Chapter 1

Introduction

In short, there is a richly subtle and complex nonverbal world that is there from the beginning of all of our lives, a dynamic world that is neither mediated by language nor a stepping stone to language, but that is literally significant in and of itself and remains literally significant in and of itself, a dynamic world articulating intercorporeal intentions that, although clearly affective in origin, are enmeshed in "agentivity," in expectations, in consequential relationships, and thereby in the phenomenon of thinking in movement.

Maxine Sheets-Johnstone (1999a, p.504)

Any technology designed for use in human activities incorporates assumptions about how it will be used. These assumptions, whether explicitly represented in the design process or not, are essential resources that designers exploit to shape their developing designs into specific products. Here, my interest is in the ways that assumptions about human activities are represented in the practices of information and communications technology (ICT) design, where those assumptions come from and how they shape the options for future use of the technology. This interest stems from the insight that our ability to think about any design problem, and the quality of our thinking, depend to a large extent on the appropriateness of the representational resources that we can use in our thinking.

Lucy Suchman (1994b, p.1)

This chapter introduces the research questions and describes the background and the context for this research. It presents an overview of the theoretical foundations and research design. It concludes with a summary of the results presented in the body of this thesis.

This thesis is concerned with designing *for*, and *from*, the experiential, moving body in the field of interaction design. The research in this thesis springs from a commitment to designing *movement-based* interaction from a lived experience of movement. Movement-based interaction is an emerging area of interaction design, where interactions with computing technologies are based on the moving body as the source of input (e.g., Feijs, Kyffin, and Young, 2007; Larssen, Robertson, Loke, and Edwards, 2007b). The advent of motion-sensing technologies has enabled new kinds of interaction paradigms with a renewed focus on the active, moving body. This in turn has called for new approaches, methods and tools for designing these forms of interaction. One line of investigation, common to the fields of interaction design and human-computer interaction (HCI), is to look to other disciplines such as philosophy, psychology and anthropology as a source of potential approaches, methods and tools. This thesis explores ways of understanding, experiencing, describing and representing the experiential, moving body in the design of movement-based interaction, sourced from other disciplines and fields including dance, somatics, movement analysis, interaction analysis, anthropology and phenomenology. The specific domain of interest for this thesis is the moving body in interactive, immersive environments (or spaces) built on video-based, motion-sensing technologies. This kind of interactive system enables free body movement, without the use of physical or tangible input devices.

Within the context of movement-based interaction design, the research questions explored in this thesis are:

1. What understandings of human movement are relevant?

2. How and in what ways can the experiential nature of the moving body be accessed and understood?

3. How and in what ways can the moving body be described and represented?

These questions are framed with reference to the traditional task of human-computer interaction (Preece, Rogers, Sharp, Benyon, Holland, and

Carey, 1994), which is concerned with designing the input-processing-output loop in the following way:

- The design of input that people can perform and the computer can comprehend;

- The design of suitable feedback to the user on what the computer is doing in response to the input; and

- The design of output by the computer that people can comprehend.

The focus of this thesis is primarily on the *input* part of the input-processing-output loop; the relationship between people moving and the machine sensing and interpreting those movements. When the moving body becomes the primary input to interactive systems, it becomes part of the design material in a more significant way. An intimate knowledge of the design materials is fundamental to good design and for movement-based interaction design, the design materials include the moving body as well as software, hardware, input and output devices, motion sensors and so on. What knowledge and skills of the moving body do designers require in this emerging area of movement-based interaction design? This thesis advocates designers cultivating a bodily awareness of the forms, processes and qualities of movement being considered for design. It stems from a phenomenologically-inspired inquiry into the moving body, where we investigate our own experiences of movement, together with the experiences of others. The felt aspects of movement and the movement itself are inseparable in the lived experience of movement. In this way, designers can access the potential experiences of users in future movement-based interactive, immersive environments and design for both the external, functional aspects of movement and the internal, felt qualities of movement.

On the other side of the input process is the machine and its interpretation of the input of movement. In the design of movement-based interaction, some forms of bridging representations are required that enable the mapping between the movements performed by people and the sensing and interpretation of those movements by the machine. This thesis explores how designers

can traverse between experiential understandings of the moving body and design representations of human movement to enable the design and evaluation of movement-based interactive technologies.

If we wish to design for vitality and aliveness, for pleasure in moving, then it is important to recognise that these qualities derive in part from the felt, kinaesthetic experience of the moving body. We need to be cognizant of the experiential effects of possible movement patterns used for interaction. *TGarden* (Wei, 2002), *whisper* (Schiphorst and Andersen, 2004) and *Body-Bug* (Moen, 2005, 2007) are three very different interactive systems reliant in different ways on improvised movement and kinaesthetic experience. The attendance by users of these systems to the felt experience of the movements used in interaction is crucial for ongoing interaction and for pleasurable engagement. Machine algorithms do not necessarily recognise 'felt experience' as such. The machine sensing and interpretation of the input data provides in turn new conditions for engagement. However the conditions for satisfying user engagement rely to some extent on the innate relationship between doing, sensing and feeling in the process of human movement, in the intertwining of human action and perception, as well as the contexts for movement provided by the design of the system.

1.1 Background

The field of interaction design is characterised by research and design approaches that focus on the human experience and practices of people using computing technologies in their work and everyday life (Preece, Rogers, and Sharp, 2002). Human-centred design approaches, in particular, employ methods aimed at acquiring understandings and insights into the practices of potential users of technology, prior to designing new technologies and future devices, products and systems. Ethnographically-inspired and phenomenologically-inspired approaches to design both value first-hand, first-person perspectives and experiential data.

Well established tools for representing users, their activities and contexts of use include personas and scenarios. Scenarios have typically been used

for envisioning and simulating future use situations, allowing reflection-in-action and the continuous presence of the users during the design process (e.g., Kyng, 1995; Bødker, 1998, 2000; Carroll, 2000a,b; Rosson and Carroll, 2002). More recently, scenarios have been used for exploring situations where the setting is less well-defined and contextual information and awareness are desired such as in mobile and ubiquitous computing (Howard, Carroll, Murphy, Peck, and Vetere, 2002; Pedell and Vetere, 2005). However, there is still a lack of research explicitly dealing with describing and representing moving bodies.

New methods for designing for, and from, real and imagined situations of use are emerging that view enactment and physical role-playing as pivotal to exploring the design space (Ehn and Sjögren, 1992; Burns, Dishman, Verplank, and Lassiter, 1994; Sato and Salvador, 1999; Brandt and Grunnet, 2000; Buchenau and Suri, 2000; Howard et al., 2002; Iacucci, Iacucci, and Kuutti, 2002; Kuutti, Iacucci, and Iacucci, 2002; Carroll and Tobin, 2003; Laurel, 2003; Oulasvirta, Kurvinen, and Kankainen, 2003; Strömberg, Pirttilä, and Ikonen, 2004; Svanæs and Seland, 2004). Inspiration for these methods has come predominantly from theatrical performance practices. Researchers claim that the use of these methods increases designers' empathy with users and facilitates the generation, exploration and evaluation of design concepts in situations of use.

The development and availability of sensor technologies in the last decade has resulted in new fields of computing such as mobile and ubiquitous computing, tangible computing, interactive art and interactive product design. Motion sensors, in particular, enable input and sensing of the dynamic, qualitative characteristics of movement. Researchers and designers working in these fields have begun to draw on approaches to design involving the use of physical movements by designers to gain a bodily understanding of gestures and movements and to communicate design ideas and findings (Buur, Jensen, and Djajadiningrat, 2004; Donovan and Brereton, 2004; Jensen, Buur, and Djajadiningrat, 2005; Klooster and Overbeeke, 2005; Hummels, Overbeeke, and Klooster, 2007). A small number of researchers is also working with the moving body, by drawing on understandings and techniques from dance and

somatics, to inspire design concepts and to reflect aspects of the kinaesthetic experience of movement in the actual interaction afforded by the interactive system (Schiphorst and Andersen, 2004; Kjölberg, 2004; Klooster and Overbeeke, 2005; Moen, 2005, 2007; Jacucci, 2006; Hummels et al., 2007; Jensen, 2007; Larssen, Robertson, and Edwards, 2007a).

1.2   Theoretical foundations

This research is inspired by philosophies of phenomenology and pragmatism as both offer perspectives for design research that privilege and look to *lived experience* as the continual source and verification of human knowledge and action as we encounter ourselves, others and the world. Ihde (1998) describes the emergence of three styles of philosophy in the mid-twentieth century, namely pragmatism, phenomenology and positivism. All three styles were concerned with praxis, but adopted quite different epistemological definitions and methods. Of the three, pragmatism and phenomenology looked to lived experience for understandings of phenomena and practice. Positivism turned to science and its experimental method based on hypothetical-deductive reasoning as the source of empirically founded knowledge. For a thesis such as this one, positioned in *design research* and committed to research that values the lived experience, the practices and the agency of potential users of technology, phenomenology and pragmatism supply theoretical principles and tools to support the particular methodologies developed and utilised here. Phenomenology provides a philosophical foundation for the central focus on the lived, moving body, as described in Chapter 3. I use the phenomenological philosophers, Maurice Merleau-Ponty and Maxine Sheets-Johnstone, and their advocacy of the central role of movement in perception and cognition, as a foundation for my theoretical approach to this research.

Pragmatism has been useful here for issues of methodological validity in design research. I draw on the criterion of 'workability' as defined by the pragmatic philosophers, Rosenthal and Bourgeois (1977). In the case of design research, workability can be offered as a criterion for the validity of design artefacts, including representations of movement. An explication of

this is given in Chapter 4.

The research methodology is distinguished by the attendance to both the lived experience of the potential users of interactive technologies and the community of practitioners that informs the research, as well as to the experiential understandings gained from direct experience by the researcher. There are well-established research doctrines and practices that value experiential understandings by the researcher, particularly in the humanities. Strauss (1987) in *Qualitative Analysis for Social Scientists*, acknowledges the value of experiential data derived from personal experiences of the researcher in understanding phenomena. The dance anthropologist, Sally Ann Ness (2004) advocates the shift from an observational stance to an experiential investigation of the moving body by the researcher in anthropological investigations into dance in different cultures.

Sheets-Johnstone (1999a) provides a Husserlian-derived practical, philosophical method for accessing and elucidating experiences of movement. She draws parallels with the introspective methods of the scientist, von Helmholtz, for acquiring understandings of how movement is entwined in perceptual phenomena. We become 'laboratories unto ourselves' (Sheets-Johnstone, 1999a, quoting von Helmholtz). It is this notion of using our own bodies to acquire understandings of phenomena and practices that I embrace in this thesis. Sheets-Johnstone (1999a) provides a very clear articulation of the phenomenological attitude, which underpins the method of *free variation* for accessing the structures of experience.

> The phenomenological method is one of description; yet, as is evident, it is at the same time more than that, for in aiming toward a description of the phenomenon, it reflects backwards toward an elucidation of the structures of consciousness. It bypasses all question of the subject's objectivity or the object's subjectivity by elucidating the immediate world of lived experience, the world as it is immediately and directly known through a pre-reflective consciousness. This initial and direct knowledge constitutes the foundation upon which all future knowledge is built. (Sheets-Johnstone, 1999a, p.13)

In phenomenology as practiced by Sheets-Johnstone, the aim is to identify

the essential characteristics of movement phenomena through the application of free variation. But in design work we can work with the same technique in a different way. Through free variation, we can open up the possibilities for movement and the corresponding forms of felt experience.

An understanding of the phenomenological attitude is helpful for this research in clarifying the nature of phenomenological analyses as conducted by philosophers and of phenomenologically-inspired approaches and methods used by technology designers. For Sheets-Johnstone, phenomenological work necessarily includes first-hand experiential data. Her own work draws on three sources: observations of phenomena of interest, first-hand experiential data and the use of scientific findings as phenomenological clues. Technology designers using phenomenologically-inspired approaches and methods value first-hand, first-person perspectives in understanding technology use and practice (as discussed in section 2.1). It is this same perspective that I follow in this thesis, by drawing on participants' experiences and practices of the moving body and urging designers to understand movement phenomena through their own felt, bodily experiences and inquiries.

My own understandings in this emerging research field of movement-based interaction design are informed and envigorated by movement practices that cultivate an awareness and sensitivity of the internal and external relations of the moving body in space and time. These include Ashtanga yoga and alternative dance forms incorporating movement practices of Body-Mind-Centering (Cohen, 1993) and the Bodyweather system of Butoh. I have a personal commitment to experiential and bodily knowing as a valid form of knowledge. Things are known and felt in the body which are not easily articulated through verbal and visual forms, but which can be explored, articulated or communicated through movement and touch. Polanyi (1983) distinguishes this form of knowledge as *tacit* knowing. He describes it for the case of visual perception, where we attend *from* internal bodily processes *to* the qualities of things outside. Movement practices like the ones I engage in provide a subjective, self-reflexive means of approaching research into movement-based interaction design, grounded in one's own body. The pragmatist philosopher, Richard Shusterman (2000) makes a similar case for

the co-development and intertwining of bodily and mental awareness in his proposed discipline of *somaesthetics*. I also acknowledge the influence of my formal training in electrical engineering and computer science and my current teaching position in software design subjects for the past eight years. All these diverse backgrounds put me in an opportune position to successfully negotiate the disparate worlds of the experiential, moving body and the machine, as they come together in the design of movement-based interactive technologies.

1.3   Research design

The research questions were explored through a series of three distinct, yet related, projects. Each project focused on different situations of design and different conceptions of movement in order to gain an adequate understanding of a proposed design approach to movement-based interaction that prioritises the lived experience of movement. The overall aim of the three projects was to identify and trial methods and tools for understanding, describing, representing, experiencing and generating movement in the design of movement-based interaction. Two lines of investigation of potential design tools conducted throughout the three projects included Laban movement analysis and its companion movement notation system, Labanotation (see section 3.4 for background) and the adaptation of the analytic framework of Lucy Suchman (1987) (see section 2.3 for background).

The first project comprised an analysis of an existing movement-based interactive product, Sony Playstation2© Eyetoy™ (hereafter referred to as Eyetoy), to examine the movements of players interacting with the Eyetoy games. The focus in the Eyetoy project was on an individual, moving body. The Eyetoy games were treated as a prototype of future movement-based interactive, immersive systems that could be interrogated about the kinds of movements that worked or not within these systems.

The second project, Bystander enabled a shift from a focus on an individual, moving body to many bodies. Different conceptions of movement arise and different aspects of movement become relevant when dealing with

multiple bodies in interactive, immersive environments. Bystander is an interactive, immersive artwork built on video-based, motion-sensing technology. The research work in Bystander was concerned with the extension of traditional human-centred design approaches, methods, tools and techniques to the design of novel interactive, immersive environments available for public use in gallery and museum settings. The emphasis for this thesis was on constructing design representations to explicitly address moving bodies in social contexts and on the subsequent use of these representations for design reflection-in-action through physical immersion and enactment of movement in the prototype environment.

The third project, Falling Into Dance, continued the work done in the first two projects, by validating and extending their findings. One of the primary motivations was to extend the range and kinds of movement to be sensed, from everyday movement (in Bystander) and limited range of arm gestures (in Eyetoy) to more complex, heightened and choreographed forms of movement. Two studies were conducted with trained dancers and physical performers. A movement study of the act of falling was conducted with skilled movers. Falling was chosen for the purposes of 'making strange', as it is a movement pattern that we all know in some way and yet is not an established part of the movement lexicon for gestural input to interactive technologies. This notion of 'making strange' became instrumental to the development of the design methodology of Moving and Making Strange, arising from the results of the third project. It is covered in detail in Chapter 9. The second study involved working with dance and movement improvisation practitioners to find ways of generating and devising movement for use in the design process.

A detailed description of the rationale for the research methods and of the evolution and composition of the research is given in Chapter 4.

1.4 Contributions of the research

The primary contribution of the thesis is the design methodology of Moving and Making Strange. The contributions of the research in relation to the design methodology are summarised in Figure 1.1. Each of these contributions
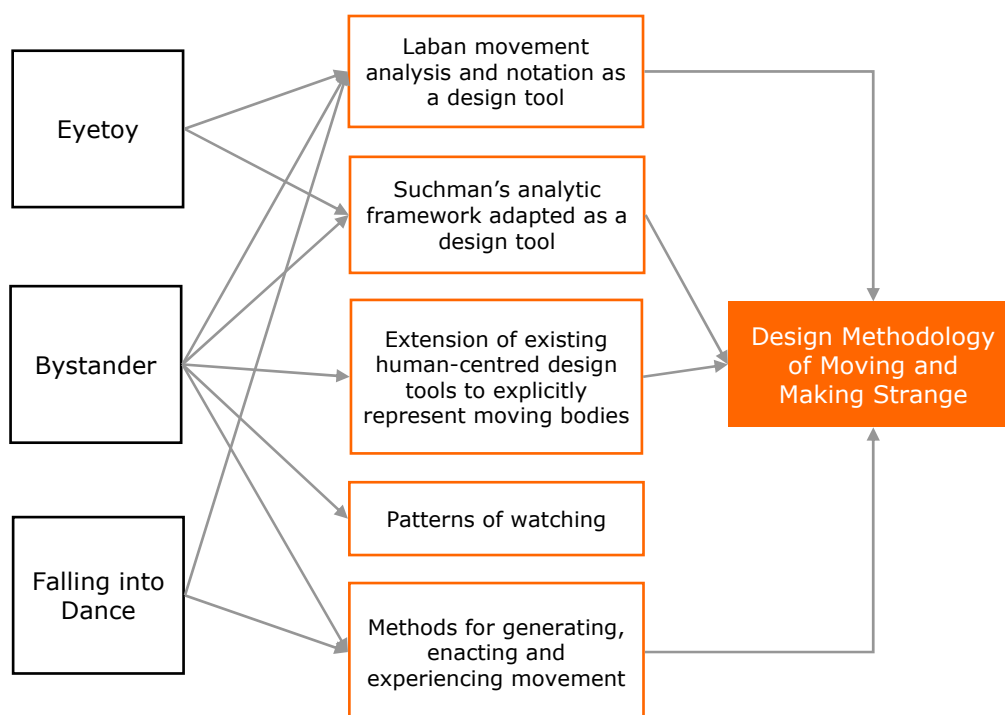
Figure 1.1 Diagram of thesis contributions

is briefly described in the following sections.

1.4.1   Design methodology of Moving and Making Strange

The design methodology of Moving and Making Strange is a design approach to movement-based interaction design that prioritises the lived experience of movement by both designers and users and values the creative potential of the experiential, moving body. It contains a range of methods and tools for exploring, experiencing, describing, representing and generating the moving body that enables designers to shift between the multiple perspectives of the mover, the observer and the machine. The methodology is underpinned by the notion of *making strange*. By *making strange*, I mean ways of unsettling habitual perceptions and conceptions of the moving body to arrive at fresh appreciations and perspectives for design that are anchored in the sensing, feeling and moving body. This notion of "making the familiar strange" is described by the phenomenologist, Sheets-Johnstone (1999a, p.143), as

a way of reacquainting ourselves with familiar or habitual movements by varying our normal movement patterns and processes. Making strange or *defamiliarising* is a basic strategy in artistic expression (Danto, 1981) and in ethnography (Marcus and Fischer, 1986), as exemplified by Clifford Geertz and Harold Garfinkel. Geertz (1973) describes anthropology's preoccupation with the exotic as a device for making the familiar strange. The breaching experiments of Garfinkel (1967) were designed to disturb familiar ways of perceiving everyday life. A more detailed account of the application of the strategy of making strange in artistic, ethnographic and design practices and the relevance to the proposed design methodology is given in Chapter 9. An early version of the methodology was first published in Loke and Robertson (2007).

1.4.2 Laban movement analysis and Labanotation as a design tool

The continued application of Laban's system of movement analysis and notation in this research confirmed the usefulness of the system for describing and visually representing relevant aspects of movement to be treated as input to motion-sensing technologies, in particular Labanotation floor plans and Effort-Shape analysis. This thesis makes the following contributions of Laban movement analysis and Labanotation as a design tool in movement-based interaction design (Loke, Larssen, and Robertson, 2005a; Loke, Larssen, Robertson, and Edwards, 2007).

- Labanotation floor plans were used to visually represent the spatial trajectories of users and could easily be extended to represent the social interaction of moving bodies. This representation was termed the *spatial movement schema.*

- The Effort-Shape analysis was useful for describing the dynamic, temporal qualities of human movements and could act as a bridging representation between the movements of people and the sensing of those movements by a computer.

- Laban movement analysis provides a language and vocabulary that translates readily to the field of interaction design. Both the functional and expressive aspects of movement can be described. Laban movement analysis is beneficial for developing movement observation skills and sensitivity and awareness to movement and the kinaesthetic aspects of movement.

1.4.3 Suchman's analytic framework adapted as a design tool

This thesis contributes Suchman's analytic framework adapted as a design tool (Loke et al., 2007), renamed the Moving-Sensing schema. The framework provided a way of organising and structuring the representation of the interaction between user(s) and machine that enabled a clear focus on the relationship between the movements and actions of the user(s) and the sensing and interpretation of the user(s)'s actions by the machine. It assisted with the identification of alignments and slippages between the mutual interpretation of the interaction between human and machine, in the manner of the original framework. The description of the user's movements within the framework ensured that the movements could be understood in the context of interaction, from both the perspective of the user and the perspective of the machine.

1.4.4 Extension of existing design tools to explicitly represent moving bodies

The extension of existing human-centred design tools for representing users, their activities and contexts of use was a major focus of this thesis. This thesis contributes the following design tools for representing human movement as part of human-computer interaction, for interactive, immersive spaces built on video-based, motion-sensing technologies (Robertson, Mansfield, and Loke, 2004; Loke and Robertson, 2005; Loke, Robertson, and Mansfield, 2005b; Robertson, Mansfield, and Loke, 2006; Loke and Robertson, 2008b).

- *movement-oriented personas* and *movement-oriented scenarios*: traditional personas and scenarios were extended to represent moving bodies in social contexts.

- *user activity script*: combination of movement-oriented scenarios and spatial movement schemas for use in enactment and evaluation.

1.4.5   Patterns of watching

A catalogue of the *patterns of watching* was derived from the analysis of actual visitor activity (in terms of their movements and stillness) to the Bystander installation in a public gallery. These patterns of watching contribute to the existing literature on understandings of audience behaviour in interactive, immersive environments and gallery/museum settings.

1.4.6   New methods for generating, enacting and experiencing movement

This thesis contributes methods for generating, enacting and experiencing movement, drawn from dance and movement improvisation practices (Loke and Robertson, 2008a). The methods include movement improvisation scoring techniques, working with imagery and qualities of movement and working with kinetic variations of speed, scale and direction. These methods access the creative potential of the moving body and develop a designer's ability and sensibility to work with the moving body as a design material. The movement improvisation scoring techniques can also be used for enactment in, and evaluation of, interactive, immersive spaces.

1.5   Thesis structure

The thesis is organised into the following chapters:

Chapter 2 reviews the literature on interaction design and human-computer interaction relevant to this thesis. In particular, it covers phenomenologically-inspired approaches to interaction design, ethnographically-inspired approaches

to interaction design, interaction analysis and Suchman's analytic framework, design representations and ways of seeing and methods and techniques for working with the moving body.

Chapter 3 reviews the literature on understandings of the moving body drawn from philosophy, dance, somatics, social science, anthropology and computer vision. It introduces and defines the theoretical foundations of this thesis with regard to the central role of movement in perception and action. Five conceptions of movement are presented to organise the understandings of movement from other disciplines. Ways of analysing and describing movement are reviewed, with a particular focus on the Laban system of movement analysis and notation.

Chapter 4 describes the evolution and composition of the research methodology and the research methods employed in the three projects.

Chapter 5 presents Project I: Eyetoy. The activities, analysis, results and findings are described in detail.

Chapter 6 presents Project II: Bystander. The activities, analysis, results and findings are described in detail.

Chapter 7 presents Project III: Falling into Dance. The activities, analysis, results and findings are described in detail.

Chapter 8 contains a reflection on the use of two potential design tools—firstly, Suchman's analytic framework adapted as a design tool in the projects Eyetoy and Bystander. And secondly, Laban movement analysis and Labanotation as a design tool in the projects Eyetoy, Bystander and Falling into Dance.

Chapter 9 presents the design methodology of Moving and Making Strange, a proposed design approach to movement-based interaction.

Chapter 10 briefly summarises the thesis and its conclusions and offers suggestions for future work.