HERE AND NOW
Foundations and Practice of Human-Experiential Design

Kei Hoshi
Abstract

The thesis claims that an experiential approach to design really does promise the possibility of scientific design of everyday life. The purpose of this thesis is to show the promise. René Descartes conceptualized the classical formulation of a mind-body dichotomy. Various resulting and unbalanced dichotomies, such as subjective-objective, internal-external, experiential-practical and so on, raise serious concerns surrounding the concept of design. The thesis raises a crucial issue about the imbalance between technological and human concerns in the context of human-computer interaction, an imbalance that has been caused partly by the mechanistic aspect of informatics and its impact on designing human computer interaction. The thesis first explores the origin of design as a distinct activity during the industrial revolution, and reviews the tide of design history from then until today. The brief review of design history indicates that design is not merely the skill of making things or presentations. This gives direction to how design can be positioned in our modern information society. Second, the author starts a critical discussion about ordinary design approaches that, it is suggested, may have hindered true human-centred design, and then introduces an alternative approach to design and research, which the author calls Human-Experiential Design. Third, the notion of Tangible Presence in Blended Reality Space is introduced. The conceptual grounding that illustrates the experiential approach to interaction design is discussed. Fourth, the thesis presents use cases and provides examples of Human-Experiential Design in specific practical contexts. The concrete examples suggest that the emphasis on ‘balance’ or appropriate blending is very important in the development of better interactive systems for health, capitalizing on seamless combinations of the virtual and the physical in Blended Reality Space. As exemplified in the thesis, the human-experiential approach, striving for optimal combinations of tangibility and evoked presence, offers a promising tool in designing for special needs groups such as elderly people with some cognitive weaknesses, and children undertaking physical rehabilitation programmes. It is suggested that such virtual-physical blends will release human beings from the strain that existing perceived dichotomies bring. Finally, the author concludes by offering a way forward, a way that is neither subjective nor objective but rather a meaningfully integrated blend of the dichotomies, which responds to the question of what it means to be human.
Preface

The thesis incorporates the following papers published over the last 4 years. These papers have been internationally published with peer reviewing as academic conference papers, book chapters and a journal paper. This thesis, however, has further developed on the basis of discussions, comments, reviews and my insights after the papers were published.


**Contribution:** First author

The whole paper was written by the first author. Specifically, my responsibility was to develop the conceptual foundation of blended reality, to design applications, to develop prototypes, to analyse the focus group interviews and the discussions. Fredrik Öhberg, a co-author, was responsible for the encoding and configuration of the physical component inside the prototypes. Annakarin Nyberg, a co-author, was responsible for gathering data from the focus group interviews. All information and data have been shared among the authors.


**Contribution:** First author

The whole paper was written by the first author. My responsibility was the development of the contextual reality framework. Fredrik Öhberg (co-author) and I developed the prototypes. Annakarin Nyberg (co-author) was responsible for gathering data from the focus group interviews. We analysed the gathered data. All information and data have been shared among the authors.


**Contribution:** Single author
The conceptual foundation of blended reality space and the concept of human-experiential design were developed and introduced by the author.


**Contribution:** First author

The whole paper was written by the first author. My responsibility was to design the experimental study, to execute the study, to collect data and to analyze the gathered data. John A. Waterworth, second author, helped constructing detailed experimental method and analysing the gathered data.


**Contribution:** Second author

My contribution to the paper was to provide a psychological and perceptual perspective on interactive computer play, which may promote players’ performance and keep motivation and interest in game-initiated events. This is expected to contribute to motor control improvement.


**Contribution:** First author

The whole paper was written by the first author. My responsibility was to design the experimental study, to execute the study, to collect data and to analyse the gathered data. John A. Waterworth, second author, helped constructing detailed experimental method and analysing the gathered data. Ulla.-Mija Pesola and Eva L. Waterworth contributed by recruiting appropriate subjects.

*Hoshi, K., & Waterworth, J. A. (2008). Effective collaboration for healthcare by bridging the reality gap across media-physical spaces.*

**Contribution:** First author

The whole paper was written by the first author. My responsibility was to develop a conceptual solution for healthcare collaboration, which includes a discussion of issues in e-health communication and collaboration, an introduction to a new way to approach the issues, and a description of future needs for further research on collaborative healthcare. John A. Waterworth, second author, reviewed my scholarly work of the paper.

Many of the ideas and concepts in the thesis were inspired by eminent predecessors. For example, metaphor theory from Geoge Lakoff and Mark Johnson, blending theory from Gilles Fauconnier and Mark Turner, and intercultural communication theory by Edward Hall. I became a designer and a design researcher because many advisors and senior designers led me in the right direction. I can talk about design and do design because of the accumulation of effort and hardships by such design forerunners as the Arts and Crafts thinkers in England, the Bauhaus scholars in Germany and among many prominent designers in the world. Information technology was invented by the effort of many engineering forerunners, and has been evolving continuously. It therefore would be intrusive to claim that my thesis is purely original. I would like to be respectful towards the forerunners and always to keep a humble manner.

For that reason, the thesis often uses the term ‘we’ as a representation of design disciplines including my self and also as joint efforts with my colleagues, especially in some cases of practical studies. However, if it is my clear aim to claim my own contributions, the pronoun ‘I’ has been used. I believe that this thesis has a number of original contributions for research community and mostly for better human life.
Acknowledgements

This thesis is not merely a set of theories, methods and practices. I suppose I could say that through exploring the nature of design, this thesis attempts to explore those resources of sensitivity that one's own culture must have.

Communication is not easy. There is no fully communicating explicit language. Rather, I experience that mutual communication exists solely in our sensory perception.

There is a term ‘contextual emptiness’ presented in the present thesis. When people successfully share the meaning in communication, they try to listen to each other rather than pushing their claims at each other. The careful listening helps to sense the weave of nuanced tone of voice, facial expression, and emptiness or silence. Mutual communication depends on how we sense, rather than how we assert our right. We have therefore facilitated to evolve a way of communication using “emptiness” to try to economically understand each other.

The same may be said of the nature of design. I did not attempt to chase an absolute truth on describing design. Instead, I have pursued a way to sense ‘design.’ Through this thesis, I hope that we can gain an awareness of design that is woven out of the remarkable diversity and complicatedness of our senses as registered by one’s own culture. We then become able to distinguish the hidden meaning contained in silence and emptiness that have nothing to do with words.

There is a metaphor in eastern philosophy:

“it is the finger that points to the moon”

It is not easy to describe design by words. ‘Design’ can be replaced as the bright moon in the sky. Words can be replaced as a finger. We tend to look at the finger that points to the moon’s location. However, the finger is not the moon. So we have confused things, as though the finger is the moon (true design).

I think design is to waken the sleeping senses that we should but have forgotten. In order to remind ourselves of it, we continuously chase what design is by describing, even though we or our body already know it. So design has nothing to do with chasing what is new/old, because we have already known it.

Writing a thesis is a cooperative effort. While I must have ultimate responsible for the content, form, style, and organization of ideas, if there
was no the assistance of others, my research would be immeasurably
lengthened. My first acknowledgment therefore with thanks and
appreciation is to Professor John Waterworth, who provided an extensive
and thoughtful critique of my research, and reviewed and strengthened the
manuscript at various stages. He helped me to find the most important thing
that I have missed through entire my life even though I have already known
it. That is the title of this thesis. It is probably the most important “beauty”
for human beings, I believe.

Since I started my design career, it has been almost 20 years. Time goes
past so quickly. It is impossible to thank the myriad people who have helped
me out in developing my design career over 20 years. I apologize in advance
if inadvertently I have failed to acknowledge a debt.

I have been fortunate in having a series of inspiring teachers and advisors.
As I have moved through product design, interaction design, and human-
computer interaction, each of these advisors has contributed to my ability to
understand the subject matter of design. From 1991-1994, I studied product
design under the direction of Professor Keiichi Sato (currently, at the
Institute of Design, Illinois Institute of Design). He had been teaching design
in the U.S. from the 70’s. I therefore could soak up knowledge of user-
centred design that had already become common in U.S. and could build a
professional design career. I have been most fortunate to have received good
counsel from Keiichi Sato.

In 2003 I had the opportunity to work with Isao Hosoe, a Milan-based
designer in Italy for more than 40 years, where I came to a turning point,
especially my design approach from ordinary user-experience design to
human-experiential design, which focuses on human experience that covers
our shared embodied knowledge evolved over thousands, even millions of
years. He gave me a fresh eye from based on the eastern philosophical
aspect. He has turned 70 years old this year and is still an active designer. I
dedicate this thesis to those inspired and inspiring people, those teachers
and advisors.

The bulk of the thesis work has taken place since I came to the department
of informatics, Umeå University. I want to thank everyone in the department
for making it such a good place to work. I also acknowledge the tolerance of a
number of my colleagues, who have let me pick their brains time after time,
especially Karin Danielsson, Ulla-Maija Pesola, Andreas Lund, and Rickard
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Over the years, I have had rich opportunities to find a group of academic friends and colleagues who learned to tolerate my repeated questions and from whom I have learned a great deal, thanks to members of the department of informatics, the AGNES project and the Q-life research group.

Without the support of my Swedish Institute scholarship, and without my acceptance for admission by Anna Croon Fors and Eva Waterworth in June 2008, I could not have started my Ph.D. research in Sweden. I am grateful to the foundation for the support, and deeply indebted to Anna and Eva for the invaluable opportunity they gave me to pursue Ph.D. research. It goes without saying that I could not have completed my thesis without the moral support of my parents (my father passed away in 2004) in Japan.

People have unfavourable impressions of the winter in northern Europe. It is said that it is dark and cold. This morning, Umeå is covered in new snow, and it is still falling. I had sensed that it was silently dancing during night. The silence tells me of the accumulation quietly building up outside. My body has secretly sensed the silence and emptiness. It is likely that the flakes will continue falling tonight. I will profoundly enjoy the silent beauty. I love the winter in Umeå.

March, 2012
Kei
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PART I: Perspectives of Design
Chapter 1: Introduction

1.1 Introduction and Motivation
What is ‘design’, actually? In our current era characterized by the information society, the role of design and its importance in this circumstance has long been a topic of discussion.

This is the fundamental question among designers and even design researchers, and they spend their days trying to find the answer somehow. We, representing the design disciplines, have some doubts about recent designs and design work, and also about design research.

Even if we do design with the best intentions to make good products, to improve daily life, we know that in a way we are just glamorizing the ownership of things. Design is generally seen as an inherent part of production or business management. The aim of design is believed to be that of increasing productivity and efficiency of production. Hosoe et al. (1991) referred to such concepts as user-experience design, human factors or ergonomics applied in the design process as a starting point, and stressed that “they have never completely succeeded in ridding themselves of the industrial logic connected to them” (p.6). The term ‘Design’ has become popular and somewhat fashionable with the rise of commercial developments throughout the globe, what people are calling ‘globalism’.

Various recent terms applied to design, such as ‘—centred design’ or ‘—able design’, might be rooted in the philosophy of, for example, functionalism, positivism, materialism, pragmatism, the mechanistic view of the universe, and so on. But the concepts of design founded under those terminologies are simplistically transformed into modern ‘buzz words’. The resulting designs seek a superficial effect on mere phenomena. Liam Bannon (2011) has thrown a question on human concerns in human-computer interaction (HCI) and the way that “the terms ‘human-centred computing’ and ‘human-centred design’ have been touted as possible replacements for HCI.” This thesis argues that the designs taken from this kind of approach are actually considered in the absence of human beings as such.

What if we need to design a chair for example? We can easily imagine a chair in our head. A chair is an everyday life object, which we use almost everyday. When a chair is a given task as a thing to be designed, our head becomes full of ideas about what kind of chair we want to design, and we are at a loss for a way of designing a chair. We become a little less sure of our
knowledge of a chair. Finally we end up thinking about what a chair actually is, with no idea of designing a chair, even though we use chairs in our everyday life. By conceptually understanding design and accumulating knowledge of design, we feel as though we are one of the great designers. But we don't actually know anything about what design is. I suppose that this ‘we don’t know anything about what design is’ is the most sincere attitude.

Scholars and the disciplines in HCI, information systems, engineering, and business and so on have tried to conceptualize a rational design methodology (Hevner et al., 2004; Tomiyama, 2009; Finger & Dixon, 1989; Owen, 1998). But it is about a design methodology based on the mechanistic view of the world. The methodologies of design, based on this aspect, had to demonstrate that the ‘scientific’ view was capable of formalizing design. But it has not yet succeeded, because human beings and human life, where design belongs, are formed of numerous things, which are not easy to externalize and foresee (Hosoe et al., 1991).

On the other hand, to the extent that ‘design’ is formalized, it evolved as a part of corporate management resources, and as a marketing aspect that supports economic development in a pragmatic manner closely linked to management strategy and marketing analysis including customer/user research. It can be said that design has contributed to a particular kind of culture, but placing the emphasis on only the quantitative value brought by ‘Design’, such as the economic or business point of view, is overly simplistic. There are no absolute principles for the basic criteria of good design.

René Descartes established a period of thinking about cognition that separated mind and body, cognition and action. There is, by this view, the ‘separated environments’ assumption: the idea that there are two separated environments, a mental (subjective) world and a physical (objective) world. The revolution of digital computers largely relies on mechanical metaphors. Descartes had interpreted the mind as a subjective consciousness that held ideas that mapped (or did not map) to what was in the world. The body can be seen as a machine controlled by the mind, which is non-material and outside the laws of nature. It seems that technological mastery has accrued much of the prestige of science, rather than its origin of scientific thinking. Many recent scholars have argued against this, for example, as the mind-as-machine view by George Lakoff (1987) and as the mechanistic picture of the world by Dijksterhuis (1965).
Human-Computer Interaction ‘Design’ largely relies on the mind-as-machine view (Lakoff, 1987) or the mechanistic picture of the world (Dijksterhuis, 1965). A typical example is the cognitivist assumptions in HCI underlying views such as the model human processor (Card et al., 1983). This view aimed to practically harmonize accessibility, usability, acceptability, and engagement based on a formalization of human cognition of the world. This equals avoidance of the complicatedness of the real world and of humans. The ecological psychologist Edward Reed (1996, p6) has discussed the critical issues from their psychological aspects. Design also has been conceived as ‘scientific’ to the extent that it kept away from dealing with everyday concerns.

The mechanistic view tends to reinforce the preconceived ideas that;

1) to the extent that it is scientific, design must be about bodies as distinct from minds;

2) to the extent that it is about minds, design cannot hope to be scientific in the explanatory sense.

If any of these assertions can be proved correct, then true human-centred design would be impossible. Also a subject deserving the name ‘Design Science’ could never be a viable discipline.

However, this assumption misleads in a most harmful way. This mechanistic bias is one of the leading reasons why scientific ‘Design’ has had so little success in helping us to understand reality from a design’s point of view. What we have to seek is not what sort of design we might want in current progressive industrial/information age, but by designing, whether we can answer the question of what it means to be human.

If science uses only the language of mathematics, far away from everyday life concerns (Hosoe et al., 1990), probably we have to conclude that there is not anything that being human is like, because all minds are just forms of computation on symbols (see Nagel, 1974). Or, more probably, American, European, Asian, Japanese, or whatever nationality, and even different religious perspectives, each have their own ways to be human based on their own cultural manner, that stipulates the supposed limits of human nature (Reed, 1996).

Surprisingly, just as design researchers try to relate ‘design’ to rational aspects, it is striking that to the extent ‘design’ has been conceived as ‘scientific,’ it has tended away from dealing with everyday concerns.
As the ecological psychologist Edward Reed (1996) stressed: “the vast majority of ‘scientific’ psychologists take refuge in a self-justifying myth that science equals experimental control equals avoidance of the complicatedness of the real world” (p.6). Reed (1996) has claimed that a truly scientific psychology should essentially seek psychological aspects of reality. This tells exactly what scientific design should seek.

Similarly, design science will succeed if it offers us a way out of this imbalanced situation, if it provides properly scientific foundations and methods (including empirical ones) for the study of real, living, design issues.

1.2 Audiences

This thesis should be well suited for design disciplines, researchers in the field of HCI, and researchers in the field of the kind of informatics that belongs to social science.

It is not accidental that Design and Human-Computer Interaction belongs to the subject of informatics in social science. Although there are number of areas of applied informatics such as medical informatics, business informatics, organizational informatics and social informatics and so on, informatics in general can be defined as “the study of the design and use of information technologies focusing on their interaction with individuals, organizations, and society” (http://www.informatik.umu.se, accessed on March 12, 2012).

A noteworthy point is that in two historical emergent disciplines, design and sociology, the origination of perceiving of design and sociology in a society can be found at about the same historical period when the industrial revolution dehumanized human beings, societies, labours, and the environment.

The nature of design history will be explored in greater depth in Chapter 2. However in brief, the Arts and Crafts movement, raised by the profound romanticist thinker William Morris, has been identified as the origin of design (Nikolaus Pevsner, 1991). This was the emergence of design as an established profession in society following the industrial revolution in England. During this historical moment, ‘design’ emerged as the strong negative reaction of aesthetic sensibility against the crude industrial system in England, which was forcefully destroying a sensitive and reflective way of living. The reaction originated its way of perceiving of design in society.
Mazlish (1993) explored the advent of sociology, especially in terms of its relationship to the humanities. Mazlish categorized nineteen-century thinkers as ‘lamenters’ and ‘breakers’, who were dominated by a metaphor for the breaking of all connections to the past, what Mazlish calls the ‘Cash Nexus.’ Mazlish positioned those who broke and those who lamented the breaking side by side as though they were dichotomized. Discussions on the basis of Mazlish’s viewpoint can be replaced as a current discussion over modern information culture. This also implies that issues and discussions on HCI (human-computer interaction) design align with the same dichotomous debate as the lamenters-breakers. Lamenters, described as romantic people who include Burke, Rousseau, Elizabeth Gaskell, Benjamin Disraeli, George Eliot, Wordsworth, and Carlyle, are alienated from the modern world and hope that their sensitive literary project might rescue bonds of human sympathy from the breakdown of previous connections. On the other side, Breakers, who more scientifically theorized modernism, include Sir Henry Maine, Karl Marx, Emile Durkheim, Max Weber, and others who see the breaking of all connections to the past as making possible the way for freedom and independence to be enjoyed by each individual. Mazlish’s perspective is that, by examining historically the social sciences, in this case specifically sociology, we find that it had its origins especially in relation to the humanities. This coincides with the origin of design.

1.3 Theoretical background and the contributions to the present thesis

As mentioned previously, the thesis seeks the ‘design aspect of reality.’ What we have to seek is not what sort of design we might want in the current progressive industrial era, but by designing, whether we can answer the question of what it means to be human. In order to respond the question through a human-experiential design (HXD) account, the present thesis has been grounded on a multi disciplinary framework that consists of:

1) Philosophical theory: Experientialism
   a. Embodied cognition
   b. Metaphor theory
   c. Blending theory
2) Psychological theory:
   d. Presence research
   e. Consciousness study
3) Intercultural communication theory: the concept of High-Low context culture
4) Design theories and methods (User-centred design principles)

The theoretical foundation has made significant contributions to the present thesis. First, I assume that scientific understanding and actual human experience are not capable of being separated. In the same way that we cannot walk without a pair of legs, or a brain, true design science presupposes humans' everyday life experiences. The experientialist account, which includes embodied cognition, metaphor theory and blending theory, explores the embodied imaginative structure of human understanding (Johnson, 1987; Fauconnier & Turner, 2002). Especially, metaphor theory and blending theory are complementary to each other, and contribute to the establishment of HXD.

The present thesis focuses two types of imaginative structure: image schemata and metaphorical projections. Those are forms of imagination that emerge from our bodily experiences and guide our understanding and reasoning. The conceptual models have been applied to HCI in which designer, engineer and usability analyst try to understand how users think and behave with systems. I will take up image schemata and metaphorical projections and how they can be applied to HXD that the present thesis offers, in a detailed way in Chapter 5.

One of the contributions of experientialist account to design is to comprehend the embodiment of human meaning and understanding and how this is associated with the imaginative structuring of experience. It contributes to design based in embodied everyday experience, what I would call the scientific design of everyday life, which will fit in our modern information society.

Our everyday experiences are increasingly mediated by digital technologies. HXD pursues the human natural flow of action unconsciously carried out in the external world of the present, what presence researchers called mediated presence (Waterworth et al., 2010). Presence research in relation to consciousness offers an important exploration that contributes to an understanding of how the sense of presence can be induced in a mediated environment, how a subjective sensation of being present can exist through information technology.
Is design an activity that has to be conducted on the basis of completely objective and absolute truth? Who can decide it? We can see that there are various views or gaps between cultures. There is a culture that claims to be absolutely objective, but another culture claims that subjective intuition is the nature of design. Each cultural point of view would see the other as based on mistaken assumptions.

The experientialist account claims that understanding and truth is always relative to a cultural conceptual system, which is grounded in our experiences through our daily interactions with all surrounding contexts in our physical, cultural and social environments (Lakoff & Johnson, 1980). According to Hall (1976), the level of context is the foundation of the nature of communication. Contexts can be of various kinds from internal to external and sensual to conceptual. They are essential to the formation of meaning. Hall’s intercultural communication theory, especially the conceptual framework of high-low context culture, contributes to understanding the nature of context in which people behave, perceive and develop meaning. Hall’s theory and the experientialist account help developing the contextual reality framework for managing, structuring and composing contexts in designing interactive systems for special needs groups, introduced in Chapter 7.

Above all theoretical foundations contribute to understanding humans, hence to explore developing true human-centred design in ways they are applied to design practices from user observations to actual implementations.

1.4 Thesis outline
The thesis, Here and Now: Foundations and practice of Human-Experiential Design (HXD), consists of 10 chapters, which are clustered into five parts: (1) Perspectives of Design, (2) Experiential Approach, (3) Foundations and Empirical Studies of HXD, (4) Exploring HXD in Specific Practical Contexts, (5) Contributions and Conclusions

PART I: Perspectives on Design
The first part, Chapter 1-2 on Perspectives on Design, explores the origin of design in the Arts and Crafts movement, and reviews the tide of design history up to today. The brief review of design history indicates that design is not merely the skill of making things or presentations. This gives a direction to how design can be positioned in our modern information society. Chapter
3 starts with a critical discussion about ordinary design approaches that may have hindered true human-centred design, then introduces an alternative approach to design and research.

Chapter 1
Most researchers and designers have a general idea about what design is, and use their idea to design and describe their work. A vague notion of design makes people confused not only academic research but also business and manufacturing sectors. This chapter raises the question ‘what is design?’, introduces the research goal, and briefly describes what the research attempts to address and accomplish. Critical issues about current design approaches are briefly summarized.

Chapter 2
Chapter 2 takes a moment to review the origin of design. Confirming a perspective that looks out on both human life and design within the tide of design history should be one of the helpful guides in order to response to the question ‘what is Design?’ It is important to review a perspective within the tide of design history, the period from the origin of the concept of design up to today.

Chapter 3
The aim of this chapter is to propose a new way meaningfully to bridge the dichotomy between technological and human concerns. We see ‘Design’ as having the responsibility to ensure that humans can fulfill themselves in the world of things (or technology). First, this chapter starts with a consideration of the view that there are two separated and imbalanced environments (subjective-objective) that has arisen from the Cartesian view and its impact on design. Second, the chapter raises issues surrounding human-centred design, caused by three major dichotomies that have caused a lack of true human-centredness: 1) cognition-action dichotomy, 2) the human-user dichotomy, 3) the virtual-physical dichotomy. Third, the chapter reframes a categorization of customer, user, person and human, which allows us to discover new aspects of ‘humans’ and of true ‘Human-centred design’.
PART II: Experiential Approach to design
In the second part, a new way of approaching human-centred design and research, which I call Human-Experiential Design is proposed, through which the experiential-practical dichotomy is effectively bridged.

Chapter 4
First, Chapter 4 sketches out an alternative design practice designated as ‘human-experiential design’, which emphasizes appropriate blending of technological and human concerns. Technology and human are not opposing concerns. The human-experiential approach offers a view from which both concerns can be met. This chapter is attempting to explore a third way, neither objective nor subjective. This chapter suggests that design may play the role of integrating the opposites, and designers are suitable for the role. Second, this chapter then attempt to investigate how the designers’ role can be positioned with respect to scientific design research. A variety of perspectives on design research are explored.

PART III: Foundations of Human-Experiential Design (HXD)
In the third part, Chapter 5-6 on Foundations and Empirical Studied of Human-Experiential Design introduces the notion of Tangible Presence in Blended Reality Space. The conceptual grounding that illustrates the experiential approach to interaction design is discussed.

Chapter 5
In Chapter 5, the concept of Tangible Presence in Blended Reality Space, and its study as an emerging weaving of HCI and presence research are presented. First, this chapter starts with a discussion about critical issues relating to presence arising from the recent evolution of tangible interaction techniques as an alternative interaction paradigm to the familiar WIMP-based Graphical User Interfaces (GUIs). This chapter illustrates the foundations of Blending and Blended Reality Space, interactive mixed reality environments where the physical and the virtual are seamlessly combined and affect each other. Second, the conceptual grounding that describes the experiential approach to interaction design is then discussed, adopting a standard figurative representation of blends. This helps understand the role of a blending that meaningfully bridges unbalanced separations between cognition and action,
and the physical and the virtual. The emphasis on ‘balance’ or appropriate blending is very important in the development of better interactive systems for health, capitalizing on seamless combinations of the virtual and the physical in Blended Reality Space.

**Chapter 6**

In Chapter 6, an experimental study is then described, which examined the influence of three key factors in the way blended realities may be implemented: tangibility, viewpoint and avatar identity. The study examines the effect of manipulations of these factors on rated presence and self-presence. The findings emphasize the importance of tangibility for presence, but suggest that presence and self-presence are actually unrelated phenomena. Finally, as critical concerns in designing and implementing blended reality spaces for a variety of purposes, context sensitivity and usability issues are discussed. The empirical work shows that the intersection of sensory, cognitive and also emotional aspects in such interfaces takes us a significant step further than GUI techniques. HXD represents an important step in the development of better e-health.

**PART IV: Exploring Human-Experiential Design in Specific Practical Contexts**

In the fourth part, Chapter 7-9 on Exploring Human-Experiential Design in Specific Practical Contexts, present use cases and provide examples of HXD.

**Chapter 7**

This chapter discusses specific practical issues in communication and collaboration arising from the reality gap between different managerial and operational levels in healthcare and patients. It then proposes an overview of the experiential approach to problems for which conventional design methods offer no clear solution. The chapter also explores where the contextual reality gap emerges in social sharing of knowledge, understanding and experience generated between users (also between a designer and a user) in different contexts. It goes on to examine how this ‘contextual reality gap’ can be bridged effectively in the sharing of meaning through mediated communication. The Contextual Reality Framework, a conceptual framework for understanding contexts in designing interactive systems, is proposed.
Chapter 8
As a concrete example, the AGNES project, which is aimed at developing 'user sensitive home-based systems for successful ageing in a networked society', is introduced. This work suggests that the emphasis on 'balance' is very important in the development of better interactive systems for health, capitalizing on seamless combinations of the virtual and the physical in Blended Reality Space.

Chapter 9
In Chapter 9, the thesis suggests that the human-experiential design approach, carries the potential to make full use of, while not overburdening, the flexible but limited capacities of selective attention. These findings can, for example, be incorporated into design principles to develop free movement based interactions for motor rehabilitation. New research on interactive training for children with sensorimotor disorders is introduced. This suggests that interactive computer play generating tangible presence is a promising tool in the physiotherapeutic rehabilitation of children.

PART V: Contributions and Conclusions
Chapter 10
This final chapter addresses the expected contributions of the thesis. Then it concludes by offering a third way forward that is neither subjective nor objective, but a meaningfully integrated blend that bridges the dichotomies outlined earlier, and which responses to the question of what it means to be human.
Chapter 2: The origin of design

2.1 Introduction
The present chapter takes a few moments to review the origin of design. A perspective that looks out on both human life and design within the historical tide of design should be a helpful guide in order to respond to the question ‘what is Design?’

Design has been discussed as crafts work by a large number of scholars (Long & Dowell, 1989; Rosner, 2009; Fetaji et al., 2007; Plass, 1998; Chalmers, 1996; Benyon, 2002; Wright, 2006; Norman, 2007). They describe ‘Designing’ as an activity of craftsmanship that deals with internal images and subjective sense, it also contains aspects that are hard to illustrate through theoretical points of view. They use such terms as ‘tacit’, ‘experiential’, ‘unknowable’, ‘skilled physical manipulation by hands’ and so on as main elements of the crafts work. However, it is doubtful whether design professions truly recognize own-selves as craftsmen. It may be a view from non-design disciplines. At least, I as a design professional have never become conscious of being a craftsman.

However, after looking into the details of well-designed things, we realize that amazingly rich thought process has been condensed in them. We see that there are logical decisions in the detail of making things incorporate subjective senses. Designers synthesize various conditions such as functionalities, use scenarios, and material characteristics as if they were weaving those conditions into fabrics in which their design is realized. Well-designed things are a depiction of the delicacy with which subjective sense and logic are engaged. We, designers, grasp design as an activity that puts the body into the reorganization of the pair: senses and logic. The nature of design is understood only through actual first hand experiences, because no matter how much you study theories and concepts, they would be meaningless unless they are sublimated onto the design activity. It is not until theories are embodied as bodily experience that substantial design skills are acquired.

In everyday life, we see that sensing does not yield to logic. Sensing in others is not easy to understand, even in ourselves it is not easy to explain. It becomes clear only as an intrinsic part of life. As Krippendorff (2005) mentioned, “since we cannot observe others’ senses, we have no direct access to the meanings they construct and no direct way of knowing why they see
the world as they do” (p.55). But why do we have logic and the senses contrasted as though they were dichotomized? The sense-logic conflict can be construed as the subjective-objective dichotomy.

Lakoff and Johnson (1980) state that “whereas scientific truth, rationality, precision, fairness, and impartiality are allied as objectivism, the emotion, intuitive insight, imagination, humaneness, art, and a higher truth are allied as subjectivism” (p.189). From person to person and from culture to culture, the ratio of objectivism and subjectivism governed in everyday life is varied (Figure 2.1). However, in modern society as a whole, “the realms of science, law, government, journalism, morality, business, economics, and scholarship” seem underpinned by objectivism (Lakoff & Johnson, 1980. P.189).

As science becomes more influential through technology in human life, we can find some reactions against imbalanced situations historically. For example, when the industrial revolution in England became dominant through large-scale machine production, poets, artists, and social thinkers reacted against the machinery tide, in what art historians call the ‘Arts and Crafts movement’. It was the advent of the Romantic tradition as a reaction against a crude machine production system. The Romantics positioned themselves as representing subjectivism and declared that science, reason, and technology had turned away from humans and the natural environment. They further claimed that art and poetry were not produced by rationality, logic or reason but were “the spontaneous overflow of powerful feelings” (Lakoff & Johnson, 1980, p.192) and suggested “a return to nature as a way for humans to recover their humanity” (also p.192). I believe that it is no exaggeration to say that these reactions can be understood as ‘the origin of design,’ or ‘the advent of design’.

![Subjective-Objective](image)

Figure 2.1 Subjective-Objective
We are beings located just here and now between the future and the past. We can look forward to the future lying ahead of us, but also there is a history of design behind us. In the following section, the period from the advent of the concept of design in the Arts and Crafts Movement through to today is briefly reviewed, so that we can see a perspective of design within the tide of history.

2.2 History of design: A trace of the change in design’s role
According to etymological dictionaries (Online Etymology Dictionary, 1988; Barnhart Dictionary of Etymology, 1988), the origin of the term ‘Design’ is to be found in the 1540s, from the Latin, designare ‘to mark out, devise, choose, designate, appoint.’ It is from de- ‘out’ + signare ‘to mark’ from signum ‘a mark, sign.’

It seems that to design is to bring order to a chaotic state. It can be interpreted as also to develop a plan and conceive it in mind in “order” to visualize or form.

There are a number of discussions about the origin of the concept of design based on different perspectives and disciplines from culture to culture. A thousand designers and scholars would define a hundred ways of description in terms of design. For example, some of them would argue that ‘design’ originated as the human species’ use of technology began with the conversion of natural resources into simple tools such as stones 200,000 years ago (Smithsonian Institute, 2011), or the prehistorical discovery of the ability to control fire before 1,000,000 BC (Crump, 2001; UNESCO, 2011). It can be also said to be the origin of technology. Another example is cave paintings from 32,000 years ago (Clottes, 2003). They were supposed to be a sort of ‘design’, used as a communication tool. Further, in relation to communication tools, western calligraphy in the Bible probably played a role to bring order for communication. Especially, Johannes Gutenberg (1398-1468) who invented the printing system with movable types, which made possible mass-producing different typographic designs and relatively rapid printings (Henri-Jean, 1995).

There is also an accepted view that explains the origin of design as emergence of an established profession after the industrial revolution in England (Pevsner, 1991). Design or designer as a profession had a responsibility in society and played a role to contribute to society. That means that the professional way of thinking of design was recognized in
society. This thesis adopts this view of the origin of design in the origin of industrial design. The following sections discuss the history of design and the advent of design, based on this view, in the origination of a way of perceiving of design in a society.

2.2.1 Design as social thought

Arts and Crafts Movements: the advent of design

We see that similar history repeats itself at different times and in different places. Throughout history profound thinkers have screamed out for help against a reckless society, but those sensitive voices are drowned out by the mainstream of the world.

The sweep of the era could not stop the machine production as long as it continuously boosted the tides of mass production and mass consumption.

England’s growing prosperity in the 18th-19th century was actively stimulated by the machine production system, the Industrial Revolution. The crude machine-made productions were merely copies produced by the unskillful machine production system. Craftsman skills cultivated for a long while were distorted and ignored. A mere trace of patrician taste in craftworks was continuously produced on a large scale at unusual pace (Hara, 2007).

According to the art historian Nikolaus Pevsner, in his book ‘Pioneers of modern design’ (1991), the advent of design emerged from the two profound social thinkers; William Morris (1834-1896) and John Ruskin (1819-1900). They were proponents of social thought and the founders of the Arts and Crafts Movement. During the era, John Ruskin and William Morris with much respect and fondness for their own culture must have been concerned about the decline in sense of beauty. They alleged that humans had lost something in achieving this new mass production. The sensibilities, which had been nurtured by skilled craftsmen’s work against the concealing background of sophisticated European culture, rather clearly emerged as a result of their protest against industrialization (Hara, 2007).

Lakoff and Johnson (1980) have introduced Wordsworth and Coleridge as symbolizing romanticism, in that “they gladly left reason, science, and objectivity to the dehumanized empiricists and exalted imagination as a more humane means of achieving a higher truth, with emotion as a natural guide to self-understanding” (p.192). Although this romanticism or Ruskin’s
and Morris’s Arts and Crafts Movement reinforced anti-science attitudes, with both defending the renaissance of the skilled craftsman practices and taking critical attitude toward the harmful impacts of machine production, their disputes vanished into the mainstream of the era and were unable to draw enough movement to block the rapid changes of the industrial revolution or to decelerate society’s alteration (Pevsner, 1991; Hara, 2007). The result of this separation between the romantic position and rapid industrialization was the isolation of the romanticists from the mainstream of society. By willingly accepting subjectivism, the romantic position made distinct “the dichotomy between truth and reason, on the one hand, and art and imagination, on the other” (Lakoff and Johnson, 1980, p.192).

The romantic tradition in terms of ‘design’ could be described as the strong negative reaction of aesthetic sensibility against the callousness and prematurity concealing in the industrial system, which was forcefully destroying a sensitive and reflective way of living in the environment. As Hara (2007) pointed out, this then provoked the concept of design, or the origination of its way of perceiving of design in society.

The romanticism movement in the era led by poets, artists and philosophers is a clear symbol of how humanity and science were opposed. Their sensitive views that the source of quality of life exists in the relationship between design and everyday life were handed down to the design thinkers in later eras, who supported the design movement. This was the main source of the concept of design, which went on to have meaningful impacts on society after all. This design thinking emerged by taking the appearance of crude, machine-made consumable products as a starting point.

It is clear that ‘design’ originally had a social aspect. Hara (2007) refers to the Kelmscott Press and says that:

“their spirited drive in demonstrating—not through theory but through real objects—an antithesis to the doltish objects manufactured by the clumsy machine is still intense and ardent enough to unsettle the sensibilities of today’s designers; we still succumb to its beauty”. (Hara, 2007, p.417)

Our society today has been newly transformed by the rapid development and spread of information technology. Different kinds of pain have arisen in the recent information society as if we were repeating history and turning back to the era of Ruskin and Morris. This reminds us of the origin of design
in various arts movements in civil society. It is a good time to re-consider the
origin of design thought.

The Bauhaus: the establishment of modernism design
The Bauhaus is a leading art and design movement in the realization of the
concept of design. In 1919, the Bauhaus was established as a school of design
and is positioned as a historically prominent art and design movement that
began in Weimar, Germany (Droste and Gossel, 2006). Its rich activities
were practiced for only fourteen years. They had forcibly to close for political
reasons in 1933 (http://www.uni-weimar.de, accessed on December, 2011).
After the period from the Movement originated by Ruskin and Morris
through to the activities of the Bauhaus, a new phase of art movements
emerged across the world.

Although those emergences, approaches and expressions were varied from
culture to culture in different countries and ideology, they appeared in every
area of Europe and in every field of art and design such as Cubism, Art
Nouveau, the Vienna Secession, Futurism, Dadaism, De Stijl,
Constructivism, Absolutism, Modernism and so on (Pevsner, 1991). In the
same historical moment, a variety of concepts for the arts were brought to
the surface by the art movements of the beginning of the 20th century, and
were reorganized by the Bauhaus.

The industrialized system, denied by Ruskin and Morris, was positively
recognized through the activities of the Bauhaus. Hara (2007, p.420)
emphasized that “John Ruskin and William Morris nurtured the seeds; the
art movements of the early 20th century cultivated the soil; consequently it
was on the soil of Germany that design put forth small buds in the form of
the Bauhaus.” Their concept of design was accomplished by integrating the
modernism movement and the mass production system.

The Bauhaus was a truly ambitious and repeated trial and error approach
to completely deconstruct all the vocabularies of the historical decorative
arts of the past, such as adornment expressions and modes, and cliquish,
crusted and patrician tastes. All kinds of elements in relation to art
expressions were speculatively simplified into sensual such primitives
elements as dot, line, shape, colour, texture, volume, plane, space, and such
principles as balance, proportion, contrast, pattern, rhythm and so on, which
could not be reduced to further primitives (Droste and Gossel, 2006). It was
the Bauhaus that deconstructed ornamental and aristocratic art styles and
forms into simple elements, filtered out, arranged and ordered those elements.

The Bauhaus is the result of the deconstruction of styles and forms of arts movements, and the integration of all elements and activities carried out by such many talents as Walter Gropius (1883-1969), Johannes Itten (1888-1967), Hannes Meyer (1889-1954), Paul Klee (1879-1940), Laslo Moholy-Nagy (1895-1946) and Wassily Kandinsky (1866-1943) so on (Pevsner, 1991; Droste and Gossel, 2006). As many historians and designers have mentioned, it is not easy to characterize the Bauhaus philosophy by any single aspect. It was a compilation of activities attempted by a large number of designers, artists, architects, and philosophers.

The present thesis argues that whether from Ruskin and Morris or from the Bauhaus, design has the romantic aspect. That means that the concept of design was originally conceived and developed on the premise of idealistic social ethics. Ruskin and Morris detested being controlled by an economy in which human life was filled up with crude machine productions. The development of the Bauhaus was made possible by the existence of the social-democratic government in Weimar; “it can be said that the social-democratic trend fostered the Bauhaus way of thinking” (Hara, 2007, p.422). As art and design historians mentioned (Pevsner, 1991; Hara, 2007), the machine production and the power of the economy engaged and began to drive the world in the second half of the 20th century. At a time when design was supposed to be the development of blossoming of ability, it ended up being buffeted by economical pressures. Hara (2007) pointed out that “The purer the concept, the less able it is to live up to its ideal, within the intensity of rapid and accelerating economic principle” (p.421). This also reminds us of the way in which the poets, artists and philosophers of the romantic position were estranged from mainstream society (Lakoff & Johnson, 1980).

Modernist designers, architects and philosophers, who emigrated to escape the 2nd world war, brought the concept of design to the wider world. Walter Gropius (1883-1969) joined Harvard University in the United States, Mies van der Rohe (1886-1969) was invited to the Illinois Institute of Technology in the U.S., Laszlo Moholy-Nagy (1895-1946) established the New Bauhaus in Chicago (Droste and Gossel, 2006).

Even though “the social democratic-tinged thought of the Bauhaus” (Hara, 2007, p.425) fed into the concept of design, the Bauhaus-based design thought in an economical developed culture evolved with the development of
pragmatic methods that support its economic development in the United States. This pragmatism influenced ‘design’ in the western bloc culture in which the United States is the driving force behind the world economy. Recently, we see that this stream has been flowing ever faster and becoming a mainstream of our society.

The evolution of design after the closing of the Bauhaus differs from society to society depending on the circumstances of its national politics and economical system, for example between Japan, the United States, and Europe. Our planet has long been revolving on the blindly accepted standard of economic might. In a world in which economic power dominates the majority of our belief, science became a powerful tool to predict economical changes, in turn to preserve the economic might. The present thesis claims that this is a reason why science has largely kept away from everyday concerns. Science became a tool for exploring economical opportunities, and design was exposed to pressure to be scientific. After the 2nd world war, the scientific aspect of design clearly had its direction merged with that of technological and economical mastery which itself accrued much of the prestige of science, rather than its origin in scientific thinking.

In this situation, innovation by design is likely to be interpreted as a way to increase people’s appetite for consumption. So design in current commercialized societies is a strategic tool to motivate consuming and spending, and design has responded by taking on the role of producing continual changes to product appearance and interfaces based on novel technologies. All kinds of consumer products have made noisy claims through changing their appearances and stimulating consumer desires.

2.2.2 Design as an economical development tool

As a servant for rapid economic growth
After the 2nd world war, the countries of the western bloc (and Japan) had industries preparing for post war revitalization and economic growth, and the assiduous workers to take on the responsibility of that growth. It can be said that industries and design in capitalist society also contributed in large part to standardization and mass production as well. A clear example of design that contributed to standardization and mass production is Japanese industrial design. As a design professional I experienced this situation and most design disciplines would agree with it. Japanese industrial design was
directed toward rapidly growing the economy, but not toward improving a mature consciousness of higher aesthetic and cultural life, and turned toward the direction of economic growth in order to recover from the devastating damage of war, rather than towards the true nature of our aesthetic life (Hara, 2007). In such industrial design, the identity of design and designer is subdued. Rather, the design and designer has to support and accurately reflect the strategy of the corporations to make profits.

On the other hand, Japanese design rationally and skillfully combined materials and technology in industrial design responses to the requirements of the civilized lifestyle. It brought high product quality in the longer term, but design remained the servant of the market.

As a presentation tool
The world has long been revolving around the standard of economic competition. Design today, in a society in which economic strength accounts for the majority of our values, has been a tool for presenting the latest innovations of technology.

Our society has stepped into a complicated period of disturbance, marked by the striking progress of ICT (information and communication technology). We believed the new technology of the ‘computer’ could dramatically increase the quality of human life, and the business world has reacted to potential business chances in that computerized future. Yet technology is so imperfectly applied to our everyday life. Obviously, people are silent about claiming imperfect technological progress. At one time, the Romantics asserted that “science, reason, and technology had alienated man from himself and his natural environment” (Lakoff & Johnson, 1980, p.192). As a result, the Romantic aspect intensified the dichotomy between the designer, artist and poet and the mainstream of society. Hara (2007) refers to people in modern information society and says that:

“It may be that deeply seated in the consciousness of our contemporaries is an obsession of a sort, to the effect that those who contradicted the machine civilization were thought of as lacking in foresight and were looked down upon.” (Hara, 2007, p.439)

Therefore, people are probably afraid that they end up feeling themselves to be displaced in time. People reflect that information society should evolve more slowly and take the time to be matured rationally, in the light of
repeated through empirical observation. But as romantic people experienced earlier, the recent information society has no time for those who can’t keep up with the pace.

Information technology continues with an advanced edge far away from everyday life, and has been growing exponentially, beyond the limit that can be comprehended or made sense of by a human being. For example, at one time, car-owners could understand the whole system of owned cars. They could fix and repair their own cars by themselves. Since more and more information technology has been integrated into the system, a level of complexity unmanageable by an owner has been created. The unstable information systems rooted in an unsteady ground system have rapidly evolved, but are weak and at risk of failure. People have been forced into being in our current unstable information society.

As a corporate management resource
Prominent products designed by the talent of individual designers guarantee quality and originality. The product reputation for superiority is then maintained as a ‘brand’ (Hara, 2007). The concept of ‘brand’ has been further developed and studied as a methodology within marketing, corporate management and strategic advertisement, especially in the United States (American Marketing Association, 2011).

One of the roles of design today is to strategically incorporate such information as corporate identification (CI) and brand management into corporate business (Wheeler, 2006). It is also the United States that first skillfully developed management methods in order to conduct more profitable business.

And yet we can find distinctive characteristics of German and Italian design, for example Braun and Olivetti. Olivetti has kept higher originality and excellence in communicating its brand image through design. It is not well known that the Bauhaus graduate Alexander Schawinski (1904-1979) indeed contributed to Olivetti’s graphic and product design from 1933 to 1936 (Baroni & Vitta, 2003). The Braun brand is the result of high-attitude human factor researches, in collaboration with the Ulm School of Design that inherited the Bauhaus philosophy, described in the following section.
2.2.3 Design as integrated disciplines

Just as European craftsmen show their skilled performance, European designers take pride in and responsibility for their skilled craftsman-like design work. Historically, the spirit of well-trained craftspeople lies behind European manufacturing. The Bauhaus education system basically gave co-teaching lessons with a professor and a master craftsman. According to Whitford (1993):

“...Bauhaus not only because it specifically referred to bauen (building, construction) – but also because of its similarity to the word Bauhütte, the medieval guild of builders and stonemasons out of which Freemasonry sprang. The Bauhaus was to be a kind of modern Bauhütte, therefore, in which craftsmen would work on common projects together, the greatest of which would be buildings in which the arts and crafts would be combined.” (Whitford, 1993, p32)

In Germany, the Ulm School of Design (1953-1968) took over the Bauhaus philosophy (Spitz, 2006). We can find the prominent design results in the education program at the Ulm School of Design. German quality products symbolized by Braun AG are typical example of the results of the principles of the education program. It was the result of intellectual research into human factors in which the philosophy of the Bauhaus was inherited by the Ulm (Krippendorff, 2006). The principle of the Ulm School of Design positioned design within integrated research disciplines that include the field of architecture, environment, product form, visual communication and information (Spitz, 2002).

At the Ulm School of Design, Louis Henry Sullivan’s dictum “form follows function”, replaced as ‘Functionalism’, served as “a principle for rational justifications of designs” (Krippendorff, 2006, p. 298). Max Bill (1908-1994) organized the design program and refined Sullivan’s dictum as four functions: technical, material, production, and aesthetic (Spitz, 2002). According to Krippendorff (2006), they provide, not simply traditional design knowledge and practice with material, color and form, but also philosophy, aesthetics, human factors, physics, information technology based on integrated design education, premised on inclusive science. Their approaches were apparently scientific. However, they fell prey to industries, which circulated the idea that the success of the Ulm was because their designs defeated obsolete designs described as though they were unscientific and indefensible (Krippendorff, 2006). This apparently scientifically
objective design was well matched to the needs of postwar industries in order to replace 'out of date' products.

As a phenomenon that deserves special mention in the design history of the world, a design movement called 'postmodern', originating in Italy, sparked off in the '80s. The movement spread across such disciplines as architecture, interior design and product design. The present thesis does not intend to discuss the philosophy of postmodernism. It is not easy to philosophically define what is postmodern in architecture and design. Postmodern in architecture and design seems a stray thread at the end of modernism, hence we are still in the modernist era.

Almost all the objects produced these days are comprised of basic elements such as colour, form and texture entrusted to the rational and lucid modernist process that aims to integrate those elements. In other words, ‘Design’ in a broad sense has aimed to be the pursuit of an integrated balance and harmony of the human mind through the rational process of making things. Therefore, the activities of design can be understood as the willingness to interpret the meaning of human life through the integrated design process. This can be referred to as design as social thought.

Design originates in society but not self-expression. From the perspective of daily life, design offers a criticism on civilization. Not that this is anything new. Design has been critical from the beginning, as can be seen from the Bauhaus and the Arts and Crafts Movement. The concept of design has always kept a position directly adjacent to this awareness and rationality through social thought. In this sense, the entire world needs a rationally balanced design, which integrates flexibly issues on every front: a truly fair economy, resource conservation, sustainable environment, mutual respect for culture and so on.

2.2.4 Design today

Does design have to cling closely to new technologies? Is design a servant to the economy or technology? In our recent industrial and information society, design has played a role as the rational and efficient pilot, steering towards optimal objects and environments that improve daily life. Designers fulfill the responsibility with the best intention to pursue better solutions, in every technological progress that reveals a new possibility for creating new products or services.
Designers today have realized immeasurable possibilities for design in the shared scenes of our everyday lives, not simply in the new novel fruits brought by technology. The combination of technology, information and communication let designers begin to rethink the possibilities. This does not mean that they try to replace the outdated communication media with new media (Hara, 2007). But they create more positive outcomes through accepting the former media. Such communication media as E-mail, mobile phones and social networking service have been rapidly popularizing, yet we are happy when we receive a handwritten card. The substantial texture and original calligraphy on the card arose our curiosity. Design is a true profession without relying on one-sided ways of using either old or new media. I would stress out that the present thesis does not intend to explore what is new/old media or what is next wave coming and so on. Rather, design has a role exploring the true nature of media, but design is not a servant of media. Design and design research should not take part in making what’s new today look old tomorrow, otherwise we have to seek what’s new everlastingly.

Recent designers and researchers have focused on the profoundness and intricacy of the quality of information and communication perceivable when all senses become integrated. Tangible interaction, haptic interfaces, and augmented reality in HCI are typical examples of new communication media integrating several senses. This shows that people have realized the importance of the very delicate human senses rather than conceptual thought, in the forefront of technology. We integrate our communication with the environment via our diverse sensory perception. We then can comfort and satisfy essential human life. This kind of design is not trying to draw the audience’s consciousness with an attractive expression, but having the expression permeate into the sensual perception. This is design that is very modest and disappears from our perception. It tangibly exists before we even realize it’s there.

This brief overview of design history tells us that the origin of design was not merely an activity to adorn outer surfaces, and design is not an activity that draws customers’ consciousness with catchy presentations. Rather, design is a subtle activity to discover new issues in everyday life. It is the creativity that repeatedly derives modest ideas from partial fragments of our shared everyday life. In other words, design is an activity that creates empathy among human beings through our common values. The more
delicate and subtly shared, the more powerful the empathy sensed. The empathy is sometimes called, for example, shared feeling or shared reality. The resources of design exist only as small minor objects and behaviours in everyday life. This seems to be what Romantic people and the Bauhaus had pursued. The future of a human-centred design science lies beyond the rational pursuit of the human being, in the integration of humans, technology and science.

### 2.3 History of interaction

For nearly sixty years, we have seen a vast amount of often successful development of digital technologies, not only the traditional desktop personal computers, but also computers incorporated into devices, so-called embedded computing such as smart phones, car-based systems, and even kitchen appliances.

Many disciplines and researchers have tried to conceptualize the history of interaction with computers, the historical development of user interfaces. There are many points of view to discuss it from, such as the technological view, political view, psychological view, and social view and so on (Card, Moran and Newell 1983; Dourish 2001; Grudin 1990). Dourish (2001) presented “the stages in the historical development of user interfaces in terms of the different history sets of human skills they are designed to exploit” (p.5). Electrical, symbolic, textual, and graphical forms of interaction were identified.

When the symbolic forms of machine language was used, the users were mostly programmers who had special knowledge and skills and were willing to use machine language for industrial use or in research laboratories. The computer was not seen in the commercial mass market at this stage. However, as Dourish (2001, p.10) describes it:

"the textual stage drew upon language much more explicitly than before, and at the same time it was accompanied by a transition to a new model of computing, in which a user would actually sit in front of a computer terminal entering commands and reading responses." (Dourish, 2001, p.10)

The so-called Command Line Interface (CLI) is one kind of interaction with a computer operating system by typing commands to manage specific tasks. This method of instructing a computer to perform a given task obviously requires explicit knowledge, which is articulated, and can be
expressed and recorded as words, numbers, codes, and mathematical and scientific formulas. Since then, the computer began to stretch out into society, being more inexpensive and smaller, and came into common use particularly for office workers. It gradually became the Personal Computer (PC). This interface evolved to be more intuitive and easier to use for general users, not only office workers. The evolution is well known to us as the transition from textual user interface to Graphical User Interface (GUI).

It is often discussed that whereas CLI is classical and inconvenient, GUI is intuitive and easier to use. However there are indeed advantages and disadvantages. End users prefer to use GUIs, but CLIs are often used by programmers and system administrators in engineering and scientific environments, and by technically advanced personal computer users. Actually the CLI continues to co-evolve with GUIs. The development of graphical interaction techniques brought a specific kind of model of the interface. Users directly operate explicitly represented objects, which is known as direct manipulation. The designers sought to evoke explicitly people's knowledge of office work to help them understand the operation of the computer.

Since the development of digital technologies progressed, information systems have become complicated. A large number of disciplines are also involved in the system development process. The whole system is often not understandable and not easier to use for users. Therefore, the concept of *human-centred design* or *user-centred design* has been introduced to emphasize the importance of involving users and incorporating users’ aspects and contexts of use into the design process.

The more important users’ viewpoint becomes in system development, the more the participatory design approach has adapted to system development. Especially, Scandinavian participatory design has more than thirty years of history. Participatory design became a more and more integral part in the system development process. Disciplines including designers, managers and workers in the participatory design process investigate and represent the skills and experiences of users, so that the design and organizational implementation of computer systems can be improved (Schuler & Namioka, 1993).

The following part of this thesis gives more detailed discussion of how ‘users’ can be defined and how human-centred design today is redefined. On this base, a reframed categorization of customer, users, persons and humans.
is introduced as well as the new concept of Tangible Presence in Blended Reality Space, an emerging integration of HCI concerns and Mediated Presence research. Finally, a new way of approaching human-centred design is proposed, called Human-Experiential Design (HXD).
Chapter 3: The Dichotomies of Design and Interaction Research

3.1 Introduction
The present chapter reviews the serious intellectual problems bequeathed to ‘Design’ by the mechanistic worldview of scientific tradition and begins to suggest an alternative based on experiential aspects in order to bridge various dichotomies, especially between technological and human concerns.

From a Cartesian perspective, design in general is likely to be interpreted as a way to create decoration to adorn outer surfaces, producing transitory feelings without the need for any logical thinking, because ‘Designing’ tends to be seen as an activity armed with subjective senses and imagination. But if design is about touching people’s heartstrings, it comes to fruition by way of a process that interweaves the sensitivity to and the logic of properties of material and colours (subjective phenomena), functionalities and usabilities (objective phenomena), amongst many others (Walls, J.G et al., 1992; Hevner et al., 2004). In other words, it actually implies that the senses and logic, the mind and the body, the surface and the structure affect each other. Even though it is not really possible to dissociate them, we are familiar with thinking about the origin of these matters as a dichotomy. Liberal arts, visual arts, music and literature are essentially human activities that rest on the assumption of subjectivity. On the other hand, in the more mechanistic objective view of the universe, the whole world is seen as a material system that mechanically develops according to natural laws. Although the latter brought the apparent progress of recent technological change and economical opportunities (and pressures) into our life, it also brought a gap between the human scale and the industrial scale. That may be a sign of success for the human race as a whole (or not), but what have we lost in achieving this? Even though human life is experientially delicate and aesthetical, the industrial scale of forcible power within the economy and technology exposes human life to the intensity of rapid and accelerating world change. Also the gap between the human scale and industrial scale replaces design’s deeper role with that of a presentation tool for introducing the novel fruits that technology brings. Various resulting and unbalanced dichotomies raise serious concerns surrounding the concept of design (see Figure 3.1).
Essentially, no human being can be formalized. However, in our current recklessly progressive industrial era, human beings have been seen as formalized groups of user/customers with certain objective statistical characteristics. People struggle to understand and use computers, mobile phones and other embedded computing devices, whose designs are still largely based on the formalization of human cognition of the world on the basis of explicit conceptual knowledge. People therefore have to forcibly adapt to the mediated computing environment, even though human sensation and perception is an embodied implicit phenomenon. People for example with dementia preserve concrete implicit bodily skills even if they lose explicit and conceptual knowledge (Park, 1992).

Human beings, and perhaps especially the vulnerable, the elderly and the socially handicapped, have become increasingly dissatisfied with their incomplete environment. We believe that they should no longer be expected to tolerate the pain that much current design of technology brings (Waterworth et al., 2009a; Waterworth et al., 2009b). The age-related critical situations in relation to ICT will be taken up in a detailed way in Chapter 7.

The human being and the user/customer have been separated, in other words. Actual human beings have been lost within formalized user/customer groups. Even applied observation techniques used in recent design processes commonly see their subjects as people who use products in general, who tell stories as users, who use a particular product.
3.2 Dichotomies arising from Design science and research concerns

The Cartesian mechanistic view underlying much of science has brought an undesirable gap. It seems that objectivism reigns supreme especially in science. When ‘Design’ is seen through a scientific lens, ‘design science’ comes from a blind acceptance of the objective position. This thesis would support the argument that there is no absolute ‘Design’ that shows absolute objective truths about the world. What is prominent and fair design in one culture, often is poor design in another culture even though it makes for successful business.

3.2.1 Objective and Subjective Positions in Design

As already mentioned in Chapter 1, design has been viewed as a craft, described as tacit, unknowable and experiential by scholars mostly other than design practitioners. I suppose that they see designers as subjective and none of them are purely rational or objective. This perspective can be summarized in the following points:

- Designers’ senses and intuitions are their best guides for design activities. They rely on their senses and develop intuitions only they can trust.

- Designers believe that feelings, aesthetic sensibilities, moral practice, and spiritual awareness are essential in human life, and those are good design resources and practice.

- Art, music and poetry and so on put designers in touch with the more important reality of their feelings and intuitions. Designers gain this awareness through imagination rather than reason, rationality and objectively.

- Designers use the language of the imagination for expressing the unique and most personally significant aspects of their experience. Ordinary explicit language is not suitable in matters of personal understanding.

- Designers believe that objectivity can be dangerous, because it misses what is most important and meaningful to individual people. Therefore, they believe that objectivity can be inhuman, and it is harmful for true ‘human-centred’ design.
In contrast to ‘design’, people who believe that science is ‘absolute truth’ that gives a correct, definitive, and general account of reality through scientific methodology, since objectivism reigns over science define themselves in opposition to design, and claim that:

- To the extent that scientists are objective, science is rational. To the extent that designers are subjective, to design is irrational and to give in to the emotions.

- Whereas scientists are objective, designers are subjective indulgers since they emphasized the importance of the personal point of view.

- Scientists are objective and always fair. Therefore they can avoid personal prejudice and a biased view of the external world.

- Science provides us with a methodology that allows us to be fair, understanding from a universally valid and unbiased point of view. On the other hand, ‘Design’ relies upon the personal judgments of a designer.

- Scientists deal with only objective knowledge that is absolute knowledge. They speak objective language that is clearly and precisely defined, that is straightforward and direct, and that can fit reality. Designers use poetic, fanciful, rhetorical, and figurative language in ways that meanings are not clear and precise and do not fit reality in any obvious way.

- There is an objective reality, and scientists can say things that are objectively, absolutely, and unconditionally true and false about it. Illusions, errors of perception, errors of judgment, emotions, and personal and cultural biases are human error.

- Scientists believe that the world is made up of objects that have properties independent of any people or other beings who experience them. For example, a rock is a separate object and it is hard.
Scientists believe that we obtain knowledge of the world by experiencing the objects in it and getting to know what properties the objects have and how these objects are related to one another. Therefore they believe that subjective thought and intuition can be dangerous, since they can be lead to losing touch with reality.

(“On the basis of the myth of objectivism” Summarized and modified from Lakoff and Johnson, 1980, p.186)

The position of science reflects the view that the external world needs to be understood so that humans can live properly in it. The position of design is focused on internal aspects of understanding the world. Designers intend to address what makes human life meaningful and worth living. On the other hand, the position of science says that, for example, all the elements of the universe as separated from each other, divisible and wholly isolated.

3.2.2 Cognition-Action Dichotomy

In Discourse on Methods (1637), Descartes argued that we exist as thinking beings, different from brute animals. The world is made up of two separated substances; physical substances (bodies) and mental substances (minds). This Cartesian view underlies much of science, and has allowed vast areas of understanding of previously mysterious phenomena to develop and flourish. On the other hand, the dichotomy has brought undesirable effects, and is even reflected in various aspects of so-called ‘Human-centred design.’ The rigid dichotomies have made it extremely difficult to find a place in our views of human meaning and rationality for structures of imagination. As Johnson (1987, xxix) expressed it: “Imagination seems to exist in a no-man’s-land between the clearly demarcated territories of reason and sensation.”

Traditional HCI researchers have the assumption that the brain functions to construct and utilize representations of the world around us, ‘a model of the world’ (Craik, 1943; Reed, 1996). The animal must collect, collate, and interpret stimuli until it has a ‘model of the world’ constructed by the brain or mind, in order to let it send commands that will cause its body to behave in suitable ways. Several scholars and disciplines have argued the limitation of this cognitivist view of HCI, as found in discussions in terms of augmented and mixed realities, tangible interaction, and situated action (e.g. Dourish, 2001; Suchman, 2007).

Lakoff refers to the view that the mind as a computer with biological hardware and has contended that:
“the mind runs using programs essentially like those used in computers today and it
may take input from the body and provide output to the body, but there is
nonetheless a purely mental sphere of symbolic manipulation that can be
classified in terms of algorithms of the sort used in computer programs.”
(Lakoff, 1987, p.338)

Such mechanical systems all have one thing in common: They must have
an external agency in order to let them act.

Based on this assumption, it may be true that a tool is something that
extends the action of workers. Therefore a tool, for example a computer, can
do this only because workers and other sources of power bring it into action.
Designers of interactive systems based in the cognitivist view have tended to
assume that every emergence of action/behaviour needs ‘stimulus’ to some
extent either from outside the system or from inside. There are so-called
reactive mechanisms based on external stimuli and instructive mechanisms
based on internal stimuli or commands in psychological theories (Reed,
1996).

Whereas machines and robots need a stimulus to bring them into action,
animals are active in whole or in part. We experientially know also that
humans are always active and far from machines and robots. And even
though machines, tools and computers are not active in the way that animals
are, interactive systems have been designed on the basis of modelling animal
and human behaviour on mechanical principles.

Card, Moran and Newell (1986) discussed, in their book The Psychology of
HCI, a model of human behaviour in the forms of a human information
processing model referred to as a model human processor (MHP) in the
GOMS (goals, operators, methods and selection rules) approach. The MHP
describes human behaviour in terms of memories, processors, their
parameters and interconnections, which further probes details about how
the information-processing components of the model might work or how the
components might be structured. The MHP is supposed to be used for
approximate prediction, such as the assumed information processing
capacities of a person, gross behaviour, and user behaviour in HCI, by
applying a simplified view of psychological theories and empirical data. The
MHP can be said to be an integration of a set of memories and processors.

The MHP is composed of three subsystems that have their own memories
and processors: the perceptual system, the cognitive system and the motor
system. The perceptual system consists of two different image stores: an
auditory image store and a visual image store. While it is being symbolically encoded, the output of the sensory system is retained. The cognitive system receives information symbolically coded from the perceptual system that contain the sensory image stores in its working memory and employs information previously stored in long-term memory to decide about how to react. The motor system then carries out the responses. There is a separate processor in each subsystem: a perceptual processor, a cognitive processor and a motor processor, which are supposed to have possible capacity of both serial and parallel processing.

The cognitivist view considers that users act rationally to obtain their goals. On this base, we can predict a user's behaviour by determining the user's goals, methods and operators and the constraints of the task. This has been formulated in the GOMS approach, which helps prediction of user's behaviour, based on the assumptions:

“That underlying the detailed behaviour of a particular user there are a small number of information processing operators, that the user's behaviour is describable as a sequence of these, and that time the user require to act is the sum of the time of these individual operators.” (Card et al., 1986, p.139)

The GOMS model is specified by which a user's cognitive structure is supposed to be composed of: a set of goals, a set of operators, a set of methods for attaining the goals, and a set of selection rules for choosing appropriate methods for goals.

By views such as these, the whole idea of HCI still largely deals with the complex environmental conditions in which humans put themselves into motion via stimuli or inputs signaled to the brain. Their behaviours as responsive outputs commanded by the nervous system. While the computing environment has become more intelligent and pervasively penetrated into our everyday live, is it suitable for humans?

We can find challenging and interesting applications for educational, medical and industrial usage designed on the basis of mechanical principles, but many are not at all suitable, and especially not for people with special needs. Human beings have to forcibly adapt to the computing environment based on mechanistic principles, even though human behaviours should be essentially a natural flow of action based on constant activity. It seems that ‘Design’ is rational to the extent that a designer is being objective.
3.2.3 The Human-User Dichotomy

Previously, the historical development of HCI has been briefly summarized (see chapter 2). Designers tried to seek a new concept of user interfaces especially for office workers, since computer users are historically office workers. The designers therefore sought to evoke explicitly people's knowledge of office work to help them understand the operation of the computer.

The typical design approach to HCI uses metaphor in order for users to understand the functionality of the system (Imaz & Benyon, 2006; Waterworth et al., 2003), which encompasses what users feel, think, and are able to do as they interact with the products/systems that deal with the formalization of human cognition of the world. This has been called ‘User-Experience Design’ and has become popularized in the last few years. The user-experience designer tries to help users’ understanding of the system by adopting users’ experience in another domain (Imaz & Benyon, 2006; Waterworth et al., 2003). Over the past twenty years, more and more interfaces have adopted this style, and now it is spreading to other devices such as mobile phones, digital cameras, audio-visual equipment, and many web sites in our everyday life.

User experience design is a very fuzzy concept in which the term is diversely used in many different ways. User experience design is supposed to be rooted from the principles of human-centred design defined in ISO 13407 (1999); revised as ISO 9241-210. In essence, user-experience design conforms to human centred design principles. Whereas the defined human-centred design largely focuses on traditional usability factors, recent user-experience design focuses on factors relevant to affect, interpretation and meaning (Roto et al, 2011). Designers, especially user-experience designers, emphasize that user-experience design focuses on humans not merely technology, and it is far from usability and customer experience but it affects them. We can find a number of definitions in academic papers (Alben, 1996; Hassenzahl & Tranctinsky, 2006; Sward & MacArthur, 2007; Hekkert, 2006; Hassenzahl, 2008; Colbert, 2005) and well-known websites (www.nngroup.com (Nielsen-Norman Group), 2011; www.upassoc.org (Usability Professionals’ Association), 2011; www.interaction-design.org, 2011). There are also other definitions for user experience such as co-experience, shared experience or group experience, which focus on socially constructed experiences (Hassenzahl & Carrol, 2010). Since digital products,
computers and mobile phones have been distributed everywhere, social and cultural aspect of design is becoming of importance. Recent user-experience design considers more about situations in which experiences are a constructive process where participants together contribute to sharing experience in mutually creating interpretations and meanings from everyday life context and for allowing co-evolution with social practices (Battarbee, 2003).

Even though there are many definitions of user-experience design, it is not easy to find a clear distinction between user and human in design. To define true human-centred design is to give an answer to a question of who we are. It supposes that we are not merely segmented customers nor users and much less predictable machines.

There are also several physical constraints that limit users' interactions, such as those of physical displays, other input-output devices, and social factors. For example, the user typically concentrates on foreground tasks through full access to a fixed display. The mouse reflects the two dimensional paradigm that assists with easy spatial navigation, by clicking, dragging, selecting and operating 2D graphical objects. Although a flexible approach, this two-dimensional input-output interface is still limited when applied to, for example face-to-face collaboration or distributed environments. So people forcibly have to adapt the limited environment, which breaks their natural flow of action. The elderly and socially handicapped have become increasingly dissatisfied with the environment, especially as their cognitive functions decline. So they prefer to use free body movements with knowledge that their bodies remember (Zacks et al., 2010; Schacter, 1987; Benjamin et al., 1994).

Many researchers have discussed ways to modify or even escape from this self-limiting trend and have, for example, experimented with sensor-based techniques for interacting with virtual entities via the manipulation of physical objects in space (Ishii, 2008; Hoshi, 2009). Recently, we have witnessed the emergence of a wider variety of HCI technologies, including handheld smart phones with more intuitive onscreen interfaces. These computing environments are slowly becoming more intelligent and more pervasively penetrating into our everyday life.

In such a situation, given the correct design approach, users need not – indeed should not - be aware of themselves as 'Users'.
Design should become seen as aiming to realize an ideal in which our activities are characterized by a natural flow of action, without any intrusion from technology. It is time to consider reframing audiences from ‘User’ to ‘Humans’. People with special needs such as patients, elderly people and those with disabilities would be naturally included as ‘Human’. If we take this view, how is ‘Users’ redefined?

**Users and User-Centred Systems Design**

According to the Oxford Dictionary of English (2003), A user is ‘a person who uses or operates something’. In computing, a user is a person who uses a computer hardware/software or an internet service. However, what do users actually do in use of these artefacts/products?

As a term, User-Centred System Design (UCSD) was introduced by Donald Norman and Stephen Draper (1986), reflecting the development of the User Centred Design (UCD) approach during the 1980’s. Keinonen (2008) states “UCD is a broad umbrella covering approaches such as traditional human factors and ergonomics, participatory design, human-centred design processes, usability measurements and inspections, and design for user experience” (p.211). Humanistic roles of design were emphasized and widely brought over into the product development process, which became a dominant subject in HCI during the last few decades. Later, the “human-centred design” concept was developed and applied to overcome the insufficient design of software products with WIMP (windows, icons, menus, pointer) graphical user interface. The process has contributed to the evolution of the standard WIMP interface and of the growth and success of consumer IT in the market. Since the advent of modern WIMP interfaces launched for ordinary people, and especially for the office work environment, computing for the masses has kept growing. The domain of HCI has been continuously expanding into our everyday life. This means that computing with the standard office type applications, such as word processors, databases, and spread-sheets, has come to dominate our lives, even though people in everyday life are essentially not office work users. ‘User’, as a guiding concept, is still in the centre of the product development process.

Recently, user-centred approaches have been repeatedly emphasized in both design literature and practical development. There is also an ISO standard for the user-centred design process with an emphasis on user
participation in the system development process (ISO 9241-11, 1998; ISO 13407, 1999). The standard provides guidance on “human-centred design activities throughout a development life cycle of computer-based interactive systems”, but does not specify detailed methods and techniques (Usability Professionals’ Association Resources, 2009). In fact, the usability, accessibility and understandability of the products have been improved by emphasizing the needs of user-centredness or the user’s voice. Even though the quantitative data shows much improvement, complexity of the products still remains high. Even companies following human-centred principles have often released complex, confusing products. In both academia and industry, many disciplines and professionals have discussed and used the term user-centred or human-centred design without any clear distinctions. In the domains of interaction design, HCI, and information systems design and so on, many scholars, disciplines and designers use such generic terms as human-centred computing (HCC), human-centred design (HCD), and human-centred systems (HCS) in a simplistic way without a common foundation of understanding (Bannon, 2011).

In order to understand the complexity of users, applied user observation techniques based on working more closely with users have been introduced, which include qualitative research techniques such as ethnographic studies, participatory design that directly observes users’ behaviour and the environment across a number of people who use products, who tell stories as users, who use a particular product. Quantitatively, according to Mactavish (2009, p.121), in recent products such as mobile phones, personal digital assistants, and computer applications, gathering quantitative data about user activity and behaviour includes a formal study of task productivity explicitly illustrated with learning time, task initiation time, task completion time, task completion success rate, operator error rate, error recovery tasks, error recovery time and so on. Researchers normally aggregate these data by direct observation or video capturing, logging data based on various interaction aspects, or biometric monitoring for example (Mactavish, 2009).

This user-centred approach has been introduced in the consumer market in order to understand more deeply users and the market. Interdisciplinary groups formed with such professionals as anthropologists, psychologists, and designers, are often involved in the development process.

Sato (2009) has defined the “knowledge cycle between artefact development and user” (p.30). According to Sato (2009), the development
groups generate knowledge from analysed users and usage of artefacts to embed it into artefacts. Users also produce knowledge through using, reading and interpreting of embedded knowledge in the artefacts, and understand the significance, meaning, and validity of using the artefact in various situations in their everyday life. What has been discussed in the recent so called user-centred design process obviously explains the knowledge cycle between artefact development and the user.

Thus, a user-centred design process can be seen as a process centring on the knowledge lifecycle that includes knowledge of use, knowledge of design and the user who generates knowledge through interpretation of embedded design knowledge in artefacts/products. It begins by observing the activities and interactions of users in a certain situation. Hence, Users can be defined as; people who have knowledge of use and generate knowledge relevant to artefacts/products in a knowledge lifecycle between user, artefact and artefact development. Therefore, User-centred design is a design activity based on the cycle of mainly explicit knowledge of use.

In the process of practical design information development, industry practitioners also use abundant customer data for interpreting, understanding, and discovering customer value-based demands (Mello, 2002), which enable companies to find not only new market but also repeatable product life cycles and measurable product development cycles that lead continuously success. Here, there is a simple question. Although ‘User’ can be defined, how can ‘Customer’ be defined? What are the differences between users and customers in the information gathering process?

**What is a customer?**

This seems clear. In general, a customer is “a person who buys goods or service from a shop or business” (Oxford Dictionary of English, 2003). ‘A customer’ more specifically refers to a current or potential buyer or user of the products of an individual or organization that is usually called the supplier, seller, or vendor through purchasing or renting goods or services. Depending on the industry, it is also called client, buyer, or purchaser. There is a place where buyer and seller meet, which refers to a set of potential customers, the so-called ‘market’. If a buyer can be referred to a customer, then a seller can be referred to a company/corporation. Organizations sometimes abuse terms and phrases such as “customer-oriented, customer-
driven, listening to the voice of the customer, customer-centric, customer awareness, and customer retention” (Mello, 2002, p.4) to emphasize that the customer and the market drive the business. This is sometimes called ‘customer-centred design’. Since industries often exploit user-centred design as a tool to get their own customers, ‘customer’ and ‘user’ have been frequently confused.

Business strategy, which is important for success, is a plan of action designed to accomplish credible defined goals intended that generally include “sales volume, rate of growth, profit percentages, market share, and return on investment (ROI), among others” (Rosenzweig, 2003, p.1). These concepts help to understand a market rather than give an understanding of users and the usage of products. Markets can be represented accurately in terms of segments. The first task of a marketing group is to identify relevant market segments, which creates a framework for developing market strategy with segmentation variables such as “demographic, geographic, psychographic, product use and application so on” (Rosenzweig, 2003, p.3). Some may be defined as subsets of other variables for example, the marketing people may segment the world in terms of country markets and then analyze each, using life style variables.

In the segmentation process, human beings are formalized as customer groups. For example, according to Rosenzweig (2003), demographic segmentation tries to formalize people based on “family income, age, sex, ethnicity, and education level as explanatory variables predicting differences in taste, buying behaviour, and consumption patterns (p.3); psychographic segmentation tries to formalize consumer lifestyle such as attitudes towards self, work, family and peer group identity” (p.4). There are a variety of techniques and methods, and this is only small instance of many. However, it is the most obvious way of formalization from human to customer. In such approaches, ‘customer’ is represented as the most abstract human with objective statistical characteristics.

Human-centred and human-experiential design
Suri (2005, p.164) has mentioned a phenomenon “where people make interpretation about the objects around them all the time, how it might work and what we can do with it. We develop an exquisite awareness of the possibilities and sensory qualities of different materials, forms, and textures.”
We tend to believe that most of our actions are carried out consciously. It is, however, our unconscious behaviour that preserves the natural flow of action in specific situations. We become harmonized to things that all of us end up doing without really thinking. For example, in specific situations, placing something for convenience, holding hands to a forehead because of blinding sunlight, and bringing up a cool canned drink to one's cheek are universal and instinctive, drawing on experiences with mind, body, and environment so embodied that they are almost unconscious. According to Suri (2005, p.164), “this awareness is evident from our actions, even when we are not conscious of them. These are unconscious behaviours.”

A sequence of unconscious interpretation and adjustment creates our behaviour. But it is difficult to realize that the environment is the driving force behind human interpretation, because introspection tells us that human behaviour is caused by human conscious intentions. Yet it is meaningless to think of mind, body, and environment separately. Our reality is composed of a complex of customs, social situations, personal experience, culture and objects, and our environment determines our being to an inconceivable extent. Awareness largely follows behaviour, rather than vice versa.

Some design practitioners have intuitively observed people in everyday life, examined these everyday interactions, and sublimated their thought from these observations into their design solutions (Suri, 2005; Hosoe et al., 1991; Goto et al., 2004). They discover a lot about how people physically and perceptually blend with their surroundings. They look carefully at what people actually end up doing in everyday life: why have people put something here in a certain way or similar way? What are people making a pose doing there and why do people respond to the object? Why did people react in that way or similar way among them? Introspection can reveal what is of value to us behind these everyday interactions that occur around us all the time, but in fact we are not usually consciously aware of our actions and reactions. In this case, humans can be characterized as; people who intuitively interpret what is of value for their purposes in their current environment and try to become harmonious with it in everyday life activities.

To understand this phenomenon, there is a key concept in ecological psychology. James J Gibson, in his book entitled The Ecological Approach to Visual Perception (Gibson, 1979), invented the term ‘affordance’ from the
verb ‘to afford’. According to his theory, a chair possesses an affordance for sitting, but the chair does not force a person into sitting. People may find themselves sitting without any awareness of having decided to sit. Further, a chair affords the prospect of sitting regardless of a person’s health, condition or mood. Affordances seem to possess our natural flow of action in specific situations. But although the concept of affordance has been much discussed in HCI research in general, yet the use of the principle for people with special needs is very limited. Every organism including humans utilizes affordances in the environment. Affordances are something that everyone knows intuitively and largely unconsciously; they are innumerable, complex and mysterious.

Similarly, people sometimes get healing from paintings, poems and music in everyday life. They sometimes unconsciously end up crying when they are in a church. They are then human, neither customer nor user. As Dutton suggests:

“the most recent research on universal features, for example in art, has come out of evolutionary psychology, which attempts to understand and explain the experience and capacities of the human mind in terms of characteristics it developed in the long evolutionary history of the human species” (Dutton, 2005, p.283)

In everyday life, we encounter the embodiment notion, resting on the idea that the mind and the body, or cognition and action, are fundamentally associated in human experience. Following a perspective based in the ‘Experiential Realism’ of Lakoff and Johnson (1987, 1999), we can agree that “human beings understand their experiences largely depending on basic, bodily interactions with physical environments, as well as on social and cultural interactions with other humans” (Waterworth et al., 2003, p.137).

This is because we are all human beings with the same primitive experiences that cover our shared embodied knowledge evolved over thousands, even millions of years (Waterworth et al., 2003, Hosoe, 2006). ‘Human’ can be said to characterize organisms who share the same evolutionary history and hence, bodily structures and potential for experiences. Because of this, they also share the same primitives for understanding information – which is the fundamental principle underlying human experiential design applied to interaction. The place of the human in a categorization of audiences is summarized as Figure 3.2.
Since the ubiquitous GUI was introduced and became the standard paradigm in HCI, it has contributed enormously to the development of society, especially the way we work. Recently, we have witnessed the emergence of a wider variety of HCI technologies, such as those implemented within sensor-based environments, handheld smart phones with more intuitive onscreen interfaces and orientation sensors, and these and others are now gradually penetrating society. However, we still cannot effectively utilize our skills for manipulating physical objects to any great extent, even though that would improve the nature of interaction, especially for people with mental and/or physical special needs. Research work on tangible interaction has been focusing on numerous but narrow activities such as the manipulation of building blocks or shaping models out of virtual/physical clay (Ishii, 2008).

Currently, we live in the physical world in which computers are distributed, with interaction windows onto the virtual world provided by the display, keyboard, and mouse. It is not a surprising idea to combine in ‘the interface’ the virtual and the rest of physical product of an interactive device, since the user sees the product itself as a unified physical/virtual system. But the rest of the physical world, and most of the bodily skills and experiences of the user, lie outside this unified and defined world. Users are further limited by a variety of factors, such as physical display constraints, input-
output constraints, and social constraints. For example, physical display constraints mean that the user usually concentrates on only foreground tasks with full access to a display.

The evolution of interaction techniques has largely also been the history of improving the usability and appeal of the WIMP-based GUI. These work well in many situations, most obviously and importantly for many kinds of office work. But the work and the style of interaction have co-evolved and reinforced each other: we do the work we do because of the tools we have, and we have the tools we have because of the work we do. Many researchers have discussed ways to modify or even escape from this self-perpetuating trend and have, for example, experimented with sensor-based techniques for interacting with virtual entities via the manipulation of physical objects in space. Most of the broad range of new interfaces developed by HCI researchers are seen as alternatives to the current GUI paradigm and try, in one way or another, to diverge from the WIMP-based approach (Jacob et al., 2007).

We can find numerous emerging post-GUI/WIMP interaction styles, and they emerge as a huge growing trend in the HCI literature, because of their clear advantages of bringing more real, more tangible and more usable interaction. Typical examples are; augmented reality, tangible interaction, ubiquitous and pervasive computing, context-aware computing, handheld, or mobile interaction and so on (Jacob et al., 2008). Technology creates the virtual world, but also exists in the physical world - with which the virtual often competes for our attention. Many of these new interaction styles clearly exhibit the combination of the physical and the virtual, sometimes called mixed reality. Today mixed realities of different kinds are an increasingly prevalent approach to interaction that strives to combine the physical and virtual environments. Mixed reality is also a growing object of study for the HCI research community, as part of a widespread effort to develop viable and more flexible alternatives to WIMP-based GUIs. But do these interaction styles have many benefits for those who use them? We find challenging and interesting applications for educational, medical and industrial usages, but many are not at all suitable in many other situations, and especially not for people with special needs. In terms of the perceptual and psychological aspects of use, the effect of these post-WIMP interaction styles has yet to be fully studied and explicated.
Another post-WIMP trend is that digital media are becoming more pervasive in our everyday life. Everywhere in our built environment devices such as video screens, electronic access systems, and sensor based smart environments are rapidly increasing. But there is still a huge gap between media and ourselves as bodies in physical reality space. We still do not have a clear understanding of the scope of this phenomenon, especially its perceptual and psychological aspects. We predict that the intersection of sensory, cognitive and emotional aspects in emerging mixed realities will be significantly important in attempts to go a further step in the development of better combinations between the physical and virtual environment, in what we call *Blended Reality Spaces* (Hoshi et al., 2009).

Blended Reality Space is an interactive mixed reality environment where the physical and the virtual are seamlessly combined and affect each other. As yet, this is an ideal guiding research and design, rather than an actuality, and most mixed reality falls well short of the blended reality ideal. From an idealistic viewpoint, in a true blending of the physical and the virtual, the technology itself should completely disappear from our perception. In such a situation, there will be no conscious effort of access to information (Waterworth and Waterworth, 2010). It would then be possible to realize an ideal in which our activities are characterized by a natural flow of action, without any intrusion from technology, from the physical-virtual divide. The user perceives and acts directly, as in everyday life unmediated activities.
PART II: The Experiential Approach to Design
Chapter 4 Human-Experiential Design

4.1 Introduction: The Experiential Approach

Our society has long been led by scientific technology. Technology is the primary force behind the production and development of novel interactive systems and information/communication systems, what people are calling technology-driven society (Hara, 2007). Recent design has been brought in technological mastery aiming to make good use of products and services in everyday life whose forming activity was initiated by technology. A typical example is product design, which has become a presentation tool in order to introduce newly invented technology with attractive forms and interfaces. Those products connect to the internet, which contains attractive graphics on web site design and virtual reality discretely generated from numerical data. They have sometimes penetrated into our environment and architecture, competing to use new materials and structure that also technology also brought forth. In the last few decades, perceptual experience by using virtual objects or communicating with someone in virtual reality (VR) environments, has been most actively encouraged. Hara (2007) refers to a term ‘technology-induced’ and points out that we once predicted that an enjoyable life would be carried out for us if we could be happy with a technology-induced virtual reality, a simulated environment, but we have been increasingly realizing that it is not easy to replace real happiness with virtual happiness in a technology-induced illusion.

Whereas recent design practices have contributed to introducing a large number of novel products thanks to our technology-driven society, our experiential approach is the pursuit not of technology but of human sensual perception to invoke the animating force of designing.

The experiential approach to designing interactive systems has been discussed to some extent in the HCI literature (Dourish, 2001; Lund, 2003; Fällman, 2003; Imaz and Benyon; 2006; Waterworth, 1999). In the rest of the present chapter, an alternative design practice designated as ‘human-experiential design’ is sketched out, which emphasizes appropriate blending of technological and human concerns. The approach suggests that these are not opposing concerns. It offers a perspective from which both concerns can be met. This chapter is attempting to explore a third way, neither objective nor subjective.
4.2 Experiential Approach to Design and Research

4.2.1 Design as mediator
Experiential approach in the present thesis offers a way to understand the role of blending that meaningfully bridges unbalanced dichotomies in the context of ‘Design.’ Although importance of balance, blending and integration of separation has been already discussed by various disciplines, but, there has been very little in design disciplines. The development of design theory that was based on the logic of science had to prove that science was capable of foreseen design. It is still doubtful that there is a truly rational methodology that supports design (Hosoe, 1991). It hardly says that there are absolute methodologies made up of the ideal design principles.

Design may play the role of integrating the opposites. The present section suggests that designers are suitable for the role.

The origin of design, whether of Ruskin and Morris or the Bauhaus, has had the romantic tint on the premise of idealistic social ethics. HCI, Product designs, Architectures and websites and so on consist of technologies. Humans and technologies have co-evolved. We cannot ignore science that becomes an ever more powerful influence on our society. Therefore, Design should play the role of integrating rationality and creative imagination basically from the idealistic social ethic that humans are central. Humans are seen here not as separate from nature as western cultural tradition would have it, but as an integrated part of nature and the environment.

Merleau-Ponty (1962, 2002) suggested that there are two sides of embodiment, bodies as structures and as lived, experiential structures, biological and phenomenological, which are not opposed but continuously engage each. In order to profoundly understand the notion of two side of mesh, the embodiment of knowledge, cognition, and experience need to be investigated in detail (Merleau-Ponty, 1962, 2002). Merleau-Ponty’s recognition revealed a middle way, an “entre-deux” (Merleau-Ponti, 1962, 2002), between self and world, between the inner and the outer. The entre-deux is a space that comprises the gap between self and world, and allows for the continuity between them (Varela et al., 1993).

Interestingly, many historians, ethnologists, anthropologists and linguists, but few natural science disciplines, have searched for a flag-waver with the aim of unifying all oppositions through the role of a mediator, which can be seen as paralleling that of the designer. For example Yamaguchi (2007), a
cultural anthropologist, has investigated mythological creatures, and identified the role of ‘trickster’ as a catalyst that unifies two separate realities. Yamaguchi cites De Josselin de Jongh’s book ‘The Origin of the Divine Trickster’ (1929), which positioned the god Hermes-Mercury in the role of integrating all oppositions, beginning from that between man and woman, mature and immature, and internal and external. And he also referred to Claude Levi-Strauss, who introduced a figure who plays the role of unifying of opposites in his literature, for example, *Les mythologiques (1964-71)*. According to Yamaguchi (2007), a mythological character in Nigerian culture, called ‘Hare’, is the mediator between the king and the common people, between the city and the country, between astuteness and stupidity, between culture and nature. In the works of Shakespeare, King Lear, the buffoon, was given the role of integrating rationality and irrationality, regality and madness, centre and periphery. In the 20th century, new expressive forms and styles established by the avant-garde artists such as Picasso were done on the basis of the image of Harlequin (Arlecchino) who was brought forth from Hermes-Mercury (Yamaguchi, 2007; Hosoe, 1991). In Northern Europe, the Viking god ‘Loki’ played a role as mediator, between wisdom and misrule (Crossley-Holland, 1982).

Hosoe (1991) refers to a hypothesis about the cultural role of the trickster as a dynamic catalyst within the binominal centre and periphery, elaborated by Yamaguchi (2007), and says that “designers role is to be a dynamic catalyst within the binominal center and outskirt” (p.185). As Hosoe mentioned in his book Play Office (1991), and as many scholars have suggested, the catalyst or mediator has a role of vital communication that is able to ensure the balance of our whole world. Figures such as a trickster have common characteristics summarized below;

- They have a role as a mediator between separations.
- They never stay tranquil, but they behave continuously in searching for something.
- They are intelligent but take foolish action ridiculed by the common people.
- Their behaviours are unpredictable and unformalizable.
• Their mischiefs bring deconstruction of pre-existent order and simultaneously produce a new order.

• They destroy fixed information. They brings entropy. Simultaneously they create a new structure in which entropy is transformed to neg-entropy.

As another example, Edward Hall (1969) has introduced the terms low-context and high-context. Separated positions between objective and subjective can be partially replaced as low-context and high-context. According to Hall, the information or message either in the physical context or embodied in the person is exchanged in a high-context (HC) communication (Figure 4.1).

For example, a married couple who have been together for many years, or twins who have grown up together can and do communicate through more economically implicit ways of communication (HC), whereas a low-context (LC) communication consists of the vast of the information fixed in the explicit code, just like two lawyers in a courtroom during a trial (Hall, 1969). HC communication contains minimal information in the transmitted message, which is pre-programmed information (time must be devoted to programming) and is in the receiver and in the setting, while most of the information in LC communication must be in the transmitted message in order to compensate for absence in the internal and external context (Hall, 1969). We often find good art, good designs and good products, which are long-lived and slow to change. LC communication can be changed easily and rapidly.

![Figure 4.1 High context-Low context (based on H-L continuum by Hall)](image-url)
The imbalance between high and low context can be found in our everyday life. Let’s look at recent mobile phones that frequently bring out a new model. It is clear that a mobile phone can be very low-context, since they get out of date even before they come into the light of day. They frequently change their functionality and often change the entire model, before users internalize the functionality into their experience. Recent rapid change of technologies restricts high contextuality.

On the other hand, some users keep mobile phones for many years. It can be said that the communication between the user and the mobile phone has been internalized. They have been developing high contextuality.

Some musical instruments, for example a violin, have never changed the style of interaction and even the form over the last few centuries. Architecture styles of churches in western and temples in eastern cultures have been firmly established for hundreds of years, and are still quite traditional styles for preserving religious beliefs and ideas up until today (Hall, 1969). It can be said that high-contextuality places great importance on the need for being firm and stable, while low-context is the reverse, the need to conform and undergo a change. We need a development strategy for balancing two apparently contradictory needs which design should pursue.

Varela et al. (1993) challenge prevalent belief throughout cognitive science, “cognition consists of the representation of a world that is independent of our perceptual and cognitive capacities by a cognitive system that exists independent of the world” (Varela et al, 1993, xx). They stress the separation between cognitive science and everyday experience in our present world. They claim the importance of having a sense of common foundation integrating cognitive science and human experience. They focused on one tradition that derives from the eastern philosophy of examining experience, what the eastern philosophers call mindfulness, which refers to awareness of being here and now. Their unique attempt is to naturally bridge between the eastern philosophy and the western tradition of science, namely human experience and cognitive science, by applying the concept of non-self and non-dualism that grew out of mindfulness.

In the brain science or neuroscience domain, it is well known that there are functional asymmetries of the human cerebral cortices. Meinard Simon Du Pui in 1780 claimed that mankind has a double brain with a double mind, what he called Homo Duplex (Taylor, 2008). Dr. Roger W. Sperry in his 1981 Nobel lecture commented:
“...The same individual can be observed to employ consistently one or the other of
two distinct forms of mental approach and strategy, much like two different people,
depending on whether the left or right hemisphere is in use.” (http://nobelprize.org,
1981)

A brain scientist, Jill Bolte Taylor (2008) claims the importance of
shifting from unbalanced brain functions towards the right balance. She
explains the left and right brain functions with the terms, doing-
consciousness and being-consciousness. The left brain can be characterized
as the doing-consciousness that is trained to perceive oneself as a solid thing,
separate from others, while the right brain presides over the being-
consciousness that perceive the whole that relishes the natural state of
flowing. The left brain has repeatedly reigned over the seat of our
consciousness as linguistic, sequential, methodological, rational, and
intellectual. If we keep staying unilateral in the left brain, our thinking would
be end up analytically critical, rigid and lacking of flexibility.

On the other hand, to the right brain, only the present moment exists, and
each moment is vigorous and animated with sensation. That is the moment
of now, timeless and eternal. No rules and regulations exists, the right brain
has no ability of judging the correct or wrong way of doing something. Our
right brain takes things as they are without inhibition or judgment. The
exploration of the possibilities that each present moment brings is intuitive
and creative. The right brain is spontaneous, carefree, and imaginative. It
allows our artistic being to flow free. The right brain is a dominant character
of the sense of wholeness without self as a single, solid, separate from it. The
right brain has an ability to perceive how everything is related, connected
and shared, and how every single thing unifies as one to form the whole.
More importantly, Taylor (2008) consistently claims the need for creating
the healthy balance between the two characters, which “enables us the ability
to remain cognitively flexible enough to welcome change (right hemisphere),
and yet remain concrete enough to stay a path (left hemisphere)” (p.138).

The right brain function reminds us of the characteristics of trickster,
which is amusement, ludicrous, omnipresence, entropy, and freewheeling
and so on. She also stresses that if the brains making up our society are
mentally healthy, then our society is also mentally healthy, but recent
modern society seems difficult to live in for the right hemisphere character.

The concept of mediator/facilitator is nothing new. In the domain of HCI,
CSCW, and contextual research such as ethnographic research and
participatory design for example, the importance of mediator or facilitator has long been discussed (Schuler & Namioka, 1993; Nardi, 1993; Wiberg, 2001). The social scientist or applied ethnographer has been viewed as the interface between a user and a designer. The researcher collects primary information or uses secondary information to get insight about the user needs. The researcher translates the information and proposes a document as a form of design criteria. The designer further translates these criteria into concept sketches, scenarios, or early prototypes. The translations may or may not be used for the process for usability testing.

Participatory design gives a shared workshop space for a team of people who represent the stakeholders such as users, designers, marketers, management people and developers to understand needs and preferences in the development process. The results are formulated as design criteria that reflect user requirements and business goals. Lists of subjects, problems, issues, and questions are introduced by which the facilitator conducts the workshop. The facilitator induces discussion and helps communication among all the stakeholders, ensuring that both planned and unplanned issues are covered (Kaner et al., 2007).

As shown in this section, many disciplines and scholars have pointed to the role of mediators and their importance in balancing two apparently contradictory aspects of being.

It is certain that as long as audiences are viewed as users in the process of system development, it still belongs to user-centred design that is far from HXD. We should train ourselves to have a clear picture of who is the target audience in a particular design project. Viewing design as a mediator shares with the experiential approach the capability of satisfying the real and reasonable concerns that have motivated both subjectivity and objectivity. The mediator in HXD acquires a different character from a middleman, negotiator or facilitator that scholars in HCI, CSCW, and contextual research have described. It has an essential role in seeking the design aspect of reality namely responding to the question of what it means to be human.

The following section explores ‘design’ as characterized in ordinary design science and research and brings issues into the open. The section then investigates alternative, scientific knowledge in design research, which integrates rationality and creative imagination. The designer’s attitude in how human experiential approach to research can be conducted is discussed.
4.2.2 Issues in Design Science and Research

I have discussed the ill effects caused by oppositions, such as the subjective-objective dichotomy, and introduced the designer’s role as a dynamic catalyst that integrates oppositions. In this section, we attempt to investigate how the designers’ role can be positioned with respect to scientific design research. This section proposes that to look at ‘presence research’ allows us to bridge the gap between the both positions. An alternative framework, neither objective nor subjective, on integrated blend in Design Science is proposed. Without a clear understanding of the different types of design research, understanding of design science will be also confused, since there are a variety of perspectives on design research.

Design Knowledge in Design Practice

According to Sato (2009, p.27), two types of design research can be identified.

1. The practice of developing information for a particular design project that includes number of activities for gathering information such as customer/user needs, social issues, markets, competitive products, and related technologies. This design research focuses on understanding customers’ and users’ needs for developing artefacts/products from the user’s point of view. This is generally called user-centred design and research.

2. The practice of developing a general formalization of knowledge that includes theories, methods, principles, and tools that can be applicable as resources for knowledge development cycle. The generated knowledge is shared across different design practices and commonly verifiable from an academic point of view.

The latter is further divided into two distinct areas of interest, general design research and domain-specific design research (Sato, p. 28).

2-a) General design research is the scientific study of the acts of design, which leads to general design theories and methodologies that provide general models of design process and knowledge, and contributes to improvements to in the practice of design.

2-b) Domain-specific design research is the study of the subjects of design, which leads to the development of knowledge about specific
domains of design concern. HCI, for example, is one of domains of design concern.

This categorization of design research is summarized as Figure 4.2. General design research is composed of a variety of design theories and methodologies, which are categorized as descriptive and prescriptive. General design research has been identified with two aspects of design research, design theory and design methodology (Tomiyama, 2009). According to Tomiyama (2009), design theory focuses on scientific study relevant to a number of such design activities as “design process, design activities, design knowledge, and designed artefacts/products” (p.49), which contribute to further development of design theories and methodologies. On the other hand, design methodology is applied in design practice, for effectively supporting design and process, which is aimed at better design results. Tomiyama (2009) pointed out that “scientific understanding helps researchers to identify what to research, and helps design practitioners to correctly understand what can be done and what cannot with a particular types of design methodology” (p50).

Figure 4.2 shows that ‘design knowledge’ could be intellectually externalized and could be a matter of the intellect.

Can ‘design’ be conceptually explained by language? As far as ‘design’ addresses all the natural dimensions of our experiences, including our sensual perception, it is not easy to externalize. So ‘design’ is not merely a matter of language, and merely a matter of the intellect. Here, there is a question. What is scientific knowledge in design research actually?

<table>
<thead>
<tr>
<th>Design Research</th>
<th>Research type</th>
<th>Aspect of research</th>
<th>Knowledge</th>
<th>Specific domains</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) The practice of developing information for a particular design project</td>
<td>e.g) User Research</td>
<td>Information Development</td>
<td>e.g) Statistical Data</td>
<td>e.g) Information Systems</td>
</tr>
<tr>
<td>2) The practice of developing a conceptualized body of knowledge</td>
<td>e.g) Market Research</td>
<td></td>
<td>Contextual Information</td>
<td>Design (sustainable, healthcare, etc)</td>
</tr>
<tr>
<td>2-a) General Design Research</td>
<td>General Theory/Method Development</td>
<td>Design Theory/Method Development</td>
<td>Design Methods, Frameworks and Principles</td>
<td></td>
</tr>
<tr>
<td>2-b) Domain-Specific Design Research</td>
<td></td>
<td></td>
<td>Human-Computer Interaction</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.2 Categorization of design research
Many scholars, disciplines and researchers have realized that ‘design’ originated from a craft-work cannot support design today evolving fast and complicated (Poggenpohl, 2009; Krippendorff, 1995; Owen, 1998; Buchanan, 2001). Jurgen Habermas (1998, 33) discussed a distinction between know-how and know-that. A person with habituated skills has ‘know-how’ which is the understanding in which a skilled practitioner crafts or executes something. On the other hand, ‘know-that’ is the explicit forms of knowledge in which a person is able to know-how. A number of design activities can be seen as ‘know-how’ based and difficult to express in the explicit forms of language.

Humans have both embodied and abstract forms of knowledge. They actually affect each, and are not easily dissociable. In scientific research, researchers and scholars mainly deal with descriptive knowledge with an explicit form of language. On the other hand, Humans also have unexpressed knowledge, so-called tacit or implicit knowledge (Polanyi, 1966). In general, implicit knowledge can be communicated by shared meaning between people. It is far from explicit knowledge that can be communicated in an explicit form of language. Effective engagement between explicit and implicit knowledge could enhance ‘creativity’ in design process and could open a research area in design disciplines.

Recently, practitioners in business and design management have tried to adapt the term tacit knowledge to describe inexpressible mechanisms of individual and organizational ‘creativity’. However, the approach has not yet well succeeded (Nonaka, 1991). One reason is that there is a lack of understanding of the notion of creativity. Ironically, creativity itself is hard to illustrate and externalize. If the context of design activity is preceded with inexpressible knowledge, creativity is also equal to, or part of, tacit knowledge.

The activities and skills of design practitioners must appear very strange to the eyes of those people who believe there is absolute objective, unconditional truth. They describe how, for example, designers ignore the result of design research under the assumption that design research is inapplicable and useless to design practice, hence, designers execute their own design process without explicitly using theories and methodologies. Designers then describe their own design solutions thus: design solutions that come from scientific theories and methods are relatively frail compared with design solutions obtained on the basis of ‘intuitive’ experiences.
(Tomiyama, 2009). In other words, even though design can be improved by profound scientific studies expressed as for example accessibility, usability, acceptability, it is not always suitable for our aesthetic and sensitive everyday life.

Certainly, there is a something not easy to externalize in design knowledge (not only design knowledge but also human knowledge in general). But, designers must have understood ‘design’ and do design based on their understandings. If not, it is clear that they could not do design or could not externalize their idea thought and could not apply the externalization into developing artefacts/products. The present thesis consistently claims that we, humans not only designers, are always creative and imaginative to live, survive and grasp the world around us in everyday life. However, we, design disciplines, have yet to explain what is creative thought from the truly human aspect through profound human-observation.

It could be possible to identify scientific knowledge in design research, in which rationality and creativity are integrated, if human creativity is revealed through investigating the process of understanding. Investigating the process of human-understanding equals investigating the process of designer’s understanding, which is the process of creation. Namely, the profound observation of human understanding can bring understanding of designer’s creativity.

The following section explores design knowledge from a problem-solving paradigm. It reveals dichotomies, gaps and lacks that must be integrated effectively to develop IT artefacts. The investigation also helps to identify how scientific knowledge of design research can be positioned from the experiential design perspective.

**Design Knowledge in Problem-Solving Paradigm**

The needed unification has become an increasingly obvious issue within the information systems (IS) discipline, in efforts to produce effective health information systems (Walls, J.G. et al. 1992; March & Smith, 1995). These kinds of issue have also long been discussed in information systems (IS) design (Boland et al. 1994; Glass 1999; Winograd 1996; Winograd 1997; Lyytinen 1998). We can find several dichotomies in different aspects of this work, dealing with people, organization, technology, and design. For example, many IS researchers and practitioners have discussed distinct paradigms of behavioural science and design science, which are foundational
to the IS discipline (Walls, J.G. et al. 1992; Hevner et al. 2004). Whereas the behavioural science paradigm has its roots in natural or physical science research methods that explore what is true (i.e., principles and laws), the design science paradigm has its roots in engineering and the sciences of the artificial, which seek to create what is effective (Simon 1996; Tsichritzis 1997; Denning 1997; Hevner et al. 2004).

Alexander (1969) mentioned that “scientists try to identify the components of existing structures, designers try to shape the components of structure”. Fielden (1975) described engineering design as “the use of scientific principles, technical information and imagination in the definition of a structure, machine or system to perform pre-specified functions with the maximum economy and efficiency”. Discussions of Alexander (1969) and Fielden (1975) are about the static structure of architectures and engineering, but can be applied to the dynamic structure of information systems as well (Walls et al. 1992).

It is clear that design knowledge in IS research has been developed within the interaction between business strategy, IT strategy, organizational infrastructure, and IS infrastructure (Hevner et al. 2004). In order to effectively develop and implement information systems within the interaction between them, ‘problems’ need to be understood and successfully solved.

In information systems research, design knowledge has been developed from a different point of view. Rather, design knowledge and theory in IS disciplines has been defined as “a prescriptive theory that integrates normative and descriptive theories into design paths intended to produce more effective information systems” (Walls et al. 1992). According to Silver et al. (1995), one reason is that “Information systems are implemented within an organization for the purpose of improving the effectiveness and efficiency of that organization”. Concrete prescriptions have been defined as constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems) (Hevner et al. 2004; March & Smith 1995).

The objective of systems theory is to identify properties of systems common to all types of systems and to use these properties to understand and describe systems (Walls et al. 1992; van Bertalanffy 1973). Methods of effective development and a type of instantiation for a particular class of
models (Marks et al. 2002) are then prescribed. Constructs help to communicate between problems defined and solutions represented (Schön 1983). Models use constructs to conceptualize a real world phenomenon, and visualize the design problem and its solution space (Simon 1996). Disciplines in the domain use models in order to understand problems and solution, and to represent the effects of decision-makings and changes in the real situation in which problem and solution components are engaged (Hevner et al. 2004). Methods also define processes, which guide how to find the solution space. Constructs, models, and methods need to be integrated to effectively implement solutions in a system at real situation. Instantiations, in other words, designing and prototyping, demonstrate feasibility, enabling to evaluate an artefact's suitability from users’ aspect for its intended purpose (Hevner et al. 2004; March & Smith 1995).

Design knowledge in user-centred design, including not only systems design but also product and interaction design more broadly, and industrial design in general, has two aspects, a product (artefact) and a process (set of activities) (Hevner et al. 2004; Walls et al. 1992). As defined previously, a user-centred design process can be seen as a process centering on the knowledge lifecycle that includes knowledge of use, knowledge of design and the user who generates knowledge through interpretation of embedded design knowledge in artefacts/products. The goal of developing knowledge from the aspects of problem-solving paradigm continuously shifts aspects between design processes and designed artefacts dealing with the common complex problem. The design process is a knowledge development cycle that generates innovative products/artefacts. The evaluation of the artefacts and the process is needed in order to understand the problems in which the process of knowledge cycle is effectively carried out, which in turn improve both the quality of the product/artefact and the design process. The knowledge development is a lifecycle loop repeatedly conducted before the final artefact is designed (Markus et al. 2002). Developing knowledge in design research and IS research shares a paradigm in which they pursue the same goal, which is a ‘problem solving.’ The developed theories prescribe effectiveness of system solutions for a particular class of user requirement (Markus et al. 2002, p.180). Design knowledge in these domains focuses more on situated utility (March & Smith 1995). As the categorization of audiences shown previously (see figure 3.2) reveals, the process of human-understanding on a more human scale, more experientially sensitive and
aesthetical are not discussed and investigated in this domain. These paradigms aim to explicate users and phenomena surrounding users.

**Theoretical Models**

‘Design’ does indeed exist alongside both aspects, absolute objectivity and purely subjective intuition, or in other words, rationality and imagination. Although it contains implicit notions not easy to externalize in words, only externalized expressions are conceptualized as theoretical models in science. It seems, therefore, ‘Design’ is hardly accepted as ‘Science’. What is a conceptual model? What is a theoretical model?

Many different models exist from everyday life to science. For example, teachers have a model answer to an exam question. Parents should be role models for children. Mechanical models explain how a machine works, and can be used for generating and analysing data from experiments with the mechanical models, such as scale models of vehicles wheeling in wind tunnels. There is a mould model to reproduce machines or plastic arts. Linguists investigate grammars and writing systems and explain them with models of language. Cultural anthropologists use theoretical models rooted in culture. Highly abstract forms of models are often used to explain the entire culture that is itself a series of contextual models for behaviour and thought (Hall, 1969). On the other hand, mathematical theoretical models are used to express scientifically reliable qualities, quantities, and relationships encountered in life, by predominantly natural scientists. For example, mathematical models can be used to investigate how the more measurable aspects of the economic system operate by economists in general. We can find different types of models expressed as cognitive systems, in science, philosophical systems and even myths (Hall, 1969).

Scientists and scholars have studied only those things people could or would externalize with modelling. They use models in order to experiment with how things work, and try to foresee how things would function in the future. They judge the effectiveness of a model by exploring how consistent it is, not as an everyday life concern but as a mechanical or philosophical system.

In the design domain (called ‘scientific design’), theoretical models are usually composed of theory, method and tool. Theory is a generalized and abstract form of explanation, which helps to understand the salient issues that we try to design or solve. It helps also to describe particular phenomena,
but describing is not the same as designing. As pointed out earlier in the example of designing a chair, we can describe what a chair is in a generalized way, but it is not easy to design a satisfactory chair. Method in many forms of physical and digital design is a tool of understanding actions relevant to a domain of problem. The generalization of theory, the development and testing of method, and the creation of a tool are explicit activities based on critical analysis and experimenting until a solution is found (Poggenpohl, 2009).

Sometimes designers and design researchers in the scientific approach blindly accept that methods guarantee designers to come out with a satisfactory design achievement. It is however not a guarantee of superior design. We should not forget that design method is a tool in the explicit way, and it can be said that all theorizing processes and theoretical models are incomplete. Hall (1976) pointed out that:

“by definition, they are abstractions and therefore leave things out. What things they leave out is as important as, if not more important than, what they do not, because it is what is left out that gives structure and form to the system.” (Hall, 1976, p.14)

This ‘leaving out’ has tended to equal avoidance of the complicatedness of the real world and of humans. The ‘design’ has been ‘scientific’ to the extent that it has kept away from dealing with everyday concerns.

We can find an imbalance between highly explicit models and beneath them the real world of humans. The balanced integration has become an increasingly obvious issue in developing knowledge in IS design, HCI design, and even product design. However, recent knowledge development in design research has been imbalanced between the practical and experiential approaches. The practical approach based on the mechanistic picture of the world has been dominant in recent design research.

This does not mean that designers should ignore theories or look upon theories with suspicion. Rather, by definition, this is fraught with danger of avoiding the complicatedness of the real world and of humans. Even though the role of the model is to enable us to make a better action in dealing with the complicatedness of the real world and of humans, beneath the clearly perceived, highly explicit surface phenomenon, there lies the rest of the world. And the underneath and the surface are inseparable. The alternative approach, what I call “Human-Experiential Design”, takes account of; overt and covert, implicit and explicit, things you externalize to talk about and
things you do not. I would like to make clear that one of purposes of the approach is to show an imbalance that has arisen partly from the mechanistic approach and its impact on design. This thesis however is certainly not intended as industry or technology bashing, nor to say that designers should ignore theories or look upon theories with suspicious.

This thesis offers a framework that rectifies the imbalance that has arisen partly from these paradigms. We propose Human-Experiential Design as an approach to designing applied in our everyday lives, in ways that are implicit, often unconscious, not easily externalisable in words, which only our bodies know. It helps to understand the notion of the designer’s creativity that has not described yet, and conceptualise the integrated scientific knowledge in design research.

4.2.3 Integrated Design Science: Human-Experiential Design

Our experience and everyday life are rapidly becoming mediated through digital computing and information/communication technology. Technologies will increasingly mediate our experience of the world around us, from mobile phone to home entertainment and mediated computer games, even living/housing environment and architecture. It is fairly realistic to see the future of the human sense of presence as reflecting the rapid development of ever more pervasively penetrated digital technologies (Waterworth et al., 2010). It is about a perceived experience through technology as if it is only mediated by human senses and perceptual processes.

However it is currently not easy to achieve this state, since technology is designed on the basis of explicit conceptual knowledge, while human sensation and perception is rather an embodied implicit phenomenon. Human beings therefore have to forcibly adapt to the mediated computing environment, even though human behaviours should essentially be expressed as a natural flow of action based on the constant activity of being present in an environment. I will explore the embodied implicit phenomenon in greater depth in Chapter 5. How can the feeling of presence be derived in computer-mediated environments; what scholars have termed mediated-presence? If technology disappears from our perception in use, the experience perceived through the technology can be defined as ‘mediated presence’ (Waterworth et al., 2010). How can technology be designed to make humans experience the sense of presence in the physical world?
If technology can be defined as machines, devices, or other application of things, those artefacts/products have been designed on the basis of recent user-centred design principles during the last few decades. Design research in user-centred design practice has contributed to the recent technological developments of our lives.

Many disciplines and professionals in both academia and industry have discussed and used the term user-centred or human centred design without any clear distinctions. Hoshi (2011) has reframed categorization of customer, user person and human. On this basis, we use the term ‘User-centred design practice’ or ‘User experience design’ in cases of design approach and process centring the knowledge lifecycle of a user, unless specifically noted rather than ‘Human-centred design’. This user-centred approach has been applied and adopted for developing HCI, which aim to practically harmonize accessibility, usability, acceptability, and engagement based on an explicit formalization of human cognition of the world. People struggle to understand and use computers, mobile phones and other embedded computing devices, whose designs are still largely based on the formalization of human cognition of the world, which breaks the human sense of presence invoked in computer-mediated environment. While presence research seeks a subjective sensation of being present in our environment, the current scientific approach to design research can be seen as an objective position based on the ideas of “scientific truth, rationality, precision, fairness, and impartiality” (Lakoff & Johnson, 1980, p.189).

In my view, the human mind, rational design and technology need to be integrated, and for this we need knowledge of alternative design theories and methodologies that make realization of this integration possible.

What is creativity, or intuitive thought? How do we understand creative ideas from designed artefacts? Can a feeling of creativity replace a feeling of the unknown? How can we perceive creativity without designer’s self-complacency? We usually answer the question like this: “Designers should conduct user studies, users should be involved in a design process.”

Although design research for the most part has been evolving in order to bridge the gap between designer and user, mutual understanding can be especially difficult in sharing across different cultures, knowledge, values, and assumptions. It can be said that the problem of the gap in mutual understanding may come from a blind acceptance of objectivism based on the prestige of science.
The gap between designer and user can be seen as the gap between the objectivism position and the subjectivism position (Figure 4.3).

Up until now, scientific design research has been trying to establish an independent position through intellectualizing and with a disregard for the nonverbal. It is not easy for designers to explain irrationality in themselves and in users. Although irrationality does not yield to logic, it is an intrinsic part of life. However, we have got this particular set of logic and irrationality placed as if they are polar opposite. Humans in everyday life are largely living irrationally, but imaginatively (Figure 4.3).

We can experientially understand that we are not always living by logical reasoning. The irrational composes a significant portion of our everyday life behaviour. It is time for design researchers and designers to resign themselves to that fact. Instead of rejecting irrationality in designers and users, we should take a healthier attitude to integrating the irrational and rational.

Designers in scientific design research and users live in different cultures. Understanding each other, each culture and the world and explicating the irrational are inseparable aspects of the same process. Hall (1969) pointed out that “Culturally based paradigms place obstacles in the path to understanding” (p.220). Our thoughts based on the separated paradigms hinder the unravelling of cultural processes. Mutual misunderstandings between designer and user are not unfamiliar problems. They arise in all extended communications where understanding is important. In a verbal communication in everyday life, people need a flexible adaptability in world view, as well as expertise for finding the appropriate metaphor to communicate the relevant parts of limited sharing of experiences or to
emphasize the shared experiences while tone the others down. Metaphorical imagination is a critical skill for designers as well in creating harmony and in communicating the nature of shared experience between designer and user.

The experiential approach to design is a matter of integrating creative imagination and rationality. Understanding what cannot be comprehended totally, for example senses, feelings and aesthetic experiences, involves seeing one kind of thing in terms of another. This is the integration of reason and imagination, which can be described as metaphorical thought (Lakoff & Johnson, 1980). According to Lakoff and Johnson (1980) “our conceptual system is metaphorical in nature. The essence of metaphor is understanding and experiencing one kind of thing in terms of another” (p.5). Metaphors are rooted in physical and cultural experience. So, a metaphor can serve as a vehicle for understanding a concept only by virtue of its experiential basis.

Designers use metaphors in graphic design, interface design and interaction design, and so on. Metaphors work effectively in relations perceived in similar ways between the designer and the user. If the user doesn't have the same cultural background as the designer, it is difficult to understand them. Even in the same or similar cultures, there can be significant misunderstanding.

If an artefact, designed by the designer's thought process seeing one kind of thing in terms of another kind of thing, is understood by user's thought process similar to designer's one, the meaning can be shared between designer's and user's metaphorical thought. Integrated creative imagination and rationality is shared between designer and user. When they share it, the reality gap between designer and user can be bridged. Users could perceive the creativity in a modest manner. They understand the meaning of the artefact and its functionality as well. The creativity involves all the natural dimensions of our experiences including sense experiences such as colour, shape, texture, sound and so on. Metaphors integrated with imagination and rationality are as much as a part of our functioning as our sensory perception, and as precious. Designer and user share the sense as though the ability to comprehend experience through metaphor is like seeing, touching or hearing. Metaphor integrated with imagination and rationality is not merely a matter of language, just as design is not merely a matter of the intellect.

True creativity can be shared between designer and user via sensual experience. Their experience through the designed object is as if they share
the embodiment for understanding information, and as if they are conscious of the present, *here and now*.

It is not too much to say again and again that designers should have the ability to put themselves in the users’ place, to ‘sense’ their ‘sense’, to be in their situation, to see through their eyes. The core principle underlying the shared feeling, or empathy, is that designer and user are connected when they are both conscious of *here and now*. This is nothing other than sharing primitives for understanding information. As defined previously, humans share the same primitive, designer and user are connected at a human primitive level. Through their design activities, designers should be conscious of the present. Users perceive consciously in the present through using the designed object. In this regard, more detailed discussion will be conducted in Chapter 5.

HXD is a different point of view from that based on the designers’ tacit knowledge. Rather, it straightforwardly focuses on human beings having the same primitive experiences. While it may be that much evolutionary memory is conserved in our senses, much memory is, we believe, hidden for future survival, or transformed to adapt to the present time. Waiting patiently, these memories will emerge to be appreciated someday (Hosoe, 2006). HXD plays a role in redressing unbalanced dichotomies towards the right balance. A Human-Experiential Designer can be positioned as a mediator for balancing two apparently contradictory needs.

This thesis suggests that HXD can be positioned as a design practice applied in our everyday live, and experienced in ways that are implicit, often unconscious, not easily expressed in words, and which only our bodies know. The HXD approach attempts to produce a feeling of presence in which sensual, perceptual and conceptual experience are integrated (Hoshi, 2011). It aims at scientific understanding of the design process, design activities, design knowledge, and designed objects, contributing to further development of design theories and methodologies, overcoming dichotomies between mind and body, and objective and subjective positions.
PART III: Foundations of Human-Experiential Design
Chapter 5: Human-Experiential Design: Conceptual Foundations

5.1 Introduction
This chapter attempts to place the present work in the context of current issues in HCI research, and as a development of an experiential perspective on human sense-making. The role of metaphor and blending in human experiential design is described, and in particular the notion of Blended Reality Spaces in which tangible presence can be experienced.

5.2 Issues in current HCI research
Technology creates the virtual world, but also exists in the physical world - with which the virtual often competes for our attention. Many new interaction styles clearly exhibit the combination of the physical and the virtual, sometimes called mixed reality (Jacob et al., 2007; Chalmers et al., 2003; Rogers et al., 2002). Today, mixed realities of different kinds represent an increasingly prevalent approach to interaction that strives to combine the physical and the virtual. Mixed reality is also a growing object of study for the HCI research community, as part of a widespread effort to develop viable and more flexible alternatives to WIMP-based GUIs. Most of the broad range of new interfaces developed by HCI researchers are seen as alternatives to the current GUI paradigm and try, in one way or another, to diverge from the WIMP-based approach (Jacob et al., 2008). For example, sensor-based techniques for interacting with virtual entities via the manipulation of physical objects in space have been explored by HCI researchers.

Recently, we have witnessed the emergence of a wider variety of HCI technologies, such as those implemented within sensor-based environments, handheld smart phones with more intuitive onscreen interfaces and orientation sensors, and these and others are now gradually penetrating society. They emerge as a huge growing trend in the HCI literature. Typical examples are; augmented reality, tangible interaction, ubiquitous and pervasive computing, context-aware computing, handheld, or mobile interaction and so on (Jacob et al., 2008). Since the ubiquitous GUI was introduced and became the standard paradigm in HCI, the post-WIMP trend is that digital media are becoming more pervasive in our everyday life. Everywhere in our built environment devices such as video screens,
electronic access systems, and sensor-based smart environments are rapidly increasing. But there is still a huge gap between the media and ourselves as bodies in physical space.

We need a clear understanding of the scope of this phenomenon, especially its perceptual and psychological aspects. It is predicted that the intersection of sensory, cognitive and emotional aspects in emerging mixed realities will be significantly important in attempts to go a further step in the development of better combinations between the physical and virtual environment, in *Blended Reality Spaces* (Hoshi & Waterworth, 2009).

The history of HCI is can be seen as the evolution of the standard WIMP interface composed of desktop metaphors. When metaphors don’t work well, they might lead to people to develop inappropriate expectations of technologies (Imaz & Benyon, 2006). In order to understand how blends are framed and formed, we need to get a picture of metaphors and how metaphors and blends actually work together. It helps to also understand the embodied notion in HCI, derived from our bodily and social experiences.

### 5.3 Metaphors and Blends in HCI

#### 5.3.1 Metaphor

We usually don't have a doubt that metaphors have been used in the design of digital devices. The well recognized personal computer user interfaces have been designed on this basis – known as the ‘desktop’ metaphor. The designer explicitly tries to draw on people's knowledge of office work to help them understand the operation of the computer.

Metaphor is the well-known approach to the design of HCI, which draws on users' experience in another domain to assist their understanding of the system (Waterworth et al., 2003). Users praise metaphors when their previous experiences are suitable for comprehending some new interaction, on the other they criticize metaphors when they don’t understand them or what they are for (Imaz & Benyon, 2006).

Over the past twenty years, more and more interfaces have adopted this style, and now it is spreading to other devices such as mobile phones, digital cameras, audio-visual equipment, and many web sites in our everyday life. The metaphors should work well where the designer and the user perceive them in similar ways. But while metaphors are provided to let people bring their previous experiences to understand new interactions, they might lead
to people misunderstanding the purpose of the functionalities even in the same cultural background. Much of this confusion arises because metaphor is not well understood. That means that the embodied notion of metaphor, derived from our bodily and social experiences, is not understood well. In order to gain insight into a metaphor that structures the action we perform in a particular culture, Lakoff and Johnson (1980) refer to a culture where arguments are viewed in terms of war.

‘ARGUMENT IS WAR’

According to Lakoff and Johnson (1980), people in the culture understand, feel and act the battle with their body. In the culture, arguments are partially structured by the concept of war such as an attack, defence, shoot, etc. This is a linguistic battle, of course, not a physical battle. If there is a culture where arguments are viewed in terms of ‘dance’, they have a discourse structured in terms of ‘dance’. We can assume that people in this culture similarly understand and experience argument in terms of dance performance. As Lakoff and Johnson (1980) mentioned, they live in a culture where in arguing no one wins or loses, and no one assaults with sense of attacking or defending. Our (human) thought processes are made up of metaphors in most part, and we act according to the way we imagine things, which can vary from culture to culture because metaphors are rooted in physical and cultural experiences (Lakoff & Johnson, 1980). Michel Polanyi (1966) has pointed out that “our message had left something behind that we could not tell, and its reception must rely on it that the person addressed will discover that which we have not been able communicate” (p.6). This example illustrates how there can be significant misunderstanding or gaps even in the same or similar cultures. In every culture, linguistic metaphors are tools for understanding and can be meaningful and true. But the embodied gap exists somewhere between different cultures (Lakoff & Johnson, 1980). The gap between designer and user is, in most cases, essentially a bodily, cross-cultural gap. In designing interactive systems for healthcare, the gaps can be found in several places, for example between patients and doctors, or elderly people and care givers.

We feel our physical experiences of the world, our spatial awareness, our bodily movement and the way we manipulate objects, through metaphors. Imagine our everyday life, we adopt a drooping posture when we come upon sadness or are living with depression. On the other hand, we adopt an erect posture when we feel positive emotional states. We sometime describe our
feelings as 'feeling up' or 'feeling down' to understand indefinite substance in terms of directionality (Lakoff & Johnson, 1980). Lakoff and Johnson mentioned the fact that “we have bodies of the sort we have and they function as they do in our physical environment” (p.14). Such spatialization shows that the way we think, what we experience, and what we do every day is very much a matter of metaphor. Lakoff and Johnson point out that metaphors are pervasive in everyday life, in our thoughts and actions.

‘Argument is war’, spatialization and other metaphors take account of an embodied pre-linguistic structure of experience that motivates conceptual metaphor mapping, called an ‘image schema’ (Johnson, 1987). According to Lakoff (1987), image schemata are simple structures that constantly recur in our bodily experience, formed from our bodily interactions, from linguistic experience, and from historical context. Schemata have been applied in ‘experiential’ approaches to design. For example, Andreas Lund developed an information exploration environment called ‘Schemata space’ that seeks to capture the human scale of people interacting with basic-level image schema categories, and through which interaction is experienced as natural both conceptually and perceptually (described in Lund, 2003, Waterworth, 1999; Waterworth et al., 2003).

5.3.2 Image schemata and metaphorical projection

We are animate beings that must interact with our environment. All such interaction requires the exertion of force either we are exerted passively or we exert actively. Our experience is inseparable from forceful interaction. By focusing on more our experience of forceful interaction such as motion, directedness of action, degree of intensity, and structure of interaction and so on, human-primitives and the practical use into design process is disclosed.

Image schemata

Johnson (1987) stressed that “forms of imaginative structuring of experience that grow out of bodily experience contributes to our understandings and guides our reasoning” (xiv). Human-experiential approach to design focuses on the structures of imaginative understanding that grow out of our embodied experience. Previously, Human has been defined as: People who share the same evolutionary history and hence, bodily structures and potential for experience and share the same primitives for understanding
information. The human primitives are a central concern to the human-experiential approach. Human primitives are imaginative structure, which consist of image schemata and metaphorical projections. Johnson (1987) has defined that:

“A schema is a recurrent pattern, shape, and regularity in, or of, these ongoing ordering activities. These patterns emerge as meaningful structures for us chiefly at the level of our bodily movements through space, our manipulation of objects, and our perceptual interactions.” (Johnson, 1987, p.29)

A number of image schemata has been identified by scholars (Johnson, 1987; Lakoff, 1987; Hurtienne & Blessing, 2007; Beate, 2005)). Figure 5.1 is a list of image schemata classified into seven groups relative to similarity by Hurtienne and Blessing (2007).

Let’s look at the BALANCE schema that belongs to a group of FORCE (Figure 5.1) for example. Johnson (1987) has elaborated on the growth of meaning for our notion of force.

We, humans, develop image schemata, which are schematic structures of the patterns of embodied experience and perceptual structures of our sensibility through interacting with our environment such as our perception, bodily movement through space, and physical manipulation of objects. Then grows the meaning for our notion of force. Sense is inseparably related to structuring meaning.

The present thesis explores how our system of meaning is developed with patterns of typical experience of force, so that it reveals the way in which image schemata work their way up into the bodily expression, interaction and communication with our environment, namely the HXD process.

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<tr>
<th>Basic Schema</th>
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<th>Multiplicity</th>
<th>Process</th>
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<th>Attribute</th>
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<td>CONTAINER</td>
<td>IN-OUT</td>
<td>ITERATION</td>
<td>COUNTERFORCE</td>
<td>HIGH-LOW</td>
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<td>OBJECT</td>
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<td>CONTENT</td>
<td>FULL-EMPTY</td>
<td>CYCLE</td>
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<td>NEAR-FAR</td>
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Figure 5.1 Example of image schemata (based on Hurtienne and Blessing, 2007)
Patterns growing
Take an example of how a baby develops the patterns (Johnson, 1987). When a baby is born, s/he begins to grasp the world around her/him through interacting with forces. Through the interactions with forces, patterned relations between her/his selves and the environment emerge repeatedly. The meaning of physical force is developed with such recurrent patterns. Owing to those recurrent patterns, a baby begins to grasp the world with consistent order of relation.

Therefore, sensing can be viewed an integral part of our understanding of the world around us since we are born. We further experience a large number of perceptions and activities in everyday life, such as leaning with one’s back against the wall or someone, perceiving stable structures in nature, perceiving slippery or non-skid texture, arranging books on a shelf and so on (Figure 5.2). We then grasp this structure of BALANCE repeatedly through those experiences, images, and perception. The patterned recurring relations between ourselves and our environment develop the meaning structures (Johnson, 1987).

The BALANCE schema is embodied from constant activities in our perception, bodily experience through the environment, and physical manipulation of objects.

Patterns expanding
Through various experiences in the world around us, we gradually gain and modify the meaning of and sense of force through these bodily interactions. For example, we are often frustrated by “external and internal forces such as gravity, light, heat, wind, bodily processes, and the obstruction of other physical objects” (Johnson, 1987, p13). We successfully defeat the force and often realize own impotence against the forces. We discover that we can
exert forces in repeating failure and successes. Not only defeating the forces, but also we learn that we can utilize the forcefulness by using of tools, which may be a physical tool and even oral expression that influence on others.

We develop patterns by interacting forcefully with our environment such as moving our bodies and manipulating objects as if we are centres of force. Namely, it can be said that we are part of environment and source of force as well. Finally we learn skills from gross motor to fine motor such as using chopsticks, grabbing a mug cup or moving our bodies through space. In such fine motor and gross motor activities there are repeatable embodied patterns, which give coherent, intelligible, well-regulated and meaningful structure to our bodily experience at a pre-conceptual level.

Johnson (1987) stressed that:

> “these embodied patterns do not remain private or peculiar to the person who experiences them. Our community helps interpret and codify many of our felt patterns. They become shared cultural modes of experience and help to determine the nature of our meaningful, coherent understanding of our world.” (Johnson, 1987, p.14)

**Emergence of BALANCE schema**

Previously, we have explored the way in which a baby develop embodied schematic patterns of forces. Babies try to stand, to walk but unsteadily, and sometimes fall to the floor. They repeat try and error until they open a new world of the balanced standing posture. With our body, we sense when the balance is right, how to make adjustments and how the patterns of physical movement organize the proper patterns in constant activity. Through such sensual experience of bodily balance, or of lack of balance, the meaning of balance is generated. We come to understand the notion of systemic balance in the pre-conceptual level through our bodily experience. Johnson (1987) developed “the notion of pre-conceptual gestalt (or schematic) structures that operate in our bodily movements, perceptual acts, and orientational awareness” (p.75). According to Johnson (1987), an image schema such as BALANCE is not an image, even not an object we can physically touch or see, and not a propositional structure or a conceptual rule, instead it is a way of giving order to structure particular experience schematically so as to integrate our perceptions and conceptions.

It is clear that we learn the proper BALANCE of forces with our bodies through everyday activities. However it is also clear that learning BALANCE
is something we do, not by grasping a set of abstract principles or conceptual thoughts. Any animate being must interact with the environment in order to survive. We interact with the environment, manipulate objects or we are affected by force. On all such interaction, we exert forces. When we grasp the world around us, a central factor to comprehend our experience is the structure of force. Our experience and forceful activity are not capable of being separated.

We are rarely conscious of the presence of BALANCE, and never speculate on the nature and meaning of balance, because the experience of balance is pervasively infiltrated into everyday life and definitely fundamental for our coherent way of grasping our world. Johnson (1987) has stated firmly that “the structure of balance is one of the key threads that holds our physical experience together as a relatively coherent and meaningful whole” (p.74). The meaning of balance is interconnected to such experiences as our balancing in motion and systemic balance within our bodies, and to the image-schematic structures that make physical balancing coherent and meaningful for us. Because of the embodied image schemata, it is still recognizable through bodily experience, even if we have not yet learned concepts or externalized words for them (Johnson, 1987).

Imagine when you lose your balance as figure 5.2 shows. When you slip and drop to the floor, you try to get yourself back to an upright posture. You then recognize BALANCE. You attempt to distribute weight and forces appropriately around the imaginary vertical axis. The relevant physical forces have a significant role to establish BALANCE again. The ‘imaginary’ axis is an embodied recurrent pattern in the experience of balancing, not just a diagram illustrated on a paper.

![Figure 5.3 Imaginary axis and BALANCE schema](attachment:image.png)
On the repeated experience interacting forcefully with our environment, we generate the proper patterns of the ‘imaginary’ axis in constant activity to keep our bodies balanced in space (Figure 5.3).

According to Johnson (1987), the BALANCE schemata can be expressed by force vectors and an upright axis or a point relative to which those forces are distributed (Figure 5.3). In any physical experience, balance organizes a symmetrical structure of forces around a point or axis. The prototypical schemata are modified so as vectors are reduced to two symmetrical vectors and points are reduced to a simple point that forms a fulcrum (Figure 5.3). The balanced equal force vectors meet at a point.

The BALANCE schema is one of schema examples among other schemata (Figure 5.1). Some of schema patterns may be or may be not woven together to generate BALANCE. Certainly, the weave of our experience is interlaced with relations between various image-schematic structures. So image schemata are adaptable and flexibly modified to harmonize diverse situations. Image schemata are abstract representations and schematic gestalts in nature, not just symbols (Johnson 1987). The BALANCE schema, for example, is one of recurrent dynamic patterns that emerge from bodily interactions that make up the way we grasp the world. They express the structural outlines of sensory-motor experience. They are embodied, and integrate information from various sensory systems and could be represented in forms of visual, haptic, kinaesthetic or acoustic manner through metaphorical projections (Figure 5.4).

![Figure 5.4 Cross-domain mapping](image-url)
Metaphorical projections

Metaphorical projection is a cross-domain mapping of projecting patterns from one domain to another in order to understand one concept in terms of another concept, where there is some similarity or correlation between them (Lakoff & Johnson, 1980). Physical bodily experience works as a constraint to define the kinds of mappings that can come out across domains (Figure 5.4).

Metaphor is not only a linguistic expression, but also, as Johnson (1987, v) stressed, “it is one of the chief cognitive structures by which we are able to have coherent, ordered experiences that we can reason about and make sense of.”

Patterns developed in our concrete bodily experience are employed in the form of metaphor to bring order to our more abstract understanding. Metaphorical projection from the concrete bodily experiences to the abstract domains helps understanding a world around us by making use of physical experience. Embodied schematic patterns are structured via various physical domains of bodily movements and interactions, and patterns can be projected by metaphor onto abstract domains.

The nature of metaphor reminds us the origin of the term ‘Design’ in Latin, which is from de- ‘out’ + signare ‘to mark,’ from signum ‘a mark, sign’ (see Chapter 2.2). Design can be seen as to bring order to a chaotic state and to find a plan and conceive it in mind in ‘order’ to visualize or form something.

Figure 5.5 A trace of natural flow of action (from Goto et al., 2004, Drawing and photograph: Naoto Fukasawa)
Figure 5.5 shows a trace of “people who intuitively interpret what is of value for their purposes in their current environment and try to become harmonious with it in everyday life activities” Goto et al. (2004).

If there is no umbrella-stand, people would stand the umbrella as Figure 5.5 shows. S/he puts the edge-point in accordance with a slit line of tiles. The distance between the edge-point and the wall, the angle of the tilted umbrella and the force of which the umbrella stably stands-alone are perfectly meshed. It is important not to pass over the metaphorical projection described as Figure 5.6. There exists very much natural flow of action in the situation.

This phenomenon can be described as the behaviour drawn out by an affordance. Indeed, Goto et al. (2004) described Figure 5.5 as a notion of affordance. Many scholars would use affordance to describe how constant interaction with things and environment is derived. However, embodied realism also accounts for this phenomenon, and this thesis would support it. The meaning of physical forces are developed from the day we are born or even before (Johnson, 1987). According to Johnson (1987):

“we have bodies that are acted upon by “external” and “internal” forces such as gravity, light, heat, wind, bodily processes, and the obtrusion of other physical objects. Such interactions constitute our first encounters with forces, and they reveal patterned recurring relations between ourselves and our environment. Such patterns develop as meaning structures through which our world begins to exhibit a measure of coherence, regularity, and intelligibility.” (Johnson 1987, p.13)

To reveal the primitives during observation is to carefully see embodied and imaginative structures of understanding that emerge from our bodily experience at the present moment.

Figure 5.6 Metaphorical projection
Primitives appear in various forms of harmonious accord of physical environment and human body. There is a moment that the embodied meaning of physical forces emerges from our bodily experience in everyday life.

The BALANCE schema structured by our bodily movements and interactions in various physical domains of experience can be projected by a form of metaphor onto physical object in ways s/he grasps the current state of being in our world (Figure 5.6).

In order to organize our more abstract understanding of the present moment in constant activity, we make use of embodied patterns that obtain through our physical experience. By metaphorical projection from the concrete to abstract, we are able to make the umbrella stand up with perfect distance from the wall, perfect height from the floor, and perfect angle of it (Figure 5.6). This is an unconscious bodily experience that determines the kind of mapping that generates across domains.

My main claim here is that metaphorical projection moves from the bodily sense (with its emergent schema) to grasping the world around us at the present moment. On this base, we should be able to see how it is that our experience of bodily balance, and of the perception of balance, is connected to our understanding of a balanced current state of being in the world.

It is not easy to reveal the primitives by ordinary user research such as video taping, interviewing or shadowing for example. Human-experiential approach puts design back present again in embodied everyday experience. User observation in HXD should be conducted to lead the observation back from its conceptual methods, preconceived ideas and the abstract form, to the situation of one’s experience itself. It helps design to be embedded into the experience and disappear from our perception, and supports the natural flow of action with no conscious effort. Ironically, we don’t remember when we are present in the natural flow of action and how we behave in the flow. Prejudice and preoccupation of self-identity become a hindrance for designers and researchers to see reality. It is important to divest the self and release the tenacious attitude of being oneself.

Designer and user are connected together through sharing the primitives. Designers need to observe human primitives that are revealed in interacting with the environment, but not to observe the subject as a user. It is distant from a variety of ordinary user research methods such as contextual research, applied ethnography and participatory design and so on.
HXD takes the perspective of user as human and part of environment, not separate from it. The mediator in this approach integrates design, user and environment. HXD denies the objectivist view of humans as separate from others and the environment. Designing as mediator should contribute to us remembering the wholeness we have forgotten. The mediator is not merely a middleman or a facilitator, but has a major role in which we can answer the question of what it means to be human from the design point of view.

5.3.3 Blend: What Blending Theory adds to Metaphor Theory

As Lakoff and Johnson (1980) described it conceptual metaphor refers to the understanding of one idea or conceptual domain, in terms of another. It is a cross-domain mapping, taking elements from one domain and applying them to another (Figure 5.7).

The conceptual domains hypothesized in conceptual metaphors have two main roles: source and target. For example, English expressions like “My computer is a desktop”, which could imply a desktop metaphor of a PC.

‘Desktop’ is the source domain from which we bring metaphorical expressions (e.g., My computer is a desktop).

‘My computer’ is the target domain that we try to understand and experience (e.g., My computer is a desktop).

This is a typical example where the conceptual blending makes for further understanding of conceptual metaphor. There are significant contributions that Blending Theory adds to conceptual Metaphor Theory. The first contribution is its account of emergent structure.

“My computer is a desktop” offers the primitive material for understanding new concepts. However, it does not directly indicate “a desktop interface of a PC.” The desktop metaphor of a PC is actually a newly emergent space.

Figure 5.7 Cross-Domain Mapping and Cross-Space Mapping (based on Imaz and Benyon, 2006)
The second contribution of Blending Theory is its account of metaphoric projections in the integrating process, which describes how the process of integrating or blending occurs, and how the blended emergent space results in the process. The present thesis places Blending Theory and Metaphor Theory in a complementary relation. Blending theory could contribute through exploring future blending, which may result from flexible integration with newly emerging media, while the conceptual metaphor is relatively static.

According to Imaz and Benyon (2006), “if the metaphor is a cross-domain mapping, taking elements from one domain and applying them to another, then blending is an operation that is applied to two input spaces, and which results in a new, blended space” (p.43). Blending is the ability to take two mental spaces, and connect them in certain ways such that a blended mental space emerges, and this is also the ability that gave rise to art, science, and language (Fauconnier & Turner, 2002). The concept of mental space refers to partial cognitive structures that emerge when we think and talk (Fauconnier, 1997). According to Fauconnier (1997), there is a process of mental synthesis where previous experiences, cultural contexts and historical events are brought to act in the form of frames or schemata, in between language and the real world. Mental spaces are set up and built on through many sources. ‘Connectors’ link mental spaces to one another (Figure 5.8). A mapping between an element of one space and one or more elements of another is established by a connector.

Figure 5.8 Generic space and Blended space (based on Imaz and Benyon, 2006)
As shown in figure 5.8 using standard figurative representations originally used by Fauconnier and Turner (2002), connectors map elements from both spaces, a source mental space and a target mental space. Mental spaces are established, structured, and linked to other spaces (Figure 5.8). Blending works as follows (Figure 5.8):

1. **generic space**: reflects abstract structure and organization shared by the inputs, and defines the core cross-space mapping between them.
2. **cross-space mapping**: elements and relations between two input spaces are connected.
3. **blend**: it is a new emergent structure not provided by the inputs.

Conceptual metaphor and conceptual blending are both about the idea of projection of structure between domains, but since conceptual blending is focused on new conceptualizations, the newly emergent space is often different from the real world we normally experience. The gap between a user and an interactive system, so that users still struggle to use or understand newly released systems even though technologies have been evolving steadily, can be seen as caused by this issue.

### 5.3.4 Desktop Interface as Blend

The WIMP-based GUIs have become a blend rather than a metaphor, since the notion has become a new emergent space (Imaz & Benyon, 2006) – a thing in itself as far as cognition is concerned. Figure 5.9 shows how blending works with the PC desktop.

- Two input spaces exist, input space-1, input space-2 and the solid lines indicate a cross-space mapping that connects elements and relations between the inputs. The two principal inputs have different organizing frames. Input space-1 refers to the frame of traditional computer operations, and input space-2 refers to the frame of office work. The dotted lines refer to connections between inputs and either generic or blended space.

- A generic space maps onto each of the inputs and contains what the inputs have in common, which reflects some more abstract structure and organization shared by the inputs.
Blended conceptual space is an emergent conceptual structure with new ideas and insights. The emergent property of the blend provides direct manipulation and access.

In the interfaces using the ‘desktop metaphor’ with direct manipulation and access, the grasping, releasing, and opening of an object are imitated by dragging, dropping, and double clicking on perceivable icons, objects and folders on the virtual surface. These are new emergent functions that exist neither in the real world nor the domain of computer operations. They appear in the blended conceptual space. Because of this newly emergent space, the experience is very distinctive from physical experience in everyday life.

We can clearly experience the gap between the new blended space and our physical world of action. For example, as Imaz and Benyon (2006) suggested also, a computer window in the blended space is different from a real window and a menu on the space is different from a menu in a restaurant. Therefore, users often encounter a physical-virtual gap that disrupts the flow during activities that require a changeover between the physical and the virtual. They are forced into conscious effort to access information and carry out intentions.

Figure 5.9 PC desktop as blend
However, the WIMP based GUI with desktop metaphor has been affected by a long process of evolution. We no longer see a menu on a desktop interface as a restaurant menu (Imaz and Benyon, 2006).

In the process of designing HCI, applied user observation techniques based on working more closely with users have been introduced, which include qualitative research techniques such as ethnographic studies, participatory design that directly observes users’ behaviour and the environment across a number of people who use products, who tell stories as users, who use a particular product. However, designers following the user-centred principles have often designed complex, confusing systems. In fact, while the usability, accessibility and understandability of the systems have improved, the complexity of the products still remains high. There exists an embodied gap between the designer and the user.

5.3.5 The Notion of Blended Reality Space
On the basis of blend theory, Blended Reality Space is described (as in Figure 5.10) as a new emergent experience space that is immersive, interactive and body-movement oriented, and where there will be less or no conscious effort of access to information. The user perceives and acts directly, as in everyday life unmediated activities.

![Figure 5.10 Blended Reality Space](image-url)
We see the first examples of this in some commercial games that have been applied to training people with sensorimotor disorder or with cognitive dementia. In typical examples of both Nintendo’s Wii™ (Nintendo Inc., Kyoto, Japan) and some video-capture games, the players have no direct physical connection with the game environment. Their physical movements are detected by either the ‘Wiimote’ (the Wii remote control) or by a camera. Body movements performed by players are generally in response to game-initiated events. When their free body movements in physical space are tracked and used as inputs to the game, a truly merged physical/media space may be created during play, a clear example of Blended Reality Space. This interaction style is formed in the harmony between the physical and the virtual, utilizing tangible interaction.

In a true blending of the physical and the virtual there will be no gap between the emergent virtual/physical space of technology and the physical world (Figure 5.10). Based on the people, activities, contexts, and technologies framework for HCI introduced by Benyon, P. Turner, and S. Turner (2005), Blended Reality Space can be described as in Figure 5.11.

Blended Reality Space is about harmonizing these four elements within domains. True blended reality space will release human actions from physical constraints and the physical-virtual disruption, and provide natural a flow of actions, equivalent to those in the physical world.

![Blended Reality Space Diagram](image)

Figure 5.11 Blended Reality Space Based on the people, activities, contexts, and technologies framework for HCI.
Achieving true blended reality will not be easy, for many reasons - not least the singularity of physical space and the multiplicities of the virtual. In current, partially blended gaming spaces, there exists the potential to give players a more immersive and physically challenging gaming situation, which can be expected to also produce a strong psychological feeling of presence (the perceptual illusion of non-mediation; Lombard and Ditton, 1997) within the merged space, since the technology effectively disappears from attention. This in turn may facilitate players' performance and maintain motivation and interest in the game (Lombard & Ditton, 1997).

5.3.6 Tangible Presence

Tangibility in the HCI literature is described as being built upon sophisticated skills situating digital information, to varying extents, in physical space. But the approach is subject to our current limited abilities to represent changes in material or physical properties of objects and spaces (Hoshi et al., 2009). We often find a lack of tangibility in our everyday lives with digital artefacts. At the same time, our everyday lives are increasingly pervaded with digital information from environmentally built-in media devices such as high definition displays, automated systems and sensor-based environments. Further, information surrounding us is often displayed in the periphery as well as to the focus of our attention. It is vitally important that the emerging trend towards tangibility is provided using the most appropriate combinations of the physical and virtual. I believe this to be especially true for people with special needs in their everyday lives, and this is the main motivation for our work in this area. Optimal combinations of tangibility and evoked presence carry the potential to make full use of, while not overburdening, the flexible but limited capacities of selective attention; this will be a key issue for the design of future interaction approaches, what I call Tangible Presence in Blended Reality Space (Hoshi & Waterworth, 2009).

The notion of Blended Reality Space was previously introduced as an interactive blended reality environment where the physical and the virtual are intimately combined and affect each other. Through this physical-virtual combination, the physical objects provide users with clues about the virtual environment and help them develop skills in their environment, such as picking up, positioning, altering, and arranging objects (Ishii, 2008). This definition provides a common understanding of the concept, but it does not
identify the factors influencing the perception of a virtual experience as a physical experience, nor does it describe the exact nature of the experience, which is generally called Mediated Presence.

Various scholars have debated the definition and value of the concept of presence. Presence in general is described as the perception of a virtual experience as a physical experience. An extension of the sense of self identity is described as Self-presence, and is seen as the extent to which a participant feels a virtual representation of self to be accurate (Lombard & Ditton, 1997; Ratan et al., 2007). Witmer and Singer (1998) suggested that “presence is the extent to which a participant feels a virtual representation of self to be accurate.” Even though presence is not constrained to high technology situations (at least, we may feel quite high presence when reading books or watching movies; e.g. Ratan et al., 2007), it has become closely associated with VR and other advanced media. This is sometimes described as the experience of ‘being there’ in a mediated environment. As Ijsselsteijn and Riva (2003) pointed out, as “media becomes increasingly interactive, perceptually realistic, and immersive, the experience of presence becomes more convincing.” However, since information and communication technology become more pervasive in such built-in environment as video screens, electronic access systems and smart sensor techniques, the effectiveness of interactive mixed realities has been linked to the sense of presence as judged by users of the space (Bernardet et al., 2008). What does blended reality space contribute to the experience of presence?

The presence parameter may vary according to several factors, including the available technology, the required use, and the context of use. Effective interactive systems for collaboration will work by creating harmony through using appropriate contexts and thus create optimal presence states. Contextual cues about colour, material, shape, size, texture, and weight configuration of the physical object provide improvement in a blended reality environment. Haptic feedback helps users feel a degree of tangibility, a convergence between the physical and virtual. But while haptic feedback can contribute, tangibility is more than just haptics.

Many researchers have experimented with sensor-based techniques for interacting with virtual entities via the manipulation of physical objects in space. Such interaction concepts are often termed ‘tangible’ and have been
frequently discussed in the HCI literature. The main idea of such a tangible interface, built on movement and position sensing techniques, is to provide physical forms which serve as both representations of and controls to digital information. A pioneer of Tangible User Interface (TUI), Ishi and his research group have introduced a number of “the applications that make the digital information directly manipulable with our hands, and perceptible through our peripheral senses through their physically embodiment” (Ishii & Ullmer, 1997; Ullmer & Ishii, 2000). The effects of tangibility on presence have yet to be fully studied and explicated.

Activity theory provides a tool to explore how the experiential-practical dichotomy can be unified, and to understand the notion of the natural flow of action between the emergent virtual/physical space of technology and the physical world. Activity theory helps understanding the integration of consciousness and activity (Nardi, 1996). Activity theorists claims that:

“consciousness is not a set of discrete disembodied cognitive acts (decision making, classification, remembering), and certainly it is not the brain; rather, consciousness is located in everyday practice: you are what you do. And what you do is firmly and inextricably embedded in the social matrix of which every person is an organic part.”
(Nardi, 1996, p.7)

Leont’ev (1981) defined a hierarchical framework of activity, which is made up of one or a combination of actions/tasks. Actions are performed by a combination of operations. These three levels correlate with the motive, goals, and conditions respectively (Kaptelinin and Nardi, 2006).

As illustrated in Figure 5.12, the activity is, as an example, keeping fit in everyday life. Then, the motive can be expressed as – e.g. being better through healthy life. The activity is then translated into actual behaviours through a set of actions – e.g. playing wii tennis. Each action is performed with conscious thought and effort, planned and directed towards achieving a goal (Marsh, 2003) – e.g. moving the whole body. The actions are developed through operations – e.g. hitting a virtual tennis ball. The operations are directed by some conditions such as specific restrictions and affordances associated with a given tool (Riva, 2005) – e.g. weight, texture, and size of the tennis racket.
‘Conditions’ can be identified as the surroundings, circumstances, environment, background, or settings, which constitute of subtle cues such as weight, texture, smell, airflow, sound, light and so on. ‘Conditions’ contribute to potentiate sensory experience in which players unconsciously behave without abstract explanation. If appropriate sensory experience is provided for players, higher presence would be expected.

On the other hand, an immersive gaming experience would not be expected when players are over conscious of what happened in the past and what can be expected to happened in the future. In this situation, players are exposed to conceptual experience that arouses conscious mental behaviour expressed through abstract information and an imagined body.

There is an experience that takes place in the external world of the present, neither in the past nor in the future. This is called perceptual experience or core presence, which is a group of sensations unconsciously preserved and integrated by concepts, which provides it the quality of being able to capture the current moment of attending to the here and now (Riva et al., 2004). In this situation, players become harmonized to things that all of them end up doing without really thinking. Their bodily involvement with perceived objects and perception of objects are integrated. It is vitally important that sensual, perceptual and sensory aspects are well balanced and integrated in an appropriate manner, so that players are emotionally and intellectually engaged in a gaming situation and a high degree of presence can arise.

In a Wii tennis situation, using a racket is the natural way of playing tennis, because we use a racket on a physical tennis court and we know how to use a racket and hit a ball experientially. In the game situation the player has already became well practiced and experienced without explicit user
manuels or oral guidance. Normally, the user of such embedded devices as mobile phones, computer applications, and medical devices needs an early stage of learning to use a tool/device, performed with conscious attention (Kaptelinin & Nardi, 2006, p.63).

The physical racket fills the gap between the physical and the virtual world. The conditions of weight, texture, and size of the racket with sensor based interaction techniques help in increasing the experience of being there in the blended reality space. The quality of actions and the strength of presence are correlated. The experience of presence allows feedback to the subject about the physical sensation of its activity within the state of which the activity is performed (Riva, 2005). If a designer provides effective tangible presence for ‘Users’, then ‘Users’ will disappear. Human and user will be unified without boundary. The experiential-practical dichotomy is actually blended.

Perhaps it is not a surprising phenomenon that using a tennis racket creates higher presence in a simulated tennis game. But designers tend to ignore the details of everyday life object and behaviour, and try to provide users with different experiences from previous experiences. For example, Wii tennis is actually not usually played with a tennis racket, but only with the Wii-mote device. In another words, designers have provided new aspects that inevitably interrupt the natural flow of action by provoking conscious attention, at least initially. But I believe that small and apparently minor objects and behaviours in everyday life are, in fact, hidden resources for creating a harmonious accord of humans and things in interaction design.

In the next chapter, an experimental study examines in more detail the nature of the embodied experience underlying the hierarchical structure of activity shown in figure 5.12.
Chapter 6: An Experiment on Tangible Presence in Blended Reality Space

6.1 Introduction
As I already mentioned, Blended Reality Space is an interactive blended reality environment where the physical and the virtual are intimately combined. Through this physical-virtual combination, the physical objects provide users with clues about the virtual environment and help them develop skills in their environment, such as picking up, positioning, altering, and arranging objects (Ishii et al., 2008). This definition provides a common understanding of the concept, but it does not identify the factors influencing presence, nor does it describe the exact nature of the experience.

What aspects does blended reality space contribute to the experience of presence? Motivated by this question, this section describes below an experimental study that examined three key factors in the way blended realities may be implemented:

(i) the extent to which tangible tools play a role in interaction; (ii) whether a first person or a third person perspective is provided from the user's point of view; and (iii) if a third-person perspective (of a self-representing avatar) is used, how closely the representation matches the appearance of the user. The present experiment focuses on the effect of these variables on rated presence (Lombard & Ditton, 1997) and self-presence (Ratan et al., 2007).

6.2 Hypotheses
The study used the Nintendo Wii video game and console, commonly available and widely used technology that can provide a satisfying and involving gaming experience even with relatively inexpensive technology, including computer graphics with quite low resolution. Based on earlier findings, we arrived at the following hypotheses listed in Table 6.1.

A number of researchers have experimented with sensor-based techniques for interacting with virtual entities via the manipulation of physical objects in space. Such interaction concepts are often termed ‘tangible’ and have been frequently discussed in the HCI literature. The main idea of such a tangible interface, built on movement and position sensing techniques, is to provide physical forms which serve as both representations of and controls to digital information.
The applications make the digital information directly manipulable with our hands, and perceptible through our peripheral senses through their physically embodiment (Ishii, 2008; Ishii & Ullmer, 1997; Ullmer & Ishii, 2000). The effects of tangibility on presence and self-presence have yet to be fully studied and explicated, but our expectation was that a physical tool would enhance the sense of presence (*Hypothesis 1, 2*).

Avatars provide a concrete representation of the player’s actions and identity (Borberg et al., 2008; Castranova, 2003; Becker et al., 2001). It can be expected that there would be both higher presence and self-presence when the avatar resembled the player more accurately. It can also be expected that using a tool with either kind of avatar would produce higher presence than not using a tool (*Hypothesis 3, 4*).

A 1st person perspective duplicates the natural view of ones own actions by providing interaction with the blended reality space as if from the players’ own physical viewpoint (Waterworth & Waterworth, 2008). With a 3rd person perspective, they see their own representation as an avatar whose bodily movements reflect their physical movements in real time (Waterworth & Waterworth, 2008). Because of this difference, we expected a stronger feeling of presence to be elicited with a 1st person perspective (*Hypothesis 5*).
6.3 Method

To test these hypotheses, we created several different versions of blended reality space, based on the Nintendo Wii gaming environment, its wireless movement-sensing Wiimote interaction device, and a 60” plasma display (as shown in Figure 6.1). For the present study, the simplest avatar-oriented game from various Wii games was chosen: Wii tennis (3rd person view) and Kororinpa (1st person view).

Wii tennis requires a swinging motion of the handheld Wiimote to hit the virtual ball, while Kororinpa requires more delicate hand movements of the device to guide a marble through virtual mazes.

For the tangible (with tool) conditions we embedded the Wiimote in a physical tennis racquet or maze board (Figure 6.1). For the no tool conditions the Wiimote was worn in a glove on the back of the participant’s dominant hand (Figure 6.1). In the third person view conditions, the avatar used was either the pre-supplied one (identical for all participants) or was one designed by each participant to resemble himself or herself, known as a Mii. Miis are customizable and allow the participants to capture a likeness or caricature of themselves, or others (Figure 6.1).
16 participants (20 to 65, average age 37 years) volunteered and took part in the study. All participants experienced all conditions in a within-subjects experimental design. We used this type of design because of its high sensitivity to treatment effects, given the high variance between subjects on this kind of game. It was also felt that playing several different games in one session has more validity than focusing on only one, since a higher level of interest and attention is maintained. The danger of sequence effects influencing the results was avoided by carefully balancing the order in which individual subjects experienced the different conditions.

After each game in the various conditions, the participants filled out a questionnaire regarding their feelings of presence and self-presence. Subjects were asked to rate each question on a scale from poor to excellent, which were translated by the experimenter into a numerical scale from 0 to 5. T-tests were used in order to compare the means of the dependent variable scores. The questionnaire consisted of 28 questions, which in aggregates correspond to six factors thought to be correlated with presence and self-presence: Awareness, Immersion, Involvement, Naturalness, Realness, and self-presence. We partially based this on the presence questionnaire published by Witmer & Singer in 1998 (Hoshi et al., 2008).

### 6.4 Results and Discussion

As predicted, there was significantly higher presence when using a tool versus no tool for both 1st and 3rd person perspectives (p < 0.005, paired T-test). But there was no significant effect on presence of playing from a 1st person versus a 3rd person perspective for either tool or no tool. There was also no effect on presence of playing with an avatar similar versus dissimilar to self. Figure 6.2 shows that using a tool strongly affects rated presence for both 1st and 3rd person perspectives.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Hypothesis</th>
<th>Result</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tangibility (Tool/No-tool)</td>
<td><strong>Hypothesis 1:</strong> Participants who use a physical tool will feel more presence than participants who use only their body as a tool, with both 1st and 3rd person perspectives.</td>
<td>Supported</td>
<td>0.05 &lt; 0.001</td>
</tr>
<tr>
<td>Identity (Similar/Dissimilar)</td>
<td><strong>Hypothesis 2:</strong> Participants who use a tool will feel more self-presence than participants who use their body as a tool for both an avatar similar and dissimilar to self.</td>
<td>Rejected</td>
<td>0.05 &gt; 0.336</td>
</tr>
<tr>
<td>Perspective (1st/3rd person)</td>
<td><strong>Hypothesis 3:</strong> Participants who play with an avatar similar to self will feel more presence than participants who play with an avatar similar to self.</td>
<td>Rejected</td>
<td>0.05 &gt; 0.0004</td>
</tr>
<tr>
<td></td>
<td><strong>Hypothesis 4:</strong> Participants who play with an avatar similar to self will feel more self-presence than participants who play with an avatar dissimilar to self.</td>
<td>Supported</td>
<td>0.05 &lt; 0.0004</td>
</tr>
<tr>
<td></td>
<td><strong>Hypothesis 5:</strong> Participants who have a 1st person perspective in the game will feel more presence than with 3rd person perspective both with a tool and without.</td>
<td>Rejected</td>
<td>0.05 &gt; 0.563</td>
</tr>
</tbody>
</table>

Table 6.2 Results: Effect of tool, perspective and avatar on Presence and Self-presence
There was, however, a highly significant increase in self-presence when playing with an avatar similar to self versus dissimilar to self (p < 0.001, paired T-test), but no effect of playing with a tool versus no tool. Figure 6.3 shows that avatar similarity strongly affects self-presence.

Figure 6.2 Using tool: Significantly higher presence for both 1st and 3rd person perspectives

Figure 6.3 Avatar similarity: Highly significant difference in rated self-presence
Our findings seem to confirm the importance of incorporating tangible tools in blended reality spaces aimed at eliciting a high sense of presence, but suggest that tangibility has no effect on self-presence. Although a 1st person perspective is of course more natural than a 3rd person perspective on one’s own actions, it did not increase presence, which is an interesting and important finding for the future of blended reality spaces (see also Waterworth & Waterworth, 2008; Kallinen et al., 2007; Ehrsson, 2007).

Some may argue that the number of subjects is one of weakness of the experiment. The present experiment used a within-subjects or repeated measures design, rather than a between-subjects design. Every subject was in every test condition. The comparisons are between the same people in different conditions. This can be expected to result in less variance; less differences in scores between conditions not due to the conditions themselves. One important point is that if we had not had enough subjects, we would be unlikely to have got significant differences between the conditions.

A real weakness of the current experiment is that we used different games to instantiate the different points-of-view: first and third. There could be alternative explanations for both significant and non-significant findings here, relating to the characteristics of the particular games used rather than viewpoint.

The results suggest that 1st person perspective did not provide feeling more presence than 3rd person perspective both with a tool and without. The most importantly, this experiment highlights that tangibility (using a physical tool) creates higher presence than without tool, with both 1st and 3rd person perspective. Therefore, perspective is not important in this regard.

More valid and generalizable results will be produced from future research using one game that provides the possibility for varying viewpoints. We therefore see our results as merely suggestive of the notion that a first person view may not always be necessary for high presence. This suggestion is consistent with recent findings (Ehrsson, 2007; Lenggenhager et al., 2007) from more thoroughgoing experimentation on ‘out-of-body’ experiences (essentially, third person viewpoint experiences of self).

Similarity of the virtual representation of self strongly affected rated self-pesence, but did not affect presence (see Ratan et al., 2007; Bailenson et al., 2001). Ratan et al. (2007) also found that participants who used a Mii dissimilar to themselves reported significantly less self-presence than
participants who used a Mii similar to themselves, but feelings of presence were unaffected by character assignment. Our results therefore confirm those of Ratan et al. (2007). Baillon en et al. (2001) found an effect such that subjects indicated more willingness to commit acts in front of an agent similar to themselves than in front of an unfamiliar agent.

In our experiment, subjects created their own avatar (Mii), in their own likeness, or were given a standard default avatar. Designing one's own avatar can be expected to strongly affect the sense of attachment between a subject and their avatar. This could have been avoided by having the experimenter design the user-similar avatar based on photographs. This would have been a better test of the importance of perceived similarity. The current experiment could be seen as looking at the effect of ownership, confounded with similarity. These may have quite different effects, and it would be valuable in future experimentation to independently vary similarity and ownership to tease out any different effects. For example, it would be interesting to investigate whether or not one would feel less self presence with a self-designed, but deliberately dissimilar avatar than with an objectively accurate rendering provided by the experimenter.

Concerning the role of tangibility, it should be remembered that using a racket is the natural way of playing tennis on a physical tennis court. In the game situation, the physical racket, as physical object, seems to work to bridge the gap between the physical world and virtual world, and increases the feeling of presence. It could be argued that if a game environment does not require such a physical tool, the effects of tangibility on presence may be lacking. While this was not tested in the current experiment, we would emphasize that tangibility is not the same as tool-ness. Even in a game where there is no obvious tool - say, a running game - if the game achieved a convincing blending of the physical and the virtual, we would expect a high level of presence to be elicited. For example, in the situation where the game player feels uphill resistance, wind movement, and so on, physical forces. Tangibility is not limited to using tools, and we see no reason to expect that its effect on presence will be so limited either.

6.5 Implications
Although not conclusive, as discussed above, presence and self-presence appear, on the basis of our overall results, to be quite unrelated phenomena. The latter may be more important for social presence than individual
presence, which suggests a tension in providing for both - but also gives hints for a nuanced approach to design.

The results will also contribute to the design and implementation of strategic combinations of tools, perspectives and avatars for various application scenarios. These findings will, for example, be incorporated into design principles to develop free movement based interactions for motor rehabilitation (Sandlund et al., 2009) as well as blended reality spaces for collaboration between hospitals, care organizations and the home. These works will be explored in Chapter 8 and 9.

The present study has focused on critical issues that will have implications for the future development of blended reality spaces.

Because the concept and study of blended reality space is an emerging area, combining both HCI and presence research, new dimensions and a coherent group of methods need to be incorporated. Further alternative ways of observation, description, analysis, modeling and design need to be carefully explored. I believe that the human-experiential approach to design and research will contribute to pursue the alternatives.

Through the present study, several salient issues for future research have been identified. First, the study has realized that a new framework for understanding and manipulating the contextual influences that affect interactive systems and the users needs to be developed. Second, measuring degree of presence and examining the computer-generated environments simply as virtual realities is inherently limited. The need to investigate the factors influencing presence in new blended reality spaces will become ever more critical. Finally, exploring new methods of usability assessment to identify the factors that are responsible for the experience of presence in blended reality space such as ambient environment will be crucially important. An adequate new method will help in designing better implementations and installations for real (actual) environments.
PART IV: Exploring Human-Experiential Design in Specific Practical Contexts
Chapter 7: The potential of HXD to Bridge the Context Reality Gap in Healthcare

7.1 Introduction

There are growing needs for communication and collaboration on different managerial and operational levels in healthcare. This chapter suggests a practical solution for healthcare collaboration and provides an intersectional approach to go beyond what is possible today and towards better communication and collaboration tomorrow.

First, this chapter discusses specific issues in communication and collaboration arising from the reality gap between the healthcare domain and the patients, then proposes an overview of HXD to approach problems for which conventional design methods offer no clear solution.

One important phenomenon concerns the fact that more and more patients are treated and taken care of in their own homes instead of in hospitals or specialist care centres (Winge et al., 2005). This fact suggests new types of requirement on the staff and increases the importance of well functioning communication and collaboration between the different caregivers in order to create appropriate care services (Winge et al., 2005).

Additionally the standard interface of the ‘desktop metaphor’, using a keyboard, a mouse, and a small computer screen is so familiar that it is sometimes hard to imagine other approaches. But even though it works well in some situations - such as typical office work - it is not at all suitable in many other situations, and especially not for people with special needs, such as those with mental/physical disabilities and elderly people with dementia who lose explicit and abstract knowledge.

Recent research projects dealing with IT in healthcare have focused on how IT in various ways can facilitate and support improvements of communication and collaboration between such as participants caregivers, the elderly and the disabled (Winge et al., 2005). One important feature of modern communication patterns is their lack of symmetry. The different participants involved in a communication and collaboration are often in different physical situations, which may have very different characteristics. And increasingly, they may be using different types of communication devices. Most of the communication is in an explicit way with conceptual or abstract information. The lack of expression via multiple senses bring
serious problems of misunderstandings and misinterpretations in mediated communication (Waterworth et al., 2006).

In two completely different situations the same explicit message could be interpreted very differently (Waterworth et al., 2006). This suggests that in two or more than two different contexts, mediated communications can more easily be misinterpreted, and this also reveals the contextual reality gap between participants in communication contexts. How can interactive systems effectively help with bridging the contextual reality gap generated between different users’ perceptions in different contexts? To improve quality of the healthcare collaboration with information technology there is a crucial need to share the right information through person to person contact. Also to optimize the collaborative environment with the right information, remotely located participants need the sense of being together with the other people in a shared environment; because of separated locations, the sharing of reality is restricted or concealed.

The above needs could potentially be addressed in several ways, in particular using the right information ‘context’ and creating the sense of being together with other people in a shared mediated environment. By effectively bridging the contextual reality gap, interactive systems could provide the richest communication, thus making it possible to create more effective collaborative environments that enrich the sense of being together with other participants for healthcare in remote locations.

Unlike recent mobile communication with explicit information, it is vitally important to pursue a design approach that originates in the pursuit of the senses for some users and situations, particularly those who have difficulties of using explicit and abstract information.

7.2 Human Experiential Design of Healthcare Technologies

7.2.1 Issues surrounding human-centred design of e-health
Recent modern societies are quite safely equipped with numerous implementations for people’s health, both at health services and in homes. But in practice, these carefully designed medical information systems and products often hardly work at all. This is not due to the technology itself, but rather in design and implementation processes without an appropriate human-centred point of view. For decades, most healthcare system failures
have been due to the lack of true human-centredness, even though e-health technologies have been evolving steadily (Zhang, 2008).

By human aspect of design, namely HXD, ICT-based environments will pervasively penetrate into the everyday lives of the receivers of healthcare. If the technology itself can be designed to disappear from perception in use, users would not be aware of themselves as ‘Users’. This chapter mainly focuses on ‘Design’ as having the responsibility to ensure that humans can fulfil themselves in the world of things (or technology) and expressly points to the importance of designing for humans, and especially for the vulnerable. In the following, the chapter explores and discusses the human aspect of design, and how it can be applied in the healthcare domain.

7.2.2 Issues in communication

In general, contemporary information/communication technology has broken through boundaries between cultures, societies and even political systems, but has not yet overcome the communicational boundaries that arise from a lack of shared understanding, a contextual reality gap. Understanding how people really are is difficult in cross-cultural communication. We unfortunately tend to blame ‘people of different cultures’, for their apparent “stupidity, deceit, or craziness” (Hall, 1959, ix) when it is actually obvious that we often just don’t understand people of different contexts.

How can interactive systems effectively help with bridging the reality gap generated between different users’ perceptions in different contexts? In order to explore where the sharing of reality is restricted or concealed, the present study more closely investigates everyday life communication that creatively and effectively enables mutual understandings between people. Everyday communication contains hidden resources for creating the harmonious accord of people and things in interaction design.

Communication is commonly assumed to involve a meaningful linguistic exchange. However, when we look carefully at everyday-based communication between families, close friends and loved ones, they communicate like a synchronized instrument, each anticipating the wishes of the other, when they make communication without or with little explicit information. Imagine our everyday life, for example, when a child comes home from her/his school, sits on a sofa, has a soft drink with gulping, summarizes her/his feelings about the way things went at the classroom. If
her/his mother wants the details, s/he may have to listen for a while, yet s/he perceives in an instant a significant message about her child, with implications for what kind of evening they are going to spend.

Polanyi (1966) in his book ‘The Tacit Dimension’, introduced what people know but cannot externalize, what he called Tacit Knowledge. The hidden meanings contained in the silence and blank intervals are manifest in our sensory perception. Communication relies on how well people provide and utilize the ‘empty space’ so they flexibly make own images to fill the spaces in their sensory perception, and how well we accept the images of each other.

Empty space is an important component of communication. It has a multiplicity of meanings and signifies both temporal and spatial principles, an interval of space and time. It can be the specific time that characterizes the interval of music or dance (Hosoe et al., 1991). It exists in the visual arts, architectural and urban environment as well. For example, space itself is perceived entirely different between cultures. In some cultures, especially Japanese culture, spaces are perceived, named, and even revered as the ‘MA’, or intervening interval. In western culture, mainly, people perceive the objects but not the spaces between (Hall, 1969). They pay attention to the object-arrangement. In contrast, in Japan, it is the arrangement of the spaces, the interval (Hosoe, 1991) that is most salient. Many scientists, architects, space designers, communication designers and artists have paid attention to this phenomenon (Hosoe et al., 1991; Hall, 1969; Hara, 2009). The empty or interval time and space opens and closes, swells and contracts. It gives us new ways of solution, creation and communication with constant attention to the use of space as though it gave abilities with no restraint of functional flexibility (Hosoe et al., 1991). Recently interaction designers have paid greater attention to ambient information in everyday life. For example, people also communicate with the natural sources of ambient information to interpret how things are around them in everyday life. This communication is not linguistic conceptual exchange, but people intuitively interpreting what is of value for their purposes in their current environment and trying to become harmonious with it in everyday life activities. Apparently, “this ability to convey ideas does not transfer well to humans interacting via computer” (Dey, 2001). Communication and collaboration through conventional computer and telecommunication systems diminishes the qualities of interaction that produce a sense of directness and richness, because of their limited capacity to convey a reality with contexts shared
between users (Hoshi & Waterworth, 2008). Context is an important source of information in designing interactive systems, however not yet effectively utilized (Dey, 2001; Salber et al., 1999). In the following section, a conceptual framework for managing, structuring and composing contexts in designing interactive systems, a new approach this thesis refers to as the Contextual Reality Framework, will be proposed.

7.2.3 Context and Contextual Reality

I previously discussed a meaningful communication with frequent use of ‘emptiness’ that largely lies in context. As already mentioned in Chapter 4, Hall (1969) has described this phenomenon with a different term, high-context communication where “the communication or messages is one in which most of the information is either in the physical context or internalized in the person” (p.91), whereas low-context communication is where the information is vested in the explicit code explained through words and verbalization, just as two lawyers in a courtroom make a trial. The closer the relationship the more high-context communication arises, drawing on shared meaning. But how do we derive ‘meaning’ from the empty space internalized in the person, while the coded, explicit, transmitted part of the message conveys very little? Figure 7.1, based on the hi-low context continuum originally proposed by Hall (1976), represents our concept of the Contextual Reality Framework and shows how emptiness and meaning have a strong relation established through this communicative process.

Figure 7.1 Contextual Reality Framework
In general, context refers to the conditions in which a communication exists that make its meaning understandable. Meaning, hence, can be clarified by such contextual cues as the surroundings, circumstances, environment, background, or settings. More specifically, subtle cues such as weight, texture, smell, airflow, sound, light and so on contribute to context. A contextual cue is a catalyst that facilitates creativity through sensory experience. According to Krippendorff (2006), “Sense is the feeling of being in contact with the world without reflection, interpretation, or explanation” (p.50). Naturally synchronized communication in everyday life largely relies on the unconscious affirmation of the sense of being filled up and of filling up an emptiness with contextual cues.

Perceptual experience is a group of sensations automatically retained and integrated by concepts, which gives it the ability to capture the current state of being in a world. It takes place externally, in the present, the here and now, neither in the past nor in the future (Riva et al., 2004). Our bodily involvement with perceived objects and our perception of objects are inseparable. We become harmonized to things that all of us end up doing without really thinking. It is meaningless to think of mind, body, and context separately.

Conceptual experience is based on information processing such as problem-solving, analysing, thinking what happened in the past and what can be expected to happen in the future (Riva et al., 2004). It invokes conscious mental behaviour expressing with verbal communicating and an imagined body. It is the process of mental realization including sense, perception, memory and even judgment. Hence, it is not easy to make a clear distinction between sensory, perceptual and conceptual experience. They should be integrated appropriately in a particular situation.

Lakoff and Johnson (1980) pointed out that “It is as though the ability to comprehend experience through metaphors were sense, like seeing or touching or hearing, with metaphors providing the only ways to perceive and experience much of the world” (p. 239).

Substantial information is not only to be found in such explicit information as words or texts. People sensorily feel it with their bodies. Krippendorff refers to Gibson’s ecological approach to perception that “The process of constructing the meaning relies on the human ability to act so as to change an existing sense to a preferred one” (p.53). This thesis suggests that the elderly person comes to understand implicit information in the
empty space and distinguish the hidden meanings contained in it. Studies show evidence that elderly people with dementia still maintains implicit skills (Zacks et al., 2010; Schacter, 1987; Benjamin et al., 1994).

What it comes down to is that the elderly person intuitively interprets what is of value for their purposes in their current environment and tries to become harmonious with it in everyday life activities. Contextual-emptiness does not mean communication-lack or nothingness. Rather, it indicates a condition that will likely be filled with the contextual cues they prefer. It activates users’ creativity and instils meaningful communication between them.

This approach does not require users’ forcible reasoning to interpret information. By looking at an empty vessel, not as a negative state, but in terms of its capacity to be filled with contextual cues, the risk of a reality gap will be reduced. The sharing of meaning, usually restricted or concealed because of limited capacity of conveying explicit information, will be released. However experimental studies need to be conducted to investigate how the sources of contextual cues are suited for the situations in the sharing of meaning through mediated communication within emergent virtual/physical space, so that they make possible a natural flow of action without being distracting. That means the contextual reality gap has been effectively bridged. However, critical issues have arisen through the present practice. For example, user observation is important for design. But, since we cannot observe others’ senses, we have no direct access to the meanings they construct and no direct way of knowing why they see the world as they do (Krippendorff, 2006). The gap between designer and user is, in most cases, a product of this issue.

7.2.4 Bridging the Contextual Reality Gap
Many specific domains, for example those of nurses, doctors and management people in healthcare, require abstract and objective data, with explicit expression.

In contrast, their patients and clients - elderly people with mild cognitive impairment - have different needs and characteristics. It is known that they retain concrete implicit skills even as they lose explicit, abstract knowledge and skills. There is a contextual reality gap between people at home and professional people in the healthcare domain (figure 7.2).
The needs of dependent old people and their carers, as primary and secondary end users, should be considered carefully, but the focus on the elderly as primary user has to be kept central. The primary users normally have difficulties dealing with explicit knowledge and memory such as understanding texts, making inferences, encoding information into memory, and retrieving information from memory. Contrarily, other mental processes show little or no decline with age.

The secondary users caring for the elderly, such as family members or close friends need to actively connect to the network and access information on the person’s well-being and activities (if approved by the elder) to get a picture of the elderly person’s state. They also need to be informed about subjective states and activities of the elder to allow for a much better tailored and timely response.

A potential approach would be to use sensor technology to monitor the sender’s state directly through the availability of the present external situation, visual features of the surroundings and the periphery. Such information could be presented to the receiver in a variety of different forms, and transmitted as embedded information to any form of communication (Hoshi & Waterworth, 2008). As a concrete example, our current project, AGNES: user sensitive home-based systems for successful ageing in a networked society (funded under the Ambient Assisted Living (AAL) Joint programme) will be presented in Chapter 8.
Disciplines have used the term context-sensitive or context-aware interactive systems (Jung & Sato, 2005; Berg, 2005; Dey et al., 2001). It is, in our view, to explore strategies and methods of how contexts are composed, how contexts are structured, and how contexts are described in a way to maximize whole system performance. The present thesis attempts to explore how the contextual reality gap can be bridged effectively in the sharing of meaning through mediated communication within *Blended Reality Space*. This is a more human aspect of design, more human scale.

It is vitally important to pursue innovation that originates in the pursuit of the senses. It is the pursuit of human senses to evoke the animating force of innovation with scientific progress. Unlike the nature of developing ‘conceptual synthetic knowledge’ often constructed by modern internet users, whoever they are and wherever they may be in the world (Hara, 2009) represented as recent popularized social networking services (SNS), we need to reconsider the complexity and profundity of information and communication quality perceived with active use of our senses. The human-experiential approach to design attempts to integrate action and meaning, in combination with the creation, manipulation, and sharing of meaning through interaction precisely engaged within blended reality space. It would come true if tangibility and evoked presence are appropriately incorporated into a practice.

Recently, in the field of design, profound research into sensory perception has been carried out, allowing for the establishment of a new disciplinary field merged with, for example, cognitive science, presence research, neuroscience, and information and communication technology. There will come into existence a new innovation opportunity integrating ‘tangible presence’, with ‘design’ and ‘science’.

### 7.2.5 Human-Experiential Design for E-health

The next two chapters explore how HXD can make it possible to smoothly blend perception and action, and apply it to the nature of designing embodied interaction. The concept of Tangible Presence in Blended Reality Space is applied to develop home-based systems for the physical and psychosocial well-being of elderly people, as well as for young people in need of physical rehabilitation.
Chapter 8: The case of AGNES

8.1 Introduction
This chapter explores how HXD can make it possible to smoothly blend perception and action, and apply it to the nature of designing embodied interaction. HXD would then also make it possible to realize an ideal in which our activities are characterized by a natural flow of action, without any intrusion from technology, from the physical-virtual divide. Tangible Presence in Blended Reality Space can, for example, be applied to develop home-based system for the physical and psycho-social well-being of elderly people. The approach attempts to practically (HCI) and experientially (Presence) capitalize on implicit skills by utilizing real world objects that people are familiar with. The experiential approach is ideally suited for age-related critical situations.

8.2 Designing for the elderly

8.2.1 Universal, retained skills
Park (1992) has described age-related decline in cognitive function. For example, elderly people normally have difficulties dealing with explicit knowledge and memory such as understanding texts, making inferences, encoding information into memory, and retrieving information from memory. Contrarily, other mental processes show little or no decline with age. Recent notable approaches try to improve cognitive function by exploiting intact cognitive process such as implicit memory (Ballesteros, 2004, 2007, 2009), which refers to “memories from prior experiences revealed by performance effects in the absence of deliberate recollection” (Zacks et al., 2010, p.305). Elderly people with mild cognitive impairment and dementia retain concrete implicit skills even if they lose explicit, abstract knowledge and skills. They are still capable of using and being influenced by their past knowledge, whether they are aware of it or not. This is an automatic or unconscious form of memory (Schacter, 1987; Benjamin et al., 1994). They have knowledge that their muscles physically remember, for example, but explicit sources of knowledge such as a user’s manual, verbal assistance, and so on, are unsuitable for them.

Designing simple and adequate representations for peripheral media using tangible objects is a key part of developing better combinations of the physical and virtual. The tangible object in the system plays a role that wakes
up implicit memory in which previous experiences support the performance of a task without conscious awareness of these previous experiences. It has to be designed to link an everyday object and activity that humans remember, for example, how to place fingers on a coffee mug or wear a tie, without consciously thinking about these activities.

### 8.2.2 Issues surrounding the elderly

Increased mobility means that people's family members and friends may be widely dispersed across geographic distances. This has brought an issue that elderly people in modern societies are increasingly living alone and are insufficiently stimulated, both physically and psycho-socially (Waterworth et al., 2009a). This has accelerated cognitive decline. More and more elderly people are suffering loneliness and confusion as a result (Waterworth et al., 2009b). Even though appropriate technology could help ease these problems, older people are actually largely ignored in the design of new information and communication technology, which further contributes to their isolation in a world where everyone else is becoming connected primarily through technology. This situation brings serious concerns and negative impacts on elderly people and on those caring for the elderly, such as family members and health service staff. The potential of new interactive technologies to maintain health and independent living could also improve some cognitive functions in the elderly. Yet only a limited number of experiments has been conducted. What are missing are designs for common technologies that can be used by all people, including the very old.

One trend of recent healthcare is the move of nursing care from traditional hospitals to the patient's home. Elderly people are increasingly treated and taken care of in their own homes. Health services cannot keep up with the demand for home visits and day-care. This puts new types of demand on the staff and increases the importance of well functioning communication and collaboration between elderly people at home, care persons, and close family and friends in order to give better health care.

There are also several challenges to using mobile IT to support collaborations for healthcare in many countries. The use of such mobile technology as small embedded devices, smart phones and laptop computers have been explored to create better collaboration between healthcare and patients at home, to make information accessible in a mobile way, and to explore how mobile technology can be used to enhance healthcare quality.
For example, Koufi (2008) has introduced a grid portal application to assist people who need healthcare at home, which utilized wireless Personal Digital Assistants (PDAs) and gives opportunities to remotely access an automated medical diagnostic and treatment advice system via an adaptive interface. Taylor and Dajani (2008) have mentioned that recent Web technologies convergent with personal health monitoring, affordable broadband fixed and mobile communications, and distributed data storage have the capability to significantly improve the home healthcare. Such advanced technologies as life logging, voice-based search and low-cost sensory monitoring enrich this convergence. Also the elderly share the benefits of social improvements. Through those different technologies and devices, a large amount of information and different types of data from people in their homes has to be communicated and distributed between the collaboration units.

The healthcare domain requires abstract, and objective data, with explicit expression. But elderly people with mild cognitive impairment and dementia retain concrete implicit skills even as they lose explicit, abstract knowledge and skills. Information that people at home can use and data that people at healthcare domain require are thus not easy to unify.

8.2.3 A considered approach
The needs of secondary end users (for example, the carers of the old people) should be considered carefully, but the focus on the elderly as primary user has to be kept central. The primary users could, for example, be provided with a user-sensitive ICT-based home environment that supports a personalized care process by detecting, communicating, and meaningfully responding to relevant states, situations, and activities of the user. So the users might enhance their mental and physical wellbeing with the ICT-based home environment. It should be possible to prevent and manage chronic conditions such as cognitive impairment or dementia by gentle and consistent social stimulation and timely response to detected states, situations or activities, all via appropriately designed technology and communication networks.

Secondary users caring for the elderly, such as family members or close friends would need to actively connect to the network and access information on the person’s wellbeing and activities (if approved by the elderly) to get a picture of the elderly person’s state and to allow for a much better tailored and timely response, attention and care.
8.3 The CASE OF AGNES: Context-sensitive design of a home-based system for physically and experientially well-being of aging

Figure 8.1 is a schematic outline of our approach in AGNES: a context-sensitive home-based interactive system, in which humans utilize background information with ambient media by means of a tangible object but without being disrupted in their foreground tasks. This system is composed of ambient displays, tangible interaction objects and interaction mechanisms and protocols, including gesture detection, which makes for easy-to-use and natural interaction. The tangible object and the ambient display complement each other and provide suitably gentle notifications and other information, and establish communication with connected persons. The human focusing of attention between background and foreground has to be a smooth transition, which makes it possible to achieve a natural flow of actions without awareness. Commonly available technologies such as cameras, motion sensors, and mobile devices are used in order to develop cost effective systems for daily use. Sensors should not be intrusive for the target users. By detecting the users’ states and activities, the system develops appropriate algorithms to classify body pose, and suitable methods to associate the extracted pose information over time with gestures (Waterworth et al., 2009b).
Elderly people living at home also use the system actively by accessing information, sending messages or requesting services.

In AGNES, an ambient display combined with a tangible object in the context of a person’s home form a Blended Reality Space (Figure 8.2), comprising a radically new way to manage social interaction. There should be less of a gap, or ideally no gap, between the blended reality space and the physical world (Figure 8.2).

### 8.3.1 Ambient Display and Tangible Object in AGNES

In everyday life, we pick up natural sources of ambient information to understand how things are around us. For example, people could experientially interpret implicit information from outside the window. A subtle combination of brightness, wind direction and humidity gives us the feeling of the coming rain. The perceptual feeling of a peaceful curtain-wave makes people placid, or people foresee a storm when they see the curtain waving in the dim light of the window, with no explicit information or conscious effort.
Wind has physical force. As Johnson (1987) mentioned, the meaning of force relies on commonly shared structures that come out from our bodily experience of force. We grasp the world around us, namely the meaning of ‘wind force’ from everyday life experiences. Our bodies interact with wind forces that are made up of various natural conditions such as humidity, temperature, darkness/brightness, wind directions, smells and so on. Such interactions between humans and environment expose recurrent patterns. Meaning structures grow out of such patterns.
The AGNES system will generate a variety of ambient media using aspects such as sound, light, airflow, and colour as background interfaces (at the periphery of human sensory perception) to virtual space (Figure 8.3).

The elderly person connected to others through the social networking technology receives information about messages or stories from family members and others transformed into a variety of ambient forms through an I/O unit. For example, the combination of subtle wind and green LED implies notification coming from family members, mid-level breeze and red LED gives important information from them, and strong wind and vivid red LED indicates an urgent message from them.

The ambient display is built on the basis of the blending framework previously discussed (Figure 8.4). First, there is a cross-space mapping consisting of two conceptual inputs: input-space1 is explicit information with current technology-based information displays such as voice/text messages, state-activity reports and notifications. The other, input-space2, is natural sources in everyday life with their sounds, light, airflow, breeze and shadow. Second, the generic space implies some more abstract structure shared by the inputs. Third, blended reality space, a fourth space, is a new emergent structure that provides tangible presence with no conscious effort of access to information.

![Figure 8.4 Ambient display as blend](image_url)
Imagine a situation in the physical world, where an elderly person needs to ask questions of his or her relatives or neighbours. The elderly person may lay a hand on the relative's shoulder, or may knock on the neighbour's door. The tapping and knocking have various meaning of forces. If it is an emergency situation, they may strongly tap relatives or may knock the door severely. The meaning of forces includes patterns of embodied experience that obtain through such sensual experiences as the way of our perception, the act of orienting, the interaction with objects, events, and people.

We sense, interpret and codify various patterns, and understand the meaning of forces in a particular situation. The embodied patterns become shared cultural modes in a particular culture (Johnson, 1987).

The contextual cues on the surface of the AGNES tangible object provide access to implicit memory (Figure 8.5). The object affords tapping to contact a loved one. We need to carefully choose contextual cues suited to various situations, wood texture to afford knocking, boa material to afford stroking and knit material to afford tapping, based on everyday life objects (Figure 8.5). The tangible object is built on the basis of blending frameworks as well (Figure 8.6).
Input-space 1 is that of sensor-based information input techniques such as motion tracking, position tracking and physiological detection, for example. The other, input-space 2, is physical activities in everyday life such as tapping, shaking, knocking, and stroking. Here, literal and figurative expressions are established.

“Information is breeze from a window”
“Communication is tapping someone (memory)”

The expression helps understand information and communication in terms of natural sources/physical activities in everyday life, where there is some similarity or correlation between them. Users understand meaning in their bodily interaction with the world, physically, socially, and culturally.

8.4 Involving Users
To ensure user-driven development of the prototypes, users were repeatedly involved in order to collect qualitative data, impressions and opinions by interview and discussion. Their involvement helped iteratively to develop
requirements specifications by engaging in testing and evaluating implemented components and the developed prototype system. The collected information supports the validity of our approach to a better fit with the actual needs of our user group. Since this project brings together 10 partners from six countries, focus group interviews have been conducted within the countries. At an early stage of the development, our partners from Italy, Greece and Sweden evaluated the first prototypes by qualitative interviews and in focus groups. The main findings are summarized in Table 8.1.
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<th>Sweden</th>
<th>Greece</th>
<th>Italy</th>
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<tbody>
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<td><strong>Tangible</strong></td>
<td>- difficult to grasp, to hold and manage</td>
<td>- bulky and difficult to grasp</td>
<td>- better if working also outdoor</td>
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<tr>
<td><strong>Interaction</strong></td>
<td>- better if it could work also outdoor</td>
<td>- phone is better, it allows a more personal communication (voice)</td>
<td>- one gesture is enough to get in contact with relatives</td>
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<td>- fear to forget actions and related notification</td>
<td>- The simplicity of the box and its functioning are appreciable</td>
<td>- problems with people suffering of tremors</td>
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<tr>
<td></td>
<td>“what action stands for what notification?”</td>
<td></td>
<td>(accidental spread of notifications and consequent alarm among relatives)</td>
</tr>
<tr>
<td></td>
<td>- box materials (the fabric and the wood) are appreciated</td>
<td></td>
<td>- Portability: it’s bulky, but maybe if smaller</td>
</tr>
<tr>
<td></td>
<td>- good the simplicity of the interaction with the object and its limited use options</td>
<td></td>
<td>could be hanged to something that the elder wears, or to the key ring</td>
</tr>
<tr>
<td><strong>Ambient</strong></td>
<td>- privacy issues if curtain is visible to neighbors</td>
<td>- not possible to act on it or on the screen to set alerts; receiving messages or reminders depend on relatives</td>
<td>- A more synchronous communication, a crosstalk such as “are you ok” “yes I am” via gestures</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>- if curtain is placed in only one place it will be difficult to notice incoming messages</td>
<td>- The curtain does not look pretty, some elders would feel ashamed if some guest would see it.</td>
<td>- no need to display three different colors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Relatives like the system; it allows a better monitoring on elders.</td>
<td>- Two types of notifications and one single type of gesture are enough; in each case someone would answer to the contact request</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>- They would try it at home</td>
<td>- Elders would try the system for some time but they would not be willing to buy it</td>
<td>- useful idea; they would keep it at home, but “maybe for my parents who are 85-90 years old”, because they think they are still able to use a mobile phone</td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td>- The system is easy to use; they feel they are able to use even more complicated objects</td>
<td>- It seems destined to elders with some impairments, or to people who are older</td>
<td>- It is a good attempt to make the technology approach the elders; it does not require a complicated interaction. Good for technology-adverse people.</td>
</tr>
<tr>
<td></td>
<td>- it seems to be more for emergencies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- anxiety for the possibility to miss messages if they are temporarily not at home. This could lead them to be reluctant leaving their house</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.1 Comparative Summaries (summarized by Donetti, 2011)
8.5 Discussion
The three qualitative researches conducted in three different countries revealed interesting evaluations and patterns, but not much variance between the three countries. From the findings, two main issues are identified, the physical functionalities and the meaning in relation to interaction. The issues need to be discussed further and carefully investigated. The richness of users’ impressions gathered by the focus groups helps to trace a clear and consistent picture of issues for the system design, contributing appropriately to development of the system for the particular target users.

8.5.1 Functionalities and Meaning

The functionalities
The limited functionality and simplicity of the ambient display and the tangible object were largely appreciated by the participants in all three countries. They commonly commented on the fact that the tangible object might be lost, what might happen if they would drop it and it might roll away. From this, they discussed alternative shapes that would be easier to grasp and would not roll. For example, the users mentioned the stiffness in their hands. Shapes like kidneys or dog bones were proposed as good for grasping with their hands. They were also concerned about the fact that they must stay at home in order to get the messages/information. They were afraid of missing some important notifications if they were out. They suggested other ways based on everyday objects that they would be able to take with them when they left their homes, such as bracelets and keys, which seemed both discrete and difficult to leave behind. They also considered the need for complementary use of the prototypes and the telephone and the wrist alarm that some of them have been using already in their everyday life.

The meaning
The aspect of sensual perception, such as wood, soft fabric and even breeze, were appreciated. In contrast to using current mobile phones, such simplified interaction methods as tapping and knocking were for the most part appreciated by them.

All seemed to be very curious about the ambient display. They seemed to like the lights and breeze. They questioned whether it would be possible to differentiate the various colours from one another. Sound as an alternative
was put forward. Their comments also suggested that the ambient display should be installed in an appropriate location at their home for them to effectively sense and recognize the implicit information conveyed. The quality of fabric material for displaying the implicit information is very critical in order to let them use their sensory perception.

Their comments urged to reconsider appropriate contextual cues, such as suitable shape, material, color and even breeze. User-led innovation is a key part of the design approach. Further user studies need to be conducted to investigate improved prototype in order to effectively match the needs of the target users.

There could be a culture that has no such custom of knocking. They may use their voice and may use various tones in a particular situation. We need to develop a research method that carefully investigates how we construct meaning with products/artefacts in a particular culture. We should not force one’s cultural mode developed in one’s culture to another culture.

8.5.2 User participation in human-experiential design process
Our knowledge embodied in everyday life activities comes out in our unconscious motor behaviour, such as the way we use a chair, hold a coffee mug, to turn a doorknob, and feel the saddle of a bicycle. We are not aware of these as particular objects, but we are unconsciously harmonious with them. The object disappears from our perception. In this case, the design is silent or perceived later. So users need not read user manuals, need not understand explicit conceptual information.

The embodied patterns repeatedly developed in everyday life merge when action and meaning are integrated in a particular situation. The design image that the designer forms of a solution is thought to be subjective and embodied in the designer. But if the designer’s embodied image is shared in an image embodied in users, they should empathize with the feeling provoked by it. The human-experiential designer needs to focus images that people commonly might embody, so the design would make people feel empathy.

I have suggested that it is important to focus on people’s natural flow of actions during user observation (see Chapter 5.3.2). As mentioned previously, it is not easy to find the embodied patterns or primitives that affect the flow, because they exist pervasively at a pre-conceptual level. Ironically, the natural flow of action occurs when we are unconscious. We
cannot see an embodied notion consciously. More problematic is that user observation or applied user research consciously intends to analyze or judge users. Users may even provide comments from a ‘user’s’ point of view not as people in everyday life.

In order to conduct user research and succeed with HXD, first research participants should try to divest themselves of own self-identity, such as designer, user, and researcher. Second, the designer has to be embodied in the user’s experience. The participants need to carefully investigate how the embodied image that the designer forms can be shared with the image users form in their experience. Third, the embodied patterns have to be outlined by introspecting about everyday life, since the participants share the same human primitives. The participants need to pay attention so whether the designed things are embedded into their experience or not, because the design should penetrate into their everyday life and never break their natural flow of action. We see that HXD is not an activity that makes users satisfied by new experience. It should modestly disappear from users’ perception.

While ‘doing design’ is a particular subjective, imaginative and embodied action in a designer, ‘describing design’ must be general in character since description expresses what is common to various objects. For example, the description or concept of ‘coffee mug’ can be applied to all mug cups and defines what mug cups share in common that specifies them as ‘coffee mug’. ‘Describing design’ is not a particular image of design of one thing or another. Whereas ‘doing design’ is tied to the particular mind that experiences a designer’s embodied images, ‘describing design’ is disembodied in the sense that it is shareable, abstract, and of a general nature.

These days, users hardly empathize design. The particular subjective and embodied image that the designer forms has to be converted into products or artefacts targeted for the general and abstract nature of the mass of customers. It is a disembodied design expressed as explicit information shared by customers in a potential segmentation of the market.

Whereas design for a particular group based on segmentation variables shares the general and abstract nature of information, HXD shares pre-conceptual and embodied primitives. This is because our bodies are tied to the world around us, and our imagination and rationality are inseparable from bodily orientations and interactions with the environment that all
humans must have experienced. I believe that this is the route to true universal design inclusive of design for a particular group of people.
Chapter 9: Tangible Presence for Physiotherapy

9.1 Introduction
Interactive computer play (ICP) has a significant potential in the rehabilitation of children. As yet researches presented in this field are limited in terms of evidence for its effectiveness. A need for development of new systems purposely designed for rehabilitation is beginning to appear in the literature (Sandlund et al., 2009a,b,c; Deutsch et al., 2008). In recent information society, it is commonly accepted that many children and adolescents spend several hours a day in front of a display to playing interactive games, which capture and retain children’s attention. This means that there is a significant potential for making training a fun and inspiring activity that children enjoy and would want to perform for achieving results within rehabilitation. Ordinarily, it is difficult to engage active and independent rehabilitation. But ICP can be suitable and enjoyable training for the physically disabled child to be active and independent in activities (Sandlund et al., 2009ab; Miller & Reid, 2003).

This chapter discusses a need for development of interactive computer play in the rehabilitation of children, and proposes a new way to approach issues for which experiential design methods offer a feasible solution.

9.2 Research studies in ICP for motor-rehabilitation
Interactive computer play (ICP) can be defined as an interactive technique for playing where the virtual and physical are combined and affect each other. Sandlund et al. (2009a) have pointed out issues arising from research studies concerning ICP in motor rehabilitation to date. For example, children have primarily used complex and high-cost systems designed for specific therapeutic purposes at a research centre. This requires the children to come to a research laboratory for practice (Reid & Campbell, 2006; You et al., 2005). Thus far, no low-cost motion interactive games specifically designed for rehabilitation is available on the market. A three-dimensional view of the mediated environment with sensor-based technologies can also be used, as well as interfaces that allow children to control games through free body movements alone, as in video-capture games (Sandlund et al., 2009a). Such commercially available recent computer games as Nintendo
Wii, Sony EyeToy, and Xbox Kinect increasingly use spatial tracking through which users interact in the physical-virtual world with their bodies.

The EyeToy for PlayStation2 uses a standard home TV display and a video-capture technique plugged into a gaming console, so that players perform with free-body movement as input via a video camera that is the most frequently used interactive technique in studies with children. Similarly, another video-cam based console was released in 2011, Microsoft's Kinect for their X-box game platform (Microsoft Inc., Washington, USA) which enables users to play without the need of a handheld controller, through a free-body based interaction. It provides precise full-body 3D motion capture capabilities and gesture recognition with an RGB camera and a depth sensor. The users are not interfered with, for example by putting on intrusive sensors. The Kinect interface enables users to perform exercise precisely in physical rehabilitation. Chang et al. (2011) have reported a study of physical rehabilitation using a Kinect-based system that includes an interactive interface with audio and video feedback to enhance students' motivation, interest, and perseverance to engage in physical rehabilitation. They confirmed the effectiveness of the system for motivating physical rehabilitation. The participants improve exercise performance during the intervention phases. However, one weakness is the flexibility needed for rehabilitation, as camera-based gesture recognition cannot be individually customized to specific requirements. For example, both EyeToy and Kinect require mainly gross motor skills and are not suitable for practice of fine motor skills (Sandlund et al., 2009a).

Another example is the Nintendo Wii (Nintendo Inc., Kyoto, Japan), which has evoked much interest. The players have no direct physical connection with the game environment. Their physical movements are detected by the ‘Wii mote’ (the Wii remote control), which tracks three-dimensional motion through accelerations along three axes. Their free body movements in physical space are tracked and the body movements performed by players are generally in response to game-initiated events (for example, swinging a bat, tennis racket, or golf club). A truly merged physical/media space may be created during play. Deutsch et al. (2008) notably reported that adolescents’ energy expenditure whilst playing Wii Sports was significantly greater than when playing sedentary games in a rehabilitation setting for adolescents with cerebral palsy.
A few studies have assessed the therapeutic value of such commercially available products, which are not explicitly made for rehabilitation (Deutsch et al., 2008; Flynn et al., 2007; Rand et al., 2004). Adaptations of commercial systems to rehabilitation purposes for children with hemiplegia have also been studied (Huber et al., 2008). Sandlund et al. (2009a) have also reported that children, parents and therapists are in favour of this form of training and that modern motor learning theories fit very well with the concept of practising in interactive computer-based environments.

9.3 A study with children in sparsely populated rural area in Sweden

Sandlund et al. (2009a) conducted a home-based feasibility study evaluating the use of low-cost interactive computer games in motor rehabilitation of children with sensori-motor disorders, for example children with cerebral palsy. Movement control, motivation for training, and stimulating physical activity were investigated and emphasized in the study.

Throughout 4 weeks at least 20 min/day, 15 children aged 6–16 years with mild to moderate cerebral palsy and with limited voluntary motor control of one or both arms were encouraged to practice with the EyeToy games. Their parents assisted the practice and filled in a gaming diary composed of short questions with pre-determined answer alternatives and documented time spent on playing, who took initiative for playing and if the child played alone or together with parents, siblings or friends. Pre- and post-assessments were included in order to evaluate the diary filled in by the parents.

According to the study, notable findings are classified as participants’ experience at home, adaptability for heterogeneous group, physical improvement, and motivation. The participants appreciated playing the games together that became engaging practice, which motivates the children with pleasurable activity. However, it was not easy to find appropriate games for an heterogeneous group with several different types and degrees of need. As Sandlund et al. (2009a) pointed out, the commercially available games were often much too fast, making it difficult for more severely disabled children. Also, games needing more specific control of hand and finger dexterity can rarely be found in the market. Therefore, compatible functionality that supports both gross motor skills and fine motor skills need to be embedded in the ICP for rehabilitation. They also reported that no major improvement in the children during the 4 weeks of the study was
identified. Motor tests should be sensitive enough to capture small changes in motor control at the same time as being able to monitor development over a long period. Another noticeable aspect which they found was ‘motivation’. For example, the average time for sessions played together with someone, for example friends or siblings, was nearly double the length of time than when playing alone. Children played on average 30 min/day in the majority of all gaming sessions as measured by intensity in practice and by taking the initiative to play. Rehabilitation with ICP offers the opportunity to create engaging environments that make the exercise fun.

9.4 Potentials and Challenges in ICP for Rehabilitation

In the context of remote rehabilitation at home, it will be essential to have effective collaboration between children at home and a therapist or rehabilitation team at laboratory in order for them to keep up motivation and for better diagnosis and assessment.

9.4.1 Accessibility

ICP for children in own homes both to play by themselves as well as with others creates opportunities that can be conducted regularly and over longer periods of time as a supplement to traditional therapy. In addition, ICP for rehabilitation, which can be deliverable through the internet, could open up possibilities for home-based rehabilitation, which would potentially increase the involvement and motivation of the users (Song et al., 2009), and also reduce the financial costs associated with long periods of hospitalization or travelling long distances to rehabilitation facilities (Broeren et al., 2006). The internet may also provide a platform for participants for example, children, parents, training therapists and rehabilitation team, through that they can communicate in a wider community on an equal basis without being biased or judged because of their impairment (Harackiewicz & Sansone, 2000).

Optimally, ICP for motor rehabilitation could also be used for diagnostic and assessment purposes in rehabilitation (Girone et al., 2001), not only a tool for rehabilitation. Their progress and achievement goals would visually be characterized, in as much detail as possible, and would specify the movement abilities of the individual child such as body parts activated during the play, type of movements, range of movement, movement speed, eye-hand interaction, and endurance measures and so on (Sandlund et al.,

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The visualized diagnostic and assessment could produce parameterized information for such purposes as assessing the current physical status of the child, recording the natural history of a disorder and evaluating interventions of various kinds, and can be shared via the internet to the participants, and can create more effective collaboration between them.

9.4.2 Motivation

There are several advantages that make ICP particularly appealing for use in the rehabilitation of children. One example is the opportunity to create engaging virtual-physical blended spaces (Hoshi & Waterworth, 2009) that motivates the child to exercise. This entails the integration of cognitive processes, such as attention and motivation as well as emotional processes, with appropriate sensorimotor transformations in order to produce sufficient movements (Song et al., 2009). Motivation plays an important role in a child’s physical training as a part of rehabilitation. The child should discover it pleasurable to engage in the rehabilitation for its own purpose. Motivation from the game initiated events can be expected as the child gets a sense of getting better at the environment, gaining higher scores and defeating an opponent. It is critical that the ICP provides a challenging environment of some sort for the child and that the challenge is at the appropriate level in suitable ways to pleasurably succeed for rehabilitation practice. This is usually called intrinsic motivation (Harackiewicz & Sansone, 2000). Activities begun with intrinsic motivation bring enjoyment, defined as participating in an activity that is fun and stimulating, and aligned with personal interests (Song et al., 2009; Deci, 1981). Intrinsic motivation has been studied and explicated as one of the strongest determinants of exercise adherence, and as a higher feasibility of exercise adherence (Ryan et al., 1997) and better psychological state for health (Maltby & Day, 2001).

How people experience motivation related to exercise has previously been addressed by Self-Determination Theory. It describes how external factors (e.g., rewards, competition, and punishment) affect intrinsic motivation (Deci & Ryan, 1985; Ryan & Deci, 2000). Large numbers of studies in sports and training have reported that the external factor, for example competition, may have a detrimental effect on intrinsic motivation (Rummel & Feinberg, 1988; Deci & Ryan, 1990; Deci et al., 1981; Reeve & Deci, 1996; Tripathi, 2001; Vallerand, 1986a). Vallerand et al. (1986a) observed that children aged
10-12 in a competition condition persevered significantly longer on a balancing task than children in a non-competition condition. This suggests that competition had a detrimental effect on intrinsic motivation. But the level of intrinsic motivation for high achievers is steadily kept up in a competitive context (Harackiewicz, 1989; Harackiewicz et al., 1992). Intrinsic motivation is characterized as self-determination, whereas extrinsic motivation is considered to reflect a lack of self-determination. However, recent research (Koestner et al., 1984; Ryan et al., 1982; Ryan et al., 1983) has indicated that extrinsic motivation does not diminish intrinsic motivation, rather it may even increase it (Luyten & Lens, 1981). It is important that the intrinsic and the extrinsic motivation are complementary, in order not to have a contradictory effect on the child (Sandlund et al., 2009a). External reward from such as a parents, friends and/or a therapist must be in response to the quality of the performance (Sansone et al., 2000).

9.4.3 Psychological and perceptual factors
There may be several factors to make players motivated during interactive computer play. Psychological and perceptual factors such as motivation and presence are deeply embedded in any sports or exercise activities in interactive computer play. It is largely unknown how presence influences interactive computer play and how presence can be created during play. Through a literature review, we can see that motivation has an important role in interactive computer play. ICP may give players a more immersive and physically challenging gaming situation, and can also produce a strong psychological feeling of presence within the merged space. This in turn may facilitate players’ performance and maintain motivation and interest in the game (Lombard & Ditton, 1997; Lourenco et al, 2008). Interactive computer play may enhance quality of motor rehabilitation because appropriate presence is created during a play. Song et al. (2009) have found a significant moderated mediation effect of presence toward exercise experience in the interactive computer play. Specifically, they suggested that the mediating role of presence may be moderated by the level of competitiveness.

Competition is one of the main elements of ICP. Since most games are goal directed, it is easy to find competitive situations or competition factors in ICP (Frederick-Recascino & Schuster-Smith, 2003). Yet, it is an unknown phenomenon, how competition influences the exercise experience, particularly the sense of presence in ICP. Communication scholars and
media psychologists have noted that competition affects the game-playing experience. For example, Vorderer et al. (2003) demonstrated that players tend to have more sense of enjoyment when there are immersed in competitive settings in ICP. Similarly, Williams and Clippinger (2002) and Gajadhar et al. (2008a) also have mentioned that competition makes ICP more enjoyable, and even affects players' preferences when they choose games. Gajadhar et al. (2008b) investigated players' social presence in the ICP in spatially different play settings: virtual play against a computer, mediated play against another person but in remote locations, and co-located play against another human in the same place. The degree of social presence and enjoyment significantly increased from virtual play settings to mediated play settings and to co-located settings. Ravaja et al. (2006) also affirmed that players have different degree of presence depending on the opponent they play against. The degree of presence was higher when they played against humans, rather than against a computer. Similarly, Gajadhar et al. (2008b) also found higher presence when they play against friends than strangers.

Presence is affected not only by social settings, but also tangibility. Hoshi et al. (2009), for example, have reported that tangibility increases perceived presence, but that presence and self-presence are unrelated phenomena.

To improve quality of the remote collaboration for motor rehabilitation there is a crucial need to share the right information between children at home and a therapist or rehabilitation team at laboratory. Also to optimize the collaborative environment with the right information, remotely located participants need the sense of being together with the other people in a shared environment; because of separated locations, the sharing of reality is restricted or concealed. How can interactive systems provide as appropriate the sense of being together or presence state as possible for remote rehabilitation? The following section suggests a framework for understanding how presence in interactive computer play can be optimized, and how appropriate gaming experience for rehabilitation can be designed.

9.5 Creating Tangible Presence
When people such as athletes try to motivate playing a sport or exercise, they may seek certain goals such as having fans, improving their performance, and simply winning (Vallerand & Losier, 1999). In order to attempt to master complex skills or to obtain a higher place in the rankings, they are
conscious of, for instance, plans and tactics, based on information processing such as problem-solving, analysing, thinking what happened in the past and what can be expected to happen in the future. This is more conceptual than sensory (Figure 9.1). A feature of this kind of motivation would be much self-consciousness (Riva et al., 2004).

On the other hand, when they are in more immersive playing situations, players’ motor behaviour preserves the natural flow of action in specific situations. They become harmonized to things that they end up doing without really thinking. This experience can be said as the integration of a group of sensations and concepts that gives it the ability to capture the current state of being in the world. This behaviour is generally invoked with more sensual perception (Figure 9.1). When athletes truly connect with a sport or with exercise, they become physically, emotionally and intellectually engaged by the activities in an appropriately immersive environment. Their action and motivations engage each other. It can be said that athletes are truly present in a space in which sensual, perceptual and conceptual experience are appropriately integrated. It depends on the person’s motivations toward a given activity and a current situation. Motivation will enhance their achievement. However, when the activities occur in an immersive environment, they intuitively interpret what is of value for their purpose in their current situation or environment and try to become harmonious with it. In this respect, they are in less self-consciousness. And their experience is tangible presence (Figure 9.1).

Figure 9.1 Player’s experience continuum
With free movement based interaction it is in principle possible to realize an ideal in which our activities are characterized by a natural flow of action, without any intrusion from technology arising from the physical-virtual divide.

Virtual Reality and interactive media have been steadily evolving such that they have become closely associated with presence in a mediated environment. The more interactive, perceptually realistic, and immersive they become, the more the experience of presence becomes convincing (Ijsselsteijn & Riva, 2003). Several factors such as the available technology, the required use, and the context of use may affect the presence parameter (Waterworth et al., 2006).

Personality and also their desirability on individual factors will influence the ease with which various degree of presence can be brought on. Effective interactive systems for collaboration will work by creating harmony through using appropriate contexts and thus create the optimal presence states.

The conceptualizations of presence (Lombard & Ditton, 1997) can roughly be divided into two broad categories, physical and social. Physical presence refers to the sense of being physically located in mediated space, whereas social presence refers to the feeling of being together with another person, of social interaction with a virtual or remotely located communication partner. At the common ground of these two categories, there is a shared space uniting rich characteristics of both physical and social presence. That is defined as a sense of being together, co-presence (Ijsselsteijn & Riva, 2003). This conceptualization (Figure 9.2) can be applied to address issues in ICP for rehabilitation.

![Figure 9.2 Different types of presence](image-url)
Figure 9.3 graphically illustrates the different types of presence including physical presence, social presence and co-presence, particularly in relation to the current computational realm, with interactive media examples.

Social presence in Figure 9.3 shows that traditional networked communication disconnects between the physical and the computational realm. Co-presence in Figure 9.3 clearly shows that the physical world and the virtual world correspond to each other to create the sense of being together between remote sites. This could be a collaboration of home-based ICP for rehabilitation between a child and parents at home and a therapist at hospital or research laboratory.

Collaborative work with co-presence in the gaming environment needs to provide as much immersion as possible so that gaming events effectively work for the participants with much engagement and enjoyment. As Hoshi and Waterworth (2009) reported, tangibility increases sense of perceived presence, contextual cues about material, shape, size, texture, and weight configuration of the physical object provide improvement presence in the ICP.
### 9.5.1 Tangibility

Tangibility in the HCI literature is described as being built upon sophisticated skills situating digital information, to varying extents, in physical space. Research work on tangible interaction has been focusing on aspects such as manipulation of building blocks or shaping models out of virtual/physical clay (Ishi, 2008). The approach is subject to our current limited abilities to represent changes in material or physical properties of objects and spaces (Hoshi et al., 2009). However, we still cannot effectively utilize our skills for manipulating physical objects to any great extent, skills that are predicted to improve the nature of interaction, especially for people with mental and/or physical special needs.

Chapter 5 discussed the issues of the post GUI/WIMP paradigm and the importance of the intersection of sensory, cognitive and emotional aspects, and experimented with perceptual and psychological aspects of the effectiveness of those interaction styles. The findings seem to confirm the importance of incorporating tangible tools in blended reality spaces aimed at eliciting a high sense of presence. Even in a game where there is no obvious tool - say, a running game - if the game achieved a convincing blending of the physical and the virtual, we would expect a high level of presence to be elicited. For example, in the situation where the game player feels uphill resistance, wind movement, and physical forces so on. Tangibility is not limited to using tools, and we see no reason to expect that its effect on presence will be so limited either. Based on the contextual reality framework introduced previously (see Section 5.2), those subtle cues such as weight, texture, smell, and airflow contribute to context sensitivity. That is contextual cues (Figure 9.4).

![Figure 9.4 A contextual reality gap between children at home and a rehabilitation team laboratory](image-url)
The quality of interaction that produces the sense of presence depends on how effectively a reality with contexts, the contextual reality, is conveyed in the blended reality space, and shared between users in communication and collaboration. The more appropriate sensual perception is created during interaction in blended reality space, the more tangible presence users feel. It is the natural flow of action and almost unconscious being in the here and now. Tangible presence in blended reality space will effect successful development of ICP in rehabilitation of children with sensorimotor disorders.

9.6 A Potential Solution and Prototype
This approach can be applied to the development of HCI that integrates reality-based touch and force feedback technique into a media environment, for such medical application areas as remote motor rehabilitation, remote therapy for mental health disabilities, and also collaborative care management for professional staff. The development of ICP in rehabilitation of children with sensorimotor disorders is an illustrative example of this.

During the period of a children’s rehabilitation at his/her home, professionals and the children meet via the internet to discuss the current progress, next collaborative steps and plans for the future. Various crucial decisions are drawn on the basis of these collaborations. Currently, no satisfactory tools exist to assist in making the right decision, no visualizations are brought to assist in these healthcare collaborations. One potential approach is to design and develop intrinsic information devices of various kinds and which also function as multi-sensory interaction devices that can be used in combination within a computerized communication environment (Figure 9.5).

Figure 9.5 Multiple users at remote sites cooperatively collaborate on rehabilitation by using the object in four different roles
Three ways of approaching create immersive and tangible presence in blended reality space can be considered: Active participation, natural flow of action, and embodied interaction (Riva et al., 2004). Active participation can arise in the way the participant plays a role as a performer in an interactive event. If the performer becomes emotionally and intellectually engaged by the events, high levels of presence can arise in the blended reality space.

Natural flow of action represents the extent to which:

a) the user perceives a sense of interaction with contextual cues over the game initiated events, b) the user perceives that his or her attention is focused on the present, c) the user's curiosity is aroused during the interaction on the present, d) the user finds the interaction intrinsically enjoyable and fun in the present.

Embodied immersion is a style of full body movement based interaction for more tangible, direct and automatized inputs from the blended reality space. In this combined environment, tangible interaction objects are used in four different roles: (i) as input devices, (ii) as user representations, (iii) as system agents, and (iv) as characters in the collaboration. In this last role, the tangible objects help to create a sense of shared reality between users in different physical places.

Through dynamic and tangible representation of real data and information, the system could for example provide a shared collaboration space in which remote users see each other's expression as if round a meeting table. The object used in the four roles mentioned above effectively facilitates the three design routes: Active participation, natural flow of action, and embodied interaction (Waterworth & Waterworth, 2006).

1. **The object is utilized as a user representation medium that allows a user to be a performer and to tell stories by using the object - which then works as a ‘living’ organism across the blended spaces.** The shared collaboration space provides appropriately immersive events where the performers can become emotionally and intellectually involved.

**System feature required:** Immersive tasks provided for the children are developed as an ICP, which has various sound and visual effects. The sound and visual representation work as a guide to successfully achieve children’s goals. Executed performances are observed and measured by the system, then generated into visual measures of their achievement and levels of
impairment as well. It could be a building block experience or telling a story of how to build a house, as shown in figure 9.5 for example.

2. By picking up, moving, turning, squeezing and in other ways acting on these tangible objects, communication with the computer environment and, through it, with other people, can be achieved much more easily. Contextual Information is communicated back via displayed changes to the objects, such as their color, brightness, vibrations, and the sounds they make. The performer then finds the process of interaction less abstract, more fun, and a much richer and more interesting tangible sensory experience (Figure 9.5).

**System feature required:** The force feedback function provides a sense of touching the virtual object. Variable forces on virtual objects help their rehabilitation that adapts to different levels of impairment. The therapists give more appropriate advice through collaboratively controlling the tangible object with the children at the same time. This gives a sense of being together with each other to both therapists and children (Figure 9.5).

3. Gathering data by monitoring their diagnostic data through using the object, the system generates a visual measure of children's state. The visual information can often be displayed in the periphery of users' attention (Plaue et al., 2004). The peripheral display will then function as a secondary information system while professionals create primary visualizations such as diagnosis or treatment plans.

**System feature required:** Through the process of immersive tasks, the gathered data from, for example, motion tracking and force feedback are logged and accumulated in a database system, and then translated into visualizations. Both therapists and children can access the data easily by interpreting the visual representation. While the children contribute from a remote site, the visual representation helps the therapists to follow and analyze the data circumstances simultaneously. Visually represented improvements in their performance may help to increase their self confidence, and may help to keep up motivation and active participation in the immersive environment offered by the system.

This approach should make collaborative rehabilitation overall more effective, and will bridge the reality gap across physical and virtual spaces and also between different users’ perceptions in different contexts.
9.7 Discussion

Effective computationally supported collaboration in rehabilitation of children with sensorimotor disorders will be built on existing approaches in the fields of presence with advanced media and blended reality-based interaction, while also using contextual cues effectively. Initially, a trial prototype has been developed on the basis of this design approach (Figure 9.6). It is based on blended reality space using the Nintendo Wii gaming environment, adapted with an additional tangible input object to support the use of more delicate hand movements of the device (to guide a marble through virtual mazes). This can be expected to serve as an ICP for rehabilitation of children with sensorimotor disorders, especially for children with cerebral palsy. The interactive computer games commercially available call for mainly gross motor skills, but the prototype can be suitable for practice of fine motor skills. To achieve this, an accelerometer inside the Wiimote was removed and embedded in various shapes that may be suitable for developing their fine motor skills (see Figure 9.6).

In order to execute effective assessment with children, several interviews with staff members at local elementary schools have been conducted so far. They suggested that a pencil shape might be better for training fine motor skills as a pencil is rolled by sensitive finger controls of the hand.

Since ICP for developing fine motor skills of children with cerebral palsy has been rarely found currently, they were even unsure about what kind of shapes are effective for fine motor skills.

Currently, the initial prototype has been independently developed without the internet network for diagnostic and assessment purposes. We therefore need to understand and implement mechanisms to interweave information from appropriate contextual aspects of activities. For example, therapists need quantitative or statistical parameters such as body parts activated during the play, type of movements, range of movement, movement speed, eye-hand interaction, and endurance measures so on. A functionality for diagnosing over the rehabilitation in the child’s home environment need to be embedded in the blended reality based prototype, so the current physical status of the child and the natural history of a disorder can be assessed and transferred electronically via the internet to the therapist or rehabilitation team (Sandlund et al., 2009a). In order to conduct an effective collaboration with children, parents and therapists in rehabilitation, diaries of training at home and log data of the games played, scores obtained etc. need to be
tracked and integrated, so the therapist can feedback to the child and parents to keep exercise fun and to motivate the child high. In this respect, the use of biofeedback signals, gyros and motion capture would be significant technique to give immediate feedback to the child and also to accomplish long term monitoring (Sandlund et al., 2009a).

There is a need for nuanced approaches and methods for assessing motor skills in rehabilitation with ICP. The goal of the rehabilitation of children with sensorimotor disorders is often not to achieve functional improvements in a short time, especially not if impairment is congenital (Sandlund et al., 2009a). The system needs to capture small changes in motor control by monitoring motor development sensitively over a longer period. It is not easy to estimate motor improvement after only a short intervention.

The prototype will be further developed and tested with the functionalities mentioned above. Practical research work based on experimentation needs to be carefully planned and executed with the prototype. The design and development should also be conducted with all participants over the period in an iterative cycle including design, use, evaluate and modifying the whole system before final implementation.

Figure 9.6 Prototype physical rehabilitation game with two different tangible interaction devices

Figure 9.6 Prototype physical rehabilitation game with two different tangible interaction devices
PART V: Conclusion
Chapter 10: Contributions and Conclusions

10.1 Contributions

I believe that the experiential approach to design really does promise the possibility of the scientific design of everyday life. The purpose of this thesis is to show the promise by responding to the subject matter of HCI design (main research question in the thesis). The aim is not perfect development of a single, coherent and complete theory. But it is to take an important step and open up the possibility for development of as many new conceptual foundations as this experiential approach and its methods can support. The thesis offers a design approach, Human-Experiential Design (HXD), as a productive set of foundations and a provocative set of new issues, all of which will need to be further discussed and developed. Hence, the expected contributions of this thesis are:

1. The first contribution of this thesis is to get insights into ‘what design is’. In the early part of this thesis, the period from the advent of the concept of design through to today is reviewed. This review offers insights into a correct understanding and positioning of design and an appropriate set of intended actions for a design science that has not yet been established as an academic discipline. (Chapter 1, 2, 3)

2. The second contribution of this thesis is to establish a role for design that fits modern information society. ‘Design’ can be a mediator between technological and human concerns if we try to understand the cultural and social role of design as catalytic, flexible and dynamic work, which allows the norm to adapt and to evolve. It is not merely a middleman, negotiator or facilitator, rather the mediator in HXD contributes to us remembering the wholeness we have forgotten. This is an essential role in seeking the design aspect of reality and responding to the question of what it means to be human. (Chapter 4)

3. The third contribution of this thesis is to show new aspects of true human-centred design. It shows that the separated environments assumption can be studied and meaningfully bridged with the design aspect of science. The goal is to offer a view on the question ‘Are our minds apart from the
inanimate matter of our bodies, which works as another type of fuelled machine?” It provides an identification of a reframed categorization of customer, user, person and human, which allows us to discover new aspects of the human and true human-centeredness. The approach that the present thesis offers is assumed to represent an important step in true human-centred design, capitalizing on seamless blending of the separated environments such as mind-body, action-cognition, virtual-physical, and more importantly a group of subjectivist-objectivist sympathies. (Chapter 3, 4)

4. The fourth contribution of this thesis is to describe scientific knowledge in design research, and to suggest that ‘rationality’ (objective) and ‘creative imagination’ (subjective) can be integrated if we recognize that our knowledge is not merely a matter of the intellect, but it contains our sensual experiences such as colour, shape, texture, sound, etc. (Lakoff and Johnson, 1980). It implies that human creativity is revealed by investigating the process of understanding. Investigating the process of human understanding is equal to investigating the process of designer’s understanding, which is the process of creation. (Chapter 4, 5)

5. The fifth contribution of this thesis is to show an identification of the contextual reality gap. The goal is to provide the contextual reality framework that allows designers to manage, structure and compose contexts in designing better interactive systems. In order for designers to design better, the framework also helps to explore where the contextual reality gap emerges in social sharing of knowledge, understanding and experience generated between a designer and a user, and to meaningfully bridge the gap between them. It also shows that the gap is caused by an imbalanced view of ‘the world as machine’, a lack of understanding of the profundity of information and communication quality perceived with human senses. (Chapter 7)

6. The sixth contribution of this thesis is to show the conceptual foundation and practical exploration of HXD. Two specific practical contexts in healthcare are explored. The goal is to explore the design approach of HXD, future implications and critical points, which need to be further discussed. (Chapter 5, 6, 7, 8, 9)
In this thesis, I have tried to develop theoretically the framework of HXD. To be explicit, this thesis has offered;

- A reframed categorization of customer, user, person and human
- The notion of tangible presence
- Foundations of blending and blended reality space
- The contextual reality framework
- Human-Experiential Design as a design approach that integrates the above concepts

None of these is a fully-fledged conceptualization, but each at least has the virtue of raising a number of new issues and suggesting a new frame of design science. If the frameworks lead designers and researchers to start testing and discussing some of these new ideas and relating them to the issues of design science, then this thesis will have been more than successful.

We, designers and design researchers, have a difficult task, and we also have a major responsibility. Design is not merely a menial servant who lends a hand to the economical world. If design science offers an opportunity to correctly understand human beings and human life through design activities, and to design without being a hindrance to human life, then design science will succeed. Probably, most scholars and researchers say that design is not science, or is scientifically a matter of little account. But, I believe that building up the concept of HXD equals establishing a solid basis for design science.

10.2 Conclusions
The unifying idea within the present thesis is its approach to the subject matter of ‘design’. Several researchers have previously argued that a free-body movement based interaction is still inconsistent. For example, Chalmers et al., (2003), and Broll and Benford (2005) have questioned the desirability of seamless interaction for ubiquitous computing. No mixed reality environment can ever be completely seamless, but for some users and situations, maximum seamlessness is a necessity. The prototypes for embodied interaction that the present thesis has presented are first steps towards the creation, manipulation, and sharing of meaning through interaction nicely employed within Blended Reality Space in the service of users with special needs and characteristics. The appropriate combination between action and meaning is about the relationship between tangibility
and evoked presence, which are incorporated into a practice. The action and meaning are not opposed, but engage each other.

The concept that this thesis offers is based on the assumption that action and cognition, mind and body are not dissociable, but affect each other (see also Dourish, 2001). I have argued that humans are not machines that need stimuli or input signalled to let them take action. It should not generally be the case that we are aware of something, in the here and now, and then pick up an object and act. This is mostly quite unnatural and implies explicit knowledge and conscious effort. Rather, when functioning smoothly, we act without conscious awareness, and then find later that we have been using a tool. The ambient display and the tangible object are not the stimulus that provokes an action. Modestly informed by peripheral information and unconsciously executed, we can restore the primacy of action and re-integrate the mind and the body. The technology then disappears from perception in use, with little or no conscious effort of access to information or effort of interaction. Although current technology cannot be embedded as a perfectly consistent and seamless blend, the approach that the present thesis offers should be suitable for people with special needs, especially those who have difficulties dealing with explicit knowledge. The presented concept in this thesis, an emerging integration of HCI concerns and mediated presence research, Tangible Presence in Blended Reality Space, bridges the contextual reality gap in the sharing of meaning through mediated communication.

Tangible Presence in Blended Reality Space is based on the integration of metaphor theory, blending theory, design and presence that have one important matter in common, ‘embodiment’, within the domain of everyday life based people, behaviours, objects, and their interaction with information and communication technologies. I have sought to re-integrate separated environments as an attempt to approach the subject matter of design (see Chapter 1.1). Conceptual blending has emerged in the last decades with new advances and refinements, and is based on the integration of cognitive semantics, metaphor theory and blending theory (Imaz & Benyon, 2006). We, as representatives of the design disciplines, should not ignore the complicatedness of the real world and of humans, involving the organism, action, and the environment, as Dourish (2001) pointed out. This insight is rooted in Gibson’s (1986) ecological perspective that “Ecological psychology studies knowledge in the world rather than knowledge in the head” (p.118). I
believe the integration is a new way of approaching HCI design, what I call in this thesis ‘Human-Experiential Design’.

This approach represents an important step in the development of better e-health, capitalizing on seamless combinations of the virtual and the physical in blended reality. Significantly, an experiential approach to design incorporates bodily experiences into developing interactive systems, and true universal design for everyone becomes possible. This is because all humans - including elderly people and the disabled - have the same primitive experiences arising from common and shared embodied knowledge.

I have emphasized the importance of using appropriate contextual information and models in developing interactive systems. Several contextual aspects of human activities need to be modelled, and these have not received much attention in interaction research to date. Such ‘meta-activities’ as social, cultural and political factors take on a new significance, because the contemporary internet worldwide has broken through boundaries between cultures, societies and even political systems, but has not yet overcome the communicational boundaries arising from a lack of shared understanding - a shared concept of reality. To design for the complexity of context, we also need to understand and implement mechanisms to interweave information from appropriate contextual aspects of activities. The contextual reality framework would help us to understand and model relevant aspects of communicants’ realities and as a result design more effective interactive systems that bridge the reality gap between physically remote participants.

I have raised critical concerns for future work in Human-Centred Design, and sketched out a possible approach to these concerns. The goal of discussions in this thesis is not to answer what sort of design we might want in the current progressive industrial era but, by designing, whether we can answer the question of what it means to be human. I therefore raised a question (subject matter of design, see Chapter 1) against the assumptions that:

1) to the extent that it is scientific, design must be about bodies as distinct from minds;

2) to the extent that it is about minds, design cannot hope to be scientific in the explanatory sense.
In the following, I offer a few brief concluding remarks responding to these assumptions and outlining the future emphasis of the Human-Experiential Design approach.

The driving force that brought technological development is an imbalanced view of understanding the subject matter of design. Some designers and design researchers have been servants or apostles of exploring design science based on this paradigm, even though this is not part of our everyday life experience. Others have claimed artistic imagination as the only tool for achieving true human-centred design. What this thesis suggests is that there is another alternative without recourse to radical Cartesianism (objectivity) or excessive romanticism, art, or religion (subjectivity).

Most humans are largely living in a state of unconsciousness. There are different kinds of unconsciousness. We are living in a world restricted by unconscious cultural grip, which produces effects specific to being human based on the cultural world in which we live without being aware of it. This is different from unconscious motor behaviour that preserves our natural flow of action, which occurs here and now (see chapters 5, 6, 7). People limited by unconscious cultural grip are living in their own world, a world for example of conceptual thought, judgment and belief, or a world of the remembered past and the imagined future – an ideological world, not an experiential world. They are absorbing into the internal world of their thoughts and imagination based on their cultural environment. It gives them a sense of the self outside of the present moment (Waterworth et al., 2010). It also produces a sense of separation from the external world, and breaks the human natural flow of action that is based on constant activity. When functioning smoothly, humans act with unconscious motor behaviour, they are attending to the here and now, and have a sense of complete absorption in the external world of the present. This is ‘Presence’. When we are making tea, we find ourselves holding the teapot. The design (technology) itself disappears from perception in use. Humans become part of the external world.

These days, human experiences are often mediated by digital information and communication technologies. This brings with it the issue of how and to what extent the sense of presence can be elicited in the mediated world, and how this is related to the physical world in which the human and the technology are still located. If humans do not have a sense of presence in the mediated environment, they will have a sense of being separate from
technologies, whether these are office computers or designed artefacts in the environment.

The external world is increasingly becoming an experience of the physical and the virtual blended to some degree. Tangible Presence in Blended Reality Space is the sense of the whole filled up with contextual cues, in which the physical and the virtual are seamlessly integrated for the user. Tangible Presence and contextual cues help humans re-member the wholeness. Since people share the same evolutionary history bodily structures and potential for experiences and primitives for understanding information, they also share the whole that has to be remembered.

When their reality is part of the whole in which the self disappears, there is no sense of being separate. Only the wholeness remains. The wholeness exists when humans are attending to the external world of the present, the here and now. When humans are present in this sense, they are the whole, the whole is themselves. Every single thing plays a role in being harmonious in the whole (not as the self). Everything must be balanced in the whole without any dichotomies.

Design plays a role as a mediator that bridges dichotomies. If design has a role that creates a relation between human, technology and environment, designers need to consider them as equivalent mutual relations. Not to compromise, but to settle a matter of necessity in a current environment, and find mutual harmony between them. This thesis has consistently claimed that the design (technology) has to be embedded into the experience, and disappear from perception. There is no separation, no divisions, and no boundaries between them. There is no sense of ownership, possession, or control from the human’s point of view. There is only harmonious and equivalent relation in the present, the here and now.

I believe balance is the most important consideration in HCI design. I accept the importance of using a scientific methodology to make important strides in this approach. In order to explain a phenomenon, a hypothesis that is a preliminary assumption based on a series of observations is initially built up. We have to investigate the hypothesis under controlled conditions. Before a theory can be framed, the tested result must be verified and replicated. From the results, if it is a sound theory, it must be studied and experimented repeatedly by other scientists, and the results should be the same. But the HXD account denies the value of radical and imbalanced objective culture.
HXD has made its first tentative inquiries. In this approach, there are many notions to be refined and to be further explored on the basis of fair scientific methods. It is an important first step; in this way real design science has started.
Afterword

Recently, designers have had serious doubts about their own job, the responsibility of a designer. Even if they fulfill the responsibility with the best intentions to make good products that improve daily life, they are in a way just glamourizing the ownership of things. It is maybe a romantic and nostalgic idea to imagine that designing for the essential true nature of our aesthetic life can survive recent rapid commercial development of our globe, what people are calling *globalism*. Designers have the responsibility to ensure that human beings remain in the world of things, so people will buy and use things for better reasons than simply to possess them.

Recent contemporary society produces and consumes in vast quantities. We then discard vast amounts of garbage. Our apprehension about the amount perhaps needs to be displaced with apprehension about the speed of consumption. Everyone thinks that production has no meaning without speed. We panic because of unseen competitors. The speed of our creation of amounts of products has the immediacy to shock and surprise especially when we encounter and recognize aesthetic value as well.

Human beings should no longer tolerate the pain that much current design of technology brings. The quest for speed in our contemporary society continues to destroy the environment, as well as a measured and reflective way of living. Perhaps speed is not our inevitable evolution but only a reflection of recent rapid changes in our society. Although we think that we really should slow down, that would be difficult to accomplish. That is because of the fear of doing something akin to stopping in the path of a rush-hour crowd. People have certainly taken speed to be a value, and in the flow of time we can no longer experience the benefits and pleasures of living that had been part of our former way of life, which the older generation probably enjoyed to a greater extent. Essentially, slow is the true nature of our aesthetic life, and perhaps especially for the vulnerable, the elderly and the socially handicapped, who have become increasingly marginalized with increases in the speed of change of our society. But industries cannot slow down their production. Designers optimistically think that simple shapes create a simple society.

In our current reckless industrial era, the market desires strong impressions of owning products - sometimes visually, sometimes functionally. The market becomes timid in the face of design that does not
draw customers’ consciousness, because design should be a tool to encourage customers to buy. There is a fundamental marketing assumption that design draws customers’ consciousness with attractive products and interfaces. Yet this same consciousness breaks the human’s natural flow of action, sometimes perceptually, sometimes physically.

It should not be the case that we are aware, in the here and now, and then pick up a product and act. This is generally quite unnatural and implies explicit knowledge and conscious effort. Rather, when functioning smoothly, we act without conscious awareness, and then find later that we have been using a tool (usually when something goes wrong). Tangible interaction, unconsciously executed and informed by peripheral information, restores the primacy of action and re-integrates the mind and the body. The technology then disappears from perception in use, with no conscious effort of access to information nor effort of interaction. That means that products/artefacts have to be designed for human beings, not users or customers. Human beings end up grabbing a handrail for balance or warming hands on a hot mug without any conscious thought. There is no conscious effort in the behaviours, because the experience that has already made possible the series of actions, but unconsciously. It is the implicit memory that our bodies know, rather than the explicit and abstract knowledge that we are conscious of and can talk about. The designer needs not to create a body warmer that draws consciousness, but a hot mug becomes a body warmer without thought, because it already exists in our unconscious memory. The design that draws on implicit memory erases awareness of people as ‘Users’ who need willpower to act. Whereas conventional design that draws customer’s/user’s consciousness gives a strong emotional impression even before using it, with the HXD it is possible to be using it before consciousness arises or without any consciousness.

Everyone says that design should be simple and inconspicuous, so that people are not aware of the design. But design is actually inseparable from the background environment composed of everything that exists around the design, such as human experiences and memories; customs and behaviours; history and culture; technology and trends; time and circumstance; and atmosphere, sound/noise and air. If one of the elements even slightly changes, the design impression changes too. Human beings share the whole. These days, many people in industry and academia say that they want to design products/artefacts that touch peoples’ heartstrings. But if it is about
drawing out human consciousness, I would say: please don’t touch my heart (our consciousness) so easily. To be pleasant and invigorating, human life should be free of the need to always be conscious of the environment in which it exists. We should be like the fish coming free into a clear stream from a mudflow, by struggling to swim.

A human-experiential centred approach to design incorporates bodily experiences into developing interactive systems, and true universal design for everyone, including elderly people and the disabled, becomes possible. This is because we are all human beings with the same primitive experiences that cover our common/shared embodied knowledge evolved over thousands, even millions of years (Waterworth et al., 2003, Hosoe, 2006). Embodied interaction is the creation, manipulation, and sharing of meaning through interaction nicely employed with the emergent virtual/physical space (see also Dourish, 2001). The appropriate combination between action and meaning is about the relationship between tangibility and evoked presence, which are incorporated into a practice. The action and meaning are not opposed, but actually engage each other. This thesis has tried to show that dichotomies we are familiar with are not dissociable, but affect each other.

Lakoff and Johnson (1980) refer to a misunderstanding based on the mistaken cultural assumption that “either you believe in absolute truth or you can make the world in your own image. If you’re not being objective, you’re being subjective, and there is no third choice” (p. 185). But I believe there is a third way, neither objective nor subjective. We are all humans, not just customers or users. Human beings and designs should modestly exist in the whole, well balanced, without any dichotomies.
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Investigate Optimal Condition for Tangible Presence in Blended Reality Space

General Procedure

1. The main device used in this study is the Nintendo Wii console, the Wii Remote and the Wii tennis.
2. The Experiments are divided into 6 tasks. (Subjects play 6 tennis games with different conditions.)
3. Each single task takes 10 minutes: 5 minutes for a tennis game and 5 minutes for questionnaire. It takes totally 60 minutes to complete all conditions.
4. Subjects fill out a questionnaire that asked the feeling of presence after the each single task.
5. Subjects are asked to rate each question on scale from poor to excellent

Four Steps to Complete Tasks

1. Fill out Demographic information
2. Create Your Mi
3. Play games (trial session will be provided)
4. Fill out a questionnaire (Rate the feeling of presence)

Basic Demographic Information

Subject No.

Date / / '08

Age yrs old

Gender □ male □ female

Com Game Exp. □ everyday □ often □ seldom □ never e.g.

Wii Exp. □ everyday □ often □ seldom □ never e.g.

Win-loss Record

Game Nickname Win-loss Record : (you : Wii) Time Record :
Game Nickname Win-loss Record : (you : Wii) Time Record :
Game Nickname Win-loss Record : (you : Wii) Time Record :
Game Nickname Win-loss Record : (you : Wii) Time Record :
Game Nickname Win-loss Record : (you : Wii) Time Record :
Game Nickname Win-loss Record : (you : Wii) Time Record :

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Revised Sep 10, 2008
Follow the examples shown below, then put a cross on the scale

1. How natural was the mechanism, which controlled the actions of your avatar?
   ![Crosses onPoor and Excellent]

2. How responsive was the blended reality environment to actions that you performed?
   ![Crosses onExcellent and Poor]

If you have questions, Please ask us!

1. The Mi I played with looked like a type of person I would want to be.
   ![Crosses onPoor and Excellent]

2. How much did your experience in the blended reality environment seem consistent with your real-world experience without much mental effort?
   ![Crosses onExcellent and Poor]

3. To what extent did you focus your attention on the blended reality environment, rather than on other things?
   ![Crosses onPoor and Excellent]

4. How strong was your sense of "being there" in the blended reality environment?
   ![Crosses onExcellent and Poor]

5. Overall, how would you rate the degree of realism achieved by the blended reality environment?
   ![Crosses onPoor and Excellent]

6. The Mi I played with was an accurate representation of me.
   ![Crosses onExcellent and Poor]

7. How much did your experiences in the blended reality environment seem consistent with your real-world experiences?
   ![Crosses onPoor and Excellent]
<table>
<thead>
<tr>
<th>Question</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. What was your overall comfort level in the blended reality environment?</td>
<td></td>
</tr>
<tr>
<td>9. To what extent did the bodily sensations you felt in the blended reality environment influence how real the experience seemed to you?</td>
<td></td>
</tr>
<tr>
<td>10. How natural was the mechanism, which controlled the actions of your avatar?</td>
<td></td>
</tr>
<tr>
<td>11. How stimulating was the design of the blended reality environment?</td>
<td></td>
</tr>
<tr>
<td>12. How responsive was the blended reality environment to actions that you performed?</td>
<td></td>
</tr>
<tr>
<td>13. How proficient in moving and interacting with the blended reality environment did you feel at the end of the experience?</td>
<td></td>
</tr>
<tr>
<td>14. My senses were completely immersed during the experience in the blended reality environment.</td>
<td></td>
</tr>
<tr>
<td>15. How credible were the avatars of other participants with respect to representing human beings?</td>
<td></td>
</tr>
<tr>
<td>16. Do you believe the blended reality environment was able to induce emotions?</td>
<td></td>
</tr>
<tr>
<td>17. To what extent did the blended reality environment make you feel emotions (anxiety, sadness, happiness, etc.)?</td>
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<tr>
<td>18.</td>
<td>The Mi I played with looked like me.</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
<tr>
<td>19.</td>
<td>What was your overall enjoyment level in the blended reality environment?</td>
</tr>
<tr>
<td></td>
<td>poor</td>
</tr>
<tr>
<td>20.</td>
<td>How realistically were you moved through the blended reality environment?</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
<tr>
<td>21.</td>
<td>How much did the visual aspects of the blended reality environment involve you?</td>
</tr>
<tr>
<td></td>
<td>poor</td>
</tr>
<tr>
<td>22.</td>
<td>I felt connected to the Mi I played with.</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
<tr>
<td>23.</td>
<td>How much did the auditory aspects of the blended reality environment involve you?</td>
</tr>
<tr>
<td></td>
<td>poor</td>
</tr>
<tr>
<td>24.</td>
<td>How completely were all of your senses engaged?</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
<tr>
<td>25.</td>
<td>To what extent did you feel as an active participant in the blended reality environment?</td>
</tr>
<tr>
<td></td>
<td>poor</td>
</tr>
<tr>
<td>26.</td>
<td>How aware were you of your display and control devices?</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
<tr>
<td>27.</td>
<td>I liked the Mi I played with.</td>
</tr>
<tr>
<td></td>
<td>poor</td>
</tr>
<tr>
<td>28.</td>
<td>To what extent did you feel emotionally involved in the blended reality environment?</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
</tbody>
</table>
Impressions, Comments, etc....

Your contact information. e.g. E-mail, telephone
(In case of follow up interviews and questions)

Thank you for your cooperation!!
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