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KinAesthetic Movement Interaction

Designing for the Pleasure of Motion

JIN MOEN

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The Doctoral Program "Aesthetic Learning Processes"

The doctoral program "Aesthetic Learning Processes" started as a joint project between eight institutes/university departments in the Stockholm region, financed by the Swedish Research Council (Committee for Educational Science): Department of Education at the University of Stockholm, Interactive Institute, Royal College of Music in Stockholm, Stockholm Institute of Education, University College of Arts, Crafts and Design, University College of Dance, University College of Film, Radio, Television and Theatre and University College of Physical Education and Sports. Along the way also other interested parties became involved: Cinema Studies and Musicology at the University of Stockholm, History of Ideas and Theory of Science at the University of Gothenburg and School of Computer Science and Communication at the Royal Institute of Technology in Stockholm.

The doctoral program was organised through a common course of study, special courses and recurrent seminars (reaching from half a day to two days each). Researchers from closely related fields have been invited as lecturers. Aside these activities, the doctoral students have been working at their "home-" departments. The program was in terms of content led by a joint group of supervisors/teaching staff and in terms of organisation by a formal management group, where the students have been represented.

The common knowledge orientation has been towards aesthetic processes, formal and informal learning and forms of knowledge (shape, creation, configuration, interpretation) that arise at the interface between research and artistic work. The focus of interest has been the process as such rather than its products. The present dissertation by Jin Moen is the third that has been produced within the doctoral program. Earlier dissertations have been:

Lundvall, Suzanne (and Mekbach, Jane), 2003. *Ett ämne i rörelse. Gymnastik för kvinnor och män i lärarutbildningen vid Gymnastiska Centralinstitutet/ Gymnastik- och idrottshögskolan under åren 1944 till 1992*. [Motion, Movements and Gestures as Physical culture for Men and Women 1944 – 1992.] GIH (University College of Physical Education and Sports)

Bäckström, Åsa (2005). *Spår – om brädsportskultur, informella lärprocesser och identitet*. [Traces – Skateboard Culture, Informal Learning Processes and Identities.] GIH (University College of Physical Education and Sports)

Within the framework of the program, tutors and students have published articles and have been lecturing at various conferences and seminars. More information about the program can be found at www.estetiska.nu.

Staffan Selander
Professor and coordinator
Stockholm Institute of Education

Abstract

This thesis aims at identifying and exploring properties and design aspects of human movement when used as interaction modality between people and technology. The work has been carried out with a multidisciplinary approach and combines theories, methods and practices from various areas such as modern dance, pedagogy, behavioural science, human computer interaction and research through design.

The research question asked in this work is: Which communicative aspects and properties of human full-body movement are important when designing for movement-based interaction, and how could such design be accomplished? This question has been dealt with through carrying out an explorative study of people experiencing dance-based human movement. The informants used were participants on a dance course called Physical Expression. On the basis of this study the following aspects of human movement were identified and discussed: *Movement imitation*, *Movement generation*, *Natural movements*, *The meaning of movement*, *Personal space*, *Self-confidence*, and *Movement literacy.* These notions were further explored, in relation to movement-based interaction design, through the design and implementation of an *interaction concept* and a *research prototype* called BodyBug. BodyBug can be described as an artefact that initiates and maintains bodily movements through its need to be fed with movement input. It gives the users a possibility to create and explore three-dimensional movements within a personal interaction space, both individually and in groups. BodyBug is a small device but does not necessary create small-scale interaction and movements.

The main findings from this research can be summarised in four theoretical notions that are related to human movement as a dynamic and communicative process: *Movement Literacy*, *Personal Interaction Space*, *Imitate-React-Express* and *Social Acceptability*. These notions reflect aspects of human movement such as the ability to verbalise, describe, sense and express intentions through human movement; the physical and emotional space we create when moving; the naturalness and understanding of movement; and finally, the social impact of movement. The design and implementation process of the interaction concept

exemplifies how we can apply knowledge and physical experiences of human movement in concrete design for movement-based interaction. The design process of BodyBug is therefore described as a holistic design process. It also argues for the importance of, and need for, multidisciplinary competencies and contributions throughout the whole design process.

This work has shown that making use of movement as interaction modality means to provide possibilities for getting to know one's own movement pattern and thus utilising the kinaesthetic sense and kinaesthetic awareness. However, since movement-based interaction is still in its early phase, we need more experiences and physical examples of this kind of interaction in order to develop an increased knowledge of human movement as design material. We also need to further investigate how movement-based interaction is experienced, and to continue the search for the essence and physical grounding of human movement in relation to technology and computational artefacts. Some of the biggest challenges are to design for movement-based interaction without loosing the aspects of individual preferences and differences in movement, and to preserve the spontaneity and ambiguity in human movement. As shown in this thesis, one approach to deal with these issues is to design for the pleasure of motion.

Acknowledgements

...'cause we got a PhD in advanced body movin'
keep the party movin' just like I told U
kick the old school joint 4 the true funk soldier
- Musicology, Prince

First of all, I would like to thank two persons without whom this project would have most probably looked very different. First, a big hug and warms thanks to my dear friend and splendid dance teacher Josephine Björklund. With her pedagogical skills and warm personality, she made the course Physical Expression such a great experience, both for me as a researcher and for the participants, who on their hand were heroically dedicated to their work – thank you all! Second, I would like to thank interaction designer Johan Sandsjö who I most fortunate met at the Convivio summer school in Split and directly started to work with. Without Johan, BodyBug would never have been born, and probably not even thought of. Keep on moving both of you! You are the best!

Two other people who have contributed greatly to the creation of this thesis are my tutors Cecilia Katzeff at Interactive Institute, and Yngve Sundblad at CSC, KTH. Cecilia has during four years, steadily followed my work along the winding road and kept me on the scientific track. After having started this project within pedagogy, Yngve invited me back to KTH and HCI. He also made it possible for me to offer KTH's most interesting course (?!) to engineering and computer science students during spring 2004. Thank you both, for your great support and interest as well as input and comments. I would also like to thank Jonas Löwgren at K3, Malmö University and Cecilia Olsson at Swedish Program, Stockholm University for contributing with their most helpful comments and advices during my final seminar.

This doctoral project has been mainly funded by the Swedish Research Council, Committee for Educational Science, through the graduate school and doctoral program Aesthetic Learning Processes. The dance course teacher was financed by CSC (former NADA), thanks to Yngve again, and Danshögskolan provided me with free access to their dance studios. I would like to thank Gunnel Gustafsson for her friendly assistance with bookings. The BodyBug development was financially supported by Stiftelsen framtidens kultur and Centrum för användarorienterad IT-design (CID), KTH. Thank you all for supporting my research and ideas.

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In this research, my academic host has mainly been the multidisciplinary HCI-group at KTH (former IPLab and CID). This group includes dear friends, research colleagues and PhD students, some of them now PhD's, with whom I have enjoyed discussing and working. I would also certainly like to thank my fellow PhD students, tutors and others involved with the graduate program Aesthetic Learning Processes. It has been a fun, frustrating, interesting and enjoyable journey together with all of you. I wish you all the best!

During these four years I have enjoyed the possibility to combine my interests in dance, education, personal development, technology, design and human computer interaction. I have also very much appreciated to meet and discuss with inspiring and competent people at work, seminars and conferences, especially at DIS'04, In the Making, Critical Computing and the Convivio Summer School in Split. But, what is work (or life) without friends and nice things to do? I will therefore give a big and warm hug to all my great friends, both at work and elsewhere, for contributing to moments and memories that have made me survive this period, still inspired, alive and kicking. Hopefully, in the future, we will have even more time for snowboarding, skateboarding, surfing, rock-climbing, travelling, after working, partying, reading books (fiction!), chatting (not only through various IM clients), fika, new adventures or just hanging out!

Finally, I would like to thank my parents, Åse and Arne, my sister Anita and my brother Jostein, for their love and support and for always being there for me. And last, but not least, my love and warmest thoughts go to Jörgen. Thank you for being who you are!

Jin Moen
Eidanger, Norway, December 2005

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Chapter 1
Introduction

"The variations of human movement are legion: reflexes, gestures, accommodating manoeuvres, posturing, precise complex articulations, random actions, and practical and aesthetic patterns. Sometimes movements are displayed openly (a hug or a salute); sometimes they are hidden or so minimal as to be only internally identifiable (a jumping inside your stomach)."
- Blom and Chaplin, 1988

Human movement is often described as the most basic and subtle form of communication between people. Our bodies are enormously expressive and by only watching people's body language we can get an impression of their emotional state and intentions. But the body is also a reflective display of our own experiences, to ourselves. We feel funny and good and we get butterflies in our stomachs. Most often we are reminded of the existence of our physical body in situations where it does not work as we want it to. We feel clumsy, too big or too small, or we suffer from physical pain. As movement can be performed with and within the body, but also perceived through the body, there exists a close relationship between who I am, what I do and how I move.

Today, computational artefacts and information technology (IT) services tend to have more and more human-like properties. They also take up an increasing amount of emotional space in our lives. They are objects for and facilitators of important and meaningful human relations. One could therefore ask, how it is possible to preserve and make room for the communicative, expressive and perceptive aspects of human movement in these kinds of interactions?

In the present thesis, I take the starting point in people's physical experiences of movement performance and expression in order to try to deal with this question. Further, through design and development of a movement-based interaction concept and research prototype, I finally arrive at a notion I call KinAesthetic Movement Interaction (KMI). This notion contains an emphasis on making use of the human kinaesthetic sense, and to

use movement as both input and output.

In this work I have been able to combine my two disciplinary backgrounds, as dance teacher and as engineer. My experiences from dance and dance education, as well as human computer interaction and interaction design, have therefore played an important role in this project. They have influenced my choices of research methods and approaches, as well as the possibility for me as a researcher and designer, to take part in a holistic design process, from fieldwork through design and implementation, and finally to studies of user experiences.

This research project has been carried out within the multi-disciplinary graduate school Aesthetic Learning Processes[1], which aims at combining the areas of art and science. The graduate school is also presented in the report "Handslag, famntag, klapp eller kyss?" (Karlsson, 2002), which discusses artistic research education in Sweden. During the whole project my workplace has been the Interactive Institute[2], an experimental IT-research institute that creates results through combining art, design and technology. I have also participated in seminars and other activities of the host of the academic subject of my doctoral studies, the multidisciplinary HCI group at the school of Computer Science and Communication at KTH[3]. Participation in the graduate school together with inspiration from my workplace as well as my academic host, have to a great extent contributed to and encouraged the multi-disciplinary approach taken in this thesis.

1.1 Objectives and Research Questions

In recent years human computer interaction (HCI) and related fields such as computer supported collaborative work, interaction design, and participatory design, have experienced a broadening of interest from focusing on efficiency, functionality and usability, towards an increasing interest in the aspects related to the user experience of technology and digital artefacts (McCarthy and Wright, 2004). In order to search for suitable notions for describing user experiences and interaction, several aspects of experience has been discussed and emphasised during the last years, e.g. aesthetics (Hummels and Overbeeke, 2000; Petersen et al., 2004), affections (Picard, 1997), emotions (Norman, 2004), fun (Blythe et al., 2003) and embodiment (Dourish, 2001). The different aspects of user experiences are in most cases pointing towards the same main issue, that interaction with artefacts and systems is done on several levels and not only cognitively. This issue has also become important as technology becomes more pervasive, ubiquitous and personal, and thus a self-evident and non-reflected part of our everyday lives. They are also a natural consequence for interaction design when our concern with artefacts is focused towards

[1] http://www.estetiska.nu/ (All web references are to sites in their status in December 2005.)
[2] http://www.tii.se/
[3] http://www.csc.kth.se/

their presence rather than a well-defined use (Redström, 2001). Despite the user centred and participatory design perspectives applied within HCI, one can still ask, however, to what extent people as whole human beings, are the starting point for interaction design and technology development. To what extent do we consider important aspects of human life as emotions, feelings, affections and (un)conscious actions when we choose the point of departure for user centred interaction design? How are thos aspects combined with and related to cognitive skills, behaviours and physical abilities and disabilities?This thesis discusses some of these issues in relation to an area of HCI that is still in its quite early phase, namely full-body movement interaction, and more specifically consciously making use of bodily movements as input and output modality.

Technology and artefacts influence our daily life, our habits, preferences, actions, and movements. However, human beings are very skilled in accommodating to the surroundings and learning new behaviours. Developing interaction possibilities that make use of free, natural or spontaneous movement therefore means to provide the possibility for moving according to your own physical abilities and the social context in which you are. What we consider as free and natural movement, is specific for each individual. It might depend on your previous experiences in sports, physical injuries, personality, social phobias, etc. However, the body can be trained or schooled in several aspects. But interacting with technology in everyday life should not require a certain schooling or training, and in those aspects be done freely and natural.

In order to design interaction for full-body movement, we need to increase our knowledge of human movement. To some extent we can say that all interactions between people and between people and artefacts involve human bodily movement. All human actions need a movement of some body part, external or internal. In this project however, the focus is on movements that involve the whole body, as well as movements that do not require to be performed by certain body parts or in a specific way. This is an area that is still quite unexplored, as I will discuss in the next section. There is therefore a need for more studies that deal with the interplay between technological devices and human actions on a physical, bodily level.

However, if we want to include the body in human computer interaction and emphasise physical embodied experiences we also need to deepen our knowledge in and of human movement, and how we experience the physical activity, both as input and output. What is a free movement? How do we move? What importance does our body have for how we move and how we perceive our movements? How aware are we of our movements? What do we express through our movements, both consciously, and unconsciously? How do we make use of movements in order to interact with our surroundings? How do our movements affect and influence the environment and ourselves? How does the physical and social environment influence our movements and how we move? How can people and technology interact with each other by means of movement?

The aim of this thesis is to identify and explore some important aspects and properties of human movement that are useful in movement-based interaction. This work focuses on

kinaesthetic movement interaction and makes use of movement as the main interaction modality for both input and output. The term kinaesthetic refers to the ability of the body to feel and sense its own movements, the communication within a person's body. This will be further discussed in section 1.3.

By posing and dealing with questions such as "What makes us move?" and "What generates, triggers or creates human movement?" I try to increase the understanding of human movement in a way that is relevant to interaction design. I also search for notions, descriptions, terminology and examples that could be useful when designing for movement-based interaction.

The overall research question of this thesis is:

> *Which communicative aspects and properties of human full-body movement are important when designing for movement-based interaction, and how could such design be accomplished?*

In dealing with this question I make use of theory, empirical studies and design as different steps of the research process, as each approach provides different possibilities to explore the research questions. They also contribute with different kinds of knowledge. First, I use modern dance as the knowledge base and starting point for human bodily expression and communication. Second, I design, develop and implement an interaction concept and research prototype in order to materialise and further discuss the research question. The artefact is also a qualified example of a kinaesthetic movement interaction artefact.

1.2 Movement Interaction and Technology

Multimodal interaction has developed to a large extent during the last decades. Interacting with computers and technology provides today more than just text-based or graphical visual feedback. Input possibilities in the form of touch screens, speech and even movements, are no longer rare. Making use of multimodal interfaces and interaction techniques are seen as important features in striving for a holistic perspective on the user when creating interaction between people and computers, as well as between people by means of IT. However, there is still much work to be done. From a critical point of view, design and application development are mostly technology driven when it comes to using full-body movement as interaction form. The interaction is sometimes designed in order to demonstrate what new technology can achieve or what is possible to do using high tech devices. Another goal is often to develop new technology per se. The area of HCI has also to a great extent been dominated by theories developed within cognitive psychology and behavioural science. As a complement and counter part to these existing approaches, this work takes the starting point in physical movement experiences and uses those to inform movement-based interaction design.

Recently within interaction design the physical body has come more and more into

play, and the notions of embodiment and embodied interaction are often mentioned as important aspects of the design. Today these notions are mainly discussed from a phenomenological point of view (Dourish, 2001; Svanæs, 2000; Fällman, 2003), as this philosophical tradition deals with the lived physical body. Further, phenomenology argues for a more holistic view on human experiences that involves physical and emotional as well as cognitive aspects. Another re-introduction of the human body into philosophy and aesthetics has been done by Richard Shusterman. He has proposed an aesthetic discipline called somaesthetics (Shusterman, 1992, 2000), which is based on John Dewey's pragmatism and pragmatist aesthetics (Dewey, 1958). Somaesthetics and pragmatist aesthetics have recently been suggested as a useful approaches to interaction design and user experiences (Kallio, 2003; Petersen et al., 2004).

Although approaches such as phenomenology and somaesthetics contribute to an understanding of the physical human body in interaction design, they still lack direct references to physical movement. In the present thesis I argue for the personal physical experiences as point of departure for informing design of embodied interaction.

An area that is occupied with movement as design material is dance. In dance we can find theories and examples of human movement as expression, as well as methods for training the ability to express intentions and aesthetic matters through movement. In this thesis the notion of dance mainly refers to dance as performing art as different from social dance like waltz, tango, folk dance, disco dance, etc. I am also referring to modern and contemporary dance as different from other artistic dance genres such as classical ballet or jazz.

As dance is based in the human body, phenomenology is an often-used approach to dance theory (e.g. Sheets-Johnston, 1979; Fraleigh, 1987; Rouhiainen, 2003). In this work I will refer to dance theory and methods influenced by the thoughts of the dancer, choreographer and movement theorist Rudolf Laban, who inductively derived his work from physical experiences of dance from different cultures. However, Laban's theories of movement are applicable on all kind of human movement, not only dance, as he also worked extensively with factory workers and human movement in industrial environments in Britain. Parts of his theories and work relevant to this thesis will be presented in Chapter 2.

The problem area of the thesis is related to full-body movement interaction or, more explicitly, the use of movement as the main interaction modality. Today's existing interfaces and applications that make use of movement-based interaction are quite limited when it comes to intuitiveness and richness of the interaction. Natural, spontaneous and free movements are seldom emphasised as important design criteria (Leikas et al., 2003). The movement-based interaction used in these systems could often be described as a prolongation of traditional command-based interfaces, which means that you have to learn a specific interaction language in order to interact with the systems. Applications or systems also use the body as input through scanning the person's body, posture, temperature, etc. In these situations you have less control over the intended output as a user, and has to

adapt to what the application is doing. However, this occurrence of unknown output or surprise can be an important part of an interaction experience in certain applications, e.g. games and artistic installations. Benford et al. (2005) has analysed movements occuring in human computer interaction and categorised them into expected, sensed and desired movements. Expected movements are movements that users naturally perform, sensed movements can be measured by a computer, and desired movements are movements that are required by the application. The movement categories can be useful to designers and serve as inspiration for new design ideas. They also might help the designers to discuss how to bridge the physical movement experience and technological sensor possibilities.

Human bodily movement interaction has often been reduced to only include gestures, hand movements or facial expressions. Along with the development of inexpensive and easy-accessible computer vision and motion capture technologies, the number of full-body movement interaction applications have increased both within research and commercial contexts. However, a lot of the applications are based on what the technology is able to make use of as input, and the output or feedback provided is most often vision or audio based. In the approach taken in this work, I explore, through the experience of dance, how it is possible to use movement as a communicative tool. Further, through design, I explore how to make use of movement both as input and output and in particular, the human kinaesthetic sense.

Full-body movement-based interaction is today found in commercial products such as video, computer and arcade games. The games provide possibilities for using movement input through devices such as web camera-based motion tracking, e.g. EyeToy®[4]; full-body sized joysticks, e.g. ActionStick[5], and large-scale buttons for the feet in form of dance mats, e.g. Dance Dance Revolution[6]. These devices can most often be used with computers as well as with game consoles. Systems such as motion detection alarms and door openers also make use of movement input. In these systems, the interaction might be more or less conscious and intentional.

Within new media as well as art and technology clusters there are several multi-media installations, applications and artworks that utilise the human body and movement as a way of experiencing and interacting. These types of works can be exemplified by the project referred to in the following bullet list. This overview intends by no means to be exhaustive. In most cases the projects are carried out in close collaboration between the artist(s) and people competent in the technology and media used.

- The multi disciplinary research project and real-time interactive media installation Whisper[7] (Schiphorst and Andersen, 2004; Schiphorst et al., 2005). Whisper is an acronym for Wearable, Handheld, Intimate, Sensory, Personal, Expressive, and Responsive system.

[4] http://www.eyetoy.com/
[5] http://www.itradekorea.net/game.htm
[6] http://www.konami.net/
[7] http://whisper.surrey.sfu.ca/

- The real-time body-driven three-dimensional immersive environment Body-Brush[8] (Ip et al., 2002), which maps body motion to visual expressions and sounds.
- The large-scale virtual reality performance installation Desert Rain[9] (Koleva et al., 2001), in which a virtual world is projected into a physical space.
- The art installation Very Nervous System[10] by David Rokeby, in which he maps movements performed within a dedicated space, to sound.
- The artworks The Legible City and ConFIGURING the CAVE by Jeffrey Shaw[11], in which he explores relations between the body, movements and space.

Even dance choreographers and dance artists have been interested in the use of technology in dance performances for a long time. This could be in the form of virtual dancers, creating the dance space virtually or physically, visualising and performing dance in new ways, or using technological and mechanical devices as dancers and movement partners. Some examples of these kinds of dance performances are Ghosts and Astronauts[12] (1997) by Susan Kozel, Forklift Ballet[13] (1999) by Sidney Fels (Fels, 2000), and The Lamentations of Orpheus (1998) and Navigation (2005) by Åsa Unander-Scharin[14]. Several descriptions of dance and technology projects and references to articles and academic papers within this area could be found at the website Dance and Technology Resources[15].

Along with the increasing interest for multimodal and embodied interaction as well as collaborative projects between art and technology communities, movement-based interfaces are more and more present in research projects within human computer interaction and interaction design. Some of these projects have focused on full-body movement interaction for game applications (Rinman et al., 2004) and/or as physical training environments (Chua et al., 2003; Hämäläinen, 2004). Another area of interest is to make use of bodily properties, e.g. bodily memory (Ängeslevä et al., 2003) and breath and balance (Waterworth et al., 2003). These projects and systems often aim at exploring issues concerning new forms of interaction, developing new technology or make use of available technology in new contexts. The systems might be prototypes and not fully functional. Sometimes they are still under development and used for gaining knowledge, collecting data or as objects for research studies. The research projects dealing with movement-based interaction are often carried out in collaboration with artists and have also been used as artistic installations.

[8] http://www.cs.cityu.edu.hk/~bodybrush/
[9] http://www.crg.cs.nott.ac.uk/events/rain/
[10] http://homepage.mac.com/davidrokeby/vns.html
[11] http://www.jeffrey-shaw.net/
[12] http://www.meshperformance.org/ghosts.html
[13] http://hct.ece.ubc.ca/research/forklift/
[14] http://www.scenochsinne.com/
[15] http://greatdance.com/danceblog/dancetechresource.php

1.3 The Kinaesthetic Sense

"A kinaesthetic memory flares in our moving muscles; triggered by a movement we are doing, it recalls other times of movement. … The memory is caught in the preconscious, in the sensing organs, and in the muscles. … This phenomenon, known as muscle memory, allows memory, images, and meaning to be encoded in our muscles"
- Blom and Chaplin, 1988

Haptics or haptic perception could be described as what is possible to perceive through the sense of touch, in the same fashion that optics is what is possible to perceive through the sense of vision. Haptic perception can further be separated into a tactile and kinaesthetic perception. Tactile information is what we perceive though nerve cells in our skin, while kinaesthetic perception is based on information from muscles, tendons and joints, and thus reflects physical movement. Kinaesthetic perception is also called the kinaesthetic sense as well as kinaesthesia. Mabel E. Todd describes kinaesthetic consciousness in the following way:

> *"We are unconscious of most of the small movements involved in posture and locomotion. Usually we are not aware of the initial sensation that starts the reflex or of the movement that competes it. This is true both of movements resulting from exteroceptive sensations and from the proprioceptive sensations. A vast number of these are habitual, that is automatic, though they may have been evident to consciousness at some period, as when learning to walk, to use a special tool or acquire a motor skill. However, it is possible to bring the organic impression and resulting movements into consciousness and thus to control the adjustments. This fact underlies the learning process in purposive movement and conditions any improvement." (Todd, 1937/1968, p.31)*

When I refer to the kinaesthetic sense and kinaesthesia in this thesis, I include the extroperceptive and proprioceptive sensation Todd describes, and not only the sense of touch. One important aspect of kinaesthesia and the haptic system is its bilateral nature, which causes what Merleau-Ponty calls "double sensations," i.e. to be able to touch and be touched by the same action, and the sensations this causes.

> *"When I press my two hands together, it is not a matter of two sensations felt together as one perceives two objects placed side by side, but of an ambiguous set-up in which both hands can alternate the rôles of 'touching' and being 'touched'. What was meant by talking about 'double sensations' is that, in passing from one rôle to the other, I can identify the hand touched as the same one which will in a moment be touching." (Merleau-Ponty, 1945/2002. p 130)*

In bilateral interaction it exists a mutual, however not equal or identical, relationship between you and the object you interact with. For example when squeezing a lump of clay into a shape, you feel the texture and the shape of the clay while you shape it, and thus you are able to stop the squeezing when you feel you have obtained the right, intended or pleasurable shape. This could be done even with closed eyes, i.e. without the use of sight.

The haptic system is the only perceptive system that is bilateral. In all human movement the bilateral aspect is of great importance. Through the kinaesthetic sense it provides us with feedback and information about where the different body parts are in relation to each other, and thus an ability to control our body movements. In other words it ables the body to communicate within and within itself. By emphasising the kinaesthetic aspects of bodily movements, the interaction design can be focused towards movements within the body, i.e. moving the body in relation to itself, as different from moving or placing the body in relation to the physical environment or surroundings. The importance of the kinaesthetic sense is often neglected or put in the shadow of more apparent senses like vision and hearing. However, it is the most potent and relevant sense for the dancer and the mover, as it refers to the body's ability to perceive weight, balance, verticality, laterality, gravity, buoyancy, volume, muscular tension, fatigue, release, stretch, flexion and extension, rotation, spatial orientation, and timing (Blom and Chaplin, 1988).

The importance of kinaesthesia and the existence of a kinaesthetic memory is something well known to artists and athletes. Recently even academics have turned their focus towards this issue. The interest is especially strong within pedagogy and disciplines related to different aspects of learning and knowledge as well as areas that want to obtain a more holistic perspective on human beings beyond Cartesian dichotomies that separats body and mind (Gardner, 2000; Hannaford, 1995; Damasio, 1994). In dance and other movement-based activities, we often talk about bodily memories, that the body "remembers" the movement. This could also be described as a result of training or "programming" the body or the muscles, by doing and repeating the same exercises over and over again. This aspect of movement is implemented in Topobo, which is a 3D constructive assembly system with kinetic memory, which means that it has the ability to record and play back physical motion (Raffle et al., 2004). The kinetic memory is an ability of the human body that has been utilised in the Body Mnemonics prototype (Ängeslevä et al., 2003).

The kinaesthetic sense is tightly connected and intertwined with our other senses. When we watch movements the process of kinaesthetic memory works reversely, from (visual) image to muscle memory. People trained and skilled in specific types of movement, e.g. dancers and athletes do not have to physically see the movement in order to cause physical changes in their muscles, They have developed an ability to imagine anatomically and physically correct paths without actually moving, making use of their kinaesthetic sense and bodily memory.

1.4 Contributions of the Thesis

This thesis' first contribution to the area of interaction design and human computer interaction is the notion of kinaesthetic movement interaction (KMI). KMI emphasises the kinaesthetic awareness of human movement, and introduces the related notions Movement Literacy, Personal Interaction Space, Imitate-React-Express and Social Acceptability. These

notions reflect aspects of human movement, such as the ability to verbalise, describe, sense and express intentions through human movement; the physical and emotional space we create when moving; the naturalness and understanding of movement; and finally, the social impact of movement.

Movement literacy is as an important aspect of the ability to design people-centred movement interaction as it includes knowledge of physical, intellectual and emotional aspects of human movement. Being movement literate means to be able to physically sense and feel differences in movement, and to be kinaesthetically aware of the body and its movements. It also means to have an ability to express a physical experience in terms of movement, and to know the implications of applying movement elements and concepts such as time, space and energy, as well as movement quality. Movement Literacy can be acquired and developed through the combination of physically exploring human movement and verbally reflecting on those experiences.

The personal interaction space is the three-dimensional space that is immediately surrounding a person's body and which is continuously changed and created along with that person's movements. The physical personal interaction space is defined by a person's physical range of movement, also called the kinesphere according to Laban's theories of human movement. The emotional personal interaction space is often of a different size than the physical one. It is defined by how near one prefer to be to a specific person or object, in a specific context. The size of a person's personal interaction space is therefore depending on social relations and the physical environment, and can vary from time to time.

In movement-based interaction we should provide possibilities for people to make use of their natural movements for communication and to create a dialouge with the system or application. When people can move freely and make use of their natural and spontaneous movement patterns, they can choose to use movements that feel good in the body and that correspond to the personal movement qualities. This will give the user a more natural and pleasurable interaction experience. When the interaction is based on imitation of specific and/or predefined movements, the users are helped by knowing the intention behind the

The use of movements as means for communication is always influenced by the social context. Specific movements are more or less appropriate in certain situations and environments. Consequently, the social context as well as the physical environment influence the natural movement pattern and quality of movement. In addition, the social environment will be affected by people's movement expression and mere physical presence of their bodies and movements. Design for movement-based interaction should therefore be considered in respect to the social context in which it is intended to occur.

The design and implementation process of the interaction concept BodyBug has been grounded in these findings, and therefore exemplifies how we can apply knowledge and physical experiences of human movement in concrete design for movement-based interaction. BodyBug is an interaction concept that is designed in order to trigger

movement and invites the user to move as (s)he feels. It consists of a wearable artefact that utilises movement both for input and output. It focuses the interaction towards the body and makes use of the personal interaction space. The user can improvise and explore the movement possibilities both of the artefact and him/herself, and thus create a movement dialogue with the device. BodyBug provides its wearer with a possibility to create new movements and to feel and reflect on the body and its movement in new contexts. It also emphasises the kinaesthetic awareness as it can be used to identify and learning to know movement patterns.

The research presented in this thesis shows how it is possible to combine and integrate theory, empirical studies and design as parts of the research process and from a holistic perspective. The design process of BodyBug is therefore described as a holistic design process. This work also argues for the importance of, and need for, multidisciplinary competencies and contributions throughout the whole design process. As this work is based on experiences, methods and theories from the areas of fine art, technology and science, this thesis also contributes to the ongoing discussion of artistic research, design research and the relation between fine art, technology and science.

1.5 Thesis' Outline

This introductory chapter aims to set the scene for this work, in providing a brief background and research context. In Chapter 2, I present the theoretical notions and concepts adopted from dance theory that have been used as starting point for the empirical study. These concepts are based in Rudolf Laban's work and include notions as kinaesthetic awareness, phrasing, forming, abstracting, relating movement as well as elements of movement such as time, space, energy, flow and weight. I also discuss the knowledge tradition and importance of physically acquiring an experiential body of knowledge, which is emphasised in dance education. The dance perspective taken is based in modern and contemporary dance (modern dance for short) and uses improvisation and choreography as particular areas of dance that are relevant to interaction design.

In Chapter 3, I describe the research process carried out and how the different parts, i.e. theory, empirical studies and design, are related. The methodological approach is explorative, experiential and qualitative, with an ethnographic reflexive attitude. In this chapter I also give account for the data collection techniques I have used as well as how the data has been analysed.

The empirical dance study is presented in Chapter 4. The study was carried out during a period of time of 3,5 months. The nine informants, who were mainly HCI students, participated in a dance course called Physical Expression. The dance teacher Josephine Björklund taught the course. The participants attended in total thirteen dance classes, once a week for two hours each time. In this chapter I will give account for the exercises and work carried out during the course, as well as discuss the physical experiences

and important movement notions that came out of the physical work.

In Chapter 5, I first present the work of two design workshops that were carried out as part of the dance course and that aimed at bridging the participants' physical experiences from the dance studio to interaction design. I also discuss how the dance theoretical notions that were physically explored throughout the dance course, might be related to interaction design, i.e. how the empirical results can be used to inform movement-based interaction design.

Chapter 6 describes the design and development of the kinaesthetic movement interaction concept called BodyBug. It was a collaborative work carried out by the interaction designer Johan Sandsjö and myself. In this chapter I present the design process of the interaction concept as well as the main design decisions. I also give account for how the decisions were grounded in dance theory, the empirical results and our personal previous experiences of interaction design, movement interaction and dance.

Further, in Chapter 7, the physical implementation of BodyBug as a research prototype is presented along with descriptions of users' interaction experiences of it. BodyBug has been presented at four different events and tried out by more than 50 different users. The interaction has been qualitatively and informally observed, and four persons have been asked to formulate a written description of their BodyBug experience. The interaction experiences show a great variety in individual ways of moving. The understanding of how to interact with BodyBug is closely related to the movers' personal idea of what it is and how they think the technology works. The experiences also reflect the social aspects of moving in abnormal ways in public spaces.

Finally, in Chapter 8, I summarise the findings and results and reflect on the whole research and design process. From dance theoretical notions to physical experiences of a kinaesthetic movement interaction concept, the holistic design process goes via empirical explorations of theoretical notions, design implications for kinaesthetic movement interaction design, design of the interaction concept BodyBug, implementation of the interaction concepts, and user experiences of BodyBug. In this final chapter, I also reflect on the methodological approach and movement-based design in general.

1.6 My Related Publications and Conference Papers

In relation to this doctoral work I have written the publications and conference papers presented below. The content of these texts are more or less included in this thesis.

- Moen, J. (2005). KinAesthetic Movement Interaction. A Dance-Based Approach to Human Movement. Submitted to *Personal and Ubiquitous Computing Special Issue on Movement-Based Interaction*.
- Moen, J. (2005). Towards People Based Movement Interaction and KinAesthetic Interaction Experiences. In *Proceedings of The Fourth Decennial Aarhus Conference:*

Critical Computing. Between Sense and Sensibility, pp. 121-124, Aarhus, Denmark.

- Moen, J. (2005). Dance-Based KinAesthetic Movement Interaction. In *Workshop Proceedings of Approaches to Movement-Based Interaction, Critical Computing: Between Sense and Sensibility*, Aarhus, Denmark.
- Moen, J. (2005). *The Aesthetics of Human Movement*. Position paper accepted for workshop on Aesthetic Interaction as Critical Computing, at Critical Computing: Between Sense and Sensibility, Aarhus, Denmark.
- Moen, J. and Sandsjö, J. (2005). Design Case: BodyBug – Design of KinAesthetic Interaction. In *Proceedings of the first Nordic Design Research Conference: In the Making*, Copenhagen, Denmark.
- Kjölberg, J. (2004). Interactive Poster: Designing Full Body Movement Interaction Using Modern Dance as a Starting Point. In *Proceedings of the 2004 ACM Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques* (DIS'04), pp. 353-356, Cambridge, MA.
- Kjölberg, J. (2004). *Designing Full Body Movement Interaction – A Doctoral Project*. Accepted for Doctoral Consortium at DIS'04, Cambridge, MA.
- Kjölberg, J. (2003). Serendipity in Technology and Education. In Rogala, W. and Selander, S. (Eds.) *Technology as a Challenge for School Curricula, Stockholm Library of Curriculum Studies*, Vol. 11, pp. 193-200. Stockholm Institute of Education Press (LHS Förlag).

Chapter 2
Theoretical Backgrounds and Notions

Human computer interaction (HCI) and interaction design are multi-disciplinary areas that do not belong to a specific philosophical tradition or theoretical background. However, HCI has from its start in the 1980s, a historical basis in computer science and cognitive science. In the early 1990s the area was broadened with social science, e.g. computer supported interaction between people. Recently, design and artistic perspectives have been more and more introduced to broaden the perspectives of the interaction between people and the increasing existence of computational artefacts and environments. The research presented in this thesis reflects a multi-disciplinary approach to HCI and interaction design. Theories and methods from several disciplines and knowledge traditions have been used and combined, e.g. modern dance, dance education, behavioural science, pedagogy and design praxis. However, as the main subject of this thesis is human computer interaction, I start by discussing body and movement related theories that have been used within HCI and interaction design. The major part of this chapter is dealing with theories from modern dance and dance education, as these ideas are previously little discussed in relation to HCI and interaction design. They are also the theoretical basis for the empirical work presented throughout the thesis. In the last section, I return to the area of HCI and interaction design and briefly refer to the ongoing discussion of aesthetic interaction.

2.1 Embodiment and Disembodiment within HCI

Within human computer interaction the approach taken when discussing the relation between users and technology, has traditionally been from a technological or cognitive point of view. This perspective has been criticised though, as it does not take into account emotional and socio-cultural aspects of human interaction. It has also been critisised for delimiting the user's experience to the user's mind, excluding the rest of the human body.

Within HCl the notion of embodiment has earlier been used in relation to

representation of users in social virtual environments. With the book *Where the Action Is: The Foundations of Embodied Interaction*, Paul Dourish (2001) introduced the notion of embodiment to a broader field within HCl and interaction design. He presented us with a new model of using and experiencing computer systems that combine recent trends within human computer interaction, i.e. tangible computing and social computing. Drawing upon phenomenological philosophy, he defined embodiment as "the creation, manipulation and sharing of meaning through engaged interaction with artefacts." Further, he described embodied phenomena as "those that by their very nature occur in real time and real space" (Dourish, 2001, p.126). Embodiment, according to Dourish, means more than the mere physical presence and visual appearance. To be embodied implies to participate in the world, in real-time and real-space, being here and now. It is therefore not only physical objects that could be embodied, but also conversations and actions.

Several disciplines have been occupied with different aspects of the body, embodiment and disembodiment, from organisation theory (e.g. Hassard et al., 2000; Dale, 2001) to performance artists (e.g. Stelarc[1], Orlan[2]) and feminism (e.g. Bordo, 1993; Haraway, 1997). Since the body is present in all human activity, it is not only interaction design that has been lacking references to the physical experience of the body. Within anthropology of movement disembodiment has been described as people being unaware of their own body's natural limitations, and thus the limitations of other's bodies (Williams, 1999). In other words, we are not aware of what we are able to do, or the potential of our own bodies, because we are not used to experiencing the body as such. We are rather trained to experience and appreciate the outcome of our actions, what we achieve through using our bodies, i.e. the functions of and within the body. The design and use of digital artefacts and technology has been criticised for contributing to the creation of disembodied bodies through how they stage and shape human actions and thus delimit the interaction possibilities that pull the focus away from embodiment. This phenomenon is often referred to as the absent body and has been described in the following way:

> *"While in one sense the body is the most abiding and inescapable presence in our lives, it is also essentially characterized by absence. That is, one's own body is rarely the thematic object of experience. When reading a book or lost in thought, my own bodily state may be the farthest thing from my awareness. I experientially dwell in a world of ideas, paying little heed to my physical sensations or posture. Nor is this forgetfulness restricted to moments of higher-level cognition. I may be engaged in a fierce sport, muscles flexed and responsive to the slightest movements of my opponent. Yet it is precisely upon this opponent, this game, that my attention dwells, not on my own embodiment." (Leder (1990) cited in Williams (1999))*

Another perspective that recently has gained an increased attention within interaction design is to consider the interaction between people and artefacts as a performance, using anthropological concepts of performance (Jacucci, 2004). Implications of applying this

[1] http://www.stelarc.va.com.au/
[2] http://www.orlan.net/

perspective are to look at ”how space can be configured and staged instead of measured or simulated, and how situations can be staged instead of sensed and recognised, privileging the sensing human over the sensing system” (Jacucci, 2004). But as people in general have learned not to pay attention to the interacting body, i.e. are disembodied from their bodies, we need to gain knowledge of our body's limitations as well as possibilities in order to be able to experience and sense an embodied body. The development of a physical movement awareness and sensational ability is again addressed.For embodied interaction to appear there should thus exist a mutual relationship of awareness between my opponent, as the one I am interacting with, and myself. Transferred to HCI, this implies that both the artefact and the user are interactors Further, within anthropology one has recently emphasised that human movement should be considered as actions rather than mere behaviour. Since movements can be initiated by internal and invisible intentions, they reflect more than mechanical changes of state or movement behaviour (Farnell, 1999). These perspectives must therefore be considered when we discuss how we move and make use of our bodies in relation to computers and artefacts. Further, they also points towards the relation between movement and the social context.

In order to increase our understanding of human movement we need to study the inner urge to move and what lies behind our choice of movement (Alter, 1991). Why do we move as we do? What makes us move? What triggers movement in general? What triggers different kinds of movement? Introducing knowledge and experiences from artistic as well as educational practice of modern dance, is therefore one attempt to search for an embodied physical understanding of human movement that can be used to inform movement-based interaction design. In the next sections I will introduce notions and concepts from dance theory as well as the practice of dance education. I will start by giving a short introduction to the notion of dance. As the word dance brings up different associations for different people I will try to make clear what kind of dance I am referring to in this work.

2.2 Dance and Dance Theory

The human body has to a great extent been absent within philosophy and has suffered under the Cartesian dichotomy of body and mind. Similarly, dance as art has been absent in the aesthetics and philosophy of art (Sheet-Johnstone, 2005). In addition, definitions of dance within theories of aesthetics, often emphasise the motivations for making dances, and not the dance per se. In general, the definitions of dance lack words conveying the physicality of dance. If we exchanged the word ”dance” with words as jogging, acting, playing, or praying, the definitions of dance would still make sense (Alter, 1991). One could say that the philosophical influences may have done more harm than good for the theoretical development of dance. According to Alter, some of the problems caused by this influence are the following:

- The topics discussed are narrowed to only include what is trendy and actual within aesthetics and not necessarily what is relevant and interesting to dance. A popular use of the word dance adds to the confusion about what serious writings on dance are about.
- The words, notions and conceptual models of dance lack physical examples that are based in dance. Crucial terms relevant to dance, e.g. movement, dance, centre, impulse, time, space, and force, are seldom defined or explained.
- The use of dichotomies does not reflect the complexity of concepts and notions that are extensively used within dance. The most usual dichotomies in dance theory are: mind-body, emotion-reason, conscious-unconscious, active-passive, doing-thinking, theory-practice, means-ends, art-craft, subjective-objective. These dichotomies need to be re-examined since they restrict accurate and complex understanding of central issues in the analysis of dance theory and practice.
- Aestheticians are often inspired by theory rather than by artwork and derive their ideas from books on dance written by dance theorists and not based on experiences of dance. Dance theorists, on their hand, derive their conceptual guidelines from aestheticians or take the starting point in theories outside their own field, and apply those to dance. This causes a back-and-forward reference loop that is not grounded in dance itself and has little to do with the physical experience of human movement and dance.
- Several dance theorists are influenced by an anti-ballet bias and thus reflect a defence of modern dance rather than reflective theory of dance.

In order to deal with the above presented issues, Alter proposes a dance-based dance theory and suggests making use of the ideas, methods and theories of Rudolf Laban. Laban's theories of human movement enable a separation from philosophy and provide an opportunity to consider dance as an autonomous, dance-based and independent field. Laban's work will be presented in more detail in section 2.3.

As a tool to use when creating a dance-based theory of dance, Alter proposes the following operational definition of dance:

> *"Dance activities are part of the cultural experience and expression of human beings. The physical activity, a dance, is recognized as a dance by the people doing and watching it. A dance is a sequence of bodily movements, usually composed and rehearsed. It is performed (danced) by people who assume the role of dancers, usually wearing special costumes. These people often dance in selected spaces, such as on a theatre stage, in a ballroom, or in a ceremonial setting, usually accompanied by music or other sound. The dancing activity usually occurs within a limited time frame, the dance event. Dances are danced by people for several often overlapping reasons, pleasure, aesthetic expression (as art), religious worship, courtship, and play". (Alter, 1991, p.7-8)*

Using this definition, dance as a physical activity, can be related to and initiated by different

social as well as personal intentions.

In this thesis I will refer to dance mainly as an activity of aesthetic expression and performing art, but also as an activity that are pleasurable per se. Another word for this perspective is pure dance. Laban argues that what he calls "pure dancing" has no describable story as we in pure dance follow the inner drive to move which creates its own pattern of style and strives after values that are intangible and indescribable (Laban, 1950/1980). Similarly, Fraleigh claims that dance becomes art when it is intended for someone else (Fraleigh, 1987). Social dance cannot be described as pure dance then, as it follows "rules" dependent of the social context in which it takes place. On the other hand, even dance as art is bound to specific aesthetic expressions. What characterises dance though, is that it is human movement that is the aesthetic matter and the material condition for expression. A fundamental aesthetic distinction central to dance is for example the difference between a dancer moving through a form and a form moving through a dancer (Sheets-Johnstone, 2005). Consequently, through the movement, it is the dance that is expressed, and not necessarily the dancer's personal life or inner feelings. However, as Cohen expresses it:

> *"While movement expressiveness is not an equally unique virtue of dance, it is nevertheless one of its natural properties because its instrument is a person who not only moves but feels." (Cohen, 1972, p.12)*

Dance is a visual art in the meaning that we experience dance through our eyes when watching dance. But, as the senses or perceptive systems are so intertwined, the visual experience will have a bodily connection. Consequently, we experience dance with our whole embodied bodies, when we watch it as well as when we perform it. The phenomenologist Merleau-Ponty has expressed it as follows:

> *"I the seer am also visible. What makes the weight, the thickness, the flesh of each color, of each sound, of each tactile texture, of the present, and of the world is the fact that [she] who grasps them feels [her]self emerge from them by a sort of coiling up or redoubling, fundamentally homogeneous with them, [she] feels that [she] is the sensible itself coming to itself and that in return the sensible is in [her] eyes as it were [her] double or an extension of [her] own flesh." (Merleau-Ponty, 1968)*

Dance and human movement is thus perceived through the body of the viewer and on an experiential and kinaesthetic level, which even might precede words. When watching pure dance, we experience the meaning of the movements through the play of rhythms and shapes, which can tell their own story. A phenomenological definition of dance as art has been proposed as "human movement created and expressed for an aesthetic purpose" (Fraleigh, 1987). Hence, in dance we train the ability to affect and emotionally move other people by means of bodily movement. This ability could be acquired through consciously developing an experiential body of knowledge. How this could be done, I will return to in section 2.4, but first I will introduce some of Rudolf Laban's movement theories. In this thesis, Laban's work will serve as a theoretical grounding for the approach taken to human movement and its implications. From his theories I will therefore make use of parts and notions that I find relevant for the aim of this thesis, namely to increase the understanding

for human movement as interaction modality between people and computational devices and systems.

2.3 Laban's Dance-Based Theory of Human Movement

"My methods might be developed or better forms might be found; the outlook on life, however, which is connected with the striving after the mastery of movement remains fundamental as long as the human race exists."
- Rudolf Laban[3]

Rudolf Laban (1879-1958) was a Hungarian dancer, choreographer and movement theorist that through his work has contributed immensely to the theoretical understanding of human movement. His understanding of human movement was inductively derived from in-depth dance experiences within several cultures, and it provides a full analysis of dance from an internal viewpoint, making use of dance-derived terms. Laban's physical grounding is also what separates him from other dance theorists. He saw movement as a dynamic process and considered all movement components such as time, space, force and flow, to be mutually dependent. Laban had also a great concern for the experience of movement and its perception as a mind-body unity.

Laban was one of the first persons that wrote about contemporary dance from a dancer's point of view and thus contributed to build a growing dance terminology. He wanted "on one hand, to restore the validity of the dance experience itself, and on the other, to develop a descriptive vocabulary for the phenomenon of movement for the purpose of mastering its techne" (Maletic, 1987, p.51). Techne is here referred to as the activity and skill of producing and creating dance. In the book *Die Welt des Tänzers*, Laban expressed the need for and difficulty of developing a dance terminology:

> *"When I undertook as the first one among dancers of today to speak of a world for which language lacks words, I was fully aware of the difficulty of this undertaking. Only a firm conviction, that one has to conquer for dance the field of written and spoken expression, to open it up … to widest circles, brought me to tackle this difficult task." (Laban, 1920, cited in Maletic, 1987, p.51)*

Laban emphasised the importance of putting words onto the physical experiences of dance from a mover's as well as from a viewer's point of view. His theoretical framework of movement and dance can be separated into four major parts (Maletic, 1987):

- Laban Movement Analysis (LMA), which is a general, objective movement classification and description. LMA is also the basis for Laban's movement notation

[3] Laban in Ullman, 1984, p.6, cited in Maletic, 1987, p.182.

system called Kinetography Laban or Laban Notation[4].

- Space Harmony, also referred to as Choreutics, is a theory that investigates spatial structure and relationships of movement and dance. According to Laban, spatial direction is the most significant element of bodily movement.
- Dynamic qualities of movement and dance. Laban's theories for dynamic structure and rhythm of movement and dance are called Eukinetics and Effort. Eukinetics deals with the theory of expressive quality of dance, while Effort deals with the theory of expressive qualities in human exertion, which is visible in the rhythm of bodily movement.
- Harmony of Movement is a concept that reflects the idea of a relationship between the movement's energy or Effort, and its spatial unfolding, e.g. that a light movement has a tendency upward and a strong movement aims downward. This theory was also the starting point for the Effort-Shape concept further developed by Laban's student Warren Lamb.

In this thesis I will not refer to or make use of any specific framework or movement theory, but rather use Laban's work as a basis for and reference to the importance of physical experiences of theoretical movement concepts.However, Laban's theories are to a great extent present in the following discussion of movement quality and movement concepts, as his movement theories and notions are well integrated into and established within modern dance praxis.

2.3.1 Time, Space, Weight and Flow

Movement can from a physical point of view be defined as an object's change of position within a specific time and space reference system. Consequently, time and space are two important characteristics of human movement. When we talk about the building blocks of dance, we often add a third element. This is most often called force or energy and relates to the amount of strength one applies when doing a movement. These three components, time, space and force, are commonly used terminology within modern dance. Laban considered time, space and force as general known properties of movement. In his development of the Effort theory, he added a fourth concept, the notion of flow, also called fluency or flux, which he derived from his own observations. He also replaced the notion of force with weight.

Laban described the four elements time, space, weight and flow, by naming their extreme polarities or two opposite dimensions. For time these dimensions were called fast and slow or sustained and quick; for space near and far or indirect or direct; for weight weak and strong, or light and strong; and for flow bound and released or bound

[4] There are several books written on Laban notation. For a short introduction to the subject one can visit http://www.dancenotation.org/.

and free (Maletic, 1987; Foster, 1986). The differences in how the polarities as well as elements are named are due to language and historical conditions. Laban's early writings are only available in German and his theories were developed over a long period of time. His writings have also been interpreted by a number of people and consequently there exist differences in the terminology. For the interested reader Maletic (1987) provides a great overview and extensive description of Laban's different theories, their contents and emergence. She also takes into account Laban's early German texts, and thus offers an historical perspective on his work as well as an insight to the social circumstances under which he worked.

In Laban's Effort theory he thoroughly describes how time, space, weight and flow are different aspects of every movement. Movement quality is another notion used for describing the physical result of how these four elements are combined and this notion will be exstensivly used throughout the thesis. The same movement, e.g. reaching for your cup of coffee, could be done in several different ways, i.e. with different movement qualities. For describing a movement one can therefore consider each movement element at a time, and study how the movement changes if the time, space, weight or flow of the movement is changed. How would my reach for the coffee cup be if I did it faster, more direct or with less strength? Would it feel differently for me? Would the movement be perceived differently by the viewers?

2.3.2 Individual Differences and Similarities in Movement

Personal physical differences play a great role in how we move. Laban separated movers into three groups according to their movement characteristics, i.e. deep, medium and high movers/dancer, which could be seen as analogous to the different voices in a choir, e.g. soprano and bass (Maletic, 1987). The physical and individual differences are first of all seen in the dynamic characteristics of the mover. They also influence what kinds of movement we prefer to do and which movement qualities we apply to our movements. A tall person will most probably have difficulties to follow a shorter person's tempo of e.g. skipping and jumping. Consequently, children and grown-ups will usually prefer different tempi when performing the same movement phrase.

Our physical size and thus range of movement, also influences the space in which we move as well as the space we create through our movement. Laban used the notion of Kinesphere or Personal Sphere to describe the reachable space immediately surrounding one's body. He distinguished this space from the general or infinite space. Laban also thought of spatial direction as the most significant element of bodily movement. In the book *Modern Educational Dance* (Laban, 1988) he describes his theories of spatial aspects and geometrical perspectives of human movement. I will not go further into this here, but rather focus on the qualitative aspects of movement.

According to Laban, human beings have intrinsic reasons for moving. The inner stimulus of movements, which Laban calls inner impulses, is displayed as movement through the body. People might move in order to satisfy a functional need, to reach for

or displace a specific object, driven by a physical feeling or sensation. The aims could be tangible as well as intangible. Human movement could have the characteristics of intentional actions, physical reflexes, schooled patterns, unconscious tics, or wanting to do pleasurable activities. Moving people also differ from moving objects, as objects need something from outside or built-in, that initiates their motion. Through integrating movement and the individual's internal need to move, Laban also avoids the unnecessary and misleading dichotomy of body and mind. In his theories he integrates the functions of the body, the senses, everyday movement, and dance movement. Human movement is thus a result of an impulse or intention within people. In dance this intention is aesthetics, and aesthetics for its own sake, and it even goes beyond an interest of meaning (Cohen, 1972).

Further, Laban claims that movement reveals a state of mind and is influenced by the environment of the mover. Taking this perspective he emphasises the intertwined relation between psychological and physiological motivations for moving. The inner participation can be minimal or rich, and the range of displayed movement patterns characterises individual personalities. The body enables people to communicate and express beliefs with distinct bodily action ranging from complete stillness to frantic motion. The kinaesthetic sense is thus crucial to the possible awareness of our bodies and movements. Additionally, Laban argues that all the other senses are variations of the external part of kinaesthesia. He also asserts that movement must be felt directly by the participant and empathetically in the muscles of the observer (Alter, 1991). Through moving, Laban claims, "we create changing relationships with something. This something could be an object, a person or even a part of our body, and physical contact can be established with any of these" (Laban, 1950/1980, p.66).

Even if Laban was a dancer and choreographer and based his theories of human movement on dance experiences, he argued that his framework was applicable to all sorts of human movement. "Whether the purpose of movement is work or art does not matter for the elements [e.g. time, space, weight and flow] are invariably the same" (Laban, 1950/1980, p.93). On the other hand, the intention or impulse for a movement might differ between work and art. Laban claims that in work, it is the mind, which includes both thought and emotion, that directs the movement. In play and dance, it is the movement that stimulates the activity of the mind (Laban, 1950/1980). Due to the limited physical and mechanical movement possibilities of the human body there is a limited number of possible movements. However, the size of this number is not interesting when talking about dance and quality of movement. How we perform our movements, their inner intentions and intangible aims, rather than the mere mechanical movement, defines the expression for others to experience, as well as for the mover to perceive her own movement. It is the quality of movement that makes the visible as well as sensible difference.

2.3.3 Laban and Interaction Design

Recently, Laban's theories of human movement have been used more frequently as means and reference for movement based interaction design (Camurri, 1999; Zhao, 2001; Sundström, 2005). This might imply a growing understanding for taking into account physical experiences and acknowledge other knowledge areas than traditionally done within human computer interaction. As previously discussed, Laban emphasised the importance of physically experiencing movement elements and concepts in order to gain an understanding for them. Hence, there is a risk in making use of his theories "quick and dirty" without a physical reference to their implications. In order to avoid making new disembodied mistakes, we therefore need to increase our knowledge of what the theories provide and in which aspects they can be useful to interaction design.

Laban notation has been demonstrated as a very useful tool for describing and categorising movement when used to inform moveemnt-based interaction (Loke et al., 2005). But it is also described as a quite complex system and requires well-trained skills in order to be able to read as well as to write it. Unfortunately, compared to how many people that can read music scores, there are very few dancers or people in general, that have training in Laban notation or other dance and movement notation systems, e.g. Benesh Movement Notation[5]. When notating human movement, the quality of movement is also left out. When designing for movement interaction, without paying attention to qualities of movement might be almost as hazardous as not paying attention to physically based human movement theories at all. How a movement feels might differ a lot from individual to individual. To claim that performing one specific movement is experienced similarly by all, would be the same as saying that everybody has blue as their favourite colour.

To summarise, Laban's theories of human movement provide us with useful notions and movement concept that can be used to describe design criteria such as movement quality and elements of movement. As earlier mentioned, in the present thesis, Laban's theories along with experiences of dance and dance education, will serve as a theoretical basis for the empirical work. In the next section I discuss how the theories can be physically explored.

[5] For more information on the subject, please visit http://www.benesh.org/.

2.4 An Experiential Body of Movement Knowledge

"Direct experience builds a fund of tacit knowledge which becomes embedded in the body's response system. ... Besides kinaesthetic responses, there are sensations, psychological awareness and agendas, mental images, and kinetic phenomena. The resultant accumulation is integrated into each person's response system to form a unique experiential body of knowledge."
- Blom and Chaplin, 1988

When referring to Laban's theories of human movement, I emphasised the importance of having a physical, bodily knowledge of human movement and the ability to verbalise this. Now it is time to address how this knowledge could be obtained.

Dance improvisation is a discipline closely related to modern dance. It is a performing artform in itself and contains different branches, e.g. contact improvisation. Improvisation is also a very useful tool for exploring movement, especially in searching for movement experiences and expressions, but also as a part of the creation process when we aim at composing dance expressions. Improvisation provides us with means to integrate the analysed, theoretical material into the soma-psyche, as well as it helps us in defining and exploring the choreographic elements to focus on in the dance. Blom and Chaplin have described dance improvisation as "a way of tapping the stream of the subconscious without intellectual censorship, allowing spontaneous and simultaneous exploring, creating and performing. Improvisation emerges as an inner-directed movement response to an image, an idea, or a sensory stimulus" (Blom and Chaplin, 1988, p.6).

What we do when we explore and investigate expression through movement is to try to reduce the movement to the essential feeling of that specific expression, i.e. abstracting the movement. Through the abstraction process we make it possible to understand and connect with a specific feeling because we reduce it to its essentials, "to its movement, to the primitive state that is real in all of us" (Blom and Chaplin, 1988, p.6). We do not abstract the movement from its emotional connection, but from a specific trigger, as emotional triggers are individual and vary among people. When improvising in order to explore movement and search for the essence of a specific expression, it is not always interesting to exactly remember or be able to reconstruct the movement. It is more important to preserve "the context, strategy, relationship, intention, or a real or imagined environment that comes to mind" (Blom and Chaplin, 1988, p.13).

Dance improvisation is a true in-the-making activity. It requires a constant listening and awareness for what goes on in the body, and "as we move, one awareness leads to another. Memories arise and fresh associations trigger new material" (Blom and Chaplin, 1988, p.12). But it does not only require a physical presence. We also need to be able to make use of what happens in a constructive way, which really challenges the ability to passively observe your own movements while moving, but without censuring yourself.

The creative process carried out when improvising is not something unique for dance improvisation. Similar processes occur in many different kinds of activities like research, problem solving, etc. But as Blom and Chaplin argue "what may take place over a number of years for a scientist or choreographer may happens in minutes in improv ... you are "Aaaahhhaaaing!" or "Oh yesssing!" while you are moving" (Blom and Chaplin, 1988, p.8-9). In order to experience this sensation, you do not need to be a trained dancer or very skilled in improvisation. However, it requires a kinaesthetic awareness and an ability to be one with the material from which you create, namely your own body and its movement. This ability and awareness is possible to train through physically experiencing dance improvisation, and thus gain an increased understanding of the aesthetic potential of dance and human movement.

Below I will present five concepts that are central to dance (Blom and Chaplin 1982/89; 1988). Since the activity of dance and dance improvisation is strongly depending on our senses, knowledge related to these activities could only be obtained through physical experiences. After having physically experienced a concept, people will also be able to recognise its verbalised description. Since the bodily knowledge is obtained on an intuitive level, verbalisation of the own or other's experiences through discussions or readings "reinforces your knowledge and extends it from the intuitive to the conscious level" (Blom and Chaplin, 1988, p.16). The movement concepts presented below are therefore important to explore physically in order to gain an intuitive understanding of them. They therefore contribute to developing an experiential body of knowledge of human movement and the creation of movement expressions.

Kinaesthetic awareness: Developing a kinaesthetic awareness implies training to feel differences in movements, to increase the sensibility for the knowledge that is already there within the body, i.e. the body's knowledge of its own movement. This could also be described as bodily knowledge or to trust the bodily memory. Kinaesthetic awareness is also related to the potential to move and the movement ability, to be able to feel your own limitations and possibilities.

Phrasing: All movement contains rhythms and phrases that provide the magic ingredient in any of the performing arts. However, the rhythm is not solely bound to music. It can exist within the movement itself, or reflect an inner pulse of the dancer. Movement phrases will also vary in length and shape, according to their context. Phrasing could be described as a way of grouping movements.

Forming: Human beings are forming creatures. We form in order to create meaning. The potential of the form lies therefore in its ability to organise pure movements so they make sense to the mover and viewers. It is due to the form that one can distinguish dance from a mere collection of steps. The form in dance has its analogy with form in music. One can make use of repetitions or distinctive beginnings and ends. Briefly one can express it as "form crystallizes content" (Blom and Chaplin, 1988, p.20).

Relating: We need to develop a sense of self, a moving self, before we can relate to others' movement. We need to learn to know our own movement patterns and preferences

of movement quality. Through movement we can then express and feel kinaesthetic empathy, how something is experienced through movement. When we work in groups we are given new movement possibilities, as we may do things that are impossible to do alone. Through experiencing other people's movement, we also may gain an increased understanding for that person as well as ourselves.

Abstracting: As earlier discussed, abstracting means to deal more and more with the essence of an experience. When abstracting a movement we might eliminate its literate meaning and rather explore and manipulate the movement per se in order to find out what it is about. At higher levels of abstraction we have stopped dealing with the cognitive meaning of the movement. Purely abstract movements differ from the most abstracted ones, as they refer to nothing and are self-sufficient.

How we move and perceive movement is strongly related to cultural and social factors. The same movement looks differently when performed by people that might be schooled into a certain movement pattern, prefer different movement qualities, or have differently sized and shaped bodies, as well as different personalities. Consequently, there are styles, techniques, genres and traditions within dance as in any other artform, performing as well as non-performing, which reflect different aesthetic values. In modern dance, the personal movement style is often the starting point for developing a technique, which often becomes named after the choreographer. It is the choreographer that creates or designs the movements and movement patters, which include the aesthetics of movement. Hence, one can say that people's individual movement preferences have been more important than historical style within modern dance (Blom and Chaplin, 1982/1989).

2.5 Designing for Aesthetic Interaction

Experiencing interactive digital artefacts has more in common with experiencing performing arts than experiencing art objects, due to its temporal conditions (Löwgren and Stolterman, 2004). In order to describe this interaction that happens over time, it might be insufficient to use philosophies of art that only consider traditional art objects. When we interact with digital artefacts, as in dance improvisation, it is in the interaction or that specific moment that the experience occurs. The relation between the object and the person changes over time and while the interaction happens. We observe and reflect, give input and receive output. In this sense we are reconsidering our relationship towards the artefact throughout and as part of the interaction.

The pragmatist John Dewey has described the difference between an everyday continuous experiences and an aesthetic experience (Dewey, 1958). He characterises an aesthetic experience as something that stands out because of its qualities. It integrates emotional, sensational and cognitive aspects of an everyday continuous experience into an immediate phenomenological whole. Aesthetic quality is perceived as a feeling or an appreciation that exceeds the threshold for wanting to do something for the sake of its

own. Consequently, the aesthetic experience appears as part of an activity and occurs during the interaction and in the use. As in dance improvisation, this experience does not need to be ephemeral in the sense that it cannot last or be returned to. However, it might not be possible to recreate an identical experience, which might be impossible with any experience. The sense and meaning of the aesthetic experience is therefore created while interacting with the artefact. One can say that aesthetic experiences trigger imagination and encourage a continuous exploration and improvisation (Petersen et al., 2004).

Making use of Dewey's pragmatist aesthetics Petersen et al. have pointed out three central aspects of aesthetics (Petersen et al., 2004). First, the socio-cultural approach to aesthetics implies that aesthetics is not something a priori in the world, but a potential that is released in dialogue as we experience the world. Second, designing for mind and body means that aesthetic experience is closely linked both to the analytic mind and the bodily experience. Third, the instrumentality of aesthetics suggests that aesthetics has the ability to surprise and provoke and to move the subject to a new insight of the world. One can also argue that without an imaginative or associative activity, an experience is not aesthetic but of mere pleasure (Fenner, 2003).

Similarly, Fels argues that we have aesthetic experiences when we manipulate objects skilfully, which requires an intimate relationship with the object and "aesthetics flow from this intimacy" (Fels, 2000). This view is closely related to Laban's thoughts of relationships as being created between people and objects when we move (Laban, 1950/1980), as described in section 2.3. Consequently, we might potentially have an aesthetic experience of our body and its movement when moving. When we move, we develop an intimate relationship to our own body and also increase our movement skills.

Taking the pragmatist's approach implies that an object is not aesthetic per se. However, it might have aesthetic potentials, which could be more or less intentionally designed into the artefact. The ability to design for an aesthetic experience is thus related to the ability to identify and reflect on the aesthetic potentials of the design material. According to Shusterman who has introduced somaesthetics as a body-centred philosophy of art, the aesthetic potential of the body is at least twofold: "the body, of another or even one's own, can provide beautiful sensory perceptions" but one can also have "the beautiful experience of one's own body from within" (Shusterman, 1992). These aspects reflect the sensuous body and kinaesthetic awareness. As we will see, by using dance, as Shusterman calls a somaesthetic art par excellence, for understanding human movement we might be able to design for such aesthetic and kinaesthetic interaction experiences.

Chapter 3
The Research Process and Methods

This thesis aims at exploring human movement and identifying aspects that might be particularly relevant to movement-based interaction design. The empirical work carried out includes an explorative study of human movement as well as concept design and prototype development. In this chapter, I present the research process, the empirical work, methods used, and the different roles of the data that have been collected.

3.1 Methodological Approach

"Respect creativity's whimsical nature.
Make friends with serendipity.
Have faith in yourself and in the creative process."
- Blom and Chaplin, 1988

Within interaction design we often deal with processes that are serendipitous, iterative and that require lots of tacit as well as hands-on knowledge. Working serendipitously means to make use of coincidences and chance, but without leaving everything to be decided accidentally. Decisions are taken throughout the whole process. However, in order to be able to make constructive use of coincidences, one must hold a certain sagacity or wisdom and knowledge within the field of application. Michael Polanyi who introduced the notion of tacit knowledge claimed for example that a researcher might have "a tacit foreknowledge of yet undiscovered things" (Polanyi, 1966/83).

The work processes involved with interaction design have been described as more similar to those found within art than within science (Crampton Smith and Tabor, 1996; Löwgren and Stolterman, 2004). When the interest of human computer interaction broadens from mere functionality and usability, to even include the users' experiences and the aesthetic matters of computational artefacts, we are also in need of new and

complementary competencies (Winograd, 1986). People involved with interaction design should for example posess a sensitive empathic understanding of the interaction design, as well as creative skills in order to be able to implement this aspect (Klooster, 2004).

Even though there are creative similarities within artistic, engineering and scientific processes, the results are most often of different kinds (Stolterman, 1991). Artists and designers may also have another starting point and motivation for as well as attitude towards their work than academic researchers and engineers. The starting point for an artist can be a variety of ideas or a given case. Through exploration, guided by a vision or intention, hopefully he or she will arrive at a satisfying result. This might be a contrast to the problem-solving approach often used within engineering, where one wants to find the optimal solution to a given problem. However, dealing with art, design and people's experiences, an optimal solution might not exist. More probably there exists several solutions that are "optimal" in different aspects for different people at different times. If we take an artistic and design-oriented perspective on interaction design and how we experience artefacts, it might be the diversity and dysfunctional aspects, rather than convergence and unity, that are the most interesting aspects to design for and explore (Hummels, 2000; Sandelin and Torstensson, 2003; Ilstedt Hjelm, 2004; Papadopoulos et al., 2004). However, this does not mean that artists and designers do not have an intention or aim with their work. Neither is there any value attached to the different perspectives, claiming that one should be better than the other.

Along with the new approaches and competencies that are introduced to the area of HCI, we also introduce alternative means of doing research and gaining knowledge. Through practice-based work as design and prototype development, we generate knowledge and experiences that are difficult to obtain by other means. Despite the possible lack of formal descriptions and theories, those methods are forcefully contributing along with traditional methods, to the research within human computer interaction design.

The research presented in this thesis gives an example of an explorative approach that combines artistic, bodily knowledge and work processes as well as design and prototype development. The methods used are also borrowed from several disciplines, e.g. empirical investigations in behavioural science and empirical investigations in design. In addition, the research has been carried out with an ethnographic approach in the meaning of engaging in a field and concurrently carrying out data collection and analysis as a dialectic process (Agar, 1996). I have also aimed at taking into account the four principles of ethnography: Natural settings, Holistic, Descriptive, and Members' point of view (Blomberg et al., 2003). A natural setting means the setting in which the activity of interest normally occurs, and taking a holistic perspective means to consider the activity in relation to a larger context than in which it occurs. In order to create innovative ideas for something one needs to have an understanding for what that something really is, and in ethnography one is interested in descriptive rather than prescriptive understandings of how things are in people's everyday lives. This is also why an ethnographer is interested in the members' point of view and how they are talking about these things. In the following

sections I will come back to how these principles were followed throughout the research process as well as which methods were used.

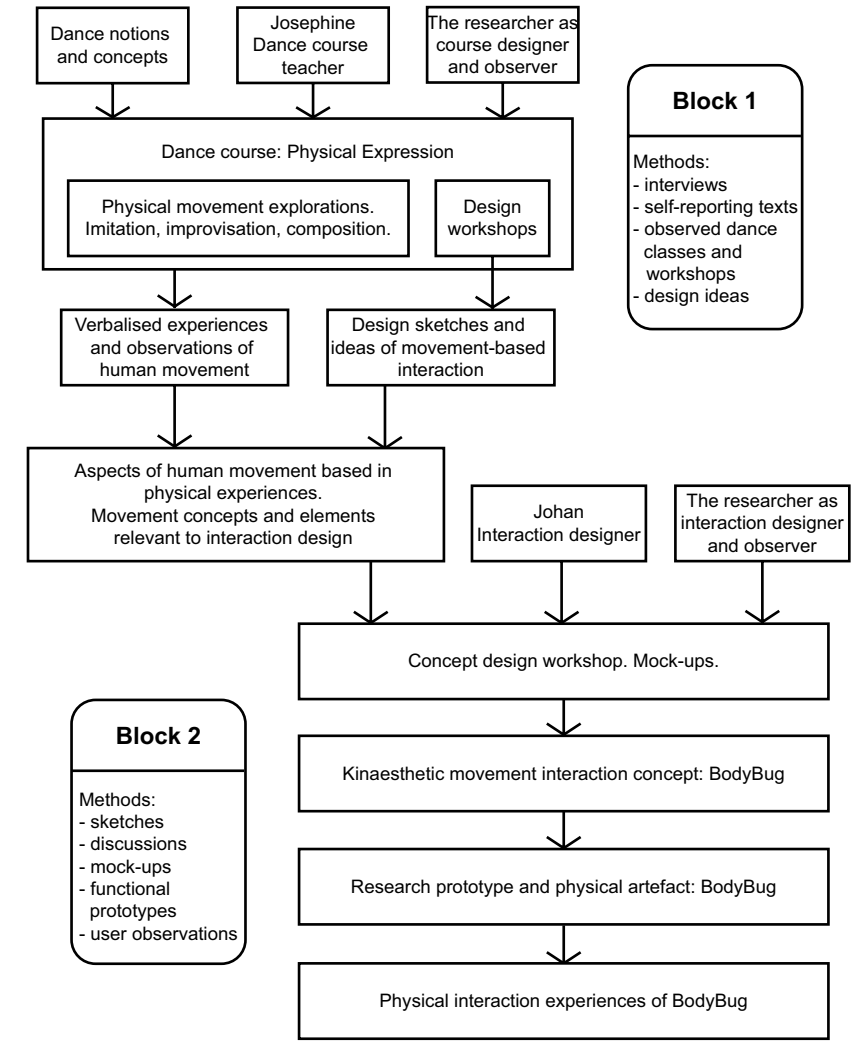
Since I as a researcher have taken part in all parts of the work, I have been the important link when combining methods from several disciplines and traditions. I have followed and participated in the whole design process, which will be further presented in the next section, although playing different roles along the way. This approach was deliberately taken in order to preserve the results from the field studies during the design and prototype development. Hence, this work emphasises the importance of including multiple competencies as well as participation of involved parts, e.g. researchers and developers, throughout the whole design process, from field studies to design and prototype implementation and evaluation. Similar approaches have been described as "agile design" (Sundblad, 2004) inspired by the agile software development method called Extreme Programming (XP[1]) where close cooperations such as "pair programming" and the customer's participation during the whole project, are some of the requirements or methodological rules.

3.2 The Research Process

The research process carried out within this project and which is graphically presented in Figure 3.1, can be separated into two main blocks. The first block includes an explorative study of human movement based in modern dance, which will be referred to as the dance study. The second block includes a design, development and implementation process as well as user experiences of a movement-based interaction concept and research prototype, which will be referred to as the design and development process of BodyBug. The bridge between these two blocks is the use of results from the dance study to inform the design of BodyBug. What I will refer to as the holistic design process includes therefore the work of planning and conducting the dance study, transforming its results to useable notions for informing design of a movement-based interaction concept, as well as designing, developing, implementing and experiencing the interaction concept and research prototype called BodyBug. Consequently, the results presented in this thesis reflect and have emerged from different phases of the holistic design process. I have chosen to name the process holistic in an ethnographical sense as this work aims at applying a broader perspective on human movement than what can be easily registered and understood by a computer. The dance study was carried out in order to search for aspects of movement that were based in subjective physical experiences of human movement and that could inform the design of movement-based interaction. In gaining an increased knowledge of how people experience movement I search for a holistic perspective on movement as interaction modality.

[1] For more information on XP please consult http://www.extremeprogramming.org/

Figure 3.1
Chronological overview of the different steps of the research process and their contributors.



Results:
- Aspects and theoretical notions of human movement relevant to movement-based interaction design.
- A kinaesthetic movement interaction concept.
- A physical wearable artefact.

As already mentioned, throughout the holistic design process I as a researcher have had various roles. In the first block of the research process I contributed to the dance course Physical Expression by writing the course description and deciding on the course curricula. In this work I was making use of my background as dance teacher and was therefore able to design a course that I though would contribute to the development of an experiential bodily knowledge of human movement. I also carefully chose the dance teacher Josephine Björklund to be responsible for teaching the course. She was a person I knew well and had previously collaborated with. I therefore knew that she had the ability to convey the course content according to my ideas. She got free hands to carry out the dance classes and chose exercises, as she preferred. Consequently, my role in the dance studio during the course, was only as a videotaping, observing researcher, and I did not interfere with the teaching or pedagogical approach. However, in addition to be present during the dance classes, I carried out the data collection as well as administrated the course. I therefore had a quite familiar and friendly relationship with the course participants. The data I collected consisted of interviews and self-reporting texts in addition to observed and videotaped dance classes. The data collection will be further discussed in section 3.5. During two design workshops that were part of the dance course I also had the role as workshop facilitator in collaboration with two colleagues of mine, Sinna Lindquist and Helena Tobiasson. The dance teacher was not involved in these workshops.

In the second block of the research process I introduced an additional person to the process, interaction designer Johan Sandsjö. We had met only a couple of weeks earlier at the Convivio Summer School[2] in Split and found our common interest in movement-based interaction. Johan's previous experience of designing for movement (Rydberg and Sandsjö, 2002), my previous experience of developing haptic interaction environments (Kjölberg, 2002; Kjölberg and Sallnäs, 2002) and the notions and concepts from the dance study, formed the basis and starting point for our collaborative work. During the design and development process of BodyBug I therefore had the role as designer as well as a participating researcher. How we worked and made use of intermediate results such as sketches and mock-ups to move the design process forward are described in section 3.7. A chronological overview of the research process, including the holistic design process, is presented in Figure 3.1. In the next sections I will present in more detail the methodological backgrounds and approaches used.

3.3 Studying Human Movement

Movements and body language are often considered to be natural, genuine and true, and body language has therefore been considered important to understand and interpret. However, this is a quite romantic picture of what is nature or natural. Within anthropology

[2] http://www.convivionet.net/

there has recently been a paradigmatic shift in studies of human movement. The shift has been "from an empiricist and observationist view of movement to consider human movements as dynamically embodied actions from an agent-centred perspective" (Farnell, 1999). This view reflects an increased general interest towards a holistic perspective on human beings. It also reflects a socio-cultural perspective of situated and context dependent actions, a perspective that also has been emphasised in relation to human computer interaction (Suchmann, 1987).

The absence of the physical body on a tangible level is equally relevant to HCI and related fields, as to anthropology. It is perhaps due to movement being an obvious, self-evident, ubiquitous, and immediate part of our everyday (inter)actions that it has not been taken into account. Or it might be that it is so complex to understand and describe that we choose not to deal with it at all. A third and maybe more relevant issue is that we lack tools, knowledge and vocabulary to discuss movement and experiences of movement. Or in other words, we lack modes of registration or specification that is adequate to the task.

The difficulty of trying to capture a movement sensation or describe human movement in text is well known. We say that a picture might tell more than a thousand words, but a physical experience of a phenomenon might be indescribable. The ironic crux when it comes to human movement is also that it might not be possible to understand a movement from observations alone. As the movement intention might come from within the person as discussed in Chapter 2, the reason or motivation for movement is not always visible. Human movement therefore needs to be physically experienced in order to understand it and to be able to describe what it is about. We need to become literate in the language we use for communication. This is an important point especially relevant to interaction design when we want to deal with the use of artefacts and systems and user centred design. The notion of user centred design addressed in this work, does not necessarily mean participatory design as it is used within the Scandinavian tradition (Bødker et al., 2000).

Even though human movement and the physical experience of this, is central to this thesis, verbal expression is the only means that we as human beings have to discuss and negotiate meanings of experiences. Talking about one's experiences is also a way to transfer the concrete physical sensations and feelings into abstract reasoning. Being able to formulate one's experiences might contribute to a clearer and more distinct impression of what that specific experience was about. As the description abstracts the physical feeling, it contributes to finding the essence of the experience. However, verbalisations can also contribute to dissociating oneself from the experience as well as they can be constructions. Methodologically one can therefore not know for sure if verbalisations are a direct reflection of an experience (Ericsson and Simon, 1993). Dialogues and talking is also a way of sharing experiences. And by sharing experiences they might get richer, be more elaborated and specified as well as be related to new dimensions. When we feel and experience movement through the body, without talking about it, the experience stays within the body, unable to be shared, although expressed. This delimits the possibility to

develop one's experience and utilise it in other situations and contexts.

To emphasise the verbalisation of human movement experiences is by no means contradictive with the necessity of physical explorations of movement and other bodily phenomena. It is neither a way to avoid or explain away the notion of bodily knowledge. It is rather a possibility to emphasise these issues, as the physical experience is the absolute necessary requirement in order to be able to generate the verbalisation of that experience. Experiencing something yourself is always different from experiencing through other's experiences, whether you are watching or listening to it. On the other hand, to watch or listen is also an experience, which will influence your own physical experience of the phenomenon.

Different aspects of movement and dance are used extensively in various kinds of body therapies or body-mind-soul techniques that aim at connecting thoughts, emotions and the physical body, e.g. Alexander technique, Feldenkreis, Pilates, dance therapy and gestalt therapy. However, it is important to point out that the intention of the dance course Physical Expression was by no means to make use of therapeutical approaches in the sense that we wanted to analyse why they moved as they did, or to change a certain behaviour. The analytical part was focused towards the movement per se and what it expressed as movement, and not as a private expression or visualisation of the personality. However, working with your body on a conscious level as in dance, will more or less always contribute to some kind of self-development. You might discover new and maybe unknown perspectives of yourself. This kind of self-development can also be obtained from other kinds of activities, and are by no means specific or exclusive for dance.

In this work, I have used my personal experiences of dance as references to the informants' descriptions of their experiences. I have related what they say to my own memories and ideas of how it is to explore the same movement concepts. This might be a very biased starting point. On the other hand, I have chosen to consider this as a very useful asset, especially in relation to the possibility to make use of the experiences to inform interaction design. As a researcher you are always influencing your field. This could be done in more or less conscious and intended ways, but should always be treated reflexively and with and awareness for the own influence on the field. In the dance course I deliberatively exposed the informants to a specific method for exploring movement as well as exercises that aimed at initiating reflective processes.

3.4 The Dance Course Physical Expression

The aim of the course Physical Expression was to explore "what dance is made of," i.e. human movement. A formal description of the course is presented in Table 3.1. As already mentioned, the course was especially formed for the purposes of this research project. The name of the course (Fysisk gestaltning in Swedish) was carefully chosen to not include the word dance as I was afraid that it could discourage certain prospective participants as well

TABLE 3.1 Physical Expression Course Description

The aims of the course are
• to introduce movement as a form of knowledge.
• to create understanding for, experience of and knowledge about the body and movements as means for expression and communication.
• to develop the personal movement language.
• to provide possibilities to express ideas using bodily movements, individually and in groups.
• to provide a basis for explorative work processes and to develop ideas related to movement-based interaction in digital media.
…in order to give the participants
• an increased understanding of different means of expression, especially bodily expressions and movement.
• a possibility to perceive themselves as physical human beings.
• an experience of the subjective dimension of one's work.
• tools for expressive and process-based work.
The course contains
• physical movement training focusing on personal creative work, composition and expression.
• analysis of your own as well as others' physical formations and expressions.
• written and practical reflective exercises.
• workshops on movement-based interaction in digital media.

as it did not reflect the main focus of the course.

As I wanted to work with people mainly inexperienced with dance as well as people having basic knowledge of interaction design, the course was offered to engineering, Master's and doctoral students specialising within HCI as well as researchers and HCI professionals at the university. The dance study could be considered as a large experimental laboratory study. However, this was not the intention. I wanted to study people's exploration of human movement in a natural setting in an ethnographic sense. As the course content was not especially tailor-made for this specific group of participants, but rather for what I found was important approaches to dance, the course was authentic concerning the content and the experience of it. Similar courses, in terms of content, are carried out elsewhere, e.g. in high schools having a dance program, and I could have chosen one of them as the field of study. However, in order to be assured that the course content was in line with my intentions and the timing of the study, I chose to arrange the course myself. This also gave me the opportunity to address people experienced within interaction design. Another possible field would have been evening classes at dance schools. However, these classes often focus on other perspectives of dance such as learning dance routines and perform them, rather than actually exploring movement as an aim per se.

One can of course argue that this specific group of participants never would have attended the course under normal circumstances. That I deliberately chose to address this group of people might be considered as an unatural setting. However, whether the course was, or was not, a natural setting, is not an important distinction in this work, as I do not draw any conclusions that depend on this distinction.

The course Physical Expression consisted of thirteen evening classes once a week during the spring of 2004. Each class had a duration of two hours. There were requirements on the participants to attend at least 80% of the classes in order to be accepted to and pass the course. They were also expected to hand in and carry out written and physical assignments given throughout the course. Participation did not require any previous knowledge of movement or physical training, but in order to have participants that were slightly familiar with HCI and interaction design, they had to have completed the first three years of their studies or equivalent. At the start of the course it was not clear if the student participants could obtain university credits for the course, which meant that they enrolled out of strong interest. However, during the course it was arranged that participants who needed academic credits got credits that corresponded to five weeks of full time studies.

The participants were informed at the time they signed up for the course, that the course was part of a research project, and that participants who accepted to take part in the study were given priority if the course became fully booked. Taking part of the research study implied acceptance of being interviewed two or three times, as well as acceptance of the researcher's videotaping and observation of the dance classes. Naturally, the participants were assured anonymity and restricted use of the research material according to common research ethics.

The pedagogy used for the dance classes was based in the tradition of modern dance, which emphasises a personal and individual movement expression. The approach taken was based on assumptions that learning results from experience, and that knowledge of and in human movement and dance is acquired through developing an experiential body of knowledge, as discussed in the theory chapter. Since the individual style has such great impact within modern dance, the dance teacher played an important role in the participants' experiences of the course and the course content. Even if the same dance exercise can be carried out in similar ways, it is the dance teacher (or choreographer) that introduces the movement concepts and present how they can be approached and understood (Blom et al., 1982/89). As the dance course participants had little or no experience of modern dance and movement concepts in general, the dance teacher and her pedagogical approach, played a great role in the participants' experiences of the course, and thus human movement.

During the dance classes the participants experienced different kinds of movement exercises that aimed at exploring movement concepts and movement patterns as well as expressing ideas and emotions. They worked both individually and in groups. An important part of the course was to experience and learn to know the own personal

movement preferences, and to develop an awareness for how one moves and what kind of movements one uses or not. Most of the participants had no or little previous experience of dance. It was therefore important to give them an individual movement base to start from, and to develop and make them conscious of their own movement expression. The course also contained common dance exercises as learning and performing a certain movement phrase choreographed and presented by the dance teacher. The different exercises aimed at training the ability and skill in different movement concepts. But focusing on one concept did not exclude that others were involved and trained as well.

3.5 Movement Data and Analysis

The informants used in the dance study were the participants of the course Physical Expression. As the course was especially arranged in order to form a field for the study, one can described the selection of informant as a purposive convenience sample (Blomberg et al., 2003). Purposive sampling means that the group of interest is specified, in this case non-experienced dancers with knowledge of interaction design, but the number of needed informants is not specified. Convenience sampling implies that one make use of the people who are available and willing to participate, and that meet the requirements of the research.

Nine people took part in the full course, five females and four males. Their ages ranged from 19 to 43 years at the start of the course. All participants had occupations that were related to HCI. Four of them were engineering students, two were Computer Science and System students, and three participants were university staff members of which two were doctorate candidates. The participants' backgrounds will be described in more detail along with the results from the dance study in Chapter 4.

My role in the dance course was mainly to be an observing, although not invisible, researcher. I interacted with the participants through administration of the course, during interviews, my presence together with my video camera in the dance studio, my reflective questions posed after each class, and through giving the participants written home assignments, as well as my presence at and conduction of the design workshops. During the dance classes I consciously tried not to comment on the course content or the participants' movement performances. I aimed at only interacting with the participants as a researcher and not as a dance teacher. However, when observing the dance classes I looked with my eyes of a dance teacher as well as a researcher, which influenced what I saw and how I perceived it. This point of view also provided me with a valuable basis for asking the "right" questions during the interviews and the possibility to encourage the informants' reflective processes in order to find answers to my questions.

During the course the participants explored theoretical movement concepts such as kinaesthetic awareness, phrasing, forming, relating and abstracting, as well as movement elements as time, space and energy. When I present the participants' work and the

Figure 3.2
Dance course participants in action.

TABLE 3.2 Dance Course Exercises

All exercises are described in Appendix A, and * indicates that video documentation is available on DVD in Appendix B.

Exercise	Name
Imitation and movement phrases	
Ex #1	Add on
Ex #2	Angel
Ex #3	6/8 *
Ex #4	Phrase
Ex #5	Diagonals
Improvisation	
Sensory Awareness	
Ex #6	Walking
Ex #7	The Flock
Ex #8	The Mirror
Ex #9	Movement Conversation
Ex #10	Balancing
Ex #11	The Match
Ex #12	Support
Ex #13	Body Part
Ex #14	Movement Impulse *
Ex #15	Moving Shapes
Space	
Ex #16	Fishes and Birds
Ex #17	Fill the Room *
Ex #18	Close Space *
Ex #19	Positive & Negative Space *
Ex #20	Interpreting Space

Exercise	Name
Improvisation cont.	
Time	
Ex #21	Fast/Slow
Ex #22	Accelerando & Ritardando
Ex #23	Changing Time
Energy	
Ex #24	Force
Movement Quality	
Ex #25	Move
Ex #26	Variations
Ex #27	As If *
Composition	
Ex #28	Floor Patterns
Ex #29	Photo & Text
Ex #30	Name Phrase *
Ex #31	Boundaries
Ex #32	Abstract *
Ex #33	Solo Piece *

results from the dance study in Chapter 4, I have chosen to separate the exercises into three different categories according to how movement was explored, namely imitation, improvisation and composition. These categories make it possible to focus on different aspects of the movement training and exploration. However, it is important to have in mind that the categories have overlapping perspectives and are often intertwined. In this work the separation has been used only as an analytical tool. Each category will be presented along with the results in Chapter 4.

In Table 3.2 I have summarised the different exercises carried out during the dance course. The exercises are grouped after which movement concept they mainly explored. However, as already mentioned, the concepts are not independent entities but are mutually dependent on each other. In Appendix A I briefly describe the dance course exercises. In Appendix B, which includes a DVD, I present a few illustrating video examples from the course.

Interviews

In order to focus on the verbalisation of the physical experiences, the analysis has mainly been based on interviews. Three interviews were carried out with each informant. The aim and description of each interview series are given below and summarised in Table 3.3. During the interviews I wanted to focus on the verbalised course experience, i.e. how they were able to put words on the physical work and experience. Before the interviews I conferred each informant's written self-reporting material, which is described in more detail later in this section, as well as previous interviews in order to search for aspects and movement issues they had brought up themselves. The reflective answers, assignments and

TABLE 3.3 Overview of the Interviews

	Interview #1	Interview #2	Interview #3
Aim	Participants' background and previous experience of movement and movement interaction.	Participants' experience of the course and the work, follow-up the first interview and data collected so far.	Participants' own description of the course and the experience of it on a personal as well as professional level.
Type	Semi-structured with specific questions, possibilities for open-ended answers.	In-depth semi-structured with an ethnographic touch, adjusted after each informant's previous data.	In-depth semi-structured with specific question areas, possibilities for open ended answers.
Time	Just before the course started.	In the middle of the course, about seven weeks after the first interview.	One or two weeks after the course had ended.

logbooks functioned therefore as basis for the design of each interview. Even exercises done at the dance classes as well as the final group discussion were used as background material and referred to during our talks. The different types of data that were collected throughout the dance study are presented in Table 3.4.

The transcriptions of the interviews have been done writing down all hearable words in the order they have been spoken, i.e. spoken language, not taking notes of pauses, breathings, laugh, gestures, humming, etc. Neither confirming comments as: mmm, exactly, yes, that's right, etc. have been considered, as I have not intended to carry out conversation analysis. I have rather been interested in what they say, which words they use, and how they express themselves verbally. When transcribing interviews there will always be some differences between what has been said and what is written. And just by transcribing an interview, an interpretation has been made, through the change of medium (Kvale, 1996).

Interview #1: Participants' background. The first series of interview were conducted the week before the course started. The aims of the first series were to learning to know the participants' previous knowledge of dance and physical training, their education and work and their motivation to attend the course. I also wanted to find out how the participants thought they might relate the course content to their professional work or education. Further, the goal was to get an impression of the participants' view on and experience of the body and physical communication in relation to human computer interaction. Finally, I wanted to let the participants describe their relationship to their own body, the use and perception of their own body and the perception of others' bodies when communicating and interacting in the real world as well as when using technology. The interviews had the form of an open, directed interview (Lantz, 1993).

Interview #2: In-depth follow up. The aim of the second interview was to collect (verbal) data on how the participants experienced the course, its content and work. As the first interview was quite structured, I wanted to use a more open form for the second interview and make use of and follow up the respondents' own descriptions and statements. Through conducting more ethnographic oriented interviews (Spradley, 1979) I was trying to get hold of a more personal experience of the course and the work it generated. This was based on the assumption that different people obtain different values from the participation, depending on their previous experiences and expectations. Prior to the second interview I went through the notes of the respondents' first interview, answers to the reflective questions as well as the first home assignment. I searched for interesting traces that concerned reflections on the own body, bodily communication, making conscious the bodily expression, and the relevancy of the area in relation to technology development and interaction design. I also searched for issues that the participants' had brought up themselves. During the interview I followed up the questions from the first interview, deepened the reflections and thoughts written after each class, and followed up the first written assignment. We also discussed specific exercises carried out in the dance studio.

Interview #3: The own story. The focus of the third interview was to obtain a subjective description and formulation of the personal experience of the course and what it had contributed to for each participant. I wanted to know what they had experienced during the course and how they could reflect upon their own development. During the last dance class, which was carried out as a group discussion, the participants were asked to summarise the course in one word. As part of the interview we further discussed the background for choosing this word. Three participants had chosen the word pleasure. The other words or notions were being relaxed, new movement possibilities and dimensions, self-esteem and acceptance, bodily knowledge and challenge. Finally, I was curious to know how they related the course experience to their personal as well as professional interests.

Video documentation

The video material has served as field notes and documentation of the work carried out in the dance studio (Pink, 2001; Blomberg et al., 2003). Most of the time I used a hand held camera in order to be mobile and follow the participants' movement through space. My lack of habits from using a video camera also affected the result and what and how the motives were filmed. Filming dance is always problematic. It is difficult to get hold of the three dimensional aspects of the movements as well as the movements' relation to the space. The experience when looking through a small LCD-screen is different from directly observing the activities without a camera. This has of course slightly affected my observation of the activities performed in the classes, as it delimited my range of visual perception. However, these issues have not been considered as problematic or restrictive in this study.

Excerpts from the video documentation will also be used as illustrations and video references when presenting the data and results. I find the possibility to attach video references as quite important and useful, as I assume that there is a rather limited part of the readers that have experiences of modern dance classes. The video material has not been analysed per se, as my main interest have been to search for aspects that reflect the participants' experiences and general insights of movement, rather than searching for specific movement expressions. The aim was neither to describe the participants' development in movement, even if that might be traceable by using the video material. Additionally, it is a very complex activity to try to transform human movement from video and real life experiences to text. Even a description of what you see on the video will be biased and reflect different things, depending on which level you decide and are able to describe what you see on, as well as the preconceptions of the reader.

Observations

Having observed the dance classes in person, I made use of those experiences when planning and carrying out the interviews. Being in the dance studio contributes to more than just the visual sense. Sensing the atmosphere and ambiance in the dance studio and among the participants, listening to the participants' comments, the sounds of their bodies interacting with each other or the physical surroundings, as well as the breathing of the

participants might indicate the level of intensity and thus engagement. All these activities contributed to the information about what was going on in the field (Blomberg et al., 2003). Having been there also becomes a part of the relation between the informants and me as a researcher. During the interviews we could relate to episodes and events that had taken place during the dance classes. In this case my experience as dance teacher also contributed to the observation, i.e. how and what I noticed. As I am trained in observing movement and how people move, I automatically looked for movement qualities and differences in movement of the participants. Without this experience I would not have been able to make use of the data as I did. I also had an on-going conversation with the dance teacher throughout the whole course, regarding how we experienced the participants' work.

Self-Reporting Texts

Different kinds of written self-reporting techniques were used throughout the dance study. The aim of the self-reporting data was to trace the participants' work and learning process and their experiences in relation to the course content and work carried out (Blomberg et al., 2003). The written exercises also trained the ability to textually express and verbally formulate the movement experiences and make conscious the physical work done during classes. The reflective questions at the dance classes were voluntary. The home assignments were compulsory course requirements.

TABLE 3.4 Overview of Data Collection from the Dance Course

Data type	Description
Videotaped interviews	Three for each informant, carried out before, during and after the course.
Observed and videotaped dance classes	Twelve dance classes of about two hours each.
Videotaped group discussion	About two hours during the final dance course class, summary and comments on the course.
Written answers to reflective questions	One or two questions answered during ten minutes after each dance class.
Written home assignments	Two assignments given throughout the course, to reflect and write about 500 words on a given subject.
Logbook	Diary-like notes written during the solo piece work.
Interaction design ideas	Descriptions, sketches and acted (filmed) interaction ideas, notions and concepts.

Reflective questions. After each dance class the participants were asked one or two questions regarding the day's work. They were given ten minutes to write down their spontaneous thoughts and immediate reflections. The reflective questions were posed during the first to the seventh class as well as the tenth and eleventh. During the eight and ninth class the participants worked with their solo pieces and were supposed to use their logbooks instead. The questions were not part of the course as it was I as a researcher that was responsible for them and presented them in the class. The questions functioned as a direct data collection tool as well as a mean of making conscious what they had been doing during the class, stimulating their reflective process and ability to express the experiences of the course in text. In this way they also got a pedagogical role in the course. The questions asked concerned what they experienced as most difficult, inspiring or important during the day's class. Or they were asked to describe their feelings or different aspects of bodily sensations as well as expectations and reflections on the course.

Home assignments. During the course the participants were asked to hand in two written assignments. Like the immediate reflections these exercises were not a direct part of the course but used as a data collection tool as well as a means that aimed at training the ability to express the emotions and experiences the work generated in a written form. The assignments were sent out and most often handed in using e-mail. In the first exercise, which was given halftime during the course, the participants were asked to individually describe how they experienced the work that the course consisted of. The second assignment was given towards the end of the course and encouraged thoughts and reflections on movement-based and bodily interaction and communication.

Logbook. The logbook was a part of the artistic task and was meant to function as a pedagogical tool for the creative process. All participants allowed me to use their logbooks also as research data.

3.6 Gaining Knowledge through Design

Technology is today getting more and more ubiquitous and pervasive. The fast development also profits on the increasing availability of inexpensive computational resources, making it possible to insert computational power into "old" devices and toys, and thus to express and explore things in new ways. HCI has always been a multidisciplinary field, although under strong influence by cognitive and behavioural science as well as computer science. In the introduction of this thesis, I mentioned that during the last years we have experienced a broadening of perspectives, from design for usability, efficiency and problem solving, to design for user experiences. This broadening also includes a critical perspective on computing and technology development and how it influences our everyday lives.

Within this emerging trend we also experience an interest that focuses on other areas than workplace studies and specific task solving problems. From ethnographic studies of interaction that already exists in a given context, and that aim at redesigning

the interaction, we now focus on designing for desirable and pleasurable products, new interaction possibilities and new artefacts. The questions arise then, how do we design interaction when the user group could be anybody and the context could be whatever or whenever or wherever? And how do we carry out "user studies" in order to evaluate the designs? What intentions could we have about the interaction experience when there is no specific problem to solve or use and user to design for?

To some extent one can say that these questions are the wrong ones to ask. As mentioned in section 3.1 by making use of other competencies as within interaction design, the problems we want to solve are differently defined and are not even always considered as problems, but rather areas of interest that should be explored. Within interaction design we are also often considering ephemeral and immaterial interaction qualities. Aesthetics, embodiment, emotional and affective values are more and more emphasised and are important aspects of the interaction with IT products, artefacts and services.

Digital technology and computational devices generate a variety of design possibilities without clear limitations. It might be difficult to grasp and complex to understand, but it is also a positive challenge and a source for great creative potential (Löwgren and Stolterman, 2004). However to bare in mind, even if everything is possible, not everything is desirable. As a consequence, we have seen a variety of interactive objects that demonstrate and visualise the technological possibilities. These artefacts do often have an intended function that might be artificially created. However, creative and novel use of these artefacts might open up for potential application areas not initially thought of. To have this non-intended use in mind and to try out concepts, mock-ups and prototypes during the design and development phase is an important aspect of user centred design (Schön, 1983; Schön and Bennett in Winograd, 1986).

The physical design work carried out as part of this doctoral project, has therefore been explorative with the main intention to create an artefact that made use of human movement as interaction modality. The design work has been a necessary part of the research process as it has made it possible to physically and concretely try out the theoretical concepts. These experiences have contributed to further questions and insights about the interaction concept, which had been difficult to establish by other means. In the next section I will describe in more detail the movement design process carried out as part of this work. The different design decisions related to the development of the interaction concept BodyBug, its implementation and interaction experiences will be described in more detail in Chapter 6.

As part of the dance course I arranged two design workshops that aimed at bridging the physical experiences obtained in the dance studio with movement-based interaction concepts and ideas. During the workshops the participants produced mock-ups and design ideas that reflected movement aspects they had found interesting. The design ideas and sketches that were produced during these workshops will be presented and discussed in Chapter 5. Together with the aspects of human movement that arose from the physical movement work, the ideas produced during the two workshops served as inspiration for

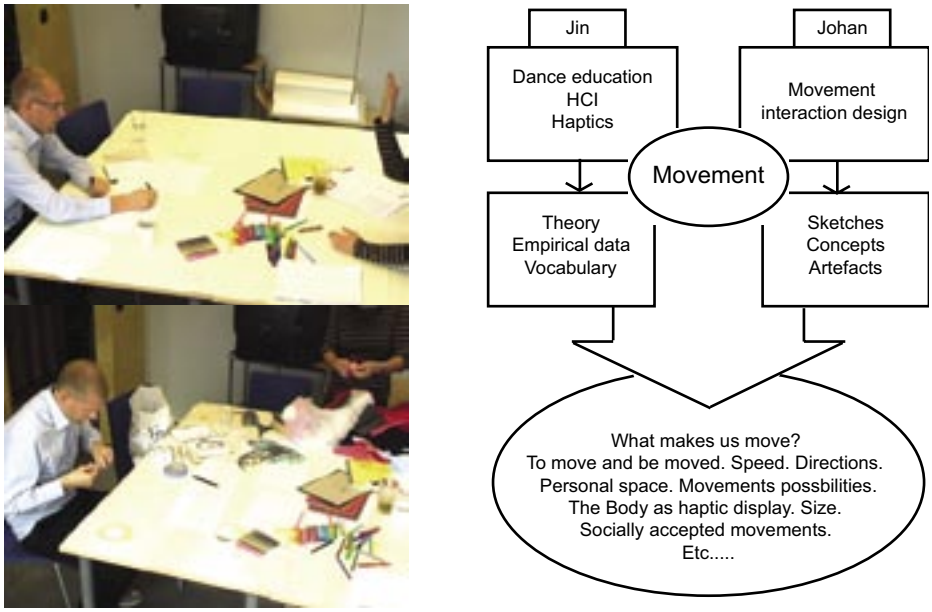


Figure 3.3
During the concept design workshop we contributed with our different backgrounds and competencies. We were sketching, discussing and making physical mock-ups.

me in my following design work, i.e. the design and development process of what became BodyBug.

The design process of BodyBug took its starting point in a two-day concept design workshop where Johan Sandsjö and I were the only participants. Prior to the workshop we had some mail contact, bringing up issues that we wanted to explore when it came to bodily interaction and movements. Some of them were "the body as haptic display", "what makes us move", "our movement-relation to the environment", "focusing on the movement or the interaction", "balance and weight", "bodily experiences and memories". During the workshop, these and other notions were further discussed and physically tried out.

The concept design workshop was scheduled for two days. At an early point we decided to have a mock-up ready the following afternoon in order to give ourselves a time frame and focus to work within. We had not planned to use a specific method in the design process as we had no previous experiences of working together neither did we aim to try out a specific method. However, during the workshop we tried to establish a common understanding of human movement as design material. This was done through watching video clips from the dance course, sketching interaction concepts, trying out movements and discussing different notions and concepts. To our discussions I constantly

brought up notions and concepts used within dance and movement training. I also related our discussions to experiences from the dance course as well as dance and dance education in general. To the discussions Johan also contributed by drawing sketches of interaction concepts, ideas, artefacts, etc, based in his experiences and ideas and inspired by our discussions. Our different backgrounds and perspectives, previous work experiences and competences turned out to suit and complement each other in a very functional and constructive way. How both of us contributed to the design work is summarised in Figure 3.3.

The concept design work brought up a number of different aspects of human movement experiences that we wanted to preserve and incorporate in the interaction design, and that were based on people's experiences of movement. Throughout the workshop and the rest of the development process, we discussed our design issues in relation to those interaction qualities and grounded the design decisions in this initial work. This work is discussed in more detail in Chapter 6.

The initial design workshop was the most important part of the design work, as it was there that the main design decisions about the interaction concept were taken. The mock-up we produced also demonstrated the interaction concept well enough to obtain external funding for the continuation of the project. During the following implementation phase there was a lot of design issues that were dealt with and that sharpened our idea and shredded light on several design aspects, e.g. the size of the object, what kinds of movements and movement concepts to use, the visibility of the object as motivation for interaction, social aspects of movement, etc. We also started to take into account what kinds of technology that could facilitate our interaction goals. These and other issues will be further discussed in Chapter 6. However, the goal of this work was to focus on the interaction modality, i.e. movement, rather than the physical object or artefact.

As soon as we had found our interaction concept we started to create physical models and low-tech prototypes. One of the big challenges was to find a well-functioning mechanical solution, as the device tended to be quite small in size. In this part of the work we also involved a professional engineer for construction of the mechanics. The building of a physical prototype included new design decisions, as we had to stick to what was possible to carry out within our limited time and budget. About ten weeks after the first design workshop, we had as scheduled, the first (almost) working prototype ready. However, due to its limited functionality, we decided to continue to further develop this version. A second version of BodyBug was therefore implemented, which included change of motor as well as a new visual design and shape.

What kind of prototype, which technology to use, application area, etc, was not decided on before the prototype development process started. This was in order to be as open, serendipitous, unprejudiced and explorative as possible. However, the design was carried out within a certain frame of references, as we wanted to take into account the aspects on movement interaction that had arose from the dance study. Within this framework we also wanted to give room for as large a design space as possible. Making a

concrete prototype of an interaction concept that we want to demonstrate, provides an opportunity for people to have an own experience and sensation of the research issues. By making a movement interaction prototype it became possible to get feedback on the use of and interaction with such an artefact, interface or its like. We could then answer questions such as What kinds of expressions and interaction does it create? How do users experience this?

The final version of BodyBug has been exhibited and demonstrated at four different events. This has made it possible to carry out qualitative user observations in real settings, i.e. in the field. During these occasions we have informally observed at least fifty users' spontaneous comments and reflections on the interaction as well as the artefact. The focus has been on demonstrating and exhibiting the prototype as an interaction concept rather than make extensive observations or user studies. However, some of our observation experiences were written down and discusses afterwards. The difficulty was in knowing what we actually observed; the prototype's functionality, if it worked, what people thought it was, how people did, how they relate to it, what is made them do, what kinds of movement and interaction it generated, etc. A few users were asked to write down their experience of using BodyBug. These descriptions are presented in Chapter 7. Thesetexts have worked as complementary data to the visual observations and contributed to the reflection on BodyBug as an interaction concept as well as a design case and a research prototype.

Chapter 4
Dance-Based Experiences of Human Movement

In this thesis I argue for taking the starting point in physical experiences when designing for movement-based interaction. An empirical explorative study of people exploring human movement has therefore been an essential and necessary part of this work. As described in Chapter 2, the first aim of the study was to gain an understanding of human movement from a "user's perspective," using modern dance as the basis for obtaining that. I wanted to study the experiences of people mainly non-experienced of modern dance, and preferred not to work with movement professionals such as dancers. The reason was that I assumed that they might have a too biased experience of human movement, but also being too specifically trained for being representative in using the body for expressive and communicating matters. Another aim of the study was to extract from the physical experiences, aspects of human movement of relevance for movement-based interaction design.

In this chapter I present the results from the explorative movement work that was carried out as part of the dance course Physical Expression. The results are presented through descriptions of the participants' experiences of some of the exercises that I found interesting because they created lots of movements, new movements, etc. I also describe exercises that the participants themselves brought up and found interesting, intriguing or fun. The findings presented in this chapter are derived from interviews and video recordings. First, in section 4.1 I present the course participants' background in order to provide an impression of their starting points and intentions for attending the course. Second, in the three following sections 4.2-4.4 I describe and discuss the participants' subjective experiences of the physical work, grouped after how the movement concepts were explored, i.e. through imitation, improvisation and composition, as described in Chapter 3. Third, in section 4.5 I discuss the participants' conception of "my own" and "other" peoples movement, and in section 4.6 I discuss the notion of movement literacy. In section 4.7 I give a general overview of the participants' experiences and learning processes that resulted from the course. Finally, in section 4.8 I summarise the findings from the

movement exploration work and discuss the relevance of these results to movement-based interaction design.

As the participants on the course were both male and female, and since moving people in general are represented by both sexes, I will interchangeably refer to the informants as he and she, when referring to the participants in general. When citing the informants, I have referred to them as Informant #1 to Informant #9. An overview and brief description of the dance class exercises is presented in Appendix A. In the following text the exercises are referred to as Ex #1 to Ex #33. Video documentation of some of the dance course exercises is available on the DVD in Appendix B. The video examples will be referred to as VE #1 to VE #6. The pictures from various dance exercises are captured from the video documentation and are therefore in some cases of poor quality. Their main aim, however, is to be illustrating and, for the interested reader, high-resolution versions of all photos can be found on the DVD in Appendix B. I would like to point out that all informants have approved the use of the visual material for presentation in this thesis.

4.1 Course Participants' Background

Even if the course Physical Expression aimed at generating movement experiences and knowledge about bodily interaction, the participants did not come to the course without any previous knowledge about these issues. However, their awareness of this knowledge was in most cases not further investigated. This section gives account for the initial conditions of the participants based on the first interview carried out before the course started.

Most of the informants had a personal motivation to attend the course. They thought it sounded fun and exciting and that it was something different than a regular computer science course. Some of them also thought that it most likely would be a personal challenging and developing experience, while others had a longing for doing something physical or bodily. They also expressed an interest in learning more about the use of bodily expressions and movements in relation to human computer interaction, as they thought that it should be more to it than just graphical interfaces and other ways of interaction. The PhD students and faculty staff in particular emphasised this aspect. Several of the informants missed a more holistic and human perspective on technology in their education, and thought that the course might give them such a perspective.

The participants expected to learn how to express themselves with their bodies and to explore the relation between movements and expressions. One informant was curious on the pedagogical perspective, how the other participants on the course would develop, but also the physical learning process, which included making use of several senses when learning. Most of the fears related to attending the course reflected anxiety of doing mistakes such as not moving correctly, not understanding what to do, or not being good enough. One person who was an experienced dancer was afraid he would fall into the trap of showing-off but also to be too under stimulated. Another informant was afraid of being

too self-censuring, and a third thought it should feel weird if they were supposed to touch each other. A fourth informant expressed that he was terrified of dancing.

All informants had some relation to the notion of dance. Some of them had personal experiences of doing dances such as folk dance, flamenco, belly dance, salsa, jive, modern and contemporary, classical ballet, and jazz. Their experiences of watching dance were often related to a fascination for the ability to do things with the body and the control of the dancers' bodies. Watching dance often made them wanting to do or be able to do, the same thing as the dancers. Dance was in most cases perceived as something beautiful, but one informant also described certain dance expressions as conveying a brutal or raw aesthetics. However, as another informant pointed out, there could be a conflict between what is aesthetic to watch and what feels good for the artist. The participants' impression of modern dance in general was that it was very physical, powerful and energetic. They also strongly related dance to music and rhythm, but one informant emphasised that the music could also exist only inside the dancer's head.

4.1.1 Participants' Previous Physical Activity and Exercising

The participants' previous experiences of physical activity and training ranged from non-organised everyday activities like walking and bicycling, organised physical exercising like going to the gym a couple of times a week, to professional ballet dancing and competing in sailing and jive. A overview of the course participants and a summary of their physical activities and training is given in Table 4.1. The participants' experiences also reflected different kinds of relationships towards their bodies and movements. This was most often related to their level of physical activity and previous training. Their motivation for doing physical activities could be separated into three main categories: physical needs, emotional needs, and functional needs, although, these different needs were intertwined in various ways.

The physical needs were most often related to a longing for feeling good in the body, having fun, and the physical sensation of moving. They also felt like having ants in their pants if they were inactive for a too long time. One informant with experience of dances such as salsa and competitive jive, referred to dance as a fun activity. She had also experiences of activities such as football and handball but she did not considered them as fun. Another informant talked about her emotional need to dance and expressed that "my soul needs it." She was often consciously using free dance to act out her emotions, for her own sake. When she wanted to communicate an emotion or expression to others, she made use of text and wrote poems. A third informant, with a former career as ballet dancer, mentioned that he missed the expressiveness in dance, but not the physical pain though.

The functional needs for movement were related to obtaining a specific goal or effect from the activity. This could be diverse aspects such as that increased muscular strength makes you able to carry home groceries, that physical activity allows you to eat candy without gaining too much weight, that exercising shapes your body and makes you look good, and that physical activity is something that leads to better concentration

and less mental exhaustion as well as reduces stress. Several of the participants expressed a knowledge and experience of the positive side effects of exercising, but they still lacked motivation for really doing it.

4.1.2 Participants' Experiences of Bodily Interaction and Movement

Our body and body language is most often considered as something very expressive and subtle. The informants gave examples of the body as a tool for expressing and representing oneself, but also for achieve different functional goals such as sports and work. In both perspectives the body is something they would like to be able to control, and it needs to be maintained and taken care of. The informants argued that we often want to be able to decide ourselves, when to express what. However, this is often experienced as quite difficult since the body provides immediate feedback and might reveal unintended or subconscious emotions and reactions. Job interviews, giving presentations and meeting new people, were examples of situations where this usually became an issue.

However, the subtlety of human movement is also perceived as a potential and an important property of the body. The informants mentioned several situations where it is possible to recognise a person by the means of his or her posture and movements. Although, this is more easily done with people you know well. The participants also argued that we trust the body language most if we experience a conflict between a person's spoken

Table 4.1 Course Participants' Background

Age	Sex	Occupation	Previous and current physical activities and training
28	Female	Engineering Student	Belly dance and flamenco.
24	Female	Engineering Student	Competitive sailing as well as high school sailing program; extensive experience of strength and cardio vascular training.
27	Female	Doctorate Candidate	Walking to the office, work out 2-3 times a week, spinning.
19	Male	Engineering Student	Taekwando, running.
41	Male	Doctorate Candidate	Educated and worked as professional ballet dancer until 12-15 years ago. Dances tango and work out at gym.
24	Male	Engineering Student	No organised sports, but bicycle, swims and take walks. Has attended one jive course.
27	Female	MSc Student	Competed in jive during ten years, danced salsa, played handball and football, doing dance inspired aerobics.
25	Male	MSc Student	Sporadic weight lifting like once each second year, take walks.
43	Female	Teacher at university	Work out 2-3 times a week, has played basket ball, done aerobics, weight lifting, and riding.

word and physical expression. When we know how to make use of our body language we can also use this to influence other people. It makes us able to negotiate meaning, be persuasive, express intentions and nuances, even in situations where we cannot find or want to make use of words.

But, as the informants expressed, the body can also be a hindrance for communication. When the attention is drawn towards physical appearances or bodily attributes that are not relevant to the content of discussion, e.g. breasts, scars, etc., the physicality of the body may complicate the communication. People's height could also be a problem, as being on the same physical height level might be experienced as more democratic. Cultural differences in the use of gestures, facial expressions and bodily movements, are also experienced as something that might cause problems and misunderstandings.

The body is most often noticed or reminded of when it does not "work properly" such as in cases with physical injuries or pain, or when you are unable to perform certain physical tasks. Physical sensations are also often present when you feel uncomfortable and have to adapt to certain behaviours or to fit into social norms. Consequently, most bodily memories that the participants referred to were of unpleasant character, e.g. burning or hurting one self, feeling depressed because of changed bodily conditions, or being nervous and shaky in unpleasant situations. But the participants also mentioned more neutral descriptions of sensing the body and using those sensations as information, e.g. when sailing or bicycling, as well as the sensations one feel when being in love or doing something that is fun.

In relation to technology the experience of movement-based interaction were quite limited among the informants. However, as one of them mentioned, even the use of keyboards, mice and touch screens is movement interaction. Technology, however, is often experienced as something that constrains and limits the possible movements and interaction, as well as it creates uncomfortable interaction. It also lacks the expressiveness that could be found in natural human-to-human communication. The bodily constrains of the interaction is especially felt when the interaction gets monotonous, and one is reminded of the body through mouse-arms, stiffness, or immobility. However, as one informant emphasised, the most important aspect of input and output, is that there should be a relevant relationship between what you give as input and what you expect and receive as output in each interaction context. Movements as interaction modality were imagined as something that could be suitable for expressing emotions, as well as providing the users with more engaging interaction experiences.

4.2 Exploring Movement through Imitation

"I have realised that my body doesn't only work the way I'm used to move,
but that it's actually possible to move like other people do.
When I see someone and think 'wow he or she moves well,'
now I know that I can do that too, if I want to."
- Informant #2

To imitate a movement means to create the same visual movement expression as the choreographer or another person has created. However, the imitation can be carried out on several levels. In a group choreography one might want everybody to look exactly the same, and then the collective timing and range of movement is important. In other situations it might be the movement quality that should be identical. To imitate movement therefore implies an ability to pick up other people's movement. This includes having the ability to understand the movement, to see what the movement consist of, to separate arms from legs, and left from right, as well as having a sense for how the different movement elements are utilised. This also requires a kinaesthetic awareness, as you will need to sense and then adjust your own movements according to the choreography. You have to know what you do. In this work the mirror can be used as a valuable tool, as well as corrections from a teacher or choreographer. Learning another person's choreography automatically provides you with an experience of phrased, abstracted and formed movements. Through experiencing others movement you also starts relating to others as well as yourself.

During the whole course the emphasis was on making use of and develop the participants' own movement potential and movement patterns. This approch reflects the view within modern dance that the movement expression is tightly connected to the person performing the dance, as discussed in Chapter 2. Consequently, the movement imitation exercises made up a small part of the course. During the dance course the participants experienced the dance teacher's as well as other participants' movements. The level of imitation varied from mirroring and following other persons' movements, using imitation as a starting point for the own movement exploration, and performing a dance phrase as a uniform group.

The first exercise on the course took the starting point in the participants' own movement material (Ex #1: Add On). Standing in a big circle, one person was asked to start and "just do a movement, whatever comes to you." When she had shown a movement, everybody imitated and repeated it a couple of times. Then the next person in the circle was asked the same, "can you do a movement?" Everybody repeated the movement and then the second movement was added to the first one, creating a short movement phrase. The movements that came up were everyday and spontaneous movements such as rolling the shoulders, jumping straight up and down, etc. This procedure continued around the circle until everybody had contributed to the growing movement phrase. The phrase was then rehearsed a couple of times in order for everybody to remember it. Finally, it was

Figure 4.1
Dance course participants performing a dance phrase (Ex #3: 6/8).

used as basis for a movement quality exercise where the participants did the phrase as big, as small, as fast, and as slow as possible (Ex #26: Variations).

Dance phrases created for pedagogical as well as artistic aims might emphasise specific dance concepts that will be experienced and exercised when performing the phrase, such as different kinds of skips and jumps (Ex#5: Diagonals) as well as abstract movement expression as in the exercises Angel (Ex #2), 6/8 (Ex #3, VE #1) and Phrase (Ex #4). Through learning dance phrases and imitating the dance teacher's or the other participants' movements, the course participants indirect experienced dance concepts such as time, space and energy. This work also contributed to their ability to, and sensation of, forming and phrasing movement. However, when copying movement you need first, to be able to "see" the movement, i.e. analyse another person's movement and decompose it. Second, in order to perform the movement yourself, you will have to make use of the kinaesthetic sense for knowing how to adjust your own movement. Depending on the level of skill, one will primarily be occupied with performing the movement "right," and not necessarily its expression, as formulated by one informant:

> *"When we followed her movement it was not so much the question of expressing something. It was more like trying to do something that looked the same. It did not come from within. The problem was more mechanical, to be able to follow that movement." (Informant #9)*

The difficulty of learning or copying specific movement phrases is often related to previous experiences of movement training, the bodily control as well as previous experience of

the choreographer's movement patterns. One of the participants had long experience of sailing. During the first interview she described her how she thought when she managed the sailing boat. She was used to sense through the body how the boat reacted to her manoeuvres, while her friend preferred to cognitively sort out what to do. However, she thought that a combination of sensing and thinking was preferred. Her habit of making use of the kinaesthetic sense and correct her own movements was most probably useful even in the dance studio. She also expressed less difficulty in learning or imitating new movements:

> *"I asked the teacher which was the most difficult phrase of this one [Ex #4] and the one we did in the first class [Ex #2]. Because this one, I found so much easier, or it felt so simple kind of. But the teacher said that this was more difficult. So that should mean that I've learned something, learned to follow." (Informant #2)*

However, the ability to pick up and understand a movement is also related to how natural it feels to do it. I will return to natural movements and relate it to movement quality in section 4.3.2. When we do not understand the movement, the body becomes something objective, and the mechanical aspects of moving body parts become the focus. The informant cited above, therefore experienced difficulties when she could not find the meaning in the movement:

> *"But I also know that I was more able to identify myself with the last phrase. And that's why it was easier to remember. Because the first one, I know that I could remember some parts, but then it was a specific part that I didn't understand the intention behind, and that's why I had trouble learning that part. I think it works that way … it has to feel good when I do a movement in order for me to remember it. But if it doesn't feel good, I don't remember the movement … if it doesn't make sense, I don't remember it that well. Then I have to think like 'okay it was up with that part and back there' and so. But if I can find the movement within the body, it stays there automatically in a way." (Informant #2)*

When learning a specific movement phrase you are also interacting with the whole group, as everybody tries to do the same. Experiencing and observing other people's ways of moving and performing movements contribute therefore to an increased understanding of the own personal movement language.

The important aspects related to imitation of movement can thus be summarised as follows:

- When imitating a movement, you need to be able to see and understand what there is to imitate.
- The main threshold for imitating a movement is to mechanically understand how to perform the movement. The expression comes in second hand.
- The ability to imitate a movement depends on your previous experiences of similar movements as well as the possibility to ground the movement in your own body.
- Imitation provides a possibility to relate the own movement language to others'.

These aspects will be returned to and further discussed in the following sections, especially in relation to the composition exercises.

4.3 Exploring Movement through Improvisation

"When improvising, you have to think and reflect,
but still you must let go the thinking in a way and just let the body lead.
And that is actually the most exciting experience, to feel that it works,
that it is possible to just let go and do lots of strange movements,
without exactly knowing what you do."
- Informant #2

To improvise means to act according to your impulses, often within given frames. Movement and dance improvisation can be used for creating and coming up with movements and movement ideas, exploring movement possibilities and the elements of movement, e.g. time, space, energy, flow, weight as well as movement qualities. When doing improvisation you train the ability to follow your own impulses to move, inner as well as outer. You make use of and develop a kinaesthetic awareness. Bodily sensations provide you with the necessary information in order to move yourself as you want to, or to move the body as the body wants to. Hence, inner impulses are felt through physical, intellectual and emotional urges to move. These are however, often caused by outer impulses emerged from the surroundings which gives you inspiration to move. In this work you are relating your movements, first of all to your self, but even to other people and the environment. Improvisation is also suitable for exploring how you can phrase and form movement. Consequently, improvisation is a very useful tool for exploring and experiencing choreographic elements and thus "what dance is made of," which was the aim of the course Physical Expression.

The big challenge when improvising is to keep the focus on the movement, without censuring yourself. Movement is tightly connected with what we consider to be allowed or appropriate to do, what looks good, funny, stupid or strange. The course participants often expressed this issue:

> *"Last class, I really felt constrained by myself when we did 40 minutes of free improvisation. I felt that it was my own thoughts that were constraining me, like 'Oh shit, this is embarrassing.' … Other times when we have improvised, it has gone too fast for having time for thinking." (Informant #8)*

It is often self-censuring that limits us to move spontaneously as we might believe that we look silly. However, being too aware of our body language, or trying to be in total control of it, might look even more constrained and unnatural. A possible way to overcome the self-censuring is to let people start to move at once, without providing time for reflection or figuring out in theory how to move. When immediately starting out by physically

exploring the notions and "just do it," you have no time for creating an inner picture of what the movement should look like. Then you hopefully avoid slipping into the self-censuring trap as one informant formulated it:

> *"You don't have time for creating a mental picture of how it should be really, before you start working. And that is relieving." (Informant #8)*

Being too reflective from the beginning makes you too conscious about yourself and how you move. However, it is both interesting and nice from a personal and pedagogical point of view, to afterwards go back and reflect and discuss on what the improvisation became. Several of the participants expressed after the course that they had wanted even more discussions.

Another method for "letting go of the mind," is to give it time. Even if it can be difficult to keep up the spirit throughout long improvisations, it usually takes some time to let go of today's thoughts and be completely aware of your body and movement:

> *"It is often a lot of thoughts that are blocking. In the beginning, one is quite constrained as one has a lot of thoughts in mind. But then, when you have been doing it for a while, you kind of relax, get into it, and then it becomes much easier just to do what you should do." (Informant #7)*

The participants' emotional state or mood affected how they experienced the movements and the work of the class. It also influenced to which extent they could engage and involve in the work. If they had had a stressful day at work it took longer time to focus on the body and movement. At those times, it was easier to only follow another person's movement than to come up with own ideas, as improvisation or composition required more intellectual work. So even though the main task in improvisation was to let go of the mind and let the body take control, doing this, sensing the body and follow its impulses, required a great portion of kinaesthetic awareness, concentration and intellectual work. Improvisation was therefore experienced as quite exhausting, cognitively more than physically.

4.3.1 Movement Impulses

> *"You act according to the body's impulses, without stopping and reflect upon it, or censure and hold back yourself. That is positive, to get in contact with what usually is rather unconscious."*
> *- Informant #6*

A classical and nice beginner's improvisation exercise is the one called the Mirror (Ex #8). In its basic form, the exercise is carried out with two people facing each other and one of them starts to move. The other person mirrors his partner's movements. After a while, one changes leader. The change of leader could also be done without specific cues, meaning that the two are shaping their movement together, sensing each other's movement intentions and the forming and phrasing of movement.

Figure 4.2
Two course participants exploring physical movement impulses and manipulations (Ex #14).

The mirror exercise can also be developed into a bodily conversation (Ex #9: Movement Conversation) rather that an imitation. As a first step, one person does a movement. The other person reacts to it, in one way or another, e.g. by making a sound or doing a movement. The first person continues by doing a new movement as a reaction to the second person's answer, and so on. The conversation can also develop to creating longer movement phrases as answers and utterances. Compared to spoken language, one can say that the communication is developed form sounds, to words, and finally to whole meanings or sentences. This exercise trains the ability to physically react to movement, which requires first to see and perceive the movement and second, to react. And third, to create an answer, an own movement expression.

Several of the dance course exercises dealt with movement impulses in order to increase the ability to identify and feel the impulse as well as making use of the first association that pops up. This includes aspects such as when to do a movement and which movement to do. The impulses might come from physical manipulations as well as visual inspirations such as other people's movements. Movement inspiration can also come from music and sounds:

> *"I tried to follow the body, let go and see what happened, and also watch others and be inspired by them or the music … feel and let it become a movement" (Informant #6)*

> *"It is easier to be spontaneous if I start with music I like … when I dance to music it doesn't require so much of me, because then I can just follow the music." (Informant #3)*

Figure 4.3
Feeling, sensing and following one's own movement impulses (Ex #14).

One exercise that generated a lot of movement was the work with physical movement impulses (Ex #14: Movement Impulse, VE #2). At first, the participants worked in pairs giving each other physical manipulations or impulses to move. They were pushing and pulling their partner's body parts in order to make her move and initiate a movement in some direction (see Figure 4.2). The person that was manipulated was supposed to close her eyes and try to feel and follow the given impulse. She should try to sense what kind of movement the partner's impulse initiated within the body, and move according to that as long as she could. This exercise was also done individually. The task was then to imagine someone giving you an impulse or initiating movement somewhere on your body, and then follow that impulse as long as possible. When working with these exercises the participants felt more free to move, as they did not have to be "responsible for what they did." They only followed the impulse and had therfore no specific inner picture of what the movement could or should be like.

A similar exercise that also generated lots of movement was to let one body part initiate or lead the movement (Ex #13: Body Part). The idea was to choose one body part, for example the right hand, start to move this, and just follow its initiated movement with the rest of the body. To make it more challenging and to increase the potential for finding new movements, the participants were encouraged to choose "unusual" body parts as left hipbone, the shoulder blade, the kidneys, etc. These kinds of exercises trained the sensibility for movement, i.e. the kinaesthetic awareness. They also contributed to the knowledge of one's own body and increased the consciousness of different body parts and how they are related.

Another explored aspect of the kinaesthetic sense was to feel other people's physical weight and movement, i.e. to physically or rather kinaesthetically, interact with someone. In dance terminology this is called contact improvisation. An introductory exercise to kinaesthetic awareness for another person's movement was the Match exercise (Ex #11). The participants worked in pairs and the task was to move around in space together. The only physical connection they had with each other was a match that was placed between the tip of one of each person's index fingers. Without talking or loosing the match, they were supposed to collectively move around in space, challenging themselves by increasing the speed and varying the movements. This work required a very strong focus towards the movement of the whole body despite a very tiny connection area. This work was also about trusting and relying on the other person as both needed to push towards the other, although not too much, but certainly not too little either. Another tangible exercise reflecting the same issues was to lean towards and from each other giving and taking the

weight of each other bodies, as well as carrying or lifting a movement partner in space (Ex #12: Support).

As already mentioned, improvisation can be rather intellectually exhausting. When improvising for a longer period of time, you often find yourself repeating the same movement over and over again. The dilemma then, as expressed by one informant, is to decide if that is ok, or if the task is to constantly find new movement possibilities:

> *"I tried to find other movements when I noticed that I did the same movements over and over again. I tried to do it in another way. But it also meant that I ignored the first impulse to move when I started to think. So it became a bit difficult to know what to do. Should I follow the impulse and do the same movement over and over again, or should I think of what I did? It was kind of double." (Informant #7)*

When referring to dance, most people think of people moving to music, and that good dancing is when the music and movement are in harmony with each other. However, even silence and sound in addition to music, can accompany movements in dance, but "ideally, the sound score for a dance is the sound of the movement – what the dancer-choreographer hears as she creates her dance" (Blom and Chaplin, 1982/89, p.11). During the course we did not specifically work on expressing the music, as the focus was on the movements. However, several of the exercises aimed at observing and feeling which differences the musical variation made to the movement. How did it feel to perform the same movement phrase to different musical qualities and genres? How did the expression change?

> *"Sometimes I get stuck, just because I can't move to that music. It happened last time. I couldn't move, I didn't like the music. … I couldn't move the way she wanted us to, to that music. It wasn't possible." (Informant #1)*

> *"We did it with two different pieces of music. It was so much more fun when it worked with the music. Music I think, I mean, it has been very useful to work so much without music. Otherwise I don't think I'd paid equally attention to the specific movements, without music. But it's certainly more fun when music and movements suit each other in some kind of way. That's what I'm used to I guess." (Informant #3)*

As Laban claims and that I have already discussed in the theory chapter, people have inner as well as outer urges to move. To summarise the movement impulse work one can point out the following aspects that generate movement and make us move:

- Visual cues, e.g. the movement of other people or objects
- Audio cues, e.g. music or sound
- Tangible intentions, e.g. reach out, grab, kick, displace
- Physical manipulations and impulses from others
- Inner and/or intangible aims, e.g. express emotions or feelings
- Movement exploration for the sake of movement

4.3.2 Natural Movements and Movement Quality

"Because we look so different, there must be movement patterns that suit different people differently. And I guess it's when you are forced into a movement pattern that not suits your body, that you get this old gymnastics or physical education feeling, that you just don't fit in, and that you are bad."
- Informant #3

In order to explore and experience different qualities of movement, the participants were freely improvising and playing around with different ways of moving. They moved with round and straight movements (Ex #25: Move), as well as followed straight and round paths throughout the space (Ex #28: Floor Patterns). The participants were also given specific qualities to explore, e.g. soft, careful, cut-up, vibrating, attacking, flowing, or falling (Ex #25: Move). In the As If exercise (Ex #27, VE #1) the participants were performing a given movement phrase with different qualities. The qualities were presented as metaphors or descriptions of feelings and characteristics related to everyday life. They were asked to perform the phrase "as if" they were extremely bored, were a Spanish matador, were weight-less in space, were in strong headwind, were really stressed, or had to put no effort in doing it.

As part of these exercises the participants also studied the other participants' performance. They looked for relations between movement expressions, movement quality and movement concepts. They watched the different movement qualities and reflected on how they influenced the time, space and force. They also observed how the expression and physical experience changed when they deliberately manipulated time (Ex #21: Fast/Slow, Ex #22: Accelerando/ Ritardando, Ex #23: Changing Time), space (Ex #20: Interpreting Space) and force (Ex #24: Force).

During the As If exercise the visual differences of movement quality and personal preferences became very obvious. The original movement phrase (Ex #3) took about 25 seconds to perform. The bored quality was performed in about the same time, but with smaller movements and less energy. Even the matador quality was performed in similar time, but with more dynamic, distinct and forceful movements. For the weightless-quality most participants used more than twice as long time as the original phrase, and their movements were very light and slow. When doing the phrase in strong headwind, a lot of the original movements were "lost." Some movements got smaller and others got more exaggerated, depending on how the participants were "disturbed by the wind." They also used longer time and more forceful movements than in the original phrase. The fastest performed quality was not surprisingly, the stressed one. Some participants performed it using less than half the original time. Their movements became smaller and staccato-like and with less flow. The final quality was to perform the phrase as if they did not have to put any effort in doing it. They used slightly longer time, and gave the impression of showing off or that they were brilliant. Video examples of the different qualities can be

Figure 4.4
The course participants performing a movement phrase (Ex #3) "as if they were doing it in strong head wind" (Ex #27).

found in Appendix B as VE #1.

As a last version of the As If phrase, the participants were asked to perform their favourite movement quality, the one they felt were the most pleasurable, nicest or funniest to do. The subjective experience of movement quality was also expressed in the Changing Time exercise (Ex#23). In groups, the participants were asked to create a movement phrase of 10 seconds. They got help to time it by the dance teacher. Later, each group was asked to perform the phrase in 5, 20, and 30 seconds respectively. Most participants preferred to perform the phrase in the original time, while others found a new favourite timing that suited them better. Even in relation to the other time exercises, the subjective time experience was discussed. Depending on the movement and its quality, 10 seconds could be experienced both as a long and short time. When repeating a fast and/or forceful movement several times, one is able to do that only for a limited time, e.g. 30 seconds, as it can be quite exhausting. If the same movement is performed slowly, it might take more than 30 seconds just to do it once. How fast one prefers to do a movement also depends on the person's physical size. For example, tall people need longer time and thus slower music, for skipping with the same movement quality than short people.

The "naturalness" of a movement was by the participants related to the level of harmony and flow that they obtained when performing the movement. The movement felt natural if they were able to find the movement quality that suited their body. As discussed in the theory chapter each person has one or several specific movement qualities that he or she prefers. Which qualities one prefers are depending on factors such as physical size, personality, previously training, etc. The preferred movement quality for a course participant was possible to see after working together in class for only a short period of time. This was exemplified in the As If exercise (Ex#27, VE#1):

"It was one class where we did the same phrase and then we should do it in several different ways. And then, when everybody should choose one, the one that suited them best, then I

knew which one they were going to choose. The one that suited you best, it was the one that felt best, I guess. And then it was performed best. So it's perceivable and visible. That's cool." (Informant #3)

To work with movement quality instead of specific movements and steps, means to work on how the phrase is performed, instead of what it consists of. This allows another movement focus to the mover. The emphasis can then be on searching for the suitable movement expression of the particular emotion or quality, rather than getting the right foot front. For some participants the former was found more interesting:

"I found the exercise where we should vary the quality of the phrase very stimulating. … I just could let myself go, even if I didn't know the basic steps very well." (Informant #8)

Another participant had an opposite personal aim with her performance. Neither she felt that she knew the basic dance phrase very well. However, her usual ambition outside dance classes, was often to do things "right," or as they should be. She therefore found the quality "as if you were a top dancer" and put no effort to it, to be the most stimulating. It gave her the opportunity to try to perform the phrase as well as possible. To add other qualities, only gave her too much to think of.

"I didn't know all the movements, so when we should start to interpret and make it sad or so, it became too much to think of. Both to know how to move but also to add a feeling to it. It got harder, so to say. So I guess that's why it was funniest just to try to do it well." (Informant #2)

On the basis of the movement quality work, as well as the imitation exercises, one can point out a few aspects of human movement that makes the movement feel natural for the mover. These aspects can also be applied as conditions for perceiving another person's movements as natural to him or her.

- The movement has to suit my physical body, i.e. size and movement ability, as well as my emotional mood.
- I have to know how to perform the movement mechanically and accept the intention behind the movement.
- The transitions between the shapes must flow and feel harmonic.
- The movement should be spontaneous and free and not require too much intellectual work when doing it.

4.3.3 Personal Space

"The human body is completely oriented towards itself.
It stands free in space. Its only resource, if we can call it that,
is its environment, the spatial sphere which surrounds it,
and into which it can reach with its limbs."
- Rudolf Laban[1]

The body as a tool for expression and communication is very sensitive to the environment and social context. Through working individually and in pairs the participants explored different spatial aspects of the physical environment, e.g. working on different (height) levels (Ex #16: Fishes & Birds) and trying to create as much motion as possible in a room (Ex #17: Fill The Room). They also worked on observing and interpreting how the expression of the space changed depending on how it was populated with people and what they did as well as their internal relations (Ex #20: Interpreting Space).

Two other spatial tasks were to explore the space immediately surrounding oneself (Ex #18: Near Space, VE #3) and to work on positive and negative space in pairs (Ex #19: Positive & Negative Space, VE #3). These exercises encouraged the participants to explore different shapes and how a shape influences the perception of space and vice versa. They also focused the interaction towards the body.

The starting point for the Positive & Negative Space exercise was the well-known optical illusion of a vase/face profile (see Figure 4.5). It is important to point out that there is no value is laid in the notions of positive and negative space. Positive space is often though of as the tangible object that is taking up space, while negative space is the area between the tangible objects (Blom and Chaplin, 1982/89). In the optical illusion and most other situations, one can to some extent choose which space to consider as positive or negative. In this exercise one person in each pair got the task to take up space, to create a shape. The other person should explore or fill the negative space, i.e. the space that was created and surrounded the shape. The exercise was further developed into, every other time, creating a contrasting or complimentary shape to the partner's shape, instead of freely exploring the space. As a second development each pair was asked to choose four collaborative shapes that they preferred, remember these, and put them together as a movement phrase, a duet, to present for the rest of the group. Video examples of the space exercises can be found in Appendix B. Figures 4.7-4.10 show photos of the four space duets.

When exploring the space close to oneself (see Figure 4.6), the focus is drawn towards the physical body and aspects such as intimacy and integrity are emphasised. Working close to and making use of another person's body also generate physical positions and relations that, in other contexts outside the dance studio, might feel awkward.

[1] Laban, 1926, p.7, cited in Maletic, 1987, p.59.

Figure 4.6
Exploring near space (Ex #18).

Figure 4.7
Space duet 1 (Ex #19).

Figure 4.5
Positive and negative space. Photo from Blom and Chaplin (1982).

Figure 4.8
Space duet 2 (Ex #19).

Figure 4.9
Space duet 3 (Ex #19).

Figure 4.10
Space duet 4 (Ex #19).

> *"You associate different body parts with intimacy. It's totally fine when someone approach my face. It's a normal situation, we're used to that. But if someone approaches this area [points at the hips] then it feels like, 'hey, wait a minute'. So I guess it's the habit, when you challenge the habit in a way." (Informant #3)*

There is also a difference in being close to and to physically touch other people. Being very close, but not touching can be perceived as more intimate than physical contact. Again, it is often how we do things, how we touch each other, i.e. the quality of the movement, which decide how we experience it, as formulated by one informant:

> *"It's a difference to sensually touch someone's foot, and when you are at pedicure and they kind of grab your foot, and it's really… Because this movement, when we were touching each other, then it was quite forceful, it was pushing and pulling. There was a different legitimacy for being close to each other because I have to be close to you in order to reach your elbow. And if you don't touch me, what's then the reason for being so close?" (Informant #3)*

How we act or react to other people is also depending on our social relation to them. A certain type of movement is perceived as something that reflects a specific type of behaviour. Our movements will therefore be interpreted as an expression for our personality or attitude. This is something we are more or less conscious about and skilled in utilising. How we move is thus related to which impression of ourselves we want to give the environment (cf. Goffman, 1959). Consequently, this also influences how we move in relation to others and in the company of others.

> *"I think that when all are strangers and they are there of the same reasons, then it doesn't matter. But if you think that next day I have to sit in a meeting with that person then it can be disturbing during the class." (Informant #3)*

The experience and definition of one's personal space in relation to other people, can thus be summarised by emphasising aspects as:

- The physical distance to the other person(s)
- Involved body parts
- The social relation to the other person(s)
- The social context in which the interaction takes place

Consequently, the physical size of the personal space may vary from time to time and is depending on the other person and the social relation to that person as well as the social context. We allow different people to enter different sized personal spheres at different times. This notion of personal space is similar to Hall's notion of intimate spheres (Hall, 1959), and does not necessary overlap with Laban's notion of personal sphere or kinesphere, which is associated to the physical size of one's body, i.e. the body's physical range of motion.

4.4 Exploring Movement through Composition

"Many people have beautiful, creative ideas for dance, but few of these are ever realized as choreographic entities. One of the reasons for this is that it is hard to know how to get from the idea, the flash of insight or inspiration, to the fully completed presentation."
- Blom and Chaplin, 1982

A movement can be literal, abstract or abstracted (Blom and Chaplin, 1988). It can be a well-known gesture such as waving goodbye. It can be an abstract spontaneous movement for its own sake without any particular meaning. And it can be an abstracted movement developed from a literal gesture, e.g. an elaborated goodbye movement. To compose movement implies to consciously create movement expressions by choosing certain movements to suit a specific goal or intention. The goal can for example be to express feelings and emotions or an atmosphere; to communicate a specific message; to tell a story; or to explore movement for the sake of movement. In this creative process one can make use of literal, abstract and abstracted movements. Making human movement expressive beyond gestures, mimics and pantomime deals with the ability to find the essence of what you want to express. The starting point however, could be anything, a personal experienced incident, a theoretical notion, or other artworks. Composition then, often deals with the process of abstracting movement as well as phrasing and forming movement, in order to create a specific movement expression. Through the choreography and the composed movement expression, one is relating the personal movement expression to the environment.

However, there is a huge difference between the fact that movement is expressive and the possibility to express a specific intention through movement. The difference between consciously expressing an intention, and to move inspired by the motion or movement, can be sometimes hard to handle, both for the mover as well as for the viewer. It is the intention of the work that decides which approach that is "the right one." Whether it is to communicate something or to explain something.

In order to gain a deeper understanding of expressions through human movement and to experience the transformation process from an abstract or concrete idea, to a movement idea and physical movement expression, the dance course participants were given several exercises of composition. In this work they combined and further elaborated movement concepts that had been experienced through the improvisation and imitation exercises.

4.4.1 Abstracting Movement

"When you want to express something on your own, to create a movement phrase from an idea or emotion, you are facing a problem that is not related to mechanics but rather intellectual. You have to try to find the questions and the problem and how it should be solved, and then relate it to the physical gestalt. And that I found very, very difficult"
- Informant #9

In the second half of the dance course the participants were given an artistic task of creating and performing a solo piece (Ex #33: Solo Piece, VE #6). The work started by collectively brainstorming words associated to "contemporary phenomena in society." The participants chose some of the suggested words and developed an idea they wanted to work with. The task was to create a dance piece of one to two minutes, which expressed this idea. It was optional to use music, but if they did, they were supposed to be able to perform the piece in silence as well. During two dance classes, the participants worked individually, commented on the work of each other and received personal supervision from the teacher. They were also asked to keep a written logbook of their work. The participants had four weeks in total available for working on the solo piece. The pieces were finally examined in class along with discussions. All nine solo pieces are available on the DVD in Appendix B, and a collage of pictures from the solos is given in Figure 4.11.

The aims of the artistic exercise were to provide the participants with a personal and individual experience of the work process of creating a dance piece, and to express an idea using movements only. During the composition and rehearsal period, the participants had time for developing, refining and reconsidering their ideas, expression and performance. They were constantly exploring, training and increasing their ability to forming, phrasing and abstracting movements, as well as making use of movement elements such as time, space, force and movement quality. In this work they made use of exercises and movement creating tools they had explored during previous classes.

"In order to find the movements that I chose to use, I improvised. I used the idea of different body parts initiating movement. I worked with soft, hard, straight movements, and so on. I consciously made use of tools that I had learned during the course." (Informant #2)

In their choreographies the participants showed examples of different levels of movement abstractions. Some of the pieces had very literate or pantomime like expressions. Other pieces made use of movement on a more abstract and abstracted level. When talking about the work the participants expressed an understanding for the potential of abstracting movement. However, everybody had not developed the skill to physically abstract movement or to create movement expressions that reflected their mental image and idea of what it should look like or what kind of feeling it should reflect.

"How I should have done? I should have kept the start about the same, and then I should have been more distinct. Because, when I watched it, I didn't really understand anything. I

should have thought more of what I did with the body. I might not have used such literate movements. I should maybe have worked on a completely abstract level. … And then I would have done each part more abstract. Except the part where I gain speed and want to change something. There I would have run and kind of, it sounds completely crazy. I should have hit myself to death, but I should have run, like running up on the wall and then falling backwards. It was that expression I was searching for. I would have done that if I had nine lives." (Informant #8)

Through their work with the solo pieces, the participants experienced the difficulty of finding physical movements that correspond to or express a specific though, idea or emotion. They also discovered that there might not be a direct literate relation between feelings or emotions and movement expression. The process of abstracting requires an ability to find the essence of what you want to express as previously discussed. One of the participants created a very expressive solo piece that took its starting point in her personal experience of being in the middle of a war. She thought that her personal and physically grounded experiences had made it easier for her to find the essence of the intended expression:

"I knew the feeling, so it was easier for me. … Compared to how it was for the others. They needed to spend time for sensing how the meaning of the words felt, to find the feeling. But I had the feeling already there. They thought it was my experience of flamenco that did it, but there was no flamenco to it. It was first of all that I knew the feeling already." (Informant #1)

Another participant also discovered the non-direct relation between feelings and movement expression. After having worked on the relation between emotion and movement for a while, she changed her approach. From trying to express the feeling in every movement, she started to focus on doing movements that suited her body and that was her own. Having found the movements, she could then apply the feeling when performing the movements. She explained her work as follows:

"I picked the words that I felt were funniest and easiest to express. They gave me a feeling I felt in my body. And in order to find movements that expressed this feeling, I listened to a song that provoked that feeling. I thought the movements should come naturally when I danced to that music, and that I could just pick out some nice movements. And to some extent it helped, because I got caught in certain movements and some of them I used. But I didn't thought it worked that well and I wanted to find a new method. So I left the feeling completely, because at first I wanted to express it in every movement and that constrained me. So I took another approach and let go of the feeling and only did lots of movements that felt nice to me. And that worked well. When I had the movements, I took back the feeling and tried to do the movements and just add the feeling. That was a good thing. It worked out very well." (Informant #2)

The participant realised thus that there was no clear correlation between the feeling and a movement, and that it was more fruitful to take the starting point in movements that suited her personal movement pattern. She could then perform the movement as if that specific feeling influenced her. This implied that she could make use of a specific quality

Figure 4.11
The solo pieces (Ex #33).

of movement in her performance, while the mechanical movement was something that suited her body physically. Together, that made a coherent movement expression and impression that reflected her intention. This discovery was affirmed by several of the other participants. It is not what you do, but how you do it, that makes the difference.

> *"She wanted to build movement out of the word. But she didn't come anywhere, cause she couldn't think of it that way. And then she just took movements and then tried to put the words into that, and then it worked. I think that was really true. I think it's more how you do what you do, and less what you do. So you can walk down the street and be very happy or very sad, or it doesn't matter what you are doing. You can deal with happiness or sadness or any other feeling." (Informant #4)*

As we have seen, the relation between physical movements and feelings are quite complex, and there exists no clear coherence between the two. However, as feelings as well as

movements are socially and contextually dependent, in specific situation it is possible to interpret certain movements as expression of specific emotions. The most important distinction however, is to remember the huge difference between expressive movements and the ability to express emotions through movement. Even if we can say that a movement is expressive and everybody can agree upon which emotion it reflects, it is a totally different issue to physically express a specific emotion. First of all, it can be difficult to identify which emotion that I feel in a particular situation. Second, an emotion is not always expressed in the same way by the same person, as he or she always will be influenced by the social context in which he or she interact.

4.4.2 The Meaning of Movement

"We had this photo and text and decided to do 'water.' It felt really silly in the beginning, just the thought of 'doing water,' you know. But then, when we first got started and physically did it, it felt really naturally. I guess that that is the challenge, to try to find out what we want to extract and express."
- Informant #7

When watching movement or dance we often try to figure out what the movement is about, why people are doing what they do, and what it means. In a choreographed piece, each movement has a meaning, but the meaning can be different to the creator, the mover and the viewer. To have knowledge and experience of creating movement yourself, implies that you are equipped with tools for understanding and analysing movement. It might not be easier to find a meaning in the movement, but you can search for meaning on other levels than just the literally or obvious ones. One informant expressed it as follows:

> *"Now I might be more analytical and try to see if there is any meaning to it, or if it's just aimed at looking beautiful. … I relate to what we have done, how we have been working and thinking. … I might wonder if they have taken the starting point in something, a theme, a story, an emotion or a feeling." (Informant #7)*

Experiencing the own ability to communicate and express an issue, that the audience understand what you want to say through movement, was a very pleasant and satisfying feeling for most participants. Even if the consciousness about the abstracting process was not always articulated, they were able to describe how they had been working. To take a concrete starting point as in the Photo & Text exercise (Ex #29) where the task was to collectively express an intention, helped the participants to discuss and create meaningful movements and movement concepts. In this work they were also making use of other people's expressions and communicated their experience and interpretation of that. Through discussions and associations regarding how they interpreted the material and what they though it was about, they collectively came down to some issues upon which they could agree:

"When I first read the poem I got a feeling for how I would have done it if I was to do it myself. But we were several people. I was quite pleased with what we did actually. It was quite cool … everybody could recognise the feeling they got from the poem." (Informant #1)

The participants found it sometimes easier to copy the dance teacher's movements than fellow participants' movements. However, the possibility to understand a movement phrase might increase if the movements are well connected and composed. Even if the movement were understood in relation to how it could be performed, people also had to accept the use of that movement in a specific context, in order to be able to perform it and remember it. This issue got particularly visible when the participants shared their movements as part of the Name Phrase exercise (Ex #30, VE #4). In this exercise the participants were supposed to write their name with different body parts and teach their movement phrase to the rest of the group:

Figure 4.12
The two name phrase groups (Ex # 30).

"I found it impossible to understand what they [the other people in the group] meant. I felt that their movements did not fit together. It was like: Ok, now I'm here, then everything can happen. It was not possible to feel what the next movement should be. The movements were randomly in some unclear direction. And that made it more difficult to remember. … I need to understand and accept the meaning of the movement. It is easier to do when I understand why." (Informant #8)

On the other hand, another participant in the same group felt that it was easier to come to an understanding of the other people's movements after a while. To understand the meaning of someone's movement can mean to understand the intention behind the movement, but also to understand how to physically and mechanically do and perform the movement.

"At first, it was difficult to understand how they had though about the letters, that a K could look like that. … But then, when I had understood how they had been thinking, it was easier to do. And it facilitated to know the name of the person. It was logical that L came after U etc." (Informant #1)

During the final dance class, the participants were for the first time, separated into one female and one male group. This decision was taken ad hoc as this constellation never had emerged earlier on the course. The exercise was to make use on movements that the participants had individually found through improvisation, and in groups create a short composition of them (Ex #32: Abstract, VE #5). The aim was to work with abstract movement or movement for the sake of movement, without having to express anything

Figure 4.13
The male group (Ex #32).

Figure 4.14
The female group (Ex #32).

in particular.

The male group chose to not learn each other's movements as some of them found the movements too complex. One of the males also expressed that he wanted to do something that was asymmetrical, as he found symmetry boring (see Figure 4.13). The group developed a system, were they triggered each other's movement phrases. For example when person A did a specific movement it triggered person B's movement or movement phrase, and he repeated this until he got the next movement cue. Consequently, this choreography could go on and on, until they might fall into a stable state where no one triggered each other. This choreography reflected a quite mathematical or algorithmic forming and phrasing of movement.

The female group on the other hand, chose to make use of one or several movements from all participants. Collaboratively, they created a symmetrical composition using the circle as the main shape or floor pattern. Their focus was inwards and towards the middle of the circle. They also had physical contact with each other by holding hands as part of one movement (see Figure 4.14).

These two choreographies showed examples of very different expressions, work methods and how to think about movement. One might also say that they reflected a gender perspective on collaboration and relations. The male group focused on a formal structure and individual movements, while the female group worked on collaborative and round forms. However, this issue has not been further analysed, as I have not applied any gender perspectives to this work. Neither has modern dance so-called male or female movements or clear roles as in e.g. classical ballet.

To summarise one can say that the meaning of movement is created differently from a mover and a viewer's point of view. The creation of meaning from a mover's point of view is related to different levels of understanding and acceptance of the movement. One can understand the movement from a mechanical point of view, that means being able to physically organise the body, or from a qualitative point of view, often related to different kinds of feelings or sensations. In order to find a meaning of the movement you have to accept the movement idea and to agree upon what the movement is about. But you also have to be able to find a personal expression in the movement. One can also accept

the movement as something that feels nice to do, without necessarily having a specific or distinct expression or meaning. Understanding the meaning of the movement helps the mover to make the movement his or her own and to take it into the own body and perform it naturally to him or her.

The creation of meaning from a movement observer's point of view is related to his or her previously experience of physically creating and forming movement phrases. The knowledge in and of the different building blocks and elements of movement makes one able to distinguish different kinds of movements and movement themes from each other. The meaning of movement is therefore related to the possibility and ability to recognise movements and movement concepts that are similar to movements one has tried out or explored one self. The meaning of movement does not have to be literally or be directly mapped between emotions and movement. Finding a meaning in movement could also be related to understanding the intention behind the movement, the starting point or the basic idea, as well as having "only" an expressive or aesthetic aim, e.g. look beautiful.

From a mover's point of view, the meaning of the movement is related to:

- That you can decompose and reconstruct the movement mechanically, accept it as a movement, that you find it logical to do the movements in a specific order and that you physically know how to perform the movement.
- That you accept the quality of the movement, the emotional intention behind the movement, e.g. if the movement is explained as a happy jump and you can feel a happy quality yourself when jumping.
- That you accept the choreographic intention behind the movement, the movement idea, abstraction, e.g. the interpretation of what a L looks like.
- That the movement expresses or communicates a meaning to you, that it is provoked by or provokes a feeling within yourself, distinctively identifiable or not.
- That it feels good in the body to move, that the transitions between the shapes works well, flows and is harmonic, that it feels natural (no specific meaning needed).

From a viewer's point of view, the meaning of the movement is related to:

- That you have a personal experience of physically creating and forming movement phrases, i.e. have knowledge in and of the different building blocks and elements of movement.
- That you can recognise movements and movement concepts that are similar to movements you have done yourself.
- That the movement expresses or communicates a meaning to you, that it is provoked by or provokes a feeling within yourself, distinctively identifiable or not
- That you understand or can identify an intention behind the movement, a starting point or a basic idea.

4.5 Relating Myself to Others

"It was so cool to see that other peoples' movements were so different from mine. But I think that I'd never seen the differences if I hadn't learned to know my own movements first."
- Informant #3

One important aspect of modern dance is to develop a personal movement expression. Hence, it is almost self-evident that the participants learned to know and got insights about their own movement patterns. However, some of them were rather surprised about their own potentials and what they had acquired. These discoveries were often related to their previous conception of dance and their own shortcomings in this area, but also towards their own physical abilities and limitations.

"I know that I'm not that small and petit. And that is probably why I'm so surprised that the movements feel beautiful, despite these long arms and long legs. You have this idea, that it's only the little petit girl that can dance so nicely. And that's why it's so cool that it can feel beautiful, even if I think it's far between my fingers and toes." (Informant #3)

"When we were finding new movement patterns … it [my body] did movements that I've never seen before, and then I've been walking around in this body for 26 years." (Informant #8)

The movement work also provided the participants with a greater bodily consciousness in general. One informant expressed that she had gotten comments from her friends that it looked like she had lost weight. Her own comment to that was that she had not lost weight, but rather changed her posture. She had started to think of how she walked, which gave her another look than before.

Learning to know one's body and movement expression also includes finding out what kind of movement quality one prefer or which movements that suit one best. As discussed in theory chapter, disembodiment can be related to the lack of knowledge of one's own physical possibilities and limitation (Williams, 1999). Being aware of one's physicality, to be embodied, therefore includes knowing one's limitations and possibilities, which clearly was experienced by the course participants.

"I've noticed that there's certain favourite movements that I feel are more fun to do, and I've also become aware of that I avoid certain movements." (Informant #9)

"I haven't got a new way to move, but I've tested different ways of moving. And to some extent I've come to an understanding of how I move. I've understood which are my limits. But I don't think that I've changed my own way of moving." (Informant #3)

Some of the insights about their own movements came as a result of experiencing other people's movements and working in groups, from watching other people performing their composed movements as well as themselves performing others' movements. They had

seen and physically sensed differences in movement qualities, phrases and forms. To do other people's movements became a way to experience how other people move, and that was exciting.

> *"Their movements were not as natural for me and my movements were not at all as natural for them. But it was very fun to try out and feel their movements, and also to experience that I was able to perform their movements, their patterns. Even though it became in my way." (Informant #2)*

> *"It's the other person's personality in the movement, it's not exactly like I feel that it's in my body. Even if I cannot see how I perform the movement, but how I feel it is." (Informant #7)*

These experiences added to the insights about personal differences and preferences. Even if the same task was given to everybody, the suggested solutions were as many as they were participants. Throughout the whole course, the teacher emphasised that there are no right or wrong answers or ways of interpreting the exercises. The own interpretation and experience can never be "wrong" when talking about expressions and how we perceive that. The most important is to follow the own impulse to move, and to catch the first association that comes to you. This skill had been extensively trained in much of the work. Taking such an approach to what is right and wrong as well as physically interacting with each other, contributed to an increased acceptance and respect for other people as well as those people's movements:

> *"I have really experienced that we are so different, and that it depends on what kinds of backgrounds we have. … Others might have a different perception of space for instance." (Informant #7)*

> *"You get another respect for each other when you are allowed to push and pull them, to influence them. Because in this work, another respect and trust for other people is needed." (Informant #1)*

> *"In language you can tell when someone says something wrong, but you can't say anything wrong in dance. … I guess what you are expressing could be wrong, but not the way to express it, I think, it can only be distasteful." (Informant #4)*

As a result from the dance course, almost all informants mentioned that they had acquired an increased self-confidence. This was both related to performing movement in class and to what kinds of movement they thought they were able to do. The insights were something they claimed they could take with them from the course and make use of in other situations and contexts. The increased bodily consciousness and awareness, as well as the experiences of their own movement expression in relation to others, had made them accept their own expression. It was no longer so embarrassing or hard to stand in front of or give a presentation to a crowd. This was also due to the experience that everybody has something they feel insecure about, but that does not have to be a big deal. The experience of creating and performing a solo piece contributed in particular to this experience, as it

was a very personal movement expression and a quite self-revealing exercise. It was also something that they had not thought they were able to do at the beginning of the course.

> *"It was a bit scary in a way, that I actually performed a movement phrase that I had created myself, something that I had reflected and worked on. To perform it, felt quite intimate or … at least personal in a way. Like 'here I am, you are going to watch me and only me right now, because I will show you something that I have created myself.' It became very, I don't know… [Me: Self-revealing?] Yeah exactly, I think so. But in the same time it was a challenge. I mean, it was very fun to do. Just to have been able to do it." (Informant #2)*

Through relating their own movements to themselves and to other people and their movements, the participants had gained an increased self-confidence as they had:

- Increased their bodily consciousness and awareness.
- Increased their acceptance of and confidence in one's own movement expression.
- Increased their acceptance of other peoples' movements.
- Overcome their fears and done things they did not believe they were able to.

4.6 Movement Literacy

"My brother says that he sometimes thinks in pictures.
I usually think in words. But it's kind of sad if you think in words,
because you can only think of things that other people have thought of
before. And then you have this clear border between things.
You can think more abstractly in terms of dance.
I think that can be pretty powerful."
- Informant #4

The famous saying "a picture is worth a thousand words" is often used when we have difficulties of explaining or describing phenomena and rather make use of pictures and illustrations. If we add the dimension of physical experience we might create an even more complex situation to describe. However, dealing with movement and dance we should at least know what we would like to express. Trying to make it easy for oneself by using the excuse that movement is too complex to describe and therefore it is better to just do it, will only make things worse or even more difficult. The ability to express the intention of what you do, and to discuss the issues, is important. I have called this ability movement literacy.

Without being able to communicate verbally about human movement and what it is about, we will never increase the general understanding for this interaction modality. The verbalisation is also the link to our previous experiences and references. Emphasising the verbal part does not mean to strive towards neglecting the importance of physical

experiences, rather the opposite. To take the consequence of the importance of physical experience is also to develop the verbal and not only the physical part of movement literacy. It also means to be able to talk and write about the physical experience as well as being able to actually sense the physical experience. Being movement literate therefore includes to be able to kinaesthetically sense movement concepts such as time, space, force, qualities of movement, phrasing and forming, but also to be able to communicate this experience to others by means of movements as well as words.

As presented in the previous sections, the course participants generated lots of physical movement experiences during the dance classes. All discussions, reflections and written exercises contributed to the verbal ability to communicate their experiences. The participants explored notions such as flow, harmony, integrity, intimacy, energy, force, space, and movement pattern, through physical movements. These notions were in fact old or already known notions and words, although, put in a new context. Through the dance course these concepts became related to other notions such as interaction, movement, body and embodiment.

> *"We have tried different dimensions of dance as expression or to use the body as expressive tool, to feel how it is to use the body, different energies and speed, up and down, and to make use of the space. It has been good to feel it because I have not thought of it that way before, that it could work in this way, that these relations exist." (Informant #9)*

> *"It's been about building new structures or rearranging the way I thought … learning to analyse what's already there. I mean, we all know have to move our bodies and act and all that, but we don't consciously think about it." (Informant #4)*

The work also contributed to a deeper understanding of the challenges and potentials of making use of human movement as an expressive tool or interaction modality. The course participants got an understanding for how we make use of our body, and again, this understanding is based in physical experiences that have been extensively discussed and verbalised. This makes it possible to use the experience in other contexts as well, and not only as a personal physical memory.

Further, as human movement is closely related to emotions, although not directly transferable, movement literacy also includes an understanding of the emotional expressive potential of human movement. As discussed in section 4.5, there is a huge difference between being able to physically express a specific emotion through movement, and that human movement often reflects or expresses emotions.

There is also a great difference between experiencing movement as a mover or as a viewer. Naturally, the skills in both aspects are related to each other. But when it comes to the expressiveness one could say that skilled dancers, who are trained in abstracting movement or performing choreographed abstracted movements, can perform a movement in a way that most viewers will perceive as a specific expression. Therefore one can say that the movement expression has a universal interpretation. However, if asking people who are not trained in abstracting movement, they might have big problems by obtaining a

similar universal interpretation of their movement expression, even if they themselves feels the particular emotion when performing the movement. From the other perspective, as a performer, a skilled dancer does not necessarily feel the specific emotion he or she expresses, although the movement will be interpreted as what it intends to express. And further, it is not likely that a randomly picked person that performs an abstracted movement would by any chance feel the emotion the movement indented to express, just by doing it, as the movement might for example be too complicated to perform.

Movement literacy therefore consists of at least four dimensions:

- A physical ability to sense and feel differences in bodily movement, i.e. a kinaesthetic awareness.
- An ability to verbally express the physical sensations and differences of movement concepts.
- Knowledge and experience of tools for creating movement in general and movement expressions and impressions in particular.
- An understanding for the difference between and the complexity of, expressing through movement and interpreting movement expressions.

Figure 4.15
Kinaesthetic awareness

4.7 The Kinaesthetic Learning Process

"I have had the chance to try it out myself, even if it has been in collaboration with the teacher or other participants. And in some way I have made it mental myself. I have transferred the experiences from the body to the mind, and it has given me so much more."
- Informant #3

The pedagogy used on the course was based on learning and reflection through physically experiencing notions and concepts in order to create an experiential bodily knowledge. However, an important part of this work was to discuss and verbally express the physical experiences in order to further understand and explore what it was about, as well as communicating the personal experiences to others (cf. Blom and Chaplin, 1988, pp. 37, 74-75). In general one can say that the participants took part in a learning process that took its starting point in exploration of their own personal movement expression and their own body's movement possibilities. By familiarising themselves with their own movement and movement pattern, habits and preferences, they increased the physical awareness of their own bodies and how they moved, i.e. developed a kinaesthetic awareness. The more they experienced their own and others' movements, the more they were able to see and discover as well as feel, differences in movements, movement qualities, and personal expressions. They also experienced the ambiguity, complexity, variety, and rich expressive potential of human movement. Through this work they got a physical, intellectual and emotional understanding of the problem area of using human movement as communication modality and design material, both within dance and within interaction design. During the dance classes they trained and experienced their ability to make use of this design potential by transforming abstract ideas and notions into physical movement, as well as abstracting movement per se.

The group exercises stimulated the reflection and generated concrete examples of differences in how people think and reason about movement and interpretations of movement. In a similar way, the written exercises contributed with reflection on and further insight to the work carried out in the dance studio. They also functioned as a possibility to put words onto the participants' experiences and thus increasing the ability to talk about the course and its content. One participant expressed that she got an aha-experience while she was writing her first home assignment. It was first when she formulated her experience of the course that she actually realised what she had learned. She was amazed by this since she had found the dance course exercises quite airy-fairy when she did them in class.

Prior to the course, the participants had very different backgrounds and experiences of working with movement and consciously express themselves through movement. Consequently, they developed their movement design ability differently and on a personal level. However, all participants expressed an increased understanding for human

movement in general and an elaborated relation towards their own movements, movement possibilities and movement patterns in particular. The had also benn able to experience an aesthetic dimension of moving and dancing based in a kinaesthetic awareness, as expressed by one informant:

> *"I think it's great that we don't make use of the mirrors, because then you don't know what it looks like. And then it's only the feeling that guides you. And when I feel that the movements suit my body, and when they flow through, and I'm in a receptive mood and everything is tuned, then it's so… I feel like, it feels beautiful." (Informant #3)*

In section 2.5 I referred to the ongoing discussion within interaction design that concerns which aspects of an experience or activity that contribute to the aesthetics of it. In this discussion I described aesthetic interaction as an improvisational, explorative activity that happens over time and that it requires associative reflections and skilled manipulations. The similarity of this description to the course participants' experiences confirms the statement that interacting with digital artefacts has more in common with experiencing performing arts than art objects. The aesthetic experience arrived to the participants when they felt that they were able to follow their feelings, to go with the flow, both mentally and physically. The experience of their own body and movement ability was put in new contexts. When the participants were improvising and composing movement phrases, they were themselves the experts of the movement pattern. Hence, they could skilfully manipulate their own body and their movements. The kinaesthetic awareness can therefore be pointed out as the basis for the aesthetic potential of the body to provide beautiful experiences of one's body from within.

4.8 Conclusions from the Dance Study

In this Chapter 4's previous sections I have given account for the results from the explorative dance study. I have described the movement exercises that were part of the dance course Physical Expression, as well as described and discussed the course participants' subjective experiences of the work. The exercises were grouped according to three different methods for exploring movements, namely imitation, improvisation and composition. Further, the participants' experiences and reflections of the course were related to theoretical movement concepts such as space, movement quality, kinaesthetic awareness, and also the activity of abstracting, forming, phrasing and relating movement. The analysis was based on multiple individual in-depth interviews with the informants, complemented by their written texts and dance class observations. This work has generated seven categories of movement aspects that reflect the informants' embodied experiences of dance-based movement exploration. The seven categories are: Movement imitation, Movement generation, Natural movements, The meaning of movement, Personal space, Self-confidence, and Movement literacy. Below, I summarise the main findings within each category by describing some of their characteristics and related notions.

Imitation of movement

- When imitating a movement you need to be able to see and understand what there is to imitate.
- The main threshold for imitating a movement is to mechanically understand how to perform the movement. The expression comes in second hand.
- The ability to imitate a movement depends on your previous experiences of similar movements as well as the possibility to ground the movement in your own body.
- Imitation provides a possibility to relate the own movement language to other people's movement pattern.

Movement generators and triggers

- Visual cues, e.g. other people's or object's movement
- Audio cues, e.g. music or sound
- Tangible intentions, e.g. to reach out, grab, kick, displace
- Physical manipulations and impulses from others
- Inner and/or intangible aims, e.g. to express emotions or feelings
- Movement exploration for the sake of movement

Natural movement

- The movement has to suit my physical body as well as emotional mood.
- I have to know how to perform the movement mechanically and accept the intention behind the movement.
- The transitions between the shapes must flow and feel harmonic.
- The movement should be spontaneous and free and not require too much thinking when doing it.

The meaning of the movement - from a mover's point of view

- The movement must be possible to decompose and reconstruct mechanically. It must be accepted as a movement, and it must feel logical to do the movements in a specific order.
- The physical quality of the the movement must be accepted, as well as the emotional intention behind the movement.
- The choreographic intention behind the movement must be accepted, i.e. the movement idea or abstraction.

- Movements can express or communicate a meaning to you, they can be provoked by or provoke a feeling within yourself, distinctively identifiable or not.
- It should feel good in the body when moving, the transitions between the shapes should work well, flow and be harmonic. It should feel natural (no specific meaning needed).

The meaning of the movement - from a viewer's point of view

- The personal experiences of physically creating and forming movement phrases, i.e. knowledge in and of the different building blocks and elements of movement.
- Recognition of movements and movement concepts that are similar to movements you have done yourself.
- Movements can express or communicate a meaning to you, they can be provoked by or provoke a feeling within yourself, distinctively identifiable or not.
- To understand or be able to identify an intention behind the movement, a starting point or a basic idea.

The experienced personal space

- The physical distance to the other person(s)
- Involved body parts
- The social relation to the other person(s)
- The social context in which the interaction takes place.

Self-confidence and personal development

- Increased their bodily consciousness and awareness.
- Increased their acceptance of and confidence in one's own movement expression.
- Increased their acceptance of other peoples' movements.
- Overcome their fears and done things they did not believe they were able to.

Movement literacy

- A physical ability to sense and feel differences in bodily movement, i.e. a kinaesthetic awareness.
- An ability to verbally express the physical sensations and differences of movement concepts.
- Knowledge and experience of tools for creating movement in general and movement expressions and impressions in particular.

- An understanding for the difference between and the complexity of, expressing through movement and interpreting movement expression.

The aim of the dance study was to generate movement experiences that could be used to inform movement-based interaction design. Consequently, the built-in focus on interaction design has also influenced the analysis. However, the work carried out in the dance studio as well as the seven categories of movement aspects has its theoretical and methodological base in modern dance. Through this work I have gained an increased understanding for aspects of human movement that people find interesting, intricate, complex or exciting. Since most of the informants were non-experienced in dance, introducing dance terminology and dance-based exercises influenced their movement experiences in a certain direction. However, modern dance was deliberately chosen as the area and starting point for this study, due to its interest in human movement and movement expression per se.

The seven categories reflect aspects of human movement that are closely related to personal preferences and emphasise the individuality in experiences. They also bring up the intimate relation between emotional, physical and intellectual aspects of human movement. In the next chapter I will relate the personal movement experiences to interaction design through referring to two design workshops that were carried out as part of the dance course. Further, I will point towards how the content of the seven categories could be transformed to relevant design implications for movement-based interaction design. In Chapter 6 I will give a concrete design example of how the experiences from the dance study were used as starting point for the design of a movement-based interaction concept.

Chapter 5

From Movement Experiences to Interaction Design

In this chapter I describe how the bridge between the dance course experiences and interaction design was created. First, I briefly describe the two design workshops that were arranged as part of the dance course. They aimed at relating the physical dance experiences to interaction concepts and ideas. Second, I discuss the interaction design ideas produced during the workshops and how they reflected dance and movement concepts. Third, I point towards how the results from the dance study could inform movement-based interaction design. A design case where these results are implemented is presented in Chapter 6 and 7.

5.1 Design Workshops as Part of the Dance Course

Towards the end of the dance course Physical Expression the participants took part in two design workshops. The aim of the workshops, as part of the course, was to give the participants a possibility to develop ideas related to movement interaction and to bridge the experiences from the dance studio to human computer interaction design. The purpose of the workshops in relation to the holistic design process was to generate interaction design ideas and interesting notions to further develop and implement in the second block (cf. Figure 3.1).

The first workshop was carried out during the last but one week of the course. It was scheduled for a full day and was facilitated by two colleagues of mine, Sinna Lindquist and Helena Tobiasson, who were experienced in facilitating user centred and participatory design workshops (Westerlund et al., 2003). They had only got a brief presentation of what the course consisted of and the workshop was their first meeting with the course participants. The workshop focused on physical movements as interaction form, bodily interaction and communication. Prior to the workshop, we had not decided any application areas to design for, or whether movements should be used as input or output or both, as we

wanted to put the focus on the interaction itself rather than the technology needed.

Our first impression of the designs resulting from the first workshop was that they were quite general and did not reflect direct relations to the course. A second workshop was therefore planned in order to generate more specific movement interaction concept. This took place one week after the last dance class. It was scheduled for a half day and was facilitated by me. The aim of the second workshop was to further explore the notion of flow that had aroused as a central issue during the first workshop, and to come up with design ideas related to flow and interaction.

After a second thought and further reflection on the designs from both workshops, it became clear that the results from the first workshop did reflect several aspects from the dance course. I will come back to this in section 5.2. The results obtained from both workshops reflected a holistic view on the human as a user and the designs dealt with physical movement aspects such as flow, harmony, stress, space, and intimacy. In the next sections I will present the work and result from each of the two workshops.

5.1.1 Results from Workshop #1

The participants were first asked to brainstorm words they associated to the dance course as well as to their education or profession, and write down the words on post-it notes. The aim was to provide a possibility for creating new concepts as a result of inventive combinations of words from the two areas. When the brainstorming was done, the participants collaboratively grouped the words into ad hoc categories. Some of the words were placed in several groups. After having categorised the words, they picked three to five words each, which they found interesting and wanted to work on. Finally, they formed three groups by searching for other participants who had picked words they wanted to merge their own with. Then, each group was asked to think of self-experienced everyday interaction problems or situations that could be associated to the chosen words. Through creating scenarios for each problem and act out the interaction situation while videotaping, they could visualise and point at issues they wanted to emphasise (Westerlund, et al., 2003). Apart from video camera equipment, they also had clay, paper and pencils in different colours to stimulate their creativity and generation of ideas. At the end of the workshop, each group presented their video films and the designs were discussed. Below, I present each group's design ideas.

The Flow Group

This group presented two problems: the Traffic Flow Problem and the Airport Flow Problem. Both problems concerned technology as a flow constrainer and they argued that most often it is people that must wait for or adapt to technology. Consequently, we cannot follow our personal flow. The Traffic Flow Problem focused on the situation when you want to cross the street and there are no cars, but the light is still red. Most often you cross anyway. You do not want to wait for the lights to switch from red to green, as you know you can cross safely anyway. As a solution, the group suggested a sensor that caused

the traffic lights for pedestrians to switch to green when you approached and there were no cars passing. The Airport Flow Problem (see Figure 5.1) addressed the huge number of different tasks and stops one need to go through when taking a flight: transfer, check in, security control, passport control, wait at the gate, boarding the aircraft, the flight, disembarking the aircraft, passport control, luggage claim, customs, and transfer again. They suggested a system where you could check in during the bus trip and once you had gone through the safety and passport control, you did not have to do it again.

Figure 5.1
The Airport Flow Problem by the Flow group.

The Posture Group

The group's work took its starting point in the importance of taking care of the body and to have a proper posture in order to avoid bodily pain and injury. Their solution was a system you could use at home that included a device that recorded and scanned your movement pattern or how you moved. You could then take the video to your doctor for analysis, and further to the physiotherapist in order to create a program for retraining your movement pattern. The solution was shown as an alternative to the traditional way of treating physical complaints by using painkillers.

Figure 5.2
Illustration by the Posture group

The Space Group

This group presented four different problems: the Personal Sphere, Sticking Together, Music Path, and the Elevator. The Personal Sphere originated in the experience of people paying too little attention to others' physical presence in cramped spaces. People bump into each other in shops or take up too much space for themselves on the pavement, such as walking several perambulators side by side. The Personal Sphere was a physical device that you placed around the waist and that physically pushed away people when they came too close. It also avoided people to be able to get to close as it defined a physical area around its wearer (see Figure 5.3 and video example #7 in Appendix B). The Sticking Together application made people remain sticking together if they bumped into each other, and they were only released when they apologised

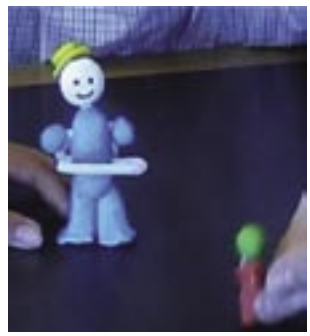


Figure 5.3
The Personal Sphere by the Space group.

themselves to the other person. The Music Path application made use of a camera or sensor that scanned people's level of stress by the way they walked. It also contained a sound system that played either calm music to stress down the walkers, or music that reflected their level of stress in order to remind them of their behaviour. The Elevator was a self-experienced problem that occurred during the workshop. The problem was to open the elevator door and push the buttons when having both arms full of stuff. They suggested using head movements to indicate which floor you wanted to go to, up or down, and stamping the foot in order to open the door.

5.1.2 Results from Workshop #2

For the second workshop I choose to continue the work with the notion of flow. It had arisen as a central notion during the first workshop. Several of the informants had also during the interviews brought up flow as an interesting interaction quality. Based on the experiences from the first workshop, we wanted to work more focused towards concrete applications and design ideas in order to see how an idea of the notion of flow could be reflected in the physical movement-based interaction design.

The workshop started by collaboratively brainstorming words associated to the notion of flow. The words such as natural, harmony, water, and stress, were written down on a white-board. Then the participants were asked to think of words that described physical places or contexts where flow as interaction quality could take place or were it was lacking, e.g. work place, queues, shopping mall, or at home. Finally, they brainstormed examples of artefacts or objects that could be used within the context of, or associated to, the previous words, e.g. water boiler, the car, mobile phone, elevator, and newspaper.

After the brainstorming session each participant chose one word from each category, i.e. a word associated to flow, a place and an artefact. Then they got the exercise to define and describe a problem related to or inspired by these three words, and come up with a draft solution to the problem. This solution could be an application, a product, an artefact, etc. They should also give the concept a name and prepare a two minutes presentation of the problem and solution for the rest of the group.

The five individual problems and solutions addressed the following issues:

- The Commercial Loop makes you to pick down commercials or put up messages that pass by (flows) on a display placed in the subway trains, by the help of your mobile phone.
- PTRem (Place and Time Reminder) reminds you if you are at the wrong place at the wrong time making use of a GPS (Global Positioning System) device and your digital calendar.
- Learn From History addresses the anxiety for making decisions. It can log your evaluation of earlier decisions and helps you decide the alternative that, according to you previous history, will make you most pleased.

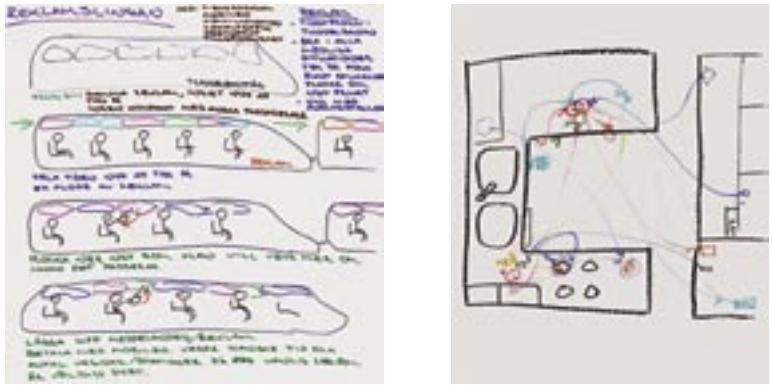


Figure 5.4
Sketches of two design ideas from the second dance course design workshop: The Commercial Loop (left) and the Optimal Kitchen (right).

- The Optimal Kitchen is designed to place together things that are used together in order to minimise the number of needed removals when cooking, e.g. cheese is normally used together with a cheese slicer and should therefore be placed near each other.
- The Schedule Updater automatically updates an online classroom schedule or lunch restaurant menu when changes are made from elsewhere.

After each participant's presentation, the problems and solutions were discussed and everybody got a chance to ask questions and make comments. The next task was, democratically through voting, to choose one of the problem/solution presented that could be further developed through a parallel design in two groups. Each participant got three votes. They were allowed to distribute them among the concepts, as they wanted. The Learn From History application got most votes and was therefore further developed by two groups, consisting of two and three persons respectively. The groups were asked to discuss and agree on how they wanted to interpret the suggested problem and solution, and to further develop the solution or come up with another one. They were asked to define a context and a user group as well as a (new) name for the solution. The interaction should be demonstrated by building a full-scale mock-up and use this when presenting the idea for the other group.

One group created a Reciptomat, an automat that generated different kinds of recipes and that could for instance be placed in grocery shops. You could choose the ingredients that you felt like having for dinner and put them on the Reciptomat. Then you got suggestions for several recipes, which included your ingredients. You could also chose the price level of additional ingredients as well as time for cooking, allergies and level of difficulty. The application reflected anxiety for decisions in everyday life, such as figuring

out what to eat for dinner each day. The group thought that bigger issues like choosing a life partner and its like, should not be left to a computer. Along with the Reciptomat the group had designed a circular grocery shop having several entrances and exits, and where the different types of groceries were placed according to the shoppers need, and not according to commercial strategically placements, e.g. fast food close to the entrance/exit and raw material for making dishes from scratch in the middle of the shop.

The other group addressed the anxiety of decision in relation to prioritising scheduled activities. They had made a PDA application similar to a calendar where you could insert all your activities, and then the application made a suggestion for which activity to prioritise. After the activity you could evaluate how pleased you were with the choice made by the application. This information was saved and made use of in the application's next recommendation. Hence, the system learned your preferences and helped you to prioritise your time schedule. This issue was often experienced as an anxiety related activity because of the possibility to make wrong prioritisations. The group also expressed that it was easier when someone else, in this case the application, made the choices. Because then they could blame the application, and not themselves, if the choice turned out to be wrong or bad.

5.2 Reflecting on the Designs

Several of the course participants expressed during the final interview that they were disappointed that they had not been able to create more physical or movement-based interaction ideas during the workshops. This might be due to the difficulty of imagining and coming up with new interaction concepts without having some examples to start with. On the other hand, after some reflecting, the participants found several connections between the dance class work and their ideas. A few participants thought that they would not have come up with the same design ideas without attending the dance course.

One reason for the participants' immediate disappointment might be that their design ideas and concepts did not specifically make use of movement as interaction modality. The concepts from the first workshop reflected physical movement experiences on a more abstract level and could be related to movement concepts such as kinaesthetic awareness, movement quality or elements of movement. One can also say that the design ideas made use of the bodily experience on a meta-level, as they reflected bodily concerns and a holistic perspective of the user and the situation in which the interaction took place.

Several ideas from the first workshop reflected different aspects of flow. The emphasis was related to the physical experience of feeling flow and harmony in their movement. The notion of flow was directly used in the Flow Group's design ideas, but was also reflected in other designs such as the Grocery Store, Personal Sphere or the Optimal Kitchen. In Sticking Together the personal flow was disrupted by the application in order to remind people to apologise themselves. The design ideas showed that the participants had been

able to transfer the interaction quality of flow to other interaction areas than mere physical movement. One of the informants had realised why he preferred taking the train instead of flying, as travelling by train allowed him to follow the personal flow to a larger extent than with airplane flights. He had also began to analyse why he felt stressed, and thought this was related to the lack of flow:

> *"I was talking to one of my friends back home and I told him that 'wow I've found this cool thing about flow and this explains why I don't like flying on the airplane and why I rather take the train.' And he was like 'oh, my mom thinks I'm crazy because I rather take the train when I go home than fly, because it's such a mess with flying.' That's a personal thing where I now begin to analyse when I get stressed, figuring out how I can organise things better." (Informant #4)*

The same informant also related the notion of flow to other areas of technology and applications such as e-mail:

> *"When we took the video camera out to film people, everywhere we saw all these problems with flow. Then the more I thought about it, the problems that we have of integrating technology into our lives are about flow. … I'm actually thinking about e-mail, because every time I get an e-mail I get really stressed and distracted. Say I'm waiting for a letter from my mom, so I open up e-mail and I get all these letters with all these unrelated things, and then I get distracted and I need to do this and this and this and this. I just wanted to do this one thing, and then it became this big mess. And I get really stressed. So just thinking of the flow, it would have been better if I decided 'ok now I want to see if there is a letter from my mother', and then, it would only let me check that, and it would keep all those other things, that are not really important, that it would keep those things away from me." (Informant #4)*

Another informant could also transfer the fluent quality of movement to how to interact with an application. As with natural movement, he found it important that the transitions between functions and different aspects of the applications should be smooth and natural:

> *"I'm working on this administration interface and I feel that I would like to add a bit of movement to it. I don't know if it's due to the course, but I've got an urge to avoid having things so square. … To make the transitions between the functions naturally." (Informant #8)*

The notion of flow used in these examples is similar to Mihály Csíkszentmihályi's notion of flow (Csíkszentmihályi, 1990). He describes flow as a mental state where you are on the edge of what you can manage. Flow can be experienced in relation to most kinds of activities. However, the informants' interaction concepts of flow reflected a more physical and sensational aspect than what is present in Csíkszentmihályi's theories, which are described on a cognitive or intellectual level.

The Posture Group's design reflected an increased bodily consciousness or kinaesthetic awareness. Their applications emphasised the possibility to teach the body how to move in order to avoid muscular pain, as alternative to synthetic painkillers. This aspect was also

Figure 5.5
Spatial aspects of human movement. From theoretical notions of positive and negative space, via physical explorations (Ex #19), to movement-based interaction design (Personal Sphere).

expressed in the Music Path application where the music imitated or interpreted people's movement quality. In order to change the quality they had to feel how they moved.

Personal space was another aspect that was reflected in the design ideas. This issue had already been brought up during the first interview with one of the informants, but was also physically elaborated during the course as discussed in Chapter 4. The exploration of three-dimensionality, forms, shapes and directions that was carried out during the course, had added to the participants' general perception and knowledge about design and form. It was especially Personal Sphere and Sticking Together from the first workshop, and PTRem and Optimal Kitchen from the second workshop that reflected spatial aspects. The designs from the first workshop were directed to the bodily personal space while the second workshop's designs addressed people's movement and change of positions in the general or infinite space.

Prior to the second workshop I wanted to see if it was possible to force the participants to design more specified movement-based applications, and therefore chose to work with flow as movement concept. However, the result turned out to be less movement related than results from the first workshop. This might be due to how the traditional methodology narrowed the design space and thus possible design outcomes. For future workshops it might be a good idea to stronger emphasise movement as the interaction modality if one wants to develop pure movement-based interaction. On the other hand, this could also have the consequence that movement is used in inappropriate contexts and only "for the sake of using movement." Consequently, one should preferably work with movement-based interaction on an experiential level and evaluate if movement might be an appropriate interaction modality in each case.

Almost all informants expressed some kind of personal development as a result from attending the course. Through their experiences they had developed general abilities and skills that could be useful in (collaborative) design and development work within interaction design. They had got an increased understanding of individual differences among people and thus a greater acceptance for others' points of view. This experience could

be useful both when designing for users' different preferences, but also when discussing with designer colleagues. The participants had also learned to trust their own impulses and ideas. Several informants expressed the usefulness of these issues when creating IT applications and carrying out design work:

> *"I will trust my impulses more. It is often about creating something. If you are going to build a system, you need to generate ideas about what it should look like. And then you need to rely on your own inspiration, the ideas you get. Not only thinking that another person I know is good, and probably have a better idea so we should use that instead, but to emphasise and develop my own ideas." (Informant #7)*

> *"I hope I become a better engineer, so to say, when having the bodily perspective as well." (Informant #6)*

One of the course participants was doing research within gesture-based interaction. During one of the interviews we discussed the possibility of using free full-body movement as interaction modality. She thought that the big challenge of using movement as interaction modality was related to the individual differences and personal preferences people have for movement as well as the richness in movement. She argued that in order to make the interaction harmonic we need to design for some kind of naturalness. But it might be impossible to implement this for all kinds of bodies and preferences in the same application. At some point we have to make generalisations and categories. These issues were also brought up by several of the other informants.

> *"When ywe use point-click-interfaces we are probably quite similar, but when we deal with bodily interaction, it can be so extremely different what we are willing to do, what feels comfortable and so on." (Informant #3)*

> *"When we do user studies on normal systems, we think of what kind of person the user is, the computer familiarity, and all these kinds of questions. Now, we have to include another dimension as well. We have to take into account how our body is suited for performing this." (Informant #1)*

> *"So, to some extent I think that if using movements in a public environment, they have to be more discreet than what they need to be when used in a computer game or at home. But I also think that it's important that the movements are based on natural body language, that they melt into each other and can be combined." (Informant #3)*

Even though design workshops did not produce any groundbreaking interaction concepts, they reflected the physical movement work that had been carried out, through notions as flow, space and bodily consciousness. They also pointed out which movement notions and concepts that had been experienced as interesting and relevant to interaction design. The design ideas functioned as input for my own design work and pointed at interesting notions and concepts to further work on. In the next section I will return to the movement aspects that resulted from the dance study and discuss how they could be relevant to movement-based interaction design.

5.3 Consequences for Movement-Based Interaction Design

In section 4.8 I summarised the seven categories of movement aspects that arose from the dance study. The categories were Movement imitation, Movement generation, Natural movements, The meaning of movement, Personal space, Self-confidence and Movement literacy. To generalise one can say that the notion of movement literacy is most relevant to the designer's ability to create and design people-centred movement-based interaction. Included in this notion, is an ambition that the designer should have knowledge of which kinds of movements that are experienced as natural movements and how meaning is created through movement, as those aspects are important to the user experience. The personal interaction space, what kinds of movements we use for input and output, as well as knowledge about what generates them, are issues that influence and are influenced by the application, its intention and its technological aspects.

The ability to communicate through a specific language is related to one's literacy in the actual language. This is still valid when we want to communicate through artefacts or products as well as design. I will therefore argue that in order to see the potentials as well as limitations for using movement as interaction modality one need to have physical and bodily knowledge of human movement, beyond everyday movement patterns. Being movement literate means to increase the potential for designing embodied interaction that is physically grounded. When ignoring the movement literacy and knowledge of the design material, there is a risk that we only make use of the mechanical or literate aspects of movement. This leads to an exclusion of abstract and abstracted movements, through which we can communicate on a more subtle level. When we can see beyond the first spontaneus need to literally understand every movement and that every movement must "mean" something, we can also start to make use of movement for the sake of movement. This opens up for designing for the mere pleasure of movement, i.e. the feeling of sensing the body in motion.

Another aspect of movement literacy is the ability to verbally express and communicate aspects of movement. Today, interaction design projects are often multidisciplinary and involve several project members. When discussing design and development the project memebers need to express their intentions and ideas to the group. Even if one can show and do movements, it is not always possible or desirable to convey the specifics of movement through movement. One also need to be able to describe and express verbally and to convey the feeling and experience of the movement, not only show its physical performance.

When using movements for communication, it is important that we have an understanding of the movement. That we feel that there is a relation between what we do and what we would like to express. If this consistency does not exist, we will feel lost or dumb. As discussed in the introduction chapter, several movement-based interfaces make use of movement imitation. However, when imitating a movement you need to be able to see and understand what there is to imitate. Further, the ability to imitate a movement

depends on your previous experiences of similar movements, but also your personal physical body and preferences of movement concepts such as movement quality. If the movement is too complex or different from your personal natural or intuitive movement pattern, you will spend too much effort and time on figuring out what to do, i.e. how to give the system the "right" input, instead of focusing on the original task or activity. However, the perspectives of this issue are very much related to the specific application and its context. As usual, one must consider the system's intended user group, use context and experience level. In some situations we might want to have a very specific movement that requires training, while other times we search for means of input that are intuitive and can be quickly learned and understood.

Talking about natural movement in relation to interaction design means to open up for individual movement preferences. This includes taking into account differences in how we move and experience movement. Movements that I think is fast, might another find slow. What you think is a happy movement, I might characterise as aggressive. When two persons perform the same movement they might have different intentions and thus create different expressions. As I will have other movement experiences than my colleague, I will get another movement impression than her. My personal impression of my own movement might also differ from the viewers' impression of my movement. This double role or bilateral aspect of human movement is an interesting potential for interaction experiences. It contributes to the possibility to observe myself when moving. I can therefore constantly change my interaction and get immediate feedback though the body. For this interaction, the kinaesthetic sense is crucial.

As previously discussed, one can have tangible as well as intangible aims for moving. However, in order to start moving one need something that encourages movement in the first place. These movement-triggers could be visual or audio cues as well as physical manipulations. A visual cue can be other people's movements and actions, as movement creates meaning. Music and sound are also something that might generate movement. However, people in general need a social excuse or reason to move. The social setting often defines which movements are appropriate and this delimits which movements one feels comfortable doing. On the other hand, through movement or when making a move, one can change a social ambiance and influence the environment physically and even socially. Moving objects are easier noticed than still ones. Moving objects can therefore be perceived as disturbing, as they are difficult to ignore. Hence, movement has social impact as well as it is influenced by the social surroundings. When making use of movement as interaction modality, we therefore need to take into account in which social context the interaction is meant to take place. Do we want to create a new movement expression in an environment? Do we want the interaction to be highly visible or discrete? Is it possible to scale the movement depending on in which context you interact?

To use movement as interaction modality might involve both input and output. The examples of movement-based interfaces described in the introduction, made in most cases use of bodily movement as input modality only. The output was based on visual

movement such as motions pictures, or sound. Another aspect of the output is that it often creates a focus away from the user, and thus outside the personal sphere. When making use of the personal sphere as interaction space for both input and output, the interaction comes closer to your self, physically. However, when focusing on the physical body, one might also discover other aspects of oneself due to the close relationship between bodily, emotional and intellectual aspects of movement. In the next chapter I will give an example of how these issues could be taken into account in concrete design through describing the emergence and experiences of a movement-based interaction concept called BodyBug.

Chapter 6

BodyBug - A KinAesthetic Movement Interaction Concept

The design work that resulted in BodyBug was carried out in collaboration with interaction designer Johan Sandsjö. It started off by a two-day concept design workshop where we created a mock-up that demonstrated an innovative movement-based interaction concept. The concept was further developed and implemented into a functional prototype within a time frame of ten weeks. As a second phase, we reconsidered the prototype's mechanics and physical appearance and built a second version. In this chapter I describe the interaction concept and how it emerged through using results from the dance study as basis for our design decisions. The dance exercises will be referred to as Ex #1 to Ex #33, and the video examples as VE #1 to VE #6, as in Chapter 4. The implemented prototype along with interaction experiences of it will be presented in Chapter 7.

6.1 Initial Design Intentions and Criteria

In order to delimit our design space we started the work by discussing some desirable properties of the intended interaction concept. We agreed on making an artefact or object rather that a system. In addition, the artefact should be small enough to be carried around, i.e. be a mobile, wearable device. Further, the interaction concept should be independent of context and place, and everybody irrespective of (dis)abilities or age should be able to use it. The aim of the interaction concept was to make people move, and we decided not to build in any further functionality in the device. We wanted to design "something that I can take with me wherever I go and that I can use as I want to." These decisions followed from an interest in the growing trend within interaction design that deals with artefacts without any specific functionality or context of use, apart from being provocative or critical objects. These objects can also be used as expressions of identity or group affiliation, as well as being toys, jewellery, ornaments, or just "designed stuff." However, we had one important design criterion that was to make use of movement as the main interaction

modality. The emphasis was therefore put on developing a movement-based interaction concept rather than finding application areas for it.

Our ambition for the movement interaction concept was that it should make people move and trigger movement. Preferably it should also create "new" or "unusual" movement through encouraging spontaneous movements. Further, we discussed whether to define the concept as a tool, or a toy, as art or as something in between. As we wanted the concept to be an artefact that could stand for itself, the closest we got to categorise it was that it could be used as a device for learning about your own movements through experiencing and sensing them. We also discussed the notion of toy, but we thought that aiming at designing a toy would limit rather than open up for a variety of uses and users. On the other hand, the concept could definitely be considered as something to play around with, especially since we aimed at creating a concept that was fun to use. One of the important experiences from the dance course study was that the participants thought it had been fun to attend the course and that it was fun to move. Consequently, we aimed for preserving the pleasure of movement and motion as an interaction quality in our movement concept.

Even though we wanted to create a small device, we aimed at designing a full-scale interaction space, which meant to involve the whole body when interacting. However, we thought that the size of the device does not have to be proportional to the interaction space it creates. We took the ball as an example. A ball can be a very tiny object, but still make people move through large spaces and it can generate big movements. This could be

Table 6.1 Initial Design Intentions and Criteria

Artefact criteria
• A small, wearable device, something I can take with me
• An independent artefact, not built into something else
• A neutral and robust-looking everyday object
• Not a toy, or a tool, neither art, maybe a learning device
• No specific in-built functionalities
Movement intentions
• Make people move and trigger movement
• Create "new" or "unusual" movements
• Learn about your own movements through experiencing and sensing them
• Involve the whole body
• Use movement as both input and output, no additional lights or sounds
• Could be used independently of space and place
• Could be used by everybody, disabled or non-disabled, young or old

compared to a mobile phone, which focuses and converges the interaction towards small movements in a tiny interaction space.

In everyday life, we normally manipulate and interact with objects through use of our hands and fingers. In order to search for how we could create and trigger new movement, we did a very simple but useful experiment. In order to try out how it was possible to make use of other body parts than our fingers as interaction tools, we tried to gesture with our hands fisted. We thus disabled the rich expressive and sensing potential of the hands. Our movements became bigger and more exaggerated which automatically involved larger parts of the body. Loosing the expressiveness of our hands, we needed to make use of additional parts of our body in order to create a nuanced and rich movement expression.

As earlier discussed, existing movement-based interaction applications often make use of movements as input. Most often the output is not a tangible or physical movement, rather moving visual graphics or sounds. We therefore wanted to create a concept that made use of movement both as input and output, and that also was independent of visual and audio output. This implied to make use of the kinaesthetic sense to feel and perceive movement, or in other words to use the body as a haptic display. The initial design intentions and criteria are summarised in Table 6.1.

Prior to the design workshop I had sent a few texts to Johan that described parts of my previous work including the dance course, as well as various reflections on the design work to be carried out. However, as Johan had no previous experience of modern dance training we watched a few videotaped examples of exercises from the dance course. This gave me the opportunity to share my observations from the dance course and to show examples of some of the movement work that I intended to use as a basis for the design. When we watched the video clips I described the aims and pedagogical intentions of the exercises. I also pointed at aspects of movement that could be experienced through this kind of work such as time, space, energy and movement quality. We watched exercises that concerned exploration of the notion of space (Ex #17: Fill the Room, Ex #18: Near Space, Ex #19: Positive & Negative Space), movement qualities (Ex #27: As If), movement impulses (Ex #14: Movement Impulse), and movement composition (Ex #33: Solo Piece). Video examples of these exercises can be found on the DVD in Appendix B. In Table 6.2-6.5 I present the video examples that we watched along with a summarised version of how i described the work to Johan during the workshop, this is indicated by referring to "Jin, Concept design workshop."

In the following sections I present the results of our discussions and reflections of the movement concepts and how we related them to the design. I also discuss the initial design criteria and how they were further specified and grounded in the dance course experiences throughout our work.

6.2 Personal Interaction Space

People in general are not so aware of the three-dimensionality of their bodies and movement, or the depth they take up in space. An illustrating example is when people wear backpacks and do not think of their increased size, and starts turning around, bumping into people as a result. During the dance course the participants were encouraged to explore the use of different body parts as well as directions. They trained the ability to sense and feel their bodies and to increase the kinaesthetic awareness of how they moved through space. All dance classes were carried out without making use of mirrors. Although mirrors can be very useful tool in dance education, when watching yourself through the mirrors, the expression is reduced to two dimensions. The mirror also locks the visual focus and thus your bodily orientation towards one specific direction. The three-dimensionality of human movement was something we wanted to preserve in the interaction concept. Consequently, we aimed at designing a concept that was independent of a specific dedicated interaction space or direction.

How a space is created when people interact in it was explored in the Interpreting Space exercise (Ex #20). The dance teacher asked one or two participants to enter the stage space, defined as one half of the dance studio, in different ways and to take different position, make a shape, or do a movement. The rest of the group commented and discussed how the impression and interpretation of the physical space changed depending on the poses and directions of the body. The participants that populated the space also got the possibility to express how they felt about being in the space. The experience and interpretation of moving within a dedicated interaction space might be related Goffman's notions of frontstage and backstage as well as the expressions given and the expression given off (Goffman, 1959). In performing arts the separation between the stage and the audience has traditionally been an important part of the aesthetics. However, along with influences from performance and installation art the borders between spectator and performer more and more vanish. This is even relevant to interaction design as it relates to the increasing use of ubiquitous and pervasive computing. In this aspect the notion of embodied as well as tangible interaction has come into play.

Figure 6.1
Exploring physical shapes and positive and negative space (Ex #19).

We also wanted to design for tangible interaction, but aiming for involving the whole body and not only the hands. The full-body tangibility was also part of striving towards using movement both as input and output as well as being able to kinaesthetically sense the interaction, i.e. making use of the body as a haptic display. Consequently, we wanted to create an artefact that interacted close to the body, and could be touched and manipulated by other body parts than the hands. Therefore we became especially interested in working

Table 6.2 Video Example #3: Space

Ex #17 - Fill the Room
Filling the room with motion
"They moved quantitatively a lot, which means they did big movements involving large muscle groups, like jumps and swinging the whole length of their arms, stretching out their bodies in order to reaching and move through as large spaces as possible. The focus of the movements seemed to be outwards and a have a direction forwards. They related their bodies and movements to the physical space that they were supposed to fill, i.e. the physical room. The speed was quite fast, but not as fast as running, large movements takes longer time to do. They were quite exhausted after the 30 seconds the exercise lasted." (Jin, Concept design workshop)
Ex #18 - Close Space
Exploring the immediate space around themselves
"The movements got much smaller now than in the previous exercise. The movement seemed to be more careful and they also moved more slowly. Their focus seemed to be inwards or towards their own body. Most of them stayed at the same, small physical spot during the whole exercise. However, some participants moved around and explored the "new" immediate space that was created along with their displacement in space." (Jin, Concept design workshop)
Ex #19 - Positive & Negative Space
Working in pairs. One person is making a shape and "freezes" that shape, the other is making a shape that "fitted" into the first one. They were also every other time filling the space around each other's shapes with movements.
"The teacher was first showing the well-known illustration of a vase/two silhouettes (Figure 4.5) where it is possible to see either one of the motif. The aim of the exercise was to get a sense of the physical shape made by the other person and to complement or contrast that one. From an observer's point of view it became very intimate relations in some of the duets. They placed themselves in positions and at distances you should never allow anyone to have in an everyday situation. Being close but not touching made it very intimate. Sometimes it is less intimate to physically touch someone than to be really, really close but still not touching, e.g. only feeling the warmth from the other's body. During the exercise the participants did not seem to be disturbed by the intimacy but rather focused on the task. However, during the interviews one participant was worried for getting a too informal or intimate relation to one of the other participants as she had a professional role as that person's tutor."
Performing a short choreography or movement phrase made out of four of the complementary shapes each pair had created in the previous exercise.
"This was one of the first exercises where they created movements that was performed in front of the other participants. The short choreographies showed that some of the pairs also had started to touch or physically interact with each other using different body parts." (Jin, Concept design workshop)

with the space immediately surrounding ourselves. We had seen in the space exercises that explorations of this space focused the movements towards the body. It also created smaller, subtler movements and had a more directed focus towards the body than movement that aimed at utilising the far space, i.e. outside one's kinesphere. The interaction also seemed to include greater bodily movement awareness as the movements were performed slower. As discussed in section 4.3.3, the personal interaction space is not only following the user's displacements, but the user also defines it. This space is three-dimensional and we carry it with us wherever we move, and consequently it is place independent.

From our discussions of spatial aspects of movement we got the following three design criteria:

- Three-dimensional interaction independent of direction
- A mobile interaction space defined by the mover
- Tangible interaction close to the whole body

6.3 Natural Movements

We program our bodies and movement patterns more or less consciously through our everyday activities. By doing the same movements over and over again, we train the ability to perform specific movements without having to consciously figure out how to do it each time. This issue is also relevant for interaction design, in terms of whether you need to consciously think of what to do in order to interact with the system or if the interaction design opens up for spontaneous and/or intuitive actions. The level of movement skill needed in different aspects of the interaction therefore influences the interaction experience. One example is writing a text on a keyboard. Depending on the experience and habit of typewriting on that specific keyboard, the focus might be on the

Table 6.3 Video Example #1: Natural Movements

Ex #27 - As If
Learning a movement phrase from the dance teacher and perform it with different movement quality
"When they knew the basic movement phrase, they did it applying different qualities of movement, i.e. doing it as if they were really bored, a Spanish matador, weightless in space, in strong headwind, very stressed, or putting no effort to it. As part of this work they could experience qualitative differences of the same movements, and also try to express the same movement differently. Certain movement qualities suited certain persons better than other, something that they expressed during the interviews. They preferred one specific quality themselves, but it was also possible to see which quality a fellow participant most likely preferred. It might be that this movement quality was closer to that person's natural movements or emotional state at that time." (Jin, Concept design workshop)

content of the text or on how to find the right key to press in order to be able to write at all. The dance course participants also expressed this interaction aspect, especially in relation to learning and doing other people's movements. When they did not understand how the movement was put together, its intention or the meaning of it, they experienced the movement to perform as more difficult. In other situations where they did not have to care if the movements were exactly imitated or when they improvised, they could make use of their natural and fluent movements.

In order to obtain a natural or spontaneous movement interaction one needs to make use of movements that are close to what the mover experiences as natural movements. The user should be able to make use of his or her own movement pattern and preferred quality of movement. The personal preference depends on a variety of aspects, such as physical size, schooling, personality, emotions, or mood. Even if the preferences might change between different days, we often have a basic movement quality or movement pattern we come back to in specific situations.

In some interaction situations it might be appropriate to use a predefined movement. People are in general very good at learning new movement patterns, and after a short period of training the movement might become natural. However, for our interaction concept, we wanted to preserve the individuality of human movement, and design for natural and spontaneous movements. Even if we wanted to create new movements, they should be based on each person's movement potential. The intention was therefore to create a concept that let the users discover new aspects of themselves and their movements. The course participants had discovered that during the dance classes they had performed movements that they had not thought of or seen before, or that they thought they were able to do. We wanted therefore to preserve this experience in the interaction concept.

This resulted in the following additional design criteria:

- Make use of the user's natural and/or spontaneous movements
- Interaction should not require no previous training or specific movement skills

6.4 Movement Impulses

One of our initial intentions for the interaction concept was to make people move. When we discussed existing artefacts that trigger movement, we used the balloon as a nice example. When a balloon is thrown into a crowd of people, almost without exceptions, people start to interact with it by hitting it and keeping it in motion. What are the properties of the balloon that create this spontaneous and natural or rather instinctive movement interaction? Could it be that it is moving itself and therefor already has suggested an interaction language? It has given us a invitation to move. A balloon also moves slowly enough for people to have time to react to its movement and then interact with it. If a tennis ball had been smashed into a crowd, people would probably have tried to avoid it, rather than trying to catch it or return the movement.

The Movement Impulse exercise (Ex #14) generated quantitatively as well as qualitatively lots of movements. It also created new movement patterns for the participants. The exercise required a certain bodily awareness in order to feel the impulse. as the participants had to let go of conscious habitual movement patterns and to feel and be guided by the movement impulse. When working in pairs, they followed outer physical impulses, and when working individually they followed an inner movement impulse or initiation.

Impulses to move can also come from outer non-physical, visual or audio cues. In the Movement Conversation exercise (Ex s#9) the course participants worked in pairs and reacted to each other's movements and sounds. One person did a movement and the other person made a sound as reaction or answer to that movement. They also developed the utterance to whole movement phrases. One participant expressed that when he was communicating through movement, he first repeated his partner's movement and interpreted it before he could make his own movement. It was like he said that "Okay, when you say so, I understand that you mean this, then I think that." Hence, he first imitated his partner's movement, then he did his own version of it, and finally, he came up with his own movement utterance. One could therefore say that movement triggers movement, as we tend to imitate our surroundings. This is also a normal social behaviour. People do what other people do.

Our aim was to make use of movement both as input and output. As earlier pointed out, movement output is not very common. However, today there exist several haptic input/output devices that make use of tactile and kinaesthetic output. Tangible and physical output has often been used as means for correcting wrong behaviour. Movement has also often been related to changing a bad movement pattern or inappropriate movement behaviour. As a contrast to this we aimed for creating a concept that encouraged

Table 6.4 Video Example #2: Movement Impulses

Ex #14 - Movement Impulse
Working with movement impulses.
"First they worked in pairs where one person was giving the other "passive" person movement impulses by physically pushing or pulling a body part. The person who was "passive" received the impulse and moved according to it, i.e. in the direction and with the force it implied. This required a sensibility for feeling what kind of influence the impulse had on the body, what kind of movement it initiated, in which direction it was given, and for how long it should last. The difficulty lied in really follow the impulse without amplifying or reducing it. This exercise created a lot of movement from the participants, as they did not have to "come up with" movement themselves. They only followed an impulse, and were therefore able to move in new ways, letting the body lead the movement. After having worked in pairs, they worked individually and tried to just imaging another person giving them an impulse, but initiate the impulse themselves. This also generated new movements and they trained the ability to sense the body and to move guided by that sensation." (Jin, Concept design workshop)

movement, similar to the carrot hanging in front of a mule in order to make it walk. However, we wanted to avoid the output being a punishment, if one did not succeed to create movement. Our interaction concept could also be used even without trying to make it move. It could for example be worn or kept as jewellery or accessories.

The design criteria from our movement impulses and what-triggers-movement discussions were:

- Create movement in order to trigger movement
- Utilise the kinaesthetic sense in order to be guided by bodily movement impulses
- No kinds of punishments are given if it is not used "right", as there are no rights or wrongs
- Create possibilities for movement dialogues

6.5 Movement Impression and Expression

Movements can categorised asbe literal, abstract or abstracted (Blom and Chaplin, 1988), e.g. a gesture, a movement for its own sake, or an abstract movement developed from a literal gesture. In the Solo Piece exercise (Ex #33) the participants showed different levels of abstracting movement, and through the interviews a few informants expressed difficulties when working with pure abstract movement. As we aimed for creating an open-ended interaction concept as possible, we did not want to design for specific types of movement or meanings of movement. From the dance study we were informed that the meaning of movement can be created on several levels, and that it is strongly related to personal movement experiences.

Using movement as interaction modality has certain social aspects as it is related to meaning and understanding of other people and their activities. The course participants had expressed that they learned a lot about their own and other's movement through collaboration. We therefore wanted to design a concept that could be used individually as well as in group. Again we took the ball as an exmaple. The ball is something you may use by yourself, but it could be more fun to share it with others. When several people are collaborating it is possible to do other things than one can do alone. This perspective had also been brought up during the dance course, especially when exploring partner work (e.g. Ex #12: Support, Ex #31: Boundaries) or learning each other's movements (e.g. Ex #30: Name Phrase, VE #4). Being two or more people also opens up for the communicating aspect of human movement, the expression and the impression.

Human movement can be very expressive and in everyday life we get movement impression all the time. The visual perception of movement is very strong and movement is often related to social contexts. If we see a person do a deviant movement, i.e. a movement that is deviant in that specific context, we will wonder why he is moving as he does. On the other hand, if we can find a logical reason for why he moves as he does, we might not

pay any attention to him at all.

Our movements are also bound to the natural forces, such as gravity. This influences or frames our possible movements and which movement that looks natural. For example in classical ballet, one strives to visually and physically repeal gravity in order to create a specific expression. While in some modern dance and jazz techniques as well as African dance, the aesthetics emphasise gravity and the grounding of the body downwards. As we all know, movements might also be physical exhausting. Hence, movement expressions and impressions will be influenced by the physical condition of the users. The level of intensity of the movement interaction should therefore be appropriate for the intended use. It is for example difficult to do very fast movements and keep the speed during a long time. On the other hand, slow movement can also be difficult to perform as they might require more balance.

One aspect we wanted to take care of in the interaction concept was the user control of the interaction, i.e. knowing when one is interacting. There are several applications that for example make use of biological data through scanning the user. In some of these situations it is rather difficult to influence the input. Other times it might be impossible to know when or where one is interacting with pervasive or ubiquitous systems. However, in our interaction concept we wanted to provide the user with control of the input/output functionality.

The design criteria from these discussions were:

- All kinds of movement should make sense in relation to possible input/output
- The concept could be used individually as well as collaboratively
- What causes the movement interaction should be visible and/or understandable for a viewer
- It should be possible to switch of the technology

Table 6.5 Video Example #6: Movement Composition

Ex #33 - Solo Piece
Solo pieces, two examples: Homeless and Making a difference.
"They got the exercise of creating and performing a solo piece that should express a contemporary phenomenon in society. The process started out with a brainstorming session generating words associated to a society phenomenon. Then they chose one or two words they wanted to work on and developed and idea or theme to express. Some of the pieces were more concrete, dramatised and pantomimic, others had a higher level of abstraction. They were supposed to perform the dance piece in silence, without using music, emphasising the movement expression. However, they were encouraged to make use of music during the creating process if they wanted to. One participant was totally dedicated to his performance, he gave himself into the movements, not only when he performed his solo piece. Several times he mentioned that he got blue marks from the work. Prior to the course he had expressed that having to dance terrified him, as he felt he had no ability to control his movements." (Jin, Concept design workshop)

6.6 The Interaction Concept BodyBug

"BodyBug is a movement-based interaction concept that makes use of bodily movements in order to create a physical dialogue between you and the artefact, as well as with the environment. When you feed BodyBug with movement impulses, the bug will climb along a path that can be attached to your body. Depending on how you move, BodyBug will respond to you in different ways. BodyBug could be used in optional contexts and in optional ways, in order to support your personal movement impression and expression."
- Johan & Jin, October 2004

In order to verbalise and point out the direction for our design intentions we wrote the above presented description of BodyBug. The text was formulated early in the design phase and served mainly as a statement and guidance for us as designers. The first physical mock-up of the interaction concept BodyBug was a small ball of Styroform with a piece of straw penetrating it, through which monofilament (a fishing line) was thread (see figure 6.3). The mock-up was attached around the waist and the task was to make the Styroform ball move along the fishing line. Figure 6.4 shows Johan interacting with the mock-ups. A one-minute video clip of this interaction can be found on the DVD in Appendix B (VE #8).

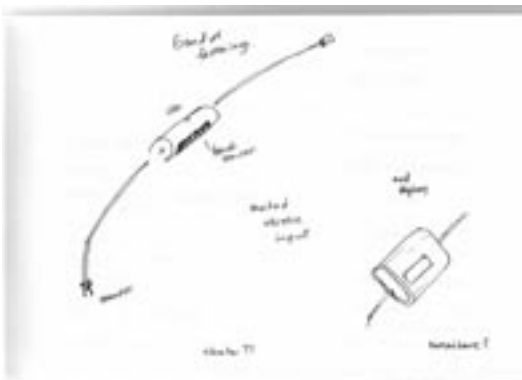
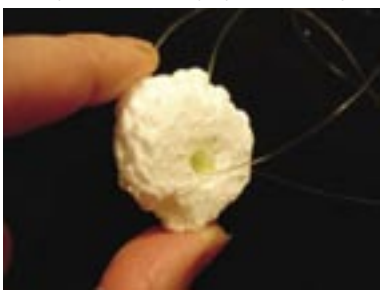


Figure 6.2
Early BodyBug sketch.

Figure 6.3
Monofilament and Styroform mock-up.



In order to make use of the ability of the body to physically sense movement interaction, input as well as output, we wanted the interaction object to be as close to the skin as possible. We thought of it as a friendly flea or grub that moved on the body. It should be like a wearable, cosy pet animal. It could also be described as a moving Tamagochi[1], the virtual pet created by Aki Maita and sold by Bandai. By giving the grub a movement impulse, through moving one's body, it should start to move. The tactile sensation of its displacement would make one feel where it was heading. In this way the movement communication between the wearer and the artefact could continue and develop.

Throughout our work, we had to abandon our idea of an artefact that was attached to the skin. We therefore thought of using magnetic fabric or creating a t-shirt with a

[1] http://www.tamagotchi.com/

Figure 6.4
Johan interacting with the first BodyBug mock-up made of Styroform, fishing line and a straw.

magnetic grid on which the bug could move. However, as we did not want to make "a t-shirt with a crawling grub," we decided to design an artefact that could stand for itself. We also decided to let the artefact be visible for others, in order to increase the possibility for the surroundings to understand the user's motivation for moving, but also to increase the communicative potential. The artefact was therefore created as a bug that climbed along a specified path that could be hung onto the body outside the clothes. As we wanted the artefact to move all over the body, we found that the path, on which the case ran, needed to be quite long, in order to cover large parts of the body. However, we did not want the presence of a path to decrease the movement possibilities or restrict the personal movement patterns. We therefore designed a path that could be worn in different ways and according to the user's own preferences.

The mock-up that resulted from the two-day concept design workshop was made of an inexpensive curtain wire, which I by chance had at home and brought with me the second day (see Figure 6.5). One of the wall attachments for the wire was used as the running device, the bug. This simple mock-up demonstrated our interaction concept well enough to get funding for the following work of developing and implementing the concept into a prototype.

The movement interaction concept BodyBug can be summarised by the aspects presented in the bullet list below. The implementation and interaction experiences of BodyBug are presented in the next chapter.

- It is an artefact that initiates and maintains bodily movements through its need to be fed with movement input.
- It lets the user explore three-dimensional movement possibilities as well as generate new movements.
- It is communicative as it creates bodily expressions and impressions.
- It provides haptic input and output through the user's physical movements as well

as the object's movement, and the user is independent of visual output.

- It gives room for a varied use and different interaction possibilities, as the input can be made in several ways. Everybody can use it, independently of context or physical abilities.
- It can be used individually and in groups.
- It is a small device but does not necessary create small-scale interaction or movements.

Figure 6.5
BodyBug mock-up

Figure 6.6
BodyBug interaction

BodyBug - a kinaesthetic movement interaction concept

BodyBug can be worn in various ways, according to your own choice and flavour of the day. You can attach the ends around your arms, legs, neck, head, waist, etc. If you prefer, you can wear it as jewellery and just let it hang onto your body. Or you can start a dialogue with it, using its language of communication, namely movements and motion. When you start to move, the bug will sense your movements and somehow respond to you by starting to move itself. You can move exactly how you want to. You can walk, dance, jump and stand still, just move one body part, or whatever. Why not attach one end to yourself and the other to a friend of yours, and then BodyBug together? Through exploring the bug's movement pattern, you can train your skills in directing the bug's answers, or you can choose to just let it respond to you, as it wants to. However, no matter how you do, you need to continue to move in order to keep up the dialogue. The bug's movement ability depends on how you feed it with movement, as if it was a digital hula-hoop.

Figure 6.7
Collaborative BodyBug interaction

Chapter 7
Implementation and Experiences of BodyBug

In this chapter I present the implementation and user experiences of the movement-based interaction concept BodyBug, which is described in Chapter 6. BodyBug has been tried out and experienced at four different events. This gave me valuable information of how such a movement-based interaction concepts is experienced, but also how it might be developed further.

7.1 Prototype Development

The interaction concept resulting from the concept design workshop was well defined regarding its function and use. During the development and implementation process that followed, a lot of design decisions were taken that influenced the final prototype's appearance, performance and thus the interaction experience. Other constraints such as economy, material, time, technology and competence, also contributed to the actual outcome. A first restriction on the prototype was to make something that was possible to implement according to the time frame of the project, which meant an artefact that could be tried out and evaluated by function after ten weeks, and that could be a final prototype after about five to six months. In the previous chapter I described how the interaction concept emerged. The design criteria for BodyBug that resulted from this process are summarised in Table 7.1.

After having made and tested a few interaction mock-ups and models (see Figure 7.1), we continued to discuss possible technologies that could make our concept work in real life. The choice of technology can be characterised as ad hoc and explorative. We aimed at making use of technological solutions that preserve the focus on kinaesthetic awareness, personal interaction space, and individual movement patterns. We also needed technology that suited the kind of input we wanted to work with, i.e. movement impulses. Consequently, it was the quality of interaction that guided the choice of technology.

Table 7.1 Design Criteria for BodyBug

Personal interaction space
• Three-dimensional interaction independent of direction
• A mobile interaction space defined by the mover
• Tangible interaction close to the whole body
• Independency of visual or audio output
Natural movements
• Make use of the user's natural and/or spontaneous movements
• Interaction requires no previous training or specific movement skills
Movement impulses
• Create movement in order to trigger movement
• Utilise the kinaesthetic sense in order to be guided by bodily movement impulses
• No kinds of punishments are given if it is not used "right", as there are no rights or wrongs
• Create possibilities for movement dialogues
Movement impression and expression
• All kinds of movement should make sense in relation to possible input/output
• The concept could be used individually as well as collaboratively
• What causes the movement interaction should be visible and/or understandable for a viewer
• It should be possible to switch of the IT

Figure 7.1 Early mechanical models of BodyBug.

We discussed several technological input devices for sensing the users' movements, and found that accelerometers suited our goals. An accelerometer can register changes of its own movement in space by making use of the force resulting from acceleration and decelleration. The movement input measured by the accelerometer was then used for deciding, through programming of the motor, in which direction and for how long the bug should move along the wire.

During the implementation phase we made design decisions related to technological issues and the physical appearance, which certainly would influence the interaction experience. For each decision we went back to our initial discussions of movement concepts

and search for arguments to guide the interaction design. Regarding the movement-based interaction we were in most cases helped by the results from the dance course. They reminded us of where to put the focus and then choose the technological solution that reflected this.

Figure 7.2
The artefact and research prototype BodyBug.

The BodyBug prototype consists of a case, "the bug," running on a plastic covered wire that is about 2,5 meters long. At the ends of the wire there are two 65 cm long Velcro-straps. These can be used for attaching BodyBug onto your body. Electronics and mechanics are placed inside the case, i.e. motor, gearbox, accelerometer, micro controller, motor controller, switch, voltage regulator and a 9V battery. When the user moves in space, the accelerometer will register in which direction the case is moved. Depending on how the motor is programmed regarding input/output, which means how much and in which direction the user needs to move in order to gain feedback from BodyBug, the bug will start to move for a set time and direction along the wire. The electronics can be switched on and off using a small button. This makes it possible for the user to choose when the bug can respond to his or her movements or, in other words, when the bug is able to talk back.

Below, I summarise some of the most important issues regarding technology, mechanics and electronics that we considered during the implementation phase.

- **Power supply.** The battery looses its freshness too soon, and the bug seems "tired." When using batteries, they must be rechargeable or exchangeable. The battery also takes up much of the space of the device, and therefore influences the possible minimum size.
- **Mechanics.** Robust mechanics is a big challenge. The motor should be powerful enough to drag the weight of the whole case upwards. The gearbox is quite sensitive to forced movements of the case along the wire.
- **Movement input/output.** How fast and long should the case move? How should the input, e.g. the force of the impulse, relate to the output direction? The object has only one degree of freedom of movement, i.e. along the wire. The case's movement is the only provided output. No lights or sounds (except for the motor sound) are given.
- **User control.** The movement of the case should not be haphazard. It should be possible to control or understand how to move in order to obtain the planned "result." It should also be stable and predictable, which means to react in the same way each time. The device should be possible to switch off.

- **The wire and Velcro attachments.** The stiffness in the wire influences the bug's movement. The wire also generates its own kind of movement. The lengths of the wire and Velcro straps influence in which possible ways one can wear BodyBug.
- **The case.** The size of the case is pretty much decided by the size of the motor and power supply, but even electronics and mechanics. The shape should be rounded in order to not get stuck with clothes etc. The contact surface of the case should be as big as possible (in relation to the total size) in order to feel and sense the contact. It should be possible to feel the weight of the case. The bug should not be too heavy as it can be tiring to wear.

Further development of BodyBug and similar interaction concepts should focus on varying the different movement related concepts of the interaction, e.g. the speed of the case's movement along the wire, the time it moves, the amount of movement you have to create in order to make it move, etc. In many devices today, the output that is provided aims at focusing the user's attention towards the device or a specific event through sound and light. This is not the case with BodyBug as it requires another kind of bodily awareness in order to take part of the output, i.e. awareness of its physical movement. The movement output provided might be described as subtle and small. On the other hand, to some extent the amount of movement output could be changed by programming the input/output relation differently.

Another way to influence how the interaction is experienced is to change the motor, which is related to the possible speed of the case. The length of the wire and the Velcro attachments also influence the interaction experience as they constrain how BodyBug could be worn. It could also be possible to make BodyBug autonomous in the way that it learns the movement pattern of its wearer, and adjust its movement according to that. This creates an opportunity to try out other people's movement pattern when sharing BodyBug between people.

Technologically, one big challenge related to BodyBug is the lifetime of the batteries used. This is a common problem with wearable and mobile devices. As the freshness of the batteries influences how fast or powerful the motor can work and thus the output, this is a crucial issue for how the interaction is experienced. We also believe that the interaction concept might be better developed and experienced using more advanced technology. However, keeping to a certain time and economic frame, we chose to make use of inexpensive and easy-accessible technology that was suitable to demonstrate the interaction concept. Desirable, BodyBug should be able to accumulate movement energy and make use of this to power the motor. This functionality can be found in certain watches. However, BodyBug requires, with today's technological solution, more energy than a watch.

Some of the known issues that influence the interaction experience are presented below. These issues should be reconsidered in a possible next iteration of the prototype:

- The Velcro used for attachments might destroy the clothes. It is also difficult to

Figure 7.3
BodyBug experiences

attach the straps yourself, and it does not stay in certain positions, as it slides down.

- The battery capacity is important. One should consider other possibilities for alternative power supply. The battery size also influences the size and weight of the case.
- The wire gets bent and needs to be changed in order for the case to climb smoothly.
- Different motors give different possible feedback.
- The prototype makes use of inexpensive, quite lo-tech devices. One might obtain a "better" and more efficient or desirable input/output possibility if using more advance technology, e.g. nano-technology, but this is also a question of finances, competence, time, etc.

The discussed aspects of further development support the focus on movement as the main interaction modality, rather than its visual appearance. However, as its appearance is important for the conception the users get of the artefact, it should be taken into account.

7.2 Interaction Experiences of BodyBug

The prototype BodyBug has been presented and demonstrated at four different events: A multidisciplinary design conference where a paper on BodyBug was accepted as Design Case; an Open House arranged by the HCI group at the technical university, and where current research projects were presented; an exhibition that was part of an applied IT research conference; and an Open Session at an international HCI-related conference. These occasions gave us the opportunity to carry out informal qualitative observations of people interacting with BodyBug in "real settings," as different from laboratory user studies. Our aim of collecting interaction experiences was to gain feedback on what kind of interaction BodyBug created in order to reflect different aspects of the prototype, to inform further possible development, and to increase our understanding of using movement as interaction modality.

When presenting BodyBug we were to some extent influenced by our own experiences from making it, for example known issues and problems as well as features we wanted to emphasise. The visitors at the different events had varied backgrounds and interests. They had also various experience and interest for this kind of artefacts, i.e. artefacts without a specific application area or function. This aspect also influenced how we presented the interaction concept. As BodyBug is a quite small, mobile and anonymous object it tends to kind of disapears in relation to applications consisting of large screens and displays. The prototype therefore needs to be demonstrated in use, in order to be noticed. On the other hand, when demonstrated it attracts the environment's attention. The social context also affected the users' experiences and how they dared and felt comfortable to interact with

BodyBug. Those kinds of social aspects had also been discussed as design issues.

When we designed the visual appearance of BodyBug, we aimed at making it look neutral and robust and we also excluded other output than movement. During the try-outs we got comments than it looked boring and dull, and surely not like something you want to have close to the body. There were also people who wanted more feedback and suggested using lights and sounds.

To describe the prototype can be quite difficult and abstract as people in general have no or little understanding for the problem area or questions. The interaction concept does not resemble a well-known device and most people are therefore rather blank on what to expect of the interaction. However, when trying out BodyBug it takes only a few sentences or comments in order to make people come up with their own understanding of what it is and what it is about. It became very obvious that the concept needs to be tried out in order to get an experiential understanding for what it is or can be. The physical experience created as part of the interaction was very useful as starting point when we as designers described the prototype, our design approach and the research questions and results.

Our main experience concerning the interaction form was how differently people moved. We observed all aspects from big, violent movements taking up large physical spaces, to people standing still and just moving one body part. Some people did not move at all as they tried to really sense what was going on. A typical observation however, was that people engaged with their whole bodies in the interaction, even when the focus was on moving one specific body part. This made clear how interrelated our body parts and thus movements are. There was also a difference in whether people had their focus towards the artefact, i.e. the case, and if or how it moved, or if the focus was towards themselves, their body and how they moved. See Figure 7.3 and 7.4 for interaction examples.

From observing the try-outs and talking to the users of BodyBug, it was possible to identify two main interaction levels: an intellectual and an experimental.

- **Intellectual interaction level.** People want to know what it is, how to do and how the technology works before they try it. Then they adjust their interaction according to how they think the technology works or their conception of the artefact.
- **Experiential interaction level.** Some people just do something and wait for something to happen, and find this interesting or not. People in general are very open and curious as it is a new type of artefact and interaction concept. They have no previous experiences of or references to similar devices. However, they "understand" and relates to it quite fast.

Most people who experienced the prototype were first time users. However, several people came back and wanted another try. Some users felt that they had "succeeded" the first time and wanted to see if it could work again. Others felt they wanted "revenge" on the device or at least a second chance, as it had not worked that well during the first try. One person expressed "I thought of it like a pigeon. You try to encourage it by doing specific things. And when I get some feedback on something, I do more of that." The output might be

considered as quite subtle, but she had the curiosity, patience and interest to try out and improvise when interacting.

Another experience was that people very easily adjusted their interaction to how they thought the technology worked. Some people believed that the sensors were placed inside the Velcro attachments, others' thought that the wire was an electric cord and in some way had effect on the case's movement. There were also people that considered the interaction as something to manage, a task that should be successfully completed. One person attached the Velcro around his head and said "I don't feel anything." In some cases it was obvious that people were interacting after the principle the more input, the more expected output. If they did not experience any feedback, they started to move even more exaggerating. Others were moving without experiencing any output or had wished more output in other modalities. These examples show that people today are quite used to various interactive artefacts that give audio, visual and haptic output. However, the movement output seemed for some to be surprising even when they had been told that the case was going to move when they moved.

7.3 Subjective Descriptions of BodyBug Interactions

Below I present four subjective interaction experiences of BodyBug. These are comments that the movers wrote down about four to six weeks after their interaction experience. The texts therefore represent the users' memories of the interaction, which might have been further elaborated since their first experiences. The try-outs described were all carried out at the same occasion and with the same condition of the device.

Mover #1

"At first I was not sure what to expect as watching others is not the same as doing it yourself and of course lots of people were watching so I felt shy and self-conscious. I felt frustrated when I started to try because I could not make it 'work' so I thought I was doing something wrong. Then eventually I got the bug to move and I had a different feeling - quite difficult to explain really - I kind of 'understood' what was happening and I saw that perhaps I could learn to be more skilful. I understood that the bug was not working very well that day and is only a prototype - but even so I wanted it to move more - I wanted more in return for my effort if you like - but perhaps if it moved more and more as you learned it (or it learned about you) that would be good it would draw you in to keep moving.... In some ways it made me more aware of the space around me: 'my bag' of space if you like, rather than just more aware of the fleshy me - I had no idea how to move to 'make it work' so perhaps I was able to move in ways that were not related to any other object or music or style of dance etc - I had to explore to find out - so it encouraged me to move in new ways. (Because people were watching this was difficult as I felt I should be more graceful or elegant or something.)"

Figure 7.4
BodyBug experiences

Mover #2

"A little cute rodent thing is what it made me think of… some sort of alive, little animal that wanted to climb from one end of the string to the other and that's the way I almost immediately began treating it, I'd say in the first minute or so. Once it became 'alive' I became quite absorbed with trying to 'help' it on its way. The thing I was most trying to avoid was it making the jittery noise (I later got told that it wasn't supposed to do this). The jittering made me think it was angry and it didn't like whatever I was doing but I couldn't quite figure out what it did like, exactly. What appeared to me to be happening was that any time I moved in random and rather outrageous directions, the BodyBug started climbing where I thought it wanted to. One of my frustrations was to not knowing how to drape the contraption over myself. I think I could have done a better job of this and halfway through using it, as I dangled my right foot precariously above my waist, trying to coax the jittering mousey thing on a presumably easier downward slope, I realised that the picture I'd seen of someone using the bug had put on the Velcro straps in different places or draped the string in a different way. I wanted to rearrange the Velcro but didn't think that I should ask to do this because now there was a crowd and I thought I should hurry up and get the bug to where it was supposed to go and let someone else use it and lower my leg because lots of people were now looking at me. I didn't notice the audience for a while, as I was quite engrossed in the bug. But the audience made me more aware and uncomfortable of my own movements as I thought I looked a bit silly. The only thing I deduced of the bug's preferences was that it liked constant movement that went all over the place and didn't necessarily respond well to repeated movements or jerky movements. It liked variety and gentleness. Or at least, that's what I thought. Other things: it was fun and engaging, wanted to spend longer on it, wish it hadn't been jittery so I could have figured out more, would have preferred less people watching, though have little shame in front of the researchers, can't now remember what the purpose of designing it was."

Mover #3

"Equipped with the BodyBug I started moving gently. It was rumbling a little, like not quite in gear or something, but all of a sudden it was running smoothly, downhill I guess. Trying to get up on the other side it started rumbling again, something was obviously wrong with it, like a defect clutch in a car. Still though, it was intriguing, somehow challenging. Can I make it go the way I want it to or does it have a mind of its own, the latter rather than the former I guess! People urged me to move; I am moving I said - or was, I am waiting for it to respond, trying to communicate with it. The little guy was tired I think, needed a rest and some fresh cogwheels. I would certainly like to try again :o)"

Mover #4

"I felt a bit uncomfortable to stand in public and try it out, as I had been freer if I had tried it in private. Hence, I felt a bit "watched at," but that was not so important. I wanted to "wear" BodyBug as if it was jewellery or clothing. I wanted to feel it close to the body in

order for me to sense the impulses through the sense of touch and give it signals myself. I did not try any extreme movements. My general impression of BodyBug was that it probably should work in relation to my movements, but that when I tried it, it had too many technical defects. It made sounds, which distracted me quite a lot, and the engine did not seem to function as it was supposed to. This made the experience less fluent than it ought to be. The physical design of BodyBug reminded me of a PC mouse. I also remember that I tried to wire the wire around my waist and I was thinking that one could probably take BodyBug for a walk, like walking a dog. Often when I am introduced to new technical gadgets, I try to sort out how they work. In this case I already knew quite a lot about BodyBug, but still I caught myself thinking in terms of "if I do like this, what will happen and why?""

7.4 Social Interaction and Acceptability

One of the main concerns for all movers reflected in the subjective descriptions above, was the relationship to other people and the environment's possible reaction to their movements and behaviour. The movers felt a bit silly or kind of stared at. On the other hand, as they got quite involved with BodyBug, they forgot about the surroundings. They moved spontaneously and explored the interaction concepts according to their own movement possibilities and conceptions of how BodyBug could be used. Several of the movers were concerned about their interaction performance. They wondered if they were "good enough" or if they interacted with BodyBug as it was intended. These fears were similar to the ones of the dance course participants prior to the dance classes. One reason can be that there is a clear visible difference between skilled and less skilled movers performing specific movements, and that physical clumsiness often is related to embarrassing situations.

Which kinds of movements one makes are therefore dependent on the social context, but they also depend on the physical space, e.g. the size of a room. One of our intentions when designing the concept was to encourage people to do new movements and maybe create new socially accepted movements. Unusual movements are often more accepted when people understand why you move as you do. For example when people see a person running in the street they might look oddly on that person. But if they understand that he is running because he wants to catch the bus, no one founds that strange.

For some years now, skateboarders and their likes have populated, reshaped and contextualised the public space with new movements and physical activities (Borden, 2001; Bäckström, 2005). A growing bodily movement community that make use of the physical environment in similar ways as skaters but have no other equipment than their bodies, is Le Parkour[1], also called Free Running. It is described as a sport, an art, a passion,

[1] e.g. http://www.le-parkour.com/

as well as an everyday philosophy, and is created by David Belle and Sebastien Foucan. People who practice the sport are called Traceurs.

Another contemporary phenomenon that is related to social aspects of movement is Mobile Clubbing[2]. "Mobile clubbing is a form of flash mob where people gather and dance to music playing in their headphones from their own portable music player in a public space" (Wikipedia[3]). The community started out by a happening created by two art students in the UK, Ben Cummins and Emma Davis, but has now spread worldwide. At the Mobile Clubbing web page one can subscribe to notifications of the next mobile clubbing event in a specific city. One can also find instructions for the clubbers:

- Arrive at location at given time.
- Start dancing to your personal stereo, to the music of your choice.
- Please utilise the whole space, spread out. This will prevent us from being moved on.
- Don't worry clubbers. You will be one of many.

The following citation is from a review of an mp3 player with in-built motion sensitive games. The comment adds to the general idea of movement as context dependent.

> *"If you think the YP-T8 hanging off your neck won't get you enough attention, try the four motion-sensitive games. Seriously, we wouldn't try to hold onto the player and simulate throwing a dart in a subway. That's just what is required to succeed in one of the mini games, called One Shot Dart. They are supposedly well-written and most importantly, fun handheld games, but society norms could deter you from enjoying them in public places."* [4]

A few years ago, walking around gesturing and talking out in the air would to most people seem quite weird or lunatic. However, today we are more than used to people talking in their mobile phones using various hands-free devices in all kinds of appropriate and less appropriate places. Technological devices are increasingly introduced to our everyday lives and create new behaviours and movement patterns, which we do not longer question. Most likely it is only a question of time when we will accept other kinds of movements that seems weird to us today.

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[2] http://www.mobile-clubbing.com/
[3] http://en.wikipedia.org/
[4] http://www.everythingusb.com/samsung_yp-t8_1gb.html

Chapter 8
Findings, Reflections and Conclusions

In this thesis I have explored and identified aspects of human movement to consider in design for movement-based interaction. I have taken the starting point in modern dance as an area of knowledge that is based in and deals with human movement for an aesthetic purpose. In the first part of this work, dance was explored both theoretically and physically. In the second part, I made use of the dance explorations to inform design and implementation of a movement-based interaction concept. The findings of this thesis have therefore emerged from physical experiences of dance and movement concepts, and are theoretically grounded in dance-based theories of human movement. Further, through design and prototype development, the movement concepts and physical experiences have been reshaped, re-contextualised and physically tried out. In this last chapter, I summarise the main findings and reflect upon the holistic design process, the methods used and the results obtained.

8.1 Main Findings

The research presented in this thesis shows that we need to find the essence and physical grounding of human movement when we want to to design for people centred movement-based interaction. The methodological approach taken combines dance theory with empirical fieldstudies of dance-based physical movement exploration, design and prototype development. From this work I have been able to describe how people experience and express movement aspects such as time, space and force, movement quality and kinaesthetic awareness, and also the activity of abstracting, forming, phrasing and relating movement. Together with developing an experiential bodily knowledge of human movement, the physical experiences were verbalised, discussed and communicated. Those experiences were in turn used as design criteria for a movement-based interaction concept that was implemented and physically tried out. The approach of combining methods from

different disciplines and my possibility to participate throughout the whole design process, both as researcher and designer, has therefore been very fruitful. The holistic attitude towards the design process made it possible to preserve movement aspects and emphasise movement qualities as design criteria throughout the whole process. Looking back, it turned out to be a good decision to have such an open-minded approach to the resulting interaction concept and research prototype as we had. Naturally, it is not possible and maybe neither interesting, to know how the results would have looked like, if another approach had been taken. However, when comparing BodyBug to other movement-based interaction concepts and artefacts, similar to those presented in Chapter 1, one can find important differences in how movement is used as interaction modality, for example the freedom in movement and individual movement possibilities, emphasis on the quality of movement, as well as exploring movement for the sake of movement.

In the first chapter I posed the research question "Which communicative aspects and properties of human full-body movement are important when designing for movement-based interaction, and how can such design be accomplished?" The answers to the first part of this question can be summarised by the four notions: *Movement Literacy*, *Personal Interaction Space*, *Imitate-React-Express* and *Social Acceptability*. These notions reflect aspects of human movement such as the ability to verbalise, describe, sense and express intentions through movement; the physical and emotional space we create when we are moving; the naturalness and understanding of movement; and finally, the social impact of movement.

In addition to these four theoretical notions, which are related to movement as a dynamic and communicative process, this thesis also contributes with an example of an innovative interaction concept and a physical artefact called BodyBug. The interaction concept is a result of a holistic design process and illustrates an example of how the knowledge of human movement achieved from the dance study, could be applied in concrete design. Hence, the description of the design process also answers the second part of my research question. BodyBug is designed in order to trigger movement, and makes use of movement for the sake of movement and for the pleasure of motion. Further, movement is used as the main interaction modality, both as input and output, and the interaction concept utilises human beings' kinaesthetic awareness. BodyBug is therefore an example of a kinaesthetic movement interaction concept.

Below, I summarise the four theoretical notions as well as the kinaesthetic movement interaction concept and the research protyope.

Movement Literacy

Movement literacy is as an important aspect of the ability to design people-centred movement interaction as it includes knowledge of physical, intellectual and emotional aspects of human movement. Being movement literate means to be able to physically sense and feel differences in movement, and to be kinaesthetically aware of the body and its movements. It also means to have an ability to express a physical experience in terms of movement, and to know the implications of applying movement elements and

concepts such as time, space and energy, as well as movement quality. Other important notions are abstracting, phrasing and forming movement. As a movement interaction designer one should also have knowledge of how these movement aspects influence the visual expression and the physical experience of the movement, as well as how we can relate ourselves to others through movement. If we ignore the existence of movement literacy and the knowledge of human movement as design material, there is a risk that we only make use of mechanical or literate aspects of movement. This leads to an exclusion of abstract and abstracted movements, through which we can communicate on a more subtle level, which further means to communicate the essence of an expression. Movement Literacy can be acquired and developed through the combination of physically exploring human movement and verbally reflecting on those experiences.

Personal Interaction Space

The personal interaction space is the three-dimensional space that is immediately surrounding a person's body and which is continuously changed and created along with that person's movements. The physical personal interaction space is defined by a person's physical range of movement, also called the kinesphere according to Laban's theories of human movement. The emotional personal interaction space is often of a different size than the physical one. It is defined by how near one prefer to be to a specific person or object, in a specific context. The size of a person's personal interaction space is therefore depending on social relations and the physical environment, and can vary from time to time. When interacting with wearables and mobile devices we are making use of our personal interaction space and we often increase or decrease its size in relation to the context. To fully utilise the personal interaction space, one should therefore design movement concepts that give room for three-dimensional and place independent movements. This means for example to provide possibilities for turning and using different directions and levels, as well as moving through space.

Imitate-React-Express

In movement-based interaction we should provide possibilities for people to make use of their natural movements for communication and to create a dialouge with the system or application. When people can move freely and make use of their natural and spontaneous movement patterns, they can choose to use movements that feel good in the body and that correspond to the personal movement qualities. This will give the user a more natural and pleasurable interaction experience. The interaction and communication process can be described as similar to how people communicate verbally with each other. When we are in a dialogue with other people, we often first repeat the other person's utterance in order to ensure us that we understood it correctly. We then transform its content to our own frames of reference, interpret it and add a meaning to it. In other words, we are reacting to it, physically, intellectually as well as emotionally. Finally, we might be ready to express our own stand point, or to add new input to the conversation. When the interaction is based on imitation of specific and/or predefined movements, the users are helped by knowing

the intention behind the movement in order to make it understandable and thus be able to create a meaningful interaction.

Social Acceptability

Getting to know your own movement pattern as well as experiencing others' movement patterns, increase the understanding of and acceptance of your own and other people's movement behaviour. However, the use of movement is always influenced by the social context. Specific movements are more or less appropriate in certain situations and environments. Consequently, the social context as well as the physical environment influence the natural movement pattern and quality of movement. In addition, the social environment will be affected by people's movement expression and mere physical presence of their bodies and movements. Design for movement-based interaction should therefore be considered in respect to the social context in which it is intended to occur.

BodyBug as a kinaesthetic movement interaction concept

BodyBug is an interaction concept that is designed in order to trigger movement and invites the user to move as (s)he feels. It consists of a wearable artefact that utilises movement both for input and output. It focuses the interaction towards the body and makes use of the personal interaction space. The user can improvise and explore the movement possibilities both of the artefact and him/herself, and thus create a movement dialogue with the device. BodyBug provides its wearer with a possibility to create new movements and to feel and reflect on the body and its movement in new contexts. It also emphasises the kinaesthetic awareness as it can be used to identify and learning to know movement patterns.

BodyBug as a research prototype

BodyBug is an artefact that adds to the growing set of designed research prototypes as well as art and technology objects and it can be described as a "functional artefact without functionalities." BodyBug consists of a case, "the bug," which moves along a wire. BodyBug could be hung onto the body by using the Velcro straps that are attached in each end of the wire. The bug is a small, climbing object that moves when its wearer moves. The implementation illustrated the importance of making concrete the design issues in order to gain more knowledge of interaction design and to further discuss and answer the research questions. Hence, this work was an important part of the research process. Wearable movement interaction artefacts are still very few, and BodyBug might function as a starting point for further discussing and exploring kinaesthetic movement interaction.

8.2 Reflections and Discussion

Today, technology is affecting our lives in several ways, from what we do, to how we do it, when, and where. Technology is also affecting our movements and thus our bodies. Computational artefacts have almost become a detachable as well as "built-in" part of the body. They influence how we (are able to) move, and thus our bodily expressions and impressions. On the other hand, technology has to some extent, always been influencing the life of human beings. McLuhan wrote already in 1964 about media as the extension of man (McLuhan, 1964). Looking back today, it is interesting to see how he foresaw the IT revolution. Today, the development of computational artefacts, systems and services is still going very fast, and people in general are able to take part in this development more actively and in other ways than before. Digital and new media have opened up for new and other possibilities for expression and comunication through interaction and alternative aesthetic values. To some extent we can say that we are considering the same issues today as we did several years ago, but within new contexts and by other means.

In this thesis i argue, that if we want to make use of human movement as interaction modality, we need to have an understanding of the essence of human movement. When people use their bodies to consciously express intentions and to interact with artefacts or systems, they must be able to feel a relation between what they do and what they get in return. If this contingency does not exist, we will most probably feel lost or dumb.

As discussed in the introduction chapter, several movement-based interfaces make use of movement imitation. This might cause problems if we want to create intuitive and usable interaction possibilities. When imitating a movement you need to be able to see and understand what there is to imitate. Further, the ability to imitate a movement depends on your previous experiences of similar movements, but also your personal preferences of movement aspects such as movement quality. If the movement is too complex or different from your personal, natural or intuitive movement pattern, you will spend too much effort and time on figuring out what to do. The problem becomes then, how to give the system the "right" input, instead of focusing on the original task or activity. However, the perspectives of this issue are very much related to the specific application and context. As usual one must consider the system's intended user group, use context and the users' required level of experience. In some cases we want to have a very specific movement that requires training. In other cases we might search for means of interaction that are intuitive and can be quickly learned and understood.

8.2.1 The Methodological Approach

This project has involved different disciplines, knowledge areas, theories and methods. Naturally, the findings have emerged throughout the research process and cannot always be directly related to a specific moment. When looking back, it can also be interesting to reflect on which of the results were expected and which were not. What could I have done differently and what worked quite well?

Serendipity, which means to make unexpected discoveries and insights through accident and wisdom, is a word that I got to know during the first year of my doctoral studies. Even if the meaning of the notion was already known, I found it really useful when describing my way of working (Kjölberg, 2003). As I discussed in the theory chapter, dance improvisation is an in-the-making process where you constantly need to sense, perceive, reflect and manipulate yourself and your body. This can be a very exhausting activity, both intellectually and physically. But improvisation is also a serendipitous process in the sense that you make use of chance. Depending on your previously movement experiences and knowledge, you can make use of chance more or less skillfully, and therefore reach your intentions. However, to see and make use of chance requires awareness in and of the situation. When it comes to movement, this awareness is kinaesthetic. The serendipitous discovery you can make about yourself and your movements are for example the ability to create new movements, and to enjoy moving for the sake of moving.

When describing my research methods, I referred to the interaction design process as a serendipitous process. To some extent one is improvising along the way, guided by traditions, theories, prejudices, personal experiences, generally accepted ideas, and so on. These factors are also those that censure the emerging ideas and that form your ability to make use of possibilities that occur along the road. Consequently, I cannot say which parts of the process that were most important, as all parts belong to the process and therefore are intertwined in the results. What I can say though, is that I have found it useful, although sometimes frustrating, to have a serendipitous and open-ended approach to the research process as well as the subject. The area of movement-based interaction is quite unexplored and we need develop new methods and approaches when designing for different kinds of user experiences.

To create the bridge from ethnographically informed field studies of human movement experiences to movement-based interaction design has been the most important part in this work. The challenge of similar tasks is often related to difficulties of making relevant use of the ethnographical findings in the design of a system or artefact. To transfer experiences to concrete design concepts is difficult. This was also shown in the two design workshops that were part of the dance course. However, one of the most interesting aspects of these workshops, was the fact that the first workshop resulted in more movement related design ideas than the second one. Even if our first impression was that movements as interaction form were lacking during the first workshop. The second workshop had a more focused subject area, i.e. flow, which was a notion that had been extensively used on the dance course, and that had been discussed during the interviews. However, one can say that the design ideas from the first workshop were more related to movement concepts and reflected an abstracted knowledge of human movement. This raises the question of how we should facilitate movement-based interaction design. How much personal knowledge of movement is needed, and how is it possible to access this knowledge in order to reflect in the concrete design? From this work I might say that in order to be able to transfer one's physical movement experiences to interaction design, there is need for a vocabulary that

deals with human movement in order to discuss the physical movement experiences. But first, one needs to make conscious the movement experiences. For doing this there are most probably several available methods, and I have only tried out one, namely modern dance. Therefore I look forward to further explore this question.

8.2.2 Designing for Movement-Based Interaction

When dealing with interaction design, one can ask if it is desirable, or even possible, to design an interaction in the sense that we through design "force" the user to interact the way the designer intended, which means that there is no room for other ways of interacting. Certainly, this is a complex question, and the obvious answer seems to be no. Human beings have free will and intrinsic intentions for their actions, they are irrational beings, and are socially and culturally influenced. However, through design, it is possible to provide certain interaction possibilities and thus exclude other possibilities. A designer has always an intention with the design. But, one can never be sure that all first-time users will experience an artefact in similar ways, no matter how directed and contextualised the design has been carried out or is presented. Nevertheless, as humans are social and cultural beings, within specific contexts where common understandings of certain activities exist, it is possible to design for specific interaction experience, or at least intend to do so. Returning to dance, Blom and Chaplin express this intriguing aspect of human experience in relation to choreography:

> *"Remember that you, as creator, only provide the feast; you cannot control how it will be eaten, what it will taste like on different palates, when it will be digested. What you can control is the extent to which you "make the outer in harmony with the inner feelings"." (Blom and Chaplin, 1982, p.11)*

From a user centred perspective, it is the intended user's cultural and social dependencies the designer should have in mind. But since even the designer is a human being, his or her background will evidently be reflected in the design. In order to avoid a too influencing bias from the designer and to make use of the intended user's dependencies rather than seeing them as problematic, participatory and user centred design can successfully (and also not so successfully) be carried out. But again, this might be more appropriate when the user group and the context of use are well defined, or when the design is aimed at solving a specific problem. In this work I have tried to consciously make use of the designer's personal background and experiences, and showed how it can influence movement-based interaction deisgn.

The art scene is an area that usually picks up new trends quickly and often utilises new technologies in a critical way. Artists also make use of the technology in order to create alternative expressions. When technology becomes an important part of the artwork, even the engineer, interaction designer, programmer or whoever is involved in making the technology work, becomes an artist in some way. They contribute to the expression of the artwork through their work and personal touch. However, they might not be the ones who

have decided how everything should be or look like. It could be compared to a dance or theatre performance, where the text or choreography is set, but the performers influence the expression. Unfortunately, inexperience of complex collaboration processes like this might lead to interactive art that does not reflect or provide possibilities for the intended expression, and thus experience. The focus on aesthetic experiences might also be due to the difficulty of distinguishing digital artefacts from artwork, if this is an interesting distinction. However, the increasing area of interaction design, critical computing, dysfunctional objects, cultural probes, computational everyday objects, expressionals, and so on, contribute to the cross-over between fine art, design, personal expression, trends, and research.

When carrying out this work, and especially in relation to the prototype development, the intention has not been to make art. The interaction concept rather adds to the growing set of digital artefacts that emerge from the intersection of art and technology. BodyBug has also been blogged[1] on the we-make-money-not-art blog created by Régine Debatty. On the other hand, in order to even influence the art scene with this work, it would have been interesting to choreograph a dance performance taking the starting point in BodyBug and its movement expression. This might be my next project.

Another possible application area for BodyBug and similar movement-based interaction concepts is the health industry. The growing problem of an immobile life that causes fatness and ill health, hurting necks and backs, is often put in relation to an increased use of desktop computers, video games and watching television. As mentioned in Chapter 1, the game industry is increasingly developing movement-based input devices and game controls. But in addition to the cardio vascular or strength training effect movement can contribute to, it can also be used as a relaxing activity. Movement training similar to yoga and tai chi might have stress releasing and mental effects, which are also influencing our health. As BodyBug creates a quite subtle movement interaction, this latter category might be more suitable as its application area. The following citation is from the article The Joy of Living in One's Body, which I found in a bodybuilding magazine. Even if that might seem as very distant to dance, the author emphasise the same aspects of the body as in this thesis, namely the kinaesthetic aspect:

> *"As emotions are perceived in part kinesthetically, kinesthetic awareness is also important for man's emotional well-being. A person with a healthy level of kinesthetic awareness will have the capacity to be all the more intensely aware of his emotions; most importantly, of course, he will have the capacity to be more intensely happy."(Clark, 1998)*

The increased knowledge of one's own body and thus oneself, which can be obtained through kinaesthetic activities such as movement training, also contributes to discover our physical potential and limitations. In Chapter 2 I referred to the discussion of embodiment and disembodiment within social science. There, technology was blamed for creating more disembodied bodied through how it stages and shapes human actions. In order to

[1] http://www.we-make-money-not-art.com/archives/004325.php

design for embodied interaction we need a mutual relationship of awareness between the computational artefact, as the one I am interacting with, and the user.

The increasing use of theories and approaches such as Labans' theories of movement, contributes to a broader perspective on human movement and movement-based itneraction. As discussed in the theory chapter, time, space, weight and flow, are the main building blocks of all human movement. The combinations of those movement elements create the movement quality, which is unique for each individual. Consequently, it exists a huge variety in movement possibilities. When we design for human movement, we therefore need to have in mind, how the movement quality might influence the users' experiences. This include to reflect on how the movement interaction should be carried out and how the movement should feel, rather than which specific movement the user must do.

When computers and computational objects tend to be more human like in their behaviour, how we will communicate with the computer depends on what we know about its possible reactions and responses to our actions. What we expect of the computer will be framed and shaped by its embodiment, its bodily appearance and presence, and thus its "body language." Today we are almost too well used to certain interaction forms, and we hardly are able to imagine alternative ways of doing it. We are "too educated" when it comes to interaction with computers and its likes. Consequently, we need new approaches to interaction design that open up for new insights and throw away old interaction paradigms and metaphors. What we should expect and wish for in the future of human computer interaction, is that the interaction is based on human actions and not technological abilities. In other words, we need to develop technologies that can adjust to our desired interaction, based on people's actions and abilities, rather than a derived interaction based on the technology.

Ubiquitous computing has been criticised for hiding the computer and thus the interface and interaction. One consequence is that the user might feel less in control of the interaction. In an interactive system, the consequences of one's actions should be possible to predict or understand (Bylund, 2005). Tangible computing could be said to be a comment or reaction to ubiquitous and pervasive computing. The focus is then put on the physical, tangible, object and not its invisibility or integration with its environments. However, to understand the full potential of ubiquitous and pervasive computing, it is important to notice that the invisibility potential is not necessary related to the possibility to build computers into all kinds of artefacts. The invisibility is rather related to that computational artefacts have other physical appearances, embodiments, than what we expect from a computer. This also shows how culturally primed we are of how we interact with computers and technology. Consequently, we might not treat the artefacts as computers.

This is also the crux of BodyBug. People do not recognise the concept. It is difficult to associate it with things they have seen before or already know. They do not understand how to interact with it, or the point of it. BodyBug is therefore ubiquitous in the meaning that you do not see the computer, and it is tangible in the way that you interact with a

physical object.

8.3 Concluding Remarks

In this thesis I have shown that kinaesthetic movement interaction provides possibilities to create embodied, aesthetic and rich user experiences. This is especially obtained when the movement is defined by the person who is interacting and when the movements are related to how (s)he prefers to move and the personal movement quality. However, human movement is not always appropriate as interaction modality. This might be due to aspects such as efficiency and to the social and physical context. When we design for movement-based interaction, it is therefore important to have an idea about why the specific interaction modality is used and what it contributes with. How we design and develop technology also influences people's movement patterns and movement habits in a longer perspective. Hence, our development of movement-based interaction artefacts contributes to the social "education" of our bodies.

Movement-based interaction is still in its early phase. We therefore need more experiences and physical examples of this kind of interaction in order to develop an increased knowledge of human movement as design material. We also need more knowledge of how movement-based interaction is experienced and to continue the search for the essence and physical grounding of human movement in relation to technology and computational artefacts. Some of the biggest challenges are to design for movement-based interaction without loosing the aspects of individual preferences and differences in movement, and to preserve the spontaneity as well as ambiguity in human movement. As shown in this thesis, one approach to deal with these issues is to design for the pleasure of motion.

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Appendices

APPENDIX A:
DESCRIPTION OF THE DANCE COURSE EXERCISES

* indicates that video documentation is available on DVD in Appendix B.

Ex #	Name	Description
Imitation and movement phrases		
1	Add on	Standing in a big circle, the first person does a movement and everybody copy. Next person does a movement, everybody copy and then add it to the first one. Next person in the circle does a movement, all copy and it adds on to the growing movement phrase. Continue this way until everybody has contributed with one movement to the movement phrase. Rehearse the whole phrase.
2	Angel	The phrase was quite abstract with no specific timing or clear rhythm. The emphasis was on the movement quality rather than specific movements or steps. Most qualities of the movements could be described "as if" you were… The phrase was performed to different musical alternatives. The participants worked on the phrase for about 30 minutes.
3	6/8 *	The phrase contained specific movements or "steps", turns, etc, quite technically challenging. The music was in 6/8 beat. The participants worked on the phrase for about 40 minutes. The phrase was repeated at the following class as well, then used as basic material for a movement quality exercise (Ex #27).
4	Phrase	The phrase dealt with timing, dynamics and levels, and contained a few more technically challenging steps. It was performed with two different musical alternatives, i.e. one slower and one faster. The phrase was repeated at the following class as well.
5	Diagonals	Various jump and skip combinations across the floor.
Improvisation		
Sensory Awareness: Kinesthesia, Touch, Sight, Hearing, Speech		
6	Walking	The teacher talks the participants through the exercise: Walk freely, up-tempo, utilising the whole space. Be aware of (take in) the physical room and the people being in it, but focus on yourself and your body. Pull the attention towards the "sit-bones" and the pelvis as the centre of the body. Tilt the pelvis back and forward respectively, as well as let it hang straight down. Feel the weight from your centre down towards the floor, and a flow of energy from the centre and up through the top of your head. Now and then shift the weight from the feet to the hands on the floor, still moving forwards up-tempo, slide down on the floor, roll, etc, and come up again. Slow down, come successively to a stop. Place your feet beside each other, feel the weight of the pelvis down to the floor, and the energy flowing up through your head. Raise the heels, and come on to the tip of your toes. Find your balance, slowly lower the heels.

7	The Flock	Stand close to eachother in a group. The person at the front starts to move and all the others follow that person's movement, until another person becomes the one in front (i.e. when changing direction), which then becomes the new leader. Make the change of leader continuously and smooth.
8	The Mirror	Work in pairs, facing each other. One person starts to move; the other person mirrors the movement. Change leader. Decrease the time for each leader, and finally move changing leader continuously so it seems that no one leads.
9	Movement Conversation	Work in pairs. One person does a movement; the other person makes a sound associated to the movement, i.e. answer the movement with a sound. Change partners. One person makes a movement phrase; the other person answers with a movement phrase. Change partners.
10	Balancing	Explore balancing on different body parts. Play with being in balance or in control, then release the tension, the balance, the control, and finally regain the control.
11	The Match	Work in pairs. Take a match and use it as a bridge between your fingers, i.e. press the tip of e.g. your index fingers towards the match. Start to move together in space, without talking, keeping the match as your connection point. When you feel stable, try to challenge yourselves e.g. by moving faster.
12	Support	Work in pairs. Give and take weight, lean towards and from each other. Carry, lift and drag your partner, or parts of his/her body, in space.
13	Body Part	Focus on one body part and let that part lead or initiate the movement. Let the body part take you somewhere. Change leading body parts.
14	Movement Impulse *	Physically give your partner a movement manipulation, i.e. a movement impulse, and initiate a movement. The person receiving the impulse should follow it as long as it takes him or her. Change partners. Next level is to imagine that you are given a physical movement impulse by someone and follow that impulse as long as it takes you.
15	Moving Shapes	Make a shape with or your body. Feel it and memorise how the shape feels. Start to move the form in space. Continue to move as long as you can feel the original shape, and then choose a new one.
Space		
16	Fishes and Birds	Move through space (e.g. across the floor, from one side of the room to the other) on different levels; as close to the floor as possible; a little bit higher; etc. Increase the level each time until moving as close to the ceiling as possible.
17	Fill the Room *	Collectively, fill the room with movement during 30 seconds.
18	Near Space *	Explore the space close to yourself.
19	Positive & Negative Space *	Work in pairs. One person creates a shape; the other person moves, fills and explores the space around the shape. Change roles. One person takes a shape; the other person takes a contrasting, complimentary, etc. shape; the first person takes a new shape, etc. For each pair, chose four collaborative shapes that you like and put them together as a phrase to perform.

20	Interpreting Space	Define a space as the stage space of the room, e.g. one half of the room. Let one person enter the stage space and take a position, make a shape, do a movement. Discuss what it expresses, how the observers interpret the scene. Let in an additional person; change persons on the stage; change shapes; etc. Discuss how the space and the expression change.
Time		
21	Fast/Slow	Move as slow, and fast respectively, as possible during 30 seconds.
22	Accelerando & Ritardando	Do a movement accelerando and ritardando respectively. Start as slow/fast as possible and successively speed up/slow down the tempo of moving or the movement.
23	Changing Time	Create in groups, a phrase that takes 10 seconds to perform. Perform the phrase on 5, 20, and 30 seconds respectively.
Energy		
24	Force	Move as if you are: feeling and touching the air; inside an elastic fabric; pushing or moving solid walls.
Movement Quality		
25	Move	Explore movements that are: soft and careful, attacking, vibrating, falling; bending and stretching; round, soft, straight, edgy; flowing and "staccato" (cut-up).
26	Variations	Perform the phrase (Ex #1) slow, fast, big, small.
27	As If *	Perform the phrase (Ex #3) as if you were: really bored, a Spanish matador, weightless in space, in strong headwind, very stressed, or putting no effort to it.
Composition		
28	Floor Patterns	Individually, draw five different paths or floor patterns connected to each other. Move along these, either by running or walking. At some time during the journey, make a stop or a pause, short or long. You choose yourself where to enter the space. It will be performed in groups.
29	Photo & Text	In two groups, take the starting point in a photo and an excerpt from a poem. Associate to these and create a gestalt. Performance in silence. Group 1's text (in Swedish): "Jag befann mig den gången nära något okänt och ogripbart som jag inte desto mindre hade i min hand." From "Förtöjningar" by Per Wästberg. Group 1's photo: Advertisement for a dance performance. Group 2's text (in Swedish): "Jag är ett vimmel av dig, en trängsel av mötesplatser, ett myller av avskeden, någonstans en ständig närhet, någonstans en oavbruten borthet." By Sandra Key-Åberg Group 2's photo: A man playing an accordion.

30	Name Phrase *	Individually, draw your name using one body part to lead the movement (Ex #13) for each letter of your name. Rehearse the phrase and perform individually in two groups. In each group, teach and learn each other's movement name-phrases. Put together all phrases to one phrase and rehearse the phrase as version 1. Start manipulating the version 1 phrase, the motifs. Rehearse the new (choreographed) phrase as version 2. Both versions will be performed.
31	Boundaries	In groups, create a physical gestalt of "Boundaries". You do not have to "illustrate" or "describe" the notion, but use it as a starting point. You may use music for the performance.
32	Abstract *	Individually, play with different shapes and the transitions between the shapes, find 3-5 movements that you like and remember them. In two groups, choreograph a short piece making use of the individual material in each group. You do not have to learn each other's movements, and you may use music.
33	Solo Piece *	Collectively, brainstorming words associated to the notion "contemporary phenomena in society 2004." Choose 1-3 words that you respond to, that interest you. Continue to brainstorming around these towards some issues that you would like to explore through movement by creating a gestalt. A solo that could be looked upon as a "comment" to this phenomenon. The piece should be about 1-2 minutes. You may use music as inspiration, but be able to perform the piece in silence. (4 weeks were allowed for working, including 2 classes with tutoring individually and in groups, from the dance teacher as well as each other.)

APPENDIX B: DVD AND VIDEO EXAMPLES

Dance Course Exercises

VE #1	Ex #3, #27 - Movement phrase and quality	9:47 min

This video clips shows the exercise called 6/8 (Ex #3). The name reflects the beat of the music. The example is from the second class the participants did the phrase. In total they had been working on it for about 45 minutes during two classes. The second part of the video clip shows when the participants were asked to perform the 6/8-phrase with different movement qualities, or "as if" they were in specific situations (Ex #27). They were separated into two groups so they could observe the other group's performance and expression. Both groups performed the phrase as if they were really, really bored, a Spanish matador, weightless in space, or in strong headwind. One group also did it as if they were really, really stressed, and the other group as if they were putting no effort to it. Finally, they choose the quality that was their favourite.

• Ex #3: 6/8	1:46
Ex #27: As If	
• ...as if you were really, really bored	0:56
• ...as if you were a Spanish matador	0:55
• ...as if you were weightless in space	1:50
• ...as if you were in strong headwind	1:16
• ...as if you were really, really stressed	0:16
• ...as if you were putting no effort to it	0:30
• your favourite as if...	1:08

VE #2	Ex #14: Movement Impulse	3:41 min

This video clip shows the exercise Movement Impulse. First, they work in pairs where one person is manipulating or giving movement impulses to the other. The person who is manipulated was asked to close his or her eyes in order to emphasise the physical sensation that should guide the resulting movement. Second, they worked individually and tried to follow an imagined movement impulse, by using their kinaesthetic memory of how it was to be manipulated. Hence, they should move as if they were given an impulse, or according to their own movement impulses.

• Manipulate and be manipulated	2:04
• Follow one's own movement impulse	1:19

VE #3	**Ex #17, #18, #19 - Movement Element: Space**	**4:04 min**

This video example shows first an excerpt from the exercise where the participants were asked to fill the room with movement during 30 seconds (Ex #17). Second, it shows the exploration of the space immediately surrounding themselves during the same amount of time, i.e. 30 seconds (Ex #18). Third, the participants worked in pairs exploring positive and negative space (Ex #19). One person formed a shape and the other person filled or explored the space around the around the shape. Finally, the video shows four short duets that each pair had created out of their collaborative shapes.

- Ex #17: Fill the Room 0:29
- Ex #18: Near Space 0:35
- Ex #19: Positive & Negative Space 0:44
- Ex #19: Positive & Negative Space - Performing duets 1:32

VE #4	**Ex #30: Name Phrase**	**5:38 min**

In this exercise the participants were first asked to write their name letting one body part lead or initiate the movement that represented each letter. This video example shows first Group 1 performing their individually resulting name phrase. The second clip shows Group 1's phrase where they hade merged all names. Everybody in the group had taught the other participants their name phrase. Then all name phrases were merged. Finally, the group were asked to create a composed version of the merged phrase, which meant that they could elaborate the movements they had already created and work on forming and phrasing the movement. They were also allowed to remove and/or repeat specific movements. The next three clips shows Group 2's individual, merged and composed name phrases.

- Group 1: Individual names 0:40
- Group 1: Merged names 1:34
- Group 1: Composed phrase 0:49
- Group 2: Individual names 0:26
- Group 2: Merged names 0:40
- Group 3: Composed phrase 0:49

VE #5	Ex #32: Abstract	5:31 min
	This video clip shows the phrases that were result of the male as well as the female group in the Abstract exercise. The male group had created a phrase where they repeated that could go on an on forever. This clip shows about half of their performance. The last clip shows an excerpt from when the participants on their own initiative, performed the two phrases within the same physical space.	
	• Male group 2:00	
	• Female group 0:50	
	• Male + female group 2:20	

VE #6	Ex #33: Solo Piece	23:20 min
	These video clips show the participants' solo pieces. The titles are chosen by me, but related to which phenomena they wanted to explore in their work.	
	• Captivity 1:47	
	• Cycle of pain 1:48	
	• Demands 0:57	
	• Election 1:52	
	• Escape 4:25	
	• Homeless 0:52	
	• Making a difference 1:53	
	• Multi cultural abuse 6:13	
	• War 2:26	

Interaction Concepts

VE #7 - Personal Sphere	
This video clips shows the interaction concept Personal Sphere created during the first design workshop that was part of the dance course.	00:41 min
VE #8 - Mock-up Interaction	
This video example shows Johan interacting with the first BodyBug mock-up. The mock-up is attached around his waist under his shirt and is therefore not visible.	01:00 min

Photos

Colour versions of the photos used in this thesis.