily on the orange prop in a bid to raise temperature))

((Vicktor uses red prop to increase force))

Vicktor: Come on, make it. (Inaudible noise) No, that's as high as it goes.

Luke: 30, so I'm [on-]

Vicktor: 30?

Luke: Yeah, look ((Gestures towards to screen))

Luke: I got bad:: breath(.) urhm, now you have to get that up and down ((gestures to the vibration sensor)) without getting it to vibrate, <u>four</u> times, In <u>under</u> 10 seconds

Vicktor: What::

Luke: Okay, 5 times in under 10 seconds

Vicktor: Okay

((Luke sets watch countdown))

Luke: Ready, okay ready and onto the table (.) not the plastic

Vicktor: what come on

Luke: Read, 5 times, okay, ready steady

((Vicktor moves the prop up))

Luke: I didn't say go

Vicktor: wait, wrong one ((changes props)) This is the right one

Luke: right, ready steady, go

((Vicktor carefully picks up the prop and puts it down again))

Luke: one, it has to touch the table

((Vicktor carefully picks up the prop and puts it down again))

((Vicktor carefully picks up the prop and puts it down again))

((The cup vibrates))

Luke: Haha, my go

((Laughing))

Luke: That was way too much fun

The video ends here

Session 1 - Stage 1: Plymouth 01/05/15

Source: video: MediaCity_RW_Stage1.mov, MediaCity_RW_Stage1Front.mov

Participants: Rob and Will

Duration: 3′ 33′′

(   )::

Rob: Rules of the great crazy game

Will: Urhm

Rob: And you're force can't go above ten

Will: the force (.) It's goes from 0 to 2000 in the space of nothing

Rob: and yes, you can't make it go above (ten)

Will: Well, urhm::

Off-screen: Well, guys, try light touching

((Will picks up red prop))

((laughing))

Rob: let me have a try

Will: I got nothing, no one knows off 2000

Off-screen: No, You got 155

((Rob tries using the red prop))

((Will picks up the vibration sensor and shakes it))

Will: The tilt is always low (.)

Will: Oh, here you go ((claps))

Will: What we could do is we could use

((Will picks up vibration sensor)),

Will: values coming from this

((Will touches the red prop))

Will: So the pressure from this and the vibration from this and could have urhm(h)

((Will moves both orange and green circle props onto the board))

Rob: Oh hang on, That's falling apart

Will: it'll be fine ((Waves hand)

Will: But we could have some sort of race to the finish using that

Rob: [Right then]

Will: [The high]er the value, the further you go

Rob: So if each square is worth(.) ((counts the squares on the board)) urh, 500

Will: [500]urh, yeah, yeah

Rob: So, you go first

Will: Okay urh::

((Will shakes the vibration sensor))

Will: uh(h) that would be (.) 2106

Off-screen: You win

((laughing))

Will: I move four spaces, okay, so yeah, we'll put the edge like that.

((Will moves prop along))

((Rob squeezes red prop))

Will: Let go and then it should register (.)

Will: 759

Rob: I move one

((Rob moves prop along))

Will: <u>Nice</u>

((laughing))

Rob: and a half

Off-screen: You're now performing for people on the Internet, I've got a couple of people looking at the page {if someone wants to periscope or mere cat this as well

Will: [I get 4000]

Off-screen: I'll get a twitch stream going

((laughing))

Rob: Okay

((Rob squeezes prop))

Will: Push as hard as you can(.)

Will: 2933

((Rob moves prop along))

Will: We can say if you're like 100 off [you can round up] so you get 3000

[People talking]

((Will uses vibration sensor))

Will: 2234 so four::

Rob: 1 2 3 4, so there

Will: Yep

Rob: Alright

((Rob squeezes red prop))

Will: 3132, Oh you're catching up,

Rob: So there?

Will: Yeah, no six. Six

((Rob moves his prop along))

Will: He's catching up

Rob: Oh I'm catching up(h)

((Will shakes vibration prop))

Will: 2063, so 2000, there we go

((Will moves prop along))

((Rob squeezes prop))

Will: Come on I can do this

Will: three, what, what

((Rob moves prop along))

Will: You have some like, unknown strength

((Laughing))

Rob: I'm secretly the hulk

((Will shakes the vibration sensor))

Will: 4000

((laughing))

Will: 1 2 3 4 5 6, Yeah(h)::

((Will raises both hands in air in celebration))

Will: I win

((Rob gives little sensor to Will as trophy and will places the piece on his head))

Will: I am the king

((laughing))

((Will poses for pictures))

Will: Who else would like a go?

The video ends here

Session 1 – Stage 2: Plymouth 01/05/15

Source: video: MediaCity_CG_Stage2.mov, MediaCity_GC_Stage2Front.mov

Participants: Chris (C) and Gerrit (G)

Duration: 3’50’’

G: Now it is again but::

((Chris breaths on temperature sensor))

((Background noise))

((They both move the props and look at the values))

G: I still don't know how you get this one so high

G: Woh

((Chris taps the green cup repeatedly))

G; It's the Netherlands, what can I say?

Off-screen: there's virtually no lag

G: Yeah, it's pretty good

((Chris moves props around and places two cups next to each other))

G: Oh we're making feedback loops today

((They start stacking props))

C: It's not working

((Chris successfully makes a feedback loop with the cups))

C: Look, no hands

G: Wohoo ((waves hands in air)) That's great

Chris: Like that

((Chris moves props around))

G: I quite like that one ((gestures towards the cups while holding the funnel))

C: ( )

G: No, that one

G: Late night coding

C: The lights are on

((They both examine the cups))

((G attempts to use the RGB prop for the light sensor prop))

((They both move props in an attempt to get a response))

G: Is this one dying as well now?

Gianni: It's dying as well?

G: Well I don't know, the light stopped

Gianni: Oh Okay ((Gianni takes the prop that G holds out))

Gianni: Maybe it's a game over?

G: Ah yeah maybe

C: But I'm trying to win

((Laughing))

G: <u>What?</u>

G: Following what rules?

Gianni: That could be used as a timer, as a controller

G: Yeah

((They both move and inspect the props))

G: Just breaking everything now

((Puts props down))

G: So are we going to play a game or

C: I Can't think of any rules

G: ((Speaking to someone off-screen)) That'd be pretty great actually

G: Yeah you can get those ()

G: That'd be cool

C: They'd have to be very small ones

((Laughing))

G: I also think they would be like

C: ((Bass noise whilst waving hand))

G: I also think it would be very energy efficient

G: Well I guess it depends and also has a lot to do with the resistors and materials in between

C: () the air

G: Yeah but if you have like, like, like a plastic layer between you just put the () on them, you don't have that much in between them. and you do have the benefit of wireless charging which is pretty cool

C: Yeah::

G: ((Shakes Green cup))

G: ((Picks up Red Cup and Shakes)

G: ((Picks up Green cup and shakes))

G: ((Puts Green cup down and drops it))

G: ((Taps Green cup on table 4 times))

G: (Looks at readings display) <u>What's wrong?</u>

G: ((Continues to shake green cup))

G: Why's it not (.) <u>did you break it Chris</u>

C: Yeah::

They both leave the game instance

First experiment

Session two – Stage 2: 09/05/15

Video Source: Davide Elena 01_low.mov

Participants Elena (E) and Davide (D)

Duration: 1′ 06′′

E: Mm::

Gianni: Okay in English

E: Okay um:: uh:: I was thinking ((Picks up two props)) (.) something like that, ah:: you don't put it in here hm::

((E picks up two props and attempts to put them together))

D: Its flashing

E: So you could like make a you know you, you could like make you know

D: Yeah but you take this and change the colour

E: Then you could

D: Its changing colour when you do things

E: I know I know, I see better let me

D: See now it is blue

E: Now it is blue and before it was green wasn't it?

D: Yes and now also he's changing colour

E: Yeah and also there is one light at the bottom

((They continue to move props around and examine them))

D: Okay

E: When you put it down it flashes twice, do you see? Do it there

((E refers to the white prop))

D: Yes, ah(h) this is green now

E: Ah(h) what did you do

D: I don't know

E: Maybe because you put it a bit further in position

D: I don't think so

E: I don't know if they if they look.

((child screaming in the back ground))

E: that's bad:: that's flashing that's flashing

The video ends here

Session two – Stage 2: 09/05/15

Video Source: Davide Elena 02_low.mov

Participants Elena (E) and Davide (D)

Duration: 10′ 44′′

E: I don't understand it

D: Those are the readings

E: So this is [( )]

[Child noise]

E: This will [(freeze)]

[Child noise]

E: So this will uh(h), it moves, right by vibrating

((D triggers the vibration and points to it))

E: So it needs to do something with it, okay, let me see, so if you do the same, on this piece ((drops the green cup onto the table))

E: Okay so now ( )

((They begin moving props around and dropping them gently))

D: What's this ((Gestures to the red prop and picks it up

E: This one moves

((They continue moving props))

D: This must be a sensor or something

E: Ah- The light is green, before it was purple, it was purple before, now it's green

D: This is-

E- Otoh otoh, maybe on the side, when you put it on the side? The side you see?

D: I don't think so

E: Why don't you think so, now purple, now it's purple

((Child noise))

D: So this one is (.) Ah(h) so it's like, a light sensor

((E begins stacking props))

E: So you put upside down?

D: I don't (.) maybe so just ((Gestures to the cups))

E: Ah(h) Look, the movement, so this one their related then, okay, so that okay

((Moves both cups to one side))

E: How about these two ((Gestures to the two circle props)) Do you think there's a relation between these two?

((Phone rings))

D: Those are the readings, the sensor readings

E: So what do you mean for sensor readings?

D: So each of those has some sensors and those are tweets

E: So this is twitter, you mean

D: So these are tweets and that one is connected to this one ((Gestures to the cups))

E: And this is for ( )

D: But this one I still do not understand ((Gestures to the small white prop))

E: Maybe it's with that one if it's not working

D: Yeah but it was changing colour, let's just try this out

((They both move props around the board))

D: Hm:: So this one has a temperature

((They move props around more))

D: Yeah, that's a temperature

((D changes his prop for a new one))

D: And this is a light sensor

D: So if you use these like this, you should be able to

E: Change the colour

D: See it's changing colour

E: Which one is changing colour

D: This

E: Yeah but I don't see any difference between-

D: No this one is not changing colour, but this ((Points to green prop)) changes the outputs

E: Ah(h)

D: Right see now-

E: [Yeah] Yeah I seen it

D: ( )

E: ( ) So this is a relationship between these two

D: I'm not sure (.) Maybe just-

E: What if I put these like this, and then ( )

D: Is just ( )

E: Okay

D: But this is [( )]

E:[Ah(h) I] understand maybe

D: But this is temperature

E: Are you sure, because it looks like- Oh(h) maybe it's just a reflection of the light

D: This is temperature, this one ((Gestures to the orange one))

E: Oh Sorry

D: But if you do like this, you get the temperature of the ((Waves hand in air)) of the environment

E: Oh you see

D: if you do [( )]

E: Oh look, look ((Picks up Green prop, puts it down again))

E: ( ) ((Picks up Green prop))

D: ((Touches Orange prop))

D: Wait wait wait, So if you look at this

E: mh::

D: You had one ring right, so if you do this, you have one ring, right and if you do [this] ytou have a different ring

E: [( )] What about if you do like this?

D: Do you see there

E: Does it work, does it make it go up?

D: Of course it works

E: But does it make it go up

D: That's the reading

E: Yes::

D: If you do this::

E: (   )

D: If you do this ((flips green prop over)) you are pointing down and you have ( )

E: mhm::

D: So it's like, in the dark, but if you do this ((points upwards))

E: The light one is at ( )

D: Yes

E: But if you do like this, it's even lower

D: Yeah but it depends on the light

E: Yeah, I understand, I understand

D: So if you do something like [this]

E: 82 82

((Moves props around))

D: but I don't understand what this one does, if this is related to something or not

E: Where is the sensor?

D: This one is the sensor ((Points at something within the green prop)) No this

E: What is it, I don't see, Oh(h) this one

D: ((Points at screen)) [You see?]

E: [See?]

D: What if you take it away? It just gets the normal light

((They both talk over each other but move onto a different prop))

D: It was working

E: Was it working?

D: Yes because it is dark

E: I know, but what if I move

D: Wait wait wait

E: What's wrong, I was doing it

D: No it's not working

D: Wait wait wait just wait

E: Okay

D: The sensor is there, right? ((Points to screen)), right okay

E: It's not a lecture, it's an (experience)

D: I know but I'm trying to tell you the relationships between the object and the readings, right (.) But now it's not working, but it's tilt-

E: Oh it's working now

D: you see it says tilt

E: Uhhuh

D: It seems like there is a type of gyroscope inside, so if you turn it like this ((D turns the small white prop around))

D: But it [appears] it's not sending signals

E: [It's not working]

D: Well that's okay, but this one ((picks up red prop)), has I think, is the force

E: So uh(h) Okay ((Picks up red prop and shakes it))

D: This one is the force ((whilst pointing to the sensor))

((They both nod in agreement))

((They move and touch various sensors))

D: ( )

E: But you see, there is a completely different force between the, the, because the pressure if different

D: ( )

E: I'm watching here and now you see

E: Even if I press very hard, they cannot reach the same force because, ((holds RGB LED against the red prop)) the surface

E: If I place my finger (.) mhm::

((Background noise))

((They move the objects around, placing them and triggering them))

D: Gianni think this one stopped working

((E continues to move the objects))

D: Oh yes, it's working

((E repeatedly hits table to try and trigger vibrations

((They both move objects around))

E: Okay

This is where the video ends

Session three – Stage 2: 15/05/2015

Video Source: Inge Valentina_low.mov

Participants: Inge and Valentina

Duration: 10′ 19′′

((Vibration sounds))

Valentina: What is this?

((laughing))

Valentina: (This)

Valentina: ()

Valentina : And then

Valentina: Uh::

Valentina: We can try to throw this(h)

Inge: Hm(h)

Valentina: Circle in the glass

Inge: In the glass?

Valentina: Yes

((Valentina gestures throwing motion))

Inge: Okay

Valentina: Try?

Inge: Okay

Valentina: I um(h), throw this in the green glass and you in the

Inge: Yes

Valentina: beaker

((Inge throws orange prop at pink cup prop and there is a loud bang glass falls over))

((laughing))

Inge: Is not possible

((Loud bang as green prop falls off of glass))

Inge: No

((Laughing))

Valentina: Wie

Inge: U::

Valentina: No

Valentina: Oh(h) yeah

((Gives thumbs up to Inge))

Inge: Wow

Valentina: Very good

((Laughing))

Inge: Maybe just uh(h)::

Valentina: Yes

Inge: ( )

((Valentina builds with the props))

Valentina: and then we

((Laughing))

((Valentina tries to put white prop piece through makeshift goal))

Valentina: Ah(h) yes

((Laughing))

Inge: Okay

((Laughing))

((Inge tries to put white prop piece through makeshift goal))

Valentina: Um::, with the finger

Inge: Okay

Valentina: And you put the hands ((puts hands together forming a wall))

((Laughing))

Valentina: It's difficult

((Laughing))

Inge: Your turn

Inge: ( ) what um::

Valentina: No?

Valentina: Is not funny game

((Laughing))

Valentina: Okay

((Inge attempts to flick the white prop, break the goal and something falls off the table))

((Laughing))

Valentina: So (.)

Valentina: I try (.)

Valentina: To (.)

Inge: Okay

Valentina: Throw this okay in this

((Valentina gestures to orange prop))

Inge: Okay

Valentina: We can uh(h) put the

((Gestures to red prop))

((Inge throws her prop and it lands inside the yellow))

Valentina: Yes

((Valentina throws her prop and it lands off the table))

Valentina: oop Sorry

((Laughing))

Valentina: Sorry Sorry, are you okay?

(.) ((white prop is put back together))

Inge: Okay

Valentina: Dangerous Game

((small laughing))

Inge: uh(h) we try to...

Valentina: We put it on your head?

((Valentina hands the red prop to Inge))

((Laughing))

((Inge places red prop on head))

((Laughing))

((Valentina motions to throw green prop over red prop))

Inge: Now you-

((laughing))

Valentina: I try to

((motions throwing motion again))

((continued laughing))

Valentina: Okay (.) Um:: (.) You (.)

Valentina: (   )

Inge: Okay

Valentina: and then you um:: try to guess the shape (.) object

((Laughing))(3.2)

Valentina: What is this?

Valentina: Also the colour right?

((Laughing))

Inge: It's a(h) (.) circle?

Inge: ((other language))

Valentina: colour?

Valentina: In English

Inge: The green?

Valentina: No

((laughing))

Inge: the orange?

Valentina: And then You

Inge: The orange

Valentina: Yes

((laughing))

Valentina: alright (.) and then with the

((Valentina hands Inge orange prop))

Valentina: you::

Valentina: Throw?

Inge: Yeah

Valentina: Throw

((Inge throws orange prop with eyes closed))

Valentina: No

((laughing))

Inge: Now you ((laughs))

((Valentina throws orange circle toy with eyes closed))

((laughing))

Valentina: No ((laughter))

Inge: Again

((Valentina throws orange circle toy with eyes closed and misses, Inge hands toy back))

((Valentina throws orange circle toy with eyes closed and misses, Inge hands toy back))

Valentina: Is impossible

((laughs))

Inge: Um::-

((Inge attempts to puts red prop inside white toy opening))

Valentina: Yeah

((Inge attempts to balance red cone toy inside white toy on table))

Inge: ( )

Valentina: m:: (   )

Valentina: the game of the ()

((laughs))

Inge: Oh? ((nods head)) maybe

Valentina: (   )

Inge: hmmm

((Valentina moves props around the board))(5.3)

Valentina: ()(.) so(.) we can move here

Valentina: ()

Inge: Ah

Valentina: (yes)

Inge: Which one?

Valentina: Yes, yes, yes, okay

((cough))

Inge: So you can have the green glass-

((Hand green prop to Valentina and the vibration sounds))

Inge: So(.)mh:: (.) do you want to start?

Valentina: Yes(.) okay

((They begin to move props around the table, taking it in turns))

Valentina: on you ((Laughs))

Inge: I don't know

Valentina: Mine, Mine ((Valentina points to green cup prop and green circle prop))

Inge: (   )

Valentina: No (.) One, two, three I won, I put this in here

Inge: Yes but its three (.) One two three

Valentina: Oh(h) okay ((laughs)) Okay

Valentina: And this ((Valentina lifts up red prop and places on head))

Inge: (   )

Valentina: Okay so (.) Umm

Inge: Play again or?(.) Try again? (.) Change::

Valentina: I'll play again

Inge: So (.) The green:: Is on your side

Valentina: Okay (.)

Inge: So we can move like the ()

Valentina: Just one?

Inge: And we can make () over the ()

Valentina: One two three

((They both gesture to points on the board))

Inge: [One two three]

Valentina: [One two three]

Inge: Okay, I want to start

Valentina: So We start you yes? Start you? yes

((They both position their props on the board taking it in turns))

Valentina: Now for you

Inge: ( )

Valentina: uh(h)

Inge: Okay

Valentina: <u>Jolly</u>

((laughing))

Valentina: Okay again

Inge: Okay again

Inge: One more, so, this is

Valentina: And this

Inge: Okay you start ((smiles))

Valentina: Okay I start Okay

((They both move their pieces around the board, taking turns))

Valentina: Yes

Inge: Okay ()

Valentina: Change?

Inge: Change

Valentina: (.) hm::, so

Inge:: We can try to make it just so it's just (   )

Valentina: Construction yes, behind me? Yes

Inge: What you want?

Valentina: ( )

((They stack the props up))

((They all fall over))

((laughing))

((They stack the props up again))

Valentina: Oh my god Try Yes Okay, now ()

Inge: () (.) Okay

Valentina: A new <u>construction</u>

Inge: ()

((They begin stacking the props again))

Off-screen: I'm sorry to interrupt you but you appear to be having a lot of fun

((laughs))

((Laughing))

This video ends here

Session three – Stage 2: 15/05/2015

Video Source: alessandro daniela_low.mov

Participants: Alessandro (A) and Daniela (D)

Duration: 9′ 11′′

Off-screen: When you want (.) Just play

A: Okay, so there's one that can (.) switch off, turn off the light (.) this one

((Gestures to prop))

((inaudible noise but A gestures to D to move the white prop inside the green))

A: No, Still ((Holds white prop up to screen)) This one right? (.) No

((D picks and squeezes the red prop, whilst A puts down the first white prop, takes the second white prop and turn it upside down))

((A examines the orange prop))

A: Well what is this?

((D gestures to the screen))

D: Why is this?

A: This is just a summary of all of them

D: Okay::

((They both carefully examine the props))

A: So see what they are saying ((Gestures to a point of the screen)) so it's this one (.) and nothing happened

((D hands A the small white prop))

D: (I don't understand)

((D picks up the other small white prop))

D: The light?

A: Uh- This is the light

D: No

((gestures to the small LED within the second white prop))

A: Ah(h)

D: Yes, green

A: No, this one has a sort of (   ) ((Whilst taking the second white prop off D))

((D begins moving props around to see if anything fits together and smiles))

A: Uh(h) and what is this? ((whilst picking up the red prop and attempting to balacne it upside down))

((They carry on moving the props around and inspecting the values))

A: This one is asking to be bigger ((Gestures to green cup))

D: Okay ((Picks up green cup)) and?

A: Nothing happened

D: It can dance

A: Which one?

D: This one ((Picks up red cups and shakes))

A: Is that dancing?

((Laughing))

D: And this ( ) (.) light light ((D picks up green prop))

((D gestures to a point on the screen and appears to ask a question))

A: ( )

((They both move the props around, inspecting the values on the screen, including shaking the props and stacking them))

((A says something into his closed hand which cannot be heard))

((A stacks the circle props on top of the cups and stop to see if the values check))

D: Are you done? ((laughs))

((A shrugs))

((A continues stacking props until they fall over))

A: Ops

((D moves the props around and gestures to points on the screen, one of the props in removed by Gianni))

Off-Screen: It's not working

((D continues to investigate the left over props and Gianni returns the prop))

D: Thank you

A: Ah(h) Now it's saying light

((D gestures to values on the screen))

A: This one if loose, this one

((The pink prop is removed by Gianni again whilst A and D use one prop to shine a light on another while looking at the values on the screens))

A: This one was saying it will turn off the light, but now it'll be okay, uh(h) this one ( ) ((Picks up white prop))

((Another prop is removed by Gianni before both props are returned))

((D picks up the pink cup and shakes it and smiles as it triggers the green cup tovibrate))

D: Ah(h)

D: Just the one time, then stop

A: Try again

((D shakes the cup))

§D: See

A: No

((D moves the green cup and sees the pink cup vibrate))

D: Okay

((They both begin moving the props with the vibrations going off as they move, this includes putting the small white prop inside the pink cup))

((They gesture towards the screen and distribute the props between each other))

[Quiet talking]

[Outside noise]

D: Go back up, no?

A: it'll go back

A: This one wants to be pick ((Picks up green cup and shakes it triggering the vibration))

((Vibration))

((They stack the props))

((A Laughs))

((long pause))

A: ((Gestures to the screen)) This keeps showing all the data, like the lights, that stay inside, it's alright

((D moves the stacked props around))

((D moves the red prop on top and smiles))

D: Okay, it's finished

A: We are done

The video ends here

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