Agency Sensitive Design:
A Relational Understanding of Design

by

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Certificate of Authorship/Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Candidate

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LIST OF ABBREVIATIONS

ANT	Actor-Network Theory
ASD	Agency Sensitive Design
BP	Blindfolded Participant
DC	Distributed Cognition
DP1	Dance Performer 1
DP2	Dance Performer 2
ECv1	Enactive Coupler Version 1
ECv2	Enactive Coupler Version 2
GP	Guiding Participant
H-D	Human-Device
H-D-E	Human-Device-Environment
H-D-H	Human-Device-Human
HCI	Human-Computer Interaction
IA	Interaction Analysis
ID1	Interaction Designer 1
ID2	Interaction Designer 2
MEQ	Movement Effort Qualities
MP1	Music Performer 1
MP2	Music Performer 2
P1	Participant 1
P2	Participant 2
P3	Participant 3
PD	Participatory Design
R1	Researcher 1
R2	Researcher 2
STS	Science and Technology Studies
TVSS	Tactile Vision Sensory Substitution
VSD	Value Sensitive Design

ABSTRACT

A relational view of agency advocates that agency is neither an attribute of subjects nor of objects; rather, it is a dynamic attribute of the relations between the entities. A growing body of research recognises the embodied, situated and relational characteristics of agency in the fields of human-computer interaction and interaction design. The research presented in this dissertation develops a relational understanding of design referred to as Agency Sensitive Design (ASD) that enables designers to incorporate a relational view of agency in their design thinking and their thinking of design. It draws on the situated perspectives and recent developments in actor-network theory, feminist technoscience, relational sociology, and phenomenology. Questions of how a relational view of agency can contribute to design, and how design can recognize and support relational agency are explored in detail through the development of three participatory design workshops employing ASD. The workshops act in two ways: first, they serve as test beds for exploring how ASD concepts and qualities can be employed in the design process; and second, they act as generative cases for advancing and refining ASD concepts and qualities. Workshop 1 and 2, in which a navigation-oriented exercise is performed in four activities by different configurations of the same collective of humans and technologies, investigate how different relational possibilities emerge and evolve by manipulating the ways in which humans and technologies come together. Workshop 3 continues with the investigation by extending the scope of configurations and increasing the variety of activities and the size of the design collective. The research methodology employs the analytical lenses of actor-network theory (ANT) and phenomenology. The methodology combines the strengths of approaches based on ANT and phenomenology to explore both general patterns of relations and the details of specific relationships between humans and non-humans. The research makes two contributions to the field of interaction design: the first is the theoretical development of ASD with five strategic-generative concepts and six qualities produced out of a large body of relevant studies. The second is an empirical investigation of some of the qualities of ASD using design workshops situated in the early phase of design.

1. Introduction

The concept of agency can be defined in its simplest sense as the ‘capacity for action’ or ‘transformative capacity’ (Giddens, 1984). Notwithstanding, ongoing debate surrounds the definition, emergence and possession of agency in artificial intelligence, cognitive science, philosophy and many other fields. One particular point of controversy is related to the attribution of agency to entities. As opposed to the technological and social deterministic views of agency, either as a property of technologies or of humans, an alternative view suggests that agency is not an attribute of subjects or objects or systems but ‘ongoing reconfigurings of the world’ (Barad, 2007, p. 141). Agency emerges out of the dynamism between entities. According to this view, agency is a relational effect of a network of humans and non-humans (Latour, 2005). Capacities of action, rather than being well defined and fixed, are situated, dynamic, relational and multiple.

Developments in science and technology studies (Callon, 1986; Latour, 2005; Law, 2004; Pickering, 1995), feminist technoscience (Barad, 2003; Haraway, 1991), cognitive science (Clark & Chalmers, 1998; Hutchins, 1995), relational sociology (Emirbayer, 1997) and phenomenology (Verbeek, 2005) have been requesting a change in our essentialist and deterministic understanding of agency. This request has been based on detailed analyses of diverse empirical cases such as quantum physics (Barad, 2003), laboratory studies (Latour & Woolgar, 1979), navigation (Hutchins, 1995), atherosclerosis (Mol, 2003), Portuguese expansion (Law, 1987) and the domestication of scallops (Callon, 1986). Parallel to these developments has been a growing body of research recognising the embodied, situated and relational characteristics of agency in the fields of human-computer interaction and interaction design (Agre, 1997; Bardzell, 2010; Boehner, DePaula, Dourish, & Sengers, 2005; Dourish, 2001; Friedman & Kahn, 1992; Gaver et al., 2004; Höök, Ståhl, Sundström, & Laaksolaahti, 2008; McCarthy & Wright, 2005; Sengers & Gaver, 2006; Suchman, 2006; Wei, 2007). Harrison et al., who associate these research studies with what they refer to as the third paradigm of interaction design, categorize them as 'situated perspectives' (Harrison, Sengers, & Tatar, 2011). They describe the central understanding of the third paradigm as ‘interaction as phenomenologically situated’ (p. 6). Drawing upon the developments in the aforementioned fields and the situated perspectives, this thesis develops a relational understanding of design, i.e., Agency Sensitive Design (ASD), which is based on a relational and non-essentialist view of agency.

In this chapter, first, I will explain the need for a relational view of agency in design. Then, I will introduce two main research questions and a brief description of ASD. After explaining the research methodology, which involves a relational attitude to the object of the research, I will present the contributions of the research to the field of interaction design. The chapter will conclude with an outline of the structure of the thesis.

1.1.1 Need for a relational understanding of agency in design

The recent works in the fields of STS, HCI and interaction design suggest some potential benefits for a relational understanding of agency in design: 1) supporting situated and improvised actions by providing resources and mechanisms in a situated way (Chalmers & Galani, 2004; Gaver, et al., 2003); 2) supporting responsible and ethical practices by recognizing and supporting the interests of various actors, and their ways of knowing and doing things (Velden, 2009); and 3) supporting creative engagement between humans and non-humans and innovation by making the design process as open and as inclusive as possible (Callon, 2004).

1.1.1.1 Supporting situated and improvised actions

An increasing number of research studies within situated perspectives in the third paradigm have already engaged in developing different conceptualizations of design as a response to developments in understanding of agency. These research studies have variously imagined the role of design as a facilitator of co-construction of meaning (Boehner, DePaula, Dourish, & Sengers, 2005), a supporter of felt-experience (McCarthy & Wright, 2005), a stimulator of more ludic and playful experiences (Gaver et al., 2004), or a source of ambiguity evoking multiple interpretations (Gaver, et al., 2003; Sengers & Gaver, 2006). Matthews et al. (2008) observe that these studies designed technology not in an instrumental but in a generative way, to enable wholly new practices rather than continue to support extant practices. Although it may not be explicitly mentioned, these studies embrace a relational view of human agency, augment its diversity and richness, and support collective relational nature.

Akrich (1992) asserts that designers 'inscribe' various values, roles, programs of action, and, more generally, their vision into the technical content of designed objects in the form of scripts similar to a film script. Although users may appropriate the object differently and play different roles, these scripts/inscriptions may have different strengths that can increase or decrease possible variation in the roles and relations. While strong inscriptions constrain the possibility of different interpretations and prevent deviation from the expected roles and relations, weak inscriptions do not offer a single program of action and are therefore open to multiple interpretations (Hanseth & Monteiro, 1997). Increasing the strength of an inscription can be considered an attempt to confine the relational character of human agency by trying to impose a particular program of action. Strong inscriptions belong to a perspective of design that aims to predict, prescribe and control the kind of relations between humans and technologies and the ways in which their interaction unfolds. Repeatability, consistency and reliability are particular kinds of qualities that characterize the human-technology interactions shaped by strong inscriptions. Although these are definitely desirable qualities for some settings such as legal, medical and educational, they may not be entirely suitable for other cases in which appropriation, personalization, adaptation, entertainment and exploration are needed (Chalmers & Galani, 2004). One common feature of these cases is that they involve situated and improvised action.

The term 'improvised action' refers to actions which are performed in cases with high levels of uncertainty and uniqueness wherein: the settings of interaction are unfamiliar to the actors, there is little guidance for interaction available, and there is a mismatch between actors' interests and inscriptions. In this respect, improvised actions are similar to 'situated action' in which plans are 'best viewed as a weak resource for what is primarily *ad hoc* activity' (Suchman, 2006, p. 26). Improvised action can be seen as 'a special case of situated action, highly contingent upon emerging circumstances; unifying design and action; quick, sudden, and extemporaneous' (Ciborra, 2002, p. 154). The difference is that in the case of improvised action, the resources for action or inscriptions are weaker than that of situated action. When designing for situated and improvised action, an assumption of agency as a predictable and fully controllable phenomenon may have important limitations. For example, there may be cases in which the interests and concerns of the actors show large variation, settings are in constant transformation or predictability is undesired. In such situations, predictive or control-based approaches are not suited to dealing with the variety and transformation. Therefore, a more suitable approach may be to acknowledge the relational character of agency and to develop sensitivity to managing the relationality in the design and the use of technologies. In this way, we can see relationality and situatedness, with their ambiguities and contingencies, as resources for design and formulating design solutions that will provide resources and mechanisms for increasing the capacity to improvise in cases with high levels of uncertainty and uniqueness.

1.1.1.2 Supporting responsible and ethical design practices

Van der Velden claims that a relational view of agency facilitates ‘the reconfiguration of design and use for more ethical effects, such as the cultivation of cognitive justice, the equal treatment and representation of different ways of knowing the world’ (2009, p. 37). Based on Barad's (1999) notion of "intra-actions', Van der Velden locates the ethical agency, responsibility and accountability not only in the individuals but also in the socio-material configurations or collectives of designers, technology and users. Defining ethical agency as ‘the capability to act responsibly towards the “other” in particular to do no harm’, she further observes that what is needed is an understanding of agency as an effect of the relations between people and artefacts without removing ‘the particular accountability of people for the things they create and for how they use them’ (Velden, 2009, p. 38). Here she draws our attention to two important implications of relational agency: first, assigning the agency to the collective should not mean the abandoning of the accountability of individual actors; second, neither the ways in which things are created nor the ways in which things are used are neutral. Therefore, she suggests avoiding deterministic formulations of accountability and responsibility. She argues that ‘understanding of technology as non-neutral, and agency as located in the intra-actions between humans and artefacts, does not in any way diminish the accountability of designers for their designs or users for their use of ICTs’ (p. 42).

Suchman's notion of located accountability (Suchman, 2002) deals with the difficulty faced in locating the accountability of human actors who do not act completely independent from their network. Suchman, following Latour (2005), deals with the issue of the inseparability of agency and accountability using a different conception of 'boundaries', which ‘recognizes the deeply mutual constitution of humans and artefacts, and the enacted nature of the boundaries between them, without at the same time losing distinguishing particularities within specific assemblages’ (Suchman, 2006, p. 260). Suchman (2002) develops a notion of located accountability, which advocates that since our views are inevitably situated and from somewhere, this makes us personally responsible for them. Her formulation of accountability in design is closely associated with responsibility. According to Suchman, while responsibility is also a relational phenomenon, it is one that requires critical awareness:

> The accountability involved is a problem of understanding the effects of particular assemblages, and assessing the distributions, for better and worse, that they engender. Responsibility on this view is met neither through control nor abdication, but in ongoing practical, critical and generative acts of engagement (Suchman, 2005, p. 4).

Suchman further suggests that a relational conception of agency allows us to focus on the contestable processes of becoming:

> The point in the end is not to assign agency either to persons or to things but to identify the materialization of subjects, objects, and the relations between them as an effect, more and less durable and contestable, of ongoing sociomaterial practices (Suchman, 2006, p. 260).

In order to support responsibility and accountability, Van der Velden suggests a perspective based on a relational view of agency, which sees design process as ‘an ongoing intra-active process, ... an ongoing dialogue between design, designers and users as designers. … and design as “design of configurations” of human and non-human actors’ (Velden, 2009, p. 45, original emphasis).

From the perspective of agency, Friedman and Kahn ask: "[I]f responsible computing is to be understood as something more than a form of a damage control, how are we to understand the term?" (Friedman & Kahn, 1992, p. 7). They highlight how different conceptualizations and metaphors of agency can culminate in different designs. For example, an anthropomorphic conception of agency such as a view of computers as humans can result in a dialogical interface, whereas a non-anthropomorphic conception of agency, e.g., a view of computers as tools, can lead to a direct manipulation-based interface. A dialogical interface is designed to support the interaction between humans and machines as if the interaction process was happening between two humans. However, a direct manipulation-based interface allows humans to 'operate directly on the objects in the computer rather than carrying a dialogue about them' (Jacob, 1984, p. 166). Different conceptions of agency of human and non-human actors may radically change the design artefact and relations between humans and the artefact.

Friedman and Kahn (1992) also delineate how lack of consideration for relational aspects may cause misattribution of agency, which, by extension, may have fatal consequences. They cite the case of the APACHE system, which was originally designed as an open-loop medical decision support system, and later became, in effect, a closed-loop ultimate decision-making system through the appropriation of people in use. While an open-loop consultation system suggests particular actions, and leaves the final decision-making to humans, a closed-loop system provides humans with the final decision-making. Friedman and Kahn point out that in medical contexts, computer predictions should not be accepted as a final clinical diagnosis as there may be many other parameters affecting the condition of a patient. Medical personnel using APACHE increase their level of trust in the system's recommendations after long-term good performance. This sees the medical personnel frequently accepting its recommendations somewhat automatically. In such cases, people using APACHE may attribute higher-level agency and autonomy to a system that was not specifically designed to function in that way. The above example of misattribution demonstrates how relationality and, in particular, long-term systemic effects arising from socio-material configurations of human and non-human actors may change people's perceptions of the agency of technology, perhaps culminating in serious outcomes. For this reason, consideration of relationality in the design process is crucial.

Friedman and Kahn (1992) suggest using non-anthropomorphic metaphors for technology and considering the larger social context when designing technology. Non-anthropomorphic metaphors prevent users from attributing human-like properties to computers. In general, metaphors are effective for drawing the boundaries between human and non-human actors and shaping the relations between them. Therefore, they should be carefully selected; and, the capabilities of designed technology should closely match those of metaphor. From the perspective of relational agency, metaphors, which provide a sense of collective nature of action and located accountability, may prove useful. Friedman and Kahn suggest that participatory design methods may offer a means of considering the concerns in a larger social context and relational effects in the long-term. Through participatory design, users can 'see themselves as responsible for shaping the system's design and use' (p. 11).

1.1.1.3 Supporting participatory innovation

The relational view of human agency emphasizes the collective nature of creativity (Fischer, Giaccardi, Eden, Sugimoto, & Ye, 2005; Mamykina, Candy, & Edmonds, 2002; Sawyer & DeZutter, 2009). Fischer et al. (2005) argue to the effect that 'much human creativity is social, arising from activities that take place in a context in which interaction with other people and the artifacts that embody collective knowledge are essential contributors' (p. 485). The arrangement of the network, which people inhabit along with other human and non-human actors, plays a crucial role in mobilizing the peoples' creative potential for action (Callon, 2004; Engeström, 2001; Fischer, et al., 2005).

Callon highlighted the role of the network or collective within the context of participatory innovation (2004). He contends that the traditional linear model of innovation, in which innovation progresses in a series of stages from design to diffusion, represents a rare case. Rather, innovation occurs in 'a whirlwind model in which different phases can no longer be separated' (Callon, 2004, p.3). There are two implications of the whirlwind model: the design process becomes a participatory process involving users and all other intermediaries and a 'never-ending process' in which each actor reshapes and reconfigures the objects of design according to his/her needs. Callon, further to his emphasis on the participatory and collective process, maintains that: 'It is collectives that invent, design, develop and use innovations' *(*p. 2).

From an actor-network theory (ANT) perspective, Callon (2004) highlights two important features of these collectives for innovation: first, he states that they should be seen as collectives of human and non-human actors (in particular technologies); second, there are multiple ways of being human and multiple forms of agency that are dependent upon the configuration of the socio-technical collective of which humans are a part.

Callon (2004) states that collectives do not only involve associated human actors who use technological tools. Technologies should be viewed as ‘authentic actors who shape collectives and open new ways of thinking and acting’ (p. 5). Stressing the different ways in which non-human actors participate in action and cognition he states:

> "[Non-humans] create coordination, they link existing actors and provoke the emergence of new ones who want to be taken into account. ... They take part in the process of production of knowledge and know-how. Intellectual achievements, ideas, projects, plans, production of information, are through and through material processes. Technologies shape their content" (p. 5).

According to Callon (2004), what actors are and do are shaped by the configurations of their collective. Following Picq (2001) and Serres (2001), he claims that ‘there is a continuum or rather a vast diversity of configurations that correspond to different ways of being human or being non-human’ (p. 5). Callon provides an example of two car drivers: one is a free, autonomous and a self-mastering subject while the other is a passive agent. The first driver is capable of determining his next move, of controlling all of the necessary information, even of exercising risky behaviour such as exceeding the speed limit. In order to be an 'autonomous' subject, he needs to incorporate various non-humans into his collective, e.g., a GPS, a dashboard, road signs and signals, and maps. Without them, he is incapable of being an autonomous driver.

> What the driver, as any other self-mastering subject, can, wants, thinks and feels, depends on environments that are created by engineers, town planners, local politicians, briefly, by a host of other agencies, themselves equipped with prostheses and empowered. (Callon, 2004, p. 6)

However, decision makers can imagine other forms of agency for the driver as a passive agent due to the problems such as pollution, traffic congestion or accidents. Many of the decisions and controls that are required for the act of driving can be delegated to technologies. For example, the distance from the car in front or the speed of the vehicle if it is controlled by a computer. Although still acting as driver, many of his competencies have been redistributed among the non-human actors of the collective.

> His body, brain, muscles and genes are not necessarily different from those of the self-mastering driver, but he's no longer the white Western male framed and enacted by the first option even if he is as artificial as him. ... Hence, the slogan I propose: change the collective, change the socio-technical arrangement, and you change the agency. You obtain another form of human being (Callon, 2004, p. 6).

Through his argument, Callon (2004) draws our attention to two concerns about the relation between innovation and agency. On the one side, he explains the role of relational view of agency in supporting the designing of an innovation or technology: the relational view of agency provides a useful means of conceptualizing collective and participatory activities for innovation. On the other, he points out the role of innovation in shaping agency: innovation participates in 'shaping new agencies or in the reconfiguration of existing ones; it doesn't mean only responding to demands or to satisfy needs' (p. 6).

Finally, Callon (2004) explains that participatory design practices involve understandings of and methods for fostering collaboration between the relevant actors concerned with innovation. However, it should not be limited to the participation of human actors only: non-humans should be recognized as actors as well. An important matter of concern for participatory design practices is the process of determining 'which type of human agencies people want to develop. Or, in other terms, which types of socio-technical arrangements people will design and experiment' (p. 7).

Having explained the potential benefits of a relational view of agency in design, in the next section I will introduce two research questions and how they are explored through the concepts and qualities of ASD.

1.2 From Research Questions to Agency Sensitive Design

The research poses two closely interrelated research questions within the field of interaction design:

1. How can a relational view of agency contribute to design?
2. How can design recognize and support relational agency?

On the one hand, the research will explore what a relational view of agency can bring to design. What does a relational understanding of agency in design entail? How do understandings of design, the design process, the object of design, and the designer and user change according to a relational view of agency? On the other, the research will investigate the ways in which design can support a relational view of agency. What does it mean to have a design process be more relational? How can a design process recognize the various sources of influence on a design problem? How can a design process support and extend the relational possibilities between humans and technologies?

1.2.1 Scope of the Research Questions

The research questions will be explored in two ways: first, a theoretical exploration based on an extensive review of recent studies; and, second, an empirical exploration using a series of workshops involving game-like activities. While the scope of the theoretical explorations covers both technology design time and use time, the scope of the empirical explorations covers workshop activities in the early exploratory phases of design only.

The research makes use of a broad definition design according to which design is seen as a productive coming together, a collective of human and non-human actors aiming to perform and explore spaces of possibilities for the objects of design in a relational way. This definition will be explained in detail in Section 3.2.2. The empirical investigation part of the research reflects a narrower conceptualisation of design as inquiry in which the primary aim of the design activities is to produce knowledge rather than material design objects. Section 1.3 explains how objects of design and objects of the research are intertwined in the workshop activities.

Finally, the research does not attempt to develop a full theory of agency. Rather, it will employ a simple definition of agency, namely the capacity to act or transformative capacity, with focus more upon how this capacity emerges out of relations between entities and ways of supporting multiplicity in formation and exhibition of this capacity in/through design.

1.2.2 Conceptual Framework of the Research

Figure 1.1 depicts the conceptual framework of the research. A need for a relational understanding of agency in design arises from an examination of the problems facing the field of interaction design through the lenses of actor-network theory (ANT), feminist technoscience, distributed cognition and phenomenology. To address this need, two research questions are proposed: How can a relational view of agency contribute to design? and, How can design recognize and support relational agency? The research questions are explored in detail through a theoretical development of concepts and qualities that constitute Agency Sensitive Design (ASD) and an empirical investigation involving three workshops. The latter serve as phenomenological experiments (Wei, 2007) for exploring what ASD concepts and qualities can mean, and how they can be supported in the early phases of design. Regarding the first question, the research develops the following five strategic-generative conceptual devices: object of design, design collective, topology, inscriptions/translations and tuning. Apropos of the second question, the research offers six sensitizing design qualities: relationality, multiplicity, visibility, configurability, accountability and duality.

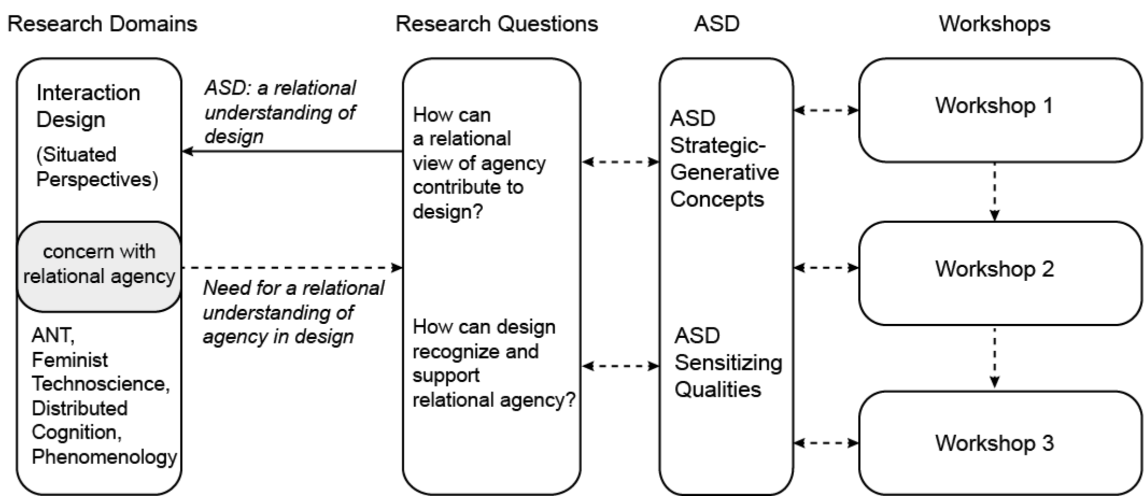

Figure 1.1 Conceptual Framework of the Thesis

1.3 Research Methodology

The research methodology is informed by certain key epistemological and ontological understandings. In order to develop a relational understanding of agency in design, what is needed is a non-essentialist worldview or paradigm, which does not look for deterministic relations or an independent single reality out there waiting to be revealed. According to this worldview, there are ontologically multiple realities (Mol, 2003). This view does not suggest that realities are multiple because of different perspectives of a single reality but rather that there are different versions of the reality that are relationally enacted. Parallel to this, methods are not neutral means of accessing realities: they are active constructors of realities. Methods are performative in that they help to produce realities. Different methods create different kinds of realities (Law, 2004).

In order to comply with these key epistemological and ontological understandings, the research methodology needs to recognize the multiplicity of realities, support their enactment and the multiple ways of knowing them. To this end, the research methodology will make use of the concepts of ANT and postphenomenology. While ANT allows the research to understand the patterns of relations in a network of humans and non-humans and the multiple effects of the network, postphenomenology enables the research to see the details of the individual relations between actors, which are not accessible by ANT (Verbeek, 2005).

ANT is based on a relational view of agency. Its main area of interest is the emergence and transformation of relations and patterns of relations. Analytically, ANT treats humans and non-humans symmetrically which allows it to understand the processes of becoming: becoming a kind of human, becoming a kind of non-human, and becoming a kind of collective of humans and non-humans. Both humans and non-humans can be authentic actors[1] provided that they are capable of doing things (Latour, 1992, p. 241) and/or modifying a state of affairs by making a difference or leaving a trace (Latour, 2005, pp. 70-71). According to ANT, agency is an effect relationally produced by a network or collective of humans and non-humans. ANT provides the research with suitable conceptual devices for understanding the construction of multiple realties that are relationally produced. It offers no specific methods or guidelines: researchers need to build their method assemblage for their research according to the key understandings of ANT (Law, 2004).

Similar to ANT, postphenomenology (Verbeek, 2005) advocates a non-essentialist view of reality and the existence of multiple realities (p. 113). Somewhat differently,

[1] In this thesis, I use the term 'actor' to indicate any thing that modifies a state of affairs by making a difference. I also position the terms 'human' or 'non-human' in front of the term 'actor' to indicate which entity I am referring to in a convenient way: not for making an a priori division between the entities.

however, it focuses on short chains of relations between a human and a non-human or a human and another human. Verbeek's postphenomenology, by building a bridge between phenomenology and ANT, allows the evaluation of influences of technologies on humans' perception and actions in terms of two structures. While the transformation of perception has a structure of amplification and reduction, the translation of action has a structure of invitation and inhibition. The research employs a post-phenomenological approach to activities in which first person experiential accounts will play a key role in understanding the construction of relations between the actors and the aforementioned structures.

In this research, ANT and postphenomenology work in two ways: as generative devices for developing ASD and experiments, and as analytical lenses through which to explore the outcomes of the experiments. The research questions will be examined in detail through a series of three participatory design workshops. There are several reasons that make participatory design workshops a suitable choice for exploring the research questions. First, participatory design supports inclusive, participatory and democratic design practices. This allows the research to bring together a diverse set of actors, their interests, and their multiple ways of knowing and performing. Second, workshops can be structured in non-deterministic and open-ended ways which provide flexible platforms that allow its diverse participants to negotiate and co-construct meaning and realities. Third, workshops can operate on scattered, partial and situated knowledge, making different forms of knowledge available for negotiation rather than abstracting them away in favour of creating a singular reality. Finally, workshops facilitate the creation of ‘third spaces’ in which old assumptions can be questioned and challenged and new relations and understandings can emerge through (re-)interpretation and (re-)negotiation (Muller, 2003).

An important part of the methodology involves an approach to conducting workshops in an evolutionary way that makes research methods more responsive to the input from empirical cases. By adopting this approach, the research embraces a relational understanding of its ways of employing methods. Three workshops will be conducted in an evolutionary mode that will gradually increase the fluidity of the initial conditions that frame the participants' actions. Increasing the fluidity of the conditions means that the conditions will involve fewer constraints and provide less guidance for the participants' actions.

The research employs a conceptualization of design as inquiry and exploration, a view of design defined as “research-through-design” (Frayling, 1993; Zimmerman, Forlizzi, & Evenson, 2007) or “design as research” (Gaver, Dunne, & Pacenti, 1999; Lunenfeld, 2003). Gaver et al. (1999) explain their view of design and research in the following way:

> Unlike much research, we don’t emphasize precise analyses or carefully controlled methodologies; instead, we concentrate on aesthetic control, the cultural implications of our designs, and ways to open new spaces for design. … Unlike most design, we don’t focus on commercial products, but on new understandings of technology. This allows us—even requires us—to be speculative in our designs, as trying to extend the boundaries of current technologies demands that we explore functions, experiences, and cultural placements quite outside the norm. Instead of designing solutions for user needs, then, we work to provide opportunities to discover new pleasures, new forms of sociability, and new cultural forms (pp. 24-25).

Similarly, this research formulates research and design as intertwined and hybrid activities taking place in workshop settings. In the context of this research, workshops facilitate the creation of ‘third spaces’ (Muller, 2003), which are suitable for conducting design as research activities. The design activities in the workshops are like small-scale research activities in which the objects of design and the objects of the research[2] are intertwined (see Figure 1.2 left).

[2] I have opted to use the terms ‘the object of research’ and ‘the object of design’ rather than ‘the aim of the research’ and ‘the aim of the design’. The main reason for my choice is that ‘the object’ refers to the aims and, as well, to the outcomes of the research and design activities. Thus, using the same term emphasizes the connection between the aims and outcomes. Throughout the thesis, I will refer to the aim of the workshops as ‘the object of design’ and the aim of the overall research as ‘the object of research’.

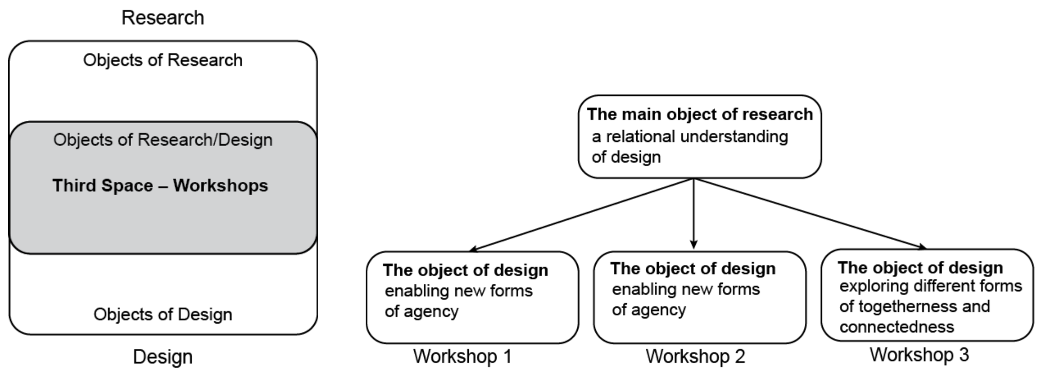

Figure 1.2 Intertwined objects of research and design within the third space of workshops (left) and the translation of the main object of research to the objects of design in the workshops (right).

The objects of design in the workshops are translated from the main object of research (see Figure 1.2 right). Workshop 1 explores its object of design – enabling new relations between human and technological actors in full-body movement based interaction scenarios – through a strategy of rearrangements in the same set of human and non-human actors. The workshop involves four activities in which the participants are asked to perform a navigation-oriented task using some technological tools. In each activity, a different physical arrangement between humans and technological tools is set. For example, while the technological tool is attached to the stomach of a blindfolded participant in one activity, it is attached to the back of the same participant in another. The workshop activities involving a navigation-oriented task can be viewed as an abstracted case of a typical design situation in which a team of designers 'navigate in the problem/solution space' by using various materials and technological tools in many ways. Workshop 2, which has the same object of design as Workshop 1, continues with the investigation by providing more fluid conditions for participants to communicate with each other and perform the task. Finally, Workshop 3 represents a larger evolution in the workshop series with revisions of different aspects characterising the formation of humans and technologies and the overall design process. Workshop 3 includes different kinds of activities and technologies in order to support multiple forms of knowing, and extends the scope of evolutionary approach by developing mechanisms for changing the workshop conditions in situ.

1.4 Contributions of the Research

The research makes two contributions to the field of interaction design: the first is the theoretical development of ASD with five strategic-generative concepts and six qualities produced out of a large body of relevant studies. The second is an empirical investigation of some of the qualities of ASD using participatory design workshops situated in the early phase of design. The intended scope of ASD concepts and qualities covers all phases of design and use, however, in the context of the research, the concepts and qualities as a whole have been empirically explored only in the early phases of design.

ASD's concepts and qualities derived from extant works and approaches. ASD's contribution is the *translation* of these concepts to the context of this research. More specifically, the unique high level contributions of ASD include: 1) the bringing together of diverse concepts from literature around a central theme of relational agency in design: 2) creating various connections between these concepts and extending their original scope; and, 3) demonstrating the various ways in which these concepts and qualities can be employed in early phases of design. Some key concepts include collective, inscriptions/translations and topology.

The notion of a collective emphasizes the fact that design involves an act of coming together of various human and non-human actors. Since there can be many different ways in which these actors can come together, each enables or constrains a different space of possibilities.

The notions of inscriptions/translations connect the temporal and spatial dimensions of the design activity by a relational understanding. While the design process is seen as a series of acts of inscribing (writing) and translating (reading), the design space is seen as a collective of inscriptions (written materials) and translations (read materials). The power of the notions of inscriptions and translations is attributable to their intertwined conceptualization according to which an act of inscription is an act of translation as well.

The notion of topology is an area of mathematics dealing with the ways in which things are connected (Kennington, 2012). It is an important metaphorical device used in ANT. The research employs the notion of topology in the designing of the initial conditions of the workshops. In this research, topology characterizes particular arrangements of collectives of human and non-human actors in a design situation. Topological thinking provides the research with a useful way of focusing on the relations between the actors rather than on the actors themselves. The research develops different ways of manipulating the topology of the collectives in order to enable different spaces of possibility for the objects of design.

In addition to the main contribution of ASD, the research offers an approach to conducting participatory design workshops in an evolutionary way, which increases the responsiveness of the methods used to the situated and emergent concerns arising from the workshops. The research demonstrates the application of an evolutionary approach at three different levels that increasingly become more responsive: workshop, iteration, and activity. One contribution of the research relates to its evolutionary approach, a method referred to as ‘adaptive inscriptions’ which address a challenge facing designers attempting to balance specificity and openness at design time. Murdoch, following Akrich (1992), explains the challenge in the following way: "[S]ome of the most difficult problems confronting network builders revolve around the issue of what choices should be inscribed in the materials that comprise the network and which should be left open to negotiation" (Murdoch, 1998, p. 363). Achieving a balance between the levels of specificity and openness at design time is important so as not to narrow down the space of possibilities too much in order to explore and address the various interests of the actors and inscribe them into the object of design. As well, it is advisable not to open up the space too much, because this can result in the design teams’ time and effort being wasted on irrelevant matters of concern rather than being spent upon exploring more relevant possibilities. A discussion of the relationship between the spaces of prescription and the spaces of negotiation appears in Section 2.3.1.

Finally, the research contributes to recent developments in participatory design (Ehn, 2008; A. Telier, 2011), in that it offers an extended understanding of participation - including non-human participation - in the design process. It brings together ANT and participatory design and demonstrates the various ways in which non-humans participate in design process in the forms of workshop, activity, and material inscriptions.

1.5 Thesis Structure

Chapter 2, which presents the background of the research, is composed of three main sections; the first introduces the different views on the notion of agency and discusses the entangled relations between agency and design. In addition, it examines the different understandings of agency with respect to three human-computer interaction paradigms suggested by Harrison et al. (2011). The second section surveys in detail the various approaches and works referred to as 'situated perspectives'. The aim of this section is to present the relevant studies and introduce important understandings that inform the development of ASD qualities and concepts. The third section explains the analytical perspectives of actor-network theory and postphenomenology and the method of interaction analysis.

Chapter 3 introduces ASD and its five strategic-generative concepts and six sensitizing qualities. The aim of this chapter is to describe ASD in a way that is independent from the research methodology. After explaining roles of the literature review and the workshops in developing ASD concepts and qualities, the chapter presents the concepts and qualities in general terms by referring back to the relevant literature.

Chapter 4 explains the research methodology. First, the ontological and epistemological views that guide the main methodological choices are explained. Then, I explain how the research methodology constructs the object of the research through a particular arrangement of the main research components. This chapter details how ASD qualities and concepts explained in general terms in Chapter 3 are specifically employed in this research. The chapter concludes with a brief explanation of the methods used in the three workshops.

Chapter 5 presents Workshops 1 and 2. The activities, results and evaluations are described in detail. Since the activity structures and tasks of Workshop 1 and 2 are the same, they are presented within the same chapter. As part of the evolutionary workshop approach, I have provided the evaluations of the workshops at the end of each workshop section. These evaluations are important for understanding the changes that occurred in the evolution of the workshops.

Chapter 6 presents Workshop 3. The activities, results and evaluations are described in detail. Parallel to the extended scope of the evolutionary approach to the workshop iteration level, there are brief notes/evaluations between workshop iterations.

Chapter 7 concludes the thesis by revisiting the research questions ‘How can a relational view of agency contribute to design?’ and ‘How can design recognize and support relational agency?’ The questions are explored through reflection on the outcomes of the workshops employing ASD concepts and qualities. After explaining the limitations and opportunities of the research, the thesis concludes with suggestions for future work.

2. Background

In this chapter, in which I provide the background for understanding the relevance and significance of a relational view of agency in the field of interaction design, there are three main sections: agency and design, situated perspectives and analytical perspectives.

The first section explains the complex relations between agency and design; as well, it provides three different views on agency. While technological determinism and social determinism are presented as two polarized views of agency, a symmetrical view is explained as an alternative relational approach. Then, the intertwined relations between agency and design are explained using the metaphors of inscription and translation. The section concludes with consideration of various ways in which a relational understanding of agency can contribute to the field of interaction design.

The second section traces the recent developments in the field, which are referred to as situated perspectives within the context of the third paradigm in Human-Computer Interaction (HCI) described by Harrison et al. (Harrison, Tatar, & Sengers, 2007). It examines the situated perspectives under three categories: social and cultural approaches, material and performative approaches, and critical and ethical approaches.

The final section presents analytical perspectives including actor-network theory (ANT), postphenomenology and interaction analysis. The chapter concludes with a discussion on the understandings provided by situated and analytical perspectives regarding the relational agency and design.

2.1 Agency and Design

In this section, I will first introduce different understandings of the notion of agency mainly in the fields of science and technology studies, feminist techno-science, and interaction design. The aim of the section is to examine a particular controversial point of the notion of agency, i.e., *attribution* of agency. I do not attempt to develop a full theory of agency. Rather, I employ a simple definition of agency, namely the "capacity to act", with focus more upon how this capacity emerges out of relations between entities. Second, I examine the complex relations between (relational) agency and design and how they can be rethought as a series of processes of inscriptions and translations. Finally, I explain the benefits of a relational understanding of design.

2.1.1 Notions of Agency

Human agency has been at the hub of discussions centring upon philosophical enquiry for a long period of time. Giddens (1984) defines the concept of agency in its simplest sense as the ‘capacity for action’ or ‘transformative capacity’. Yet, there has been ongoing debate surrounding definition, emergence and possession of agency in artificial intelligence, cognitive science, philosophy and many other fields. Agency can be associated with freewill, resistance or even absence of agency (Ahearn, 2001). While agency as freewill advocates a notion of agency independent from the context, the absence of agency emphasizes the determining role of the context in the formation of agency,_claiming that there is no pure agency. Finally, agency as resistance requires the existence of a resistance against the powerful status quo in order for agency to exist (Ahearn, 2001).

One particular point of controversy is related to the attribution of agency to entities. The three main views of agency can be separated according to their consideration of attribution of agency. While technological determinism (non-humanist view) sees agency mainly as an attribute of technology, social determinism (the humanist view) maintains that only humans can possess agency (Rose, Jones, & Truex, 2005). While technological determinism largely ignores the different ways in which technology is appropriated by humans, social determinism underestimates the role and impact of technologies in the shaping of human intentions and social structures. A third set of perspectives (post-humanist views) attempts to find a middle ground between the two extremes (Barad, 2003), (Giddens, 1984), (Kaptelinin & Nardi, 2006), (Latour, 2005), (Orlikowski, 2000), (Pickering, 1995), (Rose & Jones, 2005), and (Suchman, 2007).

Anthony Giddens proposed structuration theory in an attempt to bridge technological and social determinism by emphasizing the mutual shaping of the social and technical (1984). In support of the notion that structuration theory aims to overcome the dualism of structure and agency, Giddens argued that: “The constitution of agents and structures are not two independently given sets of phenomena, a dualism, but represent a duality. According to the notion of the duality of structure, the structural properties of social systems are both medium and outcome of the practices they recursively organize" (1984, p. 25). According to Giddens, social structures shape agency, while agency produces social structures. Structuration, which favours the social side, does not consider technology as having independent agency (Rose, et al., 2005). From the perspective of structuration, material resources, which 'might seem to have a "real existence," become resources only when incorporated within processes of structuration' (Giddens 1984, p. 33; cited in (Rose, et al., 2005)). Therefore, according to Giddens, agency relates exclusively to humans (Rose, et al., 2005).

Pickering (1993) developed a semi-symmetrical understanding of agency based upon the notion of 'mangle of practice', which sees human and material agency as 'reciprocally engaged by means of a dialectic of resistance and accommodation-- the mangle' (p. 559). His 'posthumanist' approach to studying scientific practice does not simply involve intertwined relations between human and material agency: rather, he suggests, they are mutually constitutive. Another important concept is tuning (like the tuning of a radio or a car engine. Rose and Jones explain the metaphor of tuning as follows:

> [Tuning refers to] the process of mutual adjustment by which human and material agency are interactively stabilized. Over time, ... this process may be seen as a 'dialectic of resistance and accommodation' as humans seek to shape material agency towards particular goals in ways that are not wholly determined either by the intentions of the human actors or by the material properties of technology, but by the interplay of the two. Thus, in encountering problems (resistance) in using a technology, human actors adjust (accommodate), for example by revising goals or practices, or adjusting technological parameters. (Rose & Jones, 2005, p. 34)

Pickering's approach is not totally symmetrical as he preserves the intentionality of human actors, which, according to him, is a main difference between humans and non-humans. Barad explains that Pickering's account of agency maintains the idea of agency as a 'property' of individual entities:

> While Pickering … decenters the human from his accounts of scientific practice, he nonetheless takes the human, and its distinction from the non-human, for granted. … Ironically, the liberal humanist actor that makes choices in the context of scientific practices is everywhere evident in his theory. … [H]e takes for granted the humanist notion of agency as a

> property of individual entities (such as humans, but also weather systems, scallops, and stereos), which poststructuralists problematize. (Barad, 2003, pp. 414-441)

Latour, one of the founders of the actor-network theory, maintains that agency is a relational effect of heterogeneous networks or collectives: it is neither an attribute of humans nor of non-humans (Latour, 1999b). One of his famous examples, which involves a man and a gun, illustrates how agency is exhibited by a hybrid collective of human and non-humans rather than by individual entities:

> You are different with a gun in your hand; the gun is different with you holding it. You are another subject because you hold the gun; the gun is another object because it has entered into a relationship with you. The gun is no longer the gun-in-the-armory or the gun-in-the-drawer or the gun-in-the-pocket, but the gun-in-your-hand ... The twin mistake of the materialists and the sociologists is to start with essences, those of subjects or those of objects... If we study the gun and the citizen as propositions ... we realize that neither subject nor object ... is fixed. When the propositions are articulated, they join into a new proposition. They become 'someone/something' else. (Latour, 1999b, pp. 179-180)

Unlike Pickering's mangle, in ANT, intentionality is distributed over a network of humans and non-humans as is the case of capacities for action; as well, it is a relational effect. Latour (Latour, 1999b) notes that:

> Purposeful action and intentionality may not be properties of objects, but they are also not properties of humans either. They are properties of institutions, apparatuses, or what Foucault called dispositifs. (p. 192)

Here, the term 'institutions' implies collectives of humans and non-humans. In parallel, Suchman cites Gell's comments (1998) on the situated characteristic of intentionality of human agency: 'Intentionality needs to be understood not as an attitude of mind located within the individual, but as a field of socially and materially mediated possibilities within which persons act' (Suchman, 2004, p. 11).

In the field of feminist technoscience, Barad (2003) has developed notions of intra-action, which are not only symmetrical in their treatment of humans and non-humans, but also propose a radically constructive ontology. Barad, explaining the notion of intra-action, states:

> The notion of intra-action (in contrast to the usual "interaction," which presumes the prior existence of independent entities/relata) represents a

> profound conceptual shift. It is through specific agential intra-actions that the boundaries and properties of the "components" of phenomena become determinate and that particular embodied concepts become meaningful. ... the universe is agential intra-activity in its becoming. The primary ontological units are not "things" but phenomena—dynamic topological reconfigurings / entanglements / relationalities / (re)articulations. And, the primary semantic units are not "words" but material-discursive practices through which boundaries are constituted. This dynamism is agency. Agency is not an attribute but the ongoing reconfigurings of the world. (Barad, 2003, pp. 815-818)

Agential realism suggests a view of agency not as an attribute belonging to either humans or other entities but, as Barad suggests, 'the ongoing reconfigurings of the world'. Furthermore, intra-action refers to a process in which entities 'emerge' out of their encounters with each other. Barad uses the term 'cut' to explain the construction of boundaries between entities as a result of intra-actions. The cuts create subjects, objects, agency and intentionality.

Symmetry, mutuality and co-constitution are common themes within the third perspectives. Structuration theory is not symmetrical: it assigns agency to humans while seeing materials as resources waiting to be incorporated into the intentions and actions of humans. Mangle can be viewed as semi-symmetrical in that it assigns agency to both humans and non-humans while keeping the intentionality on the human side. According to actor-network theory, agency is neither an attribute of humans nor of non-humans but a relational effect of their collective. Finally, agential realism suggests that not only the capacities of action but also entities emerge out of their encounters with each other.

In this research, I will use an ANT perspective of agency based on a relational and fully symmetrical understanding of agency. In addition, the notions of network and collective will serve as useful lenses for seeing design activities as a collective of human and non-human actors and their relations. Post-ANT, which will be introduced in Section 2.3.1.1, further increased analytical sensitivity to particularities and multiple realities.

2.1.2 Agency and Design

There is a complex relationship between agency and design; in this section, I will explain the relations between the two in the context of HCI. First, I will explain their relations as a series of inscriptions and translations in three different stages of design. Then, I will explain how different views of agency, which were explained in the previous section, can be associated with the three paradigms of HCI described by Harrison et al. (2011).

2.1.2.1 Inscription and Translation

Inscription and translation are two important concepts of ANT. In this section, I will explain how design process is a series of processes of inscription and translation. In addition, I will explain how these processes are intertwined and indeterminate processes, which start at the very beginning of a design project and continue up to the end. Finally, I will argue (a) that design can be viewed as an activity of inscribing; and (b) that agency can be viewed as an activity of translating. The intertwined nature of the relations between inscription and translation can be observed between design and agency.

Design activities, in varying degrees, ultimately aim to create, modify, enable and/or constrain some capacities of action through designed artefacts. Designers inscribe values, visions, and programs of action into technology design. Akrich (1992, p. 208) explains the notion of inscriptions in technology design as follows:

> Designers thus define actors with specific tastes, competences, motives, aspirations, political prejudices, and the rest, ... A large part of the work of innovators is that of "inscribing" this vision of (or prediction about) the world in the technical content of the new object. ... To be sure, it may be that no actors will come forward to play the roles envisaged by the designer. Or users may define quite different roles of their own.

The technical content of the objects embodies a script similar to a film script, defining the actors, roles and their settings (Akrich, 1992). A script involves, in varying strengths, ‘programs of action’ that are ‘translated’ in practice (Akrich, 1992; Callon, 1986; Latour, 1994). However, these inscribed programs of action may not succeed should the translation processes vary; in addition, actual interactions between entities may unfold in unexpected ways. There is a mutual influence between interacting entities: objects enable or constrain the actions of humans; but, at the same time, humans reshape the objects and their relationships with them. For Akrich (1992), humans, objects and their relations are co-constituted in this 'translation' or 'de-scription' process through acts of appropriation, resistance and displacement. To understand the relations and adjustment mechanisms in this process, we need to focus on ‘circumstances in which the inside and outside of objects are not well-matched. We need to find disagreement, negotiation, and the potential for breakdown’ (Akrich, 1992, p. 207).

The strength of an inscription may vary from very strong, i.e., imposing one particular inflexible program of action, to very weak, offering many flexible programs of action. Hanseth and Monteiro (1997) note that the strength of an inscription does not depend merely upon the technical content of the object but relies on the size and complexity of the surrounding network of human and non-human actors and the degree of connection between the inscription and the surrounding network.

Latour (2005) provides an example of progressively increasing the strength of an inscription. The case cited is that of a hotel manager, who wants his/her guests to deposit their room keys at the reception desk when departing the hotel. The manager first uses oral communication, then written notices to invite the desired behaviour. However, neither form of communication, implemented to define a desired program of action, proves successful. Finally, a metal weight is attached to the room keys, an inscription that proves successful. While the first two inscriptions were weak inscriptions, the final one was strong enough to impose the desired behaviour on the hotel guests.

One important area in which the notion of inscription has been used effectively is in politics and values in design. The relation between politics, values and design is highlighted in Langdon Winner's widely cited and contested article ‘Do artifacts have politics?’ (Winner, 1980). Winner explains that technologies are not neutral: they embody ‘specific forms of power and authority’ (p. 121). He further claims that city planner Robert Moses deliberately designed and built bridges low to ‘discourage the presence of buses on his parkways’. Since the buses couldn’t use the bridges, this limited ‘access of racial minorities and low-income groups to Jones Beach, Moses's widely acclaimed public park’ (Winner, 1980, p.124). Winner argues that Moses ‘inscribed’ his values and ethnic and class prejudices into the design of the parkway bridges. Black people and low-income groups, who could only go to the park by public transport, were prevented from accessing the park. Although Winner's argument was criticized for being too (technologically) deterministic (Woolgar, 1991), and was much later refuted by

Joerges (1999) for being counterfactual, it has been very influential in demonstrating the ways in which technology or artefacts can embody politics and values.

While Winner illustrates the ways in which values can be inscribed into artefacts for achieving certain social effects, Latour emphasises the role of technologies or artefacts as indeterminate relational actors:

> Objects are never assembled together to form some other realm ... simply 'reflecting' social values or being there as mere decorum. Their action is no doubt much more varied, their influence more ubiquitous, their effect much more ambiguous, their presence much more distributed than these narrow repertories ... even as textual entities objects overflow their makers, intermediaries become mediators (Latour, 2005, p. 85).

Drawing upon Akrich, Hanseth and Monteiro assert that the notion of inscription allows a balance between technological and social determinism:

> Balancing the tight-rope between, on the one hand, an objectivistic stance where artefacts determine the use and, on the other hand, a subjectivistic stance holding that an artefact is always interpreted and appropriated flexibly, the notion of an inscription may be used to describe how concrete anticipations and restrictions of future patterns of use are involved in the development and use of a technology. (Hanseth & Monteiro, 1997, p.3).

In practice, human-technology interactions may happen in unexpected ways or, as Akrich (1992) points out, users' definitions of roles may deviate from the intended roles. Thus, rather than assuming agency as a predictable and fully controllable phenomenon, designers may acknowledge its relational character and develop sensitivities to manage relationality in the design and use of technologies. Akrich suggests that:

> If we are interested in technical objects ... we have to go back and forth continually between the designer and the user, between the designer's projected user and the real user, between *the world inscribed in the object and the world described by its displacement*. For it is in this incessant variation that we obtain access to the crucial relationships: the user's reaction that gives body to the designer’s project, and the way in which the user's real environment is in part specified by the introduction of a new piece of equipment. (1992, pp. 208-209, original emphasis)

In this way, it is possible to see relationality, with its ambiguities and contingencies, as a resource for design (Gaver, Beaver, & Benford, 2003) and to formulate design solutions to deal with unexpected situations that may happen during the use of technologies.

Translation, another metaphorical concept closely linked to inscriptions, has been used to explain different processes during the construction of a collective or network. According to Callon, translations are processes in which actors relate to one another and ‘the identity of actors, the possibility of interaction and the margins of manoeuvre are negotiated and delimited’ (Callon, 1986, p. 203). According to Murdoch, translation involves the ‘the processes of negotiation, representation and displacement which establish relations between actors, entities and places’ (Murdoch, 1998, p. 362). Callon (1986) identifies four stages of translation: (a) problematization: a process in which the interests of actors are aligned according to a problem defined by the focal or critical actors; (b)interessement: a process in which the critical actors try to create an interest and convince other actors to follow their program of action; (c) enrolment: a process in which actors accept the roles assigned to them; and (d) mobilization: a process in which "enrolled actors seek to mobilize their constituencies to action" (Ponti, 2010, p. 25) and a set of methods are used by critical actors to keep the collective stable. Callon's model of translation has been criticized for providing and imposing a "template" or particular view of how the translation process occurs (Callon, 1986).

In effect, translations and inscriptions are intertwined processes. What are translated can be the inscriptions embodied in materials or interests or intentions of some actors. In fact, the very act of inscribing something involves an act of translating. An actor translates its interests to different mediums, which can be anything from words and gestures to objects and laws and may be material or semiotic. These mediums embody the interests of the actor through the inscriptions such as the case of hotel keys. The act of translating is actually inscribing the interests into various mediums. Therefore, the inscriptions can be defined as embodied translations in a medium, which will in turn be translated by other actors in practice.

Designers 'translate' the interests of relevant stakeholders (including themselves) and 'inscribe' them as a program of actions into the object of design in design time. Users translate these programs of action in a way as inscribed or possibly in some other different ways in use time. Users can re-inscribe different programs of action into the object of design during the translation process. In turn, the set of the various translations in use-time work as inscriptions, which shape the design of the next incarnation of the object of design. The agency involved in design time shape the object of design; then, the object of design shapes the agency exhibited in use time. However, the shaping processes in design time and use time are not one directional but mutual. In design time, agencies shape the object of design; but, the object of design can resist embodying the interests translated by designers and shape the agencies that try to shape it. A similar tension takes place between the object of design and users in use time. While the object of design shapes the agency of the users, the latter may resist acting in the inscribed way and shape the object of design that tries to shape themselves. Therefore, during design and use time, we see a series of processes of inscriptions and translations, which are intertwined, co-shaping and indeterminate. Design and agency are intertwined like inscriptions and translations.

2.1.2.2 Agency and Design Paradigms

Harrison et al. (2011) suggest that there have been three paradigms of design in the field of HCI. The term 'paradigm' in their study is based on the notion of paradigm developed from Thomas Kuhn's theory of the structure of scientific revolutions (Kuhn, 1970). Kuhn claims that scientific development can be explained in terms of paradigms. Scientific knowledge progresses not only in continuous and gradual ways, but also in the forms of paradigm shifts in which dominant theories, ways of understanding and the overall worldview are radically altered. Harrison et al. draw our attention to the framing defined by paradigms: 'paradigms can be characterized by a common understanding of the phenomenon under study, the kinds of questions useful to ask about the phenomenon, how we should structure answering those questions, and how the results should be interpreted' (Harrison, et al., 2011, p. 386). A paradigm shift takes place when the dominant understandings cannot explain the increased number of anomalies, causing a period of crisis in which previously taken-for-granted terms, types of questions, ways of answering the questions and validating the answers are challenged.

Furthermore, Harrison and his colleagues (2011) argue that the field of HCI has been through a similar crisis period. Drawing on Agre's theory of generative metaphors in technical practice, which suggests that technical fields are shaped according to particular and dominant metaphors (Agre, 1997), they have characterized three paradigms within the field of HCI according to three dominant metaphors. Harrison et al. (2007) emphasise one important difference between Kuhn's scientific inquiry and Agre's emphasis on metaphor in discourse:

> [T]he notion of scientific inquiry implies an absolutist metric, in which one paradigm has to be right and the others wrong. Thus, Kuhn argues that Newtonian physics is wrong, though convenient. In contrast, Agre's approach allows metaphors to exist side-by-side without the necessity of reconciling all contradictions. (p. 3)

In Agre's model, dominant metaphors of a field centralize some phenomena while marginalising others. New metaphors can bring marginalised phenomena into the centre. Using Agre's model of generative metaphors and Kuhn's notion of paradigm, Harrison et al. (2007) identify three HCI paradigms: 1) human factors/engineering; 2) cognitive revolution; and, 3) situated perspectives.

In the first paradigm, the underlying metaphor of interaction functions ‘as a form of man-machine coupling’, which is mainly informed by industrial engineering and ergonomics. The aims are to ‘optimize the fit between humans and machines’; ‘identify problems in coupling’, and ‘develop pragmatic solutions to them’ (Harrison et al., 2007, p. 3).

The second paradigm is based on a central metaphor of ‘human mind as information processor’ and on the assumption that ‘the interaction between humans and computers can be viewed as an exchange of information’ (Harrison, et al., 2007, p. 3). Typical questions include: 'how does information get in', 'what transformations does it undergo', 'how does it go out again', and 'how can it be communicated efficiently'. As the information-processing model is applicable to humans, computers and the interaction between them, it is possible to predict and optimize their relationship by modelling the states of both the person and the computer.

The third paradigm's central metaphor is ‘interaction as phenomenologically situated’ (Harrison, et al., 2007, p. 6). Central to the third paradigm is supporting situated action and meaning-making in specific contexts. Typical questions include: 'What existing situated activities in the world should we support?'; 'How do users appropriate technologies, and how can we support these appropriations?'; 'How can we support interaction without constraining it too strongly by what a computer can do or understand?'; and, 'What are the politics and values at the site of interaction, and how can we support them in design?' (p. 9).

In addition to the differences in conceptualization of interaction, there are various distinctions between the epistemologies of the three paradigms (see Table 2.1). One major difference is related to objectivity of knowledge. While the first and second paradigms focus on objective knowledge, the third advocates that 'all knowledge arises from and is related to specific social, cultural, and historical circumstances – a particular point of view' (Harrison, et al., 2011, p. 388). Another important difference is generalizability. While the second paradigm seeks for generalizability of knowledge that is often produced in controlled conditions, the third values and supports multiple interpretations of interactions and attempts to keep the multiplicity as much as possible.

Table 2.1 Epistemological differences between the paradigms (Harrison, et al., 2007)

	Paradigm 1: Human Factors/ Engineering	**Paradigm 2: Cognitive Revolution**	**Paradigm 3: Situated Perspectives**
Appropriate disciplines for interaction	Engineering, programming, ergonomics	Laboratory and theoretical behavioral science	Ethnography, action research, practice-based research, interaction analysis
Kind of methods strived for	Cool hacks	Verified design and evaluation methods that can be applied regardless of context	A palette of situated design and evaluation strategies
Legitimate kinds of knowledge	Pragmatic, objective details	Objective statements with general applicability	Thick description, stakeholder "care-abouts"
How you know something is true	You tried it out and it worked.	You refute the idea that the difference between experimental conditions is due to chance	You argue about the relationship between your data and what you seek to understand.
Values	Reduce errors Ad hoc is OK Cool hacks desired	Optimization Generalizability wherever possible Principled evaluation is *a priori* better than ad hoc, since design can be structured to reflect paradigm Structured design better than unstructured Reduction of ambiguity Top-down view of knowledge	Construction of meaning is intrinsic to interaction activity What goes on around systems is more interesting than what's happening at the interface "Zensign" – what you don't build is as important as what you do build Goal is to grapple with the full complexity around the system

Apropos of agency, it is possible to associate understandings of agency, which were presented in the previous section, with the three paradigms. First, the transition from paradigms 1 and 2 to paradigm 3 corresponds to a transition from essentialist accounts of subject and object to non-essentialist accounts. In other words, while paradigms 1 and 2 assume clearly separated and independent subjects and objects interacting with each other, paradigm 3 sees subjects and objects as indeterminate and entangled entities that do not have well-defined and fixed identities: what the entities are and what they do are dependent of relations between the entities in particular situations. Parallel to this transition to non-essentialist accounts, the idea of design is switched from a prescriptive understanding to a facilitative understanding. While paradigms 1 and 2 focus on "designing of automation" and "designing of use", paradigm 3 focuses on "designing for interaction". In fact, the difference between the prepositions 'of' and 'for' reflects the difference between essentialist and relational attitudes. Table 2.1 brings together different views of agency, models or theories of agency, three HCI paradigms and corresponding conceptualizations of design, humans and non-humans.

This research, which is situated within the third paradigm, develops a *relational* design approach referred to as Agency Sensitive Design (ASD), which is based on a relational view of agency and aims to support multiplicity and variety in the ways in which entities relate to each other in design and use of technologies. There are already many approaches, models and frameworks associated with the third paradigm, which can be categorized as 'situated perspectives' (Harrison, et al., 2011). ASD derives many concepts, qualities and strategies from studies of situated perspectives and brings them together with the explicit aim of recognizing and supporting the relational nature of agency in design and use.

Table 2.2 Different views of agency and three paradigms of HCI

Agency as	**Theory or Models**	**Design Paradigm**	**Idea of design**	**Humans as**	**Non-humans as**
Attribute of non-humans	Technological determinism	1st Paradigm	Designing *of* automation	Vague and independent	Predictable and independent
Attribute of humans	Structuration	2nd Paradigm	Designing *of* use	Predictable and independent	Predictable and independent
Attribute of humans and non-humans	Mangle of practice	2nd and 3rd Paradigm	Designing *of* interaction	Semi-predictable and entangled	Semi-predictable and entangled

Agency as	Theory or Models	Design Paradigm	Idea of design	Humans as	Non-humans as
Attribute of relations between humans and non-humans	Hybrid collective	3rd Paradigm	Designing *for* interaction	Indeterminate and entangled	Indeterminate and entangled

2.2 Situated Perspectives

In this section, I will review the design approaches that recognize and support the relational nature of agency in many ways and from different perspectives. This presentation has two purposes: first, it will provide an overview of recent developments in accommodating the embodied situated and relational nature of human action and dealing with the messiness of the realities in the field of interaction design; second, it will work as a generative conceptual source from which I will draw some qualities related to design artefacts, the design process, and the idea of design in general. These qualities will inform the construction of a relational understanding of design.

2.2.1 Social and Cultural Approaches

2.2.1.1 Participatory Design

Participatory Design (PD) constitutes a diverse set of theories, approaches, practices, analyses and actions with the aim of involving the relevant stakeholders as co-designers in the design process of social systems and technologies (Kensing & Blomberg, 1998; Muller & Kuhn, 1993). Stakeholders are those who are going to use the systems and are going to be affected by the introduction of the systems. Their participation can take place at various stages of the design process and be related to design decisions on any aspects of the systems (Törpel, Voss, Hartswood, & Procter, 2009). PD began mid-1970s as part of a Scandinavian work place democracy movement advocating for workers' rights, raising concern about the workplace and about the social effects of new technologies like dislocations and deskilling. (Kensing & Blomberg, 1998).

There are typically three kinds of reasons for user participation in design: 1) improving the knowledge that will inform the design of the systems; 2) shaping the expectations of the users and reducing their resistance to change; and, 3) facilitating workplace democracy by involving members of organizations in decision-making that may affect their work and lives (Bjerknes & Bratteteig, 1995). Bjerkness points out that many Scandinavian PD projects focused on the third reason, which involved democratic empowerment and political aspects of design decisions. In contrast, contextual design (Beyer & Holtzblatt, 1998), which was a US-based design approach inspired by the developments in PD, has maintained the element of user involvement without dealing with issues of democracy (Spinuzzi, 2002). Spinuzzi stresses that while contextual design focused on functional empowerment, it did not deal with democratic empowerment. Whereas functional empowerment allows workers to be more efficient and more productive in accordance with the management's goals, democratic empowerment allows them to act as actual co-designers, who are capable of redesigning their work flow, controlling their own tools and questioning designers (Spinuzzi, 2002).

Another set of motivations can be organized around three perspectives: pragmatic, theoretical and political (Greenbaum, 1993; Törpel, et al., 2009). Pragmatic motivations include the benefits of using the expertise of domain workers in discussions shaping the workers own future work (Törpel, et al., 2009). Here, PD can be beneficial for increasing the product and service quality (Greenbaum, 1993) and rendering technology appropriate (Törpel, et al., 2009). There can be many theoretical motivations; for example, phenomenology (Ehn, 1988; Winograd & Flores, 1987), ethno-methodology (Suchman & Trigg, 1992), activity theory (Bødker, 1990) and science and technology studies. Törpel states that science and technology studies (Suchman, 2002) with emphasis on the inseparability of the social and the material, provide theoretical motivations for choosing PD (Törpel, et al., 2009).

Finally, the most common political motivations are related to industrial democracy and workers' rights (Ehn & Kyng, 1987). In this thesis, my motivation is mainly theoretical albeit to some extent political. Actor-Network Theory (ANT), which originated in science and technology studies, has provided theoretical arguments for engaging in PD. The main understanding of ANT is based on notions of hybrid collectives or heterogeneous networks of humans and non-humans acting, relating and co-constituting. All actors take part in shaping the capacities and effects of the collective. This understanding of togetherness creates a necessity to recognize the various actors or multiple sources of influence in a design situation. PD, with its participatory methods and understandings, is a suitable approach to investigations motivated by ANT. My political motivation is related to a need to explicate the political character of design decisions. The politics can be involved in many stages of design and use of technologies. For example, it is possible to observe the politics at the very beginning of the projects, implicated in the design of the design process and in the making of 'protocols of design' (Pedersen, 2007); or, at the end of the projects, embodied in the designed artefacts (Akrich, 1992; Winner, 1980). From the perspective of politics, this research examines how the various arrangements of actors within a design collective transform the actors' roles and relations, making the actors more passive/active, visible/invisible and leader/follower.

Muller (2003) maintains that PD, which emphasizes mutuality and reciprocity, serves as a kind of third space for HCI in which new relations and understandings emerge. Muller uses Bhabha's (Bhabha, 1994) conception of two spaces creating a hybrid third space ‘that contains an unpredictable and changing combination of attributes of each of the two bordering spaces’ (p. 4). Within the hybrid third space, the old assumptions can be questioned and challenged: new relations and understandings can emerge through (re)interpretations and (re)negotiations. According to Muller, in addition to creating a third space for HCI, PD contains its own third space in which there is a diverse set of design techniques, methods and practices. Muller characterizes the third space according to the first dimension of the taxonomy of Kensing and Munk-Madsen (1993), which involves two methods: abstract and concrete. Muller considers the two methods as polar ends of a continuum. While at the abstract end of the continuum users are invited to enter the world of software professionals in order to participate in using methods like rapid prototyping and quality improvement, at the concrete end, the software professionals enter the world of the users through methods such as ethnography, on-going tailoring during usage, and end-user design (Muller, 2003). The hybrid practices, i.e., the practices in between that do not take place at the abstract or concrete end-points of the continuum, constitute the third space of PD. Muller explores the potentials of the various PD methods and co-constructed artefacts including sitings

(Muller, Carr, et al., 1995), workshops (Kensing & Madsen, 1992), stories (Beeson & Miskelly, 1998), photographs, dramas, games (Ehn & Kyng, 1992), language, descriptive artefacts and prototypes (Bødker, 1992) in the interests of creating a hybrid third space. He stresses, however, that a single practice may involve more than one method or artefact.

This research is situated in what Muller (2003) refers to as a hybrid third space in PD, my aim being to support fluid relations and emergent actions. To this end, I conducted a series of workshops that consisted of various activities involving collage making, games, and various technological prototypes. In the next sections, I will explain the basis for these methods.

2.2.1.1.1 Participatory Design Workshops

Workshops are one of the main methods of PD. Muller (Muller, 2003, p. 9) explains the key characteristics of workshops as follows:

> [W]orkshops usually introduce novel procedures that ... take people outside of their familiar knowledge and activities, and must be negotiated and collectively defined by the participants. Workshops are thus a kind of hybrid or third space, in which diverse parties communicate in a mutuality of unfamiliarity, and must create shared knowledge and even the procedures for developing …[such] shared knowledge.

A well-known workshop format, Future Workshops, consists of three phases: the Critique, the Fantasy and the Implementation (Kensing & Madsen, 1992). While the Critique phase aims to understand issues about the current work practice, the Fantasy phase focuses upon "what if" scenarios of the workplace. Finally, the Implementation phase aims to identify the resources required to make realistic change (Kensing & Madsen, 1992). The workshop format was first applied to a library project. The participants were library staff and the workshop theme was ‘computer technology on our terms’. Another technique that the researchers employed was metaphorical design. In the Critique and the Fantasy phases, metaphors such as the library as warehouse or the library as a store were introduced to the participants. These metaphors worked as conceptual and inspirational devices designed to help the participants think about different possible future scenarios and express their relevant likes and dislikes.

As a sub-set of participatory design workshops, performative workshops (Loke & Robertson, 2008; Moen & Sandsjö, 2005; Schiphorst, 2008) involve full-body movement and interaction between participants and various digital or non-digital artefacts. The structure and content of the performative workshops are influenced by the workshop tradition of domain of performance. In her workshops, Schiphorst (2008) made use of performance techniques such as improvisation, props, phantom partners, prosthetic devices, ritual space and placebo objects. Schiphorst cites the view of Schechner, a Performance Studies practitioner and scholar, regarding workshops (Schiphorst, 2008, p. 117):

> A workshop is the active research phase of the performance process... Probably the most prevalent kind of workshop is used to "open people up" to new experiences, helping them recognize and develop their own possibilities... To workshop something is to produce a prototype or experimental model.

Schiphorst (2007), after exploring human experience and its inseparability from the material processes of technology, transferred the knowledge from the field of Somatics to HCI. More specifically, she tries to demonstrate how embodied values of Somatics can be utilized in the different phases of design and evaluation processes of HCI and how research through art can be applied to explore, design, document and evaluate the research intentions. She employed the workshop method in an 'experience discovery' process that informed the design of the interactive artwork whisper; as well, she conducted a series of workshops with the goal of understanding to what degree a group of people would pay attention to their own body state and share their sensations with others in a space. Each workshop had a specific theme such as 'listen', 'between', 'extend' and 'phase'. For example, in the listen workshop, participants were asked not to speak. The participants were each given a pair of earplugs and then left alone with no further instructions for approximately 15 minutes. After the activity, participants were given response cards bearing the questions: What did you hear? How did you hear? What did it feel like? Schiphorst reported that the workshop series facilitated a large variety of experiences that helped her to develop an interactive artwork.

Moen (2005, 2007) conducted two workshops with the participants from a dance course, i.e., a program organized as part of the research study. The aims of the workshops were to generate interaction design ideas for informing the design of a movement interaction prototype, BodyBug. The first workshop focused on physical movements as interaction form, bodily interaction and communication. Moen worked with two other researchers, who had experience in facilitating participatory design workshops. The researchers preferred to conduct a very open workshop with little constraint. The workshops consisted of three phases: brainstorming, group-work and presentation. In the brainstorming phase, the participants were asked to brainstorm words that they associated with the dance course, their education or profession and then write them down on the post-it notes. The next stage was to combine the words into ad hoc categories. In the group-work phase, participants in groups were asked to think of self-experienced everyday interaction problems. Then, they explored some scenarios for each problem by using video, clay, and paper and pencils of different colours. In the final session, the groups presented their work.

The focus of Moen's second workshop (2005), which had a similar structure to the first, was upon one of the ideas from the first workshop: the concept of flow. This time, participants were asked to create more concrete problem-solution pairs. The final ideas were found to be not very movement-based. The researchers stated that the participants expressed some disappointment because they had not been able to create more physical or movement-based interaction ideas. The researchers suggested apropos of future workshops that a stronger emphasis on movement as the main interaction modality might be better for developing more movement-based interaction. However, they also stressed the importance of evaluating movements experientially to test the appropriateness of the movement modality in each case, should this strategy be employed.

Loke (2009) conducted two workshops as part of a research program developing a methodology referred to as 'moving and making strange' (Loke & Robertson, 2007). As the content and structure of her workshops were highly influential in the design of the workshop of this research, I will allocate more space to the explaining of them. The workshops aimed to explore how movement could be understood, described, represented, experienced and enacted in the design of movement-based interactive systems. To this end, Loke formulated a 'constructed design situation', using a hypothetical, future system as a vehicle for exploration. She explained that ‘creating a constructed design situation enabled prolonged attention to and visibility of the design artefacts and their transformations throughout the project’ (2009, p. 166). She further stated that she preferred to work with participants who were trained dancers and physical performers given their expertise in using the moving body as a design material. For the purposes of 'making strange', the theme of the workshop was the *falling* body, which was not a typical kind of everyday body movement. The analysis involved a first-person experiential perspective, an external, observational perspective, movement sequences of the moving body and Laban Effort-Shape descriptions of the qualitative, dynamic character of the movement.

The eight participants in the first workshop were trained dancers or physical performers. Each participant took part in a half-hour session in which he/she improvised various acts of falling. While first-person experiential accounts were obtained verbally during and after the sessions, external third-person analysis was performed retrospectively using video recordings. Loke (2009) reported a rich variation in descriptions of movement process and experiences of movement across participants' performances. She pointed out that the workshop process showed the importance of using techniques for generating improvised movement such as *scoring*, which could provide guidance for generating movement according to particular elements or parameters. Speed, duration, timing, scale, focus and use of space may be used as parameters for creating a score. According to Loke, the first workshop was not effective in producing adequate data for exploring ‘interactive treatments of choreographed movements’ and related representations and interpretations of the movements due to the fact that there were too few contextual constraints for the participants to work within. Therefore, in the second workshop, a strategy of introducing a specific and well-defined context or domain for generating meaningful movement was employed.

In the second workshop, Loke chose ‘The Divine and Bodily Experience’ as a theme that was expected to provide a rich, recognized context for acts of falling (Loke & Robertson, 2008). Loke emphasised that ‘the particular theme chosen is not significant in itself, but for its ability to generate meaningful movements and for its accessibility to performers’ (p. 83) In addition, an inspirational resource kit was provided in advance of the workshop. It contained image tiles, evocative texts, movement description cards, a floor plan of space, a CD of music/sound samples, and written descriptions of the acts and scenarios. Loke reported that the framing strategy, which provided a context and resources for the participants, played a key role in the success of the workshop. The results of the workshop contributed to a set of methods for generating and choreographing movement and tools for describing and representing movement. These methods and tools were integrated into the design methodology of Moving and Making Strange (Loke & Robertson, 2007).

Finally, although not a participatory design workshop in the traditional sense, Wei's 'phenomenological experiments' (Wei, 2002) can be viewed as participatory transformative performances. Wei describes them as 'phenomenological experiments about interaction and response, agency and intention' (p. 607). While his experiments are concerned with philosophical concepts, at the same time they are closely associated with inquiries centring on the idea of design. In TGarden, a responsive space, actors-spectators improvise gestures with specially designed costumes equipped with sensors (Wei, 2007). This responsive space supports the improvised gestures by producing synthesized media elements like light projections and sound. Wei (Wei, 2002, p. 457) describes TGarden as follows:

> [Its] software tracks gesture rather than recognize gesture, because at no place in the software is there a 'model' that codes the gesture ... The software does not infer what the player means by her gesture, it merely tracks the gesture and continuously synthesizes responses. So what we have done is to set aside entirely the problem of inferring human intent from behaviour, or more generally from observables. Yet by providing and even thickening the sensuous response, we make fertile the substrate for agency. This approach remains agnostic as to whether movements are intentional; the responsive system simply does not need to know.

Wei stresses that because the boundary between actor and spectator becomes blurry, 'anybody may adopt the disposition of an actor as an agent of change in the event, or equally a spectator as a witness of the event' (Wei, 2007, p. 611).

He advocates that performance research and phenomenological experiments provide suitable ground to experiment and force the boundaries (Wei, 2007). What is needed is a shift of emphasis from spaces of representation to spaces of experience, to shift the emphasis from 'taxonomy, and schemas and classifications or standards and protocols … to the dynamics of processes that stir, up, shape, and unshape the material patterns that constitute the life world' in favour of improvised gestures and relations in responsive media-saturated mixed reality spaces (Wei, 2007, p. 615).

Wei's study is a complex philosophical inquiry into being a human. TGarden demonstrates how philosophical inquiry into varieties of agency can be performed collectively in a non-anthropocentric way. TGarden's software does not have any human-like 'intelligence' embedded into the code; the rationale behind this is to radically investigate the alternative materialities of computing. This is a good point in terms of challenging the widely accepted view of agency of computers; i.e., that they are obliged to mimic human agency.

In summary, workshops and, in particular, performative workshops can provide a suitable play platform for informing the design of tangible computing applications (Moen & Sandsjö, 2005; Schiphorst, 2007), deriving design representations, developing design methodologies (Loke & Robertson, 2008) and/or inquiring into more philosophical concepts (Wei, 2007). I employed the workshop method as a means of exploring the connectedness and relationality of human and non-human actors in various constructed design situations and of developing a relational understanding of design. In this respect, my use of workshops can be situated somewhere between the workshop approaches of Loke (2009) and Wei (2007) respectively.

2.2.1.1.2 Posters

Posters including maps, collages, rich pictures and sketches are the generative methods frequently used in PD studies undertaken by (Bødker & Kensing, 1994; Dandavate, Steiner, & William, 2000; Elovaara, Igira, & Mörtberg, 2006; Elovaara & Mörtberg, 2010; Loke, 2009; Noble & Robinson, 2000; Patton, 2000; Sanders & Stappers, 2008; Sanders, 2000; Sanders & Branaghan, 1998; Sanders & William, 2001). Muller, explaining the strategic character of collages, states (1993, p. 20):

> Relatively few people make collages as part of their work activities, and relatively few people interpret their collages to one another as part of their work conversations. Yet the content of the collages is strongly anchored in what people know. The collages thus become marginal constructions, not part of any defined workplace field or discipline, but

> informed by familiar knowledge. The novelty of the collage encourages the challenging of assumptions and the interpretation and presentation of collages encourages mutual learning across the diversity of experiences and knowledge of the participants.

Sanders (2000) claims that these generative methods are useful for: 1) Using visual ways of sensing, knowing, remembering, and expressing; 2) Giving access and expression to the emotional side of experience; 3) Acknowledging the subjective perspective in people's experiences with technologies; and 4) Revealing the unique personal histories that contribute to the ways in which people shape and respond to technologies. Muller (2003) asserts that collaboratively produced collages have the potential to challenge assumptions, the co-creation of meaning, collective action and dialogue.

Elovaara and Mörtberg (2010) used cartographic maps when designing an e-government project called 'I, My Workplace and My Work'. The civil servants who participated in the design process engaged in map-making to describe themselves, their workplaces and their particular forms of practice. Their maps included photos of their environments and colleagues, descriptions of their daily routines, drawings and any other material explaining their workplaces. The end product was a rich map consisting of an assemblage of people, artefacts, environments, and their relations and concerns illustrated from multiple points of view. The simplicity and limited number of constraining rules pertaining to the mapping exercise allowed the civil servants to express their partial knowledge while simultaneously keeping a level of detail of their relations, skills and work context as much as possible.

In a workshop conducted by Loke, the dancers were asked to create collages out of the images, texts and sketches in a resource kit (Loke, 2009). Unlike the collage work co-created in the 'I, My Workplace and My Work' project, these collages were produced individually, a choice possibly influenced by the artistic nature of the research study. The resulting collages were rich expressions and representations of ideas, associations and choreographic sketches involving movement paths and stick figures. Loke notes that the collages played a dual role: an inspirational role in terms of provoking and generating ideas, and a documentary role in terms of providing an alternative medium for articulating and presenting an idea. Loke explains that collages can create multiple opportunities for creating movement choreographies:

> ... [The] process of using the kit reveals a method of generating and devising movement that begins from multiple entry points: a piece of text or a word can invoke a movement impulse or inspire thinking on related or associated concepts; images can evoke a feeling state. A concept can give rise to a movement or kinaesthetic sensation that can then be developed choreographically (p. 194).

Collaborative, generous and flexible methods and tools such as sketches, low-fi proto-types, rich pictures and maps could prove useful in obtaining multiplicity in representation. These rich representations are particularly important for keeping the concerns of the different stakeholders or multiple sources of influence visible. By employing this strategy, the design process can maintain its capacity to address those concerns that risk being lost in the production of formal system requirements specifications.

2.2.1.1.3 Prototypes

A prototype can be anything from a paper-based storyboard to a complex software simulation, or from a cardboard mockup to a molded or pressed piece of metal (Sharp, Rogers, & Preece, 2007). Prototypes can be characterised in terms of: the aim of the prototype (Houde & Hill, 1997), the level of fidelity of the prototype (Rudd, Stern, & Isensee, 1996), the time of using the prototype in a development life-cycle (Ratcliffe, 1988), and the lifetime of the prototype (Davis, 1992). Lim et al. (2008) suggest that prototypes can have two main roles: 1) prototypes are for traversing a design space, leading to the creation of meaningful knowledge about the final design as envisioned in the process of design; and 2) prototypes are purposefully formed manifestations of design ideas.

Holmquist differentiates two ‘incomplete representations’, i.e., prototypes and mock-ups (Holmquist, 2005). While mock-ups have the appearance but not the function of a certain artefact, prototypes have the functionality but not the appearance of a future artefact. Mock-ups can be used to ‘identify potential problems and explore alternative avenues early in the process, without investing the work involved in creating a fully functional artifact’ (Holmquist, 2005, p. 50). Prototypes are preferred for testing the feasibility of a technological idea without requiring the researcher to deal with factors like form, durability or operation time (Holmquist, 2005). While a mock-up is 'the embodiment of form; this is how an artifact could manifest itself in the world, as a tangible device or as buttons and widgets on a screen', a prototype represents 'the knowledge of function; it is a tangible artifact in which the necessary technology to achieve a particular functionality is implemented' (Holmquist, 2005, p. 51).

Holmquist, with reference to the roles of representations as mock-ups or prototypes as generators, explains generators as follows:

> A generator is at the center of a process that generates inspiration and ideas - it is not an end in itself. By making abstract thoughts concrete, and by providing a focus for exploration and discussion, a generator can give rise to new insights. What one should take away from a generator are ideas and inspiration, which are potentially valuable (Holmquist, 2005, p.51).

In PD, mock-ups or low-fidelity prototypes have been usually preferred. As they are simple, cheap, and quick to produce and modify, they are suitable for exploration of alternative ideas in a practical way (Sharp, et al., 2007). In addition to their practicality, as Holmquist (2005) emphasises, the incompleteness of the representation allows users and designers to explore a larger range of alternatives and relations. Among well-known low-fidelity techniques are Storyboarding (Madsen & Aiken, 1993), Sketching, Wizard of Oz, cardboard and plywood prototypes (Bødker, Ehn, Kammersgaard, Kyng, & Sundblad, 1987; Bødker, Grønbæk, & Kyng, 1995; Ehn & Kyng, 1992), and PICTIVE (Muller, Tudor, et al., 1995).

Ehn, suggesting that one should recognize the performative and constitutive character of the representations (2008, p. 95), insists that:

> [T]he focus should instead be on these devices as on the one hand material constituents of the evolving object of design, and, at the same time, public things, supporting communication or participation across design games in the design process. They are potentially binding different stakeholders together, and there is clearly also a performative dimension of the evolving object. These 'representatives' of the object of design have of course to be elected and enrolled by the other participants but, once engaged, they are active participants in the design thing as a collective of humans and non-humans.

Similarly, Bødker (2009, p. 2) emphasises the non-neutral and performative nature of artefacts in design:

> The classic artefact of HCI and interaction design, the prototype in its various guises, is not a neutral representation of a method, but has acute consequences for both designer and stakeholder understanding of design concepts implied in the representation as well as for empathy and the understanding of situations, contexts, and use. Thus, the ongoing design process is affected by the production of the prototype.

Bødker (2009) asserts that the artefacts can be performative or make an effect on human actants. For example, in a participatory design workshop, participants tended to perform in collaborative ways when provided with large sheets of paper rather than small sheets, the latter being more likely to constrain activity. Material agency can play an important role in idea generation, problem formulation and resolution by enabling particular kinds of practices while at the same time constraining others.

2.2.1.1.4 Games

In PD, games provided not only techniques for exploring the design context and facilitating communication between the stakeholders (Bødker, et al., 1995; Pedersen & Buur, 2000) (Ehn & Kyng, 1992; Ehn & Sjögren, 1992; Jacucci, Jacucci, Wagner, & Psik, 2005; Kensing & Madsen, 1992; Muller, 1991, 2001) but also a theoretical foundation for understanding (participatory) design (Ehn, 1988). In this section, focus is upon Ehn's theoretical foundation.

Drawing on the Wittgenstein's notion of language-games, Ehn conceptualizes the design process ‘as intertwined language-games of design and use (professional designers and professional users), where “performative” design artifacts such as prototypes and “design games” could act as representative 'boundary objects' binding the different language games together’ (Ehn, 2008, p. 94). Ehn explains that in language games, one have to learn to follow rules that may not be very explicit (Ehn, 1988). ‘The rule following behavior of being able to play together with others is more important to a game than the specific explicit rules’ (Ehn, 1993, p. 64). The family resemblance to other language-games previously played facilitates the learning and understanding of said games.

Conceptualization of the design process as language-games represented a strong attack against the Cartesian rationalism of systems design. Language-games signified a shift from understanding language as description to language as action. Ehn explains how his understanding of design was shaped by an understanding of language as description (Ehn, 1988, p. 62):

> While thinking about how perspectives make us select certain aspects of reality as important in a description, I realized I had completely overlooked my own presumption that descriptions in one way or another are mirror images of a given reality. My earlier reasoning had been that because there are different interests in the world, we should always question the objectivity of design choices that claimed to flow from design as a process of rational decision-making. Hence, I had argued that we needed to create descriptions from different perspectives in order to form a truer picture. I did not, however, question the Cartesian epistemology and ontology of an inner world of experiences (mind) and an outer world of objects (external reality). Nor did I question the assumptions that language was our way of mirroring this outer world of real objects. By focusing on which objects and which relations should be represented in a systems description, I took granted the Cartesian mind-body dualism that Wittgenstein had so convincingly rejected in Philosophical Investigations (1953).

Ehn's experience with the UTOPIA project enabled him to reconsider his philosophical assumptions. His engagement in design-by-doing and design-by-playing methods and descriptions - such as mock-ups and work organization games - allowed Ehn and his colleagues to shift their perspective from system descriptions to scripts for action. These 'hands on' design devices or 'representations' provided meaningful ways for users to participate in the design process. Ehn (1988, p. 62) explains the importance of maintaining a family resemblance with the users' everyday practice:

> Design tools such as models, prototypes, mock-ups, descriptions, and representations act as reminders and paradigm cases for our contemplation of future computer-based systems and their use. Such design tools are effective because they recall earlier experiences to mind. It is in this sense that we should understand them as representations.

Therefore, what Ehn proposes is a more practice-based, experiential and non-static understanding of representations in design. This view of representations is highly influenced by the opposite idea of 'picture theory of reality'; that is, ‘what a picture describes is determined by its use’ (p. 63).

Ehn's recent formulation (2008) has brought together the concepts of communities-of-practice and communities-of-interest[3] and the concept of language-games. According to this extended formulation, design is seen as 'participative, entangled, meaning-making design-games (having a conceptual family resemblance both with intertwined language-games and with overlapping communities-of-practice)'.

Ehn (2008, p. 4) suggests that there can be many different design games:

- There are the many everyday professional (design) games of both users and designers (participants' everyday practice related to a design project understood as design games).
- There are the explicitly constructed specific design games that have family resemblance with these everyday design-games (the design process as a shared design thing).
- There are specific performative 'design-by-doing' and 'design-by-playing' design-games (design methods and devices understood as design-games).
- Though not design-games in the same sense, there are even specific 'design games' like participatory organizational games, 'concept design games' (Habraken & Gross, 1987) or 'video as design material' (Buur, Binder, & Brandt, 2000) (the use of specific design devices understood as design-games).

This formulation brings together a meta-design approach, design for design after design (Fischer & Giaccardi, 2006), and a participatory design approach, design for use before use (Redström, 2008). The motivation behind this move is to address the critique that immediate users who participate in the design games of PD are not the only stakeholders (A. Telier, 2011). Furthermore, independent from the level of participation, actual use can always deviate from envisioned use. In an attempt to address these shortcomings, participatory design, i.e., 'designing for use before use', is complemented by meta-design, 'designing for design after design' (Ehn, 2008). From this dual perspective, while participatory design deals with 'unattainable design challenge of fully anticipating or envisioning use before actual use takes place in people's life worlds' and

[3] While communities-of-practice consist of practitioners whom work as a community in a certain domain, communities' communities-of-interest may be defined as a group of stakeholders brought together from different CoP on the basis of a common concern or interest, for the purposes of solving a particular complex design problem (Fischer, 2007)

meta-design becomes ‘a way to meet the equally unattainable design challenge of all-encompassing anticipation and envisioning the potential design as it will occur in use after completion of project design’.

In their co-authored book titled *Design Things* (A. Telier, 2011), Pelle Ehn and his colleagues Thomas Binder, Giorgio De Michelis, Giulio Jacucci, Per Linde and Ina Wagner further extended the idea of design to design *things.* In Section 2.2.2.5, I will examine some important understandings from *Design Things*.

Before concluding this subsection, I will briefly present exploratory design a game in PD. Brandt (2006) investigated exploratory design games and their characteristics and different roles in design process. Her work provided designers with useful ‘handles’ for creating their own games. Elsewhere, Brandt, Messeter and Binder offered some features for a tentative definition of participatory design games (2008, p. 54):

- A diverse group of players are gathered around a collaborative activity guided by simple and explicit rules, assigned roles and supported by pre-defined gaming materials.
- The game materials typically point to either or both existing practices and future possibilities.
- The games are played within a confined and shared temporal and spatial setting often removed from the everyday context of the players.
- The purpose of the game is to establish and explore novel configurations of the game materials and the present and future practices to which these materials point.
- At the end of the game, the players will have produced representations of one or more possible design options.

The exploratory design games used by the workshops of this research have all the features above. However, in regard to the last feature, the workshops did not produce any design representations in the form of material artefacts. Rather, the outcomes were in form of new knowledge, relations and experiences.

2.2.1.2 Meta-design

Meta-design (Fischer & Giaccardi, 2006) is a conceptual framework aiming at defining and creating socio-technical infrastructures in which different forms of collaborative design can take place. Meta-design operates at two main phases: design time and use time. While design time refers to the phase during which a system is being built by system developers, use time refers to the phase wherein users on their own use the system. Similar to PD, meta-design involves domain experts or users in design time as co-designers. However, the participating users are only representative of future users: the actual use cannot be fully anticipated; and, the anticipated practice and its needs are not fixed but change in ways that designers may not predict. For these reasons, participatory design processes at design time prove insufficient. In order to address these concerns, meta-design advocates that design activities must not stop at design time but should continue at use time. To this end, meta-design creates 'open systems' or 'under-designed' systems that can be modified by their users and evolve at use time. Fischer and Giaccardi (2006) state that under-design is an attempt to create design spaces for others: it does not mean less or incomplete design. Rather, it provides resources and mechanisms for users to reconfigure the system according to their changing needs.

As part of the meta-design framework, Fischer et al. (2001) propose seeding, evolutionary growth and reseeding the (SER) model, which ‘is a descriptive and prescriptive model for large evolving information repositories. It postulates that systems that evolve over a sustained time span must continually alternate between periods of activity and unplanned evolution, and periods of deliberate (re)structuring and enhancement’ (Fischer, et al., 2001, p. 447). The SER model conceptualizes the designer's activity as meta-design, which considers users as co-designers or knowledge workers. System developers and future users construct an initial collection of domain knowledge, i.e. a seed, which is expected to evolve at use time. During the evolutionary growth phase, the seed is used for doing work or for exploring problems, mainly by users. Developers perform substantial systems and information space changes according to the guidance of users (Fischer & Ostwald, 2002). Here it is important to note that from the perspective of meta-design, there are no fixed divisions between the identities of user and designer. Rather, there is a continuum of roles: ‘consumer/designer is not an attribute of a person, but a role assumed in a specific context' (Fischer & Giaccardi, 2006, p. 7). Table 2.3 provides a summary Table comparing the objectives of traditional design and meta-design.

Table 2.3 Traditional design versus meta-design

Traditional Design	**Meta-Design**
guidelines and rules	exceptions and negotiations
representation	construction
content	context
object	process
perspective	immersion
certainty	contingency
planning	emergence
top-down	bottom-up
complete system	seeding
autonomous creation	co-creation
autonomous mind	distributed mind
specific solutions	solutions spaces
design-as-instrumental	design-as-adaptive
accountability, know-what (rational decisioning)	affective model, know-how (embodied interactionism)

Source: (Fischer & Giaccardi, 2006, p. 6)

Fischer and Giaccardi (2006) explain that there can be three levels or spaces of design in meta-design: 1) a technical infrastructure that is evolvable, referred to as 'designing design'; 2) a learning environment and work organization that allows users to become active contributors, referred to as 'designing together'; and, 3) a socio-technical system in which users can relate and find motivations and rewards, referred to as 'designing the in-between'. According to Fischer and Giaccardi, while the first level provides a structural openness through computational malleability, the second and third levels provide interactive openness through collaborative and embodied relationships and activities respectively. Included among the applications of the meta-design framework are the Envisionment and Discovery Collaboratory (Arias, Eden, Fischer, Gorman, & Scharff, 2000), the Memory Aiding Prompting System (Carmien et al., 2005), and Courses-as-seeds (DePaula, Fischer, & Ostwald, 2001).

The concepts and strategies that are part of meta-design approach support more relational design practices. For example, its emphasis on unfinished design or under-design enables users to appropriate technology in their own way. Meta-design considers them as co-designers and provides them with adaptable and flexible seeds. Meta-design and participatory design can be viewed as complementary (Ehn, 2008). While participatory design primarily focuses on designing for use before use, which takes place in design-time, meta-design's focus is mainly upon designing for design after design.

This research, extending the scopes of participatory design and meta-design even further, takes into consideration design before design, which refers to the design decisions or protocols of design that shaped the initial design problem, its scope, and the structure and content of the design process.

2.2.1.3 Further approaches

In addition to the approaches discussed above, the next sections briefly present other relevant socio-cultural approaches and methods that value participation, multiplicity, openness, flexibility, relationality and configurability.

2.2.1.3.1 Probes

Among the more influential approaches are cultural probes, which were developed by Gaver and his colleagues in 1999. Cultural probes are physical packets consisting of various materials such as maps and postcards, with open-ended and provocative tasks for acquiring inspirational responses from the community of participants. Cultural probes value uncertainty, play, exploration and subjective interpretation as ways of dealing with the limits of knowledge. The designers' collective aim is to gain inspiring design ideas for technologies that will enrich people's lives in new and pleasurable ways. Unlike normative scientific approaches, their approach advocates particularity, ambiguity, multiplicity and subjectivity. Gaver et al. (1999) explain some aspects of the rationale behind their approach:

> . Asking unambiguous questions tends to give you what you already know, at least to the extent of reifying the ontology behind the questions. Posing open or absurd tasks, in contrast, ensures that the results will be surprising.

. Summarizing returns tends to produce an "average" picture that may not reflect any individual well, and that filters out the unusual items that can be most inspiring.

. Seeking justifiable accounts of probe returns constrains the imaginative engagement and story-telling which can be most useful for design

In their recent study, Gaver et al. (2009) describe an anatomy of failure case for one of their probe studies. This example was particularly important for critical design research because it clearly explained how open-ended systems and strategies for 'polyphonic' assessment need not necessarily be incompatible with making definitive assessments of success or failure that can help shape future design work. This explanation was particularly important as a response to some counter attacks labelling this approach an ‘anything goes mentality’. Gaver and colleagues evaluated the success of their system according to four themes: engagement, reference, accommodation, and surprise and insight..

Boehner et al. (2007) state that irrespective of the wide uptake of cultural probes by various forms, e.g., Empathy Probes, Technology Probes and Empathy Probes, some of the attributes of cultural probes have been broadly altered or left behind. One of the important attributes of Cultural Probes was ‘subversion of existing method’, which aimed to subvert or undermine traditional and dominant HCI methods (Boehner, Vertesi, et al., 2007). There was a strong epistemological position emphasising the importance of mutual construction of knowledge in terms of doing user research:

> In this model [the HCI engineering model], users are passive agents whose actions and utterances become useful only when subjected to the rationalizing scientific instrumentality of HCI engineering processes. These processes, indeed, deny the agency of both engineer and user; what is produced is an objective account of a stable world of which the engineer is an observer. What the probes set out is emphatically not a different means by which this process can proceed, or a different instrumentality; rather, they set out an alternative account of knowledge production in HCI, one that arises as a participative engagement between individuals. Irrespective of the particular merits or problems of probes themselves, what they offer is an opportunity and occasion to bring the epistemological commitments of HCI design methods into the foreground (Boehner, Vertesi, et al., 2007, p. 1085).

2.2.1.3.2 Distributed Cognition

Different from the previous approaches, the main concern of Distributed Cognition (DC) is not related to design: a descriptive framework rather than a generative method, it was developed by Hutchins and colleagues in the mid-1980s. Hutchins, in his book *Cognition in the Wild* (1995), explains how a ship is navigated by a functional system of human and non-humans including a navigator, multiple sailors, a nautical chart, a gyrocompass, a phone, and many other resources. The main argument of distributed cognition is that cognitive capabilities are not embodied in individuals; rather, they are distributed among individuals and the various artefacts in the environment. Two important concepts that Hutchins employs are representational states and media. According to Hutchins, cognition involves the propagation of representations across media in a social organization or functional system. These media can be any internal or external representations.

Hollan et al. (2000) delineate the two main principles of DC. According to the first, ″[a] cognitive process is delimited by the functional relationships among the elements that participate in it, rather than by the spatial colocation of the elements″ (Hollan, et al., 2000, p. 176). The boundaries are no longer those of individuals. The second principle states that various mechanisms can take part in the cognitive process through reconfigurations and coordination.

Latour, in his review of DC, highlights some important features of Hutchins' argument vis-a-vis the phenomenon of mediation by artefacts (1996b). According to Latour, his notion of mediation by artefacts provides a richer understanding of the relations between humans and non-humans. In order to highlight the distinction of Hutchins' argument, Latour brings together a few of his quotations (Latour, 1996b, p.5, original emphasis):

> None of the component cognitive abilities has been amplified by the use of any of the tools. Rather, each tool presents the task to the user as a <u>different</u> sort of cognitive problem requiring a <u>different</u> set of cognitive abilities or a <u>different</u> organization of the same set of abilities" p.154. "In this sense, these mediating technologies do not stand <u>between</u> the user and the task. Rather, they stand with the user as resources used in the regulation of behavior in such a way that the propagation of representational state that implements the computation can take place"

> p.154. "Rather than focus on the mediating artifact as something that "stands between", I will view it as one of many structural elements that are brought into coordination in the performance of the task. Any of the structures that are brought into coordination in the performance of the task can be seen as a mediating structure" p. 290.

This view situates material artefacts, tools or technology not 'in-between' mental events but in a collective of humans and non-humans, which reconfigures itself and the problem at hand. Cognitive capacities dynamically emerge out of (re)arrangements of humans and non-humans. In fact, this view is a strong tie connecting Distributed Cognition and the Actor-Network Theory. One of the important strategies employed in the workshop studies in this thesis, which was based on this understanding of dynamic capacities, was enabled by reconfigurations or rearrangements of the human and non-human actors.

2.2.1.3.3 Extended Mind and Enactive Interfaces

The extended mind perspective advocates a view of mind not confined to the head (Bird, Marshall, & Rogers, 2009). According to this view, the external environment and the mind are considered as a coupled system constituting a hybrid cognitive system in which environmental objects and tools enable extended mental processes. Because this coupling involves ongoing interaction and reconfiguration of the world, as a consequence it shapes our perceptions, cognition, actions and, by extension, agency. De Jaegher and Froese (2009), who investigated the interpersonal dimension of this coupling employing an enactive approach, examined the interpersonal coordination and the interaction processes and the interplay between them. Their perspective suggests: (a) that the interpersonal coordination of movements can lead to the emergence of an interaction process, which in turn can affect the constitution of agency of individuals; and, (b) that individual cognition and interpersonal interaction - as two linked aspects of our agency - mutually enable and constrain each other.

The term 'enactive interfaces' implies interfaces predicated on enactive knowledge: the latter is acquired primarily by 'doing' and is constructed on motor skills; for example, playing a musical instrument (Varela, Thompson, & Rosch, 1991). One important application area of enactive interfaces is sensory substitution systems, which cover a whole range of devices that transform stimuli characteristic of one sensory modality into stimuli characteristic of another sensory modality (Lenay, Gapenne, Hanneton, Marque, & Geouelle, 2003). TVSS (Tactile Vision Sensory Substitution), one of the very early sensory substitution systems designed to help visually impaired people, was a vision-to-tactile system converting the image of the environment captured by a video camera into tactile stimulation produced by a matrix of 400 activators (Bach-y-Rita, Collins, Saunders, White, & Scadden, 1969). Participants experimenting with this system were able to interpret this tactile stimulation when they were asked to bat a ball as it rolled off a table. Although sensory substitution systems enable visually impaired people to carry out certain tasks, e.g., recognising locations of objects which would hitherto have been impossible for them, they are still not able to provide the experience and joy of actually seeing (Lenay, et al., 2003). In this respect, sensory substitution systems may be considered as additions or supplements to an individual's sensory modalities rather than substitution. Despite the fact that sensory substitution systems were originally designed for visually impaired people, they have also facilitated research into perceptual and cognitive studies and philosophy. The features that make sensory substitution systems a suitable tool for performing practice-based research in these areas include the provision of a novel perceptual modality and a 'new space of coupling between humans and the world' (Lenay, et al., 2003). Sensory supplementation devices can provide unique opportunities to investigate the different aspects of human agency by enabling new modes of perception and facilitating the emergence of novel interactions, which are not possible without their inclusion.

Bird et al. (2009), who employed a low-fi rapid prototyping approach to building a minimal TVSS system when investigating the potential of extended mind perspective through experimentation with sensory substitution systems, demonstrate that prototyping and experimenting sensory substitution devices facilitate 'an understanding of agent-environment interactions by reducing abstraction load' (p. 6) and reveal the salient relations between them. Similar minimalist approaches have been employed by other researchers: Lenay and Steiner (2007), who claim that localisation of objects is possible using a simple sensory supplementation device composed of a photoelectric cell triggering a vibrotactile actuator, argue that minimalism of the device forces 'a spatial and temporal deployment of the perceptual activity' (p. 2). Similarly, Grespan et al. (2008) used a distance-to-tactile sensory supplementation device, the Enactive Torch (ET), to investigate the role of embodied action in the perception of external spatiality. When the ET detects an object within a range of 60cm, it vibrates. Grespan et al. designed an experiment consisting of two simple tasks related to determining the location of objects and the distance to and between them; as well, they examined the different types of perceptive strategies that allowed participants to carry out simple tasks. In this research, I built a sensory substitution device similar to ET for facilitating various ways of non-verbal communication in my workshops. In my case, the mobility of the devices facilitated the construction of various couplings between humans and devices, which radically redistributed the capacities of action.

2.2.2 Material and Performative Approaches

2.2.2.1 Feminist HCI

The last few years have seen increasing interest in integrating feminist understandings into HCI (Bardzell, 2010; Bath, 2009; Croon, 2011). Apart from studies that directly and explicitly deal with the role of feminism in HCI, there has been an increase in the number of research studies concerned with society, culture, values, reflection and experience in the domain of HCI, which either implicitly or explicitly engage with issues and constructs closely linked to the central commitments of feminism (Bardzell, 2010). Harrison et al. (2011) suggest that all of these studies can be considered within the third paradigm of HCI, and that feminism provide a lens through which to gain an understanding of the consequences and potentials of the epistemological shift the third paradigm embodies.

Bardzell defines Feminist HCI as 'the reflective integration of feminist strategies as a resource for interaction design' (Bardzell & Churchill, 2011, p. 2). Feminism consists of a set of theories, methodologies, epistemologies, and core values including agency, identity, equality, subjectivity, reflection, empowerment and social justice (Bardzell, 2010; Bardzell & Churchill, 2011).

According to Bardzell (2010), feminism can contribute to the field of interaction design in two main ways: critique-based and generative. The critique-based contributions, which have been influential in the field, highlight the unspoken values and the possible unintended consequences of designs and design processes. They work like sensitizing devices to various marginalized matters of concern; and, their benefits are usually indirect. Their generative contributions involve using feminist understandings explicitly and directly for obtaining new insights into design activities. Bardzell developed a 'constellation' of design qualities, i.e., pluralism, participation, advocacy, ecology, embodiment and self-disclosure to explain the various cases supporting these qualities. These cases highlight the many different ways in which feminist understandings contributed to interaction design other than 'pointing out instances of sexism after the fact' (p. 1308). Similarly, Sheridan (2002) writes to the effect that 'feminist theory is not just about women and gender but, of necessity, it is also about epistemology and ontology' (p. 24).

In brief, the quality of pluralism involves the rejection of universal knowledge claims and recognition of multiple ways of knowing. The quality of participation refers to valuing co-construction of knowledge through participatory design practices. The quality of advocacy requires designers to question their position and its non-neutrality when trying to support a better society or practices through design decisions. The quality of participation can help to open these decisions to negotiation. The quality of ecology refers to an understanding of the situated character of the meaning of artefacts in a larger relational system. It requires designers to consider the effects of introducing an artefact to an ecosystem involving different stakeholders. This quality is also closely related to any ethical concerns that may emerge from either use or non-use of technologies (Velden, 2009). The quality of embodiment involves embracing the embodied and situated nature of human action. Bardzell points out that there have already been many studies dealing with emotion, fun, spirituality, food and sexuality that indicate a recognition of the body and its various urges and sensations. Finally, the quality of self-disclosure refers to 'the extent to which the software renders visible ways in which it affects us as subjects' (Bardzell, 2010, p. 1307). This final quality is about explicating the working mechanisms of the systems, infrastructures and technologies.

For example, Bardzell (2010) cites the recommendation system of Amazon.com as an example of self-disclosure. Users of Amazon can select the option – 'Don't use for recommendations' - which prevents the system from using the current purchase as an exemplary case to recommend other books. Here, the recommendation system allows users to express themselves to Amazon as 'what kind of subject I want the application to treat me as'. The case of Amazon demonstrates a highly sophisticated mode of visibility, which explicates the way in which machines view users and provide resources for users to configure the machine's perceptions of said users. Here, visibility, in the form of self-disclosure, facilitates more responsible effects in design.

In general, feminism, and in particular feminist HCI, provide us with understandings of situated and embodied action, the performative nature of things, extended and relational views of materiality, unspoken or marginalized values, multiple realities and different epistemologies. In this research, I developed some qualities with particular focus on recognizing and supporting the relational understanding of agency in design. The qualities I propose are similar to those developed by Bardzell. However, as opposed to Bardzell's approach, my qualities primarily focus on ways of promoting the relational nature of agency: characterizing design artefacts, the design process and the idea of design in general.

2.2.2.2 Interactional Approach

In recent times, attempts have been made to develop design approaches that particularly focus on interactional or interactionist views (Boehner, DePaula, et al., 2005; Höök, Ståhl, Sundström, & Laaksolaahti, 2008; Leahu, Sengers, & Mateas, 2008). While Boehner et al. and Höök et al.'s focus is upon 'affect as interaction', and their research is situated in the field of HCI, Leahu et al.'s focus is upon developing an interactionist Artificial Intelligence approach to the domain of ubiquitous computing. These approaches, which I hereafter refer to as interactional approaches, share similar concerns and are based on similar understandings of the nature of human action.

The main motivation of the interactional approach may be found in the need to expand the traditional, rationalistic models of cognition, which claim that 'the mind can be understood and modeled in computational terms' (Boehner, DePaula, et al., 2005, p. 2). In accordance with the interactional perspective, Boehner et al., who aim to develop an affective system, state that there can be two main ways of seeing affect: affect as information and affect as interaction. According to the informational view based on a model of rational cognition, affect is seen as "information" which can variously be represented, encoded, transmitted and decoded. In contrast, according to the interactional approach, affect is "more than transmission - it consists of an active process of co-constructing one's affective state, which requires not decoding, but active interpretation' (2005, p. 65). The non-representationalist or affect as interaction view considers affective communication as complex, ambiguous, malleable and non-formalizable whereas the informational view sees it as something to be codified and transferable.

Boehner et al. (2005) developed an application which they refer to as Affector to support the emotional communication and reflection between two colleagues by running two video streaming windows in two adjacent office spaces. The Affector, rather than trying to recognize or predict the affective state of the persons in front of the camera, instead contributes to the creation and stimulation of different affects by providing distorted video streams with various filtering effects configurable or tuneable by users themselves on fly. The Affector supports and augments emergent affect by means of having a nonrepresentational account and by supporting tuning operations during the interaction. In addition, this project has challenged the traditional understanding of what it means to evaluate an interactive system by developing an alternative evaluation strategy, which reconceptualises the evaluation activity; that is, which does not aim to assess whether the system captured and transmitted the emotional state of the users correctly. Rather, the evaluation focuses on "how the system was engaged for the co-interpretation of affect and how the system attributes encouraged reflection on the construction of affect" (Boehner, DePaula, et al., 2005, p. 283). Affector demonstrates how interactive systems can be built by focusing on relations between the actors and facilitating emergent interactions. Van der Velden (2009, p. 37) describes this kind of design process as an 'adaptive and intra-active process in which more desirable configurations of people and technology become possible'.

Boehner at al. suggest five design principles for an interactional approach:

1. The interactional approach recognizes affect as a social and cultural product.
2. The interactional approach relies on and supports interpretive flexibility.
3. The interactional approach avoids trying to formalize the unformalizable.

4. The interactional approach supports an expanded range of communication acts.

5. The interactional approach focuses on people using systems to experience and understand emotions.

Later, Höök et al. (2008) suggested a few changes to the first and third principles, addressing some of the physical and bodily experiences and need of making generalizations without becoming reductionist:

1. The interactional approach recognizes affect as a social, cultural and bodily product

3. The interactional approach is non-reductionist

Finally, Leahu et al. (2008) propose six strategies supporting an interactional approach to the domain of ubiquitous computing:

1. Tightly integrate sensing and action in complete working systems: This strategy is supported by a model referred to as 'functional decomposition', which 'involves a chain of modules, each of which solves a subproblem and passes the result along to the next module, eventually performing a motor action'. Genghis, a six-legged walking robot, is a successful implementation of this model.

2. Sense rather than represent: This strategy, which is closely linked with the first, suggests that it is possible to achieve intelligent and useful behaviour without maintaining a representation of outside world or context by 'relying on regularities in the world' (Leahu, et al., 2008, p. 138). Another robot, which picks up empty soda cans in an office space, employs this strategy by following simple, opportunistic rules.

3. Develop ad-hoc, situated representations: This strategy suggests using partial and incomplete representations for the complex cases in which some sort of internal representation is required. Deictic representations (Agre & Chapman, 1990), which are built on the basis of representing only the relevant entities or parts of the environment according to current situation, are good examples of such representations. A computer program controlling a penguin named Pengi in a game setting employed deictic representations. The special feature oft Pengi is that it does not maintain a complete and objective world model involving entities with fixed identities: it uses situated representations such as the-bee-I-am-attacking. In effect, the representation is based on relations between the entities.

4. Design for human-in-loop dynamics: This strategy suggests using the regularities of human beings, e.g., vigorous shaking to express excitement, as resources for achieving complex interactions between humans and technologies.
5. Leverage socio-cultural knowledge: this strategy involves maintaining the complex representations in the traditional sense but not using them in a one-to-one correspondence with the outside world. This strategy highlights the difference between construction of a formal representation and how it is incorporated into the system design. The interactive sculpture Office Plant (Böhlen & Mateas, 1998) captures the emotional content of its user's email and changes its form in an indirect way that enables its users to interpret the emotional tone of the email.
6. Design for engaged audience: this strategy suggests focusing on 'human-understandability of system behaviour' rather than trying to create an internal optimal functionality of the system. The given example is Home Health Horoscope (Gaver, Sengers, Kerridge, Kaye, & Bowers, 2007), which relies on the users' interpretations to complement the system's partial understanding of the situation without attempting to sense the situation with its full complexity.

In general, interactional approaches highlight the situated and emergent nature of capacities for action which are relationally shaped. The principles suggested by Boehner et al. (2005) and Höök et al. (2008) characterise a general shift in attitude towards designing interactive systems in non-reductionist, ecological and flexible ways without trying to codify fluid realities. The strategies proposed by Leahu et al. (2008) focus on the features of systems that benefit from the interactional dynamics between systems and humans and between systems and their environments as a resource for problem solving. Their strategies favour distributed functional composition, opportunistic use of contextual elements, situated representations and emphatic understanding between entities.

2.2.2.3 Seamful Design and Technomethodology

Seamful design (Chalmers & Galani, 2004) advocates the use of (beautiful) seams in interactive systems: seams can basically be gaps and breaks in functionality, and boundaries between different components or systems. Seamful design deliberately makes the seams visible and encourages system users to appropriate them as a resource for reflection and creative engagement. Seamful technologies maintain their own features and identities while interacting with other system components. In other words, a general strategy of seamful design is 'letting everything be itself, with other things' (Chalmers & Galani, 2004).

In their seamful game, Chalmers and Galani utilized deficiency of technological infrastructure, in this case the varying accuracy of the GPS signal, as a seamful resource for players to develop strategies. Rather than considering the variability of technological infrastructure something to avoid, prevent or hide, they exposed the seams in their design and used them as a feature of the game. Such seamfulness allows recognition of the roles or working principles of these technologies, which explicitly convey what they do but not how they should be used. In this respect, seamful design supports user appropriation by making resources publicly available.

Dourish and Button's (1998) notion of 'accounts' also advocates seams in design by suggesting the use of self-explanatory and transparent system components. The notion of accounts was developed as part of their approach referred to as Technomethodology, a process that brings together technology design and ethnomethodology in such a way that a foundational relationship between the two is maintained. Button and Dourish (1996, p. 4) explain the foundational relationship as follows:

> ...[R]ather than have systems design and ethnomethodology 'reach' towards each other and 'meet' at a design, we instead look to forge more foundational relationships, and then approach design from a new position. This foundational relationship is one in which design adopts the analytic mentality of ethnomethodology, and ethnomethodology dons the practical mantle of design.

The above foundational relationships can be found through the exploration of foundational ethno-methodological principles and insights. The notion of accounts was one of such insights. The key insight into accountability is founded on ethno-methodological understanding of accounts. For example, Dourish and Button (1998), explaining situated accounts, state that:

> Real-world machines produce noises and respond to physical interference, and their physical embodiment allows us to perceive their operation and even sometimes become involved in it. Human actors allow

> us to query their actions and motivations. We organise our actions not simply around abstractions of possible actions, but around the detail of the production of action and behaviour in particular circumstances (p. 310).

Drawing on this ethno-methodological understanding, Button and Dourish (1996) define accountability of technological systems as ‘computational representations which systems continuously offer of their own behaviour and activity, as a resource for improvised and contextualized action’ (p. 23). They developed the notion of accounts in order to deal with the difficulties caused by system abstractions. In technology design, system abstractions are widely used to hide the details and complexities of operations that a system component performs by providing interfaces with only a limited amount of information. Button and Dourish claim that ‘information hiding’ characteristic of interfaces prevents users from perceiving some essential operations of the systems. Users may need such information about system operations especially during breakdowns in the system's functionality. If abstractions of systems operation can be made observable, users will be better equipped to deal with any breakdowns. That is, systems may provide more information about their operations. However, here, the important point is the reflexive and situated character of the accounts or information, which distinguishes them from the conventional error messages provided by the systems:

> So what is important about this approach is not the account itself (the explanation of the system's behaviour) but rather accountability in the way this explanation arises. In particular, the account arises reflexively in the course of action, rather than as a commentary upon it, and concerns the way in which that action is organised so that it can be made rational in particular circumstances (Button & Dourish, 1996, p. 19).

Seamful design's seams and technomethodology's accounts share a similar concern of explicating material qualities of technologies in a situated way. Both seams and accounts emerge from the interactions between humans, technologies and their respective environments. In other words, they are relational effects of the assemblages of human-technology-environment.

2.2.2.4 Socio-Material Assemblages

In the field of organizational studies, Orlikowski (2007) argues that although materiality is an integral part of organizational theory, it has been largely ignored. Moreover, organizational studies of technology tend to adopt either a technological or social-determinism. While the technological determinism largely ignores the different ways of appropriation of technology by humans, social determinism underestimates the role and impact of technologies shaping human intentions and social structures.

Drawing on the various notions emerging from science and technology studies such as actor-networks (Latour, 2005), sociotechnical ensemble (Bijker, 1995), mangle of practice (Pickering, 1995), object-centered sociality (Knorr Cetina, 1997), relational materiality (Law, 2004) and material sociology (Beunza, Hardie, & Mackenzie, 2006), Orlikowski suggests that social and material are 'constitutively entangled' or 'inextricably related - there is no social that is not also material, and no material that is not also social' (2007, p. 1437). Stressing that one important commonality of these conceptualizations is the decentralization of the human and a relational understanding of the notion of agency, she further asserts that rather than maintaining *a priori* ontological divides between entities, considerable analytical insight may be obtained by gaining a perspective of constitutive entanglement. Therefore, she suggests using 'sociomaterial' practices as an explicit recognition of this perspective in organizational studies. Orlikowski explains how practices involving Google's engineers, search algorithms, page ranks, continuously updated webpages and millions of people produce 'a mangling of human and material agencies' (Pickering, 1995) or 'a creative socio-material assemblage' (Suchman, 2006). Socio-material assemblages in turn create dynamic, relational and contingent search results, which transform various practices and relations within the assemblage.

Concepts of constitutive entanglement and socio-material assemblage give rise to the important matter of concern for the accountability of human actors (Suchman, 2006). The problem lies in the difficulty faced in locating the accountability of human actors, who do not act completely independently from their networks. Suchman, following Latour (2005), deals with the issue of inseparability of agency and accountability using a different conception of boundaries, which 'recognizes the deeply mutual constitution of humans and artefacts, and the enacted nature of the boundaries between them, without at the same time losing distinguishing particularities within specific assemblages' (Suchman, 2006, p. 260). Barad states that:

> Boundaries have real material consequences – cuts are agentially positioned and accountability is mandatory ... Our goal should not be to find less false boundaries for all space time, but reliable, accountable, located temporary boundaries, which we should anticipate will quickly close in against us (Barad, 1995:187).

Based on the idea of located accountability and feminist arguments on knowledge production, Suchman (2002, p. 137) suggests some transformations in technology design asking for:

1. Recognition of the various forms of visible and invisible work that make up the production/use of technical systems, locating ourselves within that extended web of connections, and taking responsibility for our participation;
2. Understanding technology use as the recontextualization of technologies designed at greater or lesser distances in some local site of practice;
3. Acknowledging and accepting the limited power of any actors or artefacts to control technology production/use;
4. Establishing new bases for technology integration, not in universal languages but in partial translations; and
5. Valuing heterogeneity and partial integration, achieved through practices of technology production/use, over homogeneity and domination.

There are many shared concerns between the transformative suggestions by Suchman (2002), the feminist HCI qualities by Bardzell (2010) and the interactional approach employed by Boehner et al. (2005) and Höök et al. (2008), e.g., visibility, ecology of entities and multiple epistemologies. One important complement of the suggestions by Suchman to the aforementioned interactional approaches is the bringing together of the idea of socio-material assemblages and located accountabilities, which would constitute an important step towards constructing 'an ontology that can tie humans and non-humans together without erasing the culturally and historically constituted differences among them' (Suchman, 2006, p. 270), ultimately facilitating responsible and ethical design.

Yaneva (2009) offered an ANT view of architectural design in which design is conceptualised as a kind of connector for creating social assemblages:

> Design … is a way of producing additional attachments that make a variety of actors congregate, forming different groupings and assembling social diversity. Tracing networks with wood, steel, polished surfaces and blinking signals, bip-ping doors and blinking elevator buttons, design connects us differently, linking disparate heterogeneous elements and effects, thus entering a game of producing, adjusting and enacting the social. (Yaneva, 2009, p. 282)

From an ANT point of view, Yaneva and Latour (2008) criticize the Euclidian representation and understanding of buildings and the notion of buildings as static structures. They suggest a pragmatist view of architecture "generating earthly accounts of buildings and design processes" and "tracing pluralities of concrete entities in the specific spaces and times of their co-existence" (Yaneva and Latour, p. 87).

Houdart demonstrates the different roles of architectural images in design process. She claims that architectural representations can be considered as reconfiguring tools for new social arrangements. As well, they serve as communication tools to support architectural invention. She considers perspective drawings as a very crucial step in architectural design process since all the non-architectural elements like people, trees, and greenery are included into the drawing in order to create a 'realistic' scene. She maintains that perspective drawings are very effective in reconfiguring new cosmologies by bringing together various human and non-human actors in many arrangements in which the actors do not need to be faithful to their 'real' properties or characteristics. Here, perspective drawings work as what Yaneva (2009) refers to as 'a connector' for creating assemblages of human and non-human actors.

DiSalvo and Lukens (2011) offers a nonanthropocentric perspective to design that decentres the human and situates it into a larger system of relations and interactions between all human and non-human actors. DiSalvo and Lukens point out that a nonanthropocentric perspective does not negate the human. Rather, it is an attempt to acknowledge the various roles that non-humans can play in design. They maintain that:

> [I]n shifting away from a centering, and thus priviling, of human activities and desires, nonanthropocentric design broadens the conditions and issues of design and design research. At the very least, it reveals new opportunities for and experiences of design, particularly in regard to

> designing new forms of engagement with and through technology. (DiSalvo and Lukens, 2011, pp. 421-22)

Drawing on the concepts of hybrid collectives and sociotechnical assemblages, Wilkie (2010) develops the notion of user-assemblage that aims to emphasise how users are heterogeneously composed in praxis and how users and technologies mutually construct each other. Similar to the use of the conjoint term actor-network, user-assemblage indicates that users/actors are relational effects of the assemblage/network. In regard to agency, Wilkie explains that:

> [M]y use of the notion of assemblage suggests that it is not only human agencies that are territorialized in design. There are other (non-human) agencies that are acted upon, such as interactive services, organisational capacities and interrelationships and so forth. This, perhaps, is the crucial contribution of the notion of user assemblage: as a means to decentre the visions and practices of designers from a human-centered society. (Wilkie, 2010, p. 204)

Wilkie's argument is in line with the nonanthropocentric perspective offered by DiSalvo and Lukens (2011) and the relational understanding of design developed by this research. They all emphasise the importance of: i) decentring the human; ii) acknowledging the various roles that non-humans can play in construction of networks/assemblages; and, iii) non-essentialist, relational and emergent nature of agency.

2.2.2.5 Design Things

A. Telier, a collective of authors (A. Telier, 2011) and of numerous non-humans, recently published a book titled *Design Thing*s, the outcome of their collaborative work spanning the last decade. The name of the collective comes from the ATELIER projects (Architecture and Technology for Inspirational Learning).

The book, a mélange of ideas, provocative thought, qualities, methods and practices touches upon many different aspects of object of design, design process, use process and idea of design. The focus of the book is not on the individual designer, the design object or the user, but 'on things, projects, objects, artifacts, devices, materials, places, infrastructures, designers, users, stakeholders, publics, and so on, in collectives of human and non-humans performing and transforming the object of design' (A. Telier, 2011, p. 6).

The term 'thing' is a fundamental concept of the book, which, in fact, works in two ways: a thing in the sense of assembly that brings together diverse topics of the book, and a thing, both in the sense of a design object and assembly that helps to envision a broader idea of design. I will now examine the concept of thing along with that of object of design, both of which are highly relevant to this research. A. Telier (2011) explains the term 'thing' in the following terms:

> The etymology of the English word 'thing' reveals a journey from meaning an assembly, which was decided on beforehand to take place at a certain time and at a certain place to deal with certain "matters of concern" to the community, to meaning an object, "an entity of matter". So, the term thing goes back originally to the governing assemblies in ancient Nordic and Germanic societies. These pre-Christian things were assemblies, rituals, and places where disputes were solved and political decisions made (p. 1).

A. Telier (2011) suggests that we must revisit the original meaning of the thing in order to answer the question what is it that we are designing? that is, designing an object and also the experiences and interactions around the object. According to A. Telier, designers engage in two forms of things during the design process: things as objects for characterizing the thing to be created, and things as socio-material assemblies to be experienced and gathered around. After the thing as an object or designed artefact is delivered to its users and been made public, the designed artefact becomes a matter of concern to its users, opening up new interaction possibilities. Therefore, what is delivered is not only a designed artefact or object but also a thing to be experienced by the people.

Heidegger's (1971) and Latour and Weibel's (2005) works on the concept of thing have been influential regarding this formulation of thing as socio-material design things. Here, the term socio-material emphasizes that design things are constructed not only by human relations but also by collectives of human and non-humans and their constitutive entanglement. Similar to the understanding of Distributed Cognition, the mediating role of non-humans is not limited to an 'in-between' position between humans and their tasks: non-humans are structural actors taking part in the action. I will further explicate the collective of human and non-humans in Section 2.3.1.

Another important concept is the object of design. A. Telier (2011) suggests that things constitute the object of design. Things can variously be ″devices, artefacts and representations that designers create or import during [the] design process by their experience of things″ (p. 54). A villa design project was presented as an example. When architects present a villa design to their clients, they use 2D/3D drawings, models, sketches, and historical or cultural references. People interact with the 'villa design object' through different artefacts and representations, which are referred to as ‘constituents’ of the villa design object. The constituents are not the objects that designers design: they play different roles during the design process. They enable the designers to interact with the object that is being designed and discuss its different features; in addition, they facilitate communication between the designers and between the designers and other materials; and, they are used for shaping the object of design. Even after the object is built, the other constituents of the object of design - such as models and diagrams -continue to exist and be part of the object.

In the case of this research, the important element of this definition of the object of design is that the latter is neither a single thing nor a finalized, isolated artefact. It is a collective of artefacts, devices and representations, which includes an envisioned system or artefact to be handed over. The object of design lives in design time and use time through evolution and transformation. According to this view, configurability is important as a quality in both design time and use time. In design time, A. Telier (2011) suggests, the supporting design practice involves provision of resources and mechanisms through which designers and other stakeholders engage in various constituents of the object of design, i.e., ‘the creation of a platform where participants can access, modify, align, and navigate the constituents of an object, and when needed, expand and contract it, sharing their knowledge about their actions and interactions’ (p. 76). Configurability in design time facilitates different arrangements between humans and non-humans, that is, the constituents of the object of design, and the emergence of new relations and matters of concerns. Aanestad (2003) maintains that the design process continues in the sites of technology use - in use time - through reconfigurations performed by the users of the technology. Configurability in use time supports design-in-use activities, user reconfigurations, and improvised actions in cases of breakdowns and changes in user needs or practice.

The practice of designing in *Design Things* is conceptualized and performed as a mode of inquiry rather than as a professional competency or particular domain of expertise (A. Telier, 2011). The book itself can also be considered a design thing -an evolving object of design- containing controversial things and heterogeneous matters of concern. As part of the authors design agenda, the book was made public, which transformed it into a facilitator of a thing to be gathered around the controversial topics the book rendered visible.

Before the work of A. Telier, Storni (2007, 2012) employed the concept of thing in order to produce a relational perspective on design that focuses on “the movements and the transformations that lie behind designed products, which usually lose contact with their own original conditions of design and production” (p. 89). He characterized the concept of thing in two ways: a gathering of different elements and a problematic issue in process definition. In addition, he identified two ‘tendencies’: an objectifying and a thinging one. Storni maintains that while the concept of thing allows us to “avoid different forms of reductionism and embrace the heterogeneity of elements involved in design practices, the objectifying and thinging tendencies represent analytical tools with which equally to consider confusion and order, surprise and exploitation, breakdown and mastery, necessity and possibility, and so on” (Storni, 2012, p. 109).

2.2.3 Critical and Ethical Approaches

2.2.3.1 Value Sensitive Design

Value Sensitive Design (VSD) is an approach developed by Batya Friedman and colleagues, who believed that there is a need for an overarching theoretical and methodological framework dealing with the value dimensions of design work even though there has been increasing interest in designing information technologies supporting human values such as privacy (Ackerman & Cranor, 1999), physical welfare (Leveson, 1991), freedom from bias (Friedman & Nissenbaum, 1996), autonomy (Winograd, 1994), informed consent (Millett, Friedman, & Felten, 2001) and trust (Fogg

& Tseng, 1999). VSD is defined as 'a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process' (Friedman, Kahn, & Borning, 2009, p. 69).

The VSD method prioritizes the role of values in design and aims to identify and explicate values stemming from the design process and make them available for questioning. VSD considers the positive and negative effects of design decisions and any trade-offs between the values of actors. In order to do this, it employs a tripartite methodology including conceptual, empirical and technical investigation, which is applied iteratively. Conceptual investigation involves identification of the values of different stakeholders, i.e., philosophically informed analyses of the values. Empirical investigation focuses on the interaction between humans and technological artefacts situated in the larger social context. All ranges of qualitative and quantitative methods employed by the social sciences are applicable. Technical investigation deals with the design and performance of the technology itself.

Three main case studies conducted by Friedman and colleagues focus on values like trust (Friedman, Peter H. Khan, & Howe, 2000), freedom from bias (Friedman & Nissenbaum, 1996) and informed consent (Millett, et al., 2001). Rather than explaining the details of these case studies, I will focus on some of the features that are important to this research.

VSD seeks to be proactive. It not only performs retrospective investigation of existing systems but also of prospective systems, which envision new technologies supporting various values. This proactive attitude is supported by another crucial feature: VSD as an interactional theory, which views values:

> [...] neither as inscribed into technology (an endogenous theory), nor as simply transmitted by social forces (an exogenous theory). Rather, the interactional position holds that while the features or properties that people design into technologies more readily support certain values and hinder others, the technology's actual use depends on the goals of the people interacting with it (Friedman, et al., 2009, p.86).

This interactional position allows VSD to break the simple deterministic formulations of the relations between design decisions and their ethical effects by recognizing the situated character of technology use and the role of design decisions.

Often, those who are going be affected by the introduction of a system without using it, i.e., indirect stakeholders, find themselves ignored in the design process. Another important feature is that VSD extends the network of actors who can be direct or indirect stakeholders. This feature allows VSD to render visible larger amounts of the effects of design decisions which would not be visible otherwise. Furthermore, in all of the investigations, the dual characteristic of design decisions is taken into consideration. Designs can privilege the values of some actors while ignoring the values of others (Friedman & Kahn, 1992). Thus, the inscription of values into technologies is inevitable. However, the problem is less about the inscription of particular kinds of values into technologies and more about the invisible, unquestioned and taken-for-granted values embedded in people's thinking and practices. Values shaping thinking and design decisions should be made visible and open to negotiation. VSD's tripartite iterative methodology and interactional approach provides a useful means for designers and other stakeholders to investigate, identify and debate the relevant values implicated in design and use of technologies in a larger context.

Le Dantec et al. (2009) emphasise some limitations of the VSD framework; first, a set of twelve values referred to as 'human values with ethical import': Human Welfare, Ownership and Property, Privacy, Freedom from Bias, Universal Usability, Trust, Autonomy, Informed Consent, Accountability, Identity, Calmness and Environmental Sustainability (Friedman & Peter H. Kahn, 2003), which together facilitate a discursive definition of values rather than an emergent one:

> ... By laying out an agenda tied to values of ethical import, VSD projects itself within the nimbus of morality, cultivating a dogmatic response with respect to which values are worthy of consideration and disengaging from a commitment to understanding the nuanced manifestation of a plurality of values (2009, p.2).

Le Dantec (2009) points out that although VSD considers the list of values not exhaustive and open to refinement, the structure and flow of VSD methodology prevent refinement of the values. Here, the order of investigation - from conceptual to empirical to technical - privileges the known values over the discovered values. Because the conceptual investigations are guided by the heuristic of values of ethical import, the refinements in the empirical investigations phase are performed according to the conceptual frame of known values. Le Dantec et al. suggest that VSD can be improved by providing 'more prescriptions in methods that inform value-centered investigations and less prescription in the kinds of values considered' (p. 2).

Apropos of this research, VSD teaches the need to consider the dual effects of the design decisions and to consider the interests and values of both direct and indirect stakeholders. Furthermore, agency appears as a value of design that can be open to negotiation. One can ascertain how some of the design decisions may redistribute the power relations, change the roles and relations, and invite and inhibit certain kinds of actions.

2.2.3.2 Reflective Design

Influenced by HCI's extant critical approaches, namely participatory design, value-sensitive design, critical design, ludic design, critical technical practice and reflection-in-action, reflective design seeks to answers the questions placing critical reflection in the centre of the investigation: How can designers become more aware of the blind spots in the structure of HCI as a field? How can we help users to reflect on the role of technology in their lives? How can users and designers move their reflection beyond a superficial intellectual awareness to new lived experiences? How can reflection become not only a desirable but also a useful part of technology design?

Before explaining the principles offered by reflective design, I will briefly introduce some key features of the aforementioned critical approaches that have informed reflective design. As I introduced participatory design and value-sensitive design earlier, I will now only present the remaining approaches.

The main motivation of Critical Design, an approach proposed by Dunne (2000) and Dunne and Ruby (2001), is to challenge the existing values of consumer culture and the status quo, explore the different roles that design as an object and practice can play, and open up new ways of seeing the world through reflection on both the design process and the design artefact. Sengers et al. (2005) contend that due to the provocative nature of critical design, users may simply consider the design ridiculous and extreme without examining and reflecting upon it. They therefore suggest that critical design may benefit from more participatory approaches to the construction of critical designs. This suggestion is quite similar to A. Telier's (2011) call to revisit the original meaning of things as gatherings around controversial matters of concern.

Based on the notion of designing for homo ludens - people as playful creatures - ludic design provides an alternative way of looking at playful and ludic activities not merely as subjects of entertainment or a waste of time but as a ‘mechanism for developing new values and goals for learning things and for achieving new understandings’ (Gaver, et al., 2004, p. 2). Sengers et al. (2005), highlighting the role of engagement, state: ‘Ludic design promotes engagement in the exploration and production of meaning, providing for curiosity, exploration and reflection as key values’ (p. 51). Therefore, a key characteristic of ludic design is the support of active engagement with the design object. Ludic design adopts a similar stance to critical design in terms of challenging extant and dominant values such as functionality, efficiency and optimality. Unlike critical design, its playful nature supports user participation and the co-construction of meaning without appearing to be in preaching mode (Sengers, et al., 2005).

Critical technical practice (Agre, 1997), which is grounded in Artificial Intelligence, is an approach embracing critical reflection on the basic assumption that a technical field might negatively affect technical progress. Agre explains the motivation behind critical technical practice as follows:

> I wish to investigate this confluence of technology and human experience. The philosophical underside of technology has been deeply bound up with larger cultural movements, yet technical practitioners have generally understood themselves as responding to discrete instrumental "problems" and producing technologies that have "effects" upon the world.... I would like to contribute to a critical technical practice in which rigorous reflection upon technical ideas and practices becomes an integral part of day-to-day technical work itself (Agre, 1997, p. 3).

A field's core and constitutive metaphors shape the assumptions, conceptualizations and ways of understanding the phenomenon. Critical technical practice involves ‘moves’ questioning and altering the core metaphors of a field. Boehner el al. (2005) explain these typical moves below:

> ... [By]identifying the core metaphors of the field, noticing what, when working within those metaphors, remains marginalized, inverting the dominant metaphors to bring that margin to the center, and embodying

> the alternative as a new technology. ... during this process, the values embodied by the field can be questioned and shifted (p. 2).

For example, Agre and Chapman (1990) questioned the dominant metaphor of abstract cognition in Artificial Intelligence and demonstrated how the metaphor of situated action can open up a new design space for artificial intelligence studies. Deictic representation, to which I made reference in the previous section, is an example based on situated action. Agre (1997) also uses the notion of generative metaphors, which allows disciplines to extend their boundaries. Following Boyd (1979), Agre claims that the open-ended nature of metaphors is a virtue for the construction of scientific theory.

Donald Shön's (1983) notion of reflection-in-action has been influential for reflective design. Schön describes reflection-in-action of practitioners as 'the thinking what they are doing while they are doing it' (Schön, 1987, p. xi). Reflection-in-action highlights the complementary nature of doing and thinking: they feed each other in the moment. Schön (1992) also conceptualized design as a 'reflective conversation with the materials of the situation'. Within this conceptualization, he also provided some important understandings, among them one that is highly relevant to this research: the notion of design ontology and its constructedness. According to Schön, designers construct a reality of a design situation:

> Designers ... not only ... construct the meanings of their situations, materials and messages, but also the ontologies on which these meanings depend. Every procedure, and every problem formulation, depends on such an ontology: a construction of the totality of things and relationships that the designer takes as the reality of the world in which he or she designs (Schön, 1992, p. 9).

Schön's argument vis-a-vis designers constructing ontologies which define and frame the kinds of realities and space of possibilities is closely similar to Agre's notion of core metaphors shaping the overall understanding of technical fields, and Kuhn's notion of paradigms defining possible kinds of ways of knowing and evaluating them.

The idea of constructing design ontologies is important for this research as it emphasizes the performative nature of design activity that does not take place in a fixed, pre-determined problem space but performs spaces.

> [A] 'problem space' is not given with the presentation of the design task; the designer *constructs* the design world within which he sets the

> dimensions of his problem space, and invents the moves by which he attempts to find solutions (Schön, 1992, pp. 11-12, original emphasis).

In this study, I use the term ‘design topology’, which will be introduced in the ANT section. Briefly, the notion of topology is similar to that of ontology: both define a space in which different kinds of operations are possible. However, unlike ontology, topology focuses on the relations and connectivity between the entities without trying to predefine what the entity is.

Having explained the critical approaches that influence reflective design (Sengers, et al., 2005), I will now explain the latter’s main design principles.

- Designers should use reflection to uncover and alter the limitations of design practice. This principle is informed heavily by Agre's CTP. It asks for designers to uncover the implicit assumptions and values shaping their understanding of design problem and to challenge them.
- Designers should use reflection to re-understand their own role in the technology design process. While the previous principle is concerned with a field's implicit assumptions and values, this principle requires designers to identify their personal preconceptions and influences.
- Designers should support users reflecting on their lives. This principle suggests extending the idea of reflection to users by ‘highlight[ing] the choices one makes in everyday activities and … offer[ing] up new choices that may not have been in the user's awareness’ (Sengers, et al., 2005, p. 55).
- Technology should support scepticism about and reinterpretation of its own working. This principle asks for creating open spaces that allow users to appropriate the technology or possibly reject its intended use. It can be viewed as giving users a greater ability to translate the technologies' inscriptions in different ways.
- Reflection is not a separate activity from action but is folded into it as an integral part of experience. This principle suggests that reflection should be a situated phenomenon and should not be designed as an activity independent from ongoing activity.

- Dialogic engagement between designers and users through technology can enhance reflection. This principle advocates participatory practices to knowing and designing, which has also been supported by many other situated perspectives.

Reflective design primarily highlights ethical aspects of agency. It involves supporting participatory practices, continuous reflection by users and designers, challenging the core assumptions of a field and a practitioner, and explication of accounts of technology. The principles of reflective design bring together many understandings from important critical and ethical approaches. This research extends its concerns by recognizing the role of non-human actors in the design process and formulating a relational understanding of said process.

2.3 Analytical Perspectives

2.3.1 Actor-Network Theory

Actor-Network Theory (ANT) evolved out of the efforts of scholars of Science and Technology Studies (STS), notably Michel Callon, Bruno Latour and John Law in the 1980s. The etymology of the term is French: *'acteur reseua'*. Latour (1997) explains that the term *'reseua'* was first used by Diderot to describe matter and bodies without being confined to the Cartesian divide between matter and spirit. Kuhn's work (1970) on the construction of the rationality of science in specific historical and practical circumstances exercised considerable influence over the laboratory studies of Latour and Woolgar (1979) and later the development of ANT (Jensen, 2001). In their ethnographic study of practices in scientific laboratories, during which they analyzed the daily practices undertaken in a neuro-endocrinological laboratory in California, Latour and Woolgar (1979) demonstrated how scientific facts are constructed socially in a network of relations between people, inscription devices and articles rather than being discovered. Later, in the field of STS, various studies, mainly of Latour's work on Pasteur (Latour, 1988), Law's work on Portuguese expansion (Law, 1987) and Callon's work on the Scallops of St. Brieuc Bay (Callon, 1986) were conducted, which formed the basis of ANT.

There are various other names for ANT including: the sociology of translations, actant-rhizome ontology, the sociology of associations and the semiotics of materiality

(Dolwick, 2009). Many authors infer that ANT is not a theory in the conventional sense. Mol, for example, offers other conceptualizations of ANT:

> ANT is not a "theory", or, if it is, then a "theory" does not necessarily offer a coherent framework, but may as well be an adaptable, open repository. A list of terms. A set of sensitivities. If ANT is a theory, then a theory helps to tell cases, draw contrasts, articulate silent layers, turn questions upside down, focus on the unexpected, add to one's sensitivities, propose new terms, and shift stories from one context to another (Mol, 2010, p. 253).

Dolwick (2009) considers it a descriptive method:

> [I]t is important to note that actor-network 'theory' is not necessarily a theory, per se. Theories tend to explain why something happens, but ANT places more of an emphasis on showing how associations are made and transformed (Latour, 2005). Perhaps it is best understood as a descriptive method.

Callon sees this feature of ANT as strength: 'ANT is not a theory. It is this that gives it both its strength and its adaptability' (Callon, 1999, p. 194). According to Law, ANT may be understood either as a semiotics of materiality or as a material-semiotic approach: 'It takes the semiotic insight, that of the relationality of entities, the notion that they are produced in relations, and applies this ruthlessly to all materials- and not simply to those that are linguistic' (Law, 1999, p. 3). Therefore, in ANT, relationality is not confined to explain linguistic units but extended by including any kinds of human and non-human entities.

In fact, combining contrasting terms is a key strategy of ANT; for example, actor-networks or material-semiotics. Law states that the term 'actor-network' is 'intentionally oxymoronic': it aims to embody a tension and to indicate the intertwined and co-constitutive nature of the combined terms (1999, p. 1). This strategy is part of a principle of generalized symmetry. Callon (1986) explains three methodological principles of ANT: agnosticism, generalized symmetry and free association. Agnosticism means that analytical impartiality is needed for understanding all actors. It requires 'abandoning any a priori assumptions of the nature of networks, their causal conditions, or the accuracy of actors' accounts' (Ponti, 2010, p. 58). According to generalized symmetry, both humans and non-humans have significant roles in the network, and human and non-human actors are analysed without privileging any of them. Free association refers to abandoning all *a priori* distinctions between the natural and the social and any boundaries between them. According to Callon, boundaries between natural and social events are 'the result of analysis rather than its point of departure' (Callon, 1986, p.4). Rather than starting off with a dualism between the entities and then trying to bridge them, ANT investigates how differences are produced (Postma, 2009).

The generalized symmetry principle has attracted considerable criticism (Collins & Yearley, 1992; Lee & Brown, 1994) as it treats humans and non-humans alike and considers them as relational effects. Latour (2005, p. 76) explains what generalized symmetry entails: 'ANT is not, I repeat not, the establishment of some absurd symmetry between humans and non-humans. To be symmetric, for us, simply means not to impose a priori some spurious asymmetry among human intentional action and a material world of causal relations'. Generalized symmetry is a methodological principle employed to overcome or 'bypass' binary dualisms like structure/agency, social/natural, subject/object, individual/group, micro/macro, local/global, inside/outside and particular/universal (Latour, 1999a).

For ANT, the principle of symmetry is not a metaphysical assertion but a methodological choice which facilitates the empirical study of the different modalities of agency, from strategic to machine-like action. In all cases, agency is considered as distributed: the forms it takes are linked to the configuration of socio-technical networks. The opposition between structure and agency is thus overcome (Callon, 1999).

2.3.1.1 Criticisms and Post-ANT

ANT has attracted many criticisms and evolved into what we may refer to as 'post-ANT'. Saldanha (2003) summarizes the various ways in which ANT has been criticized for: being apolitical (Star, 1991), managerialist or centrist (Singleton & Michael, 1993), too anti-humanist (Amsterdamska, 1990), relativist (Collins & Yearly, 1992), not geographical enough (Murdoch, 1997) and too local (Law & Hetherington, 1999). ANT's focus on strong actors has been considered managerialist and challenged by feminists for 'focusing on privileged actors and for its blindness to other possible ways in which networks might develop--without control or force as primary mechanisms' (Gad & Jensen, 2010, p. 58). One important criticism is of ANT's characterization of relations according to similarity and continuity (Strathern, 1996). Strathern argues that there are cases in which relations are based on difference and discontinuity. The network metaphor is unable to explain these cases.

> We need an understanding of relationality that takes into account the possibility of alterity within the relations that concern us; an alterity, furthermore that should not be reinscribed as yet another form of difference. ... We need to avoid attaching ourselves too strongly to particular metaphors. Perhaps, as Strathern is implying, we need to be cautious about the notion of relation itself: to look for other metaphors which avoid an implied ontological and spatial fixity. Certainly, then, it is clear that the metaphor of the network is too limited in its assumptions about connections, regions, and centres of calculation -- nodes that come to sum up the relations of the network. A network as a spatial imaginary works well when it is the relations between the different actors that are being sought, but to recognise Otherness as inside rather than leave it out requires other ways of thinking about space. We need a spatial imaginary more topologically complex and less certain in order to do justice to the uncertainty that Otherness brings with it (Hetherington & Law, 2000, pp. 128-129).

The above criticisms have been effective in triggering an evolution of classic ANT into what may be referred to as 'post-ANT'. According to Spinuzzi (2003), post-ANT expanded its repertoire by including heterogeneity, political negotiations in democracy and multiple ontologies. Hetherington and Law (2000) state that post-ANT recognized the importance of network failures (in contrast to construction of successful networks) and multiple voices, and the impossibility of drawing everything together to create a single account. Furthermore, new spatial metaphors have been developed such as fluid objects and spaces, which open the possibility for explaining relations that continuously change and are unstable.

Post-ANT can also be viewed as a transition to ontological multiplicity. Law & Singleton characterize this transition in terms of 'problem of difference': 'difference is no longer a matter of different perspectives on a single object but the enactment of different objects in the different sets of relations and contexts of practice' (2005, p. 342). In other words, post-ANT focuses on multiplicity, not in ways of knowing but in ways of being. Law, using the notion of fractional coherence which is about 'drawing things together without centering them' (2002a, p. 2), explains that in mathematics, fractals are lines occupying more than one dimension but less than two. A fractionally coherent subject or object is defined as ‘more than one, but less than many’ (p. 3). The metaphor of fractal allows us to obtain a balance between modernist singularity and postmodernist plurality or between totally knowable objects and the idea of ‘anything goes’.

From a design perspective, Storni (2007) suggests using the notion of metonymic plurality instead of ontological multiplicity, as cited in (Morrison et al., 2010).

> In fact, rather than talking about ontological multiplicity (according to which the object becomes a completely different one in different places), I would rather prefer to talk of a metonymic plurality where the object is not a different object per se but it is rendered as such according to different relational circumstances which activate different elements, features and characters of the same, never simple and single, object (p. 378).

Storni's (2007) formulation seems an effort to preserve some essentialist qualities in the definition of objects. Although his semi-essentialist formulation is closer to our intuitive understanding of the objects, keeping the properties of the object stable, irrespective of whether they are active or inactive, does not explain the emergent capacities of action. Furthermore, since the verb ‘activate’ implies an object with a set of fixed or already extant properties waiting to be activated, the power of the idea of mutual constitution of objects and subjects is lost. The ways in which entities come together are confined to a limited number of couplings between the entities' pre-existing properties.

2.3.1.2 Main Terms of ANT

Mol (2010) argues that ANT can be seen simply as a list of terms. While stressing that there are many important terms in ANT, in the section that follows I will discuss the relevant terms only.[4] Mol, emphasising the 'fluidity' of ANT's terms, states:

> ANT does not define these terms, but rather plays with them. It does not seek coherence. It does not build a stronghold. Instead of crafting an overall scheme that becomes more and more solid as it gets more and more refined, ANT texts are out to move – to generate, to transform, to translate. To enrich. And to betray (p. 253).

[4] For a full set of terms, see Akrich & Latour, 1992.

2.3.1.2.1 Actor/Actant

Generally, anything that acts or makes a difference can be defined as an 'actor'. Latour proposes the term 'actant' in order to overcome the cultural anthropomorphic connotations of the term 'actor'. Different scholars of ANT have provided various definitions of the two terms. An actor (or actant) can be:

'any element which bends space around itself, makes other elements dependent upon itself and translates their will into a language of its own "[an] entit[y] that do things' (Callon & Latour, 1981, p. 286).

'an actant endowed with a character (usually anthropomorphic)' (Akrich & Latour, 1992, p. 259).

'whatever acts or shifts action, action itself being defined by a list of performances through trials; from these performances are deduced a set of competences with which the actant is endowed' (Akrich & Latour, 1992, p. 259).

'something that acts or to which activity is granted by others. It implies [neither] special motivation of human individual actors, nor of humans in general. An actant can literally be anything provided it is granted to be the source of an action' (Latour, 1996a, p. 5).

'any thing that does modify a state of affairs by making a difference is an actor--or, if it has no figuration yet, an actant' (Latour, 2005, p. 71).

'a patterned network of heterogeneous relations, or an effect produced by such a network. ... An actor is also always a network' (Law, 1992, p. 4).

'[any entities] taking …[their] form and acquir[ing] their attributes as a result of their relations with other entities' (Law, 1999, p. 3).

'[any thing that] makes a difference … has an effect or leaves a trace' (Latour, 2004, pp. 68, 70)

In general, ANT scholars consider anything an actor/actant is able to make a difference. Although in many texts the terms 'actor' and 'actant' have been considered the same and used interchangeably, in some texts they have been differentiated, e.g., 'an actant endowed with a character (usually anthropomorphic)' (Akrich & Latour, 1992, p. 259) and 'any thing that does modify a state of affairs by making a difference is an actor - or, if it has no figuration yet, an actant' (Latour, 2005, p. 71). In this thesis, I use only the term 'actor' meaning ‘any thing that does modify a state of affairs by making a difference is an actor". I also preface the term ‘actor’ with either ‘human’ or ‘non-human’ to clearly indicate the particular entity to which I am referring, not to make an a priori division between the entities.

2.3.1.2.2 Network / (Hybrid) Collective

Similar to the case of actor/actant, the terms ‘network’ and ‘collective’ have been used interchangeably in ANT texts. Generally, a network or (hybrid) collective can be described as a set of heterogeneous relations defining the entities which construct the network or collective. As Law (1999) indicates, a network can be considered as an actor and an actor can be considered as a network. There are various definitions of network and collective:

A network is a ‘group of unspecified relationships among entities of which the nature itself is undetermined’ (Callon, 1993, p. 263).

‘The actor network is reducible neither to an actor alone nor to a network. Like a network it is composed of a series of heterogeneous elements, animate and inanimate, that have been linked to one another for certain period of time. ... An actor network is simultaneously an actor whose activity is networking heterogeneous elements and a network that is able to redefine and transform what it is made of’ (Callon, 1987, p. 93).

‘... I will use the word 'collective' to describe the association of humans and non-humans and 'society' to designate one part only of our collectives, the divide invented by the social sciences’ (Latour, 1993, p. 4).

‘Instead of the three poles--a reality "out there", a mind "in there", and a mob "down there"--we have finally arrived at a sense of what I call a collective (Latour, 1999b, p. 16).

‘[A] hybrid collectif is 'an emergent effect created by the interaction of the heterogeneous parts that make it up’ (Callon & Law, 1995, p. 485).

‘The notion of the hybrid collectif implodes the inside/outside binary which discerns social action as an individual property of discrete, unitary individuals (including collective individuals). Agency is reconfigured as a relational effect generated by a network of heterogeneous, interacting components, whose activity is constituted in the networks of which they form a part' (Whatmore, 1999, p. 28).

The terms 'network', 'collective' and 'hybrid collective' are metaphors for explaining heterogeneous relationships between human and non-human actors constituting a network which, at the same time, constitutes them. The network and actors mutually constitute each other. What are important are not the essential properties of the human or non-human actors but the relations between them. Post-ANT introduced further spatial metaphors such actant-rhizome or fluids. The reasons for developing new metaphors are related to misconceptions of the term Actor-network and to theory and criticisms related to ANT's focus on strong actors and conception of relations. In a bid to address the misconceptions about ANT, Latour stated that:

> There are four things that do not work with actor-network theory; the word actor, the word network, the word theory and the hyphen! Four nails in the coffin . . . there is life after ANT. Once we will have strongly pushed a stake into the heart of the creature safely buried in its coffin – thus abandoning what is so wrong with ANT, that is "actor", "network", "theory" without forgetting the hyphen! – some other creature will emerge, light and beautiful, our future collective achievement (Latour, 1999a, p. 25).

Similarly, Law notes that the term network lost its power as in the case of a dead metaphor: 'Easy use of the term "actor-network" has tended to defuse the power and the tension originally and oxymoronically built into the expression' (Law, 1999, p. 8). Furthermore, Latour explains that 'network is a concept, not a thing out there. It is a tool to help describe something, not what is being described' (Latour, 2005, p. 131). Latour explains that network in ANT is different from (a) those commonly conceptualized in other network studies dealing with the social relations of individual human actors; and, (b) those in technical engineering domains dealing with circulation between strictly connected stable nodes such as a train network. Latour further suggests that: 'ANT is more like the name of a pencil or a brush than the name of a specific shape to be drawn or painted' (p. 143).

2.3.1.2.3 Inscriptions and Translations

Inscription and translation, which are fundamental concepts of ANT, were explained in Section 2.1.2.1.

2.3.1.2.4 Spaces and Topologies

Alternative conceptualizations of objects, actors and relations through different spatial metaphors are among the main characteristics of post-ANT. Law, delineating the motivation to employ different metaphors, states:

> [T]he notion of the network is itself a form- or perhaps a family of forms- of spatiality: that … imposes strong restrictions on the conditions of topological possibility. And that, accordingly, it tends to limit and homogenize the character of links, the character of invariant connection, the character of possible relations and so the character of possible entities. (Law, 1999, p. 7).

Mol and Law (1994) argue that: '"The social" doesn't exist as a single spatial type. Rather it performs several kinds of space in which different "operations" take place' (p. 643). Jensen draws our attention to the distinctive formulation of the relation between social and space in Mol and Law's statement: 'Mol and Law do not say that the social exists in different kinds of space. Rather they say that the social performs spaces' (Jensen, 2001, p. 75). Here, their conceptualization of space can be described as an analytical metaphor, which allows creation of other metaphors to describe the different ways in which entities come together and their relations; for example, network is a kind of various other possible spaces. Mol and Law discuss different types of spaces in terms of topology, which was originally a branch of mathematics dealing mainly with properties of connectivity and continuity. In general, topology may be defined as 'the study of the way things are connected together' (Kennington, 2012). They explain the distinct feature of the notion of topology as follows:

> Unlike anatomy, topology doesn't localize objects in terms of a given set of coordinates. Instead, it articulates different rules for localizing in a variety of coordinate systems. Thus it doesn't limit itself to the three standard axes X, Y and Z, but invents alternative systems of axes. In each of these, another set of mathematical operations is permitted, which generates its own 'points' and 'lines' (Mol & Law, 1994, p. 643).

Topology characterizes possible spaces which would include Euclidian and Cartesian, the most well-known of spaces. However, Mol and Law (1994) state that topology allows exploration of ‘non-metric' possibilities beyond Euclidian understanding by articulating other spaces in which particular relationships between the entities remain invariant under continuous transformation. Topology explores the continuity of some 'essential' relations or properties of objects or shapes and different ways of measuring it:

> [T]he question here is how an object (or more precisely a shape) can be moved through space while still retaining the essential relations which secure its continuity as that shape. Which permit it to move without distortion. So what counts as 'essential'? What is it that has to be sustained? Rendered continuous? What is a distortion? Well, that is precisely what is at stake in topology. And it doesn't pre-judge the answers. For topology is a mathematical game which explores the possibilities and properties of different forms of continuity – and the different spaces which express or allow those continuities. And there is, at least in principle, an indefinite number of ways of defining what will count as (spatial) continuity. An indefinite number of ways of describing the movement of objects whilst securing their (essential) continuity. An indefinite number of corresponding spaces. And as a part of all this, an indefinite number of ways of measuring proximity or distance (Law, 2000, p. 4).

Mol and Law (1994) make reference to three different topological spaces or spatial metaphors: region, network and fluid. In regions, objects in clusters are separated by boundaries; therefore, regions have an 'inside' and 'outside'. Relations and proximity are defined according to physical distance: ‘What is similar is close. What is different is elsewhere’ (p. 647). Unlike regions, in networks, proximity is neither related to physical distance nor defined in metrical terms. Rather, it depends on similarity in composition of elements and their relations: ‘Places with a similar set of elements and similar relations between them are close to one another and those with different elements or relations are far apart’ (p. 649). Mol and Law further state that there can be other kinds of spaces in which ‘neither boundaries nor relations mark the difference between one place and another. Instead, sometimes boundaries come and go, allow leakage or disappear altogether, while relations transform themselves without fracture’ (p. 645). Fluid spaces have no clear boundaries and elements: their relations gradually change. Fluid spaces can be characterized by ‘variation without boundaries and transformation without discontinuity' (p. 658). Sørensen (2009) summarizes the three topologies in simple terms: 'A network makes us think about elements that are connected, a region makes us think of fields containing homogeneous entities, and fluid makes us sensitive to relations that vary and mutate' (p. 75).

Law explains that there are multiple forms of spatiality and that these forms co-exist. Objects enacted in these spaces are topologically multiple, 'existing as intersections or interferences between different spaces including regions, networks, and fluids″ (2002b, p. 102). The object keeps some of its properties unchanged across the spaces, enabling it to remain an object. In his study of Portuguese expansion, Law explains that a ship remains a ship from Lisbon to Calicut by being a region object and a network object. While it is a region object it has 'a constant set of orthogonal coordinates – … the relative positions of the prow, the keel, the stern, the masts and the spars are held fixed as it moves through geographical space and do not change all that much' (p. 95). It is a network object which has stable relations with 'navigators, Arab competitors, winds and currents, crew, stores, guns: if this network holds steady then the vessel doesn't founder, it doesn't get seized by pirates and it doesn't sail on, lost, until the crew are broken by disease and hunger′ (p. 93). A ship object keeps its essential qualities of both topological spaces in order to travel from one place to another.

Unlike regions and networks, fluid objects continue to exist via gradual and constant variation of their relations with other entities. Fluid objects are not only configurable: they may change their form in practice. Take for example the Zimbabwe Bush Pump, which is considered a highly successful fluid technology (de Laet & Mol, 2000). The success of the Bush Pump is not only related to its flexible, replaceable parts or modularity but also to the practices and relations evolving around the Bush Pump. The fluidity of Bush Pump is observable at different levels:

> The first aspect of the Pump's fluidity is that its boundaries are not solid and sharp. The Pump is a mechanical object, it is a hydraulic system, but it is also a device installed by the community, a health promoter and a nation-building apparatus. It has each of these identities – and each comes with its own different boundaries. ... In each of its identities, the Bush Pump contains a variant of its environment. ... The second, related aspect of the Bush Pump's fluidity is that whether or not its activities are successful is not a binary matter. There are many more relevant answers to this question than a simple 'yes' or 'no'. ... It may work for a while and

> then break down. Good technologies, or so we submit after our encounter with the Bush Pump, may well be those which incorporate the possibility of their own break-down, which have the flexibility to deploy alternative components, and which continue to work to some extent even if some bolt falls out or the user community changes. ... And then there is the actor behind the Pump, who refuses to act as such. Dr Morgan's [the designer of the Pump] carefully sought dissolution, his deliberate abandonment, is not simply an asset in any man, but is especially suited to the dissemination of the Bush Pump. Pleased with what he calls the 'forgiving nature' of the Bush Pump, he has made it after his own image – infused it with a [particular] fluidity that he incorporates himself as well. It may be that to shape, reshape and implement fluid technologies, a specific kind of people is required: non-modern subjects, willing to serve and observe, able to listen, not seeking control, but rather daring to give themselves over to circumstances (de Laet & Mol, 2000, p. 252).

Sørensen (2009) demonstrated how fluid and region spaces need to co-exist in order to ensure the continuity of design collective and object. She conducted a series of workshops with children aged from nine to twelve years old: the project was an open-ended design involving the creation of 3D virtual worlds by software called Active Worlds. Sørensen explains that while the software provided a blank canvas, which the children could flexibly fill in, and which created a fluid space, it also required the children to work inside a well-defined platform clearly separated from other groups. This allowed groups to work as one homogeneous collective. She notes that: 'In order to sustain the fluid ordering by avoiding it flowing in all directions and thereby undermining itself, regional standardising and fixing forces had to be involved. We could even say that the regionality inscribed in the design turned out to be insufficiently fixed or bounded to maintain fluidity' (p. 161).

Similar to Mol and Law (1994), Murdoch (1998) conceptualizes different kinds of spaces but, somewhat differently, he considers these spaces as variants of the network space. Murdoch identifies two broad network types:

> On the one hand, there are those networks where translations are perfectly accomplished: the entities are effectively aligned and the network is stabilised; despite the heterogeneous quality of any previous identities these entities now work in unison, thereby enabling the enrolling actor (the 'centre') to 'speak' for all. ... On the other hand, there are networks where the links between actors and intermediaries are provisional and divergent, where norms are hard to establish and standards are frequently compromised. Here the various components of the network continually

> re-negotiate with one another, form variable and revisable coalitions, and assume ever changing shapes (p. 362).

These two network types configure two kinds of spaces: 'spaces of prescription' and 'spaces of negotiation'. Spaces of prescription, configured by standardized and convergent networks, involve relations that are stable, rigid and predictable according to norms. Spaces of negotiation, configured by networks of 'variation and flux' or divergent networks, involve fluid and unstable relations. It is important to note that Murdoch (1998), following Mol and Law, conceptualizes these two spaces not as separate but as intertwined and having intricate relations: ‘Such differing spaces can emerge from within the same networks (as opposed to issuing from different network types, i.e., standardised or fluid) and that within these networks such spaces can shade, dissolve or flow into one another’ (p. 364). Murdoch cites Hetherington (1997), who claims that spaces never contain singular identities: they can be understood as complex relations between modes of ordering and forms of resistance, which are intertwined. Here, the important question is related to how to obtain a balance between formalization and negotiation (Murdoch, 1998).

Independent from the initiative of network builders, actors, in practice, may find some tactics to undermine the dominant norms and strategies (De Certeau, 1984). Although participatory practices in decision-making are very useful for determining a suitable level of formalization or scripting, a tension between formalization (modes of ordering) and multiplicity (forms of resistance) that emerges in practice due to heterogeneous sets of actors and relations (Murdoch, 1998). From the point of analysis, Murdoch (1998) asserts that the tension can be viewed either as prescription or negotiation. In a cited case, Star (1991) went to a MacDonald’s restaurant and asked for a burger without onions due to her allergic condition. However, as her request was outside of the standardized process, she was told that the service time could take more than thirty minutes. Star explains her solution:

> 'Oh,' I said to myself, 'I get it. They simply can't deal with anything out of the ordinary.' And indeed, that was the case. The next time I went to a fast-food restaurant I ordered along with everyone else, omitted the codicil about onions, took an extra plastic knife from the counter, and scraped off the offending onions. This greatly expedited the whole process (Star, 1991, p. 35).

It is possible to read Star's situation as either an actor following the script, i.e., buying the standard burger, or an actor developing a tactic or following an anti-program of action, i.e., scraping off the onions. Jonathan suggests that combining two views as seamlessly as possible might be an appropriate way of explaining the situation.

In this research, ANT concepts are employed in both generative and analytical ways. Generatively, the concept of inscription is used for integrating ASD qualities into the design process. ASD involves many strategic-generative inscription devices, which create conditions that provide an initial arrangement within which workshop participants can perform activities. Analytically, workshop participants and various materials are conceptualized as a collective of human and non-human actors constituting a design collective for exploring objects of design. This process is interpreted as a series of inscriptions and translations within the design collective, which perform spaces of negotiation or spaces of prescription. The specific ways in which ANT concepts have been employed will be explained further in Chapter 3 and 4.

2.3.2 Postphenomenology

Verbeek (2005) claims that phenomenology was effective in developing a perspective against positivistic understanding of reality by developing an intertwined account of subjects and objects. However, it has also retained some 'essentialist' elements in its investigations. Postphenomenology arose from a need to understand co-constitutive relations between entities, and, as well, from a need for a non-essentialist view of reality. Verbeek (2005) conceptualizes postphenomenology as a new interpretation of classical phenomenology:

> While ... [classical phenomenology] bridged the gap between subject and object by stressing that, in fact, these two are always already intertwined thanks to the intentional engagement of human beings and world, a new interpretation of phenomenology can take this a step further by emphasizing that subject and object constitute each other. Not only are they intertwined, but they coshape one another. Human beings can only experience reality by relating to it, which does not involve any reality-in-itself but rather reality-for-them. As consciousness (perception, experience) can only exist as consciousness of something, reality is always reality for someone; in their engagement with reality, human beings always disclose it in a specific way (p. 112).

Verbeek (2005) contends that postphenomenology overcomes the essentialism and the dichotomy between subject and object by taking a constructive view of subject and objects constituting each other. He notes that 'in wanting to overcome the dichotomy between subject and object by referring to their mutual engagement, classical phenomenology does not deny the existence of the poles but takes them as the point of departure for its analysis' (p. 163). According to postphenomenology, there is no single reality out there: 'reality arises in relations' (p. 113).

Verbeek (2005) further suggests that according to Latour, ANT can be used for studying very long chains of relations between humans and non-humans (p. 165). Phenomenology, on the other hand, is concerned with a very short chain of relations between a human and a non-human or a human and another human. In postphenomenology, a third entity, a technological artefact mediating human-non-human or human-human relations, is included. Verbeek stresses that although postphenomenology is not well-equipped for studying relations without humans or with more than three entities, it can illuminate the invisible characteristics of the short chains of relations, which are not visible to ANT. He claims that postphenomenology provides a much more nuanced understanding of the relations between the entities. While ANT sees these relations as associations, postphenomenology examines the characteristic of each connection, which can involve different types of relations.

Postphenomenology examines the different types of relations between human, technology and environment. Ihde (1990) distinguishes three main types of human, machine and environment relations: the first is called embodiment relations, in which the particular machine in use becomes transparent or 'ready-to-hand' (in Heidegger's terms). A typical example of this type of technology is a pair of glasses. When you use your glasses, they become an extension of your body and are incorporated into your body. You do not see the glasses; rather, you see through the glasses. The second type of relation is the hermeneutical relation, which is based on the interpretations of reality provided by a machine. For example, a thermometer represents a state of reality as a number without providing the actual experience of heat. The third relation is the alterity relation, in which humans interact with machine itself and the machine is considered as ‘quasi-other to which I relate’ or ‘present-at-hand’. Typical examples may include ATM machines or intelligent software agents.

Verbeek's postphenomenology can be viewed as a bridge between phenomenology and ANT. The vocabulary he introduces is useful for bridging the processes of mediation of action and mediation of perception. The bridge between mediation of action and perception also represents a bridge between ANT and phenomenology respectively. Furthermore, Verbeek sees postphenomenology and ANT as complementary perspectives:

> What postphenomenology contributes to actor-network theory is the situated perspective, the perspective "from inside out," thanks to which part of the perceived associations and translations can be more closely analyzed in terms of experience and action, existence and meaning, readiness-to-hand and presence-at-hand. Correspondingly, actor-network theory contributes to postphenomenology a way to elucidate the networks of relations that allow entities to be present (Verbeek, 2005, p. 168).

Verbeek (2005) further suggests that the influence of technologies on humans' perception and actions can be evaluated in terms of two structures. While transformation of perception has a structure of amplification and reduction, translation of action has a structure of invitation and inhibition. Consideration of the effects of technologies in terms of amplification/reduction or invitation/inhibition is important to gaining a relational understanding of design. It draws one’s attention to the dual characteristic of design decisions: designs can privilege the values of some actors while ignoring the values of others. Designs can amplify some aspects of one’s perception while at the same time diminishing others: they can invite certain kind of actions while inhibiting other kinds.

In this thesis, I employ a postphenomenological approach to understanding the experiential dimensions of relational agency, which are not accessible by ANT. This approach was employed to analyse Workshops 1 and 2 in which the first person experiential accounts played a key role in understanding the construction of the connections between the actors. In Workshop 3, focus was mainly on the translation of actions and on the connections constructed between the human and non-human actors rather than on the perceptional changes in the human actors. Therefore, analysis benefited from mainly the adopting of an ANT approach. Furthermore, postphenomenology's consideration of the effects of technologies in a dual fashion has informed the development of one of the ASD qualities.

2.3.3 Interaction analysis

Interaction Analysis (IA) is described in Jordan et al.'s seminal paper (Jordan & Henderson, 1995) as:

> [A]n interdisciplinary method for the empirical investigation of the interaction of human beings with each other and with objects in their environment. It investigates human activities such as talk, nonverbal interaction, and the use of artifacts and technologies, identifying routine practices and problems and the resources for their solution (p. 39).

The situated character of action and knowledge is central to Interaction Analysis: action and knowledge are situated in 'social and material ecologies' and ‘in the interactions between members of a particular community engaged with the material world’ (Jordan & Henderson, 1995, p. 41). Therefore, Interaction Analysis is based upon an understanding that views capacities of action as situated and relational. Although artifacts and technologies in the environment are not seen as authentic actors, their capacities to enable or constrain the various activities of human actors are recognized and studied.

IA is usually conducted together with ethnographical studies: ethnographic information ‘furnishes the background against which video analysis is carried out while the detailed understanding provided by the micro-analysis of interaction, in turn, informs our general ethnographic understanding’ (Jordan & Henderson, 1995, p. 43).

Transcriptions are an important part of IA. Jordan et al. (1995) maintain that what to transcribe - and how to transcribe it - depends upon research intentions and research goals. A transcription evolves and is shaped in practice by the analyst: it "reflects the categories the analyst has found relevant to her or his analysis" (p. 48). To this end, form and content of transcriptions in IA are selectively determined according to research aims.

> [T]here is no ideal or complete transcript according to any abstract standard. Rather, the question must be: how adequate is this transcript for purposes of the analysis to be performed? (Jordan & Henderson, 1995, p. 49).

Jordan et al. (1995) explain that there are no specific methods for analyzing video sequences; rather, they talk about ‘analytical foci’ which provide some ‘orientations’ and ‘ways of looking’ for research data. They identified a partial set of elements for 'analytical foci' - the structure of events, the temporal organization of activity, turn-taking, participation structures, trouble and repair, the spatial organization of human activity and artefacts and documents.

The structure of events: Video data may be seen as events or ethnographic chunks. Events have a structure consisting of (at least) a beginning and an end, and some additional segments, which are recognized and maintained by participants. Actors 'announce' or make visible transition from one segment to another in various ways.

The temporal organization of activity: Jordan et al. argue that unlike social theorists and historians, who study macro-scale temporal patterns, IA focuses on ‘the temporal organization of moment-to-moment, real-time interaction. ... [the] shape of an event, its high and low points, the relaxed and frenzied segments, and the temporal ordering of talk and nonverbal activity’ (Jordan & Henderson, 1995, p. 61).

Rhythm and periodicity: Rhythmicity or periodicity is seen as common features of many activities. The relevant questions regarding analysis include: In what sense are the repetitive segments identical? How much variability is allowed before a sequence is no longer ‘the same’ and becomes something else for participants? How is such segmentation achieved? Jordan et al. (1995, p. 59), with reference to Kendon's (1985) notion of 'action exchange system', claim that:

> [M]oving into synchrony with another person is one of the devices by which a person can indicate to the other that he or she wishes to establish "an action exchange system" without making an explicit request. By simply picking up on the rhythm of another's movements or talk, people establish a connection which at the same time does not commit them to an explicit initiation. Such co-calibration becomes visible on the tape.

Similar synchronization operations took place between the human actors in my workshops.

Turn-taking: In IA, the complex structure of turn-taking in human-human conversation becomes more complex due to the fact that higher numbers of actors are taken into consideration.

> [A]n Interaction-Analytic turn-taking system has to take into account more than talk: it encompasses the whole range of behaviors through which people can "take a turn," that is, participate in an interactional exchange system. Not only "turns at talk" must be considered, but also "turns with bodies" and "turns with artifacts (Jordan & Henderson, 1995, p. 64).

Participation Structures: Participation structures refer to the task orientation or 'attentional focus' shared by individuals who use some techniques such as bodily alignment and patterned eye-contact.

Trouble and Repair: Breakdowns or troubles in the expected flow of social interaction, which constitute the important focus of the analysis, reveal how participating actors see the situation. Troubles are also seen between human-non-human interactions which take place "when there is a "miss-match" between the rules and procedures employed by the user and the computer in interpreting meaning from a sequence of symbols".

The spatial organization of activity: IA examines how physical structures, spatial layout and the various arrangements between entities take part in structuring interaction; that is, 'how they encourage or hinder certain kinds of interaction between people in the scene' (Jordan & Henderson, 1995, p. 75). In effect, this perspective is quite parallel to the structures of invitation/inhibition or amplification/reduction formulated by postphenomenology.

Artefacts and documents: Similar to consideration of the spatial organization of the activity, IA aims to understand what kinds of actions are enabled or constrained by various artefacts and technologies.

> [A]rtifacts and technologies set up a social field within which certain activities become very likely, others possible, and still others very improbable or impossible. One of our central interests lies in understanding what kinds of activities and interactions particular material objects engender and support and how these change as different artifacts and technologies are introduced (Jordan & Henderson, 1995, p. 75).

2.3.3.1 Laban Movement Analysis

Although Laban movement analysis (Laban, 1971) was not included as one of the typical practices of IA in Jordan et al.'s paper (1995), many studies in which moving bodies and whole body movement-based interaction play a central role (Camurri, 1999, Zhao, 2001, Sundstorm, 2005, Loke et al., 2005), have used it for analysing and describing movement.

One important part of Laban movement analysis (Laban, 1971) is effort categories, which are useful for describing the temporal and dynamic qualities of human movement. There are four categories, each of which has two polar values: 1) Space: Direct/Indirect; 2) Weight: Strong/Light; 3) Time: Sudden/Sustained; and, (4) Flow: Bound/Free. The first three categories define the six effort actions depicted in Effort Cube in Figure 2.2. For example, glide, top, back and left corner of the cube correspond to a movement that is light in weight, sustained in time, and direct in space. The movements performed for ironing a delicate fabric can be described as an effort of glide. The fourth quality, flow, describes the continuity of the movement. In the case of ironing, the movement is bound in flow as the pauses between each effort of glide are very short. As Newlowe claims, flow is bound 'when an action can be stopped at any given moment. This will not be a complete stoppage leading to an abandonment of the action, but a pause' (1993, p.48).

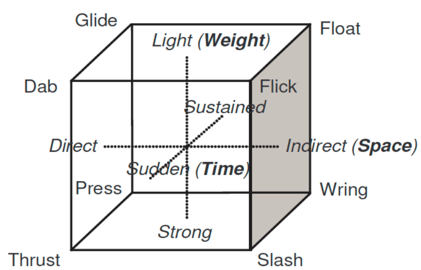

Figure 2.1 Laban Effort Cube

The thesis employed Laban's movement and effort categories together with the image sequences from videos. The Laban's movement notation - Labanotation – to describe movement using symbolic notation was not employed in the thesis, since it was found too detailed, complex and not easily readable (Höysniemi & Hämäläinen, 2004). Instead the research employed what Höysniemi and Hämäläinen refer to as image sequences of movements in conjunction with Laban's movement and effort categories. While the image sequences was used to describe the movement patterns at a particular moment visually, Laban's movement and effort categories were used to explain the multiple qualities of movements at each identified movement pattern in image sequences.

2.4 Discussion

Recent developments in science and technology studies, feminist techno-science and ethnomethodology are seeking a change in the prevailing humanistic and essentialist conceptions of agency. This request has been well received by the interaction design research community. The various studies that have been conducted within what Harrison et al. (2011) refer to as situated perspectives, which, in varying degrees, recognize the situated, embodied, collective and relational nature of agency.

The increasing recognition of situated action within the field of interaction design has started to challenge the traditional conceptions of design, design process, designer, user and object of design. As the situated perspectives represent a transition from essentialist to non-essentialist accounts of reality, ideas of design switch from a prescriptive understanding to a facilitative understanding. In other words, design's role becomes facilitating, providing resources for action rather than prescribing them. Table 2.4 compares the various conceptions of essentialist and non-essentialist/situated perspectives of interaction design. The Table's purpose is to provide an understanding by illustrating the totally extreme cases: there are definitely many shades of grey between the extremes.

Table 2.4 Comparison of essentialist and non-essentialist/situated perspectives

Essentialist perspectives	**Non-essentialist/situated perspectives**
Try to prescribe and control user actions	Try to support user appropriation
Seek deterministic relations	Seek situated characteristics of relations
Aim to predict the ways interactions unfold	Aim to support variety and richness in interactions
See users as passive information processors and containers	See users as co-designers or co-creators
See designers as heroic and authoritative creators	See designers as facilitators
See the role of design as satisfying needs	See the role of design as shaping agencies
See the design process as a rational search process	See the design process as a series of inscriptions and translations
Draw clear cut boundaries between entities	Draw temporary and blurry boundaries between entities

One common major theme among situated perspectives is participation, which highlights the importance of the participatory ways of knowing, exploring and designing. Participatory practices are helpful in supporting various actors and their values, and collective articulation of the concerns of actors. Furthermore, participation is not limited to humans but includes non-humans as well. The latter are seen as authentic actors capable of radically making a difference. Therefore, the design process becomes a process performed by a collective of human and non-human actors.

In addition to the metaphor of collective, there are also other possible metaphors for conceptualizing a design collective such as network, fluid and thing. These metaphors, which co-exist, allow a view of the different relational possibilities of the collective. Thinking of the activity of designing in spatial terms is advantageous for seeing how relations between actors 'perform' spaces of negotiation and spaces of prescription. Although there is a general sympathy for spaces of negotiation, as they support variety in the ways in which actors relate to each other, the 'framing' role of spaces of prescription and the intertwined nature of the two are also acknowledged.

For situated perspectives, the activity of designing does not stop after the production of the object of the design but continues in the sites of use through acts of appropriation, adaptation, configuration and hacking. For this reason, configurability of the object of design becomes an important feature. However, the notion of configurability is not limited to the object of the design: it also refers to configurability of the design process.

While situated perspectives note the entangled nature of human and non-humans in the collective, they also highlight the importance of located accountabilities. The critical point of the relational and collective view of agency is related to attribution of responsibility and accountability. Since the action is seen as distributed, there is a danger of unaccountable action. The suggestion is, that actors should still be responsible for the ways in which they produce things, and also, for the ways in which they use things. In other words, in the traditional sense, designers are responsible for what they design and users are responsible for how they use the designed objects. Neither technologies nor their use are neutral; hence, both should be accountable.

As part of supporting accountability and the creation of new relations between actors, different notions, e.g., 'accounts' and 'seams', have been developed in the interests of increasing the visibility of actors, resources, infrastructures and processes. The general idea behind these notions is that increased visibility facilitates increased access to what other entities do, how they do, what resources are available, what kind of relations are possible, and how various processes flow. This awareness is useful for making actors accountable for what they do and for supporting the creation of new relations and practices.

Similar to the notion of located accountability, consideration of the dual effects of decisions on the design process and design objects has been quite common among situated perspectives. It is possible to see the effects that design decisions have on structure of amplification/reduction, inhibition/invitation, and enabling/constraining. Consideration of the dual nature of effects may be seen as part of the ethical and responsible design agenda of situated perspectives.

In addition to these general understandings, two important notions have been developed in science and technology studies and ANT: inscription and translation. The intertwined nature of these notions makes them a useful metaphor for understanding the mutual relations between agency and design. In addition to mutuality, the notion of inscription includes non-human actors as well: any entity can be an actor who is inscribed and can inscribe; similarly, any entity is capable of translating and being translated. This allows one to see whole design process as a series, and, at the same time, as a collection of inscriptions and translations that are in continuous transformation. This understanding increases one's sensitivity to relations, the configurations between actors that generate the relations, and the process of reconfiguration.

ANT suggests a methodological principle referred to as generalised symmetry, according to which both human and non-human actors take part in the construction of networks and should be analysed without privileging any of them. As Latour (2005) points out, generalized symmetry does not suggest that humans and non-humans should be treated ontologically the same or should be subject to the same ethical considerations. It is simply a methodological principle or stance abandoning all *a priori* distinctions between the natural and the social and any boundaries that demarcate them.

Finally, the notion of design and innovation is not limited to satisfying needs through technological means. Innovation involves the creation of new topologies of relations which shape what a human being is, what s/he does, how s/he relates to others, and what roles other non-human actors can play. Callon (2004) maintains that the desire

> ... to conceive new technologies, new goods and new services, is not just a question of satisfying needs or demands expressed by well-identified human beings. It is also and mainly shaping new forms of human agencies and consequently constructing new types of collective life. The main challenge for the next years will be to discuss which type of human agencies people want to develop. Or, in other terms, which types of socio-technical arrangements people will design and experiment (p. 9).

Drawing on understandings garnered from these situated perspectives of the third paradigm, this research develops the Agency Sensitive Design approach by employing design qualities, various strategies vital to implementing these qualities, and analytical lenses for reflection. ASD differs from other situated perspectives inasmuch as it explicitly focuses on a relational view of agency and uses it as a fundamental understanding through which to variously shape one’s conceptions of the design, the design process, the designer, user, stakeholder, object of design, and of the human and non-human. The ASD approach will be explained in the next section.

3. Agency Sensitive Design

Conceptions of agency have already been shaping all matters of design, often in implicit ways.[5] Agency Sensitive Design (ASD) makes this shaping process visible and proposes a relational understanding of agency to inform the thinking of all matters of design. As suggested in the background chapter (Section 2.2), situated perspectives have already started to formulate concepts and approaches for accommodating a non-essentialist and relational view of agency. Drawing upon these perspectives, ASD envisions a relational design approach, which enhances the designers' ability to think about both the object of design[6] and the design process in a relational way. This entails thinking in terms of relations that can vary and be dynamic rather than essences that can be totally known, predicted and controllable. The aim of ASD is not to provide a 'model' or 'template' for either the object of design or the design process but to work as 'metaphors' for designers that will enable them to incorporate a relational view of agency into their design thinking and their thinking of design.

Our relations with technologies are always constructed and designed partially by ourselves, partially by society, and partially by designers, engineers and politicians. However, the very 'constructedness' of our relations suggests that they can be constructed in some other ways. A relational understanding of design can enable us to see and explore the various ways in which human-technology relations can be reconstructed and reconfigured for more responsible and ethical effects (Friedman & Kahn, 1992; Van der Velden, 2009), and creative engagement between humans and technology (Callon, 2004).

The fundamental principle of ASD, which includes a large range of aspects of relationality in design, is *to recognize and support variety in the formation and exhibition of agency in the design and use of technologies.* In a design process, while the 'formation of agency' refers to a process in which a heterogeneous set of human and non-human actors come together to construct a design collective, 'exhibition of agency' refers to a process in which the actors of the design collective act and take part in

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[5] See Section 2.1.2.2 for an explanation of the relations between worldviews, design and agency.

[6] The term 'object of design' will be explained in detail in Section 3.1.1. Here it simply means the intended outcome of the design activities.

creating various effects. Therefore, it is important (a) to recognize the influence of multiple actors on design problems; and, (b) to find ways to consider their concerns and effects. Similarly, it is equally important to allow the actors of the collective to perform or act in a larger space of possibilities. In order to do this, we need to avoid prescribing and predicting the ways in which human and non-human actors come together. In effect, they need to be considered in relation to each other; thus, there is a need to provide resources and mechanisms that will enable the actors to co-explore, co-create, and co-construct the space of possibilities in a relational way.

ASD has been conceptualized similar to the way in which ANT scholars have conceptualized ANT. ASD neither suggests a well-defined model for design nor provides guidelines for performing design activities. It neither describes itself as a framework, a model, nor even as an approach. Rather, ASD describes itself as a metaphor that provides an understanding of a relational design practice. It provides a list of concepts that can increase the designers' awareness of the relational nature of agency and the intertwined relations between agency and design. As well, it provides a somewhat ‘blurry’ snapshot of what a landscape of a relational design practice can be. This blurriness is a deliberate choice as ASD itself avoids establishing strongholds and essential realities. ‘Deliberate imprecision’, an important approach to knowing in ANT (Law, 2004), respects the situated and relational nature of realities and knowledge.

In parallel to the deliberate imprecision approach, another reason for proposing ASD as a metaphor instead of a model is to avoid creating and proposing a rigid set of definitions or guidelines for developing a relational understanding of agency in design. Metaphors are generally not suitable for direct application of the core ideas and relations from the side of metaphor to the side of target area: they require a translation between them. The act of translation is preferable since it is in line with the fundamentals of the key notion of relationality, which avoids creating single absolute realities and asks for being sensitive to the particularities of each case. The considering of ASD as a metaphor asks designers and researchers not to take these qualities as prescriptions or strict guidelines for action but to use them as tools to think about - or lenses through which to see - design problems and processes from a relational perspective.

ASD is composed of five strategic-generative conceptual devices: the object(s) of design, design collective, topology, inscriptions/translations and tuning; and six sensitizing design qualities; relationality, visibility, multiplicity, configurability, accountability and duality. It is important to note that the lists of concepts and qualities are neither complete nor exhaustive. They represent a starting point towards developing ASD. The aim is not to replace the extant design approaches but rather to complement them by relativising how we think and go about design. ASD is neither an independent approach to - nor a replacement of - the current design methods or approaches. In effect, it is envisaged as a complementary approach or a sensitising tool containing a set of concepts and qualities that can help designers to integrate a relational understanding of agency into their design thinking.

Before explaining the five strategic-generative conceptual devices and six sensitizing design qualities that constitute ASD, in the next section I will present the roles of literature and workshops in constructing ASD.

3.1 Construction of ASD

3.1.1 Role of Literature

All of the concepts and qualities were derived from extant works and the approaches featured in the literature. The research benefited from a large body of relevant works from the fields of STS, cognitive science, post-phenomenology, HCI and interaction design. In particular, relational understandings of agency as developed in Actor-Network Theory, and situated perspectives in the fields of HCI and interactions design formed the basis of the qualities and concepts. As presented in the Background Chapter, all of these concepts and qualities have been developed and employed in many research studies over the past two to three decades. ASD's contribution to the field of interaction design has been the gathering and translation of these concepts. More specifically, ASD brings together diverse concepts from the literature appertaining to a central theme of relational agency in design, creates various connections between these concepts, and extends their original scope.

A similar set of design qualities was proposed by Bardzell (2008) to characterize feminist HCI (see Section 2.2.2.1). And, while the qualities of ASD are similar to those developed by Bardzell, as opposed to her approach, ASD's primary focus is on ways of developing a relational understanding of agency in design: characterizing design objects, the design process, and the idea of design in relational terms.

The research employed various methods to gather and refine relevant ideas, concepts and principles. These methods include blogging, summarizing, tagging, highlighting, classifying, mind mapping, brainstorming, sketching and diagramming. The process of generating these qualities can be briefly explained as follows: first, the author examined a large body of relevant studies while at the same time tagging them and highlighting important ideas that can potentially be useful for developing a relational understanding of agency in design; second, these tags and ideas were grouped under common concepts; third, a visual diagram containing a collection of these concepts was created; fourth, various connections and relations were sketched and mapped on the diagram; and fifth, more generalized concepts and qualities were generated. See Figure 3.1 for a representation of the visual diagram containing a collection of tags and concepts.

This process of generating an initial set of qualities, however, had some limitations. Although best efforts have been made to minimize them, the coverage of the literature informing the concepts and qualities of ASD has been affected by the author's prior experience and further limited by the time concerns of the study. Therefore, this set should be considered neither complete nor exhaustive: it is a *selective* set of concepts and qualities that can be extended or narrowed down. Nevertheless, it has been produced out of a large body of relevant work and provides a useful *starting point* towards developing a relational understanding of agency in design.

The primary focus of the set of qualities and concepts is on the field of interaction design. The definitions and examples of qualities and concepts have been taken in the main from either interaction design or HCI. However, the insights are potentially useful for the other fields of design.

The next section briefly explains how the research further develops some of these concepts and qualities through a series of participatory design workshops situated in the early phases of design.

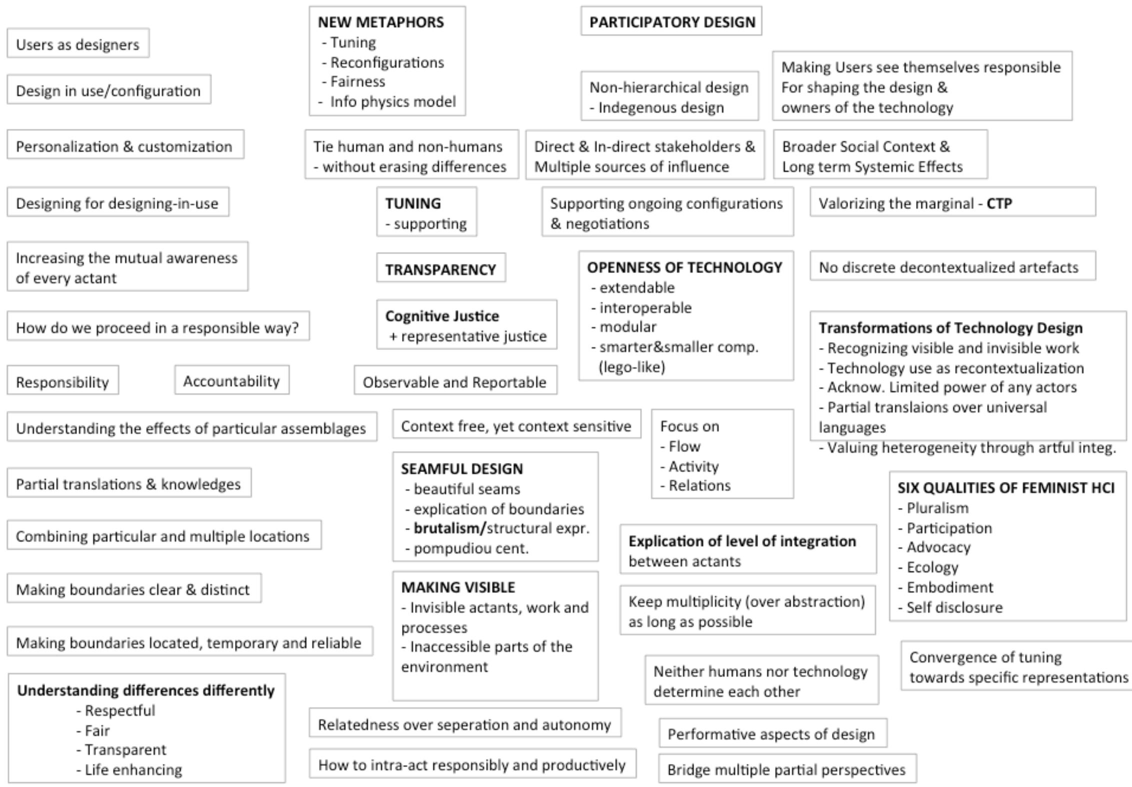

Figure 3.1 A Visual Diagram of Concepts Informing the Theoretical Basis of ASD

3.1.2 Role of Workshops

In addition to generating a set of concepts and qualities out of relevant literary works, the research has conducted some empirical experiments to investigate what ASD qualities mean in a practical design situation. The experiments involved a series of three workshops that aimed to deepen our knowledge of some of the concepts and qualities. The workshops facilitated a practice-based investigation and construction of ASD concepts and qualities rather than functioning as a means for hypothesis testing.

The research employed the workshop approach in an evolutionary way that allowed the inscriptions deployed in the workshops to become more responsive to the concerns emerging from each workshop and, consequently, explore and iteratively develop the different aspects of ASD. This iterative cycle facilitated continuous dialogue between the researcher and the situation and, hence, between the ASD concepts and the workshops (see section 4.3.1). As a result, the workshops took an active role in identifying and elaborating upon the critical nature of the ASD concepts and qualities identified from the literature. While workshop 1 and 2 developed an initial understanding of ASD concepts and qualities in an early phase of design, workshop 3 investigated the concepts and qualities in more detail and depth, in particular through the introduction of the method of adaptive inscriptions (see section 6.1).

The workshops focused on the early phase of design and constructed specific design situations in the form of exploratory design games. The main reason for situating the empirical studies in the early phases of design was that the decisions and understandings obtained in the early phases played an important role in shaping the rest of the design process. Therefore, any effort made to support ASD qualities in the early phases can prove effective in establishing a basis for developing a relational understanding of agency in the later phases. Another reason was that the early phases of design, which are mainly composed of conceptual development and ideation activities, are very suitable for performing design as a mode of inquiry (Frayling, 1993; Zimmerman, Forlizzi, & Evenson, 2007) and for experimenting with new methods.

In addition to the main aim of the workshops, which was to explore ASD concepts and qualities, there were practical goals referred to as object(s) of design, which can be understood as intended outcomes of design activities. While the object of design of workshops 1 and 2 was "enabling new relations between human and technological actors in full-body movement based interaction scenarios", the object of design of workshop 3 was "exploring the concept of togetherness and connectedness between human and non-human actors through design games utilizing different forms of knowing and doing". Unlike traditional design activities in which objects of design are in tangible material forms, in all three workshops, the object(s) of design were in the form of knowledge, experiences and relations. And, while technological devices and prototypes were used and developed during three workshops, the aim was not to inform the design of such technologies. Rather, the goal, i.e., the intended outcome, was to explore the possibilities for creating the new relations that these technological prototypes can afford when used in various different human-technology-environment arrangements and in different scenarios.

The activities of the workshops were specifically selected and designed according to their potential for providing insights into ASD qualities. Here, an analysis of activities in the early phases of design in literature resulted in the identification of a collection of activities that can prove effective when exploring object(s) of design and useful for investigating ASD qualities.

3.2 Strategic-generative conceptual devices

3.2.1 The object(s) of design

My use of the term ‘the object of design’ is similar to that of A. Telier (2011) (see Section 2.2.2.5). In fact, the term has a double meaning: it may mean a material artefact as an outcome of a design activity or it may mean simply the aim of a design activity. These two meanings are closely linked to each other since a typical aim of a design activity is to produce a material object of design. However, there can be many other things that design activity can produce such as experience, knowledge, and relations. For a closer analysis of the diverse relations between the object of design and its outcome, I will examine De Michelis’ work (2009), which argues that the object of design and its outcome are neither the same nor singular things.

> ... Despite the fact that we generally use the same name for both the object of design and its outcome, the former is not its latter: they are irremediably diverse. ... On the one hand, the thing being the outcome of the design process will be the embodiment of the design object, but it can't be reduced to it (a thing exceeds the intentions of the people dealing with it, even when they have designed it); on the other hand, the object of design is not just a thing: it is constituted by all the (inscribed) things the participants create, import and/or modify during the design process. Its constituents are all interrelated: they form a web characterizing them as different representations, versions, views and details of the object of design (p. 152).

According to De Michelis, the object of design is in a process of continuous transformation:

> The object of design is continuously changing during the design process, since day by day new constituents are created and existing ones are changed or sometimes destroyed: the creative process characterizing design is well reflected by the continuous changes of the web of things constituting its object (p. 152).

Furthermore, the transformation does not stop after the delivery of the object of design but continues in use time.

> Once design has ended, and its outcome is delivered, a completely different story begins: the story of people experiencing the outcome of design. It is during this story that users appropriate the outcome of design, reinventing their behavior and practice. The intentions of the designers, the values they wanted to give to the thing designed, are not automatically transferred to it: users are free to make their experiences with the outcome of design discovering the possibilities it offers to their behavior and practice, beyond what designers had thought and imagined (p. 154).

Finally, De Michelis points out that there is no determinant relation between the objects of design and the design outcomes:

> The object of design ... is not its outcome, its embodiment: the latter may be less rich than the process of bringing it into existence; other constituents may light up its sense or evoke qualities that it does not adequately embody already. ... [D]esigners appear to me to be immersed in a process where their aims cannot be automatically transferred to the outcome of their work which, when it comes into existence, will have a new life where they can only have a minor and peripheral role (p. 156).

Drawing on the insights provided by De Michelis, ASD suggests three understandings of the object of design:

i) <u>There are multiple objects of design enacted relationally</u>: '*The not yet existing thing that will be its [design's] outcome takes form in the design process through the actions and interactions of its participants*' (p. 152). The multiplicity of the object of design refers to two kinds of multiplicity. First, the object of design is multiple in the sense that it is never a single thing or a finalized, isolated artefact but a collective of artefacts, devices and representations, which includes an envisioned system or artefact to be handed over. Second, the object of design is multiple in the sense that it is re-appropriated by users in various different settings, generating multiple objects of design.

ii) <u>The objects of design are in a process of constant transformation and becoming during the entire design process including design time and use time</u>. In support of the idea of multiplicity, the objects of design evolve and transform during the design process. They connect with other objects, modify them and, in turn, are modified by them. The idea of continuous transformation and becoming is quite important as it supports a non-essentialist and relational understanding of the object of design.

In addition to notions of multiplicity and continuous transformation, a third understanding about objects of design is that they are active participants or actors capable of shaping spaces of possibilities and modifying various states of affairs.

iii) The objects of design are constitutive and performative. Ehn suggests that one should recognize the performative and constitutive character of the representations: *'[T]here is clearly also a performative dimension of the evolving object. These 'representatives' of the object of design have of course to be elected and enrolled by the other participants but, once engaged, they are active participants in the design thing as a collective of humans and non-humans*' (2008, p. 95). Here the term 'representatives' refers to a collection of objects, which constitute not yet existing objects of design.

3.2.2 Design collective

ASD conceptualizes design as productive coming together, a collective of human and non-human actors aiming to perform and explore spaces of possibilities for the objects of design in a relational way. However, each term in this definition deserves closer examination. First, the idea of a collective is very important given that it emphasises the act of coming together. There can be many different ways in which the actors can come together, and these ways reconfigure the capabilities of and interrelations between the actors. Second, the collective does not contain human actors only: it also contains non-humans. Human and non-human actors are entangled and co-constitute one another. Third, the collective of humans and non-humans does not act in a pre-existing space of possibilities but perform spaces and explores them. What they explore is not confined to a definitive singular object; rather, there are multiple objects of design that are constructed in a relational way; that is, through interactions between the actors. An important property of design collective is connectivity between the actors, which is the main subject of concern of topology.

3.2.3 Topology

The notion of topology (introduced in Section 2.3.1.2.4) was employed during the post-ANT movement to facilitate an understanding of the multiple realities and spaces of possibilities that cannot be explained by a single analytical spatial type such as Euclidian or Cartesian space. Briefly, topology, which is concerned with the characteristics of various spaces and forms and the various operations possible within those spaces, characterizes spaces in terms of properties of connectivity and continuity. It explores the continuity of some 'essential' relations or properties of objects or shapes and the different ways of measuring it. In other words, it explores relations or properties that are maintained across various transformations. As Law (2000, p. 4) argues: ‘Topology asks questions of what counts as “essential”? What is it that has to be sustained? Rendered continuous? What is a distortion?’

ASD suggests a topological way of conceptualizing design collectives. It employs the concept of topology for understanding the actors of the design collective in terms of their relations and the design spaces[7] made possible by those relations. The actors of the collective can come together and be associated in many different ways. Topology allows us to think about the various ways in which actors can come together and construct different spaces; in addition, it deals with the ways in which actors are connected, i.e., the connectivity between the actors, and how the collective maintains its 'integrity' during a process of transformation. As suggested earlier, what defines the integrity of an object or collective is a central concern of topology.

According to ASD, the topology of a design collective refers to arrangements between the actors and a set of possible operations. While different arrangements perform different spaces, one arrangement might perform more than one space (Mol & Law, 1994; Murdoch, 1998). For a discussion of multiple possible spaces, see Section 2.3.1.2.4. The topological features of design collectives play an important role in the emergence of various spaces and can be effective in supporting or restricting relationality. Murdoch (1998) claims that a topology can support relationality and become more ‘fluid’ if the relations between actors are able to transform and vary: fluidity allows actors to negotiate the nature and extent of their relations with other actors over a larger range. In other words, the ‘fluidity’ of topology is higher if the connectivity between the actors allows them to establish relations and connections in

[7] Here, the term ‘design space’ is used in a sense similar to Schön’s use of ‘problem space’ (1992) – they are both constructed. As an extension of the understanding developed by Schön, ASD suggests that not only designers but also collectives of humans and non-humans and their particular arrangements, i.e., topology, construct design and problem spaces.

diverse ways. In fluid topologies, relations are not fixed, prescribed and restrictive, and patterns of actions are not formalized.

Topology's role in formation of agency can be demonstrated along a continuum with two extreme ends. On the one end, there is an extremely solid topology that neither allows the construction of any new relations nor the transformation of existing relations. Everything is totally stable and fixed: anything can count as essential. The topology of relations in the assembly lines of factories can be considered as highly solid as the roles of the actors, their relations and actions are strictly predetermined. On the other end is what we can refer to as 'extremely fluid' topology that allows construction of any kinds of relations between any entities. Nothing is stable and counts as essential. Although there may not be an extant case that can be presented as an example of 'extremely fluid' topology, the case of the Zimbabwe Bush Pump (de Laet & Mol, 2000) demonstrates what a fluid topology can be. The factors supporting the fluidity of the Zimbabwe Bush Pump depend not only upon the pump's modular, changeable and adaptable parts, but also upon the relations surrounding the pump (see Section 2.3.1.2.4 for further explanation of the fluidity of the pump). Although these two extreme topologies may not exist in practice in their pure form, a discussion of the kinds of relations they envision and produce is useful for understanding the important role of topologies in shaping relations.

ASD suggests many ways of changing the topology of a collective: the first is to provide additional resources or mechanisms for the actors to connect with other actors in multiple ways. In other words, this way is related to increasing the connectivity between the actors. For example, in a design situation where the team members are geographically distributed, one topology might allow team members to communicate with each other only through an instant messaging functionality. In such a situation, the topology of a collective can be more supportive of relationality if a functionality of voice-chat is provided. The additional functionality increases the connectivity between the actors by providing another way of establishing a connection. Connectivity can be further increased by the provision of video chat, a short message service, and then by real-time document-sharing functionalities. Increasing connectivity increases the fluidity of the topology, allowing the actors to relate to one another in multiple and diverse ways.

The second way of changing the topology can be done by including new actors into the collective. A new actor can modify the topology of the collective to various degrees. Whether or not the new actor has the capacity to influence the topology will depend upon her/his/its ability to connect with the other actors. In the previous example, a functionality of voice-chat is a new actor joining the collective. Its influence on changing the topology of the collective depends upon the extent of availability of this functionality among the actors. If the voice-chat functionality is available for all actors to communicate with each other by any devices (e.g., desktop and mobile) through a web interface, then its capacity to change the topology can be considered very high. However, if the new functionality is exclusive to a few members of the collective only, can work on PC-based computers only, and requires special software to be installed, then its capacity to modify the topology is less than in the previous case. The positioning of new actor, and her/his/its ability to connect with other actors in the collective are important in the case of extending the collective.

The third way is changing the configuration or arrangement of actors in the collective without changing the content of the collective. In other words, the members of the collective are the same actors, but their positions with respect to other actors in the collective are changed. In our example of a distributed design team, this change might mean gathering some or all of the team members together in the same place for a meeting, an action that can change the 'bandwidth' of their communication and the nature of their relationships.

The fourth way is different from the other three in that it involves conceptual change, i.e., a change in the ways in which actors understand things. Based on the understandings provided by Kuhn (1970), Agre (1997), Schön (1983) and Lakoff and Johnson (1980), which are about how metaphors structure and shape ways of seeing and relating to other things, I refer to it as a 'metaphorical shift'. I will argue that topology of relations can be transformed by metaphors. Two topologies with the same the actors, same positions and same tasks can generate different sets of relations according to the underlying metaphor. Changing the metaphor changes the topology as the actors' conceptions of themselves (their roles), others (others' roles), and a range of possible relations change.

Putnam et al. (1996), after examining the roles of different metaphors in understanding the relations between organization and communication, explained how the phenomenon of organizational communication has been conceptualized and studied differently according to seven different underlying metaphors: conduit, lens, linkage, performance, symbol, voice and discourse. Putnam and colleagues considered the seven metaphors as metaphor clusters containing a set of metaphors sharing a similar view of the relations between communication and organization. For example, the conduit metaphor treats organization as containers and communication as transmission. Tool, channel and media are typical metaphors of the conduit metaphor clusters, whereas the metaphor of performance considers organization as coordinated action and communication as social interaction involving jamming and improvisation, shared meanings and theatrical productions. Enactments, co-production, drama and story-telling are types of metaphors subsumed in the performance metaphor category. Putnam et al. suggest that 'metaphors legitimate actions, set goals, and guide behaviors': they 'shape how we see and make sense of the world by orienting our perceptions, conceptualizations, and understanding of one thing in the light of another' (p. 377). Similarly, Krippendorff noted that each metaphor 'entails its own logic for human interaction and the use of each creates its own social reality' (1993, p. 48).

As anything or any inscription in a design activity is at the same time an actor taking part in a design process, the first, second and fourth ways of changing the topology may be considered one single way. However, in this section, they were presented as separate ways in order to facilitate a better understanding of the nuances of the roles of the different actors, resources and metaphors in shaping topologies. In particular, a metaphor is quite a different type of actor from any other human and non-human actors in design processes. Metaphors, which operate at a very abstract and conceptual level, can be very powerful in changing topologies as will be seen in the workshops.

ASD suggests that thinking in terms of topology allows designers to focus on relations between the actors, their transformation and how various design decisions, in the forms of inscriptions, affect the emergence of different topologies and, consequently, can increase or decrease the collectives' capacity to perform various relations.

Topological thinking is also useful for obtaining a balance between levels of specificity and openness or between spaces of prescription and spaces of negotiation when employed in tandem with the notions of inscription/translation and tuning.

3.2.4 Inscription/Translation

Inscription and translation are two important concepts of ANT. ASD employs these concepts for purposes of understanding (a) the intertwined relations between design and use; and, (b) how various actors take part in the generation of spaces of negotiation and spaces of prescription. The power of the notion of inscription comes from its broad metaphorical scope and the intertwining of its conceptualization with the notion of translation. Metaphorically speaking, inscribing can be understood as an act of writing in or on anything. When an actor writes something, the written thing, i.e., the inscription, influences the relations and roles of its actors to varying degrees. Written mediums can be anything; i.e., any of our actions, choices, even the sole existence of any human or non-human entity can be viewed as inscriptions for a situation of which they are part. They join in a collective of actors and influence the capacities of the collective to varying degrees. All actors, their acts, and the relations between the actors become inscriptions for action. Thus, the collective of human and non-human actors can be viewed as a collective of inscriptions. In this respect, all of the interactions between the actors become processes of translation: actors translate the interests of other actors or their programs of action. However, it is important to note that the translation process is an indeterminate and transformative process in which actors and their roles are redefined and the competences in the collective are redistributed. The inscriptions embodying actors' interests or programs of action are transformed during the translation process. Therefore, the actors' capacities for action are not limited to a finite number of alternatives involving fixed inscriptions to be 'read' in the collective. The actors continuously translate, inscribe, and, in turn, are translated and inscribed in the collective.

ASD suggests thinking of the design process in terms of a series of inscriptions and translations, which can be beneficial in many ways. First of all, the notion of inscription renders visible the interconnectedness of things, and the multiple sources of influence in a design situation. Inscriptions allow designers to think and act in a larger set of parameters, which would not be recognizable otherwise. Inscriptions draw our attention to the material properties of entities and their changing effects in relation to other entities: they provide an understanding of the complex nature of design artefacts. On the one hand, inscriptions highlight the fact that design artefacts embody some of the values, programs of action and interests of various actors, and ask for accountability of design decisions; on the other, they explain that the final translation is always an indeterminate process that is not subject to total control by the designers and ask for the accounting of any actions which may deviate from those expected in practice (see Sections 2.1.2.1 and 2.4.)

3.2.5 Tuning

ASD borrowed the concept of tuning from Pickering's work (1995) and used it in a similar sense in the context of design. Pickering conceptualizes tuning as a process of alignment between the interests of actors that takes place in a structure of resistance and accommodation. Tuning, which highlights the importance of the adjustability or transformability of relations in a collective, requires relations between actors to be more flexible and tuneable as opposed to being stable, fixed and strictly defined. The tuning of relations can be viewed like the tuning of a radio set. It is a process of negotiation and alignment for finding a temporarily stable relational state.

Providing support to tuning operations during design time means being responsive to concerns emerging from the design collective. In a way, this asks designers to tune the inscriptions shaping the space of possibilities. Designers define a set of inscriptions before design time (pre-design time), creating an initial topology of relations for actors of the design collective to engage in design activities. During design time, tuning involves a mutual alignment process between the initial design inscriptions of the designer (who aims to accommodate the interests of the design collective) and the translations of the design collective (that shows resistance to the interests of the designer). Following the tuning of the interests, the design collective will then start to be tuned as well. This process of mutual alignment or tuning is a core element of ASD as it allows relations to evolve and transform according to the negotiations between actors.

Similarly, the tuning of operations in use time, which refers to a mutual alignment process between the object of design and its users, requires the object of design to be customizable, flexible and adjustable, and users to be open to engage in ‘design-in-use’ activities (Aanestad, 2003). As I suggest in Section 2.2.2.3, seamful design, which explicates the seams of technology, supports appropriation by users through tuning operations (Chalmers & Galani, 2004). Similarly, the notion of ‘accounts’ suggests use of self-explanatory and transparent system components (Dourish and Button, 1998). Visibility and accessibility are essential properties of technologies that make tuning operations possible. In addition to visibility and accessibility, some mechanism for adjustments is also required. It is important to note that there may be cases in which no tuning is preferable such as high reliability required situations.[8] In such situations, the topology of relations is strictly solid and formalized to ensure an exact flow of operations.

The concept of tuning is closely linked with the concepts of inscriptions and translations: the acts of inscribing/translating for aligning the interests of actors are tuning processes. When tuning a radio set, for example, a human actor couples with a non-human actor and they engage in a dialogue. The human actor turns the knob either to the right or left according to the signals provided by the non-human actor. The tuning may end when the right frequency is found. Although it is possible that the human actor is looking for a particular radio station, s/he may come across other stations during the process and prefer to stay at one of these stations. The concept of tuning involves the interactional elements of mutuality, alignment, dialogue and surprise; hence, it is very useful for supporting relationality. Ultimately, tuning, in the context of ASD, suggests that designers tune inscriptions in design time in order to support tuning by users in use time.

3.3 ASD Qualities

ASD proposes six design qualities which characterise the design collective, the design process and the idea of design. The six design qualities, i.e., relationality, multiplicity,

[8] Here, tuning refers to actors’ high-level actions involving interpretation. In high reliability-required systems, the operations need to be performed as planned. As any deviation from the planned flow is risky, the relations are predetermined and not open to negotiation or ‘tuning’.

visibility, configurability, accountability and duality have been developed according to various understandings obtained from the situated perspectives presented in the previous chapter. What ASD does is to bring together these concepts around the central theme of relational agency in design.[9] These broad categorical qualities, which taken together provide a useful starting point from which to support the main principle of ASD, are employed along with strategic-generative conceptual devices.

3.3.1 Relationality

The quality of relationality refers to the connectedness and relatedness of human and non-human actors. It comprises heterogeneous networks (Latour, 2005) or socio-material arrangements (Suchman, 2006) in which humans and non-humans co-constitute each other through their interactions. According to Suchman, relationality emphasizes the '*relational character of our capacities for action, the constructed nature of subjects and objects, resemblances and differences; and the corporeal grounds of knowing and action*' (2005, p. 3).

In design processes, the quality of relationality asks for three sensitivities: (1) consideration of the system as a collective or network of humans and non-humans; (2) an understanding of the mutual influence, shaping and co-constitution of human and non-human actors; and, (3) the supporting of emergent and improvised action. In order to develop these sensitivities, we first need to stop formulating design solutions based upon the assumption of well-defined actors - either human or non-human - with fixed characteristics and capacities of action. Design solutions should recognize and support the existence of multiple actors embodied in one actor and the possibility of multiple enactments of one actor within a network of other human and non-human actors interacting with each other and exhibiting different capacities for action. As Pickering (1995) suggests, both human and non-human agency are temporally emergent. Rather than prescribe or control, we may design for appropriation and design-in-use. From the perspective of relationality, technologies should not try to impose a particular pattern of

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[9] Bardzell in her recent work employed a similar approach by creating a "constellation" of design qualities derived from various extant works as a part of a feminist interaction design program (2010). She noted that 'it is this constellation of qualities—all of them appearing together in a critical mass—that I argue characterizes feminist interaction' (p. 1305). Similarly, ASD brings together these concepts and their togetherness characterizes a relational understanding of design.

action; rather, they need to provide a space of negotiation in which individuals can exercise their 'multiple' capacities of action in personally unique and creative ways. Affector, which I addressed in Section 2.2.2.2, demonstrates how interactive systems can be built by focusing on the relations between the actors and facilitating emergent interaction.

In addition to supporting situated and emergent interaction, technological products should not be thought of merely as independent or decontextualized artefacts but as part of a heterogeneous network or assemblage of humans and non-humans. Technologies' capacity to be extended and combined with other technologies (Kahle, 2008), and 'the extent and efficacy of one's analysis of specific environments of devices and working practices, finding a place for one's own technology within them' (Suchman, 2002, p. 34), are the key to successful designs with relational perspectives. For example, open source software development projects such as Linux and Mozilla Firefox provide transparent and modifiable mechanisms suited to integration with other systems and further extendable by user-developers.

3.3.2 Multiplicity

The quality of multiplicity refers to a multiplicity of ways of knowing, performing and representing, which entail the participation of multiple and heterogeneous sources of influence in the design process. In this respect, participatory design provides us with useful ways of supporting multiplicity in the design process through inclusive, participatory and democratic practices. However, according to Van der Velden (2009), participation alone is not in itself sufficient: equal representation and treatment of all actors should also be ensured. Van der Velden uses the concept of cognitive justice, which covers both participation and cognitive representation. Cognitive justice allows us to overcome many traditional dichotomies such as global/local, scientific/indigenous and expert/layman and embraces knowledge diversity rather than knowledge hierarchies. Visvanathan states that the notion of participation privileges the experts' definition of knowledge:

> [E]xperts' knowledge is represented as high theory and layperson's ideas as a pot-porri of practices, local ideas and raw material. Thus democratization of science should be extended to include alternative

> sciences. It should be possible to validate other forms of knowledge. The equal treatment of actors/actants is crucial, and identification of the ways to validate and evaluate them in a democratic way (2007, p. 92).

Indigenous designs acknowledge diversity in knowledge production and provide us with useful accounts of designing in non-hierarchical and participatory ways (Van der Velden, 2009). Van der Velden, who analyses various classification systems in a bid to understand how different ways of knowing were accommodated in the design of these classification systems, explains that the organization of information on the Web is based upon an hierarchical tree-like structure in which relations are defined according to the categories of 'parent', 'child' and 'grandchild'. According to her thesis, this hierarchical categorization reflects a western view of the world: other ways of knowing and being in the world may require different categorizations. She cites TAMI (Verran, Christie, Anbins-King, van Weeren, & Yunupingu, 2007), a custom-made database, for use by the Yolŋu Aboriginal Australians, whose culture does not ontologically divide nature and culture. TAMI's design aims to accommodate the worldview of the Yolŋu. Its designers did not use any pre-set categories for - or relationships between – entities; instead, they enabled users to construct a classification system according to their worldview and understanding of relations during use. TAMI utilizes a flexible tagging mechanism, which facilitates the creation of personalized metadata for each item in the database. In TAMI, the quality of multiplicity is embodied in the design process, in its means of recognizing '*the reality of partial translations in place of claims of universality*' (Suchman, 2002, p. 10).

Similarly, the use of cartographic maps in an e-government project (Elovaara & Mörtberg, 2010), which was introduced in Section 2.2.1.1.2, demonstrates an economical and effective way of supporting and maintaining multiple points of view in design activities. In the project, various roles, relations and practices were co-created in the form of a rich collage work/map by civil servants.

In use time, 'multiplicity' refers to a multiplicity of effects pertaining to a collective of humans (users) and non-humans (design objects). In other words, the interactions between users and technologies can unfold in many different ways rather than in one particular prescribed way. Multiplicity of effects can be understood as multiple translations of inscriptions embodied in the object of design. Sengers and Gaver (2006), considering the influences of arts and humanities and new domestic domains of design, assert that multiple and potentially competing interpretations for systems can fruitfully co-exist. As a consequence, because HCI does not have to decide upon and support any one specific, correct interpretation of system, the aim becomes to find ways to incorporate and balance multiple, perhaps conflicting, interpretations and processes of interpretation in design and evaluation. They exemplify some typical arguments that support open interpretation:

> ... Not "did the preferred interpretation take hold with users?" but "How many different interpretations does a particular 'blank canvas' generate, and why?" or "Do users feel both stimulated and empowered to develop their own interpretation of an alien presence system? (Sengers & Gaver, 2006).

While the design process can embrace multiplicity by supporting participatory, democratic and open practices together with rich representations of multiple partial forms of knowledge, design artefacts can embody multiplicity by utilizing flexible, context-sensitive and adaptive mechanisms.

3.3.3 Visibility

The quality of visibility, which plays a key role in developing other sensitivities such as multiplicity and accountability, involves variously making visible/invisible work, human and non-human actors, and infrastructure and interactions in both design and use of technologies. Visibility not only facilitates a heightening of the human actors' overall awareness of themselves and of others, but also helps the performance of more responsible design practices (Van der Velden, 2009; Friedman & Kahn, 1992) and the discovery of new opportunities, constraints and 'matters of concern' (Latour, 2004) in the design process.

Quality of visibility operates in both design time and use time. Visibility in design time entails recognizing every human and non-human actor and their roles in the formulation of both the design problem and the design process. This means that the different values, views and concerns of the human actors - and the various affordances of the non-human actors - need to be explicated and considered. Bødker (2009) provides an example of how we can make explicit the actors of distributed agency by using Mike

Michael's notion of co(a)gents (Michael, 2004) and a naming scheme. For example, an assemblage of a student, a video camera and the pitching part of the workshop can be called 'Stuvidpi'. This simple naming scheme shows how we can develop sensitivity for both human and non-human agency by making visible the existence of the various actants taking part in the design. Moreover, visibility in use time entails keeping the boundaries and interactions between all humans and technologies distinct and observable. Seamful design, and the notions of accounts, which were explained earlier in this chapter, support visibility in the use of technologies through explication of the deficiency of the technological infrastructure and the inner working principles of technologies. Similarly, Bardzell's notion of self-disclosure (2010) supports more responsible effects in design by demonstrating the ways in which machines view users, and providing resources for users to configure machines' perceptions of users.

It is important to note that visibility is not limited to one sensational modality. It does not privilege the visual mode of sensation. The way in which the term 'visibility' is used in the thesis refers to an entire range of modalities. It can be better referred to as 'sensibility'. However, the term visibility is preferred since it provides more possibilities in expanding the scope of this particular quality into the relevant concepts of accessibility and availability. It is also advantageous for defining the connections with the other ASD qualities. For example, making something visible can be interpreted as making something accessible or available. On the other hand, making something sensible is not so easily interpreted. Here, the important point appertains more to the coverage and scope of the term, which is not limited to the visibility of a thing. 'Visibility' refers to the fact that a thing should be sensible, accessible or available to actors who are expected to have some form of relations with the thing.

In general, the increased awareness of self, others and systems obtained by visibility can potentially support: 1) responsible and ethical design practices; 2) the emergence of new arrangements, couplings and capacities of action between humans and technologies; and, 3) the development of the other sensitivities of accountability and multiplicity.

3.3.4 Configurability

The object of design lives in design time and use time through evolution and transformation: configurability is important as a quality in both design time and use time. A. Telier (2011) suggests that in design time, the supporting of the design practice involves provision of resources and mechanisms through which designers and other stakeholders engage in various constituents of the object of design: '*the creation of a platform where participants can access, modify, align, and navigate the constituents of an object, and when needed, expand and contract it, sharing their knowledge about their actions and interactions*' (p. 76). Configurability in design time facilitates different arrangements between humans and non-humans, i.e., the constituents of the object of design, and the emergence of new relations and matters of concern.

Aanestad stresses the fact that the design process continues in the sites of technology use, that is, in use time, through reconfigurations performed by the users of the technology (2003). Users may opt to reconfigure or customize technologies and tune their relationships with technologies. The quality of configurability asks for developing mechanisms for supporting design in use or tuning operations during the use of technologies. This can be achieved by designing open, modular and flexible technologies. Kahle defines openness of technology as '*the degree to which it empowers users to take action, making technology their own, rather than imposing its own foreign and inflexible requirements and constraints*' (Kahle, 2008, p. 35). By virtue of their modular and flexible structures, technologies may become less isolated and take part in a network or ecology of other technologies and humans (Bardzell, 2010; Callon, 2004). Configurability in use time supports design-in-use activities, user reconfigurations, and improvised actions in the cases of breakdowns and changes in user needs or practice.

The case of the Zimbabwe Bush Pump, which exemplifies 'fluid technologies', provides a broader of view of configurability. Fluid technologies are not only configurable: they may change their form in practice. Thus, there is no single form or boundary peculiar to the technology designed; in effect, it is a flexible technology transformed by users at every site of use. There is little question that the Zimbabwe Bush Pump is considered a highly successful fluid technology (see Section 2.3.1.2.4 for details of the Bush Pump).

The notion of configurability can be extended to include configurability of system components, configurability of understanding success, configurability of actors' roles, and configurability of ownership. In essence, the quality of configurability involves an understanding of the relationality of many different aspects of the design process and supporting their reconfigurations in the design and use of technologies.

3.3.5 Accountability

In particular technologies, the quality of accountability is applicable to both humans and non-humans. Dourish and Button (1998, p. 15, original emphasis) define accountability as ‘the property of action being organised so as to be “observable and reportable”’. Whereas accountability of technological systems entails the existence of accounts through which systems provide users with information about their own activities (Button & Dourish, 1996), human actor accountability requires actors to be aware of their own positions relative to those of other actors and to take responsibility for their own perspectives and partial knowledge (Suchman, 2002). The quality of accountability can be promoted by making visible the actors, roles, their locations and system accounts. However, an essential part of the designer's task is to provide other actors involved in the design with resources for increasing critical awareness of the notion of located accountability and its implications.

There are two key understandings provided by the notion of 'accounts' and 'located accountability'. While the notion of accounts advocates that technologies should be designed in such a way that the methods they employ to do things are transparent and accessible to their users in a situated way: ‘[T]he account arises reflexively in the course of action, rather than as a commentary upon it" (Button & Dourish, 1996, p. 19), the notion of located accountability is based upon the premise that our views are inevitably situated, and, from somewhere, this makes us personally responsible for them (Suchman, 2002). Within this formulation, Suchman deals with the difficulty of locating the accountability of human actors, who do not act completely independently from the network of which they are part. While the notion of account (Dourish & Button, 1998) provides us with an understanding of the accountability of non-human actors, the notion of located accountability (Suchman, 2002) explains how accountability of human actors can be formulated. Both notions draw our attention to the situated and relational character of accountability. What an account is, and how accountability arises and evolves, depends upon the particular situation and the actors' relative positioning. Therefore, it is important to ensure that actors are aware of their own - and, as well, of other actors' - roles and responsibilities according to ongoing situations.

3.3.6 Duality

The quality of duality refers to consideration of the dual characteristics of design decisions. Van der Velden maintains that technology is never neutral, neither in use nor in non-use (2009). The dual characteristics of design decisions should always be considered. Duality can manifest itself in many forms, e.g., privileging/ignoring, inviting/inhibiting and amplifying/diminishing. In this section, while my discussion focuses solely upon the dual effects of design decisions on values, actions and perceptions, the effects may be observed in many other aspects of interaction between actors.

First, our designs can privilege the values of some actors while ignoring the values of others (Friedman & Kahn, 1992). The inscription of values into technologies is inevitable; however, the problem is less about the inscription of particular kinds of values and more about the invisible, unquestioned and taken-for-granted values embedded in our thinking and practices. Parallel to the quality of visibility, values shaping our thinking and design decisions should be explicated and open to negotiation. In this respect, the Value Sensitive Design (VSD) approach (Friedman, Kahn, & Borning, 2009) introduced in Section 2.2.3.1 is useful. In brief, VSD not only prioritizes the role of values in design; as well, it aims to identify and explain any or all of the values stemming from the design process and make them available for questioning. VSD considers both the positive and negative effects of design decisions and any trade-offs between the values of actors. In order to do this, VSD employs a tripartite methodology including conceptual, empirical and technical investigation.

Second, designs can invite particular kinds of actions while inhibiting certain others (Latour, 2005). As already suggested in Section 2.1.2.1, designers inscribe programs of actions into technologies. For example, automatic door-closers enact a particular way of passing through doors: speed bumps inhibit a driver's proclivity to drive too fast. Here the inscriptions in door-closers and speed bumps are used for prescribing, defining and controlling the interaction between humans and technology. However, it is also possible - and may prove desirable - to use inscriptions not for narrowing down the space of possibilities or imposing a particular behaviour but for providing resources for user appropriation and for opening up a space of negotiation in which users may exercise their creative capacities for action.

Verbeek's post-phenomenology (2005), which highlights the dual effects of technologies on human perceptions and actions, explains the influence of technologies on humans' perceptions and actions in terms of two structures. While the transformation of perception has a structure of amplification and reduction, the translation of action has a structure of invitation and inhibition. For example, magnifying glasses or binoculars magnify a particular section of a view while at the same time excluding other sections. The quality of duality involves consideration of both kinds of invited and inhibited actions, amplified and reduced sensations, supported and ignored values, and accounting for their implications.

4. Research Methodology

We can touch more than we can grasp.
Gabriel Marcel

4.1 Ontological and Epistemological Stance

In the case of this research, the goal has been to develop a relational understanding of design based on a relational view of agency. As the latter advocates that agency is an emergent property of the relations between actors, the object of research needs to be explored from a non-essentialist world view according to which there is no single reality out there waiting to be uncovered. What is out there are multiple realities, multiple not because of the numerous perspectives of a single reality, but because they are ontologically multiple realities (Mol, 1999; Strathern, 1991). Ontological multiplicity has been a key understanding for constructing the object of this research. As I suggest in Section 2.3.1.2, ANT scholars Law and Singleton (2005), Mol (1999; 2003) and Strathern (1991) are advocates of ontological multiplicity. Jensen and Gad (2010) explain how Mol (1999) conceptualized the difference between the notions of pluralism and multiplicity.

> [M]ultiple does not reduce to plural. The notion of pluralism relates to perspectivism, a conception, which emerged as a response to objectivism. Perspectivism implies that observers with different cultures, habits, and interests will tend to view things differently. In turn, this implies a view of reality as what lies passively behind the perspectives, providing the mute material, which is being gazed at from different angles. What this means is that perspectivism affects only a superficial break with the truth regime of objectivism. ... Reality is manipulated in many ways and does not lie around waiting to be glanced at. It does not have "aspects," "qualities," or "essences," which are shed light upon by a certain theoretical perspective. However, when doing ontological work, different versions of objects appear. These, in turn, may relate and shape partially linked versions of reality. Concepts such as "intervention," "performance," and "enactment" highlight the attempt to approach reality as "done" rather than "observed" (p. 71).

The difference between plurality of perspectives and multiplicity in ontology is critical. Ontological multiplicity, as conceptualized by ANT scholars, characterizes reality as "more than one, but less than many" (Law, 2002, p. 3), a conception that allows us to find a mid-way standpoint between totally knowable objects of modernist thought and the postmodernist notion of anything goes.

As there are multiple realities that emerge relationally, methods are considered not as some neutral means for accessing said realities but as active transformative actors (Law, 2004). The object of research and the methods of research are intertwined. Law argues to the effect that methods construct a particular kind of reality:

> Method is not ... a more or less successful set of procedures for reporting on a given reality. Rather it is performative. It helps to produce realities. ... Enactments and the realities that they produce do not automatically stay in place. Instead they are made and remade. Thus they can, at least in principle, be remade in other ways. The consequence is that method is not, and could never be, innocent or purely technical. If it is a set of moralisms, then these are not warranted by a reality that is fixed and given, for method does not ''report' on something that is already there. Instead, one way or another, it makes things more or less different. The issue becomes how to make things different, and what to make. (Law, 2004, p. 143)

In other words, the critical question becomes what kind of reality one aims to create, and which methods are suitable for creating such realities. In this research, the object of research has been to develop a relational understanding of design. When developing this understanding, the aim is not to arrive at a definitive and singular picture of a relational view of design; rather, it is to create sensitizing concepts, which are offered not as black-boxed truths but as 'matters of concern' (Latour, 2004) which are open to negotiation. Therefore, the reality that the research aims to create is not singular, definite, universal and objective, but multiple, partial, situated and relational. Methods for creating such realities require ‘a way of thinking about method that is broader, looser, more generous and in certain respects quite different to that of many of the conventional understandings’ (Law, 2004, p. 4). Law suggests some different methods of knowing such realities:

> Perhaps we will need to know them through hungers, tastes, discomforts, or pains of our bodies. These would be forms of knowing as embodiment. Perhaps we will need to know them through 'private emotions' that open us to worlds of sensibilities, passions, fears and betrayals. These would be forms of knowing as emotionality or apprehension. Perhaps we will need to rethink our ideas of clarity and rigour, and find ways of knowing the indistinct and slippery without trying to grasp and hold them tight. Here

> knowing would become possible through techniques of deliberate imprecision. Perhaps we will need to rethink how far whatever it is that we know travels and whether it still makes sense in other locations, and if so how. This would be knowing as situated inquiry (pp. 2-3).

Furthermore, Law challenges a key theme running through every research study and invites us to think of other ways of relating to realities: ‘We should certainly be asking ourselves whether 'knowing' is the metaphor that we need. Whether, or when. Perhaps the academy needs to think of other metaphors for its activities - or imagine other activities" (Law, 2004, p. 3).

These ontological and epistemological understandings guide the construction of the object of this research.

4.2 Research Design: Constructing the object of the research

This section explains the way in which the research methodology constructed the object of the research and why it constructed it in that way. The ontological and epistemological frame in which the research is situated required a methodology that would allow the research to focus upon the relations between the actors and their collective transformation rather than on the essential properties of the individual actors or deterministic relations. The methodology needed to allow for the enactment of multiple realities that could be imprecise, partial, situated and relational, and for multiple ways of knowing them. The main methodological choices included ANT and postphenomenology as generative devices and analytical lenses, participatory design workshops as platforms for empirical cases, and various constructed design situations as different forms of knowing and relating.

The methodology of this research employed a combination of ANT and postphenomenology to enable an understanding of the emergence and transformation of the relations between the actors at different levels. While ANT allowed the research to understand the patterns of relations and spaces generated by the relations, postphenomenology enabled the research to explore details of the individual relations between the actors, which were not accessible by ANT (Verbeek, 2005). ANT and postphenomenology worked as both generative devices for developing the ASD approach and experiments, and as analytical lenses for understanding the outcomes of the experiments.

The research experiments needed to be designed in such a way that they would recognize and support the collective and relational understanding of the design. It was not their role to control or predict the ways in which the interaction between the actors unfolded, but to support situated actions, appropriations and open exploration. This research made use of participatory design practices for conducting the experiments. Participatory design, with its understandings and methods, supports inclusive, participatory, and democratic practices (Section 2.2.1.1). In particular, participatory design workshops, which provide flexible platforms that allow their diverse participants to negotiate and co-construct meaning and realities (Muller, 2003), are structured in non-deterministic and open-ended ways. They aim to support multiplicity in ways of knowing and representation, and usually employ what Law refers to as 'techniques of deliberate imprecision' (Law, 2004, p. 3). Unlike controlled laboratory experiments that generally aim to produce certainties and deterministic relations, participatory design workshops operate on scattered, situated and partial knowledge, their aim being to identify the multiple sources of influence on a situation and multiple matters of concern. Deviations, breakdowns and mismatches are seen as valuable sources of knowledge rather than as exceptions or outliers.

The research involved a series of three participatory design workshops that actively partook in construction of ASD concepts and qualities[10]. The workshops were structured around a constructed design situation in which various human and non-human actors were brought together in a particular laboratory setting to explore various forms of connections and togetherness through game-like activities. The object of the design was not derived from immediate everyday design situations or problems: the entire design situation involving actors and objects of design was constructed from 'scratch'. There were several reasons for using a constructed design situation. The first was related to the view of workshops as a third space (Muller, 2003). As discussed in Section 2.2.1.1, in a third space, old assumptions can be questioned and challenged, and new relations and understandings can emerge through (re-)interpretation and (re-)negotiation. According to

[10] The roles of the workshops were explained in detail in Section 3.1.2.

Muller, participatory design workshops facilitate the creation of a kind of third space. This research extends the idea "third-ness" further by constructing a third situation in a third space. Here, third situation refers to a situation that is different from everyday situations and unfamiliar to the actors in the situation. In fact, the idea of a third situation is similar to the defamiliarization strategy (Bell, Blythe, & Sengers, 2005; Loke, 2009; Sengers, Boehner, Mateas, & Gay, 2008), which has often been employed by studies for breaking the habitual ways of engaging with things and challenging established understandings. The novelty of the settings and situations is expected to facilitate the creation of spaces of negotiation. The second reason for using constructed situations was their flexibility that made them suitable for performing tuning operations or revision, which constitute a critical part of ASD (see Section 3.2.5). The third was the possibility of creating situations that involved strong couplings between the actors in the sense that actors' capacity to act was highly dependent upon each other. For example, in Workshop 2, the participants were asked to perform a series of physical exercises in which they were connected to each other through tactile sensation, which increased their feelings of interconnectedness. The fourth reason was that the ability of constructing each activity in the workshops helped facilitate various forms of knowing and relating. Finally, conducting the workshops for a constructed design situation was logistically feasible given the time and resource constraints of this PhD research.

The study employed a mixed approach of phenomenology and ANT to the conducting of empirical experiments. Rather than recruiting a high number of participants and trying to generate generalizable results through statistical means, the study explored the subject matter through the detailed analysis of the experiences of a few numbers of participants/actors. Phenomenological approaches may employ many methods to gather the experiences of participants, e.g., in-situ conversations, semi-structured interviews and questionnaires, response cards and posters. One important characteristic of these methods is that they try not to be overly reductive in capturing the experiences of the participants. This kind of approach is quite common, especially in workshop activities in the early phase of the design process (Elovaara & Mörtberg, 2010; Loke & Robertson, 2007 & 2008; Moen & Sandsjö, 2005; Schiphorst, 2007 & 2008). These workshops are very intensive and usually last for multiple hours, which are sometimes distributed over weeks. As this research aimed to explore new forms of connections between humans and technology and environment, these phenomenological workshop studies, with their open-ended and non-reductive approach, were a suitable choice for the research purposes. As Gaver et al. (1999) suggest in their study of cultural probes, the open-ended and non-reductive character of method allows researchers to focus on particularity, ambiguity, multiplicity and subjectivity.

4.3 Components of the Research Methodology

4.3.1 Evolutionary Workshop Approach

The research methodology was constructed in such a way that the methods became more responsive to the input from the workshops. The motivation behind the responsiveness of the research methods was to support a relational understanding of the ways of employing methods, which recognize the role of methods as active and responsive constructors of the object of the research and not as neutral means of understanding a static object of the research.

Responsiveness was supported through an approach to conducting workshops in an evolutionary manner that works in two ways; first, it facilitates continuous dialogue between the researcher and the situation and, hence, between the ASD concepts and the workshops. While the ASD concepts structured a workshop activity, the outcomes of the workshop informed the development of the next workshop that could involve revision of the ASD concepts or of ways of applying them in the workshops. Second, the evolutionary approach gradually increased the sensitivity to relationality at each workshop. Here, increased sensitivity means that there are increasingly more opportunities for actors to relate to one another. Increasing sensitivity is achieved by manipulating the topology of the collective of actors.[11]

Figure 4.1 shows the relations between the components of the research methodology, which worked in the following way. The research questions guided our literature review, which helped to develop the ASD concepts and qualities. The initial understanding obtained from ASD led to the formulation of a collective of human and non-human actors – a design collective – that provided opportunities for exploring the

[11] For an explanation of various topological manipulations, see Section 3.2.3.

research questions. A series of three workshops employing ASD concepts and qualities and involving different design collectives were conducted in an evolutionary way. First, ASD employed its concepts and qualities to create some conditions defining the initial arrangement or topology for the actors and workshop activities. This activity corresponded to the inscription activity. Then, the workshop design collective performed workshop activities according to the conditions defined by ASD. These activities corresponded to a translation activity. Each inscription and translation round corresponded to an individual iteration of a workshop. Analysis of the outcomes of a translation activity informed the development of the inscriptions for the next workshop. Analysis activities were performed in accordance with ANT and postphenomenology, and a set of indicators that were used for understanding the capacity of the inscriptions to support the relevant ASD qualities. The initial conditions or inscriptions were revised after Workshops 1 and 2. Finally, as part of the strategy of gradually increasing the responsiveness of the methods, Workshop 3 involved revision inside and across the iterations.

The research design depicted in Figure 4.1 shaped the progression of the three workshops in the following way; first, the researcher (the workshop facilitator) created the inscriptions for Workshop 1. These inscriptions did not change during the two iterations of Workshop 1. Then, the researcher revised the inscriptions according to his analysis of the outcomes/translations of the two iterations of Workshop 1. The revised inscriptions were used for Workshop 2. Similar to Workshop 1, the inscriptions stayed the same between the iterations of Workshop 2. After analysis of the translations of all iterations of Workshops 1 and 2, another set of revisions was performed prior to Workshop 3; in addition, there were revisions made inside and across the iterations of Workshop 3. This extension of revisions to the iteration level was part of the strategy of gradually increasing the responsiveness of the research components.

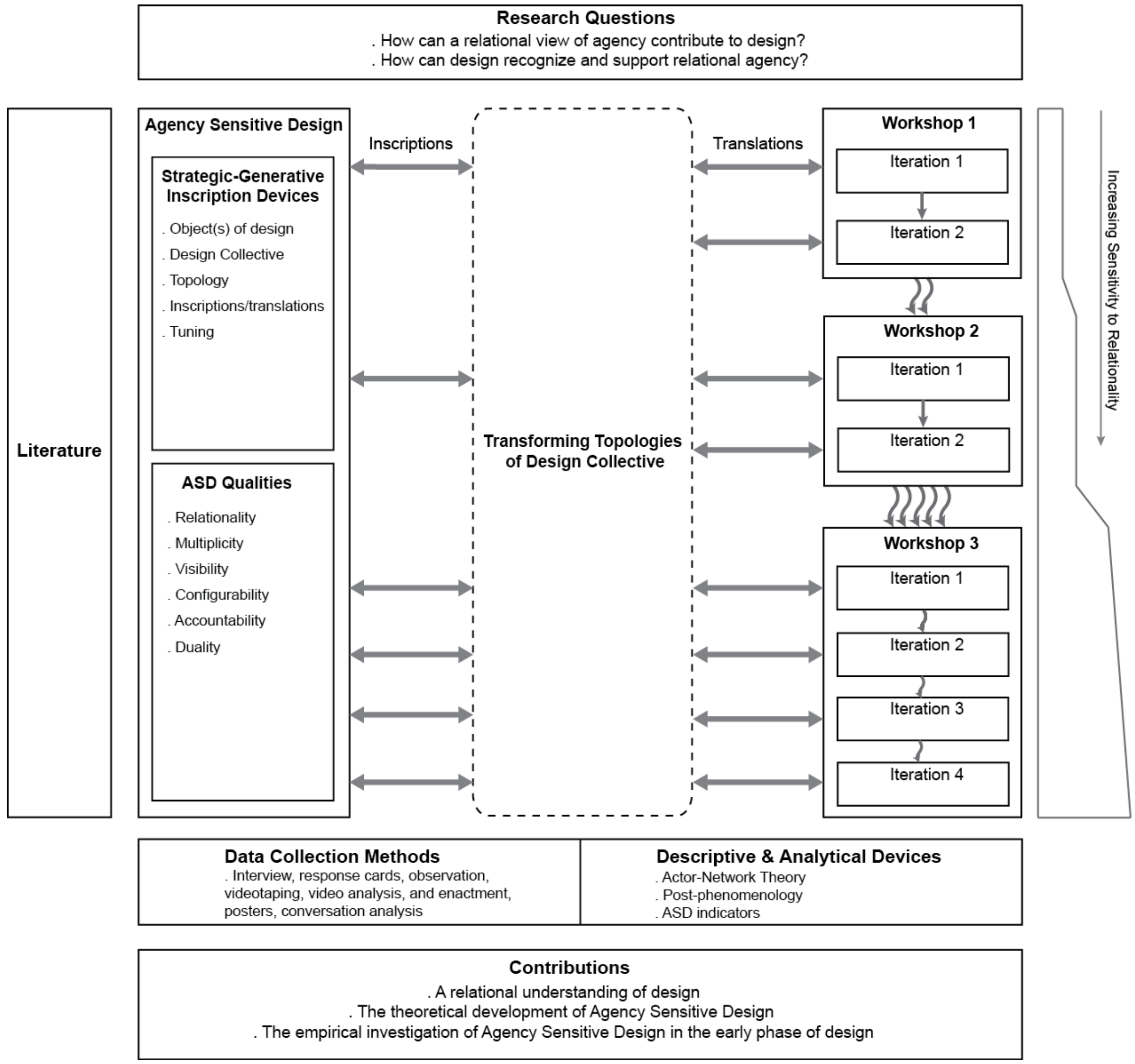


Figure 4.1 Research Design

4.3.2 ASD Concepts and Qualities

ASD's five strategic-generative concepts and six qualities were introduced in the previous chapter. In this section, I will explain how they were integrated into the research design.

4.3.2.1 Strategic-Generative Concepts

Design Collective and Topology

In the workshops, the topology of the design collectives was manipulated in order to enable the actors to relate to each other in different ways and to expand the space of possibilities that were constructed relationally between the actors. All of the four ways of manipulating the topology of a design collective that were presented in Chapter 3 were used in the workshops. The first two ways were considered together as the new resources could be viewed as new actors as well.

i-ii. Provision of new resources and actors: Workshops 1 and 2 involved activities in which one of two human actors was blindfolded. The human actors were asked to communicate in nonverbal ways using a non-human actor, either a rope or a sensory substitution device. In Workshop 3, the range of activities was increased, and various design collectives were constructed for the activities. Human actors with backgrounds in different professions such as dance and music, and non-human actors in the form of pictures, texts and digital devices were used. The motivation behind increasing the variety of actors and the ways in which they could relate to each other was to support multiplicity in roles and relations.

iii. Rearrangements between actors of the design collectives: The method of rearranging the actors in the design collectives was used in Workshops 1 and 2. In each activity, the same set of two human actors – equipped with a sensory substitution device - performed the workshop activities in a different arrangement or configuration. The aim was to support the exploration of the object of the design by activating different relational possibilities. For example, while in one activity, the sensory substitution device was attached to the back of a blindfolded participant; in another, it was attached to the stomach of the same participant.

iv. Metaphors and models of interaction: Different metaphors and models of interaction shape the ways in which human actors see and relate to other actors. In Workshops 1 and 2, the role of metaphors in structuring and guiding the relations between the actors was explored. In Workshop 1, an initial activity using a rope was introduced to the participants, the aim being to help the participants to construct a model of interaction based on their experience of their activity with the rope. In Workshop 2, the activity using the rope was dropped in order to understand how the lack of a guiding metaphor changed the participants' capacity to negotiate their roles and relations. In Workshop 3, no guiding metaphors were used; instead, another structuring/guiding strategy and adaptive inscriptions were used.

Object(s) of design

As explained in Section 3.2.1, the term 'objects of design' may refer to both the aims of a design activity and its outcomes. In the workshops, the objects of design, in the sense of the aims of the design activities, were defined in the workshops and in activity descriptions with different levels of specification. The objects of design, in the sense of the outcomes of design activities, were produced in the forms of knowledge, relations, and experience. The objects of design of each workshop will be introduced briefly in Sections 4.4 and 4.5.

Inscriptions/Translations

The main role of inscriptions was to support ASD qualities in the design process. This was achieved through three forms of inscriptions: activity inscriptions, material inscriptions and workshop inscriptions. While activity inscriptions in the form of verbal explanations supported the ASD qualities and detailed what to do and, to a lesser extent, how to do the activities, material inscriptions in the form of the physical properties of the artefacts embodied some of the ASD qualities or invited/inhibited particular kinds of actions. Finally, workshop inscriptions in the form of text defined the overall theme and structure of the workshop.

In order to assess the inscriptions' capacity to support ASD qualities such as the capacity to support visibility or multiplicity, various indicators were developed after retrospective analysis of all iterations of a workshop. The indicators of each workshop will be introduced in Sections 4.4.1 and 4.5.1.

Inscriptions with different levels of strength or specification were used to obtain a balance between openness and specification in activity descriptions and between the spaces of negotiation and prescription. For example, in Workshop 1, the workshop started with an activity that worked as a metaphor and helped the participants to construct a model of interaction for the following activities. However, despite being helpful, the initial activity was a very strong inscription that limited the participants' capacity to negotiate different relations. For this reason, in Workshop 2, there was no such initial activity to guide the participants. As a result, the spaces of negotiation in which the participants explored their relations with other participants and technologies in a larger spectrum were supported.

Tuning

Tuning operations can take place in every design activity between the inscriptions and design collectives. ASD aims to support tuning operations by increasing the responsiveness of the inscriptions. This was achieved by revising the inscriptions at three different levels. First, the inscriptions were revised at the workshop level: this involved revision between Workshops 1 and 2, and between Workshops 2 and 3. Second, the inscriptions were revised at the iteration level, involving revision between the iterations of Workshop 3. Third, the inscriptions were revised at the activity level involving revision within the same iteration of Workshop 3. From the first level to the third, the responsiveness of the inscriptions increased. They increasingly support more flexible and fluid orderings between the actors. Revision at the third level corresponded to what ASD refers to as 'adaptive inscriptions'.

Adaptive inscriptions consist of a set of inscriptions. Rather than creating one strict inscription and trying to impose it without considering the responses from the design collective, a set of inscriptions with different levels of strength or specificity is produced. At first, the least specific or open inscription is provided. If the collective cannot be aligned with the inscription, then a more specific version of the inscription is provided. In this way, tuning or alignment between the inscriptions and design collectives are supported.

4.3.2.2 ASD Qualities

ASD qualities, i.e., relationality, multiplicity, visibility, configurability, accountability and duality, were described in the previous chapter. These qualities were supported in the workshops through various inscriptions. While in Workshops 1 and 2 the qualities of relationality, multiplicity, configurability and visibility were supported, in Workshop 3, in addition, the quality of accountability was also supported. The quality of duality was not supported at all as it was found to be irrelevant in the very early stages of the design process. The specific ways of supporting these qualities will be presented in the relevant workshop chapters.

4.3.3 Analytical Lenses and Indicators

4.3.3.1 Actor Network Theory

The most important feature of using ANT as a lens through which to explore our research was its view of agency as an effect of a network or collective of humans and non-humans. According to ANT, neither humans nor non-humans own agency: it is an attribute of the relations between humans and non-humans. ANT provides a vocabulary that explains the various processes of construction of human and non-human collectives (assemblages and networks) without privileging humans. The ANT literature contains a large set of concepts; however, for analysis purposes, the research employed a small subset of said concepts including inscriptions, translations, topologies and space (see Section 3.1) as analytical lenses. Although the concepts of absence and presence[12] could be relevant to developing a relational understanding of agency, they were not employed by the research, the reason being that the workshops were situated in the early phases of design. Consideration of the effects of longer networks could create a large set of concerns, most of which might not be relevant to the aims of the workshops at that early stage. This was a similar situation to the case of the quality of duality explained in Section 7.2.2.6.

I described the workshops in the following way. First, I introduced the initial set of workshop activities and material inscriptions. After listing details of the human and non-human actors enrolled in the design collective for performing the activity, I explained how the actors translated the initial inscriptions. In Workshops 1 and 2, explanations of the translation process included descriptions of the ways in which actors establish connections with each other, the strategies employed, the meaning of the feedback messages and the awareness of the actors and the environment. In Workshop 3, my explanations of the translation processes differed from the first two workshops as Workshop 3 involved four different kinds of activities requiring different ways of describing. The specific ways of describing the activities of Workshop 3 are briefly explained in Section 4.5 and in detail in Chapter 6.

[12] Please see Law & Mol (2001) and Law & Singleton (2005) for detailed presentations of the concepts.

4.3.3.2 Postphenomenology

Post-phenomenology provided the research with another lens through which to explore the experiential dimensions of relational agency. The human participants' experiences were important for our understanding of how individual human actor's capacities of action were mediated and transformed by our inscriptions. The vocabulary introduced by the post-phenomenologist Verbeek (2005) was valuable for bridging the processes of the mediation of action and mediation of perception. The bridge between the mediation of action and perception also represented a bridge between ANT and phenomenology respectively. Verbeek's perspective allowed us to evaluate the influence of technologies on humans' perceptions and actions in terms of two structures. While transformation of perception has a structure of amplification and reduction, the translation of action has a structure of invitation and inhibition. In this study, as the research focused on the development not only of technologies but also more generally of the inscriptions, which actually include the technologies, how the inscriptions took part in the processes of transformation of perception and translation of action was investigated.

The research employed a post-phenomenological strategy in Workshops 1 and 2 with the same types of activities in which first person experiential accounts played a key role in understanding the construction of connections between the actors. In Workshops 1 and 2, while the transformations of perception were described in terms of levels of awareness, coordination strategies employed, and interpretations of feedback, the translations of action were described in terms of a variety of human-technology-human connections. Table 4.2 and Table 4.3 show the research methods employed to facilitate an understanding of these structures of transformation and translation in Workshops 1 and 2.

In Workshop 3, our focus was mainly upon translations of action and the connections constructed between the human and non-human actors rather than upon the changes in the perceptions of the human actors. The reason for this change of focus was that in Workshop 3, our main objective was to support the construction of multiple connections through various activities which enabled the actors to relate to one another in many ways to support multiplicity. The third person observational accounts were sufficient for understanding these different forms of connections. However, the first person experiential accounts were analysed in some activities in which personal understandings and perception of things were the main components of the activity. For example, in the first activity undertaken in Workshop 3, the participants were asked to stay silent and listen to the sound of the other actors and space. In such an activity, the perceptions and experiences of the participants were the main source for understanding the translations. The third person perspective does not have access to those kinds of information. Table 4.4 and Table 4.5 show the research methods used to obtain first person understandings in Workshop 3.

4.3.3.3 ASD Indicators

The research employed the original descriptions of the six ASD qualities, which were developed out of a large body of relevant work as guiding lenses for analysis. In order to construct a guiding lens, a retrospective initial analysis was performed. The initial analysis consisted of three stages:

Stage 1. Reviewing the data: This stage involved watching all of the video sequences and reading all of the transcriptions. At this stage, the researcher tried to review all of the data using a minimal lens of ANT, which simply suggests 'follow the actors', both human and non-human. The researcher examined how actors interacted, negotiated, and acted collectively.

Stage 2. Associating the data with ASD: This stage involved activities such as taking notes, and tagging and coding the data in relation to ASD qualities. The researcher drew associations between the data and ASD qualities.

Stage 3. Identifying indicators for ASD: This stage involved determining a set of indicators that could be used to define and support a relevant ASD quality in such a design situation. For example, in the Silence Session in workshop 3, most of the participants reported that they noticed previously unnoticeable things in their immediate surroundings, and that blindfolding amplified the sensation of their senses other than their visual sense. The participants' statements were associated with the theoretical definition of the quality of visibility, which emphasizes the importance of the visibility of actors, their roles and interactions. Then, an indicator of the quality of visibility for the Silence Session was created as follows: "Comments of participants on use of non-visual modes of sensation and previously invisible actors". As demonstrated in the example, the indicators were not determined prior to analysing the workshop activities: they emerged after the initial analysis stage.

4.3.3.4 Data Collection Methods

Table 4.1 provides a summary of the various data collection methods utilized in each workshop: interviews, response cards, observation, videotaping, video analysis, enactment, poster analysis and interaction analysis. The workshop data was described and analysed in accordance with actor-network theory, postphenomenology and indicators for ASD qualities.

Table 4.1 ASD Concepts and Qualities, Descriptive and Analytical Devices, and Data Collection Methods

	ASD Concepts and Qualities	**Descriptive and Analytical Devices**	**Data Collection Methods**
Workshop 1	- Re-arrangements of design collective - Predetermined metaphors of interaction - Supporting relationality, multiplicity, visibility and configurability	ANT: Inscriptions, translations, topology and spaces Postphenomenology: 1st person understandings of translations of actions, and transformations of perceptions ASD Indicators: Indicators for the qualities of relationality, multiplicity, visibility, configurability	. Interviews . Response Cards . Observation . Videotaping . Interaction Analysis . Enactment
Workshop 2	- Re-arrangement of design collective - Emergent metaphors of interaction - Supporting relationality, multiplicity, visibility, and configurability	ANT: Inscriptions, translations, topology and spaces Postphenomenology: 1st person understandings of translations of actions, and transformations of perceptions ASD Indicators: Indicators for the qualities of relationality, multiplicity, visibility, configurability and accountability	- Interviews - Response Cards - Observation - Videotaping - Interaction Analysis - Enactment

	ASD Concepts and Qualities	Descriptive and Analytical Devices	Data Collection Methods
Workshop 3	- Increased variety of activities and actors - Emergent metaphors of for interaction - Continuous tuning of design collective - Adaptive inscriptions - Supporting relationality, multiplicity, visibility, configurability and accountability	ANT: Inscriptions, translations, topology and spaces Postphenomenology: 1st person understandings of translations of actions, and transformations of perceptions ASD Indicators: Indicators for the qualities of relationality, multiplicity, visibility, configurability and accountability Laban movement effort qualities: Space, time, weight and flow	- Interviews - Response Cards - Observation - Videotaping - Interaction Analysis - Photographing - Poster Analysis - Enactment

4.3.3.5 The Role of the Researchers

The researchers were part of the design collective in all of the workshops. In the first two workshops, the researchers maintained a third person observer role. One researcher was responsible for facilitating the activities: another was responsible for any video recording undertaken during the workshops. The researchers did not actively participate in the participants' activities; rather, they stayed as third person observers. The main reason for adopting a third person role was that the focus of the research was on the effects of different arrangements between human and technological actors. These arrangements were well defined and did not require any significant revisions. However, the third workshop increased the number of activities and actors involved in the activities. In addition, the workshop introduced the adaptive inscriptions method that required the constant involvement of the researcher in revising the workshop inscriptions through a dialogue between the researcher and the participants. Therefore, workshop 3 employed a dialogical approach (Shotter, 2005) that resulted in the role of participant-researcher for the main researcher.

4.4 Workshop 1 and 2

Workshops 1 and 2 may be considered conceptually as one workshop given that they share the same object of design and the same activities. In workshop 1 and 2, a series of design games using a sensory substitution device, were created. The object of the design was to explore ways of enabling new forms of agency between human and non-human actors. For the purposes of the activities, both workshops used a version of a technological non-human actor, a sensory substitution device referred to as Enactive Coupler (EC) (a mobile and wearable device composed of a distance sensor and two vibration motors). Workshop 1 and 2 used the sensory substitution devices because of their advantages of providing new perceptual modalities and a "new space of coupling between humans and the world" (Lenay et al., 2003). The EC works on the principle that when the distance sensor detects an object within a specified range, its motors vibrate. I used two versions of the EC, i.e., EC version 1 (ECv1), and EC version 2 (ECv2). While Workshop 1 used ECv1, Workshop 2 used both ECv1 and ECv2. In the workshop activities, two human actors were asked to perform a navigation-oriented game using the ECs. There were two main rules of the game: (1) one of the human actors had to be blindfolded; and, (2) the human actors were only allowed to communicate with each other in nonverbal ways using the device. Before the activities using the ECs, in Workshop 1 there was an introductory guiding activity, which had the same objective but used a rope instead of the EC. In Workshop 2, the introductory activity was dropped in order to support the natural emergence of interaction models. A total of eight participants participated in the workshops (excluding the two researchers): four in Workshop 1 and four in Workshop 2. Details of the participants and the recruitment process are provided in Chapter 5.

4.4.1 Research Methods

Table 4.2 presents the research methods employed in Workshops 1 and 2. The workshops were conducted in a laboratory-studio setting in a university. Activities were video-recorded for retrospective analysis. The screen shots captured from the video sequences were used as still pictures for analysis. The video camera was used in a mobile fashion so that the participants' movements were captured in profile. This provided us with shots clearly showing the interaction between the participants and the devices. The videographer kept a suitable distance from the participants so as not to influence their interaction. Furthermore, to minimize any distractions, the participants and researchers removed their shoes during the workshops.

Table 4.2 Research methods: Workshops 1 and 2

Research Method	Explanation
Interview	Interviews with participants were conducted after each activity and at the end of each workshop.
Response cards	Response cards were given to the participants after each activity and at the end of each workshop.
Observation	Observation and note taking regarding participants' activities were performed during the activities.
Videotaping	Video recordings of the participants' activities were performed in a mobile fashion.
Interaction analysis	Interaction analysis focused on identification of unique human-device-human arrangements.
Enactment	Re-enactment of the workshop activities was used for gaining first person bodily understanding of relations.

The workshop data included participants' answers to the questions on the response cards, interview transcripts, video data, and first person experience of the researchers from the enactment of activities. Analysis was guided by four ASD qualities: relationality, multiplicity, visibility and configurability. The main quality supported by Workshops 1 and 2 was the quality of multiplicity. For this reason, a larger space was allocated for analysis of multiplicity. As the qualities of duality and accountability were not relevant to Workshops 1 and 2, they were not supported by the inscriptions and, hence, not analysed.

As explained in Section 4.3.3.3, four types of indicators were identified. Table 4.3 shows the indicators for the four qualities and related methods for collecting data.

Table 4.3 Indicators for effectiveness of sessions in supporting ASD qualities

ASD Qualities	Indicators	Methods
Relationality	- Appearance of interconnected movements of the participants	Observation, video analysis and still pictures
	- Comments of participants on any aspects of mutual nature of connection, strategies of coordination, and reciprocity of sensations and movements	Interviews and response card questions
Multiplicity	- The number of human-device-human connections - Comments of participants on the strategies they employed for coordinating movement	Observation, video analysis, and still pictures
Visibility	- Comments of participants on use of non-visual modes of sensation and previously invisible actors	Interviews and response card questions
Configurability	- The number of human-device connections	Observation, video analysis, and still pictures

For my analysis of the video data, I performed a minimal version of Interaction Analysis (Section 2.3.3) that focused solely on the identification of instances in which human and non-human actors were coupled in unique ways. I viewed the entire video sequences of the activities multiple times, segmented them according to unique human-device-human connections and coded them. A more detailed explanation of the coding procedure is provided in Section 5.2.2

After each activity, response cards were delivered to the participants and a short interview session was conducted. The questions sought answers to: 1) the participants' awareness of their partners, the device and the environment; 2) the strategies they employed; and, 3) interpretations of the device's signal. The questions on the response cards were prepared under the guidance of the framework for reflective practices proposed by Gibbs (1988) and of similar performance workshops conducted by Schiphorst (2007). For the response card and interview questions see Appendix C.

4.5 Workshop 3

The main object of design of Workshop 3 was to explore the various forms of togetherness between humans, technologies and the environment. In Workshop 3, the variety and number of activities were increased as part of a strategy of supporting multiplicity in forms of knowing and doing in design activities. There were four different types of activities each of which utilized a different form of exploring the object of design: silence session, physical sensitivity session, rich-poster session and machine-mediate performance session. Briefly, the silence session aimed to support the quality of visibility by amplifying some sensual modalities while diminishing the dominance of visual modality. Here, the aim was to increase the 'visibility' through other senses. The physical sensitivity session focused specifically on the notion of relationality by involving human participants in closely coupled physical activities. The aim was to explore the object of design using an embodied form of knowing. The rich poster session aimed to explore multiplicity in participants' understanding of object of design using visual and textual representations on 2D paper-based medium. Finally, the machine-mediated performance session aimed to continue with previous workshops' investigation of topological manipulations by involving different sets of technological actors that provided the participants with many opportunities to establish connections with other participants. Similar activities have been employed by many research studies (see Loke & Robertson, 2009; Schiphorst, 2007; Moen & Sandsjö, 2005). What is important is not this particular mix of activities, but bringing together a diverse set of activities and facilitating multiple ways of knowing, performing and relating. Thus, other kinds of activities can be added or some extant activities might be removed. What is important is to keep the multiplicity as a quality in design and exploration process. A total of eight participants participated in Workshop 3. For details of the participants and the recruitment process see Chapter 6.

4.5.1 Research Methods

Table 4.4 presents the research methods employed in Workshop 3. Similar to Workshops 1 and 2, Workshop 3 was conducted in the same studio space, with one researcher and one assistant available during the workshops. Unlike the previous workshops, the researcher took a more active role as the employment of adaptive inscriptions required the researcher to negotiate the level of specification of the inscriptions with the participants. All activities were video-recorded and the products of the poster session were photographed. The video camera was used in the same way as in Workshops 1 and 2. After each session, a brief reflection/interview session was conducted. The questions were related to the first person experience of the activities for the first three session and strategies of composition and improvisation for the fourth activity.

Table 4.4 Research Methods for Workshop 3

Research Method	Explanation
Interview	Interviews with participants were conducted after each activity and at the end of the workshop.
Response cards	Response cards were given to the participants after the machine-mediated performance session.
Observation	Observation and note taking regarding the participants' activities were performed during the activities.
Videotaping	Video recordings of the participants' activities were performed in a mobile fashion.
Interaction analysis	Interaction analysis focused on identification of: human-device arrangements; human-device-human arrangements; human-device-environment arrangements; and, movement effort qualities.
Photographing	Photographs of personal objects of participants and posters were taken.
Poster Analysis	Posters that were produced in the rich poster session were examined for understanding the different forms of connections expressed.
Enactment	Re-enactment of the workshop activities was used for gaining first person bodily understanding of relations.

The workshop data included interview transcripts, posters, various personal objects, video data and first person experience of the researchers. All qualities except for the quality of duality, which was found irrelevant in the context of the workshop, were supported. As in the case of Workshops 1 and 2, we identified some indicators that enabled us to evaluate the capacity of the session inscriptions to support the relevant ASD qualities. Table 4.5 shows the ASD qualities and their indicators for each session of Workshop 3.

Table 4.5 Indicators for effectiveness of sessions in supporting ASD qualities

Session	ASD Quality	Indicators	Methods
Silence Session	Visibility	- Comments of participants on amplified sensation of other modalities	Interview
		- Appearance of at least one connection through amplified modes of sensation - Appearance of previously invisible actors	Observation and video analysis
Physical Sensitivity Session	Relationality	- Comments and reflections of participants and researchers on the mutual nature of connection, strategies of coordination and reciprocity	Interview and enactment
		- Participants following the rule of keeping the contact and maintaining the roles - Participants smoothly coordinating their movements	Observation and video analysis
Rich Poster Session	Multiplicity Visibility Accountability	- The number of different representations of the design concept - Appearance of new connections	Poster Analysis and photographs
		- Expression of personal understandings of connection	Interview
Machine-Mediated Performance Session	Configurability Multiplicity	- The number of different human-device connections - The number of different human-device-human and human-device-environment connections	Observation, video analysis and photographs

For the analysis of the video data, because of the different characteristics of the activities in each session, different approaches were employed. While in the machine-mediated sessions, the video data was analysed extensively, in the silence, physical sensitivity and poster sessions, the video data was used for transcription purposes only. Similar to Workshops 1 and 2, in the machine-mediated performance session, Interaction

Analysis focused upon characterising the unique human-device, human-device-human and human-device-environment connections. As suggested in Section 2.3.3, this particular focus is referred to as ‘analytical foci’. This time, as the participants’ movements involved more expressive movement, Laban's movement effort qualities were integrated into the analysis for identifying multiplicity of movement qualities. I presented a paper focusing upon analysis of machine-mediated performance at a workshop on ‘Body in Design’, which was held as part of the Australian Computer - Human Interaction (OZCHI) 2011 Conference. The workshop participants provided me with valuable feedback on the coding scheme. A more detailed account of the procedure of the analysis appears in Chapter 6.

For Workshop 3, I closely collaborated with an experienced dance performer, and an interaction design researcher who specialized in the design of systems involving full-body interaction and had published journal articles on the subject. The dance performer and I met twice. During the first meeting, we examined the videos and my analysis of Workshops 1 and 2. During the second meeting, which lasted for one hour, we worked on the design of the physical exercises to be used in Workshop 3. The interaction design researcher was involved in both the design and analysis of Workshop 3. I met her several times to discuss the progression of the iterations during all of the iterations of Workshop 3. Her involvement was higher in the initial design and analysis phases of this workshop. We worked together on my initial analysis of the first iteration of Workshop 3 and on the revisions for the second iteration. In the later stages, I met her after the third and fourth iterations of Workshop 3 to inform her about the results of the workshops.

A paper submitted to the Participatory Innovation Conference (PIN-C) 2012 resulted in very detailed feedback on the video sequences of Workshop 3 and in continuous collaboration with an interaction designer/analyst colleague. The format of PIN-C involved matching one interaction designer with an interaction analyst. According to the format, the interaction designer sends their video data and any other accompanying material to the interaction analyst[13]. I was matched with interaction analyst Jared Donovan, who came up with a very original proposition. Jared wanted to re-run a workshop in his research laboratory according to the same workshop structure,

[13] The workshop material was shared in accordance with the ethical responsibilities of the research.

analyse his workshop data and compare the results of his workshop and my workshops. This provided me with an excellent opportunity for evaluating the workshop structure, my analysis of workshop data and exchanging insights.

I sent Jared Donovan video sequences which lasted 1 to 3 minutes for each session of Workshop 3, activity descriptions, software code for using technological tools in machine-mediated sessions, some explanations of deploying the software code, and a draft paper focusing on an analysis of the same workshop. Jared Donovan re-ran the workshop with 3 other researchers in their research laboratory. Different from the original workshop, he conducted all of the sessions with the exception of the poster session. In their paper (Donovan et al., 2012), Jared and his colleagues explain their motivation for selecting their workshop and the procedures for running it:

> We have a long-standing interest in the design of interfaces to support socio-physical interaction and in how to involve people in these processes of design, which also played an important role in how we approached our re-running of the workshop. Our current research explores how a socio-physical approach can support inter-generational interaction and healthy ageing. Within this context, the objective from the workshop of exploring how togetherness could be supported and mediated by technologies was particularly relevant.
>
> Based on our research interests and in consultation with Kocaballi and colleagues we chose to re-run the silence session, physical exercise session and performance session activities from the workshop. Four participants (including one of the authors) from our research group participated in our re-running of the workshop. All the participants were familiar with the area of embodied and socio-physical interaction, as well as with participatory design. We explained to the participants that our purpose of re-running the activity was to undertake a designerly analysis of it within the context of the making design and analysing interaction track (and what we meant by this). We also explained our understanding of the aims of the original workshop: namely to explore notions of 'togetherness'; and to enquire into how 'multiplicity' could be supported in the design process.
>
> [W]e followed the format suggested by Kocaballi and colleagues, where each activity was interspersed by a short period of reflection and discussion about the activity itself. We made audio recordings of these discussions and compiled notes of our overall impressions immediately following the workshop. We also made short video recordings of several of the physical activity sessions, so that we could re-watch these

> segments of the activity for further detailed analysis if necessary (pp. 3-4).

Jared Donovan and I contacted each other through email several times and met twice at the Body in Design workshop in OZCHI 2011 and PIN-C 2012. We discussed the workshop structure, and the design specifications of the technology, methods and findings.

Peer debriefing, which is a method used to support the credibility of data in qualitative research and for establishing the trustworthiness of the research (Lincoln & Guba, 1985), played a crucial role in the evolution of the research. Spall notes that: ‘Peer debriefing contributes to confirming that the findings and the interpretations are worthy, honest and believable’ (1998, p. 280). The peer debriefings for Workshops 1 and 2 took place in the forms of: three doctoral consortiums and weekly and monthly meetings with my primary and associate supervisors respectively. The three doctoral consortiums took place in the European Conference of Cognitive Ergonomics (ECCE) (one-day session), Designing Interactive Systems Conference (DIS) (two-day session), and Participatory Design Conference (PDC) (one-day session) respectively. The peer debriefings for Workshop 3 took place in the forms of: collaborations with an artist and an interaction designer, participations to the Body in Design workshop in OZCHI2011 conference and Participatory Innovation Conference, and, finally a ‘designerly analysis’ performed by an interaction analyst (Donovan et al., 2012).

In this study, rich and thick descriptions {Geertz, 1973 #476} of workshop processes including the workshop, activity, and material inscriptions, and translation processes are provided for supporting believability (Lincoln and Guba, 1985) and for complying with non-reductionist approach to understanding realities (Law, 2004).

5. Workshops 1 and 2

5.1 Introduction

Workshops 1 and 2 were parts of a series of three workshops for developing the ASD approach. Workshop 1 was the starting point for investigating ways of enabling new forms of relational agency through design. Workshop 2 continued the investigation by providing more fluid (less specific) conditions for the ordering of the design collective. Finally, Workshop 3 represented a larger evolution in the workshop series with revisions of different aspects characterising the formation of the design collective and overall design process.

As Workshops 1 and 2 were quite similar in their approach to forming the design collective and in their formulation of the objects of design, they will be presented in the same chapter. The degree of evolution between the two workshops was considerably less than the degree of evolution between Workshops 2 and 3. In this respect, it is possible to consider Workshops 1 and 2 conceptually as one workshop. In both workshops, the workshop structure and the objects of design remained the same. In other words, there was no revision of the iterations of the workshops. Unlike Workshops 1 and 2, Workshop 3 extended the scope of evolutionary approach to the iteration level. This means that revision took place within and across the iterations of Workshop 3 based on the content and arrangement of the design collective and the levels of specificity of the conditions between the iterations. Therefore, a gradual strategy for the evolutionary workshop method was employed. In Workshops 1 and 2, evolution occurred only between the workshops, not inside the workshops, i.e., between the iterations. However, the scope of the evolution was extended such that iterations of Workshop 3 evolved as well. The structural aspects of the workshop have been carefully revised as they may have negatively affected the coherence of the iterations.

I will follow the same structure for describing Workshops 1 and 2. First, I will introduce the workshop, it activities and material inscriptions, then present the translations that occurred in all iterations. Translations involve descriptions of participants' awareness of space and their partners, interpretations of feedback, strategies employed and the various connections between humans, devices and the environment. I will conclude with evaluations of the workshops.

5.2 Workshop 1

The aim of the workshop was to understand what ASD means in the early phases of design in which ideation and conceptual development activities generally take place. The object of design in workshop 1 was to find ways of enabling new relations between human and non-human (i.e., technological) actors in interaction scenarios involving full-body movements. These aims were addressed by employing three topological manipulation methods: rearrangement of design collective, the introduction of a new mode of communication, and use of a predetermined metaphor of interaction. The first method involved re-arrangement of the same set of actors across the activities in the workshop, the aim being to change the physical arrangement of the actors constituting the design collective while at the same time keeping the members of the design collective and the activity task the same. The aim was to understand the transformative potential of the strategy of rearrangement for providing new opportunities for the actors to relate to other actors. The second method involved the use of a sensory substitution device, which was effective in providing a distal perception and altering the sensational capabilities of the human actors radically by amplifying tactile and sonic modes of perception. The third method involved inclusion of a grounding activity with a tool familiar to the participants in the first activity of the workshop. Here the aim was to enable the human actors to use their experience in the first activity as a basis for interacting with each other in the following activities. In this respect, the grounding activity was similar to what Erin Manning refers to as 'enabling constraints' (2009) for making analogies. The thesis employed the notion of inscription, which covers the notion of restriction. In particular, the concept of enabling constraints was used as a strategy for breaking down habitual relations between actors and opening up new possibilities. Enabling constraints provide an alternative view on restrictions and constraints. Instead of seeing the constraints something limiting, this view invites us to see their enabling character. According to the concept of enabling constraints, the very existence of the constraints allows an actor to experiment new ways of interacting with other actors and take part in generation of new forms of agency. For instance, use of blindfolds constrains humans' capacity to visually see their surroundings. However, the diminishing role of visual modality creates the possibility of increased roles of other modalities such as auditory or tactile.

5.2.1 Inscriptions in Workshop 1

Inscriptions can be thought of as initial conditions or parameters for experiments. The advantage of using inscriptions is that they emphasize interconnectedness with other inscriptions and the act of translating involved in the act of inscribing. In this research, three types of inscriptions were used: workshop inscriptions, activity inscriptions and material inscriptions. See Section 4.3.2.1 in the Research Methodology Chapter for further explanations of inscriptions and translations.

5.2.1.1 Workshop Inscriptions

> *WI-1: The workshop explores non-verbal ways of communication and coordination between humans through non-human extensions.*

This inscription addresses the first workshop's aim by introducing a new mode of communication. It alters the habitual ways of perceiving and acting by using a sensory substitution device referred to as the Enactive Coupler. A full description of the device will be provided in the next sub-section.

> *WI-2: The workshop consists of four activities involving four different configurations between humans and non-humans.*

This inscription addresses the second workshop's aim by providing four activities that explicitly require human participants to use four different configurations to accomplish a task. While the nature of the task requires the participants to closely collaborate, the changing configurations provide participants with different opportunities to communicate with each other and coordinate their movements.

WI-3: The following participant brief was read at the beginning of the workshop: 'Our research explores different forms of connections between humans, technologies and space. In this workshop, you will perform four game-like activities with the same objective of guiding a blindfolded partner over the randomly established tracks using different tools or configurations. For each activity, there is a guiding participant and a blindfolded participant. You are not allowed to talk to each other. You are only able to communicate via the tools provided and by using non-verbal communication. You are not allowed to touch each other. In the interests of making the task simpler, the angle of the turning points on each track is consistently 90°. You will perform each activity twice by switching the roles of guiding participant and blindfolded participant. There will be short reflection sessions after each activity'.

This inscription involves the activity description and rules of the activities that construct an initial topology of the relations between actors.

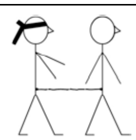
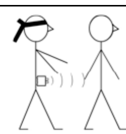
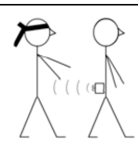
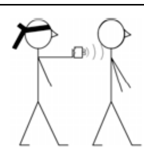
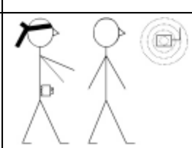
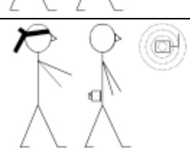
5.2.1.2 Activity and Material Inscriptions

Each activity required a guiding participant (GP) and a blindfolded participant (BP). All of the activities were structured in the form of a game with the same objective of guiding a blindfolded partner over randomly established tracks using the tools provided. The participants were not allowed to talk to each other. They were only able to communicate via the tools provided and by using non-verbal communication. They were not allowed to touch each other. The angle of turning points on each track was consistently 90°. The same pair of participants performed each activity twice by switching the roles of BP and GP.

In the activities, two tools were utilized to provide distal perception: a simple rope approximately 60cm long and a wearable sensory substitution device called the Enactive Coupler Version 1 (ECv1). The EC was composed of one Arduino controller board, one Parallax PING ultrasonic rangefinder sensor, two 10mm shaftless vibration motors and one plastic amplifier cube. Equipped with one ultrasonic range finder sensor and two vibration motors, ECv1 is similar to the Enactive Torch (see Section 2.2.1.3.3) in terms of distance-to-tactile functionality. However, unlike the Enactive Torch, the ECv1 can be attached to different parts of the body or placed onto different surfaces in the environment. When the ECv1's distance sensor detects an object within a range of 60cm, two small motors vibrate; otherwise, they stay silent. Although it was found that human subjects are able to discriminate between three and five intensities of vibration (Bird, Marshall, & Rogers, 2009), in this workshop, I used simple on/off modes for mapping the distance information to sonic and tactile feedback in order to simplify the control of the device. The ECv1 also features sonic output, which is produced mechanically by an additional vibration motor. While the tactile output was sensed only by the wearer of the device, the sonic output was audible to both of the participants.

Table 5.1 shows a summary of the activities and material inscriptions in Workshops 1 and 2. The inscriptions are defined according to the particular arrangements between human and non-human actors.

Table 5.1 Arrangements of human and non-human actors, Rope (R), ECv1, ECv2, distribution of Sensing and Effecting capacities (S, E) of technology and corresponding Activity and Material Inscriptions (AI, MI) in Workshops 1 and 2

Arrangements		Non-human Actors	Human Actor 1		Human Actor 2		Space		Workshop 1	Workshop 2
Arr. 1		Rope	R	R	R	R			AI-1, MI-1	-
Arr. 2		ECv1	S	E					AI-2, MI-2	AI-1, MI-1
Arr. 3		ECv1			S	E			AI-3, MI-3	AI-2, MI-2
Arr. 2’		ECv1	S	E					AI-4, MI-4	-
Arr. 4		ECv2	S					E	-	AI-3, MI-3
Arr. 5		ECv2			S			E	-	AI-4, MI-4

Activity 1 (Arrangement 1):

AI-1: GP guides BP with a rope extending from GP's back to BP's stomach. *MI-1: A rope is provided for the participants.*

Activity 2 (Arrangement 2):

AI-2: GP guides BP with the ECv1 attached to BP's stomach. *MI-2: The ECv1 is provided for the participants.*

Activity 3 (Arrangement 3):

AI-3: GP guides BP with ECv1 attached to GP's back. *MI-3: The ECv1 is provided for the participants.*

Activity 4 (Arrangement 2'):

AI-4: GP guides BP with ECv1 attached to BP's hand. *MI-4: The ECv1 is provided for the participants.*

One researcher and one assistant conducted two workshop iterations involving 4 participants aged between 23 and 26 years. Participant 1 was an architect: Participant 2 was a visual artist; Participant 3 was a psychologist; and, Participant 4 was a musician. The two workshop iterations were conducted over two consecutive days: each lasted approximately 3 hours. A summary of the object of design and design collective is presented in Table 5.2.

Table 5.2 Object of Design and Design Collective in Workshop 1

Object of Design	Enabling new relations between human and technological actors in full-body movement based interaction scenarios
Design Collective	Five human participants (a researcher and four participants) and three non-human participants (a rope, a striped thread and the ECv1)

5.2.2 Analysing Workshop 1 and 2

The translations that occurred in the workshop activities are described according to: 1) the various connections between humans and device; 2) participants' awareness of other actors; 3) interpretations of feedback; and, 4) strategies employed. These four dimensions were selected according to their information value for understanding the multiplicity and transformation of relations.

For an understanding of the multiplicity of connections between the actors, I identified unique forms of Human-Device-Human (H-D-H) arrangements. For example, Figure 5.1 depicts two H-D-H arrangements. The arrangement on the left is identified as *(device-at-hand)-to-back*, the one on the right as *(device-at-hand)-to-hand*. For each activity, the unique forms of arrangements were identified and counted as indicators of multiplicity in connections. Multiple instances of the same arrangements were counted as one type of connection.

Figure 5.1 Two Human-Device-Human (H-D-H) arrangements identified as (device-at-hand)-to-back (on the left) and (device-at-hand)-to-hand (on the right)

When evaluating the workshop activities, I focused upon acquiring an understanding of what ASD means in such activities in the early phases of design and on ways to support ASD qualities. Analysis resulted in the identification of four types of indicators for the four ASD qualities presented in Table 4.3 in the Research Methodology Chapter.

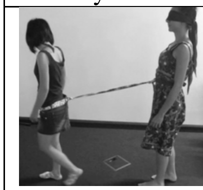
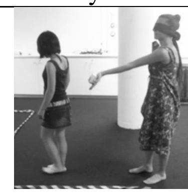
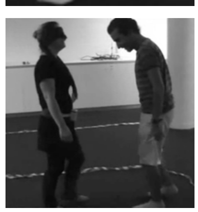
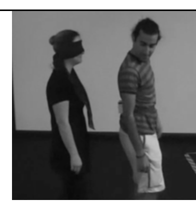
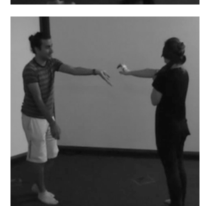
5.2.3 Translations

In the following subsections brief descriptions of connections, awareness of the other actors, interpretation of feedback and strategies of participants are presented. Please see Appendix A.1.1 for extended descriptions about the translations.

5.2.3.1 Connections

Table 5.3 provides a visual summary of the translations that took place across the four activities. The pictures show the diversity of translations in praxis. The highest variety of connections was observed in Activity 4, followed by Activity 2, then Activity 3, with the lowest recorded in Activity 1, which introduced the rope. The participants' experience of Activity 1 became a very strong inscription for them: their translations were largely based upon the rope metaphor of interaction.

Table 5.3 The connections between actors involving unique H-D-H arrangements in each activity

Activity 1	Activity 2	Activity 3	Activity 4
			   
(rope-at-back)-to-stomach	(device-at-stomach)-to-back	(device-at-back)-to-stomach	(device-at-hand)-to-back (device-at-hand)-to-chest (device-at-hand)-to-hand (device-at-hand)-to-handx2
	  		 
(rope-at-hand)-to-stomach	(device-at-stomach)-to-hand (device-at-stomach)-to-back (device-at-stomach)-to-stomach	(device-at-back)-to-stomach	(device-at-hand)-to-back (device-at-hand)-to-hand

5.2.3.2 Awareness

One important finding in all cases was the lack of difference between the BPs' awareness (1) of their partners; and, (2) of space. The participants indicated that the two meant the same for them across the activities: they did not - or needed not to - differentiate between their partners and space.

The awareness of the presence of the GP was directly affected by the placement of the EC. When the EC moved physically closer to the GP's body, the BP's awareness of the GP increased. The BPs all agreed that they felt the presence of their guiding partner most in Activity 1, then in Activity 3, then in Activity 4 and least in Activity 2. There was no common pattern of awareness of space. But, the BPs all said that it was at its lowest level in Activity 2.

5.2.3.3 Interpretation of Feedback

An important phenomenon was the co-construction of meaning, achieved by using the device's simple feedback, which was originally fixed across all activities. The device provided tactile and sonic feedback if it detected an object within its range; otherwise, it remained silent. During the activities, the meaning of the device's feedback was variously interpreted as: the rightness of orientation of the body[14], the rightness of the body movement, the rightness of orientation of hand, the time to stop the movement, a signal follow, degrees of proximity to partner, and an indication of their partners following behind them correctly. The role of device was relationally enacted differently with respect to its position in the arrangement of actors in each activity. The participants dealt with the multiplicity of meaning of the feedback skilfully and transited from one interpretation to another smoothly.

5.2.3.4 Strategies

In parallel to the multiplicity in interpretations of feedback, there were multiple strategies based on the changing meaning of the feedback. Two recurrent patterns in strategies were observed: continuous and regular provision of feedback. These two

[14] Here "the rightness" means whether the current orientation of the body is right or not. In other words, the feedback of the device is interpreted in binary form. It indicates either the right or wrong orientation.

patterns emerged out of the first activity with the rope. While in some cases BPs expected to be pulled along the track, in some others, they were comfortable with the periodic appearance of a pull. The same pattern continued in the remaining activities with the ECv1. The first activity with the rope clearly influenced the negotiation of the coordination strategies developed in the later activities.

5.2.4 Evaluation

On Multiplicity: The inscriptions involving rearrangements within the same design collective effectively created multiple meanings, strategies and connections. None of them was predetermined before the activities: they emerged from the process of negotiation between actors. Nevertheless, they were not completely unexpected. Although all of the inscriptions were highly influential vis-a-vis the interactions, they were originally weak inscriptions in terms of not prescribing any particular program of action. The only strong inscription was the participants' experience of Activity 1, which introduced a particular program of interaction that acted as a metaphor of interaction referred to as a rope metaphor of interaction.[15] We observed that all of the translations that took place in the remaining activities complied with the rope metaphor of interaction in varying degrees even though some connections deviated slightly from the rope metaphor of interaction. The grounding experience of the rope activity, as well as the different placements of the EC, served as enabling constraints. While these constraints allowed human actors to construct an interaction model that kept the movements in a predictable range, they also flagged new possibilities. No other metaphors that can be associated with the activities following the first activity were observed.

The inscriptions facilitated the emergence of several activity spaces with characteristics of spaces of negotiation and prescriptions of varying degrees. In the first activity, the particular arrangement of the bodies and the rope, together with the task,

[15] In this thesis, I use metaphors and models of interaction for referring to some conceptual structures that provide participants with guidance for coordinating their actions and movements. They are constructed retrospectively for analytical purposes. While metaphors of interaction provide actors with a more abstract set of descriptions of entities and their relations, models of interaction provide a more concrete and well-defined set of descriptions, which are produced from a higher level metaphor of interaction. Participants establish a model of interaction at each activity. This model of interaction is associated with a high level metaphor retrospectively by the researcher. One metaphor of interaction can produce multiple models of interaction that share some important relations.

facilitated the generation of an activity space with a strong script or program of action, which inhibited multiple translations. In the second activity, participants' experience of the previous activity with the rope was very influential regarding the ways in which participants performed the activity. Although the rope metaphor of interaction generated an activity space with a strong program of action again, the increased fluidity of arrangement between the bodies and the device facilitated another activity space allowing some flexible programs of action that increased the participants' capacity to negotiate the different possibilities. In the third activity, the rope metaphor of interaction was again very influential in defining a strong program of action. This time, the decreased fluidity of the arrangement between the actors limited the possibilities of negotiation. In the last activity, the strong program of action and the fluidity of the arrangements created a well-tuned balance that facilitated the highest level of multiplicity in forms of connection, meaning of feedback and strategies.

Overall, the largest space of negotiation or the highest level of multiplicity was observed first in Activity 4, then in Activity 2, then in Activity 3 and least in Activity 1. The first activity with the rope provided a useful basis, flexible enough for constructing new couplings yet specific enough for developing and sustaining a shared understanding of their mutual intentions and influences. However, the first activity acted as a very strong metaphor of interaction that did not allow the participants to construct different models of interaction. In order to support the generation of different models of interaction, the removal of any priming activity was deemed useful.

On Visibility: Inscriptions involving the use of sensory substitution devices and the blindfolding of participants increased the visibility/sensibility of the haptic and sonic sensations, while at the same time breaking the dominance of vision. In all activities, the participants successfully developed various non-verbal ways of communicating with their partners using their haptic and sonic sensations predominantly.

On Relationality: The inscriptions were effective in supporting the quality of relationality by strongly coupling two human actors with a non-human actor, either using a rope or the ECv1. In all of the activities, the humans and non-humans constituted a series of collectives in which the actors' roles and capabilities were continuously negotiated and relationally constructed.

On Configurability: Four activities involving predefined configurations created four different configurations. Therefore, configurability was supported in a predetermined way. Even though the configurations supported the creation of different connections between the actors, allowing the participants to create their own configurations may have yielded higher levels of variety in forms of connection between the actors and the strategies they employed. However, it may also have caused prolonged negotiation processes, which may not have resulted in new connections due to the absence of a common understanding or frame of reference.

5.3 Workshop 2

Workshop 2, which shared the same aims as Workshop 1, continued the investigation by providing more fluid conditions for the ordering of the design collective. Unlike Workshop 1, Workshop 2 employed a strategy for supporting emergent models of interaction by removing the initial priming activity. Furthermore, a strategy for distributing sensing and effecting capacities of technological actors was employed as well. Four participants aged between 22 and 29 years, i.e., postgraduate students from the Faculty of Architecture, University of Sydney, were recruited for the workshop.

5.3.1 Revisions

The activity in which participants used a rope was omitted in order to weaken the strong program of action inscribed by the rope metaphor and to allow the emergence of the models of interaction in an unguided way. This revision was a topological manipulation decreasing the specificity or increasing the fluidity of the initial topology of relations. In addition, the activity in which the device was attached to the hands of the BP was also omitted in an attempt to obtain a balance against a weakened program of action by retaining activities using more solid arrangements[16]. In other words, the aim was to increase the fluidity of the initial conditions in which the design collective was going to

[16] 'solid arrangements', i.e., arrangements between human and technological actors that disallow actors from relating to each other in many ways. In contrast, fluid arrangements enable actors to establish relations in multiple ways. For example, a technological device attached to a person's hand corresponds to a more flexible arrangement than a device attached to a person's back: a device attached to the hand allows a larger range and variety of action since human arm and hand movements demonstrate much greater degrees of freedom than human back movements.

construct new connections by eliminating the activity using the rope, which was enacted as a strong interaction metaphor for the activities following the first activity. In order to obtain a balance against this increased fluidity of interaction model, I kept only the activities featuring more solid arrangements between the actors. Therefore, Activity 4, the activity with the most fluid arrangements of the previous workshop - in which the EC was carried by the hand of a BP - was omitted.

5.3.2 Inscriptions in Workshop 2

5.3.2.1 Workshop Inscriptions

The workshops inscriptions were the same as those in Workshop 1.

5.3.2.2 Activity and Material Inscriptions

After covering the four arrangements in Workshop 1, Workshop 2 included two new arrangements (see Table 5.1) using a new version of the device used in Workshop 1; that is, the ECv2, which did not have sensing and effecting capacities co-located in the same device. The ECv2 placed the effecting capacity into the environment and left the sensing capacity on the body, the aim being to increase the role of the space and participants' awareness of the space, both of which were very low in Workshop 1. Ultimately, there were four inscriptions: the first two used the ECv1, and the remaining two used the ECv2. Apart from these changes, the activity structures and tasks were the same as those used in Workshop 1.

Activity 1 (Arrangement 2):

> *AI-1: GP guides BP with the ECv1 attached to BP's stomach.*
>
> *MI-1: The participants are provided with ECv1.*

Activity 2 (Arrangement 3):

> *AI-2: GP guides BP with ECv1 attached to GP's back.*
>
> *MI-2: The participants are provided with ECv1.*

Activity 3 (Arrangement 4):

> *AI-3: GP guides BP with the ECv2 attached to BP's stomach.*
>
> *MI-3: The participants are provided with ECv2.*

Activity 4 (Arrangement 5):

> *AI-4: GP guides BP with ECv2 attached to GP's back.*
>
> *MI-4: The participants are provided with ECv2.*

There were two workshop iterations involving 4 participants, postgraduate students from the Faculty of Architecture aged between 22 and 29 years. The two workshop iterations were conducted within the same week and lasted approximately 3 hours each. A summary of the object of design and design collective is presented in Table 5.4.

Table 5.4 Object of Design and Design Collective in Workshop 2

Object of Design	Enabling new relations between human and technological actors in full-body movement based interaction scenarios
Design Collective	Five human participants (a researcher and four participants) and four non-human participants (a rope, a striped thread and the ECv1 and ECv2)

5.3.3 Translations

In the following subsections brief descriptions of connections, awareness of the other actors, interpretation of feedback and strategies of participants are presented. Please see Appendix A.1.2 for extended descriptions about them.

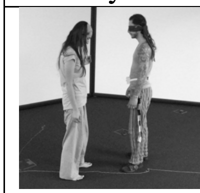
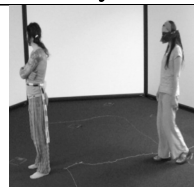
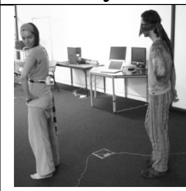
5.3.3.1 Connections

The translations that took place across the four activities were presented in Table 5.5. The highest variety of actions was observed in Activity 3, followed by Activity 1, then Activity 4, with the lowest observed in Activity 2.

One important finding was the emergence of a new model of interaction based on a new metaphor of interaction that can be referred as an *obstacle* metaphor of interaction. The first pair of participants used the feedback of the device as a warning signal indicating a wrong direction or movement. This entirely different translation of the inscription effectively changed all of their roles, strategies and couplings for the activity. The dependence of the BP upon the GP and the device lessened in the obstacle metaphor of interaction. The GP did not have to stay very close to the BP and trigger the device's sensor (see Figure 5.2). The second iteration's participants continued to use the rope model of interaction without trying to find any other alternative ways of connecting. In both activities, there was a single form of H-D-H connection only, (device-at-back)-to-stomach.

Figure 5.2 Two different translations of the same inscription according to the obstacle metaphor of interaction (on the left) and the rope metaphor of interaction (on the right)

Table 5.5 The connections between actors involving unique H-D-H arrangements in each activity

Activity 1	Activity 2	Activity 3	Activity 4
			
(device-at-stomach)-to-hand (device-at-stomach)-to-back (device-at-stomach)-to-stomach	(device-at-back)-to-stomach	(device-at-stomach)-to-hand (device-at-stomach)-to-back (device-at-stomach)-to-stomach	(device-at-back)-to-stomach (device-at-back)-to-back
			
(device-at-stomach)-to-back (device-at-stomach)-to-stomach	(device-at-back)-to-stomach	(device-at-stomach)-to-hand (device-at-stomach)-to-back (device-at-stomach)-to-stomach	(device-at-back)-to-stomach

5.3.3.2 Awareness

Changing the place of the sensing capacity affected the BPs' perceptions of their partners and space. The BPs' awareness of the GPs was higher in Activities 2 and 4 in which the latter carried the EC. This outcome, which was also supported by the findings of the first workshop, suggests a strong relation between the level of awareness and the place of sensing capacity. In contrast, changing the place of effecting capacity did not make any difference to the BPs' awareness of their partners and space.

5.3.3.3 Interpretation of Feedback

This time, there were marked differences between the ranges of interpretation of feedback between the two iterations. In the first iteration, the participants reported that there were three different meanings of feedback for them: wrong orientation of body, wrong orientation of body movement and time to stop movement. On the contrary, in the second iteration, the feedback was interpreted in six different ways: rightness of orientation of body, rightness of the body movement, time to stop the movement, a signal to follow, degree of proximity to partner, and finally, an indication of their partners following directly behind them. The different models of interaction based on different metaphors underpinned the differences in interpretation. The model of interaction based on obstacle metaphor did not require the BPs and GPs to act differently or to assume different roles when the placement of the EC was changed. Therefore, the meaning of the feedback remained the same. However, the model of interaction based on the rope metaphor required the BPs and GPs to re-negotiate their roles and communication strategies with respect to changing the configuration between actors in each activity.

5.3.3.4 Strategies

The fundamental difference in interaction metaphors totally changed the ways in which the participants coupled, communicated with each other and moved (see Figure 5.2). For example, participants who acted according to the rope metaphor of interaction were required to use the device's feedback continuously to communicate with each other and to coordinate their movements. Consequently, they had to couple and de-couple frequently during the activity. However, the participants who used the obstacle metaphor of interaction did not need the feedback from the device as much as the other pair of participants. They were able to start and keep moving without needing feedback: they only required feedback at turning points over the track. The couplings between the participants themselves and the participants and the device became looser. The role of the GP became more like that of an observer, who was not necessarily moving very closely to his/her partner but acting only when the BP's movements deviated from the actual path or the BP arrived at the turning points.

5.3.4 Evaluation

On Multiplicity: The omission of grounding activity using a rope facilitated a fluid activity space with no models or metaphors of interactions. Fluidity allowed the participants to negotiate the possibilities for models over a larger range. Ultimately, in addition to the models of interaction based on the rope metaphor, new models of interaction based on an obstacle metaphor emerged. The two different metaphors radically changed the actors' roles, the meaning of the feedback, and the strategies employed. Although both iterations started with a fluid activity space at the beginning of the workshop, they were transformed into more solid spaces with the interaction models that could be associated with the rope model of interaction. While another interaction model that could be associated with the obstacle model of interaction was utilized after Activity 1 in the first iteration, the interaction model complying with the rope metaphor did not change in the remaining activities of the second iteration. Although I did not observe any differences in the variety of H-D-H connections between the two iterations, interpretations of the feedback and the roles of the actors were more varied in the second iteration using the rope metaphor of interaction.

The newly added two configurations involving separate placement of sensing capability on the body and effecting capability in space did not facilitate the generation of new connections: neither did they effectively increase the role of space and the participants' awareness of space. When one compares sensing with effecting capabilities, changing the placement of the sensing capability of the device was much more effective in re-configuring the roles, relations and supporting different meaning generation than changing the placement of the effecting capacity. In other words, the transformative potential of the sensing capability was higher than that of the effecting in this particular setup of our experimental case. However, in some other situations, the transformative potential of these capabilities might prove different. The important point is that the different configurations within the same design collective are not neutral. Different configurations can enable different roles and hide or reveal different spaces of possibilities.

On Visibility: Similar to the previous workshop, the inscriptions effectively supported the use of haptic and sonic modes of sensation for the purposes of communication and coordination.

On Relationality: Similar to Workshop 1, Workshop 2 was effective in strongly coupling the human actors using ECv1 and ECv2 and making visible the entangled nature of their movements/actions. The coordination strategies and meaning of the feedback received were relationally constructed during the activities.

On Configurability: Similar to Workshop 1, the participants performed the activities within predefined configurations. However, somewhat differently, there was no initial activity that could work as an interaction metaphor like the rope activity at the beginning of the workshop. Thus, the initial topology or conditions for developing strategies according to these configurations were more fluid than those of the first workshop. In Workshop 2, this increased fluidity facilitated longer negotiation processes that were terminated by the emergence of an interaction model, which limited the negotiations.

Overall, the design collectives tended to act within a narrow range of possibilities and preferred to decrease the variation in coordination strategies and meaning. This may have been related to the task-oriented nature of the activities and the participants' will to finish the tasks as quickly and comfortably as possible. The next workshop included various activities involving different degrees of specificity.

6. Workshop 3

Workshop 3, which involved four iterations, represented the largest step in the evolution of the workshop series. First, it extended the scope of the evolutionary approach to the activity level: this meant that revisions were made across as well as within the workshop iterations. Second, it supported the ASD qualities to a greater extent through the inclusion of various activities, each of which focused upon a few qualities. Third, compared to the previous workshops, Workshop 3 employed a more participatory and responsive approach, which allowed the workshop to involve a larger number of human and non-human actors and to provide more opportunities for the actors to shape the design process. While involving a larger set of actors is important for exploring the different dimensions of the object of design and for rendering visible the different concerns of the actors, the ability of the actors to shape the design process is important for supporting the alignment between the actors and the process structure involving the various inscriptions.

I will provide a brief overview of the workshop and the four iterations in the next section. Then, I will present the workshop inscriptions (WI), activity inscriptions (AI), and material inscriptions (MI) involved in each workshop and delineate how they supported the ASD qualities. After explaining the methods employed to analyse the workshops, I will provide brief introductions to the workshops and evaluate how different ASD qualities were supported. While detailed descriptions of the workshop iterations are available in the relevant Appendices, reflections on the entire workshop are presented in the final chapter of the thesis.

6.1 Overview of Workshop 3

Workshop 3 performed three important tasks: 1) It increased the variety of activities and the number of actors involved; 2) It supported five ASD qualities; and, 3) It introduced the method of adaptive inscriptions, which enabled me to obtain a balance between openness and specificity in the activity definitions.

The main object of the design of Workshop 3 was exploring the various forms of togetherness and connectedness between humans, technologies and the environment. Workshop 3 explored its object of design during four different sessions: 1) a silence session, in which participants were asked to stay silent and focus on the sounds coming from their partners' bodies and the environment; 2) a physical sensitivity session, in which participants were asked to do three exercises emphasizing the interconnectedness of two bodies; 3) a rich poster session, in which participants were asked to make a collage of pictures and texts showing different forms of connections in their lives; and, 4) a machine-mediated performance session, in which participants engaged in various activities using three different technological devices to co-create sound and movement.

In addition to facilitating different forms of knowing in the exploration of the object of design, the activities supported different ASD qualities: visibility was supported in the silence session, relationality in the physical sensitivity session, multiplicity, visibility and accountability in the rich poster session, and, finally, configurability and multiplicity in the machine-mediated performance session.

We[17] planned a total of four workshop iterations involving different sets of participants with different professional backgrounds. The reason for conducting four iterations was to work with different participants (as a strategy of increasing multiplicity) and to employ an evolutionary approach at the different levels. The first iteration, a pilot iteration, was attended by participants with humanities backgrounds. As we planned to work with dance performers, interaction designers and music performers in workshops subsequent to the pilot workshop, for this workshop we opted to recruit participants without backgrounds in dance, interaction design and music. However, we were aware that the insights gained from the pilot workshop might not be directly applicable to the designs of the subsequent workshops. Thus, we were very careful when revising our workshop design according to our findings from the pilot workshop, the aim of which was to test the flow of the activities, technological infrastructure, experiences of participants, any technological issues, and to identify any overlooked details in the process. The pilot workshop was very successful in terms of revealing some problems

[17] As I developed and conducted the Workshop 3 iterations in close collaboration with other researchers and artists, I preferred to use the plural form 'we' instead of 'I' in majority of this chapter. The other researchers and artists were mostly involved in the design phase of the workshops. One other researcher assisted me during the workshops and contributed to the process of making revisions. I was the sole researcher during the analysis stage.

and opportunities. After the pilot workshop, we conducted a series of three iterations in which the dance performers, interaction designers and music performers participated. As our workshop activities involved the use of full human body movements and audio feedback, dancers with expertise in movement improvisation and choreography, musicians with expertise in music improvisation and composition, and interaction designers with expertise in bringing together different aspects of interactive systems provided us with a suitable set of participants.

6.2 Workshop Sessions and Inscriptions

The overall workshop theme was togetherness. The participants were informed about the theme of the workshop by email prior to attending the workshop. The full email text is available in Activity Inscription 6, AI-6. The two workshop inscriptions were as follows:

> *WI-1: The theme of the workshop is togetherness.*

This inscription supports the quality of relationality by emphasizing the co-existence of the entities, their connections and collective action possibilities.

> *WI-2: The workshop consists of four sessions: Silence Session, Physical Sensitivity Session, Rich Poster Session, and Machine-mediated Performance Session.*

This inscription supports the quality of multiplicity by facilitating the different forms of knowing, representing and performing through the various activities.

Apart from the main workshop inscriptions, at least one ASD quality was inscribed into each workshop session. In other words, each session supported one or more of the ASD qualities. The activities in the sessions were selected according to their potential to support ASD qualities. However, the important point was less about this particular set of activities than about bringing together a diverse set of activities and facilitating multiple ways of knowing, relating and performing. Thus, other kinds of activities could be added or some extant activities removed. The important point was to keep multiplicity as a quality of the design process. We particularly focused upon the quality of multiplicity: we supported multiplicity in activities, roles, representations, and in mediums. Each session provided opportunities and resources for the participants to engage in the design concept in various ways. We supported in turn multiple ways of engaging with the object of design, multiple forms of the object of design, multiple roles for participants and multiple mediums for expression.

Silence Session

The Silence Session was designed to be a lightweight prelude session to the following more demanding sessions. The session, which lasted for five minutes, facilitated non-visual ways of relating to other people and the environment. A researcher read the following activity inscription at the beginning of the activity.

> *AI-2: Please sit down on the floor where you feel comfortable. Close your eyes and concentrate on the sensations of your partner's body and the connection between you and your partner.*

The aim of this inscription is to support the quality of visibility by breaking the dominance of vision as the main modality of perception and increasing the visibility of the other modes of perception.

Physical Sensitivity Session

The Physical Sensitivity Session focused on supporting bodily physical ways of knowing, relating and performing. The session consisted of exercises structured to help the participants to understand and analyse the elements and qualities of the touch-based connections between their bodies. The following activity inscription was explained to the participants both verbally and by physical demonstration.

> *AI-3: There are three small exercises, palm-crown exchange, reverse palm-crown exchange, and simultaneous palm-crown exchange, in this activity. The participants will face each other in all exercises. In the first exercise, one person is leader, and the other person is receiver. The leader places his/her hand on the crown of his/her partner's head very gently and then lets the palm gradually drop to the ground so that the body goes downward. You have to maintain the contact between the palm and the crown. In the second exercise, the participants change roles then pursue the same activity. In the third exercise, the participants simultaneously touch each other's crowns and repeat the same to and fro movement.*

The aim of this inscription is to support the quality of relationality by enabling the participants to perceive, decide and act in mutual ways and to develop an empathic understanding of maintaining connections and the reciprocity of their actions.

Rich Poster Session

In this session, the participants were asked to make a collage of various pictures cut from magazines on a sheet of A0-paper: then they were asked to annotate them according to the particular kind of connection that each represented. In addition, the participants talked about some objects with which they feel a connection. There were two activity inscriptions and three material inscriptions. While the activity inscriptions (AI-4) were included in an email message sent to each participant prior to the workshop, verbal explanations of the activity tasks (AI-5) were given before the session. Material inscriptions included 150x90 cm paper (MI-1), two different coloured markers, (MI-2), and various images to be used in making the collage (MI-3).

> *AI-4: Thank you very much for agreeing to participate in the workshop. The theme of the workshop is "togetherness" and I'd like you to bring 3 things with you. The first is a picture/image or drawing, the second, a text/writing, and the third, any objects. These three things can be anything that you feel a connection to: things with which you may have an emotional connection, and/or things that you like to be together with, and/or things that may help you to say something about being connected. You might think quite broadly about it. It might be a connection with a person, a song, a place, a memory, a scent, or a dress etc.*
>
> *AI-5: First we will talk about the objects you brought to the workshop and then I will give you some pictures. I would like you to select some of the pictures that you feel a connection with and to make a collage of these pictures collectively. After finishing the collage work, I would like you to annotate each picture with some text explaining your connection with the picture. Please use a single marker only throughout this activity.*
>
> *MI-1: A large paper sheet by 150x90cm was available for participants to create their posters on.*
>
> *MI-2: One red and one blue marker were made available for participants to annotate the images on the poster.*
>
> *MI-3: Various images cut from recent local magazines were available for participants to use in their posters.*

While AI-4, AI-5, MI-1and MI-3 supported the quality of multiplicity by bringing together the various materials that could help generate multiple connections, MI-2 supported the quality of accountability by making the traces of the participants' actions observable. Finally, the entire session supported the quality of visibility by rendering clear the various visible forms of connections and personal understandings about said connections.

Machine-Mediated Performance Session Inscriptions

In this session, participants performed five short activities using three technological devices: two wearable devices - one with tilt and another with distance sensing capabilities - and one webcam with image processing capability. The three devices were referred to as Tilt, EC and Webcam respectively. The aim was to explore the different forms of connections between bodies using technologies, Human-Device (H-D); between bodies using technologies, Human-Device-Human (H-D-H); and between bodies and environment using technologies, Human-Device-Environment (H-D-E). Each activity lasted for three to six minutes: the participants could play with the tools for a few minutes to explore their capabilities before each activity. There was one activity inscription and six material inscriptions.

AI-6: The aim of the session is to explore how different human-machine-environment arrangements might enable different forms of connections between humans, technology and space. There are five activities in which you may use any of the three technological devices: Tilt, EC and Webcam. There are particular movement patterns for each activity that we would like you to perform. These movement patterns describe the speed of your movements and the mobility of your body. In the first activity, the movement pattern is slow and stationary, in the second, fast and stationary, in the third, slow and mobile, in the fourth, fast and mobile, and, in the final one, you can make movements in any pattern. For each activity, we would like you to find a theme that you want to perform and select a sound effect that you think it is suitable for the theme, along with a technological device.

MI-4: Tilt devices with sensing movement of human body in two axes: vertical and horizontal. The tilt device has one surface fitted with Velcro.

MI-5: EC devices sense the distance between two points (up to 70cm): that of the body carrying the device and that of the body or object to which the EC is directed. The EC has straps with snaps.

> *MI-6: The Webcam senses any movement within its field of view: it centres the relational capabilities of all actors*

The aim of three inscriptions above is to support the quality of multiplicity by making available various capabilities of connecting with other bodies, technologies and environment offered by the three devices. While the Tilt devices centre on the individual capabilities of one actor, the EC devices centre on the relational capabilities of all actors within its field of view.

Figure 6.1: Non-human technological actors of machine-mediated performance session: Tilt, EC and Webcam (from left to right respectively)

> *MI-7: The physical form of the wearable devices, Tilt and EC, were small and compact.*

This inscription supports the quality of configurability by making devices easily portable. The small and compact form factor allows participants to use the devices by different parts of the bodies with the help of straps.

> *MI-8: We provided participants with various straps that enabled the devices to be attached to different parts of the body.*

This inscription supports the quality of configurability by allowing participants to create different H-D connections.

> *MI-9: Mapping algorithm that couples the devices to facilitate relationality.*

A special algorithm that took the inputs from the two devices, combined them and produced a single sound effect was implemented, the aim being to support more collaboration and an increased sense of connection between the participants.

A summary of the object(s) of design and design collective in each session of Workshop 3 was presented in Table 6.1.

Table 6.1 Object(s) of Design and Design Collective in Each Iteration of Workshop 3

	Object(s) of Design	Design Collective
Silence Session,	Exploring the concept of togetherness and connectedness between human and non-human actors through design games utilizing different forms of knowing and doing	Four human participants (two researchers and two participants x 4)
Physical Sensitivity Session		Four human participants (two researchers and two participants x 4)
Poster Session		Four human participants (two researchers and two participants x 4) and various non-human participants (a poster, coloured markers, pictures, and personal objects)
Machine-Mediated Performance Session		Four human participants (two researchers and two participants x 4) and various non-human technological actors (a laptop, speakers, ECv1, ECv2, and 4 x Wiimote Controllers)

6.3 Analysing Workshops

As Workshop 3 involved different kinds of activities, and different ways of describing and analysing the workshop 'data' used. In addition to the notions of inscriptions and translations used in the previous workshops, I also identified some indicators for understanding the capacity of the session inscriptions to support the relevant ASD qualities. These indicators were translated to the context of the design activity from the original definition of each ASD quality after watching all video sequences and reading all of the transcriptions. Table 4.5 shows the ASD qualities and their indicators for the each session of Workshop 3.

In the case of the machine-mediated performance session, the activities were described according to the levels of multiplicity and configurability. Analysis focused upon the multiplicity of connections in three different areas: multiplicity in forms of Human-Device-Human (H-D-H) arrangements, in forms of Human-Device-Environment (H-D-E) arrangements and in movement effort qualities. While Human-Device-Human arrangements correspond to unique spatial arrangements between all human participants through technological devices, Human-Device-Environment arrangements represent unique spatial arrangements between a single human participant and environment through technological devices. As regards configurability, the analysis focused on identification of unique spatial Human-Device (H-D) arrangements or couplings. Simple concatenated phrases were used to represent each form of H-D-E and H-D arrangement such as device-at-hand and arms-directed-at-device; however, since Human-Device-Human (H-D-H) arrangements are quite complex to represent as simple phrases, the total number of H-D-H arrangements will be provided in the relevant sections and detailed explanations involving still pictures will be presented in the Appendix B. The range of available forms of H-D-E and H-D arrangements is detailed in Table 6.2. As the webcam was placed somewhere in space, the forms of H-D and H-D-E arrangements were identified as the same.

Table 6.2 Available forms of H-D and H-D-E arrangements

	Human- Device (H-D)	**Human-Device-Environment (H-D-E)**
Tilt & EC	device-at-hand	(human-device)-to-floor
	device-at-arm	(human-device)-to-wall
	device-at-leg	(human-device)-to-ceiling
	device-at-back	(human-device)-to-objects
	device-at-stomach	(human-device)-to-space
Webcam	arms-directed-at-(device-space)	arms-directed-at-(device-space)
	legs-directed-at-(device-space)	legs-directed-at-(device-space)
	torso-directed-at-(device-space)	torso-directed-at-(device-space)
	Head-directed-at-(device-space)	Head-directed-at-(device-space)
	Full-body-directed-at-(device-space)	Full-body-directed-at-(device-space)
	hands-directed-at-(device-space)	hands-directed-at-(device-space)

Figure 6.2 shows two connections in a machine-mediated performance session. The image on the left involves one form of H-D-H arrangement (as represented in the picture), one form of H-D arrangement (device-at-hand), and one form of H-D-E arrangement (human-device)-to-floor. The human actor directing the EC to her partner does not correspond to an H-D-E arrangement; instead, it is identified as an H-D-H arrangement. The image on the right involves one form of H-D-H arrangement (as

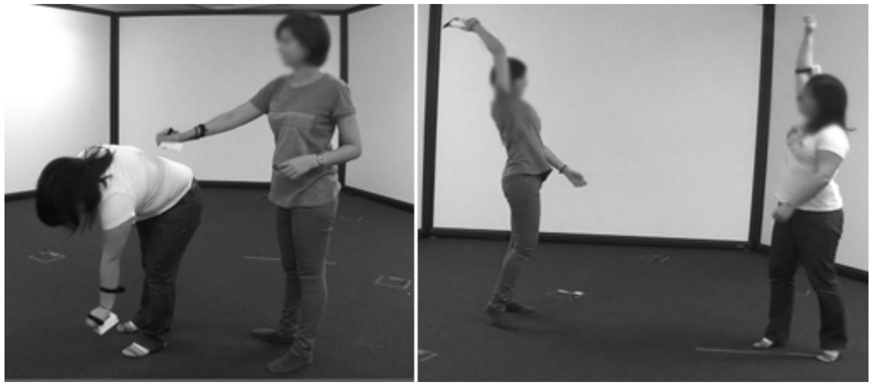


Figure 6.2 Two different H-D-H connections involving two EC devices (on the left) and two Tilt devices (on the right) in a machine-mediated performance session

represented in the picture), two forms of H-D arrangement, device-at-hand and device-at-arm, and one form of H-D-E arrangement (human-device)-space.

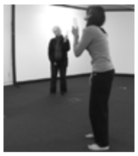
Qualitative scales were defined for multiplicity and configurability after analysing the forms of arrangements in all of the workshops. Table 6.3 shows a summary of the Multiplicity and Configurability assessment. Multiplicity in H-D-E arrangements were assessed in the following way: H-D-H arrangements numbering less than 4 were considered as Low, between 4 to 6 as Moderate, between 7 to 10 as High, and more than 10 as Very High. The number of H-D-H arrangements ranged from 2 to 14: I divided this range into four equal intervals. Similarly, there were five possible forms for H-D-E and H-D arrangements. I assessed them as follows: a 1 arrangement was considered Low, a 2 as Moderate, a 3 as High and 4 and 5 as Very High. Finally, the multiplicity involved in the movements was assessed according to the degree of use of four movement effort qualities (MEQs) by each human actor. If there was variation in an effort quality, this increased the multiplicity. For example, the category of Weight has two polar values: Strong and Light. If the connections in an activity have movements showing both Strong and Light characteristics for the Weight category, then the activity gets a multiplicity score of 1. If another effort category shows two polarities, then the activity gets a score of 2. If all of the effort categories show variation, then the activity gets a score of 4. A score of 1 was considered Low, 2 as Moderate, 3 as High, and 4, Very High.

Table 6.3 Assessment of Multiplicity and Configurability

	Low	Moderate	High	Very High
H-D-H	< 4	4 - 6	7 - 10	10 <
H-D-E	1	2	3	4 <
H-D	1	2	3	4 <
MEQs	1	2	3	4

The description of the H-D-H arrangements and the H-D-H connection Tables, which are available in the Appendix A and B, were created based on our analysis of video sequences of activities. I segmented the video sequences according to the different body-technology-space arrangements. There were various arrangements during a session but not all of them allowed participants to create a connection. In this particular scenario, a connection was defined as a sustained state in which human actors coordinated their movements and mutually composed sound effects for at least three seconds. It is important to note that the fact that the arrangements lasted three or more seconds was an analytical choice rather than a definitive assessment of minimum amount of duration required for a connection. It is possible to define even very short momentary eye contact as a connection. However, the definition of a connection depends on the context and purposes of the research. Therefore, for the purposes of this research, three seconds were considered a sufficiently long duration for determining whether the movements and composed sounds were produced by means of a mutually constructed strategy or not. I analysed the video segments using a coding scheme which included seven codes: form of H-D-H arrangement (a still photograph), connection strategy, duration of connection, movement qualities of two participants, technologies, and, finally, sound effect (see Table 6.4). I used Laban's effort categories (1971), which was used by similar studies involving analysis of full-body movements (Loke, 2009; Schiphorst, 2007), to describe the movement qualities of the participants. When coding the segments, I consulted the transcriptions of the reflection sessions of activities, which helped me to better read the connections. I ignored short-lasting and momentary changes in movement qualities. However, if the changes in movement qualities occurred more than a few times, I did not assign them any movement qualities. I simply labelled them as "vary". This was especially the case with the long-lasting connections, in which a mix of movement qualities was observed.

Table 6.4 The Coding scheme for analysis of H-D-H connections

H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	making similar and repetitive movements	4 seconds	strong in weight sustained in time indirect in space bound in flow	strong in weight sudden in time direct in space bound in flow	2 Tilt (coupled)	harmonica

6.4 Iteration 1 - Pilot

6.4.1 Introduction

This workshop was planned as a pilot workshop. There were two participants, P1 and P2, aged 23 and 28 respectively, each with a humanities background. The two researchers, i.e., R1 and R2, assumed different roles in the workshop. While one researcher acted as a facilitator of the workshop, the other one performed the activities together with other participants. Our aim was to obtain a first person understanding of the activities (Varela & Shear, 1999) and to ascertain how much guidance the participants needed.

6.4.2 Evaluation

As the Iteration 1 was a pilot iteration, I will present a brief evaluation of Iteration 1. Further explanations and details on Iteration 1 appear in Appendix A.2.1. In the Silence Session, because the participants noticed the previously insensible things in the space such as the sound of their own breathing and extraneous noises, it was concluded that the activity was effective in supporting 'visibility' or amplifying the sensation of other modalities. The exercises in the Physical Sensitivity Session were generally effective in supporting the quality of relationality. Although the participants could not perform some exercises according to the definition of the exercise, their reflections after the exercises were helpful for increasing their awareness of different aspects such as reciprocity, changing roles, and negotiation of control. The Poster Session was effective in supporting the multiple representations of the object of design, i.e., togetherness, their visibility, and, in a limited sense, the quality of accountability. The poster contained representations such as togetherness with a memory, with a place, for a common cause and for laughter. In the Machine-Mediated Performance Session, the participants found the algorithm mapping their movements to the sound effects complicated, and the requirement to focus on the production of sound too restrictive. While the maximum number of H-D-H arrangements was observed in the fourth activity using only one webcam, and in the fifth activity using all three devices, the lowest number was in the first activity which used two coupled ECs and one Tilt. The participants' movement effort qualities showed variations in all effort categories in the three activities. Overall, the final session was effective in supporting multiplicity and configurability.

6.5 Iteration 2

6.5.1 Introduction

The second iteration of Workshop 3 was conducted one week after the pilot workshop. We worked with two female dance performers, P1 and P2, aged 50 and 40 respectively. They knew each other and had performed together a few times in the past: they had experience in movement improvisation. We contacted them through our personal network: the second researcher had collaborated with them in the past. We had met with P1, the first dancer, who was an experienced body weather practitioner, two weeks before the workshop, had discussed its overall aims and goals, and the structures of the second and fourth workshop activities in which bodies were used extensively. There were two researchers available in the workshop. While the first researcher, R1, acted as a facilitator, the second took notes, video recorded the activities and sometimes contributed to the discussions. The entire workshop lasted for approximately 4 hours. Table 6.5 shows a summary of the revisions made in Iteration 2. Please see Appendix A.2.2 for the detailed explanations about the revisions and workshop activities.

Table 6.5 Summary Revisions in Workshop 3 Iteration 2

Revision 1	The requirement to sit back-to-back in the Silence Session
Revision 2	The addition of a new exercise to the Physical Sensitivity Session
Revision 3	The use of a smaller sized poster paper in the Rich Poster Session
Revision 4	Invitation to work collectively in the Rich Poster Session
Revision 5	The provision of one-page visualization of working principles of technology in the Machine-Mediated Performance Session

Revision 6	The requirement to be in a back-to-back position in the Machine-Mediated Performance Session

6.5.2 Evaluation

Silence Session

On visibility. The revision requiring the participants to sit back-to-back was effective in supporting the quality of visibility by amplifying the sensibility of other modes of sensations and supporting the construction of a tactile connection between the participants. In addition, the participants reported amplified sensations of other modalities such as hearing and touching.

Physical Sensitivity Session

On relationality. The participants performed the first two exercises, which were part of the activity inscription, followed by another exercise, which had been removed from our activity inscriptions prior to the previous workshop. They performed the exercises as described and were able to maintain contact between palm-crown during the exercises. Our planned revision involving the addition of a new exercise did not eventuate. One participant, who was involved in the design of these exercises, found our request to make a change untimely and insisted on performing the original third exercise as agreed before. She did not want to suggest any new exercise. Her role was one of designer-participant who followed a program of action against our activity inscriptions.

Rich Poster Session

On multiplicity. In the first part of the session, the objects that the participants brought proved very useful for understanding many personal meanings of connection in the participants' lives. In the second part, as one of the participants was not very selective in using the images, one half of the collage demonstrated togetherness of images rather than what togetherness meant to the participants. The activity rendered visible many forms of connection such as connection as laughter, connection as love, connection as absence and connection as fear.

On visibility. The collage of images made visible different forms of connections and provided an opportunity for the participants to reflect on them.

On accountability: The revision involving the use of smaller sized paper encouraged the participants to interact more but not to work collectively. In fact, the participants worked collectively; but, their collective work was limited to showing some interesting images to each other. The actual selection and composition process of the images were performed individually. The participants used one half of the poster and did not go beyond their own half. Thus, there was an invisible border separating the works of two participants, a separation further reified by the use of two differently coloured markers.

Machine-Mediated Performance Session

On multiplicity. Overall, the participants could complete only two activities because of perceived deficiencies in the technological devices. While the webcam was considered 'insensitive', the tilt devices were found to be 'blunt'. In both activities, we observed moderate levels of multiplicity. Technological deficiencies may have prevented the participants from generating more connections. Low to Moderate multiplicity in movement effort qualities can be explained by the use of movement constraints in the activities. As the participants were asked to 'be stationary in space and move slow' and to 'be stationary in space and move fast' in activities 1 and 2 respectively, their movement qualities were confined to the particular effort categories. Although the provision of visual explanations on paper was helpful for increasing the visibility of the technological infrastructure, it was not sufficient for participants to develop a working model for the technology. Table 6.6 shows a summary of the connections and movement effort qualities in Iteration 2.

Table 6.6 Summary of H-D-H, H-D-E, M.E.Qs and H-D values in Iteration 2

Iteration 2	Activity 1 with Tilt (Decoupled)	Activity 2[18] with Tilt (Coupled)	Activity 3 with EC (Decoupled)	Activity 4 with EC (Coupled)	Activity 5 with Webcam
Multiplicity of H-D-H	N/A	Moderate (5)	N/A	N/A	Moderate (6)
Multiplicity of H-D-E	N/A	Low (1)	N/A	N/A	Very High (4)
Multiplicity of M.E.Qs	N/A	Low (1)	N/A	N/A	Moderate (2)
Configurability of H-D	N/A	Low (1)	N/A	N/A	Very High (4)

On configurability. While configurability of the H-D arrangements was Very High in the first activity using the webcam, it was Low in the second activity using coupled tilt devices. The participants did not use the straps at all.

[18] The actual order of the activities is Activity 5, then Activity 2, then Activity 1, then Activity 4, and finally, Activity 3. Here, it is presented in a different order in order to make comparisons with the next two workshop iterations.

Participants' Reflections on the Overall Workshop

The participants' reflections covered a large range of topics from details of the technological tools to the overall research rationale. Central to their criticism was the design of the technological tools: they found them insensitive and imprecise, rendering them unable to perform the activities in the expected ways: ‘There is no sense of instrument ... it is just pure unadulterated chance’; ‘our bodies are so much more infinitely precise than these devices ... that's part of the problem they do not match’. They considered the system's output random and that it prevented them from establishing a connection with their partners: ‘Because it is random and because there is no way of understanding cause and effect ... we lose connection through bluntness’. As the mapping algorithm coupling the devices did not work in the way we expected, we decided to revise the algorithm for the next workshop iteration.

The participants suggested that we make the activities less deterministic: ‘See what happens when two people have freedom to go ... you can just explore things ... for example, what do you notice when you do this, the sound feeds in, that generates itself another arena, and that changes our relationship, then we can talk about it all, you can ask us to say what happens and what do we notice when we move and when we stop’; ‘the biggest frustration is trying to compose something as opposed to seeing what happens with these configurations’. The complexity of the mapping algorithm coupling two tilt devices, the movement constraints, and the activities' explicit focus upon sound rather than upon movement, acted against multiplicity as our design construct left very little room for emergent and improvised action. The deterministic nature of the activity inscriptions did not invite the participants to engage with the system in creative and productive ways.

The participants found the task of composing sound effects through insensitive and blunt technological devices according to a theme unattainable. They said that they would have preferred to explore the possibilities of different H-D couplings in a less scripted or more emergent way. Although the aim was to support more fluid relations and more emergent actions, the activity inscriptions were enacted as too deterministic and confining. The reason behind using activity inscriptions that particularly constrained the movements, rendering them slow or fast, was to provide the participants with a frame of reference that could guide their performance. In addition, previous work reported that employing a strategy of open exploration in such performative participatory design workshops might not prove very productive (Loke, 2009). In our meeting before the workshop, P1 suggested to us that improvisation using movement constraints in an unguided way could result in frustration for participants lacking a background in dance. However, employing movement constraints in a workshop involving dance performers who had experience in movement improvisation could prove destructive rather than constructive for their performance. For this reason, we reconsidered using movement constraints in the activity inscriptions. Given that the participants in the next workshop were interaction designers, not dancers, we were uncertain as to whether the same movement constraints would be constructive or destructive. Thus, we did not remove the inscriptions completely; rather, we decided to use what we called adaptive inscriptions.

The participants found the requirement to be positioned back-to-back in the first activity of the Machine-Mediated Performance Session irrelevant to their task: 'Because we are trying to meet through the sound, it is irrelevant to have a back touching because you are limiting togetherness to be touched. It is not just what togetherness is about. It just creates a parameter that is like a limitation ... but why would we need it?' They also pointed out that absence of vision as a communication channel was detrimental for improvising through novel technologies, which were not sensitive enough for them. We considered this an important point so we abandoned the requirement. However, this change caused yet another problem, this time regarding the participants' perceptions of the strength of the activity inscriptions. They questioned the changeability of particular design constructs, i.e., the activity inscriptions. According to the participants, if it was possible to change the design constructs, then there was no point in trying to achieve the goals within the specified constructs. As a result, our strategy of being sensitive to the emergent concerns in the workshop fuelled a negative impression and/or mistrust in the overall research rationale, goals and methods employed.

The participants suggested that the workshop theme of togetherness was a concept more related to the human, and that we should use relationality instead: 'Relationality is much more open and multifaceted than togetherness and opens up more possibilities. It is partly because togetherness tends to be human'. Although we had considered togetherness a suitable concept for exploring the various ways in which humans and non-humans may come together, we did not want to limit the participants' understanding of the workshop theme by including something which was mostly associated with humans. So, we decided to change the main theme of the next iteration.

6.6 Iteration 3

6.6.1 Introduction

The third iteration of Workshop 3 was conducted one week after the second iteration. We worked with two interaction designers, ID1 and ID2, both aged 22 years. They were close friends, who had acquired experience in developing interactive systems in both the academic and commercial contexts. They were research students in our department and we contacted with them through our personal network. Researcher R1 facilitated the workshop, recorded the video footage and interviewed the participants. The entire workshop lasted for approximately 4 hours. Table 6.7 shows a summary of the revisions made in Iteration 3. Please see Appendix A.2.3 for the detailed explanations about the revisions and workshop activities.

Table 6.7 Summary of Revisions in Workshop 3 Iteration 3

Revision 7	Making ‘connectedness’ the overall theme for Workshop 3
Revision 8	Asking participants to bring two objects with which they felt connected and
Revision 9	Using a method of varied strength inscription to guide the participants' movements in the Machine-Mediated Performance Session
Revision 10	The removal of the requirement for predefining a theme for the activity in the Machine-Mediated Performance Session
Revision 11	The use of both decoupled devices and coupled devices in the Machine-Mediated Performance Session
Revision 12	The use of real-time visualization of the mapping algorithm in the Machine-Mediated Performance Session

6.6.2 Evaluation

Silence Session

On visibility. The inscriptions broke the dominance of vision as the main modality of perception and were effective to amplify the sensations of the other modalities. The participants sensed things previously insensible in the space: the sound of a watch and the sound of the A/C.

Physical Sensitivity Session

On relationality. We achieved our aim of supporting the quality of relationality in the activity. The participants consciously developed strategies by considering the effects of their own movements on their partners and the responses they might get from their partners. They experimented with the various qualities of the connection, e.g., speed of movement, synchronised movements and the limits of the connection, all of which provided them with a shared experiential base for the activities in the machine mediated performance session. The inscriptions helped the participants to develop an understanding of the ways of constructing and maintaining a strongly coupled touch-based connection. The reflection activity at the end of the session was very helpful inasmuch as it further supported this understanding. The participants commented on their experience of the connections; that is, whether or not they were visible or sensible during the activity.

Rich Poster Session

On multiplicity. We achieved our aim of supporting the quality of multiplicity in the poster session. The participants brought three personal objects to the workshop, objects which told different stories and oriented the discussions in a variety of different ways. The diversity of images facilitated the appearance of multiple stories and interpretations and revealed many different forms of connections such as connection as shared memories and connection as shared criticism.

On visibility. Similar to multiplicity, the collage of images rendered visible the different forms of connection and provided an opportunity for the participants to reflect on them.

On accountability. The quality of accountability was not supported. In fact, there was no need to support accountability in the way our inscription did. Because the participants had known each other prior to participating in the workshop, there was a strong pre-existing connection between them. They created the collage in a very collective and harmonic way, acting as if a single person. Thus, there was no need for separate accountability of who did what. This scenario suggested that if the connections between the actors in a network or parts in a system are strong, there may be no need for separate accountability.

Machine-Mediated Performance Session

On multiplicity. Overall, while the final activity using the webcam supported the highest levels of multiplicity in the H-D-E arrangements and M.E.Q.s, the third activity using decoupled ECs resulted in the maximum number of H-D-H arrangements. The lowest level of multiplicity was observed in the fourth activity using coupled ECs. When we looked at the differences between the coupled and decoupled devices, the latter facilitated the creation of more connections than the former. The mapping algorithm coupling the two devices was enacted as an obstacle against the creation of multiple connections. The difficulty of understanding the mapping algorithm prevented the participants from creating different forms of connections and maintaining the established forms. The high level of multiplicity was supported mainly by the high connectivity of the devices rather than by their high configurability. Table 6.8 shows a summary of the connections and movement effort qualities in Iteration 3.

Table 6.8 Summary of H-D-H, H-D-E, MEQs, and H-D values in Iteration 3

Iteration 3	Activity 1 with Tilt (Decoupled)	Activity 2 with Tilt (Coupled)	Activity 3 with EC (Decoupled)	Activity 4 with EC (Coupled)	Activity 5 with Webcam
Multiplicity of H-D-H	High (7)	Moderate (4)	Very High (14)	N/A	High (10)
Multiplicity of H-D-E	Low (1)	Low (1)	Moderate (2)	N/A	Very High (4)
Multiplicity of M.E.Qs	Moderate (2)	High (3)	High (3)	N/A	Very High (4)
Configurability of H-D	Moderate (2)	Low (1)	Low (1)	N/A	Very High (4)

On configurability. Due to the fact that the tilt devices' sensors captured the movements in two axes only, the participants were unable to use them in other ways different from the configuration of device-at-hand. The inscriptions of straps involving the quality of configurability were not translated in the practice in the expected ways as the particular characteristics of the sensing technology and mapping algorithm, i.e. their inscriptions, did not invite use of many possible configurations. After the first activity, the straps were not used at all. The lack of expressive capacity of many of the configurations, e.g., device-at-arm or device-at-leg, rendered said configurations either useless or not preferable. Here, the participants found configuring the ways in which the device and the human body were connected less desirable since a particular configuration, device-at-hand, provided them with the opportunity to exploit the expressive capacity of the devices at maximum.

The EC devices, with their ability to capture distance between any two points, provided the participants with many opportunities to create connections and sound. Therefore, although the configurability of the devices was low, the connectivity of them was very high. However, the connectivity of the coupled version of the EC devices diminished as the cause-effect relation between the particular arrangements of the human-device couplings was not clearly accessible by the participants.

The webcam, which was placed in a fixed location in space, captured the participants' movements from a single point of view only, thus limiting the configurability of the H-D arrangements. However, the webcam, with its ability to capture any motion in space, allowed the participants to use any parts of their bodies to create sound and, by extension, to make a connection. It provided the participants with the highest possibility of coupling with the technology, i.e., connectivity.

There were no observed effects of the coupling or decoupling of the devices on the configurability of the H-D arrangements. In other words, neither coupled nor decoupled devices enabled the participants to attach the devices to the different parts of their bodies. The participants always preferred to use the devices by hand as this facilitated a higher level of connectivity between participants using the devices.

Participants' Reflections on the Overall Workshop

The participants' reflection on the workshop process was positive. They found the activities explorative, open and fun, stressing the importance of the fact that there were no right or wrong ways of doing things. One participant commented on how her understanding of her relations with other people and objects had deepened: 'I never thought about how understanding technology changes how you understand other people. How your relationship with objects affects how you understand other people and how you work with other people as well'. The participants found controlling the coupled devices boring as they were not able to access the whole set of musical notes. One participant said that 'the combined one might be more interesting but we should not compromise our own capacities'. Although the coupled devices failed to work in the way we expected, we opted to keep them for the final iteration as we thought that the music performers might provide us with different insights into the differences between coupled and decoupled devices.

6.7 Iteration 4

6.7.1 Introduction

In this final iteration, we worked with two music performers, MP1 and MP2, who had expertise in music improvisation. They knew each other before they participated in the workshop. The male participant was 34 years old and the female, 33. We contacted them via one of our mutual friends. We sent them a brief email explaining the goals of the workshop and the activities involved. They agreed to participate in the workshops, and we conducted the workshop two weeks after contacting them by email. The workshop lasted for about three and half hours: the two researchers were present. While one researcher conducted the workshop, the other one video-recorded the activities. There were no revisions in this iteration. As the previous iteration was successful in terms of the inscription's capacity to support the ASD qualities, we did not make any changes in the inscriptions.

6.7.2 Evaluation

Silence Session

On visibility. The inscriptions broke the dominance of vision as the main modality of perception and effectively amplified the sensations of the other modalities. However, similar to previous workshop iterations, the activity failed to create new connections.

Physical Sensitivity Session

On relationality. The inscriptions were very successful in increasing the participants' awareness of mutual aspects of our relations with other bodies. The switching of the roles was particularly effective for developing an empathic understanding. The participants' statements demonstrated a fine level of sensitivity to the existence of the other parties involved in the relations. The participants also developed a vocabulary for the touch-based connection. For example, when sending a signal to initiate movement, they found a gentle touch sufficed rather than a forceful push.

Rich Poster Session

On multiplicity. In contrast to the collage in the previous workshop iteration, there was not a large variety in the selected images and the connections they represented. No stories or experiences accompanied the images: they were either abstract patterns or colourful geometric shapes. Their meanings were abstracted away. In fact, in the final poster, all of the collage pictures, taken together, represented a single manifestation of one female participant's desire to create a visually balanced composition.

On visibility. Parallel to the lack of supporting multiplicity, the poster failed to make visible the different forms of connection. What was visible was the intention to create and realize an aesthetically pleasant collage only.

On accountability: While in reality the participants used the different markers assigned to them, the collective nature of their collage-making practice did not ask for the inclusion of an account of the different authorships. Their mutual interest in poster making was very well aligned; thus, no separate accountability was needed. And, since it was an open-ended exploratory activity, the decision or choices made did not require a strict sense of accountability.

Machine-Mediated Performance Session

On multiplicity. Overall, while the activity using the decoupled EC devices supported the highest levels of multiplicity in the H-D-H arrangements, the final activity using a webcam supported the highest levels of multiplicity in the H-D-E arrangements. The lowest level of multiplicity was observed in the fourth activity which used coupled ECs. The activity using decoupled Tilt devices supported the highest levels of multiplicity in movement effort quality. Table 6.9 shows a summary of the connections and movement effort qualities in Iteration 4.

Table 6.9 Summary of H-D-H, H-D-E, MEQs, and H-D values in Iteration 4

Iteration 3	Activity 1 with Tilt (Decoupled)	Activity 2 with Tilt (Coupled)	Activity 3 with EC (Decoupled)	Activity 4 with EC (Coupled)	Activity 5 with Webcam
Multiplicity of H-D-H	High (7)	Moderate (4)	Very High (14)	N/A	High (10)
Multiplicity of H-D-E	Low (1)	Low (1)	Moderate (2)	N/A	Very High (4)
Multiplicity of M.E.Qs	Moderate (2)	High (3)	High (3)	N/A	Very High (4)
Configurability of H-D	Moderate (2)	Low (1)	Low (1)	N/A	Very High (4)

On configurability. The straps were not used at all. From the outset, the participants preferred to use the devices by hand. Similar to previous iterations, the participants found the potentialities of the different ways in which the device and the human body could be connected unattractive when it came to exploring possibilities via these different configurations. The availability of different configurations did not support multiplicity as their expressive potential was very limited compared to the single configuration of using the devices by hand. The lack of expressivity offered by other configurations prompted the participants to explore the possibilities of a single - rather than multiple – configuration/s. If not expressive enough, the availability of different configurations may not be aligned to the collective. The fluidity of the configuration or its expressive capacity becomes a critical factor. Overall, the configurability of the Tilt and EC devices was low in the first four activities. Only the final activity using the webcam provided very high levels of configurability.

In the activities using the Tilt and EC devices, we observed only a single form of connection; that is, device-at-hand. However, the webcam provided the participants with alternative configurations they could actually utilize. The high level of connectivity of the webcam allowed the participants to couple with the system in a variety of ways.

Participants' Reflections on the Overall Workshop

The participants found the exercises in the Physical Sensitivity Session very close to their experience of improvising music: 'Body weather exercise was an interesting challenge. Through some practice you would feel very connected to the other person. In a way I felt I was improvising. Producing something that's really ... Head up and down movement was a nice distillation of it'.

As regards the coupled devices, the participants indicated that they preferred to have total control over their instruments. One participant said: 'I prefer a tight coupling between movements and sound, because that's what I'm used to as a musician. At first, something very broad and loose would be fun to play with, but to create something I'd like to have something very tight. But I liked the idea of little randomness in there. I think at least for one parameter you need to have full control; we could create something together as we had our own voices'. The participants stated that connected devices could be beneficial on the condition that they were connected in a different way: 'Connected one in some ways encouraged us to work collaboratively. If the mapping was different, we could further expand our collaborative activities, and work together more to produce something. The problem was not related with the connectedness of the devices but the way of connecting the devices. The musicians found the way of connecting the devices unusual but potentially very useful. They liked the idea of having two musicians controlling the same instrument to create a single sound effect. However, according to the participants, in order to improvise together, two devices should control the different parameters of the same sound effect, e.g., frequency and pitch. One participant commented on the transformative capacity of the mapping algorithm in relation to their music making ability: 'It was interesting see how the same devices change behaviour through software. How some of them are suitable for making music whereas the others are completely foreign'.

Providing a pre-established connection for the female participant did not allow her to improvise her actions but required her to plan them. By coupling devices, we aimed to facilitate more collaboration between participants. However, an unfamiliar existing connection between the devices failed to support the creation of many connections between the participants using these devices. As a result, in the process of coupling the devices we decoupled the participants. Ultimately, rather than predetermining the ways in which participants create connections, it would be a better approach to provide them with the resources and mechanisms that would allow them to create connections in ways preferable to them within a given situation. Further explanations on the final iteration of the workshop are available in Appendix A.2.4.

7. Discussion and Conclusions

The joint motivations of this research have been the need to develop a relational understanding of agency in design and a commitment to explore new spaces of possibility for various collectives of humans and non-humans through design. Drawing upon the extant approaches to and perspectives of STS, ANT, feminist HCI and the broader field of interaction design, and through a series of participatory workshop studies, an initial relational design approach, i.e., Agency Sensitive Design (ASD) with five strategic-generative conceptual devices and six design qualities, has been developed.

The research methodology has used the lenses of ANT and postphenomenology. The main methodological strategy followed an evolutionary and responsive approach to the object of research. The motivation for adopting an evolutionary approach was grounded in the fact that rather than accepting a fixed structure for a workshop process irrespective of what transpires in the process, the workshop design itself became responsive to our ongoing and evolving understanding of the situation at many levels.

The main contribution of the research to the field of interaction design is ASD. The contribution consists of two major parts: 1) theoretical development of ASD concepts and qualities; and, 2) empirical exploration of some ASD concepts and qualities in the early phases of the design process. The contributions are conceptual and provided in the form of abstract metaphorical connections. See section 7.4.3 for explanations of this type of contribution.

In this chapter, I will first present and discuss the two major contributions of ASD, then explain how ASD addresses the research questions. After presenting the limitations of the research and the opportunities it offers, I will conclude with comments regarding future work.

7.1 Contribution 1: ASD Concepts and Qualities

The research has produced a set of design concepts and qualities that constitute ASD. This set, which has been produced out of an extensive review of recent relevant works mainly in the fields of STS, HCI and interaction design, includes five strategic-generative concepts: object(s) of design, design collective, topology, inscriptions/translations, and tuning; and, six sensitising design qualities: relationality, visibility, multiplicity, configurability, accountability and duality. It is important to reemphasise the fact that the set of concepts and qualities is neither complete nor exhaustive; rather, it is a selective set of concepts and qualities that can either be extended or narrowed down. Nevertheless, as suggested above, it has been produced out of a large body of relevant work and provides a useful point of departure for developing and articulating a relational understanding of agency in design.

The focus of ASD is on the field of interaction design. Its intended scope covers the entire design and use phase of the design process, and, its concepts and qualities have been successfully applied separately by many previous studies operating in different phases of design[19]. However, the set of concepts and qualities as a whole has not been applied to any design case involving both design and use phases. Some of ASD's concepts and qualities have been employed by a series of empirical studies. But, the latter have only dealt with the early phase of design. Therefore, the workability of ASD concepts and qualities as a whole, and how they can be defined and translated into phases other than the early phase of design are as yet not known.

The detailed descriptions of each of the concepts and qualities were presented in Chapter 3. There were two reasons for presenting ASD prior to the empirical studies. First, given that the initial set of qualities was produced from the literature, presenting ASD immediately after the literature chapter strengthened the connection between the literature and ASD. Second, the readers could obtain a full understanding of ASD before examining the detailed exploration of ASD concepts and qualities through empirical studies.

The next section presents and discusses the findings of empirical studies exploration of what ASD concepts and qualities mean and how they can be supported in the early phases of design.

[19] The previous studies applying the concepts and qualities can be seen in the relevant sections in Chapter 3.

7.2 Contribution 2: ASD in Early Phases of Design

The research conducted a series of three workshops in order to deepen our knowledge of the five strategic-generative concepts and six design qualities. The first two workshops, which employed two sensory substitution devices, experimented with the topological manipulation methods and focused on understanding the qualities of multiplicity and configurability and, to a limited degree, the qualities of visibility and relationality. Workshop 3 employed a more participatory and responsive approach, which facilitated the involvement of a larger number of human and non-human actors and provided more opportunities for the actors to shape the design process. Four specifically designed activities focused on the four ASD qualities. Because of the nature of the activities in the early phase of design, the qualities of accountability and duality have not been explored (something the research initially intended to undertake). More explanation regarding the exclusion of the two qualities appears in Sections 7.2.2.5 and 7.2.2.6.

The next section discusses how the five strategic-generative ASD concepts characterize the design activities of the three workshops in relational terms.

7.2.1 The strategic-generative concepts of ASD

7.2.1.1 Inscriptions/Translations

Notions of inscription and translation have been employed throughout the research. The benefits of thinking of the design process in terms of a series of inscriptions and translations were outlined in Section 3.2.4. Briefly, notions of inscription and translation emphasize the intertwined relations between design and agency, the interconnectedness of all of the actors, the non-essentialist nature of the actors, and the semi-deterministic nature of the actions performed. The design process may be seen as a series of processes of inscribing and translating, and the design space may be seen as a collective of inscriptions and translations. Notions of inscriptions/inscribing and translations/transcribing are useful for seeing design activities from both temporal and spatial perspectives.

In the workshops, temporally, inscriptions allowed us to see workshop iterations as mutual transformations between inscriptions, the objects of design and the design collective. The intertwined relations between inscription and translation and design and agency were most apparent between the iterations of Workshop 3. In the beginning, all workshop iterations involved a set of initial inscriptions, i.e., workshop, activity and material. The design collectives translated them into various activities. Typically, in a workshop iteration, the initial inscriptions of the previous workshop were revised and shaped according to the translation which took place in the previous iteration. Similarly, the initial objects of design shaped the agency of the design collective, which in turn shaped the object of design. Spatially, notions of inscriptions/translations allowed us to see all of the actors in the design collective as a collective of inscriptions and translations. They could influence any relations and become the sources of any actions. Any entity can become an active actor taking part in shaping the space of possibilities for the effects of a design collective. Thinking in terms of inscriptions and translations as intertwined phenomena helps us to overcome technological or social determinism without losing our ability to account for the influence of our design decisions on the actions of the actors and the kinds of action that might deviate from the envisioned use.

One important discovery of the research was the use of adaptive inscriptions, which, in fact, consisted of a set of inscriptions. Rather than creating one strict inscription and trying to impose it without knowing how the design collective was going to deal with it, a set of inscriptions with different levels of strength or specificity was produced. Adaptive inscriptions work in the following way; at first, the least specific or open inscription is provided. If the collective cannot be aligned with the inscription, then a more specific inscription is provided. A reflective dialogue happens between the workshop facilitator and the rest of the design collective. For example, in the third iteration of Workshop 3, we employed an adaptive inscription for the activity definition of the machine-mediated performance session. We did not know how much the design collective was going to be capable of improvising or of being able to act with little guidance or constraint; therefore, we created a set of inscriptions including activity definitions ranging from a very open exploration with limited specifications to a very prescriptively defined task with many constraints. While the most open inscription was: 'Explore the different forms of connections between the bodies and technology and space through the technological devices', other inscriptions which increasingly became more prescriptive included: 'Explore the different forms of connections between the bodies, technology and space through the technological devices'; 'experiment with performing slow/fast movements'; 'experiment with being mobile/stationary in space'; and, 'experiment with performing according to a theme'. The levels of specification and their situated application enabled inscriptions to be adaptive to emerging effects and the concerns of the collective. In our case, the collectives were successfully aligned with the initial most open inscription. However, if the collectives had not been comfortable with the level of openness of the inscription, i.e., the activity definition, the inscription's level of specification would have been changed to a more specific definition in order to better support an alignment between the collective and the inscription. By having a set of inscriptions with different levels of specificity for the same activity, the inscription became more adaptive to the particularities of the design collective.

Adaptive inscriptions are an acknowledgement of the fact that inscriptions are subject to transformation during the translations. Therefore, rather than insisting on a rigid and stable definition of inscriptions, the workshop facilitator can more actively engage in the process of transformation taking place in translation processes by making adjustments in situ. The cited case of the hotel keys in Section 2.3 is an example of progressively adjusting the strength of inscription in order to impose a desired pattern of action; as well, it is a kind of adjustment of inscription. However, there are two important differences between the two types of adjustments. First, although in both cases the adjustments were made to narrow down the space of possibilities, the hotel manager made the adjustments to the inscriptions in order to impose a desired pattern of action. But, in our case, the inscriptions were adjusted in order to attain a balance between openness and specificity according to the particularities of the situation. Second, the hotel manager made the adjustments after a retrospective evaluation. However, the adaptive inscriptions were performed in situ. In other words, they were performed by reflecting-in-action rather than reflecting-on-action.

An important point related to the application of adaptive inscriptions is the danger of limiting a design collective's capacity to negotiate different relations or alternatives. This may happen if the workshop facilitator makes adjustments to the level of specificity of the inscriptions whenever a design collective experiences difficulty translating the inscriptions and aligning the different interests. Here, the timing of the adjustments becomes critical. Although each situation may have different characteristics, workshop facilitators can determine whether or not it is a good time to make any adjustments by carefully engaging in each situation and developing ‘an understanding-from-within’ (Shotter, 2005) in order to prevent the collective from converging or stabilizing prematurely without fully using its capacity to explore the space of possibilities for the object of design.

In the workshops, we employed three different types of inscriptions: workshop, activity and material inscriptions, all of which had different characteristics. While the workshop inscriptions defined very fundamental, primary and key aspects of the objects of design, which I will refer to as 'primary' inscriptions, activity and material inscriptions dealt with secondary or less fundamental aspects, which may be referred to as 'secondary' inscriptions. Adjustments to the primary inscriptions are more difficult to perform than to the secondary inscriptions, the main reason being that an adjustment to the primary inscription can change the main perspective of the exploration of the object of design. It can be seen as the restructuring of an entire workshop since it may require consequent adjustment to all of the secondary inscriptions. Therefore, because primary inscriptions are not suited to accommodating adaptive behaviour, it may prove very difficult to determine the consequences of the changes to the secondary inscriptions and make a series of well-thought-out adjustments ‘on fly’. However, adjustments can be made retrospectively as there would be sufficient time for reflection and restructuring. In the third workshop, the workshop theme was changed from ‘togetherness’ to ‘connectedness’ after the second iteration. The reason for the change was to use a concept which was less culturally loaded. Although it involved change to a primary inscription, it did not require drastic restructuring of the workshop as the two concepts were not radically different in meaning. Effecting change during the workshop would have caused confusion and inconsistencies between the primary and secondary inscriptions.

The secondary inscriptions can better accommodate adaptive behaviour. And, although it is possible to make adjustments to the secondary inscriptions without prior preparation, it is better to determine the possible set of adaptive inscriptions in advance. As suggested earlier, in Workshop 3 an adaptive inscription was defined for the machine-mediated performance session. The inscription included two activity descriptions; while one involved more open exploration, the other was more constrained and provided more guidance.

7.2.1.2 Design collective and its topology

This research introduced four different ways of manipulating the topology of a design collective.

1. Providing additional resources or mechanisms for actors to connect with other actors in multiple ways
2. Including new actors into the collective
3. Changing the configuration or arrangement of actors in the collective without changing the content or 'population' of the collective
4. Changing the ways in which actors interpret things by metaphors and models of interaction

1-2. New resources and actors:

The first two ways will be considered together as new resources or mechanisms can also be viewed as new actors. While in Workshops 1 and 2, the population or members of the design collective were kept the same, in Workshop 3, the collective included many different sets of non-human actors across the activities. Workshop 3 included four activities in which a large variety of non-human actors participated, i.e., non-material actors such as silence, personalized actors such as personal objects brought by human actors, produced actors such as posters, and various technological actors, e.g., webcam and tilt devices. The changing population of the collective facilitated multiple couplings between the actors and supported different forms of knowing and performing, which was very valuable for exploring the different dimensions of the object of design. Thus, the inclusion of various actors facilitated multiplicity of formation and exhibition of agency.

3. Rearrangement of actors in the design collectives:

The strategy of rearranging the actors in the design collectives was effective in changing the topologies of the collectives. Across the activities, the actors' capacities for action were a relational effect of the collective of humans and non-humans (Callon, 2004). The ‘same’ human and non-human actors performed the same activities; but, the actors and their relations were re-created in different ways through their (re-)arrangements. These arrangements either enabled or constrained the participants as follows: move together or separately; be more active or passive; be a guide or a follower; sense by using one or multiple modalities; and act in accordance with a single script or in a larger space of negotiation.

The collectives' capacity to negotiate their relations was affected by the flexibility of arrangements between the human and non-human actors. While a highly flexible arrangement between a human and a non-human actor increased the human-non-human collectives' possibilities for coupling with another human actor, a less flexible arrangement diminished its possibilities. For example, a technological device attached to a person's hand corresponds to a more flexible arrangement than a device attached to a person's back: a device attached to the hand allows a larger range and variety of action since human arm and hand movements demonstrate a much greater degree of freedom than human back movements.

Facilitating flexible arrangements between human and non-human actors is an effective way of generating diverse relations that perform[20] spaces of negotiation. However, in order for spaces of negotiation to work, they need to be complemented by spaces of prescription (Murdoch, 1998; Sørensen, 2009). In the workshops, while the first activity with the rope created a space of prescription that influenced the rest of the activities, the rearrangements between the human and non-human actors with different levels of flexibility supported the emergence of spaces of negotiation. The final activity of Workshop 1, in which we observed the highest variety in relations, achieved a balance between openness and specificity by involving a highly flexible coupling, i.e., device-at-hand, which was complemented by the space of prescription enabled by the activity with the rope. Although flexibility of arrangements between actors is an important factor for supporting variety in relations, the underlying metaphors and models of interaction highly influence the resultant topology, which can inhibit or support variation.

4. <u>Metaphors and models of interaction:</u>

[20] It is important to remind the difference between the phenomena of 'performing spaces' and 'performing in the space'. While the former considers spaces to be constructed by the patterns of relations between the actors, the latter considers the relations between the actors taking place in an already existing space. See Section 2.3.1.2.4 for further explanation of the phenomenon of 'performing spaces'.

In the workshop studies, different metaphors and models of interaction[21] triggered the most radical changes: this result was most noticeable in Workshops 1 and 2. At the beginning of Workshop 1, we introduced an activity involving a rope which allowed the two human actors to use their experience as a metaphor of interaction in order to construct a model of interaction or an initial topology of relations for performing the rest of the activities. The initial topology shaped the actors' understandings of their roles, relations, and a set of possible meanings. The first activity using the rope worked as an inscription for the remaining three activities, in which the two human actors interacted with each other according to an interaction model informed by a rope metaphor of interaction, which provided some fundamental understandings: two human actors go over a track together and are connected to each other via a technological device, whose signal indicates the right direction. Although the collective of actors was rearranged in the remaining three activities in which the actors constructed three different interaction models with different roles and relations, the rope metaphor of interaction remained as the base understanding for shaping the three models of interaction. The changes in roles and relations took place in the space of possibilities defined by the rope metaphor of interaction.

Since the initial activity was very influential as a metaphor of interaction, it was dropped from Workshop 2, the aim being to allow the natural emergence of interaction models. This worked as intended: and we observed two different interaction models, which could be associated with two different metaphors; a rope metaphor of interaction, and an obstacle metaphor of interaction. The fluidity of initial conditions in Workshop 2, i.e., the absence of an initial guiding activity, supported the emergence of two models of interaction. We observed longer negotiation processes, each of which was terminated by the emergence of an interaction model. The negotiation processes were radically shortened by the availability of interaction models. Interestingly, the interaction models that emerged out of the particularities of the configuration between the actors acted as strong inscriptions narrowing down the action possibilities of the actors by defining

[21] Here I would like to remind my use of the terms 'metaphors of interaction' and 'models of interaction'. While metaphors of interaction provide actors with a more abstract set of descriptions of entities and their relations, models of interaction provide a more concrete and well-defined set of descriptions, which are derived from a higher level metaphor of interaction.

particular patterns of action. In other words, the design collective preferred to negotiate less and act more in the narrow range of possibilities offered by the interaction models.

The collective tended to construct interaction models based on a higher level of understanding and metaphor and to keep them as long as possible. In the two iterations of Workshop 1 and the second iteration of Workshop 2, the collectives constructed interaction models based on the rope metaphor of interaction. However, the human actors in the collective were able to change their initial interaction metaphor by explicitly challenging its effectiveness and suitability in the first iteration of Workshop 2. The re-construction of the interaction metaphor within the same workshop was a unique case in that the collective explicitly discussed their main metaphor of interaction and then negotiated the alternatives for it.[22] Although the resultant interaction models were more restrictive than those constructed according to the initial metaphor, the collective preferred to operate in accordance with a more well-defined and predictable model. The supporting relationality achieved by the empowering of the human actors in the collective did not result in an increase in the variety of the collective's actions/effects. The collective tended to stabilize the patterns of action, which decreased the multiplicity and variety of actions. This suggested that a high-level inscription or control might be required to de-stabilize the collective or foster the negotiation process.

Controlling the choices of the actors is a critical political move somewhat similar to an election process in which voters vote for a decreased level of freedom. Here the critical question is whether anyone has the right to act against the collective of voters' personal selection even in cases in which the collective will have decreased agency. There is conflict between the two aspects of relationality: the aspect of relationality that supports variety and diversity in the effects of the collective and the aspect of relationality that supports those empowered actors, who can act on behalf of themselves and have a say in the things that affect them personally. In our case, one alternative that we could have opted for was higher involvement of the researchers in the negotiation process of the collective. We could have stressed the restrictive nature of the new interaction model; but, we did not know the restrictiveness of the model at the time. We

[22] It is important to note that the collective did not discuss their understanding of interaction in terms of metaphors. The researcher has constructed the associations with models and metaphors interpretively and retrospectively.

thought that by keeping our influence on the negotiation process to a minimum, we could support more natural emergence of the interaction models and respect the relational capabilities of the collective.

In the activities involving no initial guidance, there were long negotiation processes, which aimed to establish a model. After the construction of a model, the negotiation processes were shortened and the action possibilities were narrowed down. The collectives preferred not to engage in a continuous negotiation process; there was a tendency to stabilize the patterns of action within the collective. Explicit interest in de-stabilization, divergence and re-configuration was required in order to support more negotiation and multiplicity. However, while this may have been the case for the relatively small-sized design collectives in our workshops, larger collectives in different situations may exhibit different tendencies towards stabilization.

Obtaining a balance between specification and openness is one of the most critical challenges in both design time and use time (Akrich, 1992). In design time, balance is necessary so as not to narrow down the space of possibilities too much in order to explore and address the various interests of the actors and inscribe them into the object of design. As well, it is advisable not to open up the space too much, because this can result in the design collectives' time and effort being wasted on irrelevant matters of concern rather than being spent upon exploring more relevant possibilities. Loke emphasises that a strategy of open exploration in participatory design workshops may not prove very productive without strong contextual framing (Loke, 2009). The openness or fluidity needs to be complemented by some form of specificity and solidity. In use time, it is important for the inscriptions in non-human actors (the designed objects or systems) to provide resources and opportunities for other actors to relate to one another in various ways and to construct multiple connections rather than impose one particular program of action.

One solution to obtaining a balance between openness and specificity proposed by this research was adaptive inscriptions based on the idea of a range of inscriptions with different degrees of specificity that can be adjusted. Starting with a very fluid or flexible arrangement may prove useful; but, if the negotiation process lasts too long and fluidity continues, then it might become frustrating for the human actors and may prevent the emergence of an interaction model. Likewise, a very solid arrangement at the beginning may result in very quick convergence to an interaction model and hence inhibit the exploration of some more suitable interaction models. An alternative method, which aims to support longer negotiation, may be to start with a very fluid arrangement and gradually decrease the fluidity in a responsive way until an interaction model emerges, then to deliberately challenge and change the interaction models.

As suggested earlier, flexible arrangements between humans and non-humans facilitate different kinds of connections; however, they are also dependent upon the underlying metaphor or model of interaction. If the underlying metaphor is too restrictive, then the flexibility of couplings may not increase the multiplicity. In Workshops 1 and 2, different arrangements within the design collective facilitated different roles, relations and agency. Likewise, metaphors and models of interaction with different levels of interpretive flexibility radically changed or shifted the roles, relations and agency within the collective. Therefore, by playing with the flexibility of couplings and metaphors with suitable levels of interpretive flexibility, we could allow design collectives to perform various activity spaces in which a balance between the spaces of prescription and the spaces of negotiation could be achieved and then used for facilitating improvised (inter)action and creative engagement between the actors.

7.2.1.3 Tuning

The notion of tuning was one of the most critical elements of ASD as it allowed us to recognize the transformability of relations and respond to the need of mutual alignment. Tuning is not a one-way process: it is performed by means of a 'dialogue' between two parties at least. Although in tuning there seem to be two roles for the actors, that is, the role of tuner and the role of being tuned, both actors tune and are being tuned in the process. The goal of the tuning process is to align the interests of the actors.

In our workshops, the tuning operations took place in the workshop, activity and material inscriptions and design collectives. During the workshop activities, the inscriptions and design collectives engaged in a dialogue, in which both design collectives and inscriptions were transformed. This dialogue is a typical tuning process, which can occur in any design activity. Apart from the tuning processes between the inscriptions and the design collectives, there were three different kinds of tuning operations between researcher/design facilitator and workshops: tuning-between-workshops; tuning-between-workshop-iterations; and, tuning-inside-the-workshop-iterations. While the first two forms of tuning were performed according to a retrospective analysis of the previous workshops, the third was performed in-situ, which was closely related to the idea of the adaptive inscriptions mentioned earlier.

There were two tuning-between-workshop operations performed: one after the first workshop and the other after the second. They were fundamental tuning operations effective on all iterations within the workshop. While the first tuning changed the initial topology of relations and introduced a new technological actor, the second increased the number of activities, actors and ways in which the actors come together. The evolution between Workshops 1 and 2 involved fewer transformations than those between Workshops 2 and 3. The main object of design, which, in its most general form, can be described as the exploration of various couplings between humans, non-humans and the environment, tied the workshops together.

The three tuning-between-workshop-iterations operations were performed between the iterations of Workshop 3 only. Tuning operations between the iterations further increased the responsiveness of the inscriptions to the concerns that emerged from the workshop iterations. The suitability of the inscriptions to the object of design and the design collective was challenged, and the required changes were made after each iteration. Here, the critical question was how to determine whether the concerns that emerged from one workshop iteration were relevant to a larger set of cases. In other words, the question was: how could we ascertain whether the concerns were generalizable and valid for the next iterations? If similar concerns were likely to emerge from the next workshop iterations, then tuning the definitions of the inscriptions could prove a right decision; but, if they were relevant to a particular single case then tuning may not be the correct decision as it could orient the evolution of the object of design according to a rare case.

There can be no magic formula for understanding the generalizability of the concerns emerging from such participatory design workshops, as they are not designed to draw generalizable results, which are typically supported by strictly controlled parameters. Therefore, relevancy is a better guide for the participatory workshops than generalizability (Zimmerman, Forlizzi, & Evenson, 2007). However, determining relevancy remains a critical and difficult task. In order to overcome this difficulty, the previously discussed notion of adaptive inscriptions was developed and employed as the main strategy behind the tuning-inside-the-workshop-iterations.

The distinctive feature of the tuning-inside-the-workshop-iterations was that they were performed in-situ, which, again, further increased the *responsiveness* of the inscriptions that were equipped with an adaptive mechanism. Basically, the concerns that emerged in the previous workshop iteration were used to identify a set of relevant concerns. However, they were not taken as indisputable or fixed truths; rather, they were seen as signifiers of some critical matters of concern that deserve further attention. Tuning operations can be performed on the basis of these signified concerns but not in terms of performing the tuning on the basis of what happened in the previous case but also what might happen in the next case. For example, in the workshops, the level of specificity for performing movement emerged as a concern. The dancers found the specificity of activity descriptions too constraining, leaving very little room for improvisation. Although tuning the inscriptions by removing some of the constraints could be useful for a set of participants with backgrounds in dance, it may not be suitable for a set of participants without dance backgrounds. In our case, the two interaction designers, who had no previous dance experience, were expected to participate in the following workshop as well. The removal of some of the constraints could have rendered their task too ambiguous. The solution was to create a set of inscriptions with different levels of specifications or constraints, i.e., adaptive inscriptions. In other words, rather than making a binary choice that may or may not have suited the participants' different backgrounds, we defined a range of inscriptions from a very fluid and open task definition to a very constrained and closed description. As suggested earlier, one strategy is to start with a very open task definition and then gradually introduce new constraints. Here, the relevancy of an inscription was determined by an in-situ assessment of conditions that was made possible by the provision of *a range* of design choices.

In this example, a set of inscriptions with different levels of specificity was generated. The advantage of having a range of inscriptions lay in the fact that the suitable level of specificity could be used according to the needs of the situation. Therefore, if a problem with the level of specificity of inscriptions in an activity occurred, a less or more specific level of inscription replaced the previously used inscription. If there were no problems at all, then the current inscription was left unchanged as was the case of the workshop with interaction designers. The availability of a different range of inscriptions is helpful since inscriptions can be tuned according to the needs of different design collectives.

Tuning operations are possible when a design process is flexibly structured and the inscriptions are changeable and tuneable. Although changeability, adjustability and flexibility are useful and valuable properties for supporting relationality, they may have negative side effects. In the second iteration of Workshop 3, the participants questioned the changeability of particular design constructs, i.e., the activity inscriptions. In particular, they referred to the case when we said that we could remove the requirement for being in a back-to-back position from the next activity, a decision we reached after the participants questioned the relevance of working in a back-to-back position. Although our workshop was based on an evolutionary and open-ended design approach, which was sensitive to the emerging concerns of the participants and encouraged exploration, the changeability or flexibility of activity inscriptions became problematic. According to the participants, if it was possible to change the design constructs, then there was no point in trying to achieve the workshop's goals within the specified constructs. As a result of this conjecture, our strategy of being sensitive to the emergent concerns in the workshop fuelled negative impressions and a general mistrust in the overall research rationale, goals and methods employed. One participant stated that the entire workshop set up/constructs in Workshop 3 were inconsistent and seemed to have been randomly generated. The flexibility of the workshop structure decreased the perceived strength of the inscriptions. Some important questions were raised pertinent to the flexibility of the design processes: How much flexibility is needed in the design process to prevent any mistrust in the research rationale? How should one effect the changes needed during the design activities? To what degree should the design process and the design decisions be opened up? And, what should or should not be open to negotiation?

7.2.1.4 Object(s) of design

In this research, the object of design was enacted as a relational actor requiring a non-essentialist understanding, a conceptual and material actor variously connecting the aims, the collectives and the outcomes of the design. The connections have been performed by a series of acts of inscribing and translating. The relational character of the object of design can be explained according to the three characteristics of object of design introduced in Section 3.2.1.

i. <u>There are multiple objects of design enacted relationally</u>. During Workshops 1 and 2, there were four activities involving multiple forms of the object of design. The different configurations or arrangements of the collectives of actors created multiple objects of design in the form of different connections between human actors via technological actors. A different set of connections involving different senders, receivers and messages emerged in each activity. The roles of the senders and receivers and the meaning of the messages were redefined.

In Workshop 3, multiple forms of the object of design were produced by means of different collectives of human and non-human actors rather than by different configurations of the same set of actors. Various forms of connections emerged such as connection as memory, connection as synchronised movement, connection as sound and connection as criticism.

ii. <u>The objects of design are in a process of constant transformation and becoming during the entire design process including design time and use time</u>. Multiple forms of the object of design in each activity of the workshops could be viewed as different instantiations of an evolving main object of design. They were constituents of the main object of design in a process of becoming. As all three workshops were situated in design time, the evolution of the object of design in use time is not known.

iii. <u>The objects of design are constitutive and performative</u>. Each form of the object of design was an active actor after becoming part of the design collective. They shaped the space of possibilities for the next form of the object of design. In the workshops, the initial topologies of the design collectives, which were created in pre-design time, played a key role in shaping the trajectory of the evolution of the object of design in design time. We observed in pre-design time that there was no single object of design independent from the ways of exploring it. The object of design and the ways of exploring it were intertwined. This suggests that what an object of design can be is defined by the kinds of ways of exploring it. Exploring the object of design through linear, formal, coherent, rational and essentialist methods is likely to result in (supposedly) a single object of design. However, a nonlinear, multi-thread, non-coherent and relational ways of exploring the object of design is likely to result in multiple objects of design.

7.2.2 The six qualities of ASD

7.2.2.1 Relationality

The quality of relationality, which is the core quality of ASD, was supported by a combination of the conceptual devices and other ASD qualities. Apart from the overall research aim of embracing relational agency in design, the quality of relationality was supported explicitly in some activities the aim being to create situations in which the interdependency of the actors' capacities of action was amplified.

In Workshops 1 and 2, the inscriptions were effective in supporting the quality of relationality by strongly coupling two human actors via two non-human actors: a rope and a wearable device (the EC). In all of the activities, the human and non-human actors constituted a series of collectives consisting of the same members whose roles and capabilities were continuously negotiated and transformed.

In Workshop 3, the three exercises in the physical sensitivity session were scripted activities amplifying the sensation of reciprocity of our actions through sensing the effects of our movements both visually and in a tactile way. The proximity of the bodies amplified the sensation. The exercises were extreme cases of connectedness where one body was strongly connected to another in a physical way. The sensations and movements of one body were tightly coupled with the other. There was a very high degree of influence between the bodies that increased the visibility of the relationality of two bodies and their capacities for action. In all three workshops, the participants' comments demonstrated sensitivity to the shared capacity of their actions and co-construction of their performances. Apart from the second workshop in which the participants lost their connection frequently, the exercises were effective in emphasizing the quality of relationality.

One important point in the physical sensitivity session was the fact that its activities were 'scripted'.[23] Since ASD advocates emergent actions and fluid relations, strongly scripting the ways in which actors relate to each other may sound conflicting to relationality. However, it was exactly their following of the scripted interaction that made it possible for the actors to experience relationality and explore its various dimensions, limits and opportunities. The exercises performed in the physical sensitivity session demonstrated how it was possible to support relationality through strong scripts/inscriptions. The high level of specificity of the scripts in this session may be viewed as a solid initial topology providing many constraints for actors to relate to each other. Although this solid topology had characteristics of a space of prescription, the well-constructed set of constraints themselves enabled and stimulated the actors to develop an understanding of relationality and to perform various experiments while connected to other actors.

7.2.2.2 Multiplicity

In Workshops 1 and 2, the main strategy of rearranging the actors of the design collective was effective in supporting multiplicity of translations with multiple roles and relations of the actors, and the strategies employed. For a discussion of the transformations of the topology of the design collectives see Section 3.2.3.

In Workshop 3, the quality of multiplicity was supported in three ways: (1) multiple ways of engaging with the object of design by bringing together a diverse set of activities; (2) multiple roles for participants by employing a strategy of switching roles; and, (3) multiple mediums of expression by incorporating a range of digital and non-digital materials.

1. <u>Multiple ways of engaging with the object of design</u>. Different kinds of activities allowed us to understand different forms and dimensions of the object of design. In general, the rich poster and machine-mediated performance sessions were effective in

[23] Here the term ‘scripted’ means that strict rules defined what and how human actors were going to do in the activities. There was very little room for human actors to perform an activity in a way that differed from what was written or scripted in the activity definition.

producing various forms of connections which were revealed as follows: connection as movement, connection as sound, connection as criticism, and connection as memories, for example. Many different strategies for constructing and maintaining connections were observed: making similar actions/movements, making opposite actions/movements, combining stops and repetitive movements, combining stops and varying movements and a-synching movements. However, the inscriptions could not achieve their goal in the rich poster session with the musicians and in the machine-mediated performance session with the dancers. While the musicians preferred to create a single form of expression, the dancers found the technology insensitive to their performing together; thus, they could not complete all of the activities in the session.

2. Multiple roles. In the physical sensitivity session, the participant performed the same activity by switching the roles of leader and receiver. It was effective in enabling participants to develop a relational understanding of their movements. Therefore, the quality of multiplicity served to support the quality of relationality.

3. Multiple mediums of expression. The human actors used different mediums such as paper and technological devices to represent various personal connections in their lives. For example, the rich poster session allowed the participants to express their views of the design concept on a 2D shared medium, i.e., on paper in the form of a collage of pictures and texts. They created representations or proxies of the previous connections they had made in their lives. In addition, the totality of the pictures and texts revealed forgotten or unknown connections between places, people and memories. Moreover, each technological device invited different patterns of action. While the Wii-motes sensed the movement of human body fairly independently of other bodies, and the space using measurements in vertical and horizontal axes, the rangefinder devices sensed the movement of the body in relation to other bodies or entities in space using a directional distance measurement. Finally, the webcam sensed all of the motion within its field of view producing sounds from the movements of all of the bodies in space.

Although we have advocated the inclusion of multiplicity as a quality in design, multiplicity may result in some undesired effects for the design process. One participant from the second iteration of Workshop 3 vocalized her concern about engaging with multiple activities and multiple media in the workshop:

> Ultimately, we are transferring, transferring and transferring through different media. But, in that transference, we are getting further and further away from proximity to actual sensitivity and composition.

This was an important criticism of using multiple activities and multiple mediums in a single half-day workshop. The participants could only spend short periods of time on each activity, and this limited their capacity to develop a deeper understanding of their relations with the other participants, materials and technologies. Multiple activities might enable participants, researchers and designers to gain a broader perspective of many dimensions of an object of design, but the knowledge obtained from these short-lasting activities may prove imprecise, shallow and scattered. This could disadvantage design projects with a more specific focus. But, it could prove advantageous for design projects in the early explorative stage in which the eliciting a broader perspective of many dimensions of an object of design or problem is very valuable.

Another important matter of concern regarding the quality of multiplicity is that although multiple points of view, multiple ways of knowing, multiple ways of performing and multiple ways of relating support responsible, inclusive and innovative design practices, there can be some problems related to: coherence and consistency of the objects of design; organization and management of multiple actors; and, alignment of the diverse interests of the actors. The different actors may perceive the same situation and the roles of other actors in the situation differently. This can be the case particularly for situations in which participants from different professions work together.

The eventuation, which occurred in the second iteration of Workshop 3 in which dance performers participated, illustrates how conflicting understandings of the same situations can cause breakdowns and dissolution of the design collective. In each of the four iterations of Workshop 3, we worked with different sets of participants from different backgrounds, which was part of the strategy of supporting the quality of multiplicity. Although multiple points of view were quite useful for seeing the different dimensions of the object of design, they caused a critical breakdown in the flow of the workshop process in the second iteration with the dancers, where two kinds of workshop spaces were observed: a space of research and a space of performance. When the researchers and participants were discussing the research process or structural aspects of the workshop, the space was a space of research. However, when the participants started to perform the activities, the space turned into a performance space; in fact, it became a stage. Therefore, there was a relation between the current activity and the conception of space. 'What the space was' was defined by what the actors were doing at the time. The space as a stage was quite different from a space of research. Once on stage, the roles of the participant and the researcher transformed into roles of performers and audience respectively. In one instance, one of the participants found the act of discussing the structural matters of the workshop process during an activity totally inappropriate and stated that it ruined the performance and any possible gains that could accrue from the experience of the performance. In fact, this conflicting situation was attributable to the participants' and researchers' different perceptions of boundaries between activities and space. While the three short activities in the physical sensitivity session were independent and separable from the point of the researchers, they were closely connected to each other and part of a larger single performance according to the participants. Therefore, changes in roles may ask for different forms of interaction between the participants and researchers and require different sensitivities. The transitions between the activities and consequent transformations in the spaces and roles may be instant; thus, not every actor will capture them. Although such situations are difficult to foresee and to be prepared for, one needs to be aware of the possible challenges of multiplicity in design activities.

7.2.2.3 Configurability

In Workshops 1 and 2, the multiple configurations between the actors across the activities facilitated the creation of various connections between them. There were multiple configurations in which human and non-human actors could come together in diverse ways. As part of the strategy of rearranging the actors of the collective, all of the configurations were predetermined. Although the strategy worked well in terms of changing the topology of the relations without including new or eliminating extant actors, it highly limited the actors' ability to create their own configurations. As a result, the quality of configurability was supported in terms of the application of multiple predetermined configurations.

In contrast, in Workshop 3, there were no predetermined configurations. Wearable devices, which were compact, portable and attachable to different parts of the bodies by various straps, were used to support emergent configurations. However, the participants did not use the straps and held the devices in their hands only. The inscriptions of straps, which involved the quality of configurability, were not translated in practice in the expected ways as the particular characteristics of the sensing technology and mapping algorithm, i.e. their inscriptions, did not invite use of many possible configurations between the human body and the wearable devices. The lack of expressive capacity in many of the configurations rendered emergent configurations either useless or not preferable. Here, configuring the ways in which the device and the human body were coupled became less desirable for the participants since a particular configuration, the device-at-hand, provided participants with the opportunity to exploit the expressive capacity of the devices to the maximum.

In the machine-mediated sessions, the strategy of coupling the two technological actors (two Tilts and two ECs) was not sufficiently effective to foster collaboration and engagement between the participants. In fact, the participants attempted to collaborate with their partners when using the coupled devices; but, the pre-defined relations between the devices limited the participant's capacity to control them. The participants usually looked for a very direct one-to-one mapping between their movements and the sound effects. However, the combination of controls produced in this coupling of two devices did not allow the participants to easily understand the relationship between their movements and the devices' responses. In general, all of the participants from the third workshop had similar experiences: 'The combined one might be more interesting but we should not compromise our own capacities'; 'at first something very broad and loose would be fun to play with but to create something, I'd like to have something very tight... But I liked the idea of little randomness in there. I think at least for one parameter you need to have full control'; 'I found it [the coupled device] very frustrating because if you are asking me to create music then I'd rather have something that is extremely responsive, that I can actually get to know and understand how to work it'. Here, the comments of the human actors such as 'something very tight' and 'something that is extremely responsive' highlight an important concern pertinent to control and negotiation. The human actors' comments can be interpreted as their preference for a control-type relationship with the technological actors. Habitual understanding of technology as mere tools or the simplistic behaviour of the technological actors in the workshops may have contributed to this situation. Whatever the cause, the fact of human actors' habitual relationships with technological actors can work against the strategies for supporting ASD qualities.

In general, supporting the negotiation processes or distributing control can be suitable for open ended and/or playful exploration; but, if there is a task-oriented activity with many constraints, it can be frustrating and perceived as an obstacle. In other words, while the role of the technological actors as collaborators can be more preferable in an explorative situation, their roles as a tool can be more suited to repeatability- and reliability-required cases. A strategy of redistributing control, as in the case of coupling the technological actors, may prove useful for facilitating more exploration and collaboration. But, it needs to be designed in such a way that the human actors can develop a sense of control in their relations with the other actors. Furthermore, increasing the intelligence of the technological actors may prove useful for enabling human actors to relate to them as collaborators or co-performers.

Actually, it is the ability of tuning that the decoupled devices are able to offer compared to the coupled devices. Ultimately, rather than predetermining the ways in which participants created the connections, a better approach would have been to provide resources and mechanisms for the participants to create connections in the ways they preferred to do within the situation. In general, providing resources that enable actors to create connections in diverse ways is a more suitable strategy for supporting emergent actions and fluid relations than coding or strictly predefining the connections between actors. However, irrespective of experimentation, scripting[24] some relations or configuring an initial topology of relations is inevitable. The critical point is not about the act of scripting or the existence of scripts but about the degree of scripting, i.e., how strong and specific the script is, and the intention behind the scripting.

[24] I use the terms 'script' and 'scripting' in the same sense as the terms 'inscription' and 'inscribing'. In this part of the discussion, using script and scripting conveys the meaning more effectively.

There can be degrees and strength of scripts. A useful way of seeing openness and specificity or fluidity and solidness of scripts can be found in seeing them as a continuum with degrees of openness or fluidity rather than as well-separated categories. This view allows us: (a) to understand that elements of openness and specificity coexist in the scripts to varying degrees; and, (b) to tune the scripts according to the particularities of the situations.

In addition, there are different characteristics or intentions behind scripting. While it is generally the case to predetermine or script relations between the actors in order to control their actions and prevent deviation from the expected action, it is also possible to use preconfigured and scripted relations as a means of opening up another space of possibilities for actors to explore. As discussed before, in the physical sensitivity session, the strong script of exercises allowed the participants to develop a strong sense of relationality and to explore how such a pair of strongly coupled bodies feels and acts. At one side, while the scripts narrowed down the space of possibilities by introducing various constraints, at the other side, they provided the participants with access to another territory where the connectedness between the actors was amplified through a specific topology of relations. The availability of such constraints and the specific configuration of relations rendered visible the path to that territory.

In Workshops 1 and 2, the different placements of sensing and effecting the capacities of technology affected the roles that the human actors played. The participant, who carried the sensing capacity, felt more responsible for controlling the flow of activity. In other words, the sensing capacity required the participant who carried this capacity to be more active and the other participant to be more passive. In other settings, this particular situation may have been different. However, the important point is that the other actors who coupled with any of these sensing or effecting capabilities may become an actor more or less powerful, more or less visible, and more or less active in a design situation according to the 'transformative potential' of the above capabilities that emerge relationally. Since these transformative potentials are relational, they can only be understood through experimentation of various configurations between the actors.

The different configurations within the same design collective are not neutral. A particular choice of configuration is a political choice: those who design or determine the collectives' configurations have a responsibility to consider 'the effects' of alternative configurations, i.e., what kinds of actors are being generated; how the capacities of action are distributed; and how they can be distributed differently.

7.2.2.4 Visibility

In Workshops 1 and 2, the quality of visibility was supported in terms of increasing the 'visibility' or awareness of other modes of sensation different from the dominant, visual mode of sensation. In all of the activities, the human actors developed various non-verbal ways of communicating with each other through haptic and sonic sensations mediated by non-human actors in the forms of sensory substitution tools. Blindfolding complemented by sensory substitution tools was an economical and effective way of radically changing the habitual ways of relating to other actors.

In Workshop 3, the quality of visibility was supported in the silence and poster sessions. In the silence session, the aim was to increase the visibility of the other modes of sensation. This was achieved according to the participants' statements. The participants sensed previously insensible things in the space such as the temperature of another body, the sound of a watch, and the noise of the A/C. In the poster session, the aim was to make visible the various forms of connections between humans and other entities. Apart from the fourth workshop in which the poster was a single manifestation of visual aesthetics, the posters in the first three workshops exhibited various forms of connections such as shared memories, shared criticism and a shared culture.

In the machine-mediated performance session, we had not planned to support the quality of visibility; however, lack of visibility caused problems. Since the mapping algorithm was complex and quite opaque, the participants could not understand the working principles of the technology. The visibility and accessibility of the mapping algorithm was very low, which was something against the quality of visibility advocating the visibility of working principles of technologies. Although we did not explicitly aim to support visibility, its lack created an obstacle for the participants when it came to creating and maintaining connections. As a solution, the visibility of the mapping algorithm was progressively increased. This was a very similar case to that of the hotel manager explained in Section 2.3. We first verbally explained the mapping algorithm in the first pilot workshop, then provided a one-page visual diagram of it. However, neither proved sufficient. Finally, we provided a real-time visualization of the mapping algorithm showing how each movement position corresponded to musical notes. This final method was effective in explicating the working principles of the technological devices. It is important to note that this case showed that it might not be possible to deal with ASD qualities separately. For example, the quality of visibility plays a key role in all activities; hence, it always needs to be supported to varying degrees. Lack of visibility might prove an obstacle to supporting other ASD qualities as was the case with the activities performed in the final workshop session using coupled devices.

7.2.2.5 Accountability

In Workshop 3, we supported accountability by asking participants to use colour-coded markers in the Rich Poster Session. This was a simple way of explicating traces of each participant's actions. Although it was an effective method for supporting the quality of accountability, the nature of the poster activity did not ask for different accounts of the participants' actions. The poster creation was a relaxed, open-ended and explorative activity, which did not have important implications for any other activity or process. Therefore, facilitating accountability in such an activity was not required. However, for the purposes of demonstrating a way of facilitating accountability in a participatory workshop setting, using colour-coded markers was an effective example.

In a design situation, there can be different treatments for supporting accountability of human, non-human and their small collectives. In the case of human actors, an explicit understanding of located accountabilities can be facilitated (Suchman, 2002). For non-human actors, designing some features to increase the visibility of the working principles of non-human actors is useful for supporting accountability (Chalmers & Galani, 2004; Dourish & Button, 1998). Finally, for a collective of human and non-human actors, a particular composition of collectives can make the collective's actions recognizable and traceable. When designing the relations between humans and technologies, facilitating particular and unique couplings between humans and technologies can be an effective strategy for supporting the accountability of small collectives like the collective comprising a human actor and a colour-coded marker in the third workshop.

7.2.2.6 Duality

Before the first iteration of Workshop 3, we had planned to include some activities that would allow the participants to consider the dual nature of their design decisions. However, as the workshop was situated in an early explorative stage of a design process, we decided that it was not the right time to support the quality of duality. Duality could be considered after some alternatives for the objects of design had become solid. Otherwise, unnecessary effort could be spent on considering the dual effects of alternative design solutions that are neither feasible nor relevant. Therefore, we did not address any aspects of duality in the workshops, but supposed them to be considered in the later stages of the design process. The postponing of the considerations pertaining to the quality of duality was a suitable decision for our workshops.

In general, this case suggests that ASD qualities need to be dealt with on a case-by-case basis. The relevance and necessity for the qualities can be different at different stages of the design process and for different design cases. Integrating ASD qualities into the design process is never a straightforward decision: the relevance of the qualities, their negative side effects, and various social, ethical and monetary costs need to be considered according to the particularities of each case.

7.2.3 ASD's Contribution to Participatory Design and Iterative Design

The research has employed participatory design workshops in an iterative manner in order to explore what ASD concepts and qualities can mean, and how they can be supported in the early phases of design. As suggested in Chapter 3, ASD has not been envisaged as an alternative to the well-established approaches such as participatory design or iterative design. Rather, it has been offered as a complementary approach or a sensitising tool containing a set of concepts and qualities that can help designers to integrate a relational understanding of agency into their design thinking.

Although participatory design and iterative design have been employed as a means for exploring ASD qualities, the research has provided many insights that can prove beneficial to both approaches. Regarding participatory design, there have been some recent calls from within participatory design community vis-a-vis the necessity to extend the idea of participation so that it includes the participation of non-human actors (A.Telier, 2011; Ehn, 2008). This research, which offers ways to recognize the participation of non-human actors in participatory design workshops, has demonstrated how non-human actors, which are referred to as 'material inscriptions' in the workshops, participated in the construction of various design collectives and the ways in which they reconfigured the roles of other actors in the design collectives. In particular, the notions of inscriptions/translations provide participatory design with a useful basis from which to develop and implement an extended notion of participation.

Regarding iterative design, the strategic-generative concept of tuning offers a more responsive approach to making revisions between and inside design iterations. Here, a higher level of responsiveness is useful for accommodating emerging concerns during design activities. In brief, the method of adaptive inscriptions discussed in sections 7.2.1.1 and 7.2.1.3 defines a range of conditions with different degrees of specificity for a design activity. A suitable level of specificity is determined according to an in-situ evaluation of the design activity. Although the adaptive inscriptions employed by the research were applied to iterations in participatory design workshops only, developing methods to implement in-situ responsiveness to emerging concerns of actors may be considered an important step towards obtaining a balance between a suitable level of openness and specificity in iterations taking place in other contexts of design.

7.3 Revisiting the Research Questions

This work has proposed two core research questions: How can a relational view of agency contribute to design? and, How can design recognize and support relational agency? The first question has been addressed by ASD strategic-generative conceptual devices, the second by ASD qualities. The research has dealt with the above questions in the context of interaction design and the early phases of design. In the next section, I will briefly explain how the research questions are addressed by ASD concepts and qualities.

7.3.1 Question 1: How can a relational view of agency contribute to design?

Regarding the first question, the research has developed five strategic-generative concepts: inscriptions/translations, design collective, topology, object(s) of design and tuning. These concepts provide ways to understand and characterise the design process from a relational perspective. The research employed the concepts in a generative manner to design the workshop activities, and in an analytical manner to analyse the workshop activities retrospectively. Briefly:

Inscriptions/translations connect the temporal and spatial dimensions of the design activity by a relational understanding. While the design process is seen as a series of acts of inscribing and translating, the design space is seen as a collective of inscriptions and translations. The power of the notions of inscriptions and translations is attributable to their intertwined conceptualization according to which an act of inscription is an act of translation as well.

Design collective refers to a collective of human and non-human actors taking part in design process. It emphasizes the fact that design involves an act of coming together of various human and non-human actors. Since there can be many different ways in which these actors can come together, each enables or constrains a different space of possibilities. The recognition of non-human actors allows us to consider the effects of a larger collective of actors, their different arrangements, and the spaces of possibilities they can enable/disable.

Topology characterizes particular arrangements of collectives of human and non-human actors in a design situation. Unlike ontology, topology focuses on the relations and connectivity between the entities without trying to predefine what the entity is. This is important from the relational point of view because not defining what an entity prior to its relations with other entities enables us to understand and acknowledge the emergent capacities of action. Here, the notion of topology works in a non-reductive way regarding what entities are and what they can do. From a design perspective, this non-reductive attitude is important as it enables: i) design process to open up to a larger range of interaction possibilities between entities; and, ii) design products to become more adaptable to the needs of different situations. The research offers different ways of manipulating the topology of the collectives in order to enable different spaces of possibility for the objects of design.

Object(s) of design offers three understandings: i) there are multiple objects of design enacted relationally; ii) the objects of design are in a process of constant transformation and becoming during the entire design process; and iii) the objects of design are constitutive and performative.

Tuning highlights the importance of the adjustability or transformability of relations in a collective and requires relations between actors to be more flexible and tuneable as opposed to being stable, fixed and strictly defined. It is a process of negotiation and alignment for finding a temporarily stable relational state.

7.3.2 Question 2: How can design recognize and support relational agency?

With regard to the second question, the following six design qualities have been developed: relationality, multiplicity, configurability, visibility, accountability and duality. They have been employed in tandem with the ASD concepts and inscribed into the workshop activities as various forms of inscriptions. The six design qualities allow designers and researchers to integrate a relational perspective and sensitivity into their design thinking. This will ultimately help to produce objects of design that can support a higher level of flexibility and variety in the formation of agency. Briefly:

Relationality refers to the connectedness and relatedness of human and non-human actors. It highlights importance of understanding of the mutual influence, shaping and co-constitution of human and non-human actors, and supporting of emergent and improvised action.

Multiplicity refers to a multiplicity of ways of representing, knowing, and performing. While design processes can embrace multiplicity by supporting participatory, democratic and open practices together with rich representations of multiple partial forms of knowledge, design objects can embody multiplicity by utilizing flexible, context-sensitive and adaptive mechanisms.

Visibility refers to variously making visible the invisible work, human and non-human actors, and infrastructure and interactions in both design and use of technologies. Visibility in design time entails recognizing every human and non-human actor and their roles in the formulation of both the design problem and the design process. Moreover, visibility in use time entails keeping the boundaries and interactions between all humans and technologies distinct and observable.

Configurability refers to an ability to facilitate different arrangements between human and non-human actors. The quality of configurability is closely associated with the quality of multiplicity. A higher level of configurability is likely to support multiplicity in ways of knowing and performing. While employing various topological manipulation methods can support configurability in design time, open, modular, and flexible technologies can support configurability in use time.

Accountability refers to 'the property of action being organised so as to be observable and reportable' Dourish and Button (1998, p. 15). The quality of accountability can be promoted by making visible the actors, roles, their locations and systems accounts.

Duality refers to consideration of the dual characteristics of design decisions. Duality can manifest itself in many forms, e.g., privileging/ignoring, inviting/inhibiting and amplifying/diminishing. The quality of duality involves consideration of both kinds of invited and inhibited actions, amplified and reduced sensations, supported and ignored values, and accounting for their implications.

It is important to remember that unlike the first four qualities, which have been explored through the three workshop scenarios, the last two design qualities have been developed using relevant works in literature and have not been empirically investigated within the context of this research.

7.4 Limitations and Opportunities

7.4.1 Timing of the ASD

ASD concepts and qualities were applied to an early explorative phase in design time; therefore, how its application to the later phases of design time and how the final inscriptions of the delivered object of design can be translated are not known. However, it is possible to anticipate some strategies. In general, for the later phases of design time, typically more convergence and stabilization of the object of design are expected. Therefore, tuning operations can be performed in such a way that the fluidity of topology of the design collective gradually becomes more limited. The relational aspects of the design process need to be decreased eventually in order to be able to align the interests of the actors/stakeholders and inscribe them into the object of design to be delivered. In use time, ASD qualities can be used as analytical lenses via which to understand whether translations in practice take place in accordance with the qualities or not, and whether the actions or effects of collectives in use time are confined to a single translation or demonstrate multiplicity.

It is possible to provide some indicators for demonstrating how ASD qualities can be used for understanding the degree of support to the relational nature of agency in actual practice. Apropos of *visibility*, there can be three main areas of visibility in use time: visibility of actors, visibility of collectives and visibility of interactions. *Multiplicity:* one can look at the variety in the formation of the collectives and the variety in the effects of interaction. *Relationality*: the occurrence of improvised (inter)action and novel relations between the actors can be indicators. *Accountability:* parallel to visibility, ongoing activities and interaction between actors can be expected to be visible, observable and reportable. *Duality*: the unexpected effects of practice can be investigated. *Configurability*: while technologies can be expected to be configurable, customizable, modular, extendable and flexible, the properties of relations between technologies and human actors can be expected to be tuneable.

7.4.2 ASD in a real life design case

The workshops were conducted in a studio space in a university environment. Neither workshop settings were everyday settings: nor was the initial object of design related to immediate everyday situations or problems. The settings and the object of design were specially constructed for my inquiry. The main reason for conducting the research in a constructed situation was related to the notion of third space as defined by Muller (2003). The aim was to create not only a third space but also a third situation within that space. The actors, their activities and the objects of design were imagined to be different from their everyday contexts. Therefore, it was similar to a defamiliarization strategy, which has been often employed by studies adopting situationist and feminist perspectives (Bell, Blythe, & Sengers, 2005; Loke, 2009; Sengers, Boehner, Mateas, & Gay, 2008).

The research has constructed its object of inquiry: both what is investigated and how it has been investigated have been constructed by the research. Law suggests that methods are not some neutral means of access to an already existing reality; instead, they are performative activities that construct realities (2004). In the case of this research, the phenomenon of the 'constructedness' of realities by research studies has been taken one step further. The research has generated an entire design situation in which the actors, their roles and the objects of design had not existed in the form of a collective prior to being gathered together for the research. As there was no collective, no actors, no object of design, and no particular ways of exploring, the entire design situation was constructed from scratch.

Since the workshops were conducted in a studio space and not in a natural setting, they might seem similar to laboratory experiments. However, there were important differences between them. First, the workshops were not strictly ‘controlled’ experiments that usually have dependent and independent variables. The research was explorative and conducted in a 'lab' setting. It neither tried to predict nor control the actions of the participants: nor did it lend to hypothesis testing. Participation, adaptivity and responsiveness were key values: it did not aim to summarize or take an average of the results as would be the case with cultural probes (Gaver, Dunne, & Pacenti, 1999). It was a generative and participatory way of doing inquiry. It has not sought essences but looked for situated characteristics of cases, and how relations were established, maintained and transformed. It has not tried to measure the realities: it has tried to describe them. It has not aimed to provide guidelines or templates or tried to establish strongholds: deviations, variations, breakdowns, conflict and mismatches have been treated not as exceptions but as resources for developing a deeper understanding (Gaver, Beaver, & Benford, 2003; Law, 2004).

This strategy of using constructed situations has had its advantages and disadvantages. One advantage was that the constructed character of the situations enabled the entire workshop process to work as a metaphor involving a unique performance of actors engaging in various design activities. The various matters of concern that emerged out of the activities may be translated to other design cases metaphorically. The constructed abstract nature of the workshops increased the ability of the research to contribute to different areas related to design. This can be understood by noting the very different venues in which some parts of the research have been presented including NIME (new interfaces for musical expression), SEAM (a dance-performance symposium), ECCE (European cognitive ergonomics conference), DIS (designing interactive systems), PDC (participatory design conference), P-INC (participatory innovation conference) and DESFORM (design and semantics of form and movement). Another advantage was that ‘constructedness’ allowed me to become more experimental and more flexible when designing and tuning the workshops. This may, however, be seen as a drawback since in everyday situations, the same levels of flexibility may not be possible. However, the important point is to develop sensitivity to the notions of tuning and responsiveness: the constraints of the different situations can vary and resist tuning.

There were also some disadvantages, since all of the elements of the workshops including the settings, the object of design, and the actors' roles and activities were mostly 'new' or 'novel'. Thus, decisions regarding what could be counted as 'regular' or 'expected' - albeit temporarily- were hard to answer. In order to deal with the problem of dealing with the novel, we observed and analysed how regularities were constructed and negotiated. In Workshop 1, the first activity worked as a reference point to identify regularities and irregularities for the remaining activities. In the second workshop, Workshop 1 worked as a reference point. In the third workshop, the first iteration was conducted as a pilot workshop for understanding the relations between the inscriptions and the design collective, the flow of the activities and the potential areas of tuning.

The fact that the workshop activities were separated from the everyday lived reality context rendered invisible the many constraints, challenges and opportunities that characterize everyday life. Thus, the research has not been able to consider them. In future, ASD concepts and qualities need to be investigated in a real life design situation, which will significantly expand our understanding of ASD by revealing the actors' individual concerns in the different phases of design. In real life design cases, there can be two possibilities of investigation: a) the research can focus on the exploration of possible ways to integrate ASD concepts and qualities into traditional design activities dealing with rigid constraints and well-defined roles of actors; and, b) the research can continue to conduct game-like design activities in which ASD concepts and qualities are explored by playing with the constraints of the actors' situations and roles flexibly. The flexibility that game-like activities in a real life design case provide can be advantageous in obtaining a balance between the rigidity of real life constraints and the fluidity of game rules.

7.4.3 Evolutionary approach to the research and the tuning of the ASD

Notions of tuning, and the evolutionary approach to conducting the workshops were fundamental components of both ASD and our methodology. During the research, the tuning and evolution were well aligned with each other and intertwined, with both based upon notions of mutual transformation, adaptation and exchange. While the evolutionary approach was the selected way of investigating what an ASD approach could be, tuning was a feature derived from relevant studies that an ASD approach could incorporate. The evolutionary way of exploring what an ASD approach could entail allowed us to understand the role of tuning in ASD.

As the research has been based on an evolutionary approach, there have been no parameters that have not been subject to change. All the decisions and assumptions about the importance or essentiality of research parameters or variables could have been challenged. While this approach allowed research to be sensitive, responsive and agile, it has also prevented it from making contributions to other design studies in the form of direct generalizations. However, it has contributed to other design studies in the form of drawing upon indirect or metaphorical generalizations and implications to identify and describe situated matters of concern and critical points that may be relevant to other design studies. This type of contribution is similar to how Dourish and Button conceptualized the contribution of ethnomethodology to the field of HCI.

> In recent years, there has been an interest in utilising the insights of ethnomethodology for the development of dialogical interfaces. Attempts have been made to build in the *specifics* of Sacks et al.'s turn-taking model, such as the rules associated with speaker transfer, into computer interfaces. However, our argument is that the value of the turn taking model described by Sacks et al. is in the way in which it shows how the abstractions of conversational flow are *sustained*, rather than rote procedures by which they might be *enacted*. It is this notion of the

> ongoing management of conversation, rather than the specifics of any human dialogue, which provides an abstraction for design (Dourish, 1998, p. 25, original emphasis)

Here, Dourish and Button's suggestion that it is not the specifics but the idea of sustainment or ongoing management of conversation that works as a contribution to - and an abstraction of – design seems relevant. This research has offered a set of strategic-generative concepts and design qualities that have been explored by three workshops. Abstractions, as such, have been offered throughout the discussions on the outcomes of the workshops. For example, in Workshop 2, wherein a comparison was sought between sensing and effecting capabilities, changing the placement of the sensing capability of the device was much more effective in re-configuring the roles, relations, and in supporting different meaning generation than changing the placement of the effecting capacity. This suggested that the transformative potential of the sensing capability was higher than that of the effecting in this particular setup of our experimental case. However, the contribution of this case is not the specific difference caused by the two different technologies; in effect, it is the fact that different configurations within the same design collective are not neutral. Different configurations can enable different roles and hide or reveal different spaces of possibilities.

A further abstraction was discussed in relation to the selection of activities conducted in Workshop 3, which brought together four sessions with different types of activities: a silence session, a physical sensitivity session, a rich poster session, and a machine-mediated performance session. Here, the important point was not the specific mix of activities, but exploring the object of design through multiple forms of knowing and exploring.

A major difficulty in a research approach in which everything - at least in theory - can shift and be in constant transformation, has been to decide what to keep constant and what to change. In this respect, the research has been a topological investigation of the essential characteristics of the object of research: an investigation of '*what counts as "essential"? What is it that has to be sustained? Rendered continuous? What is a distortion?'* (Law, 2000, p. 4). Constant transformation allowed the research to detect what can be important and the critical concerns regarding ASD concepts and qualities. The decisions of transformations in the workshop inscriptions were informed by ASD qualities and emerging concerns from the workshops. The decisions were collective decisions and did not claim to be objective. They were decisions from somewhere (a particular setting) made by some collectives (collectives of particular human and non-human actors). Therefore, the results and outcomes were partial and situated. The research does not see these characteristics as weakness but as conditions of responsible and ethical practices.

As every parameter has been open to challenge, it is possible to challenge the main principle of ASD. The aim of the main principle was to state a key characteristic of a relational understanding of design that can sensitize designers' thinking about design and their design thinking relative to the nature of agency. The extent and consideration of relational aspects depend upon the particularities of each case. As discussed in 'reflections on the quality of multiplicity' section, multiplicity can break the coherence and consistency of the understanding of the object of design and may prevent actors from gaining a deeper understanding of the individual dimensions of the object of design. The amount of consideration of the relational nature of agency in the different stages of the different kinds of design projects needs to be determined on a case-by-case basis. The research neither insists on its main principle nor on its singularity: the main principle provides a useful starting point from which to develop further sensitivities.

7.4.4 From agency-sensitive process to agency-sensitive product

Applying the ASD qualities in a successful way may not necessarily lead to producing technologies that support the relational nature of agency (i.e., modular, open, flexible, and configurable products) or arrangements that tend to maximise variety. For example, in the first iteration of Workshop 2, the design collective deliberately preferred to act in a model of interaction that limited the variety of the roles and relations of the actors. This case suggests that there may be cases in which the design collective may opt for less variety and more stabilization, alternatives which are not supportive of the qualities that ASD advocates. The critical question then becomes: is it required to add another design and decision phase to tune the outcomes of the participatory design sessions? Or, should we assume that if the process involves agency-sensitive qualities, it is going to lead to agency-sensitive technologies and practices which may take many different forms according to the individual cases? Do agency-sensitive technologies have some more general properties or do they have particular properties for every case?

7.5 Future Work

In the workshops, the capabilities of the technological actors were limited to simple reactive behaviour. In other words, a possible set of actions for the technological actors were predetermined and coded into software. Although the human actors' perceptions of the meaning of the technological actors' responses were different due to the different physical arrangements, the responses to the inputs were the same, independent from the situation. An important next step can involve the implementation of a more advanced level of technological intelligence while keeping the same workshop settings and methodology.

A higher level of intelligence increases the technological actors' capacity to negotiate their relations with human and other technological actors and may enable human actors to recognize the technological actors' agency. While in this research, topological possibilities were mainly explored through physical rearrangements between the actors, in the next stage different levels of machine intelligence can be explored without changing the physical arrangements. In other words, the software code rather than the physical positioning of the actors will manipulate the ways in which the human and technological actors come together. In fact, a first step of manipulating the relations through software was implemented in Workshop 3 in which the wearable devices were used in two modes: coupled and decoupled. While the coupled devices created a predetermined link/relation between the human actors using devices, the decoupled devices allowed human actors to negotiate and establish their relations in a larger space of possibilities.

For this kind of topological investigation, the model suggested by Rammert (2008) might prove useful. He suggests two main modes of integration between human and technology: a hierarchical mode whereby specialized activities are strongly integrated and an interactive mode whereby distributed modal units are weakly coupled. They differ in how the units are divided, how they are processed, and how they are connected with one another. Rammert contends that 'the framed interactivity mode is rarely implemented because it deviates from the well-known and trusted master-slave relation. The technological units are given more freedom of choice and higher levels of agency in order to enrich their capacity of assistance and to strengthen their role as relatively autonomous agents' (p. 18). We see that hierarchical and framed interactive modes correspond to the low and high levels of machine agency respectively. For the different properties of each mode see Table 7.1.

Table 7.1 Two modes of integration between human and technological actors (Rammert, 2008, p. 18)

MODES:	HIERARCHY	FRAMED INTERACTIVITY
Type of Differentiation	Division of work Functional specialization	Distributed activities Fragmented units
Type of Organization	Mechanical Bureaucratic	Organic Open System
Type of Connection	Linear sequences Strongly coupled Fixed and general rules Pre-Programmed	Parallel processes Loosely coupled Flexible, situated and specific rules Framed Self-adaptation

An advanced level of intelligence can facilitate the creation of new connections between human and technological actors, e.g., device-device, device-human and human-device-device-human. As well, it can support new possibilities for manipulating the topology of design collectives and, by extension, enable new forms of agency and new spaces of possibilities.

Closely connected with the aforementioned topological investigation, ASD concepts, in particular, inscriptions/translations, design collectives and topology, may prove useful for studying the relationship between design teams and technologies in various design situations. Such a study can be based on an extended understanding of a design team (including technologies as actors) and focus upon two kinds of topological investigation. First, the topology of relations in 'extended' design teams can be explored according to the four topological manipulation ways alluded to in Section 3.2.3. Second, the different levels of machine intelligence can be explored for understanding what kinds of roles technological actors can play in these extended design teams.

In this thesis, two design qualities - accountability and duality - could not be explored through workshop cases even though they were part of ASD. While accountability could not be explored as the activity in the Poster Session did not require separate accounts of human actors, duality too could not be explored, as considering the dual effects of design decisions was found to be excessive, costly and too restrictive in such an early explorative phase of design. A next step could involve another workshop focusing on ways of integrating these two qualities in the design process. This workshop may involve more task-oriented activities requiring different contributions from each participant: they may need to take place at a later stage of the design process when consideration of the dual effects of the design decisions is more feasible.

Because of the constructed nature of workshops involving abstract design situations, any potential contributions of ASD to ethical practices could not be explored. Therefore, the ethical effects of using ASD in practice are not known. A next step could involve the application of ASD concepts and qualities to a design project in the wild, which will provide opportunities for understanding the ethical implications of ASD. This next step could investigate the ethical effects in use time, i.e., when these effects can be most visible. In the context of everyday life, with its multiple points of reference, the diverse interests of the actors will reveal new concerns about the application of ASD concepts and qualities and inspire their further refinement. In this respect, the case studies conducted by Friedman and colleagues which focus on values like trust (Friedman, Peter H. Khan, & Howe, 2000), freedom from bias (Friedman & Nissenbaum, 1996), and informed consent (Millett, et al., 2001) might provide useful insights.

In this research, the workshop facilitator was responsible for applying ASD qualities. However, an important point is that developing sensitivities to relationality requires collective awareness and effort and needs to be performed in a relational way through negotiations between actors. It is definitely not the task of any one actor, namely the designer or researcher, in a design collective. Therefore, future research can attempt to develop some strategies for involving various stakeholders in supporting ASD qualities in a collective way and for increasing collective awareness of a relational understanding of agency. Although participatory design methods, in particular the games like those in the physical sensitivity session in Workshop 3, are useful for emphasizing the strong relational aspects of our existence and capacities for action, changing the worldviews of people may not be possible within the limited timeframe of a short workshop. Such change may require a long-term program that will facilitate a collective understanding of relationality.

7.5.1 Is a post-post-humanist worldview possible?

A core motivation of the research has been to embrace a non-humanist or post-humanist understanding of agency in design. In order to do that, ASD has benefited from ANT's symmetrical treatment of humans and non-humans, which considered both humans and non-humans as authentic and powerful actors capable of making a difference in the world. Although the post-humanist symmetrical treatment has been useful and effective in supporting more relations-focused ways of designing, it has been limited by a high level of asymmetry between humans and the rest of the world. A deeper human-centrism has been 'inscribed' into our ways of thinking. Ultimately, as researchers or designers, we find ourselves in a position in which we are expected to relate the results and outcomes to human beings, their motives, their needs, their demands, their intentions and their joys. This form of human-centrism or human-orientation seems inevitable within the current research and design environment. Similarly, DiSalvo and Lukens draw our attention to the problem of human-centric value system:

> It is … difficult to argue for the importance, or existence, of a strong nonanthropocentric perspective because many arguments advocating for particular areas or methods of study define importance in purely human terms. Things are deemed important because they benefit us, collectively or individually, as humans. (DiSalvo and Lukens, 2011, p. 433)

A major responsible and ethical step could involve a final attack on the stronghold of human-centric value systems[25] and establishing another value system that centres the collectives of all actors without privileging humans. This new value system would work as an additional layer of consideration rather than as a total replacement of the current value system. Such a step would, in addition, contribute to the sustainable design agenda.

[25] It is important to note that the author does not claim that human and non-human actors should have the same rights, ontological or ethical status. As well, the argument does not presume to suggest that all non-human actors - either living or non-living - should be treated equally. By a new value system, author means that a collective of all human and non-human actors needs to be taken into consideration when making decisions. The ultimate aim of technological developments or innovations should for the good of all entities as a whole. Although there may be many cases in which the good of humans may need privileging, a larger set of considerations can facilitate more responsible practices.

8. References

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Appendix A: Workshops

A.1 Workshop 1 and 2

A.1.1 Workshop 1

Connections

Activity 1: All participants successfully developed strategies to coordinate their movements, e.g., keeping the tension of the rope constant as confirmation feedback or pulling the rope from different angles as an indication of right direction. While one pair of participants used their hands to pull the rope, the other used only their torsos: they did not use their hands at all. As a result, I observed two forms of H-D-H connection: (rope-at-hand)-to-stomach and (rope-at-back)-to-stomach.

Activity 2: The participants' experience of Activity 1 became a very strong inscription for them: their translations were largely based upon the rope metaphor of interaction. I observed a few connections that were translated slightly differently from the inscription of the previous activity with the rope. The major change in couplings was from a back-to-face to a face-to-face positioning. While one of the GPs used his/her hands to catch the signals of the EC, the other used only the torso and did not use the hands at all. Thus, I observed three forms of H-D-H connection: (device-at-stomach)-to-hand, (device-at-stomach)-to-back, and (device-at-stomach)-to-stomach. Participants reported that provision of both sonic and tactile feedback for the same purposes was useful for them as it increased some sort of confidence or additional confirmation.

Activity 3: All participants stated that this was the easiest activity for them, as it only required them to follow the sound source. On occasion, they used their arms. Some preferred to keep a very short distance from their partners, whereas others preferred a loose coupling with a relatively long distance between each participant. While all three BPs stated that they used the sound feedback coming from the device attached to their partner's backs as an indication of the right direction, one BP said that she used sound feedback both as an indication of right direction and as an indication of the distance to her partner; that is, the BP used the changes of perception of the sound's volume. Here we see a very different translation of a technical inscription. Although the sound output of the device had a fixed amount of volume and only discrete on/off states, the BP's appropriation of her changing perception, in accordance with the relative distance to the sound source, transformed what originally was discrete control into continuous control. Despite the differences in usage of the device's feedback, there was only one form of H-D-H connection: (device-at-back)-to-stomach.

Activity 4: The participants translated the inscription of this activity in many different ways. I observed the highest variation in couplings inside and across the sessions with this inscription. Participants created four different forms of H-D-H connections: (device-at-hand)-to-back, (device-at-hand)-to-chest, (device-at-hand)-to-hand, and (device-at-hand)-to-handx2 (use of double hands). However, it is important to note that these variations were still in a predictable range, which was defined by the rope metaphor of interaction.

Awareness

One important finding in all cases was the lack of difference between the BPs' awareness (1) of their partners; and, (2) of space. The participants indicated that the two meant the same for them across the activities: they did not - or needed not to - differentiate between their partners and space. In fact, these particular series of arrangements reduced the engagement of BPs, and to a lesser extent of GPs, with the surrounding space. This was partly caused by the inscriptions of the distance sensor, partly by the nature of the task and partly by the inscriptions that diminished the role of space as an active actor. Since the sensing range of the distance sensor was highly directional (approximately 30 degrees) and short (approximately 60cms), it inhibited the participants' engagement with the whole space. The task also inhibited interaction from taking place outside of straight lines. In addition, the inscriptions that made arrangements between only two participants weakened the possibilities of couplings with the space. However, this was mostly the case for BPs. As GPs were not blindfolded, each had the responsibility to monitor the distance between his/her partner and the walls in the space. For this reason, they had to be aware of the space and make calculations and predictions regarding possible deviations from the actual path. This proved to be quite a common occurrence.

The awareness of the presence of the GP was directly affected by the placement of the EC. When the EC moved physically closer to the GP's body, the BP's awareness of the GP increased. In general, the EC provided a proximity-based representation of entities to the BPs; however, the association of this representation to individual entities depended upon the physical distance between the entity and the EC. The association of a representation with the entity was at a maximum when the EC was physically attached to said entity and at a minimum when the EC was carried by the BPs. The BPs all agreed that they felt the presence of their guiding partner most in Activity 1, then in Activity 3, then in Activity 4 and least in Activity 2. There was no common pattern of awareness of space. But, the BPs all said that it was at its lowest level in Activity 2.

Interpretation of Feedback

An important phenomenon was the co-construction of meaning, achieved by using the device's simple feedback, which was originally fixed across all activities. The device provided tactile and sonic feedback if it detected an object within its range; otherwise, it remained silent. However, the simple and fixed behaviour of the device was re-appropriated by the participants during each activity in order for each to communicate with his/her partner. Participants did not talk about or agree on any strategies before the activities. The meaning of the feedback was mutually and relationally determined during the activities; thus, the role of sonic and tactile feedback changed within and across the activities. Although the signal was the same signal, participants co-constructed its meaning on fly during the activities.

During the activities, the meaning of the device's feedback was variously interpreted as: the rightness of orientation of the body[26], the rightness of the body movement, the rightness of orientation of hand, the time to stop the movement, a signal follow, degrees of proximity to partner, and an indication of their partners following behind them correctly. The role of device was relationally enacted differently with respect to its position in the arrangement of actors in each activity. The participants dealt with the multiplicity of meaning of the feedback skilfully and transited from one interpretation to another smoothly.

Strategies

In parallel to the multiplicity in interpretations of feedback, there were multiple strategies based on the changing meaning of the feedback. Two recurrent patterns in

[26] Here "the rightness" means whether the current orientation of the body is right or not. In other words, the feedback of the device is interpreted in binary form. It indicates either the right or wrong orientation.

strategies were observed: continuous and regular provision of feedback. These two patterns emerged out of the first activity with the rope. While in some cases BPs expected to be pulled along the track, in some others, they were comfortable with the periodic appearance of a pull. The same pattern continued in the remaining activities with the ECv1. In the case of continuous signal provision, the signal had to be always provided along the track except at the turning points, where loss of signal indicated that it was time to stop the movement. In contrast, loss of a signal may not have indicated the time to stop the movement in the case of regular signal provision since the signal was expected to appear and disappear regularly along the track regardless of the turning points. This regular pattern indicated continuation of the same movement. If a BP failed to sense a signal after a reasonable amount of time, this indicated that s/he needed to stop moving and change direction. Thus, the two patterns and meanings of feedback were tied to each other and emerged out of particular arrangements of actors in each activity. While the strategies employed in Activities 2 and 4, in which the ECv1 was carried by BPs, were similar, the strategy employed in Activity 3, in which the device was carried by GPs, was different from the other two.

The first activity with the rope clearly influenced the negotiation of the coordination strategies developed in the later activities. In some cases, the GPs were able to find alternative ways of coordinating with their partners, even though they were still acting in accordance with the rope model of coordination. In the last activity, one GP went beyond the rope model by directing the BP while s/he was not moving over the track. This was a significant deviation from all of the other strategies, which were based on the proposition of having both partners moving together over the track. Here, the GP was performing at another level of agency, using the same interface for communicating with the BP but able to act in a different way. The GP knew what the BP was expecting, based on their previous model of interaction: s/he provided appropriate input while acting according to another new model of interaction evolved from the inscribed rope model of interaction.

A.1.2 Workshop 2

Activity 1: While the participants in the first iteration easily developed an interaction model similar to the rope model of interaction, the participants in the second found it difficult to develop strategies to coordinate their movements at the first activity. The absence of the grounding activity with the rope made it difficult for the second iteration's participants to relate to this novel arrangement. The activity in the second iteration lasted more than three times longer than that in the first because longer time had to be spent on negotiating the meaning of the feedback. After three-and-half-minute-long trials, the second pair could develop an interaction model, which could be associated with the rope model of interaction. While the first iteration involved three forms of H-D-H connections: (device-at-stomach)-to-hand, (device-at-stomach)-to-back, (device-at-stomach)-to-stomach, the second involved two: (device-at-stomach)-to-back and (device-at-stomach)-to-stomach.

Activity 2: At the reflection session following Activity 1, the first pair of participants decided to change their interaction model for the next activity. They said that the sound of the device was similar to the sound of a warning signal, and that they wanted to use the feedback of the device as a warning signal indicating a wrong direction or movement. This entirely different translation of the inscription effectively changed all of their roles, strategies and couplings for the activity. This interaction model was different from all of the other interaction models observed in that it was constructed verbally between the activities, not inside them. The first iteration's participants successfully performed their task in accordance with the new model of interaction, which was a product of a different metaphor of interaction that can be referred to as an *obstacle* metaphor of interaction.

The BP started walking without any signal from the device and kept walking until hearing the signal. The BP stopped and changed his direction until the disappearance of the signal, which indicated the right orientation of the body. The pair completed the activity in one and a half minutes, which was equal to the average duration of activities completed according to the rope metaphor of interaction. The dependence of the BP upon the GP and the device lessened in the obstacle metaphor of interaction. The GP did not have to stay very close to the BP and trigger the device's sensor (see Figure 5.2).

The second iteration's participants continued to use the rope model of interaction without trying to find any other alternative ways of connecting. In both activities, there was a single form of H-D-H connection only, (device-at-back)-to-stomach.

Activity 3*:* In this activity, the pairs in both iterations were each given an ECv2. As in the previous activities, the first pair acted in accordance with the obstacle metaphor whereas the second pair acted in accordance with the rope metaphor. I did not observe any new forms of connection in either of the activities. In both activities, there were the same three forms of H-D-H connection: (device-at-stomach)-to-hand, (device-at-stomach)-to-back and (device-at-stomach)-to-stomach.

Activity 4: The first pair using the obstacle metaphor completed the activity with two forms of H-D-H connections: (device-at-back)-to-stomach and (device-at-back)-to-back, whereas the second pair using the rope metaphor completed the activity with a single form of H-D-H connection, (device-at-back)-to-stomach.

A.2 Workshop 3

A.2.1 Iteration 1 – Pilot

Silence Session

Participant 1 (P1), participant 2 (P2), researcher 1 (R1), researcher 2 (R2), video camera and activity inscriptions constituted the collective at the beginning of the activity.

The participants sat down on the floor at a distance from each other. They closed their eyes and remained silent. The activity lasted for 5 minutes as planned. The participants reported that they noticed the sound of their own breathing and of extraneous noises and music from outside. They said that they did not feel any connection to their partners or space. One participant noticed that being distant from the other participants and stationary in space prevented them from interacting with each other.

Noise and music from outside, and the sound of the participants' own breathing were enacted as new actors, which were not available in the beginning of the activity. The final collective consisted of P1, P2, R1, R2, a video camera, outside noise, the sound of breathing and the sound of the Air Conditioner. The activity inscriptions of 'close your eyes and concentrate on the sensations of your partner's body and the connection between you and your partner' were translated as 'close your eyes and stay silent'.

Physical Sensitivity Session

P1, P2, R1, R2, the activity inscription and the video camera constituted the design collective at the beginning of the activity.

The participants performed three exercises: palm-crown exchange, reverse palm-crown exchange, and simultaneous palm-crown exchange. In the first exercise, they experienced difficulty maintaining contact between the palm and the crown. P1's hand movements were too fast for P2 to follow. P1 tried to make movements to the left and right sides, which were followed by P2. Towards the end of the activity, they were able to maintain a connection involving different speeds of movement. In the second exercise, P2 raised his arm higher than P1's height so P1 could not follow. They frequently stopped because they laughed too much. Then they found if they closed their eyes they started were able to perform better. In the final exercise, their movements were mostly synchronous and they were able to maintain their contact; but, when they started to move in reverse directions, they lost contact. A lag happened. The participants stressed that when they closed their eyes, it became much easier for them to concentrate on their task. They also found it hard to judge the amount of pressure they were putting on their partners. In many cases, the participants could not use the full spectrum of pressure amounts possible. In the short reflection session after the activity, the dialogue between two participants highlighted an asymmetry between expected and given amounts of pressure: P1: 'At one point, I thought I don't wanna be P2's girlfriend. He cannot control his power. There was either very high pressure or no pressure at all. There were no mid-levels'; P2: 'I did not know her limits, how much she is capable of going down and up. I just doubled the amount she gave to me and continued like that. I should have done half of it'.

The final collective was composed of P1, P2, R1, R2, activity inscriptions and a video camera. The visual modality first emerged as a powerful actor making the participants follow a program of action against the inscriptions during the first activity. Then, it was taken out of the network and became no longer an actor part of the network as participants preferred to close their eyes.

Rich Poster Session

P1, P2, R1, R2, activity inscription, poster paper, blue and red markers, various pictures, eight objects brought by participants, and a video camera constituted the collective at the beginning of the activity.

<u>The first part: Three objects</u>

P1 brought three objects including: a needle holder, a text from the author Arthur Rimbaud, and a picture showing uprising students. The three things P2 brought were an image of the city of Istanbul, a few paragraphs of a poem and a condom. P2 loves Istanbul, and the picture shows an attractive Istanbul restaurant, where P2 used to pass time with his friends and relatives. R2 brought only two things. The first one was a family picture and the second was a scarf. The explanations of the participants revealed different forms of togetherness including: togetherness with a memory, togetherness with self, togetherness with multiple-selves, and togetherness as uniting for a common cause.

The second part: Collage making and reflection

After talking about the objects, the participants started to make a collage. They opted not to talk to each other during the making of the collage. They worked inside their own areas on the paper without interfering in any other participants' areas. After placing the images on the paper, they annotated each picture with text relevant to the content of the picture or the feelings the pictures evoked. Then, each participant briefly explained how he/she selected the images and took part in the creation of the collage. When annotating the pictures, the participants used markers different from the one assigned to them. Figure A.1 shows the poster the participants created.

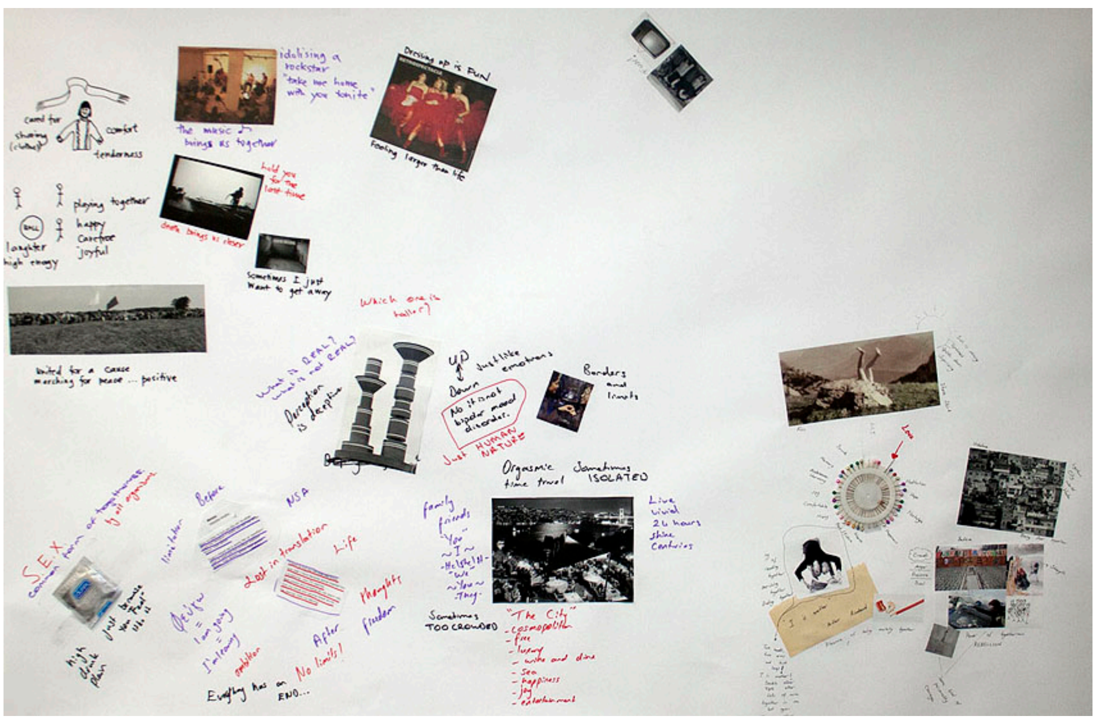


Figure A.1 The poster showing different forms of togetherness the participants expressed

P1 said that she selected images that were related to each other and also to the objects she brought. P2 talked about only two images: one was an abstract geometrical photograph and the other a picture of the restaurant in Istanbul. He said that he wanted to emphasize the deceptive nature of perception using the abstract picture and togetherness with loved ones using the restaurant picture. R2 selected three images demonstrating different forms of togetherness: a picture of an empty room to emphasize the need to be alone and to get away from being together; a picture of a dead kangaroo to highlight how death sometimes may bring people together; and, finally a picture of a riot depicting people united in a cause.

The participants found the poster activity very reflective. They responded to the images and brought up associations. They all said that they paid attention to the invisible borders between their collage area and other participants' areas. One participant said that she would have preferred to do the collage work more collaboratively; but, according to her, because of the large paper size and the limitations on time, she could not do it in that way.

The final collective involved P1, P2, R1, R2, activity inscriptions, pictures and text collages on poster paper, red, blue and black markers, eight objects brought by participants and a video camera.

Machine-Mediated Performance Session

Activity #1

P1, P2, R1, R2, two EC devices (coupled)[27], one Tilt device, activity inscriptions, movement constraints of 'Slow & Stationary movements', a large set of sound effects, various straps and one video camera constituted the collective at the beginning of the activity. One of the researchers enrolled as a participant rather than a researcher in order to obtain firsthand experience of the activities. Her experience contributed to our revision of the next iterations of the workshop.

The participants selected the theme of comfort by examining the poster they created. They selected the devices randomly and took their positions in the space. They preferred to be in a face-to-face triangular position (See Figure A.2). Then, they experimented with different sound effects and selected two effects according to their suitability to the theme of comfort.

[27] Two EC devices were coupled in the sense that the system captured the sensor data from two EC devices, combined them and produced a single sound effect.

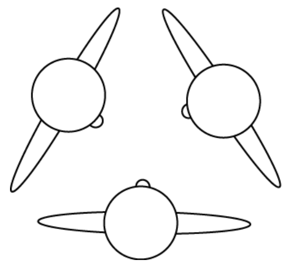


Figure A.2 Face-to-Face Triangular Position

There was 1 long connection lasting 132 seconds. Within these connections, there were 1 H-D-H, 2 H-D-E and 3 H-D arrangements (Table B.1 in Appendix B shows the details of the H-D-H arrangement). While the H-D-E arrangements were in the forms of (human-device)-to-space and (human-device)-to-objects, the H-D arrangements took the forms of device-at-stomach, device-at-arm and device-at-hand. The participants using the EC devices used straps to attach the devices to their arms and stomachs. They did not change the place of straps during the activity. The participants followed the instruction to make slow movements and remain stationary in space. This enabled them to create a harmony in terms of speed of triggering the musical notes. The participants using the ECs employed a couple of strategies to coordinate their movements; i.e., making similar movements and using stops. The participant who was using the Tilt device was not able to communicate with the other participants using the ECs. He said that ‘I was not completely disconnected but I could not fit in their rhythm because my sound was very different’. Another participant, who used one of the EC devices, said that she could not figure out exactly how the EC worked and guessed something about the working principle of the device while she was moving. But, it was still not clear to her. The movement qualities of the two participants using the EC devices were the same: light in weight, sustained in time, direct in space and bound in flow. The other participants’ movements had the same qualities for weight, time and flow categories but different for space category. The activity lasted for 3 minutes.

P1, P2, R1, R2, two EC devices (coupled), one Tilt device, activity inscriptions, movement constraints of 'Slow and Stationary movements', the theme of comfort, door and piano sound effects, straps, two speakers and one video camera were part of the final collective. The activity inscription of 'create sounds evoking the feeling of a concept you choose' was enacted as 'create sounds evoking the feeling of comfort'.

Activity #2

P1, P2, R1, R2, two EC devices (coupled), one Tilt device, activity inscriptions, movement constraints of 'Slow and Mobile movements', a large set of sound effects, various straps and one video camera constituted the collective the beginning of the activity. The participants selected the theme of comfort by examining the poster they created.

There were 2 connections lasting 5 and 11 seconds. Within these connections, there were 2 H-D-H, 3 H-D-E and 2 H-D arrangements (for details of the H-D-H arrangements see Table B.2 in Appendix B). While the H-D-E arrangements took the forms of (human-device)-to-space, (human-device)-to-floor and (human-device)-to-objects, H-D arrangements, took the forms of device-at-arm and device-at-hand. In most of the activity, the participants just made explorative movements: they followed the inscriptions of slowness and mobility during the entire activity. The participants with EC devices used the straps to attach the devices to their arms and hands. They first used them on their arms and then moved them to their hands. One participant pointed out a key matter of concern: '…whether I should relate to others by my movements or does it matter? Or should I focus more on sound composition? … I was wondering is that what we are crafting? Sound composition ... if I move in a carefree way, will it reflect the sound?' Here, the participant's question can be rephrased as 'should I move or act like a carefree person or does the sound I produce evoke or reflect a carefree feeling?' This was an important finding vis-à-vis the participant's divided focus between sound effects and movement patterns.

The final collective was composed of P1, P2, R1, R2, two EC devices (coupled), one Tilt device, activity inscriptions, movement constraints of 'Slow and Mobile movements', the theme of carefree, Honky-tonk and rain sound effects, straps, two speakers and one video camera. The activity inscription of 'create sounds evoking the feeling of a concept you choose' was enacted as 'create sounds evoking the feeling of carefreeness and make the movements of a carefree person'.

Activity #3

P1, P2, R1, R2, two Tilt devices (coupled), webcam, activity inscriptions, movement constraints of 'Fast and Stationary movements', a large set of sound effects, various straps and one video camera constituted the collective at the beginning of the activity. The participants listened to various sound effects and decided on the theme of paranoia. In this activity, they opted to use the camera.

There were 4 connections lasting 15 to 86 seconds with an average of 34 seconds. Within these connections, there were 2 H-D-H, 4 H-D-E and 6 H-D arrangements (for details of the H-D-H arrangements see Table B.3 in Appendix B). While H-D-E arrangements were in the forms of (human-device)-to-space, arms-directed-at-(device-space), torso-directed-at-(device-space), and head-directed-at-(device-space), the H-D arrangements took the forms of arms-directed-at-(device-space), torso-directed-at-(device-space), and head-directed-at-(device-space) and device-at-hand. The first connection lasted approximately 1.5 minutes. I considered it as a connection because of the continuous use of theatrical gestures and verbally choreographed movements. Although there were short lasting - approximately 2-3 seconds - disconnections, the overall flow was not affected by these short breaks. The movement qualities of all of the participants varied during the first connection. The activity lasted for 3 minutes and 30 seconds.

All of the participants found the activity very successful. They all agreed that both their movements and the sound effects related to the theme of paranoia. Their movements resembled those of paranoiac people, and the repetitive and annoying sound effect evoked a sense of paranoia. They variously said: ‘I felt like a paranoiac cleaning lady’; ‘I felt like I'm trapped in this psychotic soundscape. Being stationary and doing the same repetitive movements, frenzy’; ‘It was most successful in terms of completing the task. We really felt like paranoia. It was successful in terms of both sound and our own feelings and movements’.

The final collective was composed of P1, P2, R1, R2, two tilt devices (coupled), one webcam device, activity inscriptions, movement constraints of 'Fast and Stationary movements', the theme of paranoia, screaming and wind chimes sound effects, two speakers and one video camera. The activity inscription of 'create sounds evoking the feeling of a concept you choose' was enacted as 'create sounds evoking the feeling of paranoia and make the movements of a paranoiac person'.

Activity #4

P1, P2, R1, R2, webcam, activity inscriptions, movement constraints of 'Fast and Mobile movements', a large set of sound effects, various straps and one video camera were enrolled in the collective at the beginning of the activity. The participants decided to perform ‘celebration’: it had been decided much earlier in the workshop because they thought that the freedom that the camera offers was suited to a celebration activity.

There were 4 connections lasting from 12 seconds to 59 seconds with an average of 26 seconds. Within these connections, there were 4 H-D-H, 4 H-D-E and 4 H-D arrangements (for details of the H-D-H arrangements see Table B.4 in Appendix B). As the webcam was placed on a wall in the environment, H-D-E and H-D corresponded to the same forms of arrangements, which, in this activity, were arms-directed-at-(device-space), legs-directed-at-(device-space), torso-directed-at-(device-space), and full body-directed-at-(device-space). The participants employed strategies of making similar or repetitive movements for creating and maintaining the connections. In the first connection, they verbally choreographed their movements by counting from 1 to 3. In general, they enjoyed the freedom of using their whole bodies and a larger portion of the space. All of the movement effort qualities varied during the activity which lasted for 3 minutes.

The castanet sound effect played an important role in shaping the participants’ movements and coordination strategies. The possibility of controlling the castanet sound effect was extremely limited; as they could not control the sound, the participants preferred to dance and let the sound guide their movements. They made a series of verbally choreographed movements as they danced and commented on their experiences as follows: ‘It was very different from how I imagined. This time sound enabled us to behave differently’; ‘I think it was not we who were controlling the actions. It was the powerful sound effect. It was really effective’; ‘I think the sound could be better; it was not bad but ... at the beginning I thought it was going to be something like a samba or cha cha, but it turned out to be mental hospital door openings, and it was not changing, it was constant. I just ignored it and danced’; ‘that sound was like machine gun, it was not like how I imagined but it was very energetic’; ‘It was more like we were dancing together rather than producing the sound".

P1, P2, R1, R2, one webcam device, activity inscriptions, movement constraints of 'Fast and Mobile movements', the theme of celebration, castanet sound effect, two speakers and one video camera constituted the final collective. The castanet sound effect became a strong actor influencing the translations of the human participants. The activity inscription of 'create sounds evoking the feeling of a concept you choose' was enacted as 'dance together'.

Activity #5

P1, P2, R1, R2, two Tilt devices (coupled), webcam, activity inscriptions, free movements, a large set of sound effects, various straps and one video camera constituted the collective at the beginning of the activity. Each of the participants preferred his/her own device rather than share. P1, P2 and P3 opted for two tilt devices, a webcam and two EC devices respectively. The participants decided to perform the theme of a 'happy drunk'.

There were 4 short connections lasting from 3 to 5 seconds with an average of 4 seconds. Within these connections, there were 4 H-D-H, 6 H-D-E and 5 H-D arrangements (for details of the H-D-H arrangements see Table B.5 in Appendix B). As each participant used a different type of device, the total level of multiplicity in forms of arrangement was very high. While the H-D-E arrangements took the forms of (Human-device)-to-floor, (Human-device)-to-space, arms-directed-at-(device-space), legs-directed-at-(device-space), torso-directed-at-(device-space) and full_body-directed-at-(device-space), the H-D arrangements were arms-directed-at-(device-space), legs-directed-at-(device-space), torso-directed-at-(device-space), full_body-directed-at-(device-space) and device-at-hand. The connections were very short and lasted only five seconds at most. The participants using the ECs usually made movements with similar effort qualities: light in weight, sudden in time, indirect in space and bound in flow. Also, they interacted with each other whereas the participant using the camera usually performed alone. In most of the activity, the participants explored the effects of various movements without explicitly trying to negotiate any strategies of communication with the other participants. One participant commented on the important difference between the imagined sound and the actual sound of their activity theme: 'I tried to do haphazard movements to express happy drunk. And I really wanted to do happy drunk. But, I realized that a happy drunk body may not sound happy drunk'. The activity lasted for 3 minutes and 3 seconds.

P1, P2, R1, R2, two EC devices (coupled), two Tilt devices (coupled), webcam, activity inscriptions, the theme of happy drunk, siren, piano, and heart beat sound effects, straps, two speakers and one video camera constituted the final collective. The activity inscription of 'create sounds evoking the feeling of a concept you choose' was enacted as 'create sounds evoking the feeling of a happy drunk and make the movements of a happy drunk person'.

A.2.2 Iteration 2

Revisions

Revision 1: The requirement to sit back-to-back in the Silence Session

We asked the participants to sit back-to-back on the floor. In the previous workshop, they were able to sit on the floor wherever they wanted. The aim of this revision was to facilitate the creation of a connection through touch or other shared sensations between bodies. This revision further supported our aim of increasing the 'visibility' of other modes of sensations by increasing the sensibility of tactile sensation.

Revision 2: The addition of a new exercise to the Physical Sensitivity Session

After the first workshop, we decided to include a new exercise about proximity in the Physical Sensitivity Session as a replacement for the third activity that P1 suggested at our first meeting but which we later decided to drop. We did not include the third exercise in the pilot workshop as it was too complicated. We planned to introduce a new exercise involving proximity as a parameter to replace it in this workshop iteration. Our aim was to increase the participants' awareness of how the relationships between bodies change according to the different proximities. Proximity was one of the parameters that P1 and I discussed in our meeting prior to the workshop; but, it was not included in the exercises. Later, we decided that the proximity exercise could be a useful introduction to the other activities: participants could use proximity as a parameter for their explorations. We planned that the participants could perform the new exercise immediately after the first palm-crown-exchange exercise. Thus, the final form of the session included three exercises: palm-crown exchange (including the reverse version), simultaneous palm-crown exchange, and a new exercise using proximity of bodies as a parameter. The actual content of the final exercise was not determined before the workshop but planned to be formed under the guidance of P1. This revision aimed to support the quality of relationality by explicating the role of different physical proximities in the participants' capacity to relate to each other and create connections.

Revision 3: The use of a smaller sized poster paper in the Rich Poster Session

We decided to use a smaller paper size for creating the poster as we observed that the large paper size used in the previous workshops was not useful for inviting participants to work collectively on the poster. We used a paper that was smaller than the previous poster's paper size of 100x70cm. This revision aimed to support the quality of multiplicity by facilitating higher levels of interaction between the participants.

Revision 4: Invitation to work collectively in the Rich Poster Session

We encouraged the participants to work collectively during the making of the collage. We clarified that it was totally fine - even preferable - for a participant to interact and collaborate with his/her partner. Similar to Revision 3, this revision aimed to support the quality of multiplicity by increasing the interaction between the participants.

Revision 5: The provision of one-page visualization of working principles of technology in the Machine-Mediated Performance Session

Because the participants in the previous workshop found the mapping algorithm that coupled the two wearable devices complicated, we decided to provide a one-page graphical explanation of the mapping algorithm for the participants. This graphical explanation accompanied our verbal explanations which we expressed before the Machine-Mediated Performance Session. This revision aimed to support the quality of visibility, which was lacking in the previous workshop iteration. The graphical explanations were expected to explain the working principles of the technological devices.

Revision 6: The requirement to be in a back-to-back position in the Machine-Mediated Performance Session

We added another inscription that required the participants to stand back-to-back during the activities in which they were required to remain stationary in the space. We thought that maintaining a touch-based connection would be suitable for exploring different ways of connecting with other bodies without eye contact. The back-to-back position allowed us to break the dominance of visual sensation (the idea of one of the participants in Workshop 3 – Iteration 1). Our aim was to facilitate a sense of being connected through a tactile sensation.

Silence Session

P1, P2, R1, R2, a video camera and activity inscriptions constituted the collective at the beginning of the activity.

The participants sat on the floor back-to-back: they closed their eyes and remained silent. Towards the end of the activity, both participants gradually moved their torsos along the floor while keeping the contact between their backs. The activity lasted for 5 minutes as planned. The participants said that the most dominant sensations were touch and the temperatures of their partners' bodies. They stated that their hearing was dominated by the noise of the air conditioner. The participants said that there was tactile exchange between them when they were making the movement along to the floor.

The final collective consisted of P1, P2, R1, R2, a video camera, body temperatures and the sound of the A/C. The activity inscriptions of 'close your eyes and concentrate on the sensations of your partner's body and the connection between you and your partner' were translated as is. The participants were able to sense the touching and the temperatures of their partners' bodies and construct a connection using tactile sensation.

Physical Sensitivity Session

P1, P2, R1, R2, activity inscription and a video camera constituted the collective at the beginning of the activity.

When P1 joined the workshop, she was unaware of the changes in the physical sensitivity session that we made after our earlier meeting with her. She assumed that there were no changes in the session structure and that she was going to perform three exercises in the physical sensitivity session. We were planning to ask P1 to suggest a new suitable exercise to replace the third exercise we dropped. We planned to have an exercise involving the proximity of bodies as a parameter for the movements of the bodies. However, this caused confusion. When we asked for a new exercise, P1 complained about the lack of information about the changes and particularly about the timing of our request. We asked her to suggest an exercise related to the proximity immediately after the second exercise when she was expecting to continue performing the final exercise, which was dropped by us prior to the workshop. P1 considered the timing of the request inappropriate and as indicative of dishonouring what was happening on 'stage'. The following is the flow of the physical sensitivity session and the discussions between the researchers and participants:

Excerpt A.1 Physical Sensitivity Session - 1

R1: in this session we will do some bodyweather exercises I talked with P1 about it before at a meeting we will try to do the touching to the heads activity. How do you [to P1] call it? ++ so the first activity will about this giving and receiving [demonstrates the movements] or exchange+"

P1: why don't you call it palm to crown?

R1: ok+ so this will be the exchange and the other one-

P1: palm crown exchange

R1: ok palm crown exchange+ and the other one will be about proximity. We'll do it now and then-"

P1: do you want us to stand?"

R1: yea, yeah, I guess you will guide us [The researcher refers to the instructions to be given to the participants.]

P1: I think it is probably really important you to lead it, because I won't be here for the next workshops you need to test out whether your instructions are going to work

R1: okay sure! so what I'd like you to do is first, you [faces P2] or P1 will start and touch the crown of the head of your partner and give some pressure, and the other participant will follow the hand movements, [R1 demonstrates the exercise by using movements] down or up".

P2: the top or crown?

P1: that's not the crown, here it is crown

P1: can I just give you an explanation of how I would introduce it.

R1: sure

P1: two participants face with each other one person is leader and the other person is receiver the leader places his/her hand to the crown of the partner's head and very gently-+ and you have to maintain that contact and let the palm gradually drop to the ground so the body goes downwards [they performed the first exercise]

R1: you can change the roles

[they performed the second stage of the first exercise]

R1: now, it is both receiving and giving simultaneously

P1: so we both place the palm to the crown we are trying to work independently, so we are not giving the same stimulation that we are receiving [They performed the second exercise]

R1: How was it

P1: I would say what did you observe? if it's a body weather performance, then, what did you notice+ just exchange of observations

R1: after the final exercise, we'll talk about it

P1: I think it is better to talk it now, because if you go into more complicated relationship, which the next one is it is important that both participants understand their experiences

R1: I see

...

[After a conversation between P1 and P2 on the possible complexities of the exercise, the following discussions happened.]

P1: "T: may be it is not the best exercise. There are many complexities. My reading of it, from my tradition is, how do I move the spine downwards? Whereas yours [referring to P2] were immediately, do I take it to the contraction? These are different traditions and that hits immediately. But we are talking as dancers now, somebody else would without any dance tradition would experience this exercise very differently."

R1: "yes, definitely+ Thank you." [short pause]

R1: for the proximity one, can you suggest an exercise? [here R1 was expecting her to guide us and suggest some activities.]

P1: are we not going to the next exercise

R1: you talked about the proximity as a parameter-+

P1: but are we not moving to the next exercise now? because there was a plan for the next exercise+ [We talked about the next exercise at our meeting but later we dropped it because of its complexity. However, she did not know it.]

R2: the physical exercise

P1: yeah

P1: the next one is++ [she starts doing the activity. She again both talks and performs simultaneously and then the performance starts.] so with this one+ uhm I can take your body your crown/body in any direction and you just follow

[They performed the exercise.]

...

R1: this is really a nice exercise but I think+ I'm not sure, what I was thinking, may be, really about++ err understanding the experiences of different proximities of bodies [demonstrating the proximities by movements].

P1: but then you need to tell me what opening up from what we agreed I understood that we are going forward on the basis of what we agreed

R1: yeah, yeah

P1: and then if that's the case, that's but, so then, but if we are changing exercises, that's fine

R1: mhm uhm+

P1: that's what I'm understanding we are doing that

R1: yeah it was for the other people, you know, you mentioned about three exercises and we agreed on the first one, the palm to crown.

P1: yes these were the two that we agreed on.

R1: yeah

P1: yeah

R1: okay++ uhm may be, I did not talk about the proximity thing. We decided to do it after the first pilot workshop. Because, in the next exercises, we will be experimenting with different proximities with technological tools so what we thought is that it would be good to have+ an exercise about it here before the next sessions

P1: but I need to know, because I cannot work in the middle of a vacuum I need to know where you want to go so you cannot just say to me, give me a proximity exercise it means nothing to me because, you know we are barely engaging what we are doing

R1: yeah

R2: why don't we just continue and then at the end of the session, we can-

P1: if, for example, I understand that we left off somewhere and then you've done a pilot workshop, and it sounds like there are some other considerations that I do not know about. But if you want me to feed back on those and give you some other /suggestions\ we should do that

R1: /yeah\ yeah

P1: but then don't confuse that with what we are doing now () because we are supposed to be utilizing the experiences+ we talk structurally here

R1: yeah, please do so, it is very important

P1: but you need to honour what is going on here [referring to the stage and performance] if this is going to be a workshop about understanding what is coming out of experiences of participants and then the most important thing is to hear that++ [so my aim was not to ignore the experience, it was probably wrong timing.]

R1: yeah

P1: so separating between that and then if we are going to talk about structural considerations, then I suggest we come of the floor and talk.

R1: yeah okay mhm

P1: just as a recognition of something happens here (showing the place they were performing) but if we are gonna talk the structure let's go elsewhere [so P1 is sensitive to her performance and the stage, and the discussion of research on structure was not appropriate for her at that time. It was not the case for the previous exercise.]

R1" yeah okay

R2: I think at this point- + because it is an iterative process, and we are researching what this process can be, this is really valuable all this feedback. Now, so why don't we just forget about the proximity thing and do it later. Because it came out of the pilot and Proximity comes up later on. Because there are two bodies in space, there is always gonna be a proximal relation. The proximity concerns emerged out of the pilot workshop but that's *obviously not been fed back /properly\ ++ so why don't we just continue what this is."*

P1: /no

P1: we are half way through the exercise, we have done a third of it.

B: yeah.

L: yeah, let's continue

T: if we are gonna stop it, we should do it and then honor .. Because I am just feeling that we are not paying enough attention to the exercise.

B: ok, what do you suggest now?

T: "we are in the middle of an exercise, we have not done the opposite yet, so there are three parts of this exercise and we have just done one. So if we gonna do it, then we should complete it."

R1: yeah.

P1: ok. [Then they continued with where the previous exercise stopped]

For the first three exercises, the collective was composed of P1, P2, R1, R2, activity inscription and a video camera. However, after the third exercise, P1 resisted aligning her interests with those of R1. P1 emerged as a very strong actor who followed an anti-program of action against the activity inscriptions. In that respect, P1 acted as a designer of the exercises - not as a passive participant - and initiated the construction of another collective. As a result, the proximity exercise was dropped from the activity inscription, and a new exercise (actually, the original third exercise), which involved movements on a horizontal axis, was added to the activity inscription.

Rich Poster Session

P1, P2, R1, R2, activity inscription, poster paper, blue and red markers, various pictures, six objects brought by participants and a video camera constituted the collective at the beginning of the activity.

<u>The first part: Three objects</u>

P1 brought three things, i.e., a pebble, a picture of an artist and a book, and drew two images, one of grass texture and the other of her dogs. The three things that P2 brought were a compass, a wooden spoon and a quote from Dhammapada. The objects represented different forms of togetherness such as togetherness as a process of getting to know each other, togetherness as a feeling of absence, togetherness with memories, and togetherness with neighbours.

<u>The second part: Collage making and reflection</u>

The participants worked collectively: they sometimes showed the images they found to each other. Almost all of the images available were used in the collage. In particular, P1 did not opt to eliminate images: she used them without being selective. P1 said that she composed most of the images by chance whereas P2 said that she selected images in terms of which image spoke the most. While P1 talked about images related to joy, complexity of relationships and taboos, P2 talked about images related to laughter, her mother and a performance. One interesting thing about the collage was that the participants did not compose the images within the borders of the paper: the collage of the images exceeded the borders. Figure A.3 shows the poster the participants created.

Figure A.3 The poster showing the different forms of togetherness the participants expressed

P1, P2, R1, R2, activity inscription and a video camera aligned to the collective. As the participants used almost all of the images, the activity inscription of ‘select some of the pictures that you feel a connection with and make a collage of these pictures collectively’ was translated differently by P1 and P2. While P1's translation was ‘make a collage of these pictures collectively’, P2's was ‘select some of the pictures that you feel a connection with and make a collage of these pictures collectively’.

Machine-Mediated Performance Session

<u>Activity #1</u>

P1, P2, R1, R2, webcam, activity inscriptions, a large set of sound effects, two speakers, and one video camera constituted the collective at the beginning of the activity.

There were 5 connections lasting between 15 to 39 seconds with an average of 25 seconds. Within these connections were 5 H-D-H, 1 H-D-E and 1 H-D arrangements (for details of the H-D-H arrangements see Table B.6 in Appendix B). While the H-D-E arrangement was in the form of (human-device)-to-space, the H-D arrangement was in the form of device-at-hand. The participants moved in a very controlled and precise way.

They tried to figure out the cause-effect relations during the entire activity but could not succeed as they were not able to construct a connection through the sound. However, they maintained a connection through tactile sensation and through the high degree of attention they paid to their bodies in relation to their partners' bodies. As the participants were in a back-to-back position, they could not establish eye contact with each other. They had no chance to observe what their partners were doing so they had to find ways to gauge the effects of their own and their partners' movements. In the first connection, they made very tiny movements and used the stops frequently. P2 mostly made arm movements whereas P1 did not use them at all. They preferred to maintain the tactile sensation constant. They increased the tactile sensation in the second connection and decreased it largely in the third one. The participants separated their torsos largely. However, the system did not capture these large variations in P1's movements as needed. The combination of very slow movements, the distance to the camera, and the dark clothes of P1 - who did the large movement - resulted in poor recognition by the camera. During the large movement, P1 stopped in the middle, trying to understand whether the sounds were being generated by her movements or by her partner's. P1 could not understand the relations between the sound feedback and her movements. As a result, she became frustrated because she was unable to access the feedback properly. At that moment, they lost connection for 23 seconds. Then, in the next connection, P1 started to go downward while rotating her body towards her partner. They were communicating through the changes in tactile sensation and movements but not through the sound. Their movement effort qualities did not show any variation across the connections: they were light in weight, sustained in time, indirect in space and bound in flow. The activity lasted for 3 minutes.

Because of the value of the discussion between the researchers and the participants, almost all of the entire transcription of the discussion after the activity was included: only some irrelevant parts were omitted. In the following transcription, P1 explains her frustration at not being able to generate the sounds she desired and how the set up did not make any sense to her. This was particularly important as it very strongly showed how the participant translated our inscriptions very differently and took quite a different role. P1 questioned the workshop design constructs and found them irrelevant to exploring the different forms of togetherness. Furthermore, she criticized the overall workshop design and its rationale. I will discuss P1's concerns further in Chapter 7.

Excerpt A.2 Machine-Mediated Session Excerpt 1

P2: it would have been better to have fast movements ()

P1: I never at one stage did not understand how to activate the sound

R1: no

P1: no++ because there was far too many points through the plane of the camera I just thought it's not activating (the sound) and I didn't understand how the camera was working+ I did a whole thing all the way down through space like that [shows the related movement] but no sound then well I have got no idea of what is going on

R1: mhm

P1: it is completely meaningless+

R1: interesting so- +

P1: I think it is really uninteresting++ [Laughs]

R1: no from the technological point of view

P1: I don't see any point because I have got no way of- I am trying to gauge something if I cannot gauge it then I have got no way of playing with it.

R1: yeah it is-

P1: I've just found it completely hopeless

R1: yeah you can write it /+\your thoughts

P1: /sure+ hopeless

P2: [laughs shortly]

R1: what did you feel+ what worked well what did not work well+

P1: nothing worked well+ [laughs]

R2: specify

P1: specify [starts writing] ++++

R1: because it is generally very sensitive++

P1: that was not sensitive at all

The camera, as an actor, played a crucial role in the scenario. However, the perceived insensitiveness was not only caused by the inherent capabilities of the camera but also by the entire arrangement of the humans and non-humans in the activity: the dark clothes, the distance to the camera, the very slow movements and the back-to-back position.

Excerpt A.3 Machine-Mediated Performance Session Excerpt 2

[P1 and R1 go to the same place where P1 performed the first activity]

B: may be very slow movements may not be suitable for the camera++ can you do it fast

[P1 performs some movements]

P1: because nothing+ absolutely nothing happened+ nothing nothing nothing I'm activating all of those different grids+ [she refers to the visualisation system showing the mapping between the movements and sound] nothing happening [camera does not capture her movements properly]

B: yeah++++

[P1 goes back to the table]

P1: so the next one is wallop, the stationary and fast, orchestra sound and we are using tilts++

R1: I'd like to ask now whether this back-to-back position was helpful for you to communicate or negotiate with your partner? the touch feeling

P1: it depends what you want I mean /you are asking us to create\ sound.

R1: /you were creating the sound together\+ but you are creating the sound together

P1: I can create any sound++ I don't see any reason why we would be touching.

R1: no

P1: no+ because we are trying to because we are trying to- + if our whole operation+ is trying to go to meet through the sound, /+\it is irrelevant to have a back touching.

R1: mhm

P2: yeah, it is a spatial thing I don't- I- it is completely exterior.

P1: it just creates a parameter that is like- it's a limitation++ but why would we need it?

R1: it is- + the intention was to really to remind you to kind of the existence of your partner

P1: but we are doing it /through the sound

P2:/through the sound

R1: okay that's fine if it is enough

P1: because you are limiting togetherness to be touched. It is not just what togetherness is about just

R1: but it is a form of togetherness so there are different forms

P1: if you are asking us to work with sound then that's where we are coming together+ it has nothing to do with being physically together

R1: do you think so?

P1: no

...

R1: okay+ so then in this one you can be separated+++ if you prefer right?

P2: yeah and and to have a+ visual contact+

P1: but that is also something this is the other- I mean this is why I am not quite sure about what we are researching here because if we are talking on musical level about making sounds that generate a sense of being together+ then+ at the moment, the previous experience was something very blunt

R1: yes

P1: because I had no instruments,

...

P1: ultimately we are transferring transferring and transferring through different media. But+ in that transference then we are getting further and further away from any um+ proximity to+ sensitivity actual actual sensitivity+ (09.00) and composition.

R1: yeah+++ okay

P1: sorry that was very ()

R1: no that's fine++

P2: you could take it to the first one, you can spend 3 hours on just /working out what

P1: /what it is to make it work

R1: yeah++ if you like we may do the first one again with fast movements and separated.

P1: then what would be more useful for me is to see the screen.

R1: you think so?

P1: yeah because then I can start to gauge- ++ well I can envisage the screen that was what I was trying to do but then but then we should drop the concept of why we are doing slow movements presumably the whole idea of cutting between slow and fast was to give a greater indication of a kind of () knowledge but given the slow did not work we can try it with tilt for example

R1: would you like to try?

P1: yeah, let's keep going with this which is++

R1: okay let's do the next one then

After completing the activity, P1 criticized both the low sensitivity of the technology and the rationale of the activity inscriptions. While her criticisms were targeted to the last activity, they, in fact, were indicating a dissolution of a higher level network that tied together the workshop goals, researchers and participants.

Activity #2

Revision 7: The removal of the requirement to be in a back-to-back position from the Machine-Mediated Performance Session

As the Revision 6 did not enable the participants to develop a sense of connection, we dropped the requirement from the activity inscription. Revision 7 was different from the previous revisions as it was made during the workshop by the participants - not afterwards by the researchers.

P1, P2, R1, R2, Tilt devices (coupled), activity inscriptions, the theme wallop, a large set of sound effects, two speakers, and one video camera constituted the collective at the beginning of the activity.

There were 5 short connections lasting from 3 to 12 seconds with an average of 6 seconds. Within these connections, there were 5 H-D-H, 4 H-D-E and 4 H-D arrangements (for details of the H-D-H arrangements, see Table B.7 in Appendix B). H-D-E and H-D corresponded to the same forms of arrangements, which were arms-directed-at-device, hands-directed-at-device, torso-directed-at-device and full-body-directed-at-device. The participants employed strategies of making similar movements and stops to establish and maintain a connection. However, these strategies did not work well: they did not enable the participants to maintain a connection and explore its expressive capacities. Their movements were more like an exploration of the conditions for establishing a connection. In the final connection, they were able to make some variations in an established connection. While one participant was making very tiny and repetitive arm movements, the other participant played with various forms of vertical movements. Their movement effort qualities showed variation in only two categories: space and time. Their movements were bound in flow and strong in weight in all connections. This was deemed reasonable as the activity inscription asked participants to make fast movements and be stationary in space. The entire activity lasted for 3 minutes.

Similar to the previous activity, we had long discussions about the difficulties of the task and technological deficiency. This time, the problem was related to the perceived complexity of mapping the algorithm. In the following episode, P1 vocalized her frustration at not being able to get the same effects out of the same movements. Here, her comments indicated that the working principles of the technological devices were not clear so the quality of visibility could not be addressed sufficiently:

Excerpt A.4 Machine-Mediated Performance Session Excerpt 3

> *P1: I do not know what generates the difference in tone it is completely beyond me it is incredibly frustrating to not understand+ what it is to make it work so at one point I was doing this and getting a very high pitch up there but then other times when I do this [makes the related movements] nothing happens.*

R1: because it is relational the output of your device also depends on your partner's device position

P1: it would have been very useful to have had that information first because otherwise it is like-

R1: I tried to explain it but I guess I could not make myself clear+

P1: the frustration is if we want to create sound, we need to know how to get the octave because ultimately, you'd like to get to know how to-+ because you need to know high and low frequencies and what it means to do that and+ so it's just so blunt that we are just spending our time to fishing around- uhm+ I just find it incredibly frustrating.

R1: mhm

P1: partly because+ () it is so unpredictable and vague that we don't know-

R1: do you think if you were using independent devices

P1: () It is not about generating body positions that I'm interested in because then we have our entire physicality available to us++ but this one is actually trying to generate music it is just++ I have no idea to how do it () no control

R1: so do you think-

P1: there is no sense of instrument++ it is just pure unadulterated chance

[Later in the discussion, P1 continued talking about the causes of her frustration]

P1: the biggest frustration is trying to+ um compose something as opposed to seeing what happens with these configurations we cannot compose because we do not have control or any instruments.

A.2.3 Iteration 3

Revisions

Revision 7: Making ‘connectedness’ the overall theme for Workshop 3

We changed the workshop theme from 'togetherness' to 'connectedness'. The main reason for this change was that we realized that togetherness as a theme may suggest forms of togetherness, particularly between humans. As our aim was to explore different forms of togetherness between humans and non-humans, we preferred to use the concept of ‘connectedness’, which was culturally less loaded than ‘togetherness’ and provided us with a powerful metaphor for exploring the various forms of arrangements/

togetherness/couplings between humans and non-humans. Although one participant suggested us to use the concept of relationality, we preferred not to use it as many people were not familiar with the term. This revision was directly related to the quality of multiplicity and strongly emphasized the relationality of the entities.

Revision 8: Asking participants to bring two objects with which they felt connected and one object with which they had no connection to the Rich Poster Session

Although, in the previous workshops, the three objects that the participants brought with them represented many interesting forms of connections, we thought that bringing an object with which they felt no connection might reveal different aspects of what 'connection' meant to each participant. This strategy allowed us to learn something through articulating its opposite. This revision was not a major revision: our aim was to increase the multiplicity in representation of connections.

Revision 9: Using a method of varied strength inscription to guide the participants' movements in the Machine-Mediated Performance Session

The previous movement inscriptions, which specifically predefined the qualities of the movements to be performed, were changed. Rather than providing the participants with strong inscriptions imposing particular forms of movement, we used *adaptive inscriptions* suggesting some movement qualities if required. At the beginning of the session, we provided a weak inscription with a very open task description for the participants. If they experienced difficulty in improvising movements, we gradually increased the strength of the inscription by defining some constraints. We started with the weak inscription 'Explore the different forms of connections between the bodies and technology and space through the technological devices', which did not prescribe any qualities of movements or patterns of action. During the activity, if the participants found their task not sufficiently specific to performing movement, we suggested that they experimented with slow/fast movements or with being mobile/stationary in space.

Revision 10: The removal of the requirement for predefining a theme for the activity in the Machine-Mediated Performance Session

As the complexity of our activity inscription - which involved creating sound effects through technological devices according to a predefined theme - was found to be prescriptive, unattainable and unproductive, we decided to remove this requirement from the activity inscription. This way, the participants could perform the activity according to the themes and/or motivations that emerged out of their engagement with the situation. This revision was very important as it did not try to prescribe the motivations and actions of the participants but supported their emergence through practice.

Revision 11**.** The use of both decoupled devices and coupled devices in the Machine-Mediated Performance Session

In the previous workshops, the wearable devices, Tilts and ECs, were coupled. The participants using the coupled devices did not have total control over the generated sound effects. This meant they could not use the devices in the ways they expected to. One reason for this was their inability to understand the cause-effect relations between their movements and the sound effects. Although, in theory, it was possible to determine the relations by careful choreography and coordination of movement, this did not happen in the previous two workshop iterations. For this reason, we introduced a decoupled version of the devices. When the devices were decoupled, each device produced a separate sound effect independent from the other device. A different sound effect was assigned to each device. As learning the decoupled devices was easier than learning the coupled devices, we ordered the activities from easy to hard. The participants were asked to use decoupled Wii-motes, coupled Wiimotes, decoupled rangefinders, coupled rangefinders and, finally, webcam in each activity respectively. By having two versions of the devices, we aimed to understand the effects of coupling and decoupling devices through the ways in which the participants coordinated their movements and created connections.

Revision 12: The use of real-time visualization of the mapping algorithm in the Machine-Mediated Performance Session

As the provision of a one-page static visualization was not sufficient to explain the working principle of the mapping algorithm, we introduced a real-time visualization of how movements are mapped to sound effects. The participants were provided with real-time visualization at the beginning of the session, when they were familiarising themselves with the technologies.

Silence Session

ID1, ID2, R1, video camera and activity inscriptions constituted the collective at the beginning of the activity.

The participants sat on the floor: they closed their eyes and remained silent. The activity lasted for 5 minutes as planned. They said that there was too much outside noise: it prevented them from concentrating on the activity. One participant said that she realized for the first time how loud her watch was. Some commented on the sound made by the A/C. They said that they did not feel any connection to their partners.

Extraneous noises were enacted as a powerful actor, which was not included in the inscription as such. They interrupted the desired translation and prevented participants from following the program of action defined by the inscriptions. The watch and the A/C were two other actors rendered visible during the activity. The final collective consisted of P1, P2, R1, a video camera, outside noises, the sound of the watch and the sound of the A/C. The activity inscriptions of 'close your eyes and concentrate on the sensations of your partner's body and the connection between you and your partner' were translated as 'close your eyes and stay silent'.

Physical Sensitivity Session

ID1, ID2, R1, activity inscription and a video camera were incorporated into the collective at the beginning of the activity.

The participants performed three exercises: one-way palm-crown exchange, reverse palm-crown exchange and simultaneous palm-crown exchange. They preferred to close their eyes to prevent themselves from laughing. They tried to synchronise their movements and made movements in the same or in opposite directions. Different from the inscribed movement pattern, they made movements on a horizontal axis. They sometimes raised their hands to a level higher than their partner's height, which caused loss of contact between palm and crown, and could be considered as a deviation from the actual inscription. One participant explained the rationale behind the experimentation with higher levels: 'To see how far she can go! It was funny ... It was just to see what happens, and she jumped. It was like she was a toy-puppet'. In the reflection session, the other participant stated that it was like torment for her. They found the third activity very complicated and said that they tried to do same movements or synchronised movements in order to maintain the connection.

ID1, ID2, R1, activity inscription and a video camera constituted the final collective. During the first activity, the visual modality emerged as a powerful actor making the participants follow a program of action against the inscriptions; then, it was taken out of the network and became no longer an actor part of the network as the participants preferred not to use it. The activity inscription was translated slightly differently: it included additional movements on a horizontal axis.

Rich Poster Session

ID1, ID2, R1, activity inscription, poster paper, blue and red markers, various pictures, six objects brought by participants and a video camera were incorporated into the collective at the beginning of the activity.

The first part: Three objects

ID1 brought a drawing, a book and chewing gum; ID2 brought a sketch, a book and a clock. Their objects showed various forms of connections: connection as culture, connection as shared experiences, connection as shared objects and connection as criticism.

The second part: Collage making and reflection

The participants enjoyed the collage work and preferred to talk while making the collages rather than discuss them afterwards. They created small groups of pictures around their shared memories and/or the time they spent together. Their shared memories allowed them to select pictures and connect them easily. Almost all of the pictures told a little story; thus, the time periods connected each picture. They expressed no marked preference to annotate the images very much and used only one of the markers to annotate them. Figure A.4 shows the poster the participants created.

Figure A.4 The poster showing the different forms of connections the participants expressed

The practice of the actors, ID1 and ID2, did not render them as separate individuals but rather as an assemblage of strongly coupled people. Together, they created a new actor aligned to the collective whereas ID1 and ID2, as separate actors, were no longer part of the network. Similarly, the blue marker was taken out of the network. Activity inscription was translated slightly differently: it did not include use of separate markers for annotating the images. ID1+ID2, R1, activity inscription, poster paper, red markers, various pictures, six objects brought by participants, and a video camera constituted the final collective.

Machine-Mediated Performance Session

<u>Activity #1</u>

P1, P2, R1, two Tilt devices (de-coupled), activity inscriptions (adaptive), a large set of sound effects, two speakers, various straps and one video camera constituted the collective at the beginning of the activity.

There were 7 different connections lasting from 4 to 26 seconds with an average of 14 seconds. Within these connections, there were 7 H-D-H, 1 H-D-E and 2 H-D arrangements (For the details of the H-D-H arrangements, see Table B.8 in Appendix B). While the H-D-E arrangement took the form of (human-device)-to-space, H-D arrangements took the forms of device-at-arm and device-at-hand. The participants' main strategy of coordination was making similar movements. They communicated by talking and by eye contact. Their aims were to create harmony either through the sounds or their movements. They systematically tried to do different combinations of movements: 1) doing the same movements at the same time; 2) doing the opposite movements at the same time; and 3) doing a mixture of stops and repetitive movements simultaneously. They experimented with the various movement choreographies to explore interesting or harmonic sound effects. Three of the 7 connections were choreographed, i.e., constructed by verbal communication. For example, in the second connection, one participant said: ‘We are all robots’. Then, they started to move like robots: their focus was upon movement rather than on sound effects. The most outstanding result was the same qualities of movement for both participants for all connections in the activity. Although the qualities of movement varied in time and space, they were mostly (6 out of 7) strong in weight and always bounded in flow. The straps enabling the participants to attach the devices to many parts of their bodies were used only for the first three connections; then, they were abandoned. The activity lasted for 3 minutes and 30 seconds.

The final collective was composed of ID1, ID2, R1, tilt devices (de-coupled), activity inscription, sound effects of bubble and wind chimes, two speakers and one video camera. After the third connection, both participants preferred to hold the device in their hands instead of attaching it to some other places on their bodies. The various straps allowing the participants to attach the tilt devices to the different parts of their bodies became no longer actors. The participants reported no difficulty with the level of specificity of the activity description, which was the most open or least specific version of the adaptive inscription. Therefore, we did not need to use other movement constraints, which were part of the adaptive of inscriptions. The activity inscription of ‘explore different forms of connections with the space and your partner’ was enacted as ‘create harmony in sound or movement’.

<u>Activity #2</u>

ID1, ID2, R1, two Tilt devices (coupled), activity inscriptions (adaptive), a large set of sound effects, two speakers, various straps and one video camera constituted the network at the beginning of the activity.

There were 4 connections lasting from 3 to 75 seconds with an average of 23 seconds. Within the 4 connections, there were 4 H-D-H, 1 H-D-E and 1 H-D arrangements (For the details of the H-D-H arrangements, see Table B.9 in Appendix B). While the H-D-E arrangement was in the form of (human-device)-to-space, the H-D arrangement was in the form of device-at-hand. All of the connections were performed according to a choreography which was based on the notion of creating the effect of a slowly gathering storm. They decided to do it after playing with the tilt devices and creating some sound effects. They said that the thunder sound effect inspired them and that having a theme for the activity helped them to coordinate their movements and hence create a connection. Their movement qualities varied in three of the movement effort categories. Starting with slow and small arm movements, they gradually increased their speed and range of movement. However, the theme and choreography were not sufficient to maintain the connections longer. At one point, one participant flipped her device up into the air as an indication of her frustration at not being able to get the desired sound effect. Although the participants could not achieve the desired storm effect, they systematically experimented with different possibilities of connections using verbal communication and strong eye contact. This time, the straps were not used at all. The activity lasted for 3 minutes.

ID1, ID2, R1, tilt-devices (coupled), activity inscription, sound effects of bubble and wind chimes, two speakers and one video camera constituted the final collective. Although the tilt-devices were used for creating connections, they prevented the participants from collaborating with each other. The pre-existing coupling between the devices did not facilitate the construction of new connections between the participants. Therefore, the mapping algorithm became a powerful actor following an anti-program of action against our inscriptions. The activity inscription of ‘explore different forms of connections with the space and your partner' was enacted as 'create an effect of slowly gathering sound'.

<u>Activity #3</u>

ID1, ID2, R1, two EC devices (de-coupled), activity inscriptions (adaptive), a large set of sound effects, two speakers, various straps and one video camera were incorporated into the collective at the beginning of the activity.

There were 14 connections lasting from 3 to 35 seconds with an average of 14 seconds. Within these connections, there were 14 H-D-H, 2 H-D-E and 1 H-D arrangements (For the details of the H-D-H arrangements, see Table B.10 in Appendix B). While the H-D-E arrangements were in the forms of (Human-device)-to-floor, and (Human-device)-to-wall, the H-D arrangement was in the form of device-at-hand. The participants used verbal communication only three times to coordinate their movements: body language and eye contact were sufficient. Their main coordination strategies were doing similar or opposite movements. All qualities of movement varied across the different connections except for the quality of flow, which was again bounded for all connections. From the beginning of the activity, the participants decided to use the EC devices with their hands and opted not to use the straps to attach the ECs to any other parts of their bodies. The participants hand-operated the EC devices: this gave them the highest capacity to connect with their partners' bodies and the environment. The activity lasted for 5 minutes and 50 seconds.

ID1, ID2, R1, EC devices (de-coupled), activity inscription, floors, walls, sound effects of electronic screaming, gun shot, accordion, two speakers and one video camera were part of the final collective. The various straps that allowed the participants to attach the EC devices to different parts of their bodies became no longer an actor. The walls and floors became two new actors enrolled in and aligned to the network. The participants made use of the walls and floors of the room to create sound effects in different ways. A particular feature of the EC devices' sensing technology allowed the participants to recognize these actors that were previously irrelevant. The activity inscription of 'explore different forms of connections with the space and your partner' was enacted as was.

<u>Activity #4</u>

ID1, ID2, R1, two EC devices (coupled), activity inscriptions (adaptive), various sound effects, walls, floors, various straps, two speakers an one video camera constituted the collective at the beginning of the activity.

However, the activity could not be performed because of a technical problem with the devices. The unavailability of two technological actors caused the dissolution of the collective.

Activity #5

ID1, ID2, R1, webcam, various sound effects, the field of view of camera, two speakers, and one video camera comprised the collective at the beginning of the activity.

The webcam activity resulted in 10 different connections lasting from 5 to 27 seconds with an average of 13 seconds. Within these connections, there were 10 H-D-H, 4 H-D-E and 4 H-D arrangements (For the details of the H-D-H arrangements, see Table B.12 in Appendix B). Because the webcam was placed on a wall in the environment, the H-D-E and H-D corresponded to the same forms of arrangement, i.e., arms-directed-at-device, legs-directed-at-device, torso-directed-at-device and full body-directed-at-device. They employed strategies of making similar movements, choreographed movements, repetitive movements and stopping. The connections were radically different from the previous activities in terms of positioning of bodies and movement quality. The webcam allowed the participants to use their full bodies in many different axes. They did aerobic movements: one even did a headstand; their movements were usually sustained in time and indirect in space. For the first time, the flow of their movement was free from some connections. They used many different parts of the space and did not need to be close to their partners in space. The participants liked the flexibility in creating sound effects and the 'tool-less' freedom of interaction. They asked us to change the sound effects more frequently. Changing the sound effects radically changed their movements and ways of connecting with each other. The activity lasted for 6 minutes.

ID1, ID2, R1, webcam, sound effects of the castanets, jam and new age, the field of view of the camera, two speakers and one video camera constituted the final collective.

A.2.4 Iteration 4

Silence Session

MP1, MP2, R1, R2, a video camera and activity inscriptions comprised the collective at the beginning of the activity.

The participants sat on the floor in a back-to-back position. They closed their eyes and remained silent. The activity lasted for 5 minutes as planned. They found the activity very relaxing. Each said that what they experienced was mainly the temperature of their partner's body, and apart from that there was not really anything transferring between them. They said that the noise of the A/C captured their attention. The participants described the connection between them as minimal connection.

This time, different from the previous iterations, extraneous noises were not included in the network. Since the workshop was conducted on a Saturday afternoon, there were no sounds coming from outside of our research laboratory. Instead, the temperature of their partner's body emerged as an actor. Similar to previous iterations, the A/C was rendered visible as an actor during the activity. The final collective consisted of MP1, MP2, R1, R2, a video camera, body temperatures, and the sound of the A/C. The activity inscriptions of 'close your eyes and concentrate on the sensations of your partner's body and connection between you and your partner' were translated as 'close your eyes, stay silent and concentrate on the sensations of your partner's body'.

Physical Sensitivity Session

MP1, MP2, R1, R2, activity inscription and a video camera constituted the network at the beginning of the activity.

The participants performed three exercises: one-way palm-crown exchange, one-way palm-crown exchange by changing roles, and simultaneous palm-crown exchange. While the participants playing the lead role kept their eyes open, those playing the receiver role preferred to close their eyes. They were able to maintain the contact between palm and crown all the time. They started with very slow movements and gradually increased their speed. They said that they tried not to synchronise their movements or make movements in a rhythmic way as they thought that synchronised or rhythmic movements might be too mechanical and boring and may not necessarily involve communication. Thus, they tried to move synchronously and to create variations.

They found the third activity the hardest as it involved both leading and receiving roles at the same time. One participant pointed out the importance of switching the roles in line with his understanding of the two-sidedness of the connection: ‘It was not until I was receiving that I really understood how it was to be at the other side of the conversation ... I realized that I didn't have to push ... a little touch was sufficient to give a signal and initiate the movement’. The same participant also stated that it would have been very useful to do another iteration of the first two exercises before going to do the third: he maintained that he would have done better in the first activity in which he was leading with the experience of being the receiver. The participants also mentioned the differences between the upward and downward movements, and the difficulty of managing the downward movement as opposed to the upward because of the difficulty of determining the terminal point of the downward movement.

MP1, MP2, R1, R2, activity inscription and a video camera constituted the final collective. Different from the previous workshop iteration, the receiving participants did not use visual modality at all. Thus, it was never part of the network. Activity inscription was translated exactly as was.

Rich Poster Session

MP1, MP2, R1, R2, activity inscription, poster paper, blue and red markers, various pictures, six objects brought by participants and a video camera comprised the collective at the beginning of the activity.

The first part: Three objects

MP1 brought a toy dog puppet, a postcard and a book: MP2 brought a potato peeler, a CD cover picture and a book. The objects revealed many forms of connections including: connection as memories, connection as complementing, and connection as exploration.

The second part: Collage making and reflection

The participants created the collage based on the aesthetic quality of the individual pictures and their composition. They selected them according to their colour and visual style. They preferred to include abstract pictures or patterns and rejected those including people. In this image selection process, the views of the female participant were dominant. Although there was no explicit decision reached as to how to select the images, female participant was more active in her selection and composing activity while the male participant simply followed her selections and sometimes contributed to the collage by selecting similar images. All of the images were consistently placed according to an invisible grid system. There was a sense of symmetry in overall composition. The participants used the different red and blue markers assigned to them and annotated the images they selected only. In the reflection session, they talked about their reasons for selecting the pictures in the collage and the particular ways in which the images came together. They pointed out that the female participant led the collage work. Her main aim in making the collage was to create a balanced and visually pleasing, cohesive composition. Figure A.5 shows the poster the participants created.

Figure A.5 The poster showing different forms of connections the participants expressed

The female participant became a strong actor imposing a single translation of the inscriptions. The male participant followed the translation of his partner. The activity inscription of ‘select some of them that you feel a connection with and make a collage of these pictures collectively’ was translated as ‘select images that you found visually pleasing and make a college of these pictures'. Thus, the participants focused on a single form of connection, i.e., a connection between the participants and the aesthetic value of the images. Their collaboration was limited in that one participant's view dominated the overall selection process. MP1, MP2, R1, R2, activity inscription, poster paper, blue and red markers, various pictures, six objects brought by participants and a video camera constituted the collective. In the final network of relations, MP1 became a stronger actor while MP2 grew weaker. Various pictures were enacted as colourful geometrical shapes only and, in the process, lost their semantic content.

Machine-Mediated Performance Session

Activity #1

MP1, MP2, R1, R2, two Tilt devices (de-coupled), activity inscriptions (adaptive), a large set of sound effects, two speakers, various straps and one video camera were incorporated into the network at the beginning of the activity.

There were 6 different connections lasting from 6 to 67 seconds with an average of 16 seconds. Within these connections, there were 7 H-D-H, 1 H-D-E and 1 H-D arrangements (For the details of the H-D-H arrangements, see Table B.13 in Appendix B). While the H-D-E arrangement was in the form of (human-device)-to-space, the H-D arrangement took the form of device-at-hand. During the entire activity, the participants were stationary in the space. They controlled the devices mostly by their hand movements and occasionally by their arm movements. They did not use the straps at all. They were very attentive to the gradual changes in sound. They employed three main strategies of coordination: 1) a combination of repetitive and varying movements; 2) making similar and repetitive movements; and, 3) using stops. Their movements showed variations in all effort categories. They said that they first learned how to obtain lowest and highest pitch and make the sound louder, then they tried to make interesting sounds. They also stated that their aim was making sounds deliberate rather than just creating random noise. We observed that they developed a vocabulary of particular movement-sound pairs. For example, wave- and shake-like movements were discovered in the first connection and added to their vocabulary. Later, they used similar movements in order to get the desired sound effect that would contribute to their composition. This kind of deliberate use of previous movement-sound pairs was not observed in the previous workshop iterations. The activity lasted for 4 minutes and 12 seconds.

MP1, MP2, R1, R2, tilt devices (de-coupled), activity inscription, mixed sound effects, two speakers and one video camera constituted the collective. The inscriptions translated both MP1 and MP2 as stationary bodies in space, facing each other and engaging in strong eye contact. The various straps allowing the participants to explore the different configurations could not become actors. The activity inscription of 'explore different forms of connections with the space and your partner' was enacted as 'making sounds deliberate'. As the participants had previous experience in music improvisation, they felt comfortable performing the activity without any guidance from more specific activity inscriptions or constraints.

Activity #2

MP1, MP2, R1, R2, two Tilt devices (coupled), activity inscriptions (adaptive), a large set of sound effects, two speakers, various straps and one video camera were incorporated into the collective at the beginning of the activity.

There were 4 different configurations lasting from 11 to 61 seconds with an average of 35 seconds. Within the 4 connections, there were 4 H-D-H, 1 H-D-E and 1 H-D arrangements (For the details of the H-D-H arrangements, see Table B.14 in Appendix B). While the H-D-E arrangement was in the form of (human-device)-to-space, the H-D arrangement was in the form of device-at-hand. Similar to the previous activity, the participants were stationary in space and controlled the devices by their hands during the entire activity. The straps, again, were not used. They employed strategies of verbal communication, eye contact, and making similar movements to establish connection. In the first connection, they decided to do a particular movement pattern: one participant moved the device very slowly on a vertical axis, and the other made wave-like movements. This particular movement pattern allowed the participants to trigger all of the available notes encoded into the system. The effort qualities of their movements were varied in three effort categories of weight, time and space.

The participants in the current iteration were more attentive to the gradual changes in sound effect: they spent more time exploring the expressive possibilities of each connection. One participant found the mapping algorithm making two controllers control the same sound very interesting and unusual. The same participant compared the activity with his previous experience in musical improvisation: ‘I think it is potentially very interesting to have two people controlling the same sound. ... Generally in musical improvisation, there are two people playing two different instruments like in the first activity. It was more familiar to me. Whereas in this, I think it would be better to have a finer grained grid; then, I would have more possibilities to explore’. The participant also stated that possibility of playing with some other parameters to change the frequency or duration of notes would have been better. The other participant pointed out that her experience of using coupled devices required more planning than improvisation. In general, the participants preferred the decoupled devices as they were able to hear the sounds their movements created. They both agreed that they were connected through physicality and movement rather than through music in the second performance. The activity lasted for 5 minutes and 47 seconds.

MP1, MP2, R1, R2, tilt devices (coupled), activity inscription, the mapping algorithm, the sound effects of glocken, two speakers and one video camera constituted the network. The mapping algorithm became very visible, as the controls of the devices were not as smooth as in the decoupled mode. The situation was similar to Heidegger’s present-at-hand and ready-at-hand modes of engagement. The complexity of mapping algorithm coupling two devices changed the relationship between the devices and the participants from ready-at-hand to present-at-hand. During the entire activity, the participants could not actually engage with the devices in ready-at-hand mode. The MP1 and MP2 were enacted as stationary bodies in space, facing each other, having strong eye contact and verbal communication. The various straps could not become actors. The activity inscription of ‘explore different forms of connections with the space and your partner’ was enacted as ‘creating sounds effects by planning’.

<u>Activity #3</u>

MP1, MP2, R1, R2, two EC devices (decoupled), activity inscriptions (adaptive), a large set of sound effects, two speakers, various straps and one video camera comprised the collective at the beginning of the activity.

There were 10 different connections lasting from 14 to 25 seconds with an average of 16 seconds. Within these connections, there were 10 H-D-H, 2 H-D-E and 1 H-D arrangements (For the details of the H-D-H arrangements, see Table B.15 in Appendix B). While the H-D-E arrangements were in the forms of (Human-device)-to-floor and (Human-device)-to-objects, the H-D arrangement was in the form of device-at-hand only. The connections were established by body language and strong eye contact. The participants utilized many different surfaces to trigger the notes: the floor, their torsos, palms, and their partner's device. One participant pointed out an important difference between the controls of the tilt and EC devices; while the EC devices allow you to jump between the notes, the tilt devices do not. When using tilt devices, one needs to trigger all the notes between two notes when going from one note to another. According to the participants, this was a big limitation. The effort qualities of their movements were varied in all effort categories.

The final collective was composed of MP1, MP2, R1, R2, EC devices (de-coupled), activity inscription, floors, harmonica sound effect, two speakers and one video camera. The various straps were no longer actors. The activity inscription of "explore different forms of connections with the space and your partner" was enacted as "explore different forms of connections with the space and your partner" and "compose music together".

Activity #4

MP1, MP2, R1, R2, two EC devices (coupled), a large set of sound effects, two speakers, various straps and one video camera were incorporated into the collective at the beginning of the activity.

There were only 2 connections lasting 26 and 20 seconds with an average of 23 seconds. Within these connections, there were 2 H-D-H, 0 H-D-E and 1 H-D arrangements (For the details of the H-D-H arrangements, see Table B.16 in Appendix B). The H-D arrangement was in the form of device-at-hand. We did not observe any H-D-E arrangements. The participants' strategies for creating connections were verbal communication, making gradual changes in their movements, making similar movements and using stops. Their movement effort qualities were the same in both connections and did not show any variation in the four effort categories. Both participants agreed upon the difficulty of controlling the devices. One participant said that they were not actually very sure what they were controlling. Another said: ‘We were trying to make something work rather than creating something that sounded nice’. She added that the problem was not related to the connectedness of the devices but to the way in which the devices were connected. According to the participants, having devices controlling the same parameter was quite unusual and hard to coordinate. They suggested that devices could control the different parameters of the same sound output. The activity lasted for 3 minutes and 30 seconds.

MP1, MP2, R1, R2, EC devices (coupled), activity inscription, the mapping algorithm, mixed sound effects, two speakers and one video camera constituted the network. The activity inscription of "explore different forms of connections with the space and your partner" was enacted as "making something work".

Activity #5

MP1, MP2, R1, R2, the webcam, a large set of sound effects, two speakers, various straps and one video camera comprised the collective at the beginning of the activity.

There were 4 connections lasting from 8 to 17 seconds with an average of 13 seconds. Within these connections, there were 4 H-D-H, 4 H-D-E and 4 H-D arrangements (For the details of the H-D-H arrangements, see Table B.17 in Appendix B). The H-D-E and the H-D corresponded to the same forms of arrangements: arms-directed-at-device, hands-directed-at-device, torso-directed-at-device and full_body-directed-at-device. They employed the strategy of stopping in four connections, and making similar movements in one connection. For the first time in the workshop, they used different parts of their bodies: their full bodies, torsos and arms. They were also mobile in the space. The effort qualities of their movements varied in the first three connections and were the same in the fourth. They found the webcam the least instrument-like among the devices as it did not support precise control of the parameters. Therefore, they said that it would have been better to just move around and see what happened instead of caring about controlling. The activity lasted for 5 minutes and 30 seconds.

MP1, MP2, R1, R2, webcam, activity inscription, the mapping algorithm, piano sound effect, two speakers and one video camera constituted the network. MP1 and MP2 were actors stationary in space: they used only their hands to make sound effects at the beginning of the activity. They were enacted as actors mobile in space, using their arms, legs, torsos and full bodies to interact and create sound.

Appendix B: H-D-H Connections in Workshop 3

Table B.1 Iteration 1 - Machine-Mediated Performance Session - Activity 1

H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Movement qualities-P3	Devices	Sound
	physical face to face arrangements, eye contacts and stops	132 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, direct in space, bound in flow	light in weight, sustained in time, direct in space, bound in flow	2 ECs (coupled), 1 Tilt	door, piano

Table B.2 Iteration 1 - Machine-Mediated Performance Session - Activity 2

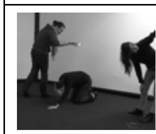
H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Movement qualities-P3	Devices	Sound
	making similar movements	5 seconds	strong in weight, sudden in time, direct in space, bound in flow	-	strong in weight, sudden in time, indirect in space, bound in flow	2 ECs (coupled), 1 Tilt	honky, rain
	making similar movements	11 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, free in flow	light in weight, sudden in time, indirect in space, bound in flow	2 ECs (coupled), 1 Tilt	honky, rain

Table B.3 Iteration 1 - Machine-Mediated Performance Session - Activity 3

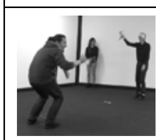
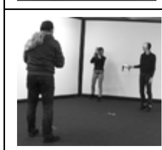
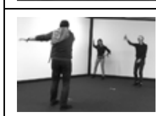
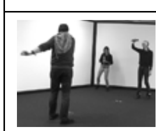
H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Movement qualities-P3	Devices	Sound
	theatrical movements and eye contact	86 seconds	Vary	Vary	Vary	2 Tilts (coupled), Webcam	
	using stops	18 seconds	light in weight, sustained in time, indirect in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	-	2 Tilts Webcam	
	making similar movements	15 seconds	light in weight, sustained in time, indirect in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 Tilts Webcam	
	making similar movements	18 seconds	light in weight, sustained in time, indirect in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 Tilts Webcam	

Table B.4 Iteration 1 - Machine-Mediated Performance Session - Activity 4

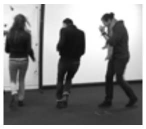
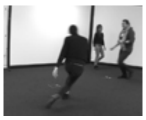
H-D-H arrangement	**Connection strategy**	**Duration**	**Movement qualities-P1**	**Movement qualities-P2**	**Movement qualities-P3**	**Devices**	**Sound**
	choreographed movements and making similar movements	20 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	castanets
	making similar movements and turn taking	16 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	castanets
	making repetitive and similar movements	12 seconds	light in weight, sustained in time, direct in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	castanets
	making similar movements and spinning	59 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	castanets

Table B.5 Iteration 1 - Machine-Mediated Performance Session - Activity 5

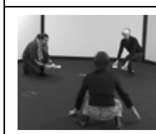
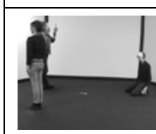
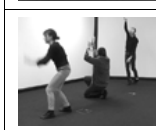
H-D-H arrangement	**Connection strategy**	**Duration**	**Movement qualities-P1**	**Movement qualities-P2**	**Movement qualities-P3**	**Devices**	**Sound**
	making similar movements	21 seconds	light in weight, sudden in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sudden in time, indirect in space, bound in flow	2 ECs 2 Tilts Webcam	
	using stops	3 seconds	light in weight, sudden in time, indirect in space, bound in flow	-	-	2 ECs 2 Tilts Webcam	
	making repetitive movements	3 seconds	light in weight, sudden in time, direct in space, bound in flow	light in weight, sudden in time, indirect in space, bound in flow	light in weight, sudden in time, direct in space, bound in flow	2 ECs 2 Tilts Webcam	

Table B.6 Iteration 2 - Machine-Mediated Performance Session - Activity 1

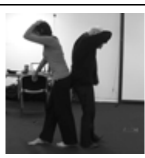
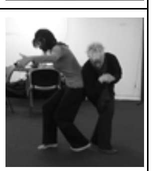
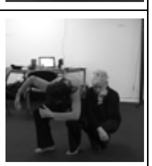
H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	using tactile sensation, making similar movements and using stops	39 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	Honky-donkey
	using tactile sensation	15 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	Honky-donkey
	using tactile sensation, making large variations	21 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	Honky-donkey
	using stops	16 seconds	light in weight, sustained in time, indirect in space, bound in flow	-	Webcam	Honky-donkey
	lost connection	23 seconds	-	-	Webcam	Honky-donkey
  	using tactile sensation	39 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	Honky-donkey

Table B.7 Iteration 2 - Machine-Mediated Performance Session - Activity 2

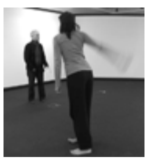
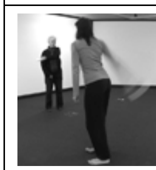
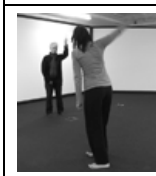
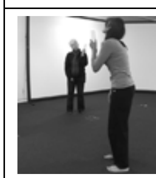
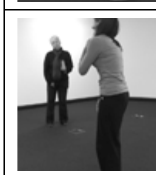
H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	making similar movements and using stops	3 seconds	strong in weight, sudden in time, vary in space, bound in flow	strong in weight, sudden in time, vary in space, bound in flow	2 Tilts (coupled)	harmonica
	using stops	4 seconds	strong in weight, sustained in time, indirect in space, bound in flow	-	2 Tilts (coupled)	harmonica
	making repetitive movements	3 seconds	strong in weight, sustained in time, indirect in space, bound in flow	strong in weight, sudden in time, indirect in space, bound in flow	2 Tilts (coupled)	harmonica
	making repetitive movements and using stops	3 seconds	strong in weight, sustained in time, indirect in space, bound in flow	strong in weight, sudden in time, indirect in space, bound in flow	2 Tilts (coupled)	harmonica
	making similar and repetitive movements	4 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 Tilts (coupled)	harmonica
	combination of repetitive and varying movements	12 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, indirect in space, bound in flow	2 Tilts (coupled)	harmonica

Table B.8 Iteration 3 - Machine-Mediated Performance Session - Activity 1

H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound

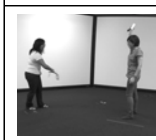
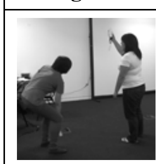
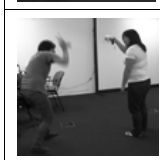
	making similar movements	10 seconds	light in weight, sustained in time, indirect in space, bounded in flow	light in weight, sustained in time, indirect in space, bounded in flow	2 Tilts (decoupled)	bubble, wind chimes
	choreographed movements and making similar movements	4 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 Tilts (decoupled)	bubble, wind chimes
	choreographed movements and making similar movements	21 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 Tilts (decoupled)	bubble, wind chimes
	choreographed movements and making similar movements	14 seconds	strong in weight, sudden in time, indirect in space, bound in flow	strong in weight, sudden in time, indirect in space, bound in flow	2 Tilts (decoupled)	bubble, wind chimes
	choreographed movements and making similar movements	8 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 Tilts (decoupled)	bubble, wind chimes
	choreographed movements and making opposite movements	26 seconds	light in weight, sustained in time, indirect in space, bounded in flow	light in weight, sustained in time, indirect in space, bounded in flow	2 Tilts (decoupled)	bubble, wind chimes
	making similar movements	18 seconds	strong in weight, sudden in time, indirect in space, bound in flow	strong in weight, sudden in time, indirect in space, bound in flow	2 Tilts (decoupled)	bubble, wind chimes

Table B.9 Iteration 3 - Machine-Mediated Performance Session - Activity 2

H-D-H arrangement	**Connection strategy**	**Duration**	**Movement qualities-P1**	**Movement qualities-P2**	**Devices**	**Sound**
	choreographed movements and making opposite movements	3 seconds	-	strong in weight, sudden in time, indirect in space, bound in flow	2 Tilts (coupled)	thunder
	choreographed movements and making opposite movements	10 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, indirect in space, bound in flow	2 Tilts (coupled)	thunder

	choreographed movements (combination of fixed and repetitive movements)	3 seconds	strong in weight, sudden in time, direct in space, bound in flow	-	2 Tilts (coupled)	thunder
	choreographed movements and making similar movements	75 seconds	vary in weight, vary in time, vary in space, bound in flow	vary in weight, vary in time, vary in space, bound in flow	2 Tilts (coupled)	thunder

Table B.10 Iteration 3 - Machine-Mediated Performance Session - Activity 3

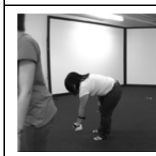
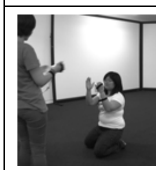
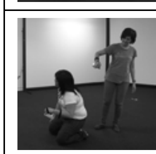
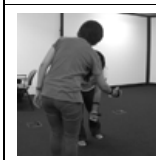
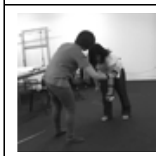
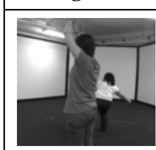
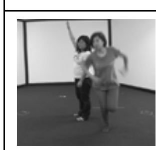
H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	making similar movements	8 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	electronic screaming, gun shot
	making similar movements	10 seconds	light in weight, gentle in time, direct in space, bound in flow	light in weight, gentle in time, indirect in space, bound in flow	2 ECs (decoupled)	electronic screaming, gun shot
	choreographed movements (fixed and repetitive movements)	19 seconds	light in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
	choreographed movements and making similar movements	22 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
	making similar movements	12 seconds	light in weight, sustained in time, direct in space, bound in flow	light in weight, sustained in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
	making similar movements	6 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
	combination of repetitive and varying movements	35 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st

Table B.11 Iteration 3 - Machine-Mediated Performance Session - Activity 4*

H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	combination of repetitive and varying movements	19 seconds	strong in weight, sudden in time, indirect in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
	choreographed movements and making similar movements	18 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
	combination of fixed and repetitive movements and making similar movements	3 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
	making similar movements	7 seconds	light in weight, sustained in time, direct in space, bound in flow	light in weight, sustained in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
	combination of fixed and repetitive movements	16 seconds	gentle in weight, sustained in time, indirect in space, bound in flow	strong in weight, sustained in time, direct in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
	making opposite movements	6 seconds	strong in weight, sustained in time, direct in space, bound in flow	gentle in weight, sustained in time, indirect in space, bound in flow	2 ECs (decoupled)	gun shot, electronic accordion st
					2 ECs (coupled)	

*The activity could not be performed because of a technical problem with the devices.

Table B.12 Iteration 3 - Machine-Mediated Performance Session - Activity 5

H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	choreographed movements and making opposite movements	13 seconds	firm in weight, vary in time, direct in space, bound in flow	firm in weight, vary in time, direct in space, bound in flow	Webcam	bubble
	combination of fixed and repetitive movements	5 seconds	firm in weight, sudden in time, direct in space, bound in flow	firm in weight, sudden in time, direct in space, free in flow	Webcam	castanets

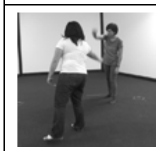
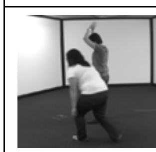
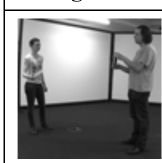
	choreographed movements and making similar movements	9 seconds	firm in weight, sudden in time, indirect in space, bound in flow	firm in weight, sudden in time, indirect in space, bound in flow	Webcam	castanets
	combination of repetitive and varying movements	28 seconds	firm in weight, sudden in time, indirect in space, bound in flow	firm in weight, sudden in time, direct in space, free in flow	Webcam	jam- various instruments
	combination of repetitive and varying movements	16 seconds	firm in weight, sudden in time, indirect in space, bound in flow	vary in weight, vary in time, indirect in space, free in flow	Webcam	jam- various instruments
	combination of fixed and repetitive movements	6 seconds	light in weight, sustained in time, indirect in space, bounded in flow	-	Webcam	new age
	choreographed movements and making similar movements	5 seconds	light in weight, sustained in time, indirect in space, bounded in flow	strong in weight, sudden in time, indirect in space, bound in flow	Webcam	new age
	combination of fixed and repetitive movements	10 seconds	light in weight, sustained in time, indirect in space, bounded in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	new age
	making similar movements	18 seconds	light in weight, sustained in time, indirect in space, bounded in flow	light in weight, sustained in time, indirect in space, bound in flow	Webcam	new age
	choreographed movements (combination of fixed and repetitive movements)	27 seconds	-	vary in weight, vary in time, vary in space, vary in flow	Webcam	new age

Table B.13 Iteration 4 - Machine-Mediated Performance Session - Activity 1

H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	combination of repetitive and varying movements	67 seconds	vary	light in weight, gentle in time, indirect in space, bound in flow	2 Tilts (decoupled)	mixed

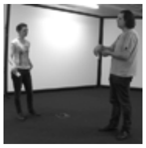
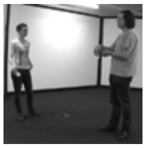
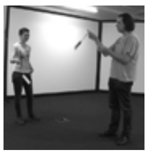
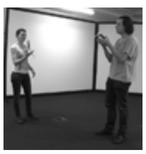
	making repetitive and similar movements	15 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 Tilts (decoupled)	mixed
	using stops	19 seconds	light in weight, gentle in time, indirect in space, bound in flow	-	2 Tilts (decoupled)	mixed
	combination of repetitive and varying movements	30 seconds	light in weight, gentle in time, indirect in space, bound in flow	vary	2 Tilts (decoupled)	mixed
	making similar movements	8 seconds	light in weight, gentle in time, indirect in space, bound in flow	light in weight, gentle in time, indirect in space, bound in flow	2 Tilts (decoupled)	mixed
	making similar movements	6 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 Tilts (decoupled)	mixed

Table B.14 Iteration 4 - Machine-Mediated Performance Session - Activity 2

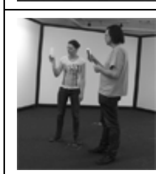
H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	verbal choreography	48 seconds	vary	vary	2 Tilts (coupled)	glocken
	strong eye contact and observation	22 seconds	vary	vary	2 Tilts (coupled)	glocken
	verbal choreography	61 seconds	vary	vary	2 Tilts (coupled)	glocken
	making repetitive and similar movements	17 seconds	strong in weight, sudden in time, indirect in space, bound in flow	strong in weight, sudden in time, indirect in space, bound in flow	2 Tilts (coupled)	glocken

Table B.15 Iteration 4 - Machine-Mediated Performance Session - Activity 3

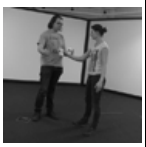
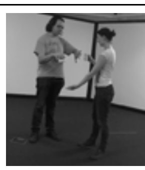
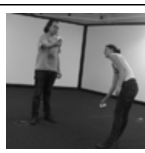
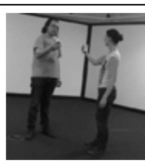
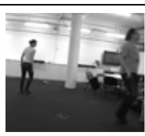
H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	making similar movements	14 seconds	light in weight, gentle in time, direct in space, bound in flow	light in weight, gentle in time, direct in space, bound in flow	2 ECs (decoupled)	harmonica
	making repetitive and similar movements	42 seconds	light in weight, gentle in time, direct in space, bound in flow	light in weight, gentle in time, direct in space, bound in flow	2 ECs (decoupled)	harmonica
	making similar movements	17 seconds	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	harmonica
	making similar movements	20 seconds	light in weight, gentle in time, direct in space, bound in flow	light in weight, gentle in time, direct in space, bound in flow	2 ECs (decoupled)	harmonica
	making similar movements	23 seconds	light in weight, gentle in time, direct in space, bound in flow	light in weight, gentle in time, direct in space, bound in flow	2 ECs (decoupled)	harmonica
	combination of repetitive and varying movements	10 seconds	strong in weight, sudden in time, indirect in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	harmonica
	combination of repetitive and varying movements	25 seconds	light in weight, sustained in time, indirect in space, bound in flow	light in weight, sudden in time, direct in space, bound in flow	2 ECs (decoupled)	harmonica

Table B.16 Iteration 4 - Machine-Mediated Performance Session - Activity 4

H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound

	making similar movements and using stops	26 seconds	light in weight, gentle in time, direct in space, bound in flow	light in weight, gentle in time, direct in space, bound in flow	2 ECs (coupled)	mixed
	making similar movements	20 seconds	light in weight, gentle in time, direct in space, bound in flow	light in weight, gentle in time, direct in space, bound in flow	2 ECs (coupled)	mixed

Table B.17 Iteration 4 - Machine-Mediated Performance Session - Activity 5

H-D-H arrangement	Connection strategy	Duration	Movement qualities-P1	Movement qualities-P2	Devices	Sound
	using stops	8 seconds	strong in weight, sudden in time, indirect in space, free in flow	-	Webcam	piano
	using stops	8 seconds	-	strong in weight, sudden in time, indirect in space, free in flow	Webcam	piano
	using stops	14 seconds	-	strong in weight, sudden in time, indirect in space, bound in flow	Webcam	piano
	using stops	15 seconds	light in weight, gentle in time, indirect in space, bound in flow	-	Webcam	piano
	making similar movements	17 seconds	light in weight, gentle in time, indirect in space, bound in flow	light in weight, gentle in time, indirect in space, bound in flow	Webcam	piano

Appendix C: Workshop Research Materials

Workshop 1 and 2 Response Cards:

Activity:

How did you move?

How did you sense? Which of your senses might have been active?

Where in your body were you sensing? What did you sense?

Activity:

What did it like?

How did you move?

How did you sense? Which of your senses might have been active?

Where in your body were you sensing? What did you sense?

Transcripts of the Response Cards:

P1, P2: Participant 1, Participant 2

Activity 1: distal perception/guidance by Rope

P1

1. How did you move?

   Slowly, carefully, I tried to adopt myself to the physical instructions of my guide.

2. How did you sense? Which of your senses might have been active?

   By means of a weak, pulling sense formed by my guide. My sense of hearing might have been more active than usual.

3. Where in your body were you sensing? What did you sense?

   I was sensing a pulling feeling around my belly that is caused by the rope attached to my belt.

P2

1. How did you move?

   My eyes guided me. After a while, I needed to turn back and check T (if she is OK or not). At one point, she hit the wall and I felt myself guilty, I moved more slowly than my usual walking speed.

2. How did you sense? Which of your senses might have been active?

   Responsible for both myself and T

   Guilty for her crash

   Powerful since I have the free eyes

   Curious about doing well or not and about our chemistry.

3. Where in your body were you sensing? What did you sense?

   I sensed by my spin, back and waist. Also I sensed by my feet bottoms. I sensed by my spin, back and waist a force (feels like burning) and I sensed just the floor in my feet bottoms (I do not feel it usually)

Activity 1: distal perception/guidance by Rope

P1

1. How did you move?

   I moved according to T's movements.

2. How did you sense? Which of your senses might have been active?

I was nervous and under stress. Curiosity about learning what my partner is doing and what she is going to do. Joy I felt better compared to previous one. Trust, after a while, I learnt that my partner is a good guide and she is slow enough. Then I trusted her and felt joyful.

3. Where in your body were you sensing? What did you sense?

   I felt by my surface of stomach/belly (almost at the beginning of lower parts of my chest). I also felt by my spine and waist (back) since I pushed myself backwards to understand the direction of the rope. I felt again a force but it was lighter than the previous one. I liked the feeling of feeling trust.

P2

1. How did you move?

   Since I was guiding my partner, I tried to walk slowly, thinking she would react my movements. I followed the route by mostly paying attention to the turning points.

2. How did you sense? Which of your senses might have been active?

   My eyes were my main guide, however the tactile sensation between my feet and floor were stronger than usual.

3. Where in your body were you sensing? What did you sense?

   I was mostly sensing the rope that is causing a pulling at my back.

Activity 3: distal perception by SSD on hand

P1

1. How did you move?

   I guided T. This time I really controlled her.

2. How did you sense? Which of your senses might have been active?

   I was more comfortable and I knew what I do and what I want to do. I thought I can turn my face to her (at last) and it was much more easier to control her and feel like a couple. I said we were doing a great job. It was funny and it was a two players game.

3. Where in your body were you sensing? What did you sense?

I sensed by my face and by my hands. I don’t know why but this was the first time that I wanted to use my hands as well. In my face because I was mostly looking at T instead of the route and I tried to make more contact with her by looking at her face directly.

P2

1. How did you move?

   With the attached device on my right hand, I tried to find my way by the sound of the device as the confirmation of my track.

2. How did you sense? Which of your senses might have been active?

   I heard the same was as I felt. Both vibrations and sound were equally effective. I felt my flexible by having the device in my hand rather than carrying it on my stomach. It was much more easier to feel that I was closer to my partner

3. Where in your body were you sensing? What did you sense?

   I felt in my hand. While sound proved that my steps were on the right path, the vibrations gave me the feeling of trust in myself.

Activity 3: distal perception by SSD on hand

P1

1. How did you move?

   I tried to pay attention to device that is used by my partner in order to keep her on the right path. Noticing my partner more flexible this time, I moved faster that the previous tasks. But I tried to slowdown wherever she felt like lost.

2. How did you sense? Which of your senses might have been active?

   My eyes led me to follow the path. By hearing the device I felt my partner is safely following me too. This woke the feeling of trust on the safety of my partner.

3. Where in your body were you sensing? What did you sense?

   While my eyes were providing my visual sight to follow the track, my ears confirmed that my partner was secure behind. Therefore, I somehow eased the feeling of responsibility.

P2

1. How did you move?

   I moved with help of my hand. I tried to find T by waving my hand like crazy. I felt like my arm helped me to find my way.

2. How did you sense? Which of your senses might have been active?

   I felt my arm tired. Vibration was not so important this time. I mostly followed the voice. I could have a relation with neither the device nor my partner. It was more like a search and find challenge, but I do not know what.

3. Where in your body were you sensing? What did you sense?

   I felt it in my hand and arm. And I felt it in my ears. My hand and arm got tired and I felt like it was the longest exercise and the longest way. I realized the directions and my turnings. I can easily turn my arm to left and right hence turn my body. This is why I realized them all.

Activity 2: distal perception by SSD on back

P1

1. How did you move?

   I moved according to the sound of the device. I just used my stomach to follow my partner and the sound (not my legs, hands or any other organs).

2. How did you sense? Which of your senses might have been active?

   I felt a bit of stress. Absence of vibration made me nervous and felt less trust. I felt coupling with my partner instead of the device (opposite of the previous exercise). I tried to follow my partner and the sound, so my ears were totally open (I have never felt like that before I realized the direction of the last two turns, but before that I just felt like I am taking steps and more indecisive about my movements)

3. Where in your body were you sensing? What did you sense?

   I mostly sensed my ears, then again my stomach (May be it is conditioned). This time, I felt like the sound was too much and I was irritated.

P2

1. How did you move?

   I followed the route by paying attention to the function of the device in order to keep my partner in track.

2. How did you sense? Which of your senses might have been active?

   Hearing was in more balance with the vibration in this task. Both of them were in harmony, but still seeing was the most efficient one in the decision to make my movements.

3. Where in your body were you sensing? What did you sense?

   I was feeling the vibration on my back with the sensation of hearing at the same time. Seeing was the most important one above all.

Activity 2: distal perception by SSD on stomach

P1

1. How did you move?

   My partner guided me but this time I felt that the device was my partner rather than T. I was slow. Step-stop-turn around-step-stop-turn around.

2. How did you sense? Which of your senses might have been active?

   I was curious because this experience was different. I very enjoyed it. It was like being in a different world and I was a little small thing who was trying to learn this new existence. I thought I was lost a few times and I felt in a panic but it lasted very short. I trusted the device and thought it will exactly help me to find my way.

3. Where in your body were you sensing? What did you sense?

   Felt it in my stomach. I felt vibration mostly and the effect of vibration increased with the sound of it. I felt joyful, enthusiastic and happy. I liked this new experience.

   I did not realize the way, turning points, straight walking. I just felt like I am turning around myself 360 degree. I did not even realize my walking. I just felt that I am turning and there was sound in the darkness. I am just stepping through the sound but there was no direction sense at all.

P2

1. How did you move?
   Following the route, I tried to guide my partner through the sound that is caused by the device attached to my belly. I tried to focus on functioning of the device in order to help my partner properly.
2. How did you sense? Which of your senses might have been active?
   Visual sensation was the fundamental one. However, since I was leading my partner, I tried to concentrate on the sound to be sure enough to keep my partner safe.
3. Where in your body were you sensing? What did you sense?
   The sensation was obviously by my eyes and ears. While taking the turning points on the route, I tried to stop and give time to my partner in order to let her understand the change in the route by sensing the sound.

Activity 2: distal perception by SSD on back

P1

1. How did you move?
   I moved slowly, and my eyes were open. I usually turned to my back and checked T and tried to learn what is her distance from me, am I doing right (like getting feedback from her)
2. How did you sense? Which of your senses might have been active?
   I was more under stress in this case than the previous one. This time, I tried to be more careful since I lost my partner in the previous exercise. Tuba was so close to me and I tried to escape from her (to prevent her hitting me)
3. Where in your body were you sensing? What did you sense?
   I felt in my spine (waist-back). It was like "little ants walking on it". Actually, vibration of the device was not so much but while listening its sound; I felt more walking ants kind of feeling. I felt my back of feet since T was continually stepping on them. It was like a mission this time, not like a game.

P2

1. How did you move?

   I moved in accordance with the device on the back of my partner. I tried to walk continuously to keep the sound constant and oriented myself accordingly as well.

2. How did you sense? Which of your senses might have been active?

   My sense of hearing was the most active one. I did not feel that the feeling of vibrations was lack with respect to the previous task. Therefore, now I certainly believed that hearing was the most and may be the only sense leading my movements.

3. Where in your body were you sensing? What did you sense?

   I was sensing my ears. However, even if we were not attached by a rope or anything else, I sensed the closeness to my partner and with the constant sound coming from the device, I was sure with my steps.

Activity 2: distal perception by SSD on stomach

P1

1. How did you move?

   I moved according to the vibrations/sound that is caused by the device attached to my stomach. I tried to keep it constant to figure out my path. But I felt lost mostly.

2. How did you sense? Which of your senses might have been active?

   My sense of hearing was much more active than the vibration caused by the device. Because the sound came from the vibration. In addition, the lack of the feeling of touching/pulling was evident and it took a while just to concentrate on the sound and where it is coming from in order to concentrate on walking more consciously.

3. Where in your body were you sensing? What did you sense?

   The vibration was a dense feeling on my belly. And hearing was in relation with this sense of vibration. I felt tense when I did not hear the sound of the device.

P2

1. How did you move?
   I walked slowly and tried to guide my partner.
2. How did you sense? Which of your senses might have been active?
   I was nervous and at the end. I got shocked, but since I knew it was a game, I could not stop laughing and it was quite joyful. When my partner left me and started to move like she was lost, my brain stopped, and I could not decide what to do. I was scared. I was under stress but enjoyable (more than the rope case)
3. Where in your body were you sensing? What did you sense?
   I sensed nothing at all. But at the same time, I felt a little stomachache, when I was scared (mostly at the end) and I felt my brain. It was paralyzed and I tried to reach my brain to find a solution to help my partner in her crazy turns around herself.

Activity 1: distal perception/guidance by Rope

P1

1. How did you move?
   While I was following the track by my eyes, I kept the rope short to control my partner better. At first I thought to lost my sense of directionality but it did not happen. I was able to direct him.
2. How did you sense? Which of your senses might have been active?
   Visual sense was dominant but I used the tactile feeling of the rope to check whether I am in control of my partner
3. Where in your body were you sensing? What did you sense?
   I sensed the tension of rope by my hands. I also felt the proximity of my partner.

P2

1. How did you move?
   By little steps, highly attentive to the signals from outside
2. How did you sense? Which of your senses might have been active?
   At first I was nervous and claustrophobic. Tactile sensation was dominant. Having blindfolds made me feel unsafe.

3. Where in your body were you sensing? What did you sense?
   I sensed the tension on my back. A little disturbing, generally at the same rhythm.

Activity 1: distal perception/guidance by Rope

P1

1. How did you move?
   It was like I am walking in a void space. When I felt the tension of the rope, I understood what to do.
2. How did you sense? Which of your senses might have been active?
   I felt the tension of the rope by tactile sensation. I felt myself lost. I felt like I could not walk, I could not find the right way. I always wondered if I am on the right track or not.
3. Where in your body were you sensing? What did you sense?
   I felt my feet. And sometimes the tension of the rope.

P2

1. How did you move?
   I checked my partner behind all the time while taking little steps slowly.
2. How did you sense? Which of your senses might have been active?
   I felt highly responsible for my partner and I tried to keep my attention at the highest level.
3. Where in your body were you sensing? What did you sense?
   I sensed the tension on my back. It was disturbing but it was a weak feeling.

Activity 2: distal perception/guidance by SSD on stomach

P1

1. How did you move?
   I moved towards the vibration.
2. How did you sense? Which of your senses might have been active?
   I felt vertigo, I felt as if I could not move forward. I turned a lot. Feeling of being lost was much more powerful. I felt the tactile sensation of vibration. Strangely, I laughed due to being nervous.

3. Where in your body were you sensing? What did you sense?
   I felt it on my stomach. And at one occasion I found my way by the help of laughing sound of my partner.

P2

1. How did you move?
   I walked slowly with little steps to be able to direct my partner. I tried to keep the distance short with the route.
2. How did you sense? Which of your senses might have been active?
   I was excited. I felt like I lost the control and I felt desperate for a short period of time.
3. Where in your body were you sensing? What did you sense?
   I did not feel anything at any part of my body.

Activity 2: distal perception/guidance by SSD on stomach

P1

1. How did you move?
   I kept the distance at a certain level to continue moving forward. By little steps.
2. How did you sense? Which of your senses might have been active?
   Visual sense and sonic sense directed me.
3. Where in your body were you sensing? What did you sense?
   In my ears.

P2

1. How did you move?
   By little steps following the signal, attentive
2. How did you sense? Which of your senses might have been active?
   I felt unsafe, it was a little disturbing, I felt like I am a part of something else.
3. Where in your body were you sensing? What did you sense?
   On my stomach very dense, both sound and vibration.

Activity 2: distal perception/guidance by SSD on back

P1

1. How did you move?
   By more sharp turns. I tried to make her understand my direction and my steps.
2. How did you sense? Which of your senses might have been active?
   I was more relaxed. I felt responsible.
3. Where in your body were you sensing? What did you sense?
   On my back, vibration

P2

i. How did you move?
   I followed the sound I heard.
ii. How did you sense? Which of your senses might have been active?
   All sonic. By hearing the sound.
iii. Where in your body were you sensing? What did you sense?
   In my ears.

Activity 2: distal perception/guidance by SSD on back

P1

1. How did you move?
   Faster and by sure steps, more self-confident
2. How did you sense? Which of your senses might have been active?
   Relaxed and comfortable
3. Where in your body were you sensing? What did you sense?
   I felt blindfolds too tight nothing else

P2

1. How did you move?
   I moved forward while checking my partner behind and keeping a certain distance constant
2. How did you sense? Which of your senses might have been active?
   Tactile and visual
3. Where in your body were you sensing? What did you sense?
   In my back

Activity 3: distal perception/guidance by SSD on hand

P1

1. How did you move?
   I looked at back an checked the volume of sound
2. How did you sense? Which of your senses might have been active?
   Visually and sonic
3. Where in your body were you sensing? What did you sense?
   By my ears, I heard the sound

P2

1. How did you move?
   Easier, by taking larger steps, more relaxed
2. How did you sense? Which of your senses might have been active?
   I felt more functional
3. Where in your body were you sensing? What did you sense?
   I sensed vibrations on my hand

Activity 3: distal perception/guidance by SSD on hand

P1

1. How did you move?
   I found where to go by moving my arms
2. How did you sense? Which of your senses might have been active?
   Since the device vibrated at my hand, my tactile sensation was active. When the amount of vibration and sound increased, I understood that I am in the right path.
3. Where in your body were you sensing? What did you sense?
   At my hand, I sensed vibrations.

P2

1. How did you move?
   At this last activity, I think I was able to move in the most effective way, fast, distinct and by using my arms.
2. How did you sense? Which of your senses might have been active?
   Functional, effective and useful
3. Where in your body were you sensing? What did you sense?
   I did not feel anything at any part of my body.

Workshops 1 and 2 Questionnaire:

Activity Code:

Participant:

Please use " √ " sign to mark the relavant boxes.

During the activity:	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1. I knew where I was in the space					
2. I knew where my partner was in the space					
3. I knew where the device was in the space					
4. I felt the device on my body					
5. I felt the device on my partner's body					
6. I felt the device in the space					
7. The vibration/sound was not at my main point of attention					
8. I used a step-by-step method for communicating with my partner					

Please use " √ " sign to mark the relavant boxes.

During the activity:	Very low	Low	Normal	High	Very high
1. My capacity of sensing the space was					
2. My capacity of sensing my partner was					
3. My capacity of sensing the device was					
4. My awareness of the space was					
3. My awareness of my partner was					
4. My awareness of the device was					

Please write your answer into the relavant boxes.

During the activity:	Hearing the sound or Sensing the vibrations meant:	Not hearing the sound or Not sensing the vibration meant:
When I was stopping,		
When I was moving,		

The Summary Tables of the Participants' Responses in Workshop 1 and 2:

BPs-A1 (device on BP's body, sound from device)	**Strongly Agree**	**Agree**	**Not sure**	**Disagree**	**Strongly Disagree**
I knew where I was in the space	k	y	o,i	b	
I knew where my partner was in the space		y,k	o,b,i		
I knew where the device was in the space	b,k	o,y,i			
I felt the device on my body	o,b,k	i		y	
I felt the device on my partner's body		y	k	o	b,i
I felt the device in the space	k	i	y	o	b
The vibration/sound was not at my main point of attention	o,k	b		i	y
I used a step-by-step method	o,b,k		y,i		
	Lowest	**Low**	**norm**	**High**	**Highest**
My awareness of the space was		b,i		o,y	k
My awareness of my partner was		i		o,y,b,k	
My awareness of the device was			o,k,i		y,b

BPs-A2 (device on BP's body, sound from space)	**Strongly Agree**	**Agree**	**Not sure**	**Disagree**	**Strongly Disagree**
I knew where I was in the space		k,i	b	o	y
I knew where my partner was in the space	k		o,i	b	y
I knew where the device was in the space	k	b,i	o		y
I felt the device on my body	k	o,i		b	y
I felt the device on my partner's body			k	o,i	y,b
I felt the device in the space	k	o,i	y,b		
The vibration/sound was not at my main point		o,b,k		i	y
I used a step-by-step method	b,k	o	i		y
	Lowest	**Low**	**norm**	**High**	**Highest**
My awareness of the space was	y	o,b	k,i		
My awareness of my partner was	y,b	o,i		k	
My awareness of the device was	y		o,i	b	k

BPs-A3 (device on GP's body, sound from space	**Strongly Agree**	**Agree**	**Not sure**	**Disagree**	**Strongly Disagree**
I knew where I was in the space		o,y	k,i	b	
I knew where my partner was in the space	o	y,b,k	i		
I knew where the device was in the space		o,y,b,k		i	
I felt the device on my body	y		b	k,i	o
I felt the device on my partner's body		o,k	i	b	y
I felt the device in the space		b,k,i	o		y
The vibration/sound was not at my main point of attention		o	b	k,i	y
I used a step-by-step method	b,k	o,i		y	
	Lowest	**Low**	**norm**	**High**	**Highest**
My awareness of the space was		k,i	y,b		o
My awareness of my partner was		b	i	y,k	o
My awareness of the device was			i	o,y,b,k	

BPs-A4 (device on GP's body, sound from device)	**Strongly Agree**	**Agree**	**Not sure**	**Disagree**	**Strongly Disagree**
I knew where I was in the space		o,k,i	y	b	
I knew where my partner was in the space	o,k	y,b,i			
I knew where the device was in the space	k	o,b,i		y	
I felt the device on my body		k	o,y	i	b
I felt the device on my partner's body	b,k	i	o		y
I felt the device in the space	k	i	y	b	o
The vibration/sound was not at my main point	o,y	b	k	i	
I used a step-by-step method	b	o,k,i	y		
	Lowest	**Low**	**norm**	**High**	**Highest**
My awareness of the space was		y,b	k	i	o
My awareness of my partner was				y,b,k,i	o
My awareness of the device was			y,b	i	o,k

b, k, o, and y represent the initials of the participant names.

Interview Questions of the Workshop 3:

1. How would you describe your experience?
2. What was good/bad about your experience?
3. What worked/did not work well?
4. What did you feel?
5. How did you feel?
6. How was your awareness about your partner and space?
7. Did you communicate with your partner? If so, how?

Workshop 3 Transcripts

Please see below a simplified transcription notation based on Vine et al. (2002) used in the research.

+	pause of one second (++ two seconds, and so on)
…/….\… …/……\…	crude indicators of simultaneous speech
NO	emphatic stress
BORIS	names of people, organisations, and so on
-	incomplete or cut-off utterance
……	material omitted
( )	unclear utterance
(over there)	unclear utterance, transcriber's best guess within brackets
[*points at drawings*]	transcriber's comments
[*laughs*]	paralinguistics

P1, P2, P3: Participant 1, Participant 2, Participant 3; and R: Researcher

Workshop 3 - Iteration 1 - Activity 1

P3: it was peaceful but also somehow irritating
P1: i think this was more like a trial for the remaining ones we did not know how they functioned so it was like a trial
P2: the pace of the sound effect too fast. i think+ but then I remembered the slow movements parameter and it helped
P1: it was very different from the physical exercise in the physical one we were doing altogether but this time girls were doing together and i was doing by myself i was not completely disconnected+ i could not fit in their rhythm because my sound was very different in physical exercise we had all the same tools I mean our hands
P3: there might be more suitable sounds
P1: yes there might be a mild wind or water++ i could communicate but it was a bit hard
R: how did you [P3] negotiate with L [P2]?
P3: i listened L's sound i'm still not sure how the device works i just guessed something while moving
P2: i tried to allow her to lead
.....
P1: i have this idea but i'm not sure if it is OK or not i was thinking about pushing something away more like a lyric dance something you do not want and you want to get rid of it i can't find the feeling for it but it is just kind of hard to describe it as a feeling
R: how about hate? is it too strong?
P1: no it is not hate could be your past experience you want to get rid of or someone you are trying to get rid of
P2: something like letting go?
P1: yeah it could be letting go++ how about in a peace? is it too much comfortable?
R: you must be tired? [laughs]
P1: no because it is slow i cannot just say ok someone else decide this one.

P3: how about carefree? [P3 decides the theme by looking at their poster]
P1: is it like+ does not care?
P2: no worries
P3: this time you take this [pointing the EC] don't feel lonely
P1: let's do camera in mobile and fast
R: what kind of sound would you prefer?
P1: relaxing+ may be water?
P2: it's gonna be slow
R: two glasses of wine might be helpful

Workshop 3 - Iteration 1 - Activity 2
P3: it was much better than the first one i think i could easily hear the sound of my device also the contrast between sounds was good my sound was easily recognizable in the previous one sounds were similar and i could not understand what P1 was doing the distinction between sounds was useful
R: did you like being independent from the others?
P3: in the previous one i felt i connected to L but in this one i felt we were all performing together i did not feel performing alone
B: did you [P1] negotiate with P2?
P1: at the beginning kind of yes but then since we were mobile it could be boring to do the same movements and we just experimented when you are mobile it is harder to maintain harmony compared to being stationary the mobile was more interesting as you created something individual but it is at the same time collective
P2: i was wondering whether i should relate to others by my movements or does it matter? or should i focus on more on sound composition? and again was wondering is that what we are crafting? sound composition it was a little tiring to carry the device on my arm i used the distance to stop the sound. our sound was very discrete and the other sound was continuous which is quite nice the contrast
P3: i liked the sound but it was probably not carefree
P1: the sound was like an anxious sound
P2: if i move in a carefree way, does it reflect to the sound?
R: i think the goal should be the sound

Workshop 3 - Iteration 1 - Activity 3
P3: i felt like paranoiac cleaning lady
P1: no it was compulsive disorder++ i don't even imagine the girls [laughs] they don't even exist [laughs]
P2: i felt like i'm trapped in this psychotic soundscape. being stationary and doing the same repetitive movements frenzy
R: so do you think it worked well in terms of feelings?
P2: yeah I guess so
P1: because of the parameters- fast & stationary we had limited range of expression the only thing you can do is turn around and move your hands like a crazy person and then trying to create a sense of paranoia
R: did you respond the girls?
P1: mhm in the beginning i kind of did but then I realized they doing their own thing

R: may be paranoia is an individual phenomenon?
P1: i don't know may be++ it was more like obsessive compulsive disorder
P3: yes i agree
P1: L was looking doing some nice things, she looked like a nice person not a paranoiac. i hope all these things are confidential [laughs]
P3: it was most successful in terms of completing task we are getting more proficient at playing with the tools we really felt like paranoia it was successful in terms of both sound and our own feelings/movements at some point me and L was looking at each other doing nothing [laughs] we were as if in another world
R: do you think that in order to create a paranoiac sound effect, you need to act or move like so?
P2: may be a little

Workshop 3 - Iteration 1 - Activity 4
P3: it was very different from how I imagined [mimicking some funny movements during the performance]. this time sound enabled us to behave differently
P1: more free in a way ++
P3: i think it was not us to controlling the actions it was the powerful sound effect it was really effective
R: did it work well for you?
P3: +++
P1: sound would be better, it was not bad but++ at the beginning i thought it was going to be something like samba or cha cha, but it turned out to be mental hospital door openings and it is not changing it is constant i just ignored and danced. [laughs]
P2: that sound was like machine gun it was not like how i imagined but it was very energetic
P1: i think we just lost ourselves using three cameras seeing us from different angels might be useful
R: how do you compare the capacity of the camera with that of wearable devices?
P1: i think devices are more flexible than camera because the camera is limited to one angle and we were not sure where the cameras field of view starts and ends basically we spent more energy to produce something there is also that sense of being watched while the camera is on you try to perform much better because that feeling of being watched. but it is a more powerful feeling at the beginning then ceases.
P2: i found ECs more closed and may be isolated. but when using tilts you may move in many different ways and open out the space camera is more spatial and also gross it can recognize only very gross movements it does not provide fine controls as much as the wearable devices it might be good choice if you want to use your whole body more fluid. it was more like we were dancing together rather than producing the sound in the previous one there was more listening thing happening
R: in the previous ones we were more focused on what we aimed to do since it was fast & mobile, anything might work for expressing celebration
P3: when i was using the devices i felt more like i was playing an instrument and making sounds but in the case camera it was more like dancing in a pub i was not the player but only one in the crowd

R: it looks like performance activities oscillated between two phenomenon. either your movements or the sound you make correspond the themes
P2: it is an interesting question isn't it? you tend to act like as if you feel in the same way like paranoia

Workshop 3 - Iteration 1 - Activity 5
P1: i found this exercise more individual than the others or individualized not in a negative way everyone had their specific device and were doing their own things and movements we tried to create a harmony+ i sometimes increased the volume of camera again after 30 seconds or so i think i was doing something else i tried to do the theme [happy drunk] but mine was more like bipolar drunk
P3: this time i guess i learned how to use the device – camera intentionally in the previous ones i used the devices but i was not very sure about their effects this time i watched my streaming image on screen and used it as feedback i think it was more individual experience but the sound was collective everyone was acting in his/her own way
P1: i also sometime used the camera just make a little change in action i also tried to engage with L but she in a way said no and showed that these are mine
P2: yeah i think those were nice moments i mostly stayed in my little corner my sound effect was tiny and my ears are not great so i could not perceive my sound effect or the mapping of my movements and sound i tried to do haphazard movements to express happy drunk+ and i really wanted to happy drunk but realized that happy drunk body may not sound happy drunk
P3: i sometimes could listen our happy drunk sound but sometimes i missed it. now i could not remember what kind of sound was it i'd love to listen it again
…..
P2: i was happy with the sequence i'd prefer to do things more related to the other people. sometimes we were doing just our own thing it might be good to have more interactions using our body movements not only through sound
P3: i think as this white paper the space is too big in a smaller space people may interact with each other more
P2: forcing to interact++
P1: i think the space was ok but i think "free" did not fit our theme of togetherness it encouraged individual expressions the movement parameters enabled us to move and act in harmony we had more restrictions and we had to focus on those things and theme altogether but in this final one we were free in every aspect and i guess it did not work well with the theme togetherness
R: what might have caused the individual use of devices?
P2: i think it is just the instruction you may say and encourage people to do so we all tend to revert the devices or use them individually
P1: using three different sounds and devices might have caused a separation
R: using only one sound effect or more which might be more useful?
P1: two is ok but three is too much. two can be managed depending on the condition, for instance two sound effects could be good in stationary because you are very limited. when you are mobile and fast, it is really hard to get the cause-effect relation. I think

paranoia activity was very successful and collective. we were limited and we knew who was doing what.
…..
P1: we collaborated very well i think. the third and fourth activities were good i think.
P3: i liked physical exercise session. we have never met before and it was a good exercise to get to know each other. i liked touching L's head
P1: i am also curious about how would this activity be with a 10 or more people. everyone is touching everyone's++ not 10 but may be 5 or-

Workshop 3 - Iteration 2
The transcriptions of the Workshop 3 Iteration 2 are available in Appendix A.

Workshop 3 – Iteration 3 – Activity 1
R: how would you describe the connection between
P1: I think they [the devices] were independent+
P2: we tried to synchronize them
R1: did you try to synchronize movement or sound
P1: both, movement and sound go together
P2: we tried to do exactly the same movements
P1: i first tried to understand how each device works but the one of them was less obvious in terms of what you can pick up
P2: we had to stop and move to figure out how it works
R: what worked well or did not work well
P1: i could not understand the relation between the devices+ how to get high or low tones, seemed random to me + if I could do a low one and she could do a high one but it did not happen
R: i see+ did you concentrate on sound effects or movements
P1: i think it was equal
P2: yeah at the start it was more movement and what you could do and then you start to focus on making a particular kind of movement to get a sound
P1: first part was playing and experimentation
R: did you communicate with each other?
P1: /yeah\
P2: /yeah\+ talking
P1: not just talking but doing the same kind of movement
P2: yeah that duelling thing
R: yeah you did a lot mimicking and synchronizing movements+ i think it is a strategy of connection i guess
P2: yes
P1: yeah

Workshop 3 – Iteration 3 – Activity 2
R: how do you compare this one with the previous one?
P1: in this one i felt you really need to coordinate because if i'm not doing that nothing would happen
P2: we had to put the device in particular positions to get noise

P1: it is definitely more collaborative you really need to talk with the other person
R: you think the connection was stronger or + how was it?
P2: actually we had goal to create a slowly growing storm and then bang
P1: yeah
R: so did it work well
P1: i think so+ once we figured out how to get the sound, and we wanted to be more crazy
R: i think there are different kinds of connections+ connection with the sound connection with your partners and movements as well at another level. so how do you manage these different connections? did you consciously negotiate?
P1: in the first activity we did not explore a lot we just figured out how each device worked+ we just needed practice that was it+ in the second activity we agreed on a theme i don't how we agreed on that
P2: yeah, that was interesting how we came to that conclusion
R: which one?
P1: to make the sound of a storm
R: do you think having a theme is useful for creating a connection?
P1: yeah of course,
P2: it is kind of you can do everything by yourself but you get there faster by doing it yourself
R: if you like, you can decide on a theme at the start of the next session
P1: i think if we have a theme and goal it is better+ otherwise we just go crazy and play and
P2: drift away
R: okay, so for the next one we can do that

Workshop 3 – Iteration 3 – Activity 3
R: how would you describe your experience?
P2: electronic
P1: it was fun like i was making music
P2: yeah
P1: this one was interesting+ it is different because in the other one you can go crazy and you can do any direction you want. you can do any movement you want but in this one it's just back an forth, but on different surfaces+ that was interesting
R: mhm
P2: i agree++
R: you?
P2: similar++ i think we did not have coordinate as much
R: you think it was not collaborative?
P2: there was collaboration but then it was kind of hard to try to understand what the other person's –
R: intentions?
P1:/yeah\
P2:/yeah\

P1: it was fun to synchronize the () when she was moving side to side. i just kept mine the still. i could have moved but ++ it could have been me moving but she was doing /everything\
P2: /but\ also sound effect was like a constant knocking [P2 mimics the sound] ++ they [the two devices] sound very similar but after a certain point mine does not play like about here [P2 demonstrates it] but her device continued to go after the ()+ because we did this at the same time [P2 demonstrates it] and mine stopped but her device was still playing
R: you experienced a narrower range of /–\
P2:/a narrower range\
R: was it discouraging for you to continue?
P2: no+ i think this [P2's device] was like the core beat
P1: it was like a theme song from 80's [P1 and P2 sing the song and laugh]
…..
R: you said something about creating like a theme song
P2: a theme song?
R: yeah
P2: a theme song from 70s or 80s, i guess it was beverly hills cop++ it was like really electronic synthesiser type music++ there were bits of it really
…..
R: how did your relation with your partner change compared to the tilt device?
P1: this one was more coordinated like we knew how each one worked but with the tilt one+ there was more experimentation i don't know+ does this controls tone does this control pitch+ we had to experiment first and coordinate afterwards but this one it was really obvious how it worked so-
P2: there has been more consistency in our actions
R: mhm in terms of-
P2: from experiment to experiment
R: yeah, a general orientation-
P1:/yeah\
P2:/yeah\
R: yeah i could observe that you were doing some similar strategies like doing the same thing or the opposite yeah those kind of-+++
R: what worked well or did not work well?
P1: it was just bad how limiting the sound was
R: mhm
P2: /yeah\
R: yeah
P1:i think it was just a bit boring+ we could not go crazy
P2: yeah+

Workshop 3 – Iteration 3 – Activity 4
Due to a technical problem, this activity was cancelled.

Workshop 3 – Iteration 3 – Activity 5

P2: that was more fun [laughs] because you could use your body in different axis- you mean
P1: yeah you could move in any way you want++ what else++ it was like a different kind of freedom
R: mhm
P1: it is kind of similar to the first one we did with the wiiremotes when they were separated++ because++ but wiiremotes were in our hands [laughs]-
P2: i think this was more free+ you did not have to have a tool to help you+
P1: yeah
P2: you just do whatever you want [P2 performs some movements]++
R: in the previous activities, there were two options+ connected and separated so which one was this one similar? was it a separate control or combined?
P1: in a way it was combined because what the camera could see it+ it was picking up both of our movements but um+ the sound it was making+ i don't know i don't know+
P2: it was different because when i was doing this constant movement and getting the same sound but when you came in, it changed but i was doing this at the same time i could here the ()-
P1: the sound changed-+ but I don't know how to describe it. it was not just same as the others-
R: so it was different from all previous activities combined or connected?
P1: some ways it was combined but um-
R: but you could still recognize you own-
P2: i think you had specific access to the specific notes, you can just activate them by your self. You did not need any other person+ to access /them\
R:/mhm\ yeah that's true
P1: yeah
R: mhm, because you keep your position+ and then+[R demonstrates some movements] the space
P1: you could do that with the wiimote but the sound was not as interesting and there was not-+ there was nothing interesting when we did the combined one with the two wiimotes, that was boring exept for/-\
R: /which one\ the combined one you mean
P: yeah the combined one
R: that one you found boring?
P2: yeah you could not activate a particular sound by yourself
R: you kind of loose your control and –
P1:/yeah\
P2:/yeah\
R: i'm interested in whether this relationship between control and the level of interest so it was kind of when you loose your control++ does it become more interesting or what does-
P1: i think () if we want to experiment by ourselves without other person, it becomes boring
R: mhm
P1: not boring but not as fun as going crazy on your own and then-
P2: yeah

R: so if you have a total control, it is more interesting in that case?
P1: no, not necessarily+ really just that we can make something interesting by ourselves but something more interesting than () other person
P2: i agree++ i mean i liked the whole idea of yeah you got control and you can access to notes that are interesting () with another person it can be better++ but you don't have to compromise what you are doing
P1: yeah
R: mhm
P2: whole of an interactive system is+ you allow a user to gain freedom essentially
R: because+ since you cannot figure out the – you don't have total control+ and does it make it more exploratory
P1: yeah, especially this one. it is almost-+ we did not have a goal
P2: no
P1: so nothing to work towards-+ so it was different from the other ones because the wiimotes and the ECs+ um+ our purpose was to synchronize or make a song but in this one, sound was already interesting enough
P2: they were harmonic
P1 yeah harmonic so-
R: did you concentrate on your own movements or what?
P1: i was looking at her movements-
P2: oh really [laughs]
P1: i was trying not to go in front of her or+ trying not to block her
R: i think it is really interesting that according to the arrangements of machines, humans and space+ they afford you to do different things right? so when you use the tilt, you want to make a synchronized things but i don't know when they become combined+ when you loose control, it encourages you to+ I don't know-
P1: i think it also depends on the kind of sound++ some sounds motivated us to synchronize our movements and make music-
R: so the sound played a role
P1: and it changed the way we moved+ even with that [P1 points the EC] and then the last one+ it sounded very good no matter what we did [laughs]
R: [laughs]
P1: it was like a little echo+ it sounded good
R: so the effect of the sound was quite strong on your movements?
P1: yeah+ tensions as well sometimes it is just all about movements what you can do
P2: activating different boxes [P2 is referring to the visualization of the software operation]
R: so you say your focus was mostly on sound right?
P1: yeah
P2: agreed

Workshop 3 – Iteration 4 – Activity 1
R: how would you describe your experience?
P2: i thought it was easy to create sounds without working out how they worked and then extend on the sounds and everything created

P1: right first we learnt that tilting was pitch this was the lowest pitch and this was the highest pitch and shaking hard made it louder and then once you learnt those parameters you learnt how to be more interesting in playing with them
R: mhm
P1: and the other aspect was the interaction and we were able to learn a little bit from each other's-+ what we were trying-
P2: yeah in complementary sounds
P1: yes and try to control+ () making not so much noise
P2: yeah+ it's just like being careful not to just be noisy++ and trying to make the sounds deliberate+
R: was it kind of creating a harmony or contrast tension those kind of things?
P2: create something that work together
P1: yeah () harmonious in that sense ()
P2: we did not want the sounds fighting with each other or we did not try to get louder () the other one
P1: yes creating a single work or something together++ and also just exploring what they produced
R: did you make music before together?
P2: not really
P1: we have made a lot of music together but not in performance+ we used software before in a much more deliberate fashion () but+ um that was not creating something or performing it was just an exercise
R2: once or twice we probably played together because it requires learning well we could improvise ()
R: did you have any kind of implicit goals during the performance?
P2: to make something that sounds cohesive
P1: i think probably anyone+ who is a+ musician has um+ even a classical musician who does not know about improvisation which we are not in+ but even they know how to listen and respond to what they hear+ as a constant negotiation and what they are improvising is+ is all about being part of what you are hearing and contributing to that and+ negotiating between them+ so even tough very-+ A's sound had more concrete pitch and shape than the one i did+ but that was not enough to be melodic or to be really explosively musical or even to be rhythmic () but there was still enough shape to do the activity together and be part of that
R: they are very simple devices with very limited capacity so i did not design them to be extremely responsive and with precise controls but more really having different capacities to interpret technology and other bodies+ through sound but here really+ it is important for me to know from point of view of a musician how they see these things how really-+ yeah
P1: it was just a simplified down an abstracted form of what you would do+ playing um+ a more complex free form of musical instrument+ but then we both have together gone and seen a lot of much more abstract free improvisations stuff where they explicitly avoid melody and even rhythm
R: any familiar patterns maybe right?
P1: yes and so+ it was not hard to connect these sounds and that one

P2: um+ yes i was trying to make um+ the++ most of the sounds that i have to play to () i did notice P did have the melodic high notes so i felt my role to do those bits that he could not do
R: yeah mhm+
R: what worked well what did not work well? is there anything you would like to say?
P1: i think one thing that really didn't work well was both of us were making lots of sounds at the same time um++ partly because this-+ we were learning um++ but also because the sounds actually i thought were interfering more and we are doing harder to tell which of us was producing the sounds so it wasn't until you started slowing down and being more subtle and then your ear could zone in what was you-++
…..
P1: i think what was interesting was that we both have the same controller and we have the same range of movements that we could do+ so we could learn from each other () and also+ have this thing of uhm+ what it is sound like if we do the same movements or respond to each other's /movements\
R: /yeah\ mhm
R: Sometimes um+ you really attend to the movements and sometimes you attend to the sound effects it changes from time to time sometimes you want to experiment the effects of a particular movement and but after learning the device you want+ to get that certain sound effect and you explore the right movement maybe
P2: /yeah\
P1: /yeah\

Workshop 3 – Iteration 4 – Activity 2
P1:actually any kind of single tones were controlled by the other one that was interesting
…..
P1: i was saying it's interesting that both controllers- perhaps we were controlling the same pitch as opposed to one was controlling some other quality but um++ that was the point and so+ one of them was able to say now we're really high now we're really low and the other one perhaps a little bit more melodic within () up and down up and down little melody so there was a certain amount of collaboration could go between performers so we could not really play full scale patterns because we did not have that break so what was quite limiting was it was only a seven by seven matrix so there are only 49 different /states+\ but i think we managed to () the possibilities
R: /exactly\
P2: i find it harder to collaborate in the first one because i guess i'm having one sound there isn't so much we could do and i did like that we could see visually how it worked like a visual explanation of what was going on-+ it was kind of a quicker way of working out what was possible
R: yeah so P you also find it more++
P1: possibly i think there was potentially something interesting because we had um+ it was something different because usually+ a musical improvisation between two people would be on two different instruments like the first one and+ that has a kind of () shape which musicians know but whereas with this thing i think if we had a more fine grid to work with i think i would have had more possibilities
R: again the same+- /single sound\ but a larger grid

P1: /yeah\ the same idea of compose and maybe then we could have um+ what would have been interesting then it's how the broad pitch changes have certain meaning and find each other different modulation of that in what we could get out of that
…..
P1: we would have I think+ we could not within+ just the movements we were doing really () i think we would have been in eye contact and that's what i thought was here+ you know i mean you could say i am going up now and i hope the other person does that but that's the only kind of change [P1 demonstrates upside down movement of the pen he's holding] or this kind of shaking which is nice so we could even simply have the one person is just keeping the sound going the other person is to move it around+ um+ i think potentially there is something really interesting about what people happen to control the same sound.
P2: yeah () more time that would allow to work out more things to achieve () needs+ more planning rather than improvisation
R: because there is also a kind of a learning time required to-+ a novel thing, usually when you do improvisation you are an expert++
P1: yeah some people are trying to pick up an instrument that they don't even know i mean it's an interesting exercise but it's probably not common.
R: mhm yeah++ mhm+ so++ what worked well, what didn't work well do you think?
P2: i liked using the first one because i felt that i could hear what the difference i was making
P1: the wider changes…
P2: yeah whereas the second one i wasn't sure
R: your effects right? on the sound
P1: definitely when you have the wider controller you have more impact on this- and so personally with the other controller i had to be satisfied with being followed.
R: again there are two roles maybe right one is kind of leading the other one is following
P1: yeah definitely that was the case either of us could shake it and make the constant sound and it's really just how far up the scale we are in so i think i am not sure how purely musically or purely sonically we were interacting each other we were because we were pretty affecting on the sound but i don't know if we were actually having communication
P2: i think the physicality of the ()- when i was using the second one anyway i was probably the one watching what he was doing () i could not hear precisely what i was doing
R: so the connection was through the physicality?
P2: yeah
R: because you were not able to observe your own effects? was it-
P2: yeah so i think i just made some complementary movements yeah+
R: how did it change your relationship with your partner+ the first performance and the second performance so+ the devices are separate and devices are combined so-
P2: the first one felt more even i think that we were both contributing and complementing whereas the second one was more you know follow up kind of accompany in the main act.
P1: yeah and it's very easy you know with two musicians and two instruments can definitely have some () in one person who is obviously a controller, the leader but does it

not have to be the case and then the way those all set up their equipment and yeah in the second one it's true, one person had much more dominance
P2: i think we were trying to make something work rather than create something that sounded nice.
R: mhm okay+ i guess you used the visualization very much to communicate in fact, to create right rather than watching your movements or listening to sound maybe the visuals were more…
P1: i think i will come back to the seven different states for that because seeing that kind of illuminated me () the constrains what they could /do\
…..
R: in terms of connection which one did you feel more connected with each other?
P2: first
P1: um+ maybe+ in some ways+ that in some ways i think maybe in the second one more because we were allowed to rely on each other especially because A prefers being the first being the leader but the leader actually was much more independent so i think my role was a more constraint role was more dependent and more connected to the leader in the second one so i think i'm inclined towards the second one
R: so yours is first and yours is the second one ok that's fine so probably you thought in terms of maybe collaboration and creating a kind of++ let's say musical piece maybe a very basic one, is it so?
P2: i felt more even in the first one but i guess we could both contributing+ um++
R: in distinctive ways right?
P2: yeah
P1: and you can connect as individuals both have freedom

Workshop 3 – Iteration 4 – Activity 3
P2: yeah, it was () creating because we were controlling very much+ but we were not clashing with each other as much because there was very little+ that we could not go outside of certain boundaries () the first one
R: so because of that you wanted to experiment this variations of-+ because this time you tried more movement based arrangements right?
P2: i guess it was just doing- even with your two hands it gets very quickly boring because it makes this sound and that sound and that sound, so it was very easy to master so then i tried to do more interesting things+ not to create the same thing
R: yeah some combinations
P1: yeah and then because when you're doing that or you have this continuous go from small to big so putting+ if you have another object then you could jump between the- () for the previous ones there was no way of jumping from this to that
R: that's true you always need to travel through in between
P1: that's right
R: yeah that's a good point
P1: yes and in these ones you're able to have discontinuity
R: yeah you can jump right to the-
P1: that was quite nice+
P2: yes i guess i was away of getting some more control on () to do something
R: how did you communicate with each other this time?

P1: um+ /eye contact\
P2: /eye contact\
P2: and i suppose exchanging of ideas more like in the first one because two of us working in the same way so we could copy from each other
R: yeah
P1: yeah we definitely did that++
R: did you have any goals?
P2: trying to find new things to do with
P1: yeah keeping it interesting and exploring-+
R: the capacity
P1: yeah
P2: yeah because we could have just () see what they can do
R: yeah++ so were you trying to make something again cohesive or+?
P1: i think i was just trying to explore the sounds
P2: yeah i think the sounds were clashing against each other so it's not like a danger compared to the first one where-+
R: because they're ultrasound waves when you face them each other things might confuse but that might bring in an interesting effect i don't know
P1: i was wondering when they faced () i couldn't tell if they're interfering each other
R: they might at some point because basically what they do is sending ultrasound waves and then when they return it gets a measurement

Workshop 3 – Iteration 4 – Activity 4
P1: some kind of modulation or distortion or something the other one does the pitch and then that would be easier+ but there is something interesting about controlling I think this was a lot harder to do-++
R: than the tilts?
P1: yeah that's right it was harder to tell what we were actually controlling
P2: i think we've spent more time carefully trying to work out what was going on rather than just trying to create () what happens when i do this and you do that or i stop and you just do this so you trying just one consistent and one () what was really what
P1: yeah um+ we didn't get to create anything
R: it was just the figuring out yeah it's quite understandable++ so again I guess contact with-++
P1: there is almost++ because we could not hear as easily as actually the same notes what is that doing and it was like a /verbal one\ i am not sure we got to the point um+ having any connection
R: /yeah yeah\
P2: yeah we exercised what we want
R: was that the hardest one among the-
P2: yeah
P1: yeah to make anything ()

Workshop 3 – Iteration 4 – Activity 5
P: so there are a couple of movements and spots a little bit same to generate much bigger sort of sound reactions if you come and move horizontally across the minimum () um+

and so it wasn't sort of just reaching up to the higher bits to have make high sounds or something felt me more abstract
B: what was abstract sorry?
P: i couldn't get a very clear sense of what parts were doing particular things
B: mhm i see
A: () so it was harder to tell the difference between there and there [A points up and down side of the plane in front of her]
B: last sound effect was seashore cell so there wasn't so much variations just maybe little
A: yeah and i felt maybe less collaborative compared to the other ones because we were trying to work out how to operate it it could be just if we didn't have the screen we didn't know how () we just moved in space and listened but i think we were watching and calculating as much as we were moving and listening
B: so would you prefer not to watch the screen?
A: yeah maybe or no- if that wasn't- i like watching because we were trying to work out i like to see where you're hitting like it could be just a different experience without watching
B: yeah maybe more /dance like\ in that case
A: /yeah\
P: () yeah um+ the kind of work up and down the whole the vertical aspects++ it could have been interesting to have top down view.
B: there was a kind of- you see the tape? [B points the ceiling] but it has a very small field of view and you need a higher ceiling+ otherwise I planned to have two versions
P: yeah that would be good, interesting ()
B: in that case you maybe more precisely activate the each -
P: yes that's right that's what i thought i don't know if we'd watch but i was wondering but in the end when we try to move hands it's just activated one thing that i couldn't tell what it was really doing that i thought i was getting more reaction from just broad sweeps-
B: then what you intended?
P: um+ well that was when I was really () i was getting some-
A: i think i first wanted each point on the grid to be a different note+ or quite obviously different to each other but+ just sort of () one placed to produce big results+ it was more about speed or closeness to hear lots of tones
B: originally they are different but the difference between the horizontal ones again less than the vertical /ones\ it may not be possible to notice you really need to have this whole thing moving and it has less precision right? then it inevitable becomes a movement thing really than i guess controlling the music
P: /yeah\
A: yeah i think we didn't get of that so half way through but sort of start looking at the screen and just ()-
B: maybe this one is the least instrument-like maybe right?
A: /yeah\
P: /yeah\
A: and probably we should not have cared about controlling, and then just moved around and saw what happens

Appendix D: List of Peer-Reviewed Publications

Kocaballi, A. B., Gemeinboeck, P., Saunders, R., Dong, A. and Loke, L., (2012). Embracing Relational Agency in Design Process, *Proc. of Design and Semantics of Form and Movement DESFORM 2012*, Wellington.

Kocaballi, A. B., Gemeinboeck, P., Saunders, R., Dong, A. and Loke, L., (2012). Transformations, Enactments, and Distrust in Promoting Multiplicity in Design Process, *Proc. of Participatory Innovation Conference PIN-C2012,* Melbourne.

Kocaballi, A. B., Gemeinboeck, P., Saunders, R. and Dong, A. (2011). Towards a Relational Approach to Design Process, *Proc. 45th Conference of the Architectural Science Association ANZAScA 2011*, Sydney.

Kocaballi, A. B., Gemeinboeck, P., Saunders, R. (2010). Enabling New Forms of Agency using Wearable Environments, *Proc. of Designing Interactive Systems DIS 2010*, Aarhus.

Kocaballi, A. B., Gemeinboeck, P., Saunders, R., (2010). Investigating Potential of Shared Agency using Enactive Interfaces, *Proc. of Int. Conference of the New Interfaces for Musical Expression NIME 2010*, Sydney