School of Design and Art
Department of Design

Designing enriched aesthetic interaction for garment comfort

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

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

Abstract

This thesis describes research-through-design approaches to identifying comfort factors within users' aesthetic experience, in particular the kinaesthetic experiences of human sensory activities and perceptions. The research explores: 1) the nature of experiential bodily knowing and understanding that is generated phenomenologically through the way women touch, move, and feel in the process of interacting with woollen textiles; 2) the development of design practice; and 3) the development of principles for clothing design.

Critical contextual review reveals that the general understanding of the comfort of wool clothing, based on scientific research, has primarily focused on material properties, for example, fabric construction fibres and the surface texture of yarn, in terms of functional qualities or ease of use. A deeper and broader understanding of comfort for clothing design can be gained from multi-dimensional research into wearers' emotional needs and their subjective experience in daily activities. This research project therefore explores women's use of their skills (how they feel, move, know) and their dynamic bodily expression while interacting with an object (how they act and feel or how they are acted upon in the process of interacting with an artefact).

The research included material innovation and investigated the comfort properties of wool through a range of conceptual designs. The preliminary results were then incorporated into a further iteration of design practice, using a framework of 'enriched aesthetic interaction.' The results provided new design solutions for comfort. This research-through-design process focused on gaining knowledge through a methodological balance: between the research and the design; between the designer's skilled ability and the user's unexplored skills and ideas; between tangible prototypes inspired by intangible theories; between a theoretical foundation and scientific validation.

All these elements of the research process were trialled in specific circumstances, for example, secure vs. insecure situations, blindfolded vs. non-blindfolded, and happy

vs. fearful conditions, in order to understand human senses and behaviours. The conceptual garments that were developed can be understood as interactive objects. They were developed by the process of designing, building and testing highly experiential designs in different aspects of interaction with the design prototypes, that is, sensorial, cognitive, emotional, and functional. The resultant garment designs reflected women's behaviour and what they created subjectively by their sensing, adapting and reacting capabilities. The garments were designed for speculating on users' new ideas, skills, and bodily interactions, and not for evaluating a final product. Herein, the notion of doing and experiencing as methodology was critical to this research. This opened up a new approach to design through emotion-driven action, and proposes a new dimension of functionality for clothing design.

The research provides: 1) a conceptual framework of 'enriched aesthetic interaction'; 2) a body of creative work; and 3) the development of design principles in the context of aesthetic comfort for clothing. The results can benefit wool producers and those who market the product internationally, and inform further research into clothing for comfort and aesthetic interaction. This research concludes that designers and researchers need to design clothing that evokes emotional responses and enables effective manipulation of space and movement in relation to the body.

Acknowledgements

Seven years ago I commenced a Masters degree in Designing for Aesthetic Interaction at Curtin University in Perth, focusing on achieving a more emotionally driven, user-centred and interaction-centred approach to design, exploring the emotional aesthetics of chair design through a cross-cultural examination of sitting behaviour; for example, by comparing floor sitting behaviour in Asian culture and chair sitting behaviour in Western culture. The study also entailed a comparison of cognitive images; for example, comparison of the perception of comfort and of pleasure in relation to chair shape (Jeon 2005). This was followed by participation in two research projects, 'Thingness of Thing' and 'Thing from the Void' in 2006, which involved research into the body's interaction with space. This project was a philosophical and theoretical investigation informed by Korean traditional culture and rituals. I then focused on the extension of my professional experience as a designer through participation in the FORM initiative (Contemporary Craft and Design Inc): the 'Designing Futures' industry cluster project in 2007. After completing my Masters degree, and a number of research projects afterwards, I felt the need to broaden my knowledge. This motivated me to begin a PhD on interactive design for woollen garment comfort.

I wish thank to Australian Research Council (ARC) and Wool Desk at Department of Agriculture and Food, Western Australia (DAFWA). This research is supported by an award from the Australian Research Council (ARC) project, 'Innovative Solutions for Wool Garment Comfort through Design' (Project ID: LP0775433), in conjunction with wool fibre specification from the Wool Desk at DAFWA. This research project contributes to wool clothing research for the ARC Linkage project. This research has expanded the practicality and application of wool fibre research outcomes through the development of research methodologies that incorporate innovative and creative design solutions and take account of human behaviour in social, cultural, and emotional contexts. The outcomes of the research demonstrate how 'value-adding' from creative production can assist wealth generation from raw materials production.

When I reflect on the past few years of this PhD research, there are numerous people to whom I am grateful.

Firstly I would like to express my gratitude to my supervisory team who helped me to undertake this study. Thanks to my supervisor, Professor Suzette Worden, for giving me the opportunity to do a PhD and for providing continual encouragement, expert guidance, constructive criticism, and attention to detail throughout the whole process. Her useful critical comments and feedback helped me enormously. This study would not have been possible without her support. I also thank my supervisor, Professor Christopher Crouch, for his guidance for the PhD examination process and for his sincere assistance in work on the final proof reading, and final check of my thesis. I thank my associate supervisor, Anne Farren, for providing useful comments on my practical work and discussions about current issues in fashion trends, and design consultation during the design prototype development. Anne also gave me the opportunity to participate in a design workshop, 'Fremantle on the Edge,' and to exhibit my conceptual garments in the WA museum. I thank my associate supervisor, Associate Professor John Stanton (Department of Agriculture and Food, Western Australia (DAFWA)) and Wool Desk researchers (Ms Amy Clarke, Ms Amanda Murphy, Ms Sara Pieruzzini, and Mr John Beilby) at DAFWA for their assistance in providing scientific data from research into wool fibre and body comfort. I took on the dual objectives of creating an individual research project that had its own internal rationale, but which also complied with the requirements of the ARC Linkage project. One of these objectives included meeting with the researchers at the Wool Desk of DEWA and contextualising the research internationally. Their useful feedback helped me to clarify my methodological approach throughout the whole research process.

Secondly, I am grateful to other members of Curtin for supporting my research. I thank Professor Leon Straker (Curtin School of Physiotherapy) and Dr. Amity Campbell (Curtin School of Physiotherapy). Based on their assistance and expertise with Motion Capture techniques, I was able to conduct this research as a feasible scientific study using the Motion Analysis Lab, which is equipped with a force platform, cameras and computers for collecting and analysing data on garments in relation to the body and movement. My thanks also go to Richard Parsons, SAS

statistics software analyst and a senior lecturer in Statistics (Curtin School of Health Science), whose assistance and expertise in analysing statistical data were invaluable to me. Without his help, this dissertation would have been difficult to finish within the timeline. I have not written this thesis alone. Many people, besides the supervisors, have helped me by reviewing and discussing the drafts of chapters. My thanks go to Dr. John Fielder (The Learning Centre at Curtin) for his guidance, encouragement, and assistance in the thesis writing process and for his sincere assistance in work on the final proof reading. Dr. Christina Houen (an editor) for her assistance in work on the copy editing, prof reading and lay-out of my thesis.

Thirdly, my special thanks to international scholars, artists, and designers who provided design consultation during the design prototype development stage and offered valuable comments on my research:

- Professor Kees Overbeeke (Department of Industrial Design, Eindhoven University of Technology, The Netherlands) for his inspiring words and feedback, which have greatly influenced my ways of working and my vision on design. I thank him also for giving me the opportunity to present my project in more depth at the Department of Industrial Design, Eindhoven University of Technology. I had a great experience and I thoroughly enjoyed meeting with researchers to share ideas. Since then, my PhD research has been greatly influenced and it is with deep sadness that I will be no longer able to meet him any more as he recently passed away.
- Professor Keiichi Sato (Institute of Design, Illinois Institute of Technology) and Professor Chris Rust (Design Department, Sheffield Hallam University) for their valuable feedback when I participated in a doctoral colloquium program at International Association of Societies of Design Research Conference held in COEX, Seoul, Korea, 18-22 October 2009.
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- Professor Byung Hoon Choi (Head of Woodworking and Furniture Design, Hong-ik University, Korea South) for his encouragement and for offering me the opportunity to lecture at Hong-ik University.
- Bradley Quinn (London-based photographer and journalist) for his interest in my creative work and illustrating some of my conceptual garments in these two books, *Fashion Futures* (2012) and *Textile Visionaries* (2012).
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- Peter Heslop (Textile & Design Laboratory Manager, Auckland University of Technology, New Zealand) for helping me to test the samples of my conceptual designs using the Siema Shiki knitting machine in the Textile and Design Lab.

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Previous presentations

Elements of this research have been presented in workshops, conferences, exhibition, and books over the past five years.

Peer reviewed conference papers

I have published the original work presented in Chapters 4, 5, 6, 7, 8, and 9 in refereed conference papers, listed below.

> Jeon, E. (2009). 'Object playing with movement': A source of comfort and enjoyment. In K. Lee (Eds.), *Rigor and Relevance in Design: Proceedings of an International Association of Societies of Design Research (ISASDR) Conference 2009* held in Seoul, Korea, 18-22 October 2009 (pp. 18-22). Seoul, Korea: Korean Society of Design Science. Retrieved from http://www.iasdr2009.org/ap/navigation/program_day3.html

This research explored: 1) the relationship of emotion and movement, in particular, our bodies and bodily aspects of clothing interactions and bodily expression; 2) the integration between movement and space and bodily communication with them (extended in Chapters 6); and 3) the development of design prototypes for wool garment design in terms of form and performance (extended in Chapter 5).

Jeon, E., & Worden, S. (2009). 'Aesthetic experience and comfort': The relationship between semantic form and body movement for the design of wool clothing. In K. Lee (Eds.), *Rigor and Relevance in Design: Proceedings of an International Association of Societies of Design Research (IASDR) Conference 2009* held in Seoul, Korea, 18-22 October 2009. Seoul, Korea: Korean Society of Design Science. Retrieved from http://www.iasdr2009.org/ap/navigation/program_day1.html

I presented the early stages of the research at the doctoral colloquium at the IASDR Conference 2009. This paper described my formulations of methodology and a contextual review (extended in Chapter 2 & 3) and designing activity (extended in Chapter 5).

Jeon, E. (2010). 'Aesthetic experience and comfort': Garment design integrated with movement qualities, dynamic bodily expression, and emotion. In P. Lévy., & C. Bouchard., & T. Yamanaka., & A. Aoussat (Eds.), *Proceedings of Kansei Engineering and Emotion Research (KEER) International Conference 2010* held in Paris, France 2-4 March 2010 (pp.1917-1929). Arts et Metiers ParisTech.

The research explored the comfort factors in users' aesthetic experience, in particular emotional and aesthetic experiences that enhance wearability. The aim was to explore how to integrate movement qualities, bodily expression and emotion in garment design (extended in Chapters 5, 6 and 7).

Jeon, E. (2011). 'Enriched aesthetic interaction' through sense from haptic visuality. In *Design at the Edges: Proceedings of International Design Alliance* (*IDA) Congress Education Conference 2011* held in Taipei, Taiwan 24-26 October 2011 (pp.28-35). Taipei International Convention Centre (TICC). Retrieved from http://www.icsid.org/uploads/media/idacongress/Eunjeong_Jeon.pdf

Jeon, E. (2013). 'Touch me, Feel me, Play with me.' In *Praxis and Poetics: Research Through Design Conference Proceedings 2013* held in Newcastle

upon Tyne & Gateshead, 3rd -2 5th September. The Baltic Centre, Contemporary Art UK.

The research explored how people feel through touch and movement (extended in Chapter 8).

The original work presented in Chapter 9 of this thesis was published in a refereed conference paper.

Jeon, E. (2012). 'Enriched aesthetic interaction' through sense of dynamic emotional bodily expression with garment: quantitative analysis with Motion Capture (MC) data, in J. Brassett, J. McDonnell & M. Malpass (Eds.), *Proceedings of 8th International Design and Emotion Conference 2012,* held in London 11-14 September. Central Saint Martins College of Art & Design.

This research investigated human walking behaviour in the correlation and comparison of three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') (extended in Chapter 9).

Refereed journal papers

The original work presented in Chapter 4 of this thesis was published in a refereed journal.

Jeon, E. (2013). 'Emotional object creation': Experiencing through unknowing and knowing through experiencing. In *Design Principles and Practices: An International Journal of Design in Society, 7* (1). University of Illinois Research Park, USA: Common Ground Publisher. Retrieved from http://ijgs.cgpublisher.com/product/pub.236/prod.45

Talks given by the author

I presented the research to the Department of Woodworking and Furniture Design Department at Hong-ik University, Seoul, South Korea (2009) and the Department of Interior Architecture at Curtin University, Perth, WA (2011) as part of my role as a visiting lecturer. I was also invited to present my research: at the London College of

Fashion, UK (2010); at the Department of Industrial Design at Eindhoven University of Technology, the Netherlands (2010, 2012, 2013); at the School of Humanities, Royal College of Art, UK (2012); and, at the Art and Design Research Centre at Sheffield Hallam University, UK (2012). I was invited to the 'Beyond Garment' Seminar (2010) as one of the artist panellists. The 'Beyond Garment' seminar (2010)[1] was to discuss how to promote Western Australia's artwork and artists internationally. I also was invited to talk about my research in relation to craft, design, and technology and involved in design debate as one of the keynote speakers entitled: Craftism held at Designhuis, Eindhoven, the Netherlands (2012).

Group exhibition

A selection of the conceptual prototype garments was exhibited at the 'Beyond garment' exhibition, Western Australian Museum, 3rd Setember-30 November, 2010.

Books

I contributed to writing a chapter entitled 'Form Empowered by Touch, Movement, and Emotion*'* in the book, called *Fashion Design for Living* edited by Alison Gwilt published by Rouledge, London, UK (2014).

> Jeon, E. (2014). 'Form empowered by touch, movement, and emotion.' In Gwilt, A (Eds), In Forthcoming *Fashion Design for Living,* London, UK: Rouledge.

A selection of my conceptual prototype garments and photographic images have appeared as illustrations in books:

- *Fremantle on the Edge Intertidal vol 5: work shop with Maria Blaisse* edited by Nancy Spanbroek and Anne Farren (2011, pp. 24-27) and published by Paper and Pencil, Perth, W.A.
- *Australian Council of University Art and Design Schools (ACUADS) Research 2009* (pp. 4-7) edited by Ross Woodrow and published by the Queensland College of Art, Griffith University.

[1] The 'Beyond Garment' seminar was held in NWS theatre, Maritime Museum, Victoria Quay, Fremantle Western Australia at 4th September 2010.

- *Beyond Garment* catalogue, edited by Ann Farren (2010, pp. 6-7) and published by Western Australian Museum (2010).
- *Advanced Textile for Health and Well-being* edited by Marie O'Mahony (2011) and published by Thames & Hudson.
- *Fashion Futures* edited by Bradley Quinn (2012, pp. 42-43) and published by Merrell.
- *Textile Visionaries: Innovation and Sustainability in Textile Design* edited by Bradley Quinn (2013, pp. 222-231) and published by Laurence King Publishers.

Workshop

I was involved in 'Close to the Body' research studio – Master in Advanced Interaction (2013) as one of the coaches: Martijn ten Bhomer (TU/e), Kristi Kuusk (TU/e), Oscar Tomico (TU/e), and Eva Deckers (Philips). Partners to the research studio was the Higher School of Design Escola Superior de Disseny (ESDi), part of the Fundació del Disseny Tèxtil (FUNDIT) by the person of Marina Castan, Bywire.net by the person of Marina Toeters and Sietske Klooster. The place of this research studio was the Institute for Advanced Architecture of Catalonia (IAAC), located in Pujades 102, 08005 Barcelona, Spain. http://www.iaacblog.com/mai2012-2013-closetothebody/

Walking as an art of movement workshop was run for design students and staff who are involved in the filed of product design and Smart Wearable Senses at Department of Industrial Design, Eindhoven University of Technology, the Netherlands (2013). This workshop involved working with Sietske Klooster (Netherlands-based design-choreographer) and was a walking lecture to understand the nature of walking in everyday activities, in particular how a whole body is shaped differently based on the different walking patterns, such as slow walking, back to back walking, dynamic walking, group walking, and walking from one space to another space where you are in. The walking lecture contributed to design students and staff opening their design discourse and understanding of the quality of the movement as an everyday activity. The experience of movement can inform and steer design practice towards a sensorimotor-driven approach in product design.

Awards

This research is supported by an award from the Australian Research Council (ARC) project, ‘Innovative Solutions for Wool Garment Comfort through Design’ (Project ID: LP0775433), in conjunction with the Wooldesk at DAFWA (Department of Agriculture and Food, Western Australia) in wool fibre specification. This research also was awarded the Greg Crombie Postgraduate Award for Humanities Research Award 2011, Curtin University.

Table of Contents

List of Tables

List of Figures

Abbreviations

The following abbreviations are used throughout this thesis.

3D	3 Dimension
ANOVA	Analysis of Variance
ARC	Australian Research Council
CISP	Dutch Creative Industry Scientific Programme
DAFWA	Department of Agriculture and Food, Western Australia
FBVHM	Forward-Backward Velocity of the Hand Movement
FBRHM	Forward-Backward Range of the Hand Movement
FG	Fearful Garment
FW	Fearful Walk
HG	Happy Garment
HW	Happy Walk
IASDR	International Association of Societies of Design Research
IDA	International Design Alliance
KEER	Kansei Engineering and Emotion Research
LMA	Laban Movement Analysis
MC	Motion Capture
NW	Natural Walk
NG	Normal Garment
SSMH	Side-to-Side Movement of the Head
SSRHM	Side-to-Side Range of the Hand Movement
SSVHM	Side-to-Side Velocity of the Hand Movement
STEPL	Step Length
STS	Smart Textile Service
UDMH	Up-Down Movement of the Head
UDVHM	Up-Down Velocity of the Hand Movement
UDRHM	Up-Down Range of the Hand Movement
WALKV	Walk Velocity

Defining Terminology

Active touch in this thesis is defined as moving a hand over a stimulus object consciously or unconsciously, which triggers enhanced compound emotions, and was inspired by Gibson's ideas of active and passive touch.

Aesthetic comfort is defined as existing for us only when we appreciate it during the process of interaction, such as when our senses are gratified (feeling), the meaning we attach to the product (knowing), and the way we experience comfort, satisfaction or pleasure through bodily action (doing).

Aesthetic interaction is defined as the enjoyment of the experience during the participant's interactions with textiles and objects, rather than on the aesthetics of form.

Cognitive affordance is defined as the garment that stimulates emotional resonance, by which women are able to recall their nostalgic memories. This definition was inspired by Gibson's (1962, 1966, 1977) idea of affordances and ecological psychology.

Comfort is an individual, experiential, and situational emotion specific to the domain the individual inhabitants. In this thesis, it is defined as being a highly desirable and beneficial sensation, so that people are likely to maintain their comfort zone.

Discomfort is defined as being in a highly undesirable state particularly in insecure situations or fearful conditions, so that people seek to find something to minimise their unpleasant condition.

Double sensation refers to the idea of being able to touch and be touched by the same action, which was inspired by the Merleau-Ponty's (1962) idea of intertwinement between sensory-motor and perception.

Embodied experience refers to the awareness of the body and mind intermingled with the conscious and unconscious lived experience in everyday activities such as touching, walking, and wrapping. This definition was inspired by the Merleau-Ponty's (1962) phenomenology of perception and Shusterman's (2000) pragmatic aesthetics.

Emotional affordance is defined as the garment that allows women to afford and be adaptable to constantly changing moods and emotions, particularly in places where women experience discomfort. This definition was inspired by Gibson's (1962, 1966, 1977) idea of affordances and ecological psychology.

Experienceable garment design refers to open, dynamic, and explorative elements, so that this garment is able to explore people's reactions, unexplored skills and speculative new ideas for conceptualising comfort. The garment's design in this study was also designed for how the garment makes participants (all women in this study) think to raise awareness, to stimulate their imagination and to provoke action, which was proposed in different interactional styles as the basis of the theoretical ideas and the EAI framework.

Fearful garment is defined as mysterious textures and making participants (all women in this study) wrapped their bodies completely, and this style helped them control their state of fear by forming a shelter, so that they transformed their feeling of fear into a recognisable state of comfort.

Fearful walk is defined as the way participants walked when they intended to express the emotion of fear.

Functional affordance is defined as the garment that allows participants (all women in this study) to be functionally and emotionally adaptable when making their own stories through bodily interaction in everyday activities that lead to dynamic interaction possibilities. This definition was inspired by Gibson's (1962, 1966, 1977) idea of affordances and ecological psychology.

Happy garment is defined as inviting touch through interesting textures and making participants (all women in this study) feel glamorous and express their self-identity, so as to reinforce their feeling of pleasure in a recognisable state of comfort.

Happy walk is defined as the way participants (all women in this study) walked when they intended to express the emotion of happiness.

Haptic perception, called haptic interface, refers to a deeper reality of understanding the sense of touch that transcends the senses of sight and movement. Defining haptic interface was inspired by Gibson's (1962, 1966)' the idea of active, passive and

inter-active touch and the Merleau-Ponty's (1962) notion of intertwinement between sensory-motor and perception.

Haptic visuality is defined as unity of tactile and kinaesthetic phenomena and unity of touch and sight, which was adapted from Mark's (2004) definition.

Kinaesthetic interaction refers to the point of action, which provides our knowledge of body expression, positions, forces and motions via end organs located in muscles, tendons, and joints. In the haptic experimentation this was defined as expressive-touch and expressive-movement, in particular hand function and performance on an aesthetic level of experience, which represents communicative, affective, caring, or healing.

Laban Motion Analysis (LMA) was developed by Rudolph Laban (1960) in terms of how people's movements and behaviour are affected physically and emotionally by physical conditions, environment, cultural issues, and in communication with their bodies and the universe at large. LMA is concerned more with a qualitative description of the movement, not simply the physical characteristics analysed by the four interrelated categories: body, space, shape, and effort. In this thesis the kinaesthetic study identifies the characteristics of participants' emotional body movements by comparing different walk types ('natural,' 'happy,' and 'fearful') and different garment types ('normal,' 'happy,' and 'fearful') using LMA.

Multisensory refers to unity of the senses to explain the multisensory nature of the experience wherein, for example, touch is integrated with other senses. The same features of objects can be experienced through different senses and all the senses influence perception of stimuli.

Natural walk is defined as the way participants walked with no intended expression of emotion.

Normal garment is defined as participants who wore black leggings or jeans and a black tight, stretchable top.

Passive touch is defined as moving a stimulus object over stationary hands consciously or unconsciously, which aroused an enhanced single emotion. It also

refers to concerned about what actual body part that was being affected by touch emotionally, perceptually, and psychologically.

Pragmatic aesthetics was proposed by pragmatists such as Dewey (1958) and Shusterman (2000). They emphasised the important value and meaning of the ordinary, everyday experience of life. They explained that value and meaning, in terms of the sensual, intellectual, and emotional aspects of everyday experience of life, should be integrated into designing aesthetic interaction.

Proprioception is part of the haptic interface, but it is more focused on how we perceive our sense through how our body moves. It is used to assess the weight of a brick in our hand; and, if we close our eyes while someone else moves our arms around, proprioception will tell us where the arms are.

Smart textiles are types of materials that have the capability to sense their environment or external stimuli, and to respond to the external stimuli and adapt their behaviour to it (Schwarz et al., 2010).

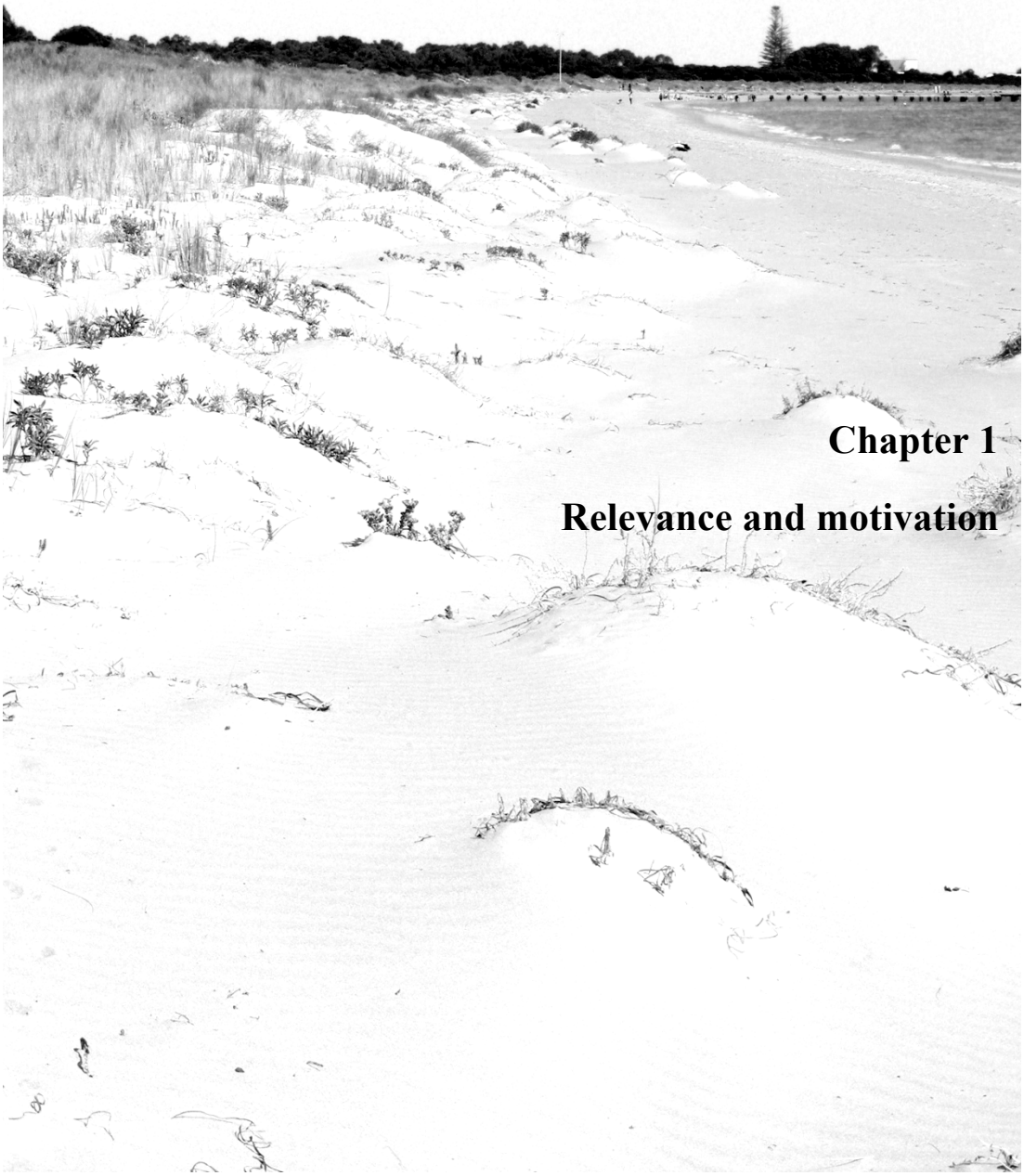
Semantic differential (SD) scale was developed by Osgood (1968) to measure the emotional content of a word. For example, it was used to construct two antonymic axes of the key terms of the research, in this case, comfort and discomfort. Haptic experimentation was conducted on the sense of touch and movement utilising a self-report method, that is, SD method (Osgood et al., 1957), using a seven-point scale to evaluate the subject's haptic experience.

Sensorial affordance is defined as the garment that invites people to touch, move and feel for their comfort. This definition was inspired by Gibson's (1962, 1966, 1977) idea of affordances and ecological psychology.

Somaesthetics was proposed by Richard Shusterman (2000) as an aesthetic discipline influenced by John Dewey's (1958) pragmatism and pragmatist aesthetics. He emphasised four important principles of aesthetic experience: (1) an object's intrinsic value in relation to human needs, value and events; (2) the application of the aesthetic experience of an object to contemporary culture; (3) the aesthetic experience of an object within a socio-cultural context; and (4) aesthetic experience and form in relation to a 'dynamic interaction of elements' in five ways: 'cumulation, tension, conservation, anticipation, and fulfilment.'

Synaesthetics is defined as the ability of the body to integrate all the different sensual perceptions. The sense of touch can be integrated and shared with other senses, such as sight, sensorially and perceptually in the multisensory nature of the cognitive process.

Tactile perception refers to the point of action, which provides sensations arising from stimulus to the skin — heat, pressure, vibration, slip, pain. In the haptic experimentation in this thesis, this is defined as task-oriented touch, which is used to feel many different surfaces of different materials.



Chapter 1

Relevance and motivation

Coogee Beach, Fremantle, W.A.
Source: photo by the author, taken when attending a workshop, 'Freemantle on the Edge' WA, in 2009

Chapter 1

Relevance and motivation

1.1 Introduction

The concept of comfort is generally described as a subjective state of cosiness and well-being in relation to a furnished environment. *Webster's Online Dictionary* defines 'comfort' as 'a state of being relaxed and feeling no pain' (*Webster's Online Dictionary*, n.d.). However, when we consider different forms of comfort, for example, the comfort of a chair and of clothing, the perception of comfort is very different because the concept of comfort has to be adapted in a different phenomenon. In addition, considering the field of textile design in the human factors analysis, the emotional dimension of the concept of comfort is mainly categorised in relation to usability. The scientific, functional, transparent, easy to use aspects are used rather than the artistic qualities of the product, or the ambition, experience, and personality of the user (Christensen, 2004, pp. 10-13). This classification, then, spawns contradictory concepts and conflicting recommendations. The controversy arises from the absence of a universally accepted operational definition of comfort.[1]

A feeling of comfort is not necessarily synonymous with absence of pain and an object being easy to use. Vink (2005) contends that comfort does not equal lack of discomfort; thus, it is surely necessary to find a more positive understanding, such as a sense of security, support, and 'assistance.'[2] For example, being comfortable is a highly desirable and beneficial sensation when it enables people to experience a sense of security and reassurance. People are likely to maintain their comfort zone precisely because it evokes a pleasant feeling. Conversely, to be uncomfortable is regarded as a highly undesirable state so that people seek to find something to minimise their unpleasant condition. In addition, to be uncomfortable in a social

[1] This issue of misconceptions of comfort relate to aesthetic quality will be explored in more detail in Chapter 2.

[2] Cranz (1998), in *The Chair: Rethinking Culture, Body and Design*, stated that the somatic perspective challenges some of our stable conventional ideas about comfort, that define comfort as 'no work.' A somatic perspective on comfort, which seeks to balance work, is closer to the original Latin meaning of the word, 'to make strong.'

situation, such as wearing an unsuitable garment in a public space, may be different to the discomfort experienced from a pain in the body. In other words, comfort is closely related to the sensual relationship of the body with its physical surroundings or physical interaction with objects, whether intimate or not. Comfort is also more than a specific physical state; it is coupled with psychological and socio-cultural responses that create its own image and usage. Nevertheless, whilst comfort is a highly complex affective state, its definition, especially in clothing, is a very important subject for both physiological and psychological sciences.

Clothing is one of the most intimate things and central elements of evoking our bodies comfort that we interact with in our daily lives. This is because they are extremely closely connected with our bodies and are identified with our bodies. For example, clothing is our body putting it on, wearing it, desiring it, taking possession of it, storing, and inheriting it. Clothes trace our momentary feeling through how we touch and move, and what it absorbs the body's smell and sweat. When worn, clothes represent our identity to others. For this reason, comfort in clothing is not only based on the human sensory response to clothing materials, but is also determined by a variety of psychological, social, and emotional parameters. In a recent overview of the conceptualisation and measurement of clothing comfort, Branson and Sweeney (1991, p. 100) state that 'clothing comfort is a satisfied state of mind indicating physical and social-psychological balance or harmony between a person and his or her environment.' Furthermore, they emphasise that the crucial aspects of comfort judgments do not follow directly from the physiological and perceptual responses of the mind and body. Some processing occurs in the mind, such that in a given situation, the interaction among stimuli elicits responses that are transformed into a comfort judgment. They apply Pontrelli's (1997) comfort judgment, a black-box phenomenon that is a filtering process in which past experiences, expectations, remembrances, and the like**,** influence the subsequent comfort judgment. This influence may be either at the conscious or unconscious level.

To integrate a design perspective, the field also requires further multi-dimensional research into wearers' emotional needs and users' aesthetic experiences. Users experience emotion when interacting with products. According to Desmet and Hekkert (2007, p. 58**)**:

> Experience is shaped by the characteristics of the user (e.g., cultural values, personality, behaviour, life style, and background) and those of the product (e.g., material, shape, texture, colour, and behaviour). All physical actions and perceptual and cognitive processes (e.g., perceiving, exploring, using, remembering, comparing, and understanding) will contribute to the experience.

These authors emphasise the experience of aesthetics, meaning and emotion in their research on product experience, as elicited by the interaction between a user and a product. For them, the process of meaning, where many cognitive processes play a role, such as interpretation, retrieval from memory, and association, is important; but bodies and bodily action also play an important role in understanding the figurative expression of products.

The idea for my doctoral research began with investigating the comfort factors of users' aesthetic experience in terms of both physical sensations and socio-psychological states, while acknowledging the influence of emotional factors. In these terms, clothing is regarded as an interactive object. To enhance the emotional experience of clothing comfort through design, comfort may be affected by a combination of how a garment feels against the skin; how it appears to the eye; how it tastes; how it is remembered; how it feels in the space (environment); how it interacts with body movements; and how it can be manipulated by the wearer to create different volumes in space. The focus of this research is on the concept of comfort in the context of aesthetic quality. In particular, it is concerned with the combination of sensorial, cognitive and emotional acquisition in the following modes:

- Synaesthetic understanding of comfort, which is the design use integrated with all the different sensual qualities;
- Kinaesthetic understanding of comfort, which focuses on being able to touch, to feel, and touch through movement; and
- Emotional understanding of comfort, which focuses on emotion evoked by movement and manipulation in relationship with an object.

In the above three contexts of understanding comfort, the primary motivations derive from investigating the comfort factors of users' aesthetic experience in such daily activities as interacting with nature, wrapping, touching and walking, all of which lead to rich aesthetic interaction. These motivations assisted in developing the four contexts of conceptual framework of 'Enriched Aesthetic Interaction (EAI)'[3] for this research area (see Chapter 3). In the next section, I will elaborate on: how I defined EAI in the context of comfort (Section 1.2); the core research goal and questions (Section 1.3); how my ideas and motivation shaped this research (Section 1.4); and the rationale for the research-through-design approach (Section 1.5). An overview of the research-through-design procedure is also outlined (Section 1.6).

1.2 Defining 'Enriched Aesthetic Interaction' (EAI) in the context of comfort

It is important to clarify the term I use in my thesis title, EAI in the context of comfort. This term represents the property of an object that has an intangible quality through which people enact and create their own meaningful action and experience — for comfort or for pleasure — while interacting with that object. This can only exist during people's engagement with the object and experience of it through bodily senses — touch, sight, smell, taste, and movement — and through the mind's perception. Further, this term EAI, as used in this research, refers to individuals' subjective experiences and rich emotions in relation to their use of skills and dynamic bodily expression while interacting with an object.

The concept of designing for EAI is focused on how people *act* or how they are acted upon in the process of interacting with an artefact in everyday experience so that I used term *designing* rather than design. The context of everyday experience in this sense refers to activities and movements in interaction with nature, such as forms of wrapping objects, modes of touching, and styles of walking. Conceptualisation of these activities in terms of EAI can prompt us to rethink these activities in terms of the added value of emotion. This perspective is closely linked to pragmatic aesthetics (Shusterman, 2000). The concept is also significantly inspired by the theory of phenomenology of perception (Merleau-Ponty, 1962) and ecological psychology

[3] Throughout this document the term 'Enriched Aesthetic Interaction' is abbreviated to EAI.

(Gibson, 1977). I adopt the phenomenological and ecological perspective in which meaning arises through interaction. We perceive the world in relation to what we can do with it. Thus, the world is inherently meaningful for our body and by moving we can gain access to that meaning. In applying these theories to designing for EAI framework and design practice, I elucidate reciprocal interplay among cognitive (knowing), perceptual-motor (doing) and emotion (feeling) based on human experiences and skills (Overbeeke et al., 1999). This phenomenological and ecological perspective of meaning through interaction sheds light on how my research can redefine the meaning of garment comfort during design process.

In designing for EAI the formal properties of my objects express experienceable designs: the open, indirect, uncontrolled, incomplete, dynamic and explorative elements with which people are able to improvise or perform their bodily expression through involvement with emotional affect; for example, enjoyable and playful interaction. This perspective is inspired by 'open design' suggested by Carline Hummels and Frens Joep (2011, p. 152). I have used the term 'experienceable prototype,' 'conceptual prototype' 'conceptual design,' or interchangeably, 'conceptual garments,' rather than simply 'prototypes or garments' in this thesis, because designing the garments involved open and explorative elements. In addition, the experienceable garments were designed to evoke people's emotions by challenging their experience, stimulating their imagination, and enhancing their beauty of interaction rather than concentrating on style, visual expression and appearance. The experienceable prototypes make users think, raise their awareness, and provoke them into action. Accordingly, the notion of EAI invites people to participate actively in creating sense and meaning. It is a sense-centred and interaction-centred research perspective as part of a user-centred and emotion-centred design research (Kansei[4] (感性, 감성[5]), rather than material-centred research. The foregoing will inform discussion of the main theoretical issues relevant to the research. I will address these issues in more detail in Chapter 2 (see Section 2.4).

[4] The Japanese term *Kansei* relates to attributes and properties that render feelings and impressions. Originally, Kansei engineering was defined as translation of consumer feelings and the image of product into some of the design elements used to create that product (Nagamachi, 2002).
[5] The term 감성(*kamseong*) is embedded in Korean culture, promoted in the Korea Society for Emotion and Sensibility (Yoon et al., 2010).

1.3 The core research goal and questions

This research investigates comfort factors in users' aesthetic experience, described as the 'Enriched Aesthetic Interaction' (EAI). The objective is to explore enriched, dynamic bodily expression and emotion in the phenomenological way people touch, move, and feel as they interact with wool clothing in the four contexts of human EAI (see Section 1.6, p. 19). My aim is to develop new design principles that will assist in the design of comfortable clothing that evokes emotional responses though the effective manipulation of space and movement in relation to the body.

This research project is a synthesis of theory, design research, and design practice. The research process is used a research-through-design approach and is based upon the research questions rather than problem-solving and decision-making. The research questions, listed below, branch off into the main two research questions of this thesis, which are:

- How can design for comfort be incorporated into aesthetic experience in the context of clothing?
- What design principles can be developed to provide aesthetic comfort for the user, in clothing as it is worn in daily life?

The sub-questions addressed in this thesis are:

- Can the dimension of comfort in everyday activities be related to aesthetic quality?
- How can dynamic bodily expression and emotion in everyday activities, for example, ways of touching, walking, moving, and interacting with nature, affect the development of innovative design concepts in the design process, in order to develop the framework of EAI in the context of clothing comfort?
- How can human sensory responses in aesthetic experience be reflected in the design of the comfort of garments? and
- Can the phenomenon of movement quality, such as the relationship between the body, space and movement, be applied to enhance the comfort of clothing?

1.4 What is meant by clothing comfort?

At the heart of my doctoral research project, which was in conjunction with the Australian Research Council (ARC) Linkage project: 'Innovative Solutions for Wool Garment Comfort through Design'[6] was a quest for what is meant by 'comfort' in order to apply this concept into design practice. My curiosity for redefining the concept of comfort stemmed from three major motivations.

1.4.1 Interacting with nature through touch

Initially my motivation in this research was to investigate comfort as the main aesthetic emotion, focusing on our personal experience of movement in everyday physical activities. Human bodily activities and daily chores such as wrapping, touching, pressing, squeezing and walking are more often recognised as practically-oriented human activities, and the aesthetic quality of these experiences is disregarded. However, an appreciation of aesthetic experience should take into account instrumental daily practice; in considering this, I have adapted the theoretical framework of Shusterman's (2000) pragmatic aesthetics. The author emphasises that aesthetics has a practical use that should be integrated into the ordinary everyday experience of life and related to actual human needs, values and events. He argues that the whole human being is actively involved in aesthetic experience through an integration of the sensual, intellectual and emotional aspects of life. The pragmatic aesthetics are relevant in this research in order to conceptualise the clothing comfort dimension. I will discuss the pragmatic aesthetics, and aesthetics as a design approach to everyday activities, in more detail in Chapter 2 (Section 2.4.2).

An aesthetic experience from nature can invigorate, vitalise, and comfort us. When an object or physical or mental experience evokes positive feelings like 'feeling good' in us, when we touch water, smell flowery scents, or recall our memories, our body and mind experience comfort as a reciprocal interaction. This sense of comfort can be integrated with all the different sensual qualities and defined as a synaesthetic perception of comfort. This perspective can be also related to a

[6] This research was supported by an award from Australian Research Council (ARC) in a project titled' Innovative Solutions for Wool Garment Comfort through Design' (Project ID: LP0775433), in conjunction with the Wooldesk at DAFWA (Department of Agriculture and Food, Western Australia) in wool specification.

phenomenological point of view of how to understand the concept of comfort in the nature of the human body and experience and the way in which people experience the senses through body and space (environment).

Figure 1. 1. Feeling sea-foam and crafting its forms with hands.
Source: photo by the author.

Touching, in particular is an important way of exploring our senses and emotions since it can help us understand an object's aesthetics and dimensions of comfort (see Figure 1.1). I will address these issues in chapter 4, particularly in regard to how bodily experience, in interaction with nature, influences the EAI framework, such as the generation of concepts and methods, and also the development of experienceable prototype garments. This experiment and interaction with nature through the body raises further questions: how do different modes of touches evoke such a feeling of intimacy as 'feeling good' or paradoxically 'feeling bad'? How can touch be integrated, shared and united with other senses in a multi-sensory way in the created design? What are the differences in people's feelings and behaviour when they are interacting with an object blindfolded and non-blindfolded? And how does touch, when a person interacts with an object, enhance positive emotions? This investigation has enabled the exploration of clothing design principles, which incorporate comfort factors. These issues will be addressed in Chapter 8.

1.4.2 Finding comfort in discomfort

My second motivation for undertaking this research was to investigate comfort or discomfort as the reflection of people's experiences influenced by their personal characteristics and issues. Experiences are holistic, situated and constructed (Dewey, 1934). 'This means they are multi-dimensional and not easily isolated… they depend on particular circumstances, and they belong to the person having the experience. Experiencing involves doing and undergoing at the same time' (Sleeswijk Visser, 2009, pp. 13-14). In fact, comfort and discomfort are subjectively experienced states, which are better seen as human, psychological, perceptual, rich, enigmatic, and complex (Castelfranchi, 2000). I consider comfort in terms of negative and positive emotions, which can be generated through someone's imagination, through recalling past (autobiographical) experience, or as a cognitive reasoning process, even without physical interaction. Peterson et al. (2004) apply Shusterman's (2000) pragmatic aesthetics in the design of interactive products and systems, and have suggested that aesthetics have an instrumental dimension related to actual human needs, values, fears and so on. An object's meaning and value change within the constantly changing contexts of experience, between cultures and persons, and even within persons (Ross, 2008, p. 58). One of the main challenges of this study was to take into account subjectivity as an individual's personalised, emotional experience, and mental states such as feelings of 'being relaxed' and 'being confident' in secure and insecure situations as part of the comfort dimension. More importantly, my essential motivation in this research was to investigate how women's past negative and positive emotional experiences, such as happiness and fear, affect specific, meaningful bodily expressive actions while interacting with garments. In fact, designing for positive and negative emotions can lead to richer interaction. This is confirmed by Desmet (2004):

> It may be interesting for designers to investigate the possibilities of designing paradoxical emotions, that is, positive and negative emotions simultaneously because this may result in products that are unique, innovative and rich, and more challenging or appealing than those that elicit only pleasant emotions. (Cited in Stead et al. 2004, p. 283)

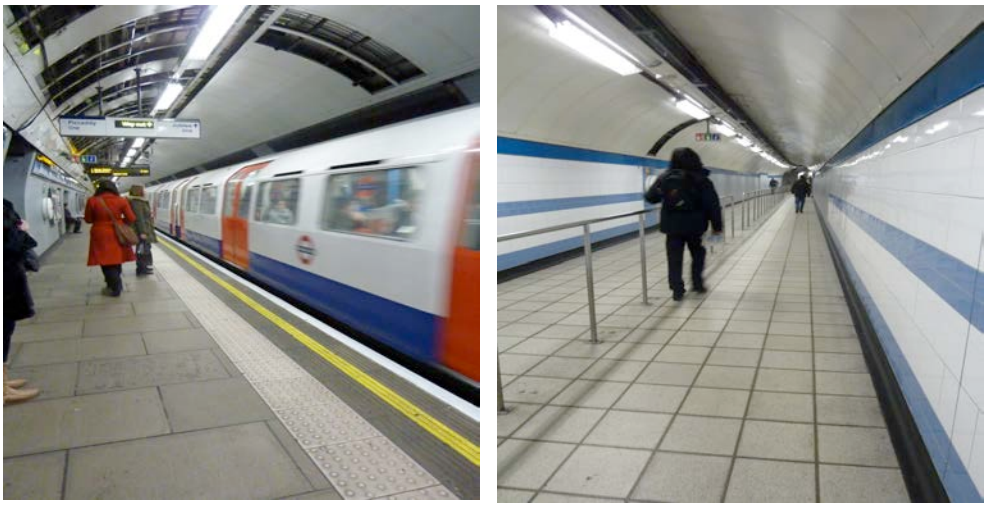


Figure 1. 2. Underground railways in London.
Source: photo by the author.

In addition, the notion of comfort in an aesthetic dimension of behaviour interaction was related to body, movement and space. The research takes account of new changes in culture, that is, technical developments and an urban nomadic lifestyle. Giedion (1955) considers comfort as a changing concept, shaped by the technological developments that mechanise various aspects of life. We live in a technologically advanced, post-modern society, within which are many transitional spaces: airports, roads, and underground railways (see Figure 1.2), where we encounter sudden temperature change, noise and pollution, stress and even crime. In these spaces, women may experience not only actual physical harm, but also psychological dangers, such as fear of attack from other individuals, or feelings of insecurity. In such a world, to be uncomfortable is considered to be a highly undesirable experience, something that should be minimised at all costs. I propose that the body needs more fluid and adaptable objects to enhance body movement and the use of space. Designers need to respond to such places by designing objects and clothes that provide shelter against the weather, noise and pollution, and protection against street crime. The conceptual prototype garments proposed in this research critique current design concepts and methods, in answer to the research questions mentioned in Section 1.3.

1.4.3 The characteristics of movement in relation to emotions

The third overarching motivation in this research was to investigate comfort by focusing on our experience of movement in such everyday activities as walking. Just as emotions can be generated from body movement, the characteristic styles of movement such as walking in everyday activities can provide vital information for recognising affective states, because a walker's movement reflects his/her identity, personality, culture, health conditions or emotions (James 1890; Laban 1980; Wallbott 1982; Montepare, 1985,1987). I walk with my mother in the morning at a nearby park. This walking activity started for the simple reason of preventing bodily ailments, such as heart attacks. My mother had been diagnosed with diabetes and cardiovascular disease; I have also been having back problems for a long time since fracturing my lumbar area. On a fine day, in May 2009, I went to the park with my mother and dog as usual, regularly observing my mother's style of walking and associating this with her bodily movement. On that day, she walked strangely in short and slow steps, which was quite different from her normal gait. Her upper body, including her head, was slightly bent toward the ground (see Figure 1.3). I realised that she was experiencing bad health conditions that day; this resulted in her slow and unsteady walk, and her closed and downward bodily movements.

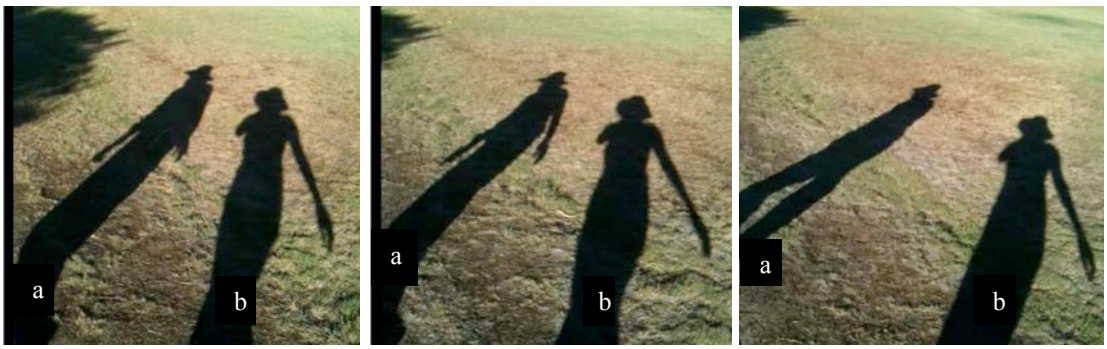


Figure 1. 3. Trajectories of walking and associated bodily movements: (a) shows sequential body figures in a downward-inward bodily movement with short steps; (b) represents a person (myself) observing my mother's bodily movements.
Source: photo by the author.

Observation of walking styles (bodily movements) can detect the emotional state of our body, and whether it is conditioned as 'good or bad.' For instance, if a person is feeling happy, they may walk along with a spring in the step. Conversely, if a person is feeling fearful, they may walk with short, quick or hurried steps. The concept of

‘movement’ is related to our experience of the physical world from inside our own bodies; the way we understand objects around us is related to our bodily experiences arising from interaction with the spatial world (Laban, 1960; Gibson, 1977; Lakoff & Johnson, 1999; van Rompay & Hekkert, 2001; Young et al., 2005). This aspect is related to kinaesthetics, which is the bodily aspect of the sense of movement. Laban (1960) introduced the basic framework of movement analysis, which is a method of notating movement in reference to physical, mental, emotional, social and spiritual aspects. Laban movement analysis made a significant contribution to my research and analysis of people’s walking in emotional experiences. My motivation for this research was to investigate the relationship between emotion and the garment a person is wearing in terms of various characteristics of body movements in everyday activities such as walking. In Chapters 9 and 10 I will address these issues in terms of experiment through 3D Motion Capture (MC) data, and Laban’s quality of movement analysis.

1.5 The research-through-design

For this research, I used a research-though-design process (Frayling, 1993). This process is iterative and systematic cycles. To formalise the process, as suggested by Zimmerman, Stolterman, and Forlizzi (2010), I used the theoretical investigation as a starting point to get ideas and knowledge combined with design activities and four phases of experiments and a pilot study. I will elaborate on more detail how I take account of the research process used with a research-through-design approach in the thesis outline in Section 1.6.

This research-through-design process is highly valued for design-researchers in terms of how link knowledge gained through a methodological balance between theory and practice, between the research and the design, between the designer’s skills and the user’s sensorial awareness. Research-through-design has been promoted as an effective method (Gaver & Martin, 2000; Swann, 2002; Zimmerman et al., 2007, 2010), because it has valuable outcomes, including definition of relevant phenomena in new spaces and perspectives, systematic processes and design/research methods. Research-through-design is similar to Archer’s (1995) concept of ‘research through

practice.' He recognised research through practice as a form of action research, which he defined as:

> Systematic enquiry conducted through the medium of practical action, calculated to devise or test new, or newly imported information, ideas, forms or procedures and to generate communicable knowledge. (p. 6)

In this research, my intention is to develop a conceptual framework for EAI in design practice, directed by a research methodology that draws on action research. My central strategy for conducting this research-through-design focuses on new understandings of comfort proposed in the four contexts of the EAI framework: 'knowing through experiencing, experiencing through unknowing'; 'feeling through touching'; 'seeing through touching'; and 'doing through feeling, feeling through doing' (see Chapter 3). The next section will explain the rationale behind user involvement in this research-through-design project in terms of who and why a particular target group was involved and how I take account of user participant in research-through design process. I also elucidate why I used felted wool as an interactive medium and why research-though design approach is significant in this research project.

1.5.1 User participation

The research experiments with design prototypes, through user participation in design activity. In particular, experiments with participants were combined with interviews and observation of a group of women participants. In-depth research methods were used for the collection of qualitative and quantitative data through participant interviews and observations. These are outlined, where relevant, in each chapter, and an overview of these research methods and their implementation is provided herewith.

The study was conducted with fifteen 'urban nomad' working women, inclusive of university students, aged between 20 and 40. The reason for choosing women as a target group was to capitalise on the evidence that women prefer an emotion-focused approach rather than a problem-focused approach to situations they encounter

(Fishcer, 1973; Grossman & Wood, 1993; Kelly & Hutson-Comeaux, 1999). It is also suggested that the mental process used by women to deal with emotions is different to and more effective than that used by men (Sexes handle emotions differently, 2002). The research cohort was fifteen in number, which takes into account the feasibility and manageability of participant observation using video and interviews in terms of the time frame available for this research. The pilot study was based on a qualitative approach with in-depth interviewing, participant observation, and focus groups involving small numbers to develop and test the adequacy of research instruments (van Teijlingen & Hundley, 2001). The experiments used both quantitative and qualitative methods. Potential participants were contacted through poster notices at Curtin University. An information sheet and a consent form were provided. The research combined the research methods, that is, semi-structured interviews using open-ended questions, together with observation using digital video recording. The use of interview findings and observations was a useful strategy to identify women's emotional responses to reflect on the development of the conceptual prototypes and to explore design principles for constructing garments that provide an experience of comfort. Two areas of study were pursued: arousal triggers and the choreography of interaction.

1.5.2 Study 1: arousal triggers

There were two aims in this phase of the study. The first was to trigger participants' memories of certain situations and past experiences, for example, happiness and fear. From the participants' responses to the interview questions, two scenarios were developed and used for participant observation when the research cohort was interacting with the garment. In addition, responses to the interview questions and observations were used for idea-generation to develop conceptual prototype garments. The second aim was to evaluate participants' responses to haptic experience, which refers to the integration of touching, feeling, and seeing. In this phase participants' use of words and images while interacting with given prototypes were collected, using Kansei Engineering and a Semantic Differential (SD) bipolar model for analysis. This entailed the application of a questionnaire incorporating bipolar responses. In a room at Curtin University, participants were provided with a research protocol comprising open-ended questions they were to answer. The interview was

recorded and transcribed for reference. This part of the study took four months, from January 2010 to April 2010 to complete.

1.5.3 Study 2: choreography in interaction

To explore the human experience of feeling, knowing and doing, particularised as body movement related to comfort, the study tested the participants' physical movements. Bodily movements are raw expression that reveal the deepest feelings and impulses of human nature in a person. In this phase, the design process was approached through 'choreography in interaction,' which provides ways of exploring behaviour in relation to new forms of garment and performance. The process of developing ideas was based on Merleau-Ponty's (1962) theory of phenomenology of perception and Gibson's (1977) theoretical notion of 'affordances,' whereby the values and meanings of objects in the environment can be directly perceived. This also builds upon the Laban (1963) movement analysis of choreography, which is an established form for communication using movement (Newlove, 1993). Participants were invited to the motion analysis laboratory in Building 408, Curtin's School of Physiotherapy, a specialised research facility designed to allow investigation of a wide range of human activities. The participants' own bodies were used as tools to design a prototype of a garment, for example, taking photos and using closed and open body forms. The participants were observed using digital video recording to capture their expressions, behaviours and reactions. Participants' body movement in relation to space was analysed by the agreed research criteria to discover patterns. These patterns of participants' mode of touch and bodily movements determined the new principles for design that has the aesthetic effect of evoking comfort in interaction with objects. The purpose of such new design principles is to contribute to the field of clothing design.

1.5.4 Felted wool as an interactive medium

I chose felted wool as an interactive object to explore how to people touch, feel and move in this research. The reason is that wool has had a long history of acceptance as a 'comfortable' fibre, and is linked closely in the minds of consumers with terms such as warmth and breathability, both properties associated with the comfort of

clothing. Wool has a number of attributes and beneficial properties, such as absorbency, insulating capabilities, resilience, durability, positive tactility and versatility (Holcombe, 1986; Stanton, 2008; Australian Wool Innovation (AWI), 2008). More importantly, this research is linked to an Australian Research Council (ARC) project: 'Innovative Solutions for Wool Garment Comfort through Design in conjunction with the Department of Agriculture and Food, Western Australia (DAFWA). I took on the dual objectives of creating an individual research project that had its own internal rationale, but which also complied with the requirements of the ARC Linkage project. One of the requirements was how to extend existing scientific research into the comfort factors of wool through collaboration between researchers, designers, academics (Curtin University's Department of Design) and industry.

This research expands the practicality and application of wool fibre research outcomes through the development of research methodologies that incorporate innovative and creative design solutions, aspects of human behaviour, and understanding of social, cultural, and emotional contexts. It contributes to the manner in which material innovation, in conjunction with human senses and behaviour, can be communicated and understood by Western Australian wool producers and those who market the product internationally. In addition, this research contributes to filling the knowledge gap between theoretical and scientific approaches to aesthetics and comfort in design methods. In particular, it contributes to the ways in which design methodologies and principles of aesthetic comfort for clothing can assist researchers and designers to design aesthetically pleasing and comfortable clothing that evokes emotional responses though the effective manipulation of space and movement in relation to the body.

1.5.5 Significance of the research-through-design process

The research-through-design process in this research project incorporates three important features, as opposed to 'normal' design processes. The first significant feature is that the development of the prototypes is not initiated by user needs, but by research questions (Frens, 2006) (see Section 1.3). Based on these primary research questions, further sub-questions have been developed after reviewing the literature

(see Chapter 2); this then led to the development of the framework for EAI, and the conduct of experiments in order to answer the research questions.

The second significant feature of this research-through-design project is how the development of the conceptual prototype garments was formulated by opening a new space for users, 'designing experience or interactions' in relation to their need for comfort, which allows researchers to answer the research questions through experiments (Frens, 2006). Specifically, the conceptual prototype garments were the subject of experiment in specific situations, with such boundaries as: secure vs. insecure situations; blindfolded vs. non-blindfolded. This also involved such subjective past experiences as being happy or fearful, so as to understand human behaviours. In other words, conceptual prototype garments were designed not to evaluate the final product but to explore speculative new ideas generated by the conceptual framework of EAI in the context of design principles as applied to clothing comfort.

The third significant feature of the research-through-design process is self-reflection on the researcher's part. Just as users play an important role in documenting their behaviours and understanding their unexplored skills, emotions and bodily experiences, designers must also use their body and bodily experience when they generate ideas and concepts and design an object specially, for movement-based interaction (Hummels et al., 2006). I participated in a design project incorporating a workshop for me as a designer and researcher. As a designer, I documented my data using photographs, video recording and transcription to inform the design process. I also documented my experiences and the development of design concepts and ideas, which arose from them. I perceived myself as the point of view from which I perceived my own senses tapping into my intuition, my bodily experience was a part of my design. I designed conceptually from a first person perspective while intermittently taking a third person perspective. In this respect, I was also behaving as a researcher, particularly in the manner in which I reflected upon and documented my design practice, methods and evolving thinking. Thus, this research draws upon the 'designer's [myself as a designer and researcher] visionary ability — an ability to imagine and synthesise solutions which users can recognise as relevant to their needs' (Bowen, 2009, p. 31). Accordingly, in the research-through-design process, I

assumed the role of researcher by critically reflecting, not only on participants' activities, but also on my activities prior to another research cycle of action and reflection. In action research, this process of ' act (bodily experience), reflect, think (idea generation) and then act (design), explore (experiment), and reflect' is an ongoing cyclical one.

1.6 The research-through-design procedure (outline of the thesis)

The remainder of the thesis is structured to follow the research-through-design process. The research process follows cycles: generating ideas — the theoretical investigation, establishing a conceptual EAI framework, and design workshop; designing — the design practice and experimenting through the user participant; evaluating — evaluation of the EAI framework for garment design, and finally, reflecting — reflection on the EAI framework for garment comfort and guidelines for design principles. The thesis is structured into four parts (see Table 1.1).

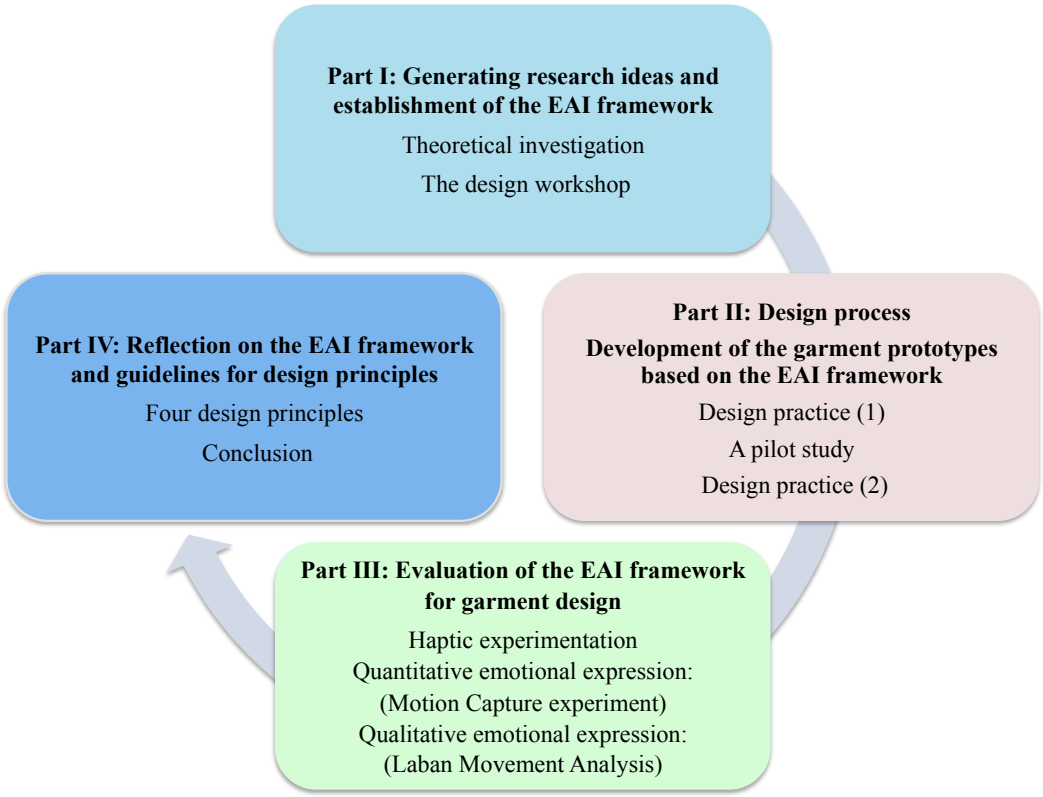


Table 1. 1. Flow chart of research-through-design process

Part I: Background and establishment of EAI framework

Part I is set out to establish the research ideas and knowledge. This part is composed of three chapters, Chapters 2, 3 and 4.

Chapter 2 addresses theoretical ideas. Theories that are embraced ground the enquiry and design activity by describing the process of research, and by the development of ideas and knowledge with which I raise further adjunctive sub-research questions. The practical part of this research is informed by a theoretical review of the broader areas of design practice that employ tactics derived from the theory discussed in this chapter. A more detailed outline of the thesis follows. This chapter describes relevant theories: phenomenology of perception and embodied experience (Merleau-Ponty, 1962); pragmatic aesthetics (Shusterman, 2000); idea of affordances and haptic perception (Gibson's (1962, 1966, and 1979). The theoretical review includes an investigation of the current state of aesthetic theory as it applies to clothing. I formulate misconceptions in aesthetic relationships between comfort and design, and formulate questions that structure the design process of emotionally driven clothing.

Chapter 3 sets out to formulate the EAI framework. The theories frame the research and underpin the EAI. I propose four contexts of the EAI framework: knowing through experiencing, experiencing through knowing; feeling through touching; seeing through touching; and doing through feeling, feeling through doing. Each context of the EAI framework discusses and shows how I develop it and what it is applied. The conceptual framework is essential and key element of the research in order to develop conceptual design prototypes and guidelines for design principles in the context of garment comfort.

Chapter 4 focuses on research through a design workshop called 'Fremantle on the Edge,' in which I engaged in active self-experimentation and interaction with nature and my body. The aim of design workshop was to test and evaluate validity the initial context of EAI framework. In the workshop, I explored how nature is conceptualised through bodily experience while interacting with five elements: water, sand, shadow, movement and body. Those experiments were not from knowledge based on theory, but from fully sensorial and bodily activities based on explorative

research. This experiment influenced and justified further the conceptualization of EAI framework and the development of prototypes. A part of this discussion was published as a refereed journal paper for Design Principles and Practices: An International Journal of Design in Society (Jeon, 2013).

Part II: Design process – Development of the garment prototypes based on the EAI framework

Part II sets out the design process. This phase addresses how the EAI framework was applied to the design process.

Chapter 5 sets out to present the initial garment prototype, Trans-For-M-otion. Trans-For-M-otion was designed around adaptability, emotion, and movement reflected on theoretical ideas (Chapter 2) and my sensorial bodily experience through experiment (Chapter 3). In other words, the development of initial conceptual prototype was reflected on what I have embarked on establishing research ideas from research-through-design cycle Part 1. The experienceable prototype was designed for exploring people's reactions, unexplored skills and speculative new ideas. This initial prototype further influenced other three conceptual prototypes. The design process followed, building and testing several conceptual garment prototypes iteratively. A part of this discussion was published as a conference paper for the International Association of Societies of Design Research (IASDR) (Jeon, 2009).

Chapter 6 focuses on a pilot study called 'choreography in interaction,' which can be described as 'emotionally expressive movement with garments'; the study interrogated and tested two different emotions, 'happiness' and 'fear.' The aim of this experiment was to investigate how women's past emotional experience of 'happiness' and 'fear' affects specific, meaningful, bodily expressive actions while interacting with a conceptual prototype design. The pilot study is presented, demonstrating the initial testing and evaluation of the Trans-For-M-otion garment prototype. This pilot study was critical to the design process because it was the first reflection on the EAI framework based on the user involvement. I elaborate on how the EAI framework is useful and is validated for further experiments with user participants. This chapter is after all about ensuring greater emotional connection

through interaction and user centred design, so the user participants' feedback is essential to the design process. A part of this discussion was published in Proceedings of an International Conference of Kansei Engineering and Emotion Research (Jeon, 2010).

Chapter 7 addresses the further development of the conceptual garment prototypes. In discussing the conceptual prototypes, outline how the first conceptual garment and importantly testing of that garment influenced the design of the other conceptual garments. The key three conceptual garment prototypes specially is discussed in detail ensuring that how each conceptual garment is constructed by designing, building and testing highly experiential versions incorporating different interaction-styles and how its concept has a clear research purpose that is related to the theory and the main research questions. A part of this discussion has been published as a conference paper for the Research Through Design (RTD) Conference Proceedings (Jeon, 2013). A selection of the conceptual prototype garments featured in the 'Beyond Garment Exhibition'[7] at the WA Museum, and were illustrated in four books: (1) *Australian Council of University Art and Design Schools (ACUADS) Research* edited by Ross Woodrow (2009); (2) *Advanced Textile for Health and Well-being* edited by Marie O'Mahony (2011); (3) *Fashion Futures* edited by Bradley Quinn (2012); (4) *Textile Visionaries: Innovation and Sustainability in Textile Design* edited by Bradley Quinn (2013); and (5) forthcoming *Fashion Design for Living* edited by Alison Gwilt (2014).

Part III: Evaluation of the EAI framework for garment design

Part III is about testing the EAI framework. In this phase user participation through three steps of experiment is explored in detail Chapters 8, 9, and 10. The intent for these experiments was not to inform an object-centred research field, but rather to build an understanding of how the nature of interaction is experienced in use. Three phases of experiments with user participant observation and interviews about participants' reflections on their actions in this study were conducted as follows:

[7] The exhibition 'Beyond Garment' is available for access at http:// www.museum.wa.gov.au/beyond-garment/

Chapter 8 sets out to conduct haptic experiments. The experiment tested the EAI framework: doing through feeling, feeling through doing; feeling through touching; seeing through touching. The aim of experiment was to investigate the comfort factors of users 'feeling good or bad.' The experiments were conducted with the research cohort (female, n=15, age of 20-40 years) to test the following research questions: How do women touch, move, and feel in two sets of conditions — blindfolded vs. non-blindfolded and active vs. passive touch? How do they touch the four conceptual prototypes to feel through active and passive and movements? How do unconscious movements influence affective states? Can the touch of women's hands be related to the body part being emotionally touched? And How does what women touch affect what they see? This research was employed in research techniques such as Kansei Engineering including the Semantic Differential technique in order to understand judgments of the comfort of clothing. A part of this discussion was published in Proceedings of an IDA Congress Education Conference (Jeon, 2011).

Chapter 9 discusses quantitative emotional expression analysed by the Motion Capture (MC) experiment. MC technique tested the physical movement of participants (female, n=8, age of 20-40 years) in the context of understanding human gait behaviour, correlating and comparing three different walk types, 'natural,' 'happy,' and 'fearful', and three different garment types, 'normal,' 'happy,' and 'fearful'. This investigation has two connected parts. The first part was based on the 3D Motion Capture (MC) experiment used by MC technique. The MC technique provides quantitative data for analysis of step, velocity and body position of hands, head, legs, and trunk. This experimentation was designed to assist in scientific testing of the performance of garments in relationship with the way a person walks. A part of this discussion was published in proceedings of the 8th international conference on Design and Emotion (Jeon, 2012).

In conjuction with Chapter 9, Chapter 10 is the second part of the investigation of human movement analysed in the context of qualitative emotional expression. The fact that the method of quantifying bodily movement through 3D Motion Capture (MC) data could not fully cover a person's qualitative dynamic movement — in particular additional features such as eye gaze necessary to detect bodily motion —

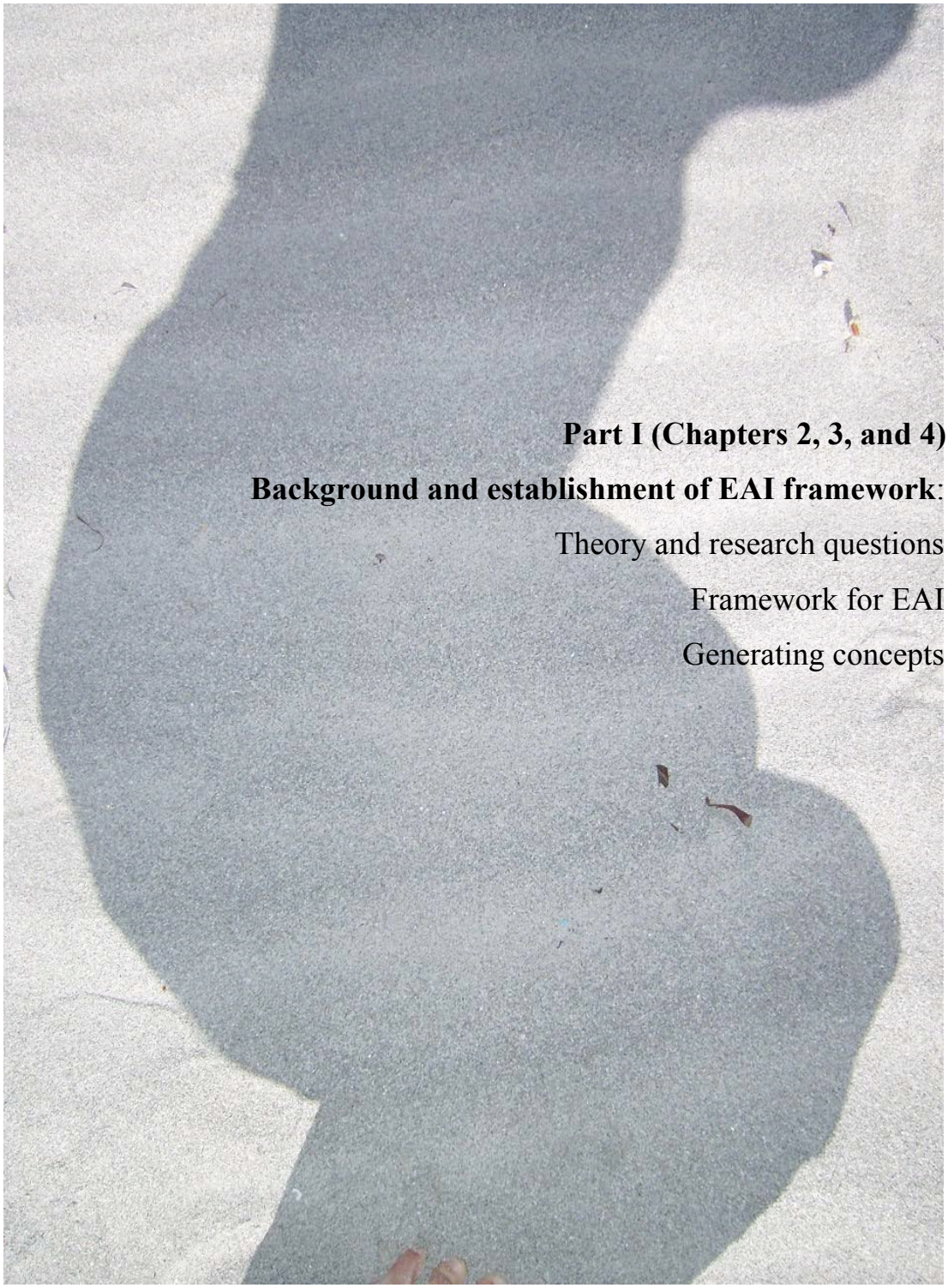
led to a theoretical investigation using Laban Movement Analysis (LMA). In this chapter, LMA is used to analyse rich interpretations and important qualitative descriptions of movements, based on a review of 2D video data. An understanding and identification of the participants' qualitative, dynamic character of movement in comparison with three different walk types, 'natural,' 'happy,' and 'fearful'; and three different garment types, 'normal,' 'happy,' and 'fearful', using 2D video data, is analysed using Laban's movement theory. These experimental MC technique and LMA theoretical approaches, collecting both theoretical qualitative data and statistical quantitative data in order to analyse different types of walking and garment types comparatively, have provided an in-depth knowledge and a balanced understanding of human senses, experience, and bodily movement.

Part IV: Reflection on the EAI framework and guidelines for design principles

This part is about evaluating the effectiveness the EAI framework for garment design and guidelines of design principles reflected on three experiments in Part III described in Chapter 11. And then, Chapter 12 concludes.

Chapter 11 sets out to discuss EAI framework and elucidate guidelines of design principles, which are drawn, reflecting on four phases of experiment and the pilot study. In particular, the framework of EAI contextualised as understanding comfort, is identified in terms of: 1) knowing through experiencing, experiencing through unknowing; 2) feeling through touching; 3) seeing through touching; and 4) doing through feeling, feeling through doing.

Chapter 12 is the conclusion in which the conclusions of this research are drawn, reflecting on the entire body of research-through-design. My original contribution to the field of knowledge and research-through-the design process, especially in terms of the gap between theoretical and actual design activity, and between phenomenal representation of nature and scientific approaches to aesthetics and comfort in clothing design methods, is identified. I offer suggestions and possible directions for further work that could develop and extend the research.



Part I (Chapters 2, 3, and 4)

Background and establishment of EAI framework:

Theory and research questions

Framework for EAI

Generating concepts

Body, sand, and, shadow.
Source: photo by the author, taken when attending a workshop, 'Freemantle on the Edge' WA, in 2009

Chapter 2

Theory and research questions

Chapter 2

Theory and research questions

2.1 Introduction

This chapter is about formulating theoretical ideas and knowledge in nascent the early phase of the research-through-design process. Chapter 1 described the purpose of the research: to understand better the comfort factors of users' aesthetic experience, in complex phenomena of both physical sensations and socio-cultural, physical (sensory-motor) and psychological states, while acknowledging the influence of emotional factors. I have also discussed how I motivated the sensorimotor-driven research in relation to the comfort factors of users' aesthetic experience in such daily activities as interacting with nature, touching, walking, and other bodily movements. Accordingly, This chapter describes the relevant areas of theory and design research that have been the starting point for this research and provided a context for this thesis. This chapter explains how I position myself in relation to these theories — Merleau-Ponty's (1962) phenomenology of perception and embodied experience, Shusterman's (2000) pragmatist aesthetics, Gibson's (1979) affordances — and how they contribute to generating a framework of 'Enriched Aesthetic Interaction' (EAI) in the four contexts of garment comfort, which I will elaborate on and elucidate in Chapter 3.

The primary research questions in this thesis addressed are:

- How can design for comfort incorporate aesthetic experience in the context of clothing?
- What design principles can be developed to provide aesthetic comfort for the user, in clothing that is worn in daily life?

Based on these primary questions, a review of the literature was conducted based on the following key words:

- Aesthetic, function, aesthetic experience, emotional design (Kansei Engineering), embodied experience, the multi-sensory nature, haptics, human skills, body, intuition, subjectivity, space, movement, phenomenology, and clothing.

These key words enabled an exploration of the following sub-questions:

- Can the dimension of comfort in everyday activities be related to aesthetic quality? If so:
- How can dynamic bodily expression and emotion in everyday activities, for example, ways of touching, walking, moving, and interacting with nature, affect the development of innovative design concepts in the design process, in order to develop the framework of EAI in the context of clothing comfort?
- How can human sensory responses in aesthetic experience be reflected in the design of the comfort of garments? and
- Can the phenomenon of movement quality, such as the relationship between the body, space and movement, be applied to enhance the comfort of clothing?

In reviewing the sources of information relevant to the research questions, the following steps were taken:

- Identifying the research problems by investigating the misconceptions about aesthetics in relation to comfort (Section 2.2);
- Overviewing current issues on aesthetics in interaction-centred design research, including the relationship between aesthetics, function, interaction, and clothing practice, as it applies to the area of emotion- (experience-) driven interaction design (Section 2.3);
- Conducting a search for theoretical aspects to reconceptualise comfort, integrating the contexts of understanding: synaesthetic, kinaesthetic, and emotional (Section 2.4). The theoretical framework of this study drew on aspects of the following:

- Phenomenological theory (Merleau-Ponty, 1962), to understand the nature of human experience through embodied interaction, such as perceiving and experiencing touch and movement;
- A pragmatic aesthetics theory (Shusterman, 2000), to understand the nature of human experience through the relationship between aesthetic experience and comfort, and incorporating aesthetics into the design approach; and
- Affordance theory (Gibson, 1979), to understand psychological action (movement) and the application of affordance theory into clothing design.

The literature review in this chapter selects information relevant to the research questions. Theories aforementioned above were relevant to answering the research questions. In particular, the theories provided insights into: 1) the way in which people experience the senses through body — in particular, lived body as the first-person perspective and the body as an object in space, which can be perceived by others; 2) the ways of understanding human experience and human skills (doing, feeling, knowing); and 3) the ways of understanding people movement in daily activities. Accordingly, the literature review informed the development of the EAI framework. This framework formed the basis for experiments through user participation, which will be discussed in Chapters 4, 6, 8, 9, and 10. The framework was also used for design practice as sketched in Chapters 5 and 7.

2.2 Misconceptions about aesthetics in relation to comfort

Before discussing relevant theories, it is necessary to identify the research problems related to comfort and aesthetics in scientific research, and provide an overview of current issues on aesthetics in interaction-centred design research.

When human factors in relation to a product of textile and clothing design are analysed, the emotional dimension of comfort is mainly categorised in relation to necessity and usability. The scientific, functional, transparent, easy to use aspects are used rather than the artistic qualities of the product, or the ambition, intuition,

experience, emotion, and personality of the user (Christensen, 2004, pp. 10-13). For example, scientific research on textiles and clothing is primarily concerned with thermal comfort (Lumley et al., 2003), thermo-physiological comfort (Holcombe, 1986), and physiological comfort (Kawabata et al., 1994; Karl, 2007). Many of these issues have been investigated in relation to material properties, based on laboratory experiment on fabric tactile properties (softness to hardness, elasticity, fitability) (Wilson & Laing, 1995), fabric thermal properties (conductivity), and fabric moisture properties (absorption, wickability) (Hollies, 1989).

These studies indicate that even though the tactile sense has been almost exclusively equated with the visual sense in the textile fashion industry, it is not always obvious to what extent these research areas (Kawabata et al., 1994; Karl, 2007) have been integrated into garment design, or if they have influenced the commercial market. In addition, the scientific data on skin comfort and wool has not been fully integrated with artistic or innovative clothing design solutions. Many of these issues remain to be investigated in relation to: 1) the physiological needs of the user; and 2) properties of the material in relation to sensory perceptive and other tactile considerations.

Research has rarely been concerned with the combination of sensory, cognitive and emotional levels of experience. These include a synaesthetic understanding of comfort, which concerns the design use integrated with all the different sensory qualities; and a kinaesthetic understanding of comfort, which is focused on being able to touch, to feel, and on the forms of touch through movement. These interactions with the material can be characterised as sub-functions, which do not seem to be part of researchers' or designers' considerations when designing clothing, in particular. Fiore et al. (1996, p. 99) contend that the sense of comfort involving tactile elements of textiles and clothing is not related to aesthetics, because it does not include enhanced pleasurable sensations. Research has focused on avoidance of negative sensations (Hollies, 1989), 'functional fabric comfort factors' (Paek, 1984, p. 339), 'functional garments' (Watkins, 1998), and 'protective clothing fabrics' (Laing & Ingham, 1983). More importantly, in further research into consumers' needs and desire for clothing, it was found that consumers have differentiated

between the concern for comfort and the concern for aesthetic qualities (Morganosky, 1987; Winakeor et al., 1980). Researchers' views of the object's aesthetic worth have been limited to a beautiful shape, a pleasant surface texture, a trendy colour scheme, practicality, and functionalism.

These researchers have not demonstrated how comfortable and pleasurable sensations are different in an aesthetic context. Fenner (2003) argued that an experience is defined as aesthetic in conjunction with an imaginative or associative activity. If not, it is mere pleasure. I argue that, just as Crowley (1999) contended that the comfort derived from material goods is not merely about necessities as opposed to (aesthetic) novelty, the conception of comfort has to be integrated into areas beyond material factors. The aesthetic appreciation of clothing needs to be considered in physical, psychological and socio-cultural contexts, comprehending human perception, senses, cognition, experiences and action in urban, nomadic lifestyles that are rapidly changing with technical development.

2.3 Overview of current issues of aesthetics in interaction-centred design research

To address the research problems related to comfort and aesthetics in scientific research, and reconceptualise comfort in conjunction with contemporary, functional demands of life in physical, psychological, and socio-culture contexts, this research question was formulated: what functions are desirable if comfort is highly regarded as a dimension of good functionality, designed to enrich aesthetic experiences? In answer to this question, the following sections give a brief overview of current issues on aesthetics in interaction-centred design research. These include:

- The relationship between aesthetics and function (Section 2.3.1);
- Current research on the aesthetics of interaction (Section 2.3.2);
- Current developments in emotion-based clothing design practice (Section 2.3.3).

2.3.1 Relationship between aesthetics and function

'Aesthetics' comes from the Greek word '*aesthesis*,' meaning gratification of the senses or sensuous delight. Aesthetics is the branch of philosophy dealing with the beautiful, chiefly with respect to theories of its essential character, tests by which it may be judged, and its relation to the human mind, as well as the branch of psychology relating to the sensations and emotions (Goldman, 2001). In other words, aesthetics includes the way we communicate through our senses of vision, hearing, touch, taste, smell, and movement, and our emotions and cognition (Hekkert, 2006; Salem et al., 2009). The emphasis on either aesthetics or function has been a controversial issue throughout the history of design. Function or functionalism, rooted in the dictum 'form follows function', as coined by the American architect Louis Sullivan (1947), refers to the notion that objects should be: simple, honest and direct; well adapted to their purpose; bare of ornament; standardised, machine-made, and reasonably priced; and expressive of their structure and materials. This principle has defined the course of progressive design for most of this century (Marcus, 1995, p. 9). On the other hand, aesthetics privileges ambiguity, ornamentation, individuality, complexity and emotion (Marcus, 1995, p. 9). In terms of function, however, the understanding of functional purpose has shifted from actual function, that is, how a form is intended to be used, to how the form is performed and felt, and how its meaning is experienced by people. For this reason, the dictum 'form follows function' becomes transformed into: form follows emotion, senses or meaning. It is important to stress in this respect that function is not restricted to utilitarian purposes. 'The function of a product can very well be experiential, like to enjoy, to enrich, to inspire, to strengthen one's identity, etcetera' (Hekkert, 2006, p. 168). In addition, the function of a product can be rich and intellectual, existing, not in final material form, but as a prototype, open to experience (Hummels, 2011), semi-real, fictional (Dunne, 1999). Dunne (1999) emphasised that aesthetics is the aesthetics of use (experience), which is incorporated into large systems utilising appearance and function, interacting with society and culture and users' everyday experience of using the product. These perspectives indicate that if the products embody their function in relation to emotional aesthetics and the body's physical, psychological and socio-cultural interactions, they give rise to people's emotional responses to the

object. The effective expression of the feelings of the designer is also essential to the satisfaction of emotional and aesthetic feelings in the creative process.

2.3.2 Aesthetics of interaction

The concept of aesthetic interaction has been focused on emotional-aesthetic experience during the users' interactions with the product, rather than on the aesthetics of form in the research area of product design research. There are examples of this emphasis in the literature: 'enjoyment' (Overbeeke et al., 1999), 'beauty' (Djajadiningrat et al., 2000), 'engagement' (Hummels, 2007), 'fun' (Blythe et al., 2003) 'Kansei experience' (Nagamachi, 2002; Salem et al., 2009), 'pleasure' (Jordan, 2000; Hekkert, 2006), 'comfort' (Vink, 2005), and 'aesthetic experience, experience of meaning, and emotional experience' (Desmet & Hekkert, 2007). Such studies have focused on human characteristics, perceptions and experiences, and producing features and functions from a more holistic perspective. Overbeeke et al. (1999), for example, asserted that aesthetics and interaction are tightly interwoven, so that the aesthetics of a product must be shaped according to its functions and roles, and its interactions must be judged by their aesthetic qualities — both sensory and conceptual. In particular, the aesthetics of interaction has focused on the enjoyment of the experience rather than ease of use. They further suggest that user-centred design should be interpreted as showing respect for man as a whole. They identify three types of human skills: cognitive (knowing), perceptual-motor (doing), and emotional (feeling) skills (Overbeeke et al., 1999; Hummels et al., 2001). In the field of human experience, Wensveen (2005) investigated further the *affective interaction* approach to focusing on a person's emotional experience. He explained that the domains of knowing (cognition — what a person knows and believes), doing (behaviour — what a person does), and feeling (affect — what a person feels) influence each other. I will discuss the relevance of these human skills in my design practice in more detail, underpinned by Gibson's affordances theory, in Section 2.4.3.1.

The focus on subjective aesthetic experience such as intuition in current research into emotional design has increased attention on the role that the body plays in registering

our senses and shaping forms through bodily movement. Researchers now are adopting a bodily focus: experience shaped by our 'sensorium,' which is our bodily interface with our environment (Howes, 2004), 'embodied cognition' (van Rompay et al., 2001), 'behavioral richness' (Frens, 2006), 'the role of touch' (Sonneveld & Schifferstein, 2008), 'multi-sensory experience' (Schifferstein & Spence, 2008), 'movement during interaction' (Blom & Chaplin, 1988; Buur et al., 2004; Hummels et al., 2007; Moen, 2006; Loke & Robertson, 2010), 'pleasantness' (Rozendaal & Schifferstein, 2010), and 'aesthetic interaction' (Ross & Wensveen, 2010).

2.3.3 Current development of emotion-based clothing practice

Design and emotion or experience has consistently been an interest of clothing design practice (The Emotional Wardrobe, 2012; Stead et al., 2004; Marzano et al., 2000; CuteCircuit, 2012; Philips Smart Connections Clothing, n.d.; Smart Textile Services, 2012). The current practices and studies of emotion-based clothing practice involve divergent views. There are two significant approaches to investigating emotions in clothing design: firstly, those based on the body-sense centred approach which is integrated with science/technology-enhanced aesthetics in relation to the emotional responses of the wearer (The Emotional Wardrobe, 2012; CuteCircuit, 2012; Philips Smart Connections Clothing, n.d.; Smart Textile Services, 2012); and secondly, those based on the movement-driven design approach such concept of transformation to adapt body movement to users' cultural and emotional requirements as: the transformation of furniture into dresses (Chalayan, 2000; Miyake & Fujiwara, 2001); Möbius strip formed as infinite possibilities (Yoon, 2009); kinetic dress formed by the wearer's activities and mood (CuteCircuit, 2012); and 'spatial prosthesis' formed by habitual body, phenomenal space, preferential pane, and constructive line (Reinhardt, 2005, p. 48). In this sense, sartorial fashion is defined as the behavioural interface, such as evolution of surface texture, structural properties, and responsive surface (Reinhardt, 2005, p. 66). In fact, the boundaries between architecture and fashion, technology and textiles and services have become increasingly blurred and intertwined with trans-disciplinary design approaches. For example, both architecture and fashion disciplines are based on the human body and on ideas of subject well-being and theories of space, volume, and movement. Each

functions as shelter or wrapping for the body — a mediating layer between the body and the environment — and can express personal, political, and cultural identity (Hodge, 2006).

2.3.3.1 New technologies and their impact on the emotion involved in clothing design

The integration of new technologies and the adoption of interdisciplinary practice are challenging conventional perceptions, the nature of fashion design, and objects. New technologies have had a significant impact on fashion and textile design in the context of emotional design. This is because new technologies can offer new design possibilities when integrated with textiles. Textiles integrated with technology, such as computing, sensors, and actuators in the textile itself, are called smart textiles. Smart textiles are types of material that has the capability to sense their environment or external stimuli, and to respond to the external stimuli and adapt their behaviour to it (Schwarz et al., 2010). They enable monitoring of people who need to pay significant attention to their health risk, such as those with dementia (ten Bhömer et al., 2013) and osteoporosis (ten Bhömer et al., 2013), and chronic illnesses (Philips Smart Connections Clothing, n.d). They also help adaptation and change in people's emotions (The Emotional Wardrobe, 2012) and new meaning of sustainability using interactive fairytale stories on smart textiles with augmented reality (Kuusk et al., 2013). This interaction leads to new design opportunities for interaction styles. In addition, the development of smart textiles has shifted from traditional technology driven approaches — functionality, efficiency, and materiality — into challenging non-technology driven approaches — emotional, societal, and serviceable adaptation (Smart Textile Services, 2012). The transitional paradigm of smart textiles development comes from acknowledging the importance of the body and senses from how we feel, which can be related to how my research is needed to consider the notion of comfort.

2.3.3.2 Emergence of new forms from movement-based on clothing design

New emerging forms can be found in how we move and how we interact with an object. Herein lies the importance of acknowledging the body and body posture reflected in movement. This perspective can overlap with the aforementioned in the

body-sense-centred approach. For example, textiles can be moved when our body moves. They can create different silhouettes by how we move. There are opportunities to research and develop movement-based-interaction styles that fit close to the body interaction, acknowledging the importance of the body and its posture in interactions. At a glimpse, the movement based on interaction styles changes the nature of the fashion design and objects all involved in the field of fashion. This is because that concept of movement offers rich interaction styles that involve the reciprocal interaction between the person and artefact integrating bodily actions, cognition, emotion and perception.

Hummels et al. (2007) emphasise that the source of movement contributes to many possibilities for design research and practice to which design practitioners and researchers should pay more attention. They further point out the importance of *doing* and *experiencing* — not only while users are interacting with an object, but also while designers are generating ideas and concepts and designing for movement-based interaction. This movement-based interaction focused on design approach could change the role of the fashion object towards individual identity, comfort, pleasure and meaningful engagement. Clearly, the work of designers such as Issey Miyake and Hussein Chalayan, and other researchers (Marzano et al., 2000; Stead et al., 2004; CuteCircuit, 2012) indicate how emotion in conjunction with movement is an everyday phenomenon having an important value as an aesthetic design element for developing garments in relationship with the body. In addition, research aided by technology, such as body movements analysed by motion capture, computer software and sensors, indicates that garments can lift a person's performance. These studies have paid attention to user-centred and interaction-centred research views rather than technology-driven, product-centred views, which focus attention on physical form and technical function. For interaction-centred research, design follows artistic criteria and becomes concerned with aesthetics, self-expression, personal philosophy and subjective reactions to the products.

2.4 Conceptualisation of comfort parameters in a theoretical context

Above, I reviewed the understanding of comfort in conjunction with the new demands of function in an aesthetic, physical, psychological and socio-cultural context, and gave a brief overview of current issues around aesthetics in interaction-centred design research, including the relationship between aesthetics and function, defining aesthetic interaction, and current emotion-based developments in clothing practice. These perspectives indicate that it is essential for designers and researchers in the field of product and fashion design: 1) to understand the product's function related to emotional aesthetics; and 2) to explore human characteristics, perceptions and experiences in order to produce features and functions from a more holistic perspective in the creative design process.

Therefore, I have concentrated on the important notions of aesthetic experience (interaction with the product) related to comfort in the light of the theoretical research. This section discusses the relevant theoretical research that supports my practical work, and informs the development of the EAI framework in the context of clothing comfort. As already indicated, there are three main theoretical areas relevant to this study:

- Phenomenological theory (Merleau-Ponty, 1962): This section is reviewed to understand the nature of the human body and experience from the point of view of phenomenological and embodied interaction (see Section 2.4.1). This section also describes: how haptic experience of touch and movement are related to the phenomenological standpoint (see Section 2.4.1.1).
- A pragmatic aesthetic theory (Shusterman, 2000) (see Section 2.4.2): This section describes ways of understanding the nature of human experience through the relationship between aesthetic experience and comfort in everyday activities (see Section 2.4.2.1). The application of aesthetics to clothing design approaches (see Section 2.4.2.2) is also discussed.
- Affordance theory (Gibson, 1979): This section is reviewed to understand psychological action (see Section 2.4.3.1), and the application of affordance theory to clothing design (see Section 2.4.3.2), in terms of understanding the bodily aspect of kinaesthetics (see Section 2.4.3).

2.4.1 Phenomenological representation of embodied interaction

The human body and experience are discussed from a phenomenological point of view (Merleau-Ponty, 1962; Dourish, 2004), based on a holistic perspective of human experience that involves physical and emotional aspects as well as the cognitive. In particular, emotional aspects of human experience are not thought of as biological, measurable, and objectively present, and in this way traditional rational cognition research neglects or demotes emotion and felt experience (Damasio, 1995; Scherer, 2005). For example, Damasio (1995) from the perspective of neuroscience argues that the relationship between emotions and human activities (experience) require only rational thought, such as problem-solving and decision-making. This perspective indicates that emotion and subjective felt experience in relation to aesthetics in interaction can be only acceptable if their parallel relationships are logically objectified. His statement has begun to contradict a view of cognition as controlled, precise, and objective and a view of emotion as intuition, vague, and subjective. From the new emergence of cultural, sociological, anthropological, and phenomenological critiques, understanding the construction of emotion and felt experiences cannot be separated between affect vs. cognition, subject vs. object, nature vs. nurture, universal vs. local, and conscious vs. unconscious (Lane & Nadel, 2000; Barrett & Wagner, 2006).

My doctoral research project is inspired by Merleau-Ponty's (1962) theory of the phenomenology of perception. His central aim was to reconsider how our perception is formulated phenomenologically by the basic experience of the world. He emphasised the body as the primary source of knowing the world. He focused on the concept of the body-subject so that consciousness, the world, and human body, are intricately intertwined and mutually engaged. In this sense, his idea of phenomenology emphasised the perceptual, bodily intertwinement between experiencer and thing. In other words, according to Merleau-Ponty (1962), this means that subject and object cannot be separated, as each is part of the other. His idea of phenomenology of perception therefore has facilitated a more nuanced understanding of the variable concepts of personhood. In this sense, he rejected conceptual dualisms such as inner-outer, self-other, subject-object, person-world, and people-environment. His idea is close to the dynamic monism of the Eastern

philosophy of Buddhism and Taoism. In Buddhism the ultimate nature of the world is described as emptiness, which is inseparable from sensorial objects or anything else (Kalupahana, 1992). In Taoism, all life is seen as part of a unified whole or a unity that originates from an unexplainable source. Thus the universe is considered a vast oneness. In addition, the backbone of understaing phenomenology of percpetion as evisioned by Merleau-Ponty (1962) was described as 'être au monde.' He pointed out that corporeity connects with space (l'espace), the notion of being-in-the world ('être au monde') and one's own body (le corps propre). This means that we are not only in the world but also belong to it. We have a relationship with the world, interact with it and perceive it in all dimensions. We perceive the world in terms of what we can to with it, and by physically interacting with it we access and express this meaning. Through involvement in the world —being-in-the-world — we (the perceiver) experience all the perspectives upon that object coming from all the surrounding things of its environment, as well as the potential perspectives that the object has upon the beings around it. Each object is a 'mirror of all others.' Our perception of the object through all perspectives is an ambiguous perception founded upon the body's primordial and innate involvement and understanding of the world and of the meanings that constitute the perception. It is not that of a propositional, or clearly delineated, perception. Accordingly, our bodily involvement with things is always provisional and indeterminate; we encounter meaningful things in a unified though ever open-ended world. In *The Phenomenology of Perception* Merleau-Ponty wrote:

> Insofar as I have hands, feet; a body, I sustain around me intentions which are not dependent on my decisions and which affect my surroundings in a way that I do not choose. (1962, p. 440)

In applying phenomenological theory to design practice, Paul Dourish (2004), in his book *Where the Action is*, applied the role of embodiment in the design of interaction. Dourish argues for embodied interaction, which is a larger part of tangible interaction from a phenomenological standpoint. He defines embodied interaction as 'the creation, manipulation, and sharing of meaning through engaged interaction with artefacts' (p. 126). In his philosophical and experimental arguments,

he concludes that embodied interaction as an approach hinges on the relationship between people's actions and a product's function, which creates meaning as part of a larger system. Interaction design undertaken from this perspective 'turns our attention away from the artefacts themselves and toward the ways in which people engage with them in different settings' (p. 30). In other words, embodied interaction is a result of a specific understanding of how the world is encountered and interacted with. It should be understood that 'man can interact with the world through doing and not through knowing' (Ferns, 2006, p. 37).

My doctoral research project herein draws on this phenonmenolgical approach. The aim of using the theoretical study has twofold implications. The first implication of developing the EAI framework was Merleau-Ponty's interpretation of perception, involving a lived dynamic between the perceptual body and the world as two aspects: the live-body and the body as an image. The former refers to the body as experience in a first-person perspective. It is one's ability and power to perceive, to act and to feel comfortable. For example, woolen clothing is known for its soft warmness because it immediately evokes in the lived body its experienced qualities. The reason is that, through bodily perception, we immediately engage with and are aware of the thing because it mutually engages with us to offer a reciprocating, pre-reflective sensibility and signification. The lived body is your own body as experienced by yourself, as yourself. Your own body manifests itself to you mainly as your possibilities of acting in the world. In the context of the development of the EAI framework for clothing comfort, I considered the notion of subjectivity and intersubjectivity; that is, personal emotional experience and mental states, such as feelings of 'being relaxed' and 'being confident,' as part of identifying the comfort dimension. I especially applied this context of the theoretical idea into how emotional responses to the interaction are expressed in terms of how people hold and wrap their bodies. The latter refers to one's body as an object in space, which can be perceived by others (Lenay, 2010). This means that the experience of your own body as your own subjectivity is then applied to the experience of another's body, which, through apperception, is constituted as another subjectivity. As indicated in Chapter 1, clothing is one of the most intimate things and central elements of evoking our body comfort that we interact with in our daily lives. That is because there is an

extremely close relationship with our body and being identified with the body. It appears to the eye how we look to others when worn that represents our identity (see Chapter 6).

The second implication was to take into account the haptic system — how our body, tactile perception, and sensory-motor functions are intermingled — that influences the research on how people feel/are felt, touch/are touched and move/are moved for their own comfort. The next section will explain this phenomena further.

2.4.1.1 Perceiving and experiencing — haptic touch through movement

In applying phenomenological theory to design practice, in terms of human experience in relation to embodied interaction, my research reflects the haptic system and the unity of sensory modalities; that is, the combination of touching (doing), feeling, and seeing. This perspective was deeply influenced by the development of the EAI framework (see Chapter 3). Haptics is defined as 'a perceptual system that incorporates inputs from cutaneous receptors and also from kinesthetic receptors embedded in muscles, joints, and tendons' (Lederman & Loomis, 1986, p. 136). The haptic system is generally understood in terms of either the tactile or the proprioceptive systems. According to MacLean (2008), the haptic sense comprises a hierarchy of subsystems. Touch comprises two such fields of perception: tactile (sensations arising from stimulus to the skin — heat, pressure, vibration, slip, pain) and the proprioceptive, which provides our knowledge of body positions, forces and motions via end organs located in muscles, tendons, and joints. In current research in the field of cognitive science, there is considerable research into haptic perception, which refers to touch in the widest sense, including the sensing of information from the skin as well as the movement and position of joints, limbs, and fingers (Jacobson, 2009, p. 13). Proprioception is used to assess the weight of a brick in our hand; and if we close our eyes while someone else moves our arms around, proprioception will tell us where the arms are. This haptic perception, called haptic interface, is the subject of a new disciplinary field exploring a deeper reality that transcends the senses of touch, sight and hearing (Gibson, 1962, 1966; Marks 1978; Lederman & Loomis, 1986; Lederman & Klatzky, 1987; Updali, 2008). Touch, united with other

senses, is a way to explore an object's aesthetics; for example, we see through touching, and through touch, we can experience comfort. In fact, the sense of touch is used not only to feel many different surfaces of different materials, but also to connect the emotional and communicative channels of affection and meditation (Guéguen, 2004). In researching from a phenomenological standpoint of view, I considered the haptic system that comprises two subsystems:

- Tactile perception: the point of action, which provides sensations arising from stimulus to the skin — heat, pressure, vibration, slip, pain. This is related to task-oriented touch, which is used to feel many different surfaces of different materials.
- Kinaesthetic interaction: the point of action, which provides our knowledge of body expression, positions, forces and motions via end organs located in muscles, tendons, and joints. This is related to expressive-touch and expressive-movement, which represents communicative, affective or healing.

Based on classification into two haptic subsystems, I selected a good example — the wooden beads used by monks — that elucidated further how haptic systems operate and how these haptic systems influence the development of the EAI conceptual framework. In Buddhism, the wooden beads represent the number of mental conditions or sinful desires that one must overcome to reach enlightenment or nirvana. The word 'bead' itself has an interfaith origin. It is purportedly derived both from the Sanskrit word 'Buddha,' which refers to self-realisation, and also from the Saxon verb *bidden*, to pray (Jnaneshvara, 2006). A string of wooden beads is used widely in praying and meditating, not only by monks but also by people generally in Asian culture. Looking more closely at a person's hand movement while interacting with wooden beads (see Figure 2.1), he holds the beads around his palm or wrist and four fingers: index, middle, ring, and little finger. The thumb is used for counting each wooden bead until the end of the string. This process of prayer and meditation by touch using the wooden beads can be involved in two main aspects of the body of a subject in haptic systems.

Figure 2. 1. Person holding and playing with beads.
Source: photo by the author.

Considering the first haptic system, that is, tactile perception, the sense of touch is used to feel the wooden beads' surfaces that provide sensations arising from stimulus to the skin — heat, pressure, and vibration. For example, the roughness or softness of wooden beads' substance is registered when forces are exerted on it by the hand. In addition, the touching of the object with the fingers and the hand produces very different sensations through touch, depending on whether it is active or passive. Katz (1989) and Gibson (1962, 1966) have identified two forms of haptic perception — active and passive touch. Both state that researchers have to consider the involvement of the observer, who seems to increase the 'object nature' of the perception in a phenomenal and ecological way. Katz considers the effects of different manners of touching and of different components of the touching process, such as hand rate and finger force. Katz (1989, p. 41) also explains 'dual-touch,' which is similar to what Merleau-Ponty's (1962) phenomenology termed 'double sensation'; that is, we are able to touch and be touched by the same action, and this causes certain sensations. In other words, the body is experienced as a duality, both

as an object — you can touch your own hand — and as your own subjectivity — you experience being touched. This skin sensation in the context of tactile perception can also transcend one sense to another sense; for example, seeing through the ways people touch.

Taking into account the second haptic system, kinaesthetic interaction, the act of touching and manipulating beads allows the hands to empower the connectivity and organization of the whole body, which is interconnected to the large areas of skin for considerable lengths of time and pressure. It requires the active participation of the person's movement, using his muscles, and whatever features of his skin senses he cares to bring to bear. The process of touching wooden beads therefore enhances active feeling, from a starting point with fingers and then to the whole of our body, which seems influence our mental control. It could therefore connect the emotional and communicative channels of affection and meditation. In this way, feeling is feeling-with, involving another tactile body, wherein the tactile and the emotional arise within each other. This presumably causes a meditative process of calming oneself physically, psychologically, and emotionally. One's self-calming happens through touch and invites contemplation through a continuous cycle of hand movements interacting with the wooden beads. According to Merleau-Ponty (1962), this means that subject and object cannot be separated, as each is part of the other. In other words, this theory indicates that perceiving sense is through action as a reciprocal system (Deckers et al., 2002). This process of interaction sheds light on how our body can perceive the senses, which evoke emotions. In this sense of the embodied nature of human experience, I considered awareness of the body — how our body is the pivotal role as a perceiver and receiver (or transmitter) — through what people feel/are felt through how they touch or they are touched, and how they express or how they are expressed for body comfort when interacting with clothing.

To sum up, my research investigates the notion of 'embodiment' in the perceptual process in terms of how mental and bodily states operate. I explore the nature of experiential bodily knowing and understanding generated through the phenomenological way people touch/are touched, move/are moved and feel/are felt in the process of interacting with an object. Emotions can be generated from body

movements through the point of body awareness (Ekman, 1971). The theory of the phenomenology of perception as a methodology and philosophy provided an entry point into understandings of the material world through the human body and mind. More importantly, this theory of phenomenology significantly influenced the development of four contexts of the EAI framework: knowing through experiencing, experiencing though unknowing; doing through feeling, feeling through doing; feeling through touching; and seeing through touching. Chapter 3 elaborates on how the EAI framework is formulated in the context of a phenomenological standpoint. In particular, the three aspects for haptic experiments are elucidated — doing through feeing, feeling through touching, seeing through touching.

2.4.2 Pragmatic aesthetics to understand aesthetic experience in everyday activities

The body was the primary design element to focus on for the research described in this thesis. I have focused on how the body plays a central role in shaping human experience in the world, understandings of the world and interactions in the world. Polanyi (1967, p. 15) notes:

> the body is the ultimate instrument of all our external knowledge, whether intellectual or practical.... experience [is] always in terms of the world to which we are attending from our body.

This research crystallises the relationship between aesthetic experience and comfort as explored by Richard Shusterman (2000). Shusterman has proposed an aesthetic discipline called somaesthetics, which is based on John Dewey's pragmatism and pragmatist aesthetics (Dewey, 1958). The pragmatists emphasised the important value and meaning of the ordinary, everyday experience of life. They explained that value and meaning, in terms of the sensual, intellectual, and emotional aspects of everyday experience of life, should be integrated into designing aesthetic interaction (Petersen et al., 2004; Fiore et al., 2005). This study adapted the four important principles of the pragmatists' approach to aesthetics (Shusterman, 2000) in order to conceptualise the dimension of clothing comfort. The first principle, outlined by Shusterman (2000), notes that:

> aesthetics has practical use, next to intrinsic value. This means that although an aesthetic experience is valuable in itself, it is instrumental in daily practice as well. (Cited in Ross and Wensveen, 2010, pp. 3-4)

This pragmatic approach to aesthetics is compared with a traditional analytic approach to aesthetics, which is focused on an object's intrinsic value, such as fine art. The notion of aesthetics is closely related to the conception of comfort, which should be integrated into everyday lives and related to actual human needs, value and events. The second principle is developed by Shusterman (2000) from this pragmatic approach, and applies the aesthetic experience of an object to contemporary culture. This means that the aesthetic experience of an object should be understood within a socio-cultural context. Thirdly, Shusterman further contends that aesthetic experience and form are inextricably interrelated as a 'dynamic interaction of elements,' rather than a static interaction. He adapts Dewey's suggestion of the 'satisfying form' of an aesthetic experience, and characterises this experience in five ways: 'cumulation, tension, conservation, anticipation, and fulfilment' (p. 7). Finally, he sees the whole human being as actively involved in the aesthetic experience, in both intellectual and bodily dimensions (Cited in Ross, 2008, p. 56).

2.4.2.1 Aesthetics as a design approach to everyday human activities

Chapter 1 described comfort, focusing on human activities, such as walking, forms of touching like pressing, squeezing, striking, and interacting with nature, such as jumping in the water, rolling in the sand and listening to sounds of the wind or of birds. This notion of comfort is related to Shusterman's (2000) idea of pragmatic aesthetics, that is, that an essential appreciation of that aesthetic experience should take into account the everyday activities. Each notion of aesthetic design for comfort in everyday life will be explicated throughout this thesis: experience of bodily interaction with nature in Chapter 4; haptic sense of touch and movement in Chapter 8; and the characteristic style of walking while interacting with garments in Chapters 9 and 10.

In particular, characteristic styles of walking can provide vital information for recognising affective states, because a walker's movement reflects his/her identity, personality, culture, health condition or emotion. As defined in Shusterman's (2000) pragmatic approach to aesthetics cited in Chapter 1 (see Section 1.3), aesthetic experience, for pragmatists, is closely related to form. The form of the experience derives from a 'dynamic interaction of elements' such as bodily movement expressed by rhythms, rather than static spatial relations (p. 7). A review of the literature found that interesting research has been done on the identification of walking styles and patterns and related emotions, and this is one of the research focuses of this thesis. James (1890) found that observation of a person's walking could reveal what the walker was feeling. This concurs with German Expression psychologist, Wallbott (1982), who maintained that a person's character could be ascertained from a person's style of walking. Birdwhistell (1970) and Henley (1977) claimed that walking patterns serve as potent sources of gender information. Variations in walking have been found to be strongly influenced by personality and an individual's emotional state (Walk & Homan, 1984; Montepare, 1985; Montepare & McArthur, 1986; Dittrich et al., 1996; Montepare et al., 1987, 2003). Montepare et al. (2003) examined styles of walking which reveal certain emotions. They found that walking information enabled them to identify participants' specific emotions, for example, sadness, anger, happiness, and pride. They concluded that emotional cues could be determined from the way someone walks, such as the amount of arm swing, stride length, heavy footedness and walking speed. More specifically, their findings included that happy walking was revealed in a subject's pace; a faster pace than when walking generally. Angry walking was found to be relatively heavier-footed than other walking styles, and sad walking was found to have less arm swing than the other forms of walking. Montepare et al. (1987) explained why some emotions were more easily identified than others. They stated the reasons, adapted from McArthur and Baron's (1983) ecological approach to social perception as explained below.

> Based on the notion that emotions serve as social affordances, which guide important interpersonal behaviours, the ecological position argues that it may be socially and biologically adaptive to detect certain emotions more quickly and accurately than others. For example, the expression of sadness may

> indicate to observers that a person is ill and in need of immediate care. The expression of anger may signal danger or threat to observers and encourage their necessary attention or avoidance. While the detection of pride may serve to communicate positive affect, failure to identify this emotion may not carry with it the negative consequences the failure to detect emotions such as anger or sadness might. (Cited in Montepare et al., 1987, pp. 39-40)

The reason for the difficulty in detecting emotion, such as pride, in walking information is caused by the hidden nature of the stimulus, which leads subjects to exhibit movements (Montepare et al., 1987). In addition, there were found to be differences in walkers' ability to communicate particular emotions, which were consistent with differences in encoding of emotions noted in other research into nonverbal behaviour (Davitz & Davitz, 1959). Montepare et al. (2003) revealed the reason why some walkers are better at encoding certain emotions than others. One of the factors identified was based on how efficiently subjects encode the task of the stimulus with which they were asked to imagine the specific situations. In order to use the stimulus effectively, they suggested 'an alternative emotion manipulation technique such as allowing targets to think of a personal situation in which they have experienced a particular emotion'; they were asked to do this before they walked (Montepare et al., 1987, p.41). This technique has also been used successfully by researchers interested in facial sources of emotional information (Malatesta & Izard, 1984).

The findings outlined above demonstrate the validity of using scenarios for participant observation that researches how much subjects are able to communicate and encode particular emotions, and accordingly have been applied in this study. My research methodology included subjectivity in the form of a personal situation by allowing subjects to think of a personal situation in which they had experienced a particular emotion, for example, happiness and fear.

Based on this existing literature, the following research questions are the focus for the investigation reported in Chapters 9 and 10:

- Can walkers change emotions triggered by different garment styles?
- Can different styles of clothing possibly influence people to walk and behave differently?
- How do specific emotions like fear and happiness influence walking behaviour?
- How does a specific garment style influence walking behaviour?

2.4.2.2 The use of pragmatic aesthetic theory in the design process

In this thesis, pragmatic aesthetics was influential as a useful approach to generate design motivation, concepts and design activity, and to develop the framework of EAI in the whole design process. The focus on the use of aesthetic interaction in the design process was as follows:

- I used aesthetic experience as a design mechanism to generate motivations and concepts in the design process. In particular, I discerned comfort as the main aesthetic emotion in our experience of movement in everyday physical activities, such as: interacting with nature, for example jumping in the water, rolling in the sand, listening to sounds from the wind or birds; and forms of touching, for example, pressing, squeezing, striking, and walking, which in fact are more often recognised as practically oriented human activities rather than aesthetic experiences.
- I researched design in the socio-cultural context. I observed subjective individual experience, for example, fear and happiness based on changes in socio-cultural lifestyle such as technical developments and nomadic patterns of living. In these contexts, people, in particular women, experience not only actual physical harm but also psychological dangers, either fear of attack from other individuals, or feelings of insecurity.
- I made dynamic form, related to 'behaving' and 'feeling,' explicit; clothing stimulates people to evoke senses and moods.
- I actively involved the whole human being throughout the design process; sensitivity to bodily, cognitive, and emotional aspects is essential to evaluate and develop the conceptual prototypes.

2.4.3 Body being in-the-movement

I explored how the bodily aspect of kinaesthetics is related to the perceived quality of performed movements. Kinaesthetics is an important aspect of aesthetic experience, as it provides us with our self-perception of movement, the felt sense of our bodies in motion (Laban, 1960; De Rivera, 1977; Gibson, 1979; Sheets-Johnstone, 1999). For example, De Rivera (1977) developed his theory of the structure of emotion, which concerns how particular emotions can be understood as potential movement within interpersonal, psychological and lived space. He further classified the four basic emotional movements as 'towards out,' 'towards self,' 'away from self,' and 'away from other' (Cited in Robbins, 1999). Gibson's (1979) 'affordance' theory suggests that the world unfolds itself in readiness for action. We perceive the world in relation to what we can do with it. Thus, the world is inherently meaningful for our body and by moving we can gain access to that meaning. Laban (1960) describes a method of notating movement, in which the term refers to physical, mental, emotional, social and spiritual aspects of movement.

In applying theories of movement to product design, new design approaches, methods, and tools have emerged that incorporate movement qualities into product form and interaction (Vaughan, 1997; Yamamoto, 1999; Buur et al., 2004; Klooster & Overbeeke, 2005; Young et al., 2005; Moen, 2006; Loke & Robertson 2010). Yamamoto (1999) relates aesthetics of movement to the Japanese concept of *iki*, which includes daily behavior. Moen (2006) investigated experience from the perspective of dance and body movement and proposes full-body movement interactions, which he calls kinaesthetic movement interaction. Young et al. (2005) developed Laban's (1960) notation theory and Vaughan's (1997) theory of understanding movement, deriving appropriate 'variables (grammar) for motion in product notation' (p. 8). These variables are as follows: path (the line that an object movement follows); volume (the use of space by the object, including scale change); kinesphere (the limits of an individual's reach into space without changing place or usage); direction (the direction in which the object moves — up, down, towards and away), and velocity (the speed, acceleration and tempo of the object) (pp. 8-9).

For the design of clothing, little is known about the phenomenon of movement from the point of view of lived experience. Hillestad (1980, pp. 117-125) investigated the form, shape, and motion of the body interacting with clothing and adornment, developing a taxonomy of the personal body's appearance. She asserts that the body is a complex unit in the structure of appearance, which includes aspects of body form, body surface and body motion. Body form can be described by the characteristics of size, shape of various body parts, and composition or morphology (proportion of bone/muscle mass/adipose tissue). Body surfaces are dependent on genetic inheritance to a large degree. They include skin and hair, colour, skin and hair texture, amount of body hair, likelihood of tanning, and so on. Body motions encompass walking, sitting, gestures, mannerisms, posture and all the ways we move our bodies. Consequently, movement of the human body is perceived as having an expressive quality (Walk, 1984, pp. 211-221). This movement contributes to the aesthetic experience of the viewer (Reid, 1980, pp. 165-170). An individual can also have an aesthetic experience due to the kinaesthetic experience resulting from the expressive movement of his or her own body (Moore & Yamamoto, 1988, p. 103).

This thesis utilises the method of Motion Capture techniques and Laban Movement Analysis (LMA), which comprises the basic elements of four interrelated categories — *Body, Space, Effort,* and *Shape*. Rudolph Laban[1] introduced the basic framework of movement analysis which made a significant contribution to the study of movement and the observation of human movements in dance, performance of industrial work tasks and in everyday situations. There are two systems in the work of Laban for capturing the quality of movement: Labanotation and LMA (Laban & Lawrence, 1947; Laban, 1960, 1963). The principle aim of Labanotation is to record by means of symbols the physical and structural aspects of such movements as direction, place, position and involved body parts, whereas LMA is concerned more with a qualitative description of the movement, not simply the physical

[1] Rudolph Laban (1879-1958) was an Austrio-Hungarian dancer, choreographer, teacher, philosopher, theorist and writer. He is still considered the most important movement theorist of the 1900s. The overarching theme of Laban's work was in terms of how people's movements and behaviour are affected physically and emotionally by physical conditions, environment, cultural issues, and in communication with their bodies and the universe at large (Adrian 2008). In this study, I did not investigate in detail his historical background as this was beyond the scope of this study, but focused on the LMA system to develop a movement framework for observing qualitative bodily changes in movement.

characteristics. LMA (Laban, 1960) describes a method of notating movement, in which the term refers to physical, mental, emotional, social and spiritual aspects of movement. Chapter 3 describes the reason why I utilised LMA in conjunction with MC data to understand and analyse human walking behaviour in the context of the EAI framework. In addtion, Chapter 10 addresses how to apply LMA into the qualitative and dynamic characteristics of the participants' movement system, which was analysed by comparing three different walk types ('natural,' happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful').

In the next section, the characteristics and qualities of movement are explained. Through a theoretical exploration of Gibson's (1979) affordances, I begin to explore valid means of creating aesthetic interaction focused on meaning, body, space and movement. This ecological approach to human perception in Gibson's theory of affordances (1977) can be linked to Merleau-Ponty's (1962) phenomenological standpoint. I will now explicate how these theories can be applied in clothing design.

2.4.3.1 Theory of affordances

Gibson (1977) introduced an ecological approach to human perception in his theory of affordances, which points out the reciprocal relationship between man and his environment evolving together. This concept propounds the idea that what is inherent in the properties of an object or material is essential information about that object or material. For example, substances may be solid, rigid and hard; they may be liquid, elastic, soft, or deformable, but they are all properties with characteristic affordances like manipulability or graspability. In addition, Gibson's thinking implies that the values and meaning of things in the environment can be directly perceived. This concept can be explained in this way:

> I walked into the water, which was warm and gentle when touching my body. The water invited me to paddle my feet and hands unconsciously to feel it. The experience of the power of ocean was like a feeling of easiness and comfort from touching, hearing and seeing the gentle waves, the ebb and flow, the light breeze.

The above observation was made when I engaged in active experimentation and interaction with nature via the body, sand, water, shadow, and movement as an interactive medium in attending a workshop titled 'Fremantle on the Edge,' WA (15-17 April 2009). This experimentation will be addressed in Chapter 3.

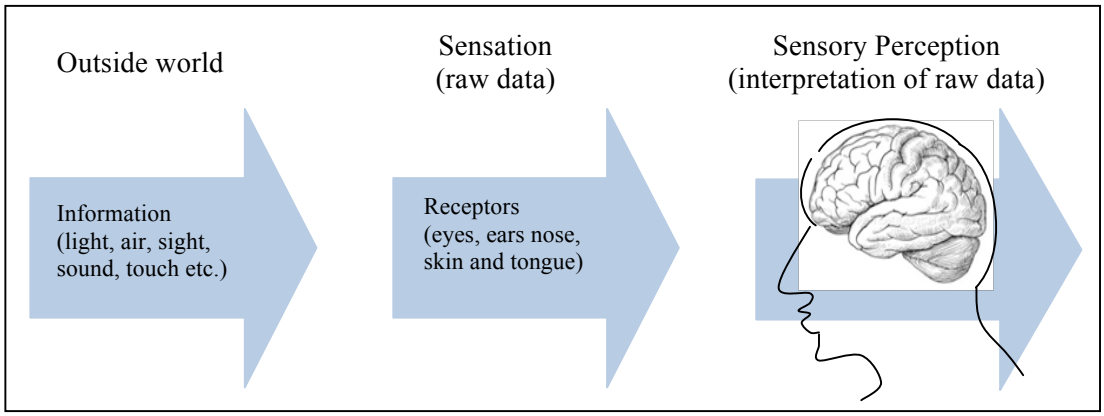


Figure 2. 2. Information from the world is taken in and given meaning by our action.

I experienced a sense of easiness and comfort from what I saw, heard, and what I felt through the interaction with my body, time and the environment. At a given moment, my brain received and responded to an infinite variety of information in configurations which were based on how my body acted as a kind of sensor, registering all the signals sent out by the natural environment and any changes that took place in it (see Figure 2.2).

Our perceptual systems have evolved to facilitate our senses and interactions within a real, three-dimensional world. Nature can be a source to conceptualise a means of inducing bodily interactions, that is, how we move our hands and fingers, our legs and bodies, our eyes and ears, to deal with the world that presents itself. Gibson (1977, 1979) suggested that the world unfolds itself in potential for action. We perceive the world in relation to an intuitive bodily understanding of what we can do with it. Thus, the world is inherently meaningful for our body, and by moving we can gain access to that meaning, as behavioural meaning. This idea can be linked theory of Merleau-Ponty's (1962) phenomenology of perception as noted in Section 2.4.1. In other words, in what the environment affords to them, objects afford actions and it is these possibilities for action or affordances that people perceive. Action-oriented

meaning can vary greatly with context. In fact, the meaning of an object or event is what that person can do with and perceive from the object or event. Thus, depending on the context, a bottle of Coca-cola, for example, can be used as a cooking utensil for Bushmen or a message apparatus for women, or a weapon, or a vase. A soft, fluffy blanket asks you to caress yourself with it, to wrap the blanket around you, and tuck yourself inside. Similarly, splashing water and beautiful scenery are the context that combines with objects and memories to suggest actions consistent with warmth, relaxation, and enjoyment. The concept of affordance has been applied by many researchers to designs for interaction (Norman, 1988; Smets, 1995; Sanders, 1997; Overbeeke et al., 1999; Wensveen, 2005). Norman (1988) applied Gibson's (1977) concept of affordance to the perceptual-motor skills of the user and the characteristics of the environment, criticising the psychology of product design and suggesting users are often quick to blame themselves when the product does not work. According to Norman, extending the meaning of affordances enables the systematic exploration of the roles of affordances, functions, and natural mappings in the design of cognitive artefacts. Smets (1995) focused on affordance based on the physical characteristics of the environment. The concept of affordance in the field of quality of interaction design has been criticised and expanded from perceptual-motor skills to emotional skills. Sanders (1997) defined the concept of affordance as the unity of subject and object, which includes intentions, actions, and imagination. Overbeeke et al. (1999) identified three types of human skills: cognitive, perceptual-motor and emotional skills. Wensveen (2005) proposed a method for designing adaptive products on the basis of emotionally rich interactions. Emotionally rich interaction relies heavily on emotion expressed through behaviour. The essence of this approach is that a product not only elicits emotionally expressive actions, but that the feedback is inextricably linked to these actions. In this thesis I do not wish to study affordances in depth, but the concept of affordances functions as the inspiration for the design of 'information-for-use' (Wensveen, 2005; Ferns, 2006).

2.4.3.2 How is the theory of affordance applied in clothing design?

This 'affordance' theory can be adapted to accommodate clothing design in terms of what you can do with the products; in this case clothing, which is related to the

psychological concept of affordance. Affordance suggests that we do not categorise products though product names, but rather through an intuitive bodily understanding of what we can do with them. Looking at everyday life, it is evident that women around the world look to fashion to fulfil many of their emotional requirements and practical concerns in their more active and nomadic life styles, where personal boundaries need to be clearly marked, for instance, when they are commuting, travelling and working, and in modes of inhabitation and social and territorial boundaries (Marzano et al., 2000). We live in the shifting conditions of contemporary culture or lifestyle and occupy the changing spatial sphere of a transitional, super-modern environment (Auge, 1997, p. 35). Women generally appreciate functionality in terms of sensory experience, performance, comfort or enjoyment. From this perspective, the content of affordance (adaptability) is related to a subject's well-being, and facilitates the senses and the bodily movements that enable flexibility of thinking, acting, and responding to their environment. These theoretical investigations led to the development of the 'Enriched Aesthetic Interaction (EAI)' framework to support design practice (see Chapter 5), and as the basis to conduct experimentation with user participants. I will elaborate on and elucidate the proposed framework of EAI in the next chapter.

Chapter 3

Framework for ‘Enriched Aesthetic Interaction’ (EAI)

Chapter 3

Framework for 'Enriched Aesthetic Interaction' (EAI)

3.1 Introduction

This chapter addresses a framework of 'Enriched Aesthetic Interaction' (EAI) in the context of comfort. The framework integrates relevant theories of emotion- and movement-based design research that I discussed in Chapter 2. The proposed conceptual framework of EAI is explicated for the four contexts of understanding comfort: 'knowing through experiencing, experiencing through unknowing'; 'feeling through touching'; 'seeing through touching'; and 'doing through feeling, feeling through doing.' The basis of this conceptual framework influences a series of innovative garment prototypes (see Chapters 5, 7) and leads to five phases of experimentation conducted with user participants (see Chapter 4, 6, 8, 9, 10). From the outcomes of these experiments together with reflection on the experienceable design prototypes, a set of design principles for clothing comfort is developed.

3.2 Conceptualising comfort in the framework of EAI

This thesis argues, in the context of an extensive review of the relevant literature on theories of phenomenology, pragmatic aesthetics, ecology of perception, and the concept of 'adaptability' that to conceptualise comfort in clothing from a design point of view means seeing clothing no longer as simply an object for practical, utilitarian use. In this thesis, comfort is interpreted in a multi-dimensional framework and includes a sense of actively engaging affective states, where the body is the primary source of knowing the world and has the ability to anticipate the physical sensation and the mental association. In addition, the body is the orienting centre of perception, not just perceived in itself. The interpretation of comfort in this research also focuses on the subjectively felt tendency to investigate bodily expression, appraised as 'feeling good' (beneficial concerns) or 'feeling bad' (harmful concerns), as a common part of the processes involving 'appraisal' (Frida, 1986; Lazarus, 1991; Roll, 2007). Frijda (1986) argues that when we appraise a stimulus as beneficial to

our concerns, we will experience positive emotions and try to approach this particular stimulus. In this sense, emotions can be classified functionally as rewarders and punishers (Roll, 2007). This definition accords with the view that emotions can be instrumental. In this view, emotions are considered to serve an adaptive function (Lazarus, 1991) because they establish our position in relation to our environment, attracting us to certain people, objects, and ideas, and pushing us away from others (Desmet, 2002). An example of an emotion might thus be the happiness produced by being given a reward, such as a pleasant touch. Another example of an emotion might be fear produced by the sound of someone rapidly approaching or the sight of an angry expression on someone's face. We will work to avoid such stimuli, which are punishing. Another example would be relief produced by the omission or termination of a punishing stimulus, such as the removal of a painful stimulus, or sailing out of danger (Roll, 2007, pp. 831-832). As mentioned in Chapters 1 and 2, the concept of comfort implies it is an individual, situational emotion experienced in specific situations and integrated as an ordinary part of everyday life. The conception and evaluation of comfort for clothing design, I argue, should be more precisely concerned with motivators or subjective factors, such as an individual's autobiographical fearful and happy experience.

I propose the term 'Enriched Aesthetic Interaction' (EAI) (also called 'Enriched Aesthetic Experience') to be applied to the conceptualisation of clothing comfort. The term describes an individual's subjective experiences and rich emotions in relationship with their use of skills while interacting with an object. More specifically, the terms refer to people's engagement with an object and their experience through such bodily senses as touch, sight, smell, taste, and movement, — all the ways the body senses its living in contexts — and the mind - that is - perception. Perception therefore could give not only an experience of objects, but also a connection with them. It includes a kind of pre-condition that makes perception possible. This 'perceptual consciousness' or 'perceptual field' forms in the space between perceiver and perceived by means of the active engagement of the two' (Crossley, 1996, p. 29). Perception therefore could give rise to the meaning of things in the sense of how people interact with the world and objects that they experience in particular situations and environments.

3.3 Framework for exploration

As discussed in the preceding sections, I developed the EAI framework, which is concerned with understanding aesthetically embodied comfort through human experience. Aesthetically embodied comfort refers to how clothing becomes sensible synaesthetically, kinaesthetically, and emotionally to people as bodily extensions and thereby integrates the body-subject and the space they are in. As indicated in Chapter 2, I discussed relevant theoretical review specially, how the theory of phenomenology (Merleau-Ponty, 1962), affordance (Gibson, 1977, 1979), and the pragmatic approach to aesthetics (Shusterman, 2000) can be understood in the context of human experience and how these theories are applied in the design practice. These theories shed light on the various lived ways in everyday activities, multisensory intertwinement, and sensorial-motor wise, which the body in its pre-reflective perceptual presence engages and synchronises with the world at hand and objects.

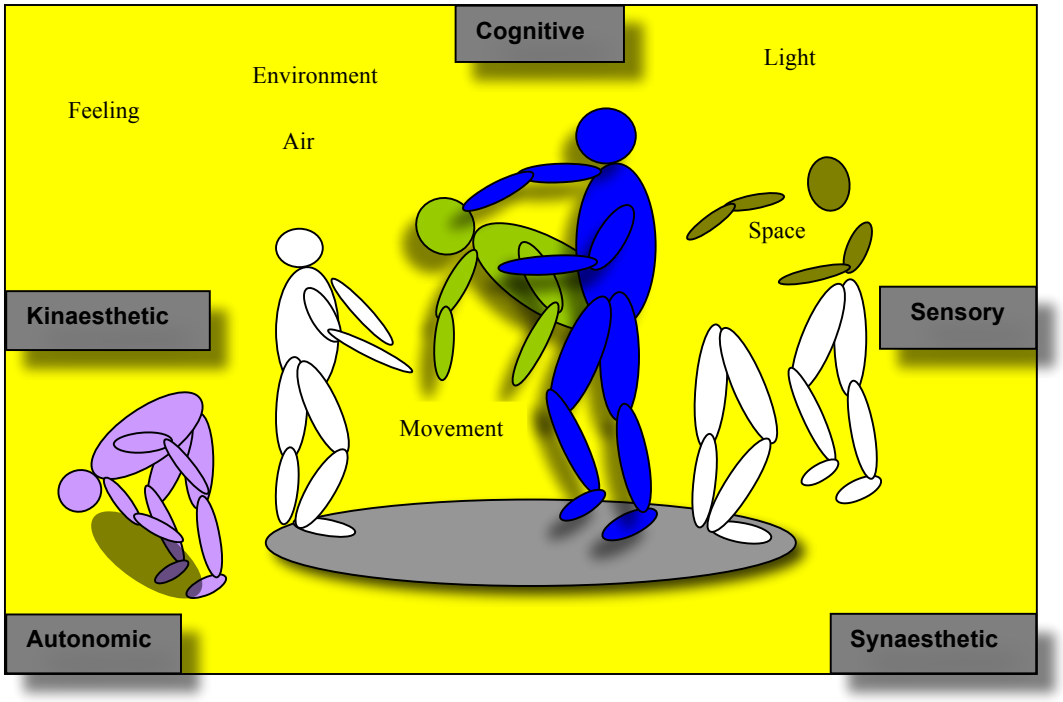


Figure 3. 1. The form of human experience.
Source: drawing by the author.

I consider herein, how I adapted these theories to explore the EAI; how we experience comfort on many levels; we perceive and communicate through senses

from information in the outside world like air, light, space, sight, touch, as well as through the synaesthetic (combining senses and perception), cognitive, autonomic (gut feelings), and kinaesthetic (acting and doing) levels of functioning (see Figure 3.1).

From this definition, I developed four contexts for exploration of the EAI framework, focused on human experience in terms of how people know, feel, and do. Four contexts of the framework of understanding comfort are: (1) knowing through experiencing, experiencing through unknowing; (2) feeling through touching; (3) seeing through touching; and (4) doing through feeling, feeling through doing. I will explain these contexts more detail in the following next section.

3.3.1 Knowing through experiencing, experiencing through unknowing

Knowing through experiencing, experiencing through unknowing refers to a person's deepest feelings coming from the deep impulses of human nature. We move about the world and respond to situations emotionally. This context of the framework indicates a view of emotion and felt experience in respect to a person's intuition. We interact with the world before we think, so 'our intellectual thoughts cannot be used to explain away that pre-reflective experience' (Matthews, 2006, p. 33). In fact, the notion of the meaning of things in a sense is neither from inside our minds nor in the world itself, but it results from how we interact with the world in the space we experience intuitively (Matthews, 2006). Intuition in this context was in the part of the design approach focusing on how people (including designers) express their feelings about sensing nature intuitively. Intuition can be explained phenomenologically. The object, which allows people to perceive intentions is directly present to the intentionality at play; if the intention is filled by the direct apprehension of the object, one has an intuited object. Having a glass of wine in front of you, for instance, seeing it, feeling it, or even imagining it — these are all 'filled' intentions, and the object is then intuited (Merleau-Ponty, 1962). The aim of this context of the research was: (1) to sketch insights of understanding human experience in terms of how the body's senses and mental apperceptions are intricately woven into the real context; and (2) to develop concepts and methods

utilised by a body-centred and sensorimotor-driven design technique. In this context of the EAI frame work I explored my bodily ability to sense experience through actively experimenting and interacting with the environment, while attentive to feelings, emotions of immediacy, and the bodily knowing process. In particular, I explored the following research questions:

- How do we communicate our perceptions, senses, and emotion in the natural environment?
- How do we experience beauty and comfort from the unconscious, normally unnoticed environmental elements, such as movements of water, sounds from the ocean, and bodily responses?
- Can these aesthetic experiences inform the development of innovative design concepts in the design process?

These questions are answered in Chapter 4.

3.3.2 Feeling through touching

Feeling through touching refers to an emotional understanding of comfort, which focuses on emotion arising from movement and manipulation in relationship with an object when a person approaches and feels it. This refers to what a person does with an object and how they interpret their feelings. As highlighted in Chapter 2, in applying phenomenological theory to design practice, in terms of human experience in relation to embodied interaction, this context of the EAI framework reflects on the haptic experience of how tactile perception and sensory-motor modalities can be intermingled, that is, the combination of touching (doing) and feeling. In this context the design process represents the way women touch and move consciously or unconsciously and actively or passively, and feel something while interacting with an object. In other words, this design process used with a research-through design approach concentrates on the movement of hands and the body through in-depth observation. The research question focus on the feeling process and the emotional effect:

- Can the touch of women's hands be related to the body part being emotionally touched? If so,
- How can an actual body part be felt and touched emotionally?

The findings are addressed in Chapter 8 (Section 8.5.1.3).

3.3.3 Seeing though touching

Seeing through touching refers to a synaesthetic understanding of comfort, meaning the ability of the body to integrate all the different sensual perceptions. The design process used with a research-through-design approach explored the discourse on comfort by investigating haptic experience. This sense of haptic experience involved more than one sense and discerned an integration between such senses as touch, sight, and movement and perceptual cognition of past experiences and images. These senses are expressions of 'double sensation' (Merleau-Ponty, 1962).[1] We can experience a feeling of comfort based on what we see an object through: how we touch/are touched; how we feel/are felt; and how we move/are moved. Touch can be integrated, shared and united with other senses in the multisensory nature of the cognitive process. Philosophical idea of perception of phenomenology (Merleau-Ponty, 1962) shows that we are able to 'see' an object sensuously and perceptually through the hands, which are a perceptual and manipulative organ and the entire body. Literature from recent cognitive sciences also points out that sensory modalities are connected perceptually: what we touch affects what we see; what we see affects what we hear; what we smell affects what we taste, and so on (Marks, 1978; Upali, 2005, 2008). Marks (1978, pp. 128-144) proposed the theory of unity of the senses to explain the multisensory nature of the cognitive process. This theory consists of four systems of cognitive science, each outlining an empirically supported similarity of the senses. The first system of cognitive science asserts that the same features of objects can be experienced through different senses. For example, one may gain information about the size, shape, and texture of an object both tactilely and visually. The second system of cognitive science acknowledges dimensions of sensation shared by the senses. Intensity is a dimension of visual, tactile, olfactory,

[1] The term 'double sensation' was used by Merleau-Ponty to express the idea of being able to touch and be touched by the same action.

taste, and auditory sensations. The third system of cognitive science states that there are laws governing all the senses that influence perception of stimuli. Sensory fatigue, for instance, governs all the senses so that all senses experience loss of sensitivity to a stimulus when overexposed to sensory input. The fourth system of cognitive science addresses the similarity of the physiological (neural) mechanisms of all the senses. For example, for all senses, the neural mechanism for sensory intensity appears to be the number of active nerve fibres or frequency of neural discharge. In addition, research in the field of cognitive science and into haptic perception has explored a new disciplinary field of sense of touch, known as the haptic interface. Upali (2005) conducted a case study that investigated the perceptual choices people make. She found that people construct subjective and embodied mental maps of their environments, where sensory impressions are integrated with cognitive concepts, such as emotion or object recognition. Furthermore, when one sense is muted, such as closing the eyes, other senses are prioritised. In other words, people can see through touch, and our movement is guided by sensory information, which is connected perceptually when we press an object and when we sit, and when we move our fingers to touch.

In this context of the EAI framework, the experiment was focused on the research questions:

- How does what women touch affect what they see?
- How do they integrate the experience of touch into their perceived images in their head when blindfolded as compared to when they are not blindfolded?
- What do they feel, say, and imagine while they are interacting with the four conceptual prototypes in two sets of conditions — blindfolded and non-blindfolded?

The research questions directing this enquiry were explored through participant observation and interviews. Discussion of these questions is presented in Chapter 8 (Sections from 8.5.1.4 to 8.5.1.5).

3.3.4 Doing through feeling, feeling through doing

Doing through feeling, feeling through doing refers to a kinaesthetic understanding of comfort in relation to body and hand function and performance. In this context of the framework, the design process used the research-through design approach to follow people's doing and feeling, and not their thinking, accounts. To examine the further haptic interface of forms of touch and the performance of hands in detecting and evaluating an object, there were three primary theoretical and experimental touchstones for this context of the study:

- Merleau-Ponty's (1962) term, 'embodied experience'
- Gibson's (1962, 1966) term, 'active and passive touch'
- Gibson's (1977, 1979) term, 'affordances.'

Merleau-Ponty (1962) has described the process of embodied experience, which can be understood on two levels — the conscious or phenomenological and the cognitive unconscious. The former describes the awareness of the body through actions. The contact through bodily interaction between the perceived object and the person perceiving can be closely interlinked. Taking into account this phenomenological perspective of embodied experience, I explored how our body is experienced as a duality, both as an object — you can touch your own hand; and as your own subjectivity — you experience being touched. This perspective can lead to people (including designers) drawing on their imagination to fill their head with a conscious image in their head not through thinking but through action. The latter describes unrecognised activities, including neural processes of message transmission and learning that enable individuals to think and act. In this sense of unrecognised activities, the manner in which habitual activities influence affective states was explored in this context of the research. Furthermore, in this context of the EAI framework, I discerned how non-functional tactile interaction could create emotional meaning for people. More specifically, the research investigates how unconscious and unintentional movements can influence affective states, in terms of the degree of comfort or discomfort users experience in 'feeling good' and 'feeling bad.'

Secondly, in order to analyse and evaluate the context of haptic experience, forms of touch are considered as active and passive touch. Katz (1989), who first discussed the concepts of passive and active touch from a phenomenological standpoint, stated in his terminology, 'in active touch the objective pole, 'what's out there,' prevails. Passive touch, in which items touch an individual evoke a distinctly different subjective percept that of an internal sensation confined not to the environment but to oneself: 'riveting, with a sense of immediacy' (cited in Tayler et al., 1973, p. 41). Katz (1989) has described also 'dual-touch' which is in the similar exploration about what Bolanowski and his colleagues (2004, p. 41) called 'inter-active' touch. They clarified the differences in performing such actions: 'someone touching oneself (intra-active touch), touching someone else (active touch), and being touched by another (passive touch).' Tayler and his colleagues (1973, p. 254) stated that researchers have to consider the involvement of the people who seem to increase the 'object nature' of the percept and also suggest 'we must pause to give greater consideration to what seems a central feature of the touching process as it is used in everyday life.' Gibson (1962, 1966) further applies his concept of affordance in Human Computer Interaction (HCI) to two forms of tactile perception, active and passive touch. Gibson (1966) states that researchers have to consider the involvement of the observer, who seems to increase the 'object nature' of the perception in a phenomenal and ecological way. Gibson (1962, 1966) points out the differences in perception that occur in passive touch compared to active touch. In active touch, a person touching someone or something else produces an impression of that which is touched (Bolanowski et al., 2004). In active touch, the feeling of an object by the hand involves the feeling of the position of the fingers, hand, arm, body, and even the head, relative to gravity, all being integrated in some hierarchy of positional information (Gibson, 1962, p. 479). Furthermore, active touch is an exploratory rather than a merely receptive sense. Gibson's (1962, 1966) exploratory perception with haptic touch emphasized that the perceptual capacity of the hand has an important role to sense an object not only for practical purposes, such as to grasp, push, pull, lift, carry, but also for explorative, performative, and expressive functions, such as to squeeze, rub, palpate. The subjective feeling is important within tactile perception to be able to be recognised as one of the key factors in obtaining richness, which involves personal taste in touch-feel perception and experience.

Active touch then must be distinguished from passive touch. Passive touch does not involve movement of hands and fingers. Stimuli are simply pressed into the skin. Larssen et al. (2007) give some good examples to explain the differences:

> Close your eyes and have another person press an object into your hand, try identifying what it is. Now, try this again, this time you can use your hands to explore the object (still with your eyes closed). (p. 273)

The first example describes passive touch, while the second describes active touch. In short, passive touch is how a body part is touched, and when the body part does the touching, it is active touch.

Based on the theory and empirical experiments of tactile perception, definitions of the two movements in the exploratory experimental study — active and passive touch — were further developed to distinguish the way participants moved their hands, and the association between cognition and emotion. Active touch in this study was defined as moving a hand over a stimulus object consciously or unconsciously, which triggered enhanced compound emotions. Conversely, passive touch was defined as moving a stimulus object over stationary hands consciously or unconsciously, which aroused an enhanced single emotion. In passive touch, I also discerned what actual body part was being affected by touch emotionally, perceptually, and psychologically.

In this context of the experiment, I explored the following research questions:

- How do women touch and move to feel?
- How do different touches (both active and passive) and movements to feel?
- How do unconscious and unintentional movements influence affective states such as the degree of comfort experienced by users when they are ‘feeling good,’ compared to discomfort when they are ‘feeling bad’?

These findings are presented in Chapters 6 (Section 6.5.3) and 8 (Sections 8.5.1.1 and 8.5.1.2).

Thirdly, in this context of EAI framework, I also considered a kinaesthetic understanding of comfort in relation to negative and positive emotions such as fear and happiness, which can be generated as a cognitive reasoning process, even without physical interaction, through someone's imagining a situation or recalling a past experience. In this sense, I tested the idea of affordance (adaptability) in two different emotional situations ('happiness' and 'fear') inspired by Gibson's (1966) theoretical idea of 'affordance.' This 'affordance' theory was applied to clothing design and this context of the research questions:

- How do women hold and wrap their bodies in relation to their interaction with an object; in particular, how they interact with the garment to transform their feelings of fear into a recognisable state of comfort?
- How do they interact with the garment to reinforce their feeling of pleasure as a recognisable state of comfort?

Affordance suggests that we do not categorise products though product names, but rather through an intuitive bodily understanding of what we can do with them. The aim of this experiment was to investigate how meaningful bodily expressive actions manifested in the study group of women (n=15, age (20-40) in relation to past emotional experiences, for example 'happiness' and 'fear,' while they were interacting with clothing prototypes. I explored these research questions:

- How does a specific emotion, for example, happiness or fear, influence movements such as bodily expression and walking behaviour when women are interacting with clothing;
- How do different styles of clothing influence emotions and bodily movements?

In this context, the quality of kinaesthetics was combined with emotional engagement, particularly in secure and insecure spaces. This part of the research sought to understand the dynamic expressiveness of bodily behaviour, and the satisfaction and comfort experienced by women when forms of clothing are configured for their bodies. This content is presented in Chapters 6, 9, and 10.

In particular, in order to comparatively analyse different walk types ('natural,' happy,' and 'fearful') and garment types ('normal,' 'happy,' and 'fearful'), Laban Movement Analysis (LMA), combined with the Motion Capture (MC) technique, is applied (see Chapters 9 and 10). LMA is used especially effectively in this study firstly, because it analyses the phenomenon of quality of movement from the point of view of lived experience in terms of the physical as well as the mental, emotional, social and spiritual aspects (Laban, 1960). Secondly, this approach is appropriate and necessary to give a correct description of people's movements as an emotional aesthetic expression, such as the person's style of walk, which is not simply and quantitatively characterised in terms of biomechanical or physical speed, direction or path. Rather, LMA uses meaningful symbolic language and thought-provoking interpretation to describe the character of body movements and such aspects as how the body moves and changes in space, and how the body uses energy. For example, if the movement follows a smooth direction in space, it is considered to be indirect and flexible; whereas if it tends to move in a straight trajectory it is called direct. In a similar manner, a movement is considered not in terms of physical speed alone, but as leisurely or urgent in character, and as sustained or quick. Thirdly, the LMA approach encompasses the whole complexity of human movement, and is not only focused on dance expression, but also extends to the natural or organic movements of everyday life. So it is relevant for how the body moves in the real world, accomplishing real tasks, like those performed by workers in their usual activities, such as walking styles. I will describe in detail how LMA analysis and validation can be applied to design principles for designers in Chapter 10.

To sum up, four contexts of the EAI framework (see Figure 3.2) are developed: 'knowing through experiencing, experiencing through unknowing'; 'feeling through touching'; 'seeing through touching'; and 'doing through feeling, feeling through doing.' This EAI framework is structured by reflection on the theoretical contexts of the human body and embodied experience — phenomenology, pragmatic aesthetics, and affordances — in terms of sense and movement, and such human skills as knowing, feeling, and doing. The exploration of the human body, human experiences and human skills has been conducted in four phases of experimentation using this framework with user participants' study. The ultimate aim was to develop: (1) an

innovative design approach to EAI; and (2) design principles for clothing comfort. This conceptual framework can take the form of applying knowledge from human experience to design, and sensitising concepts to directly help designers and researchers to consider the richness of multimodal human senses and skills in the context of aesthetically embodied comfort in the field of clothing and textiles.

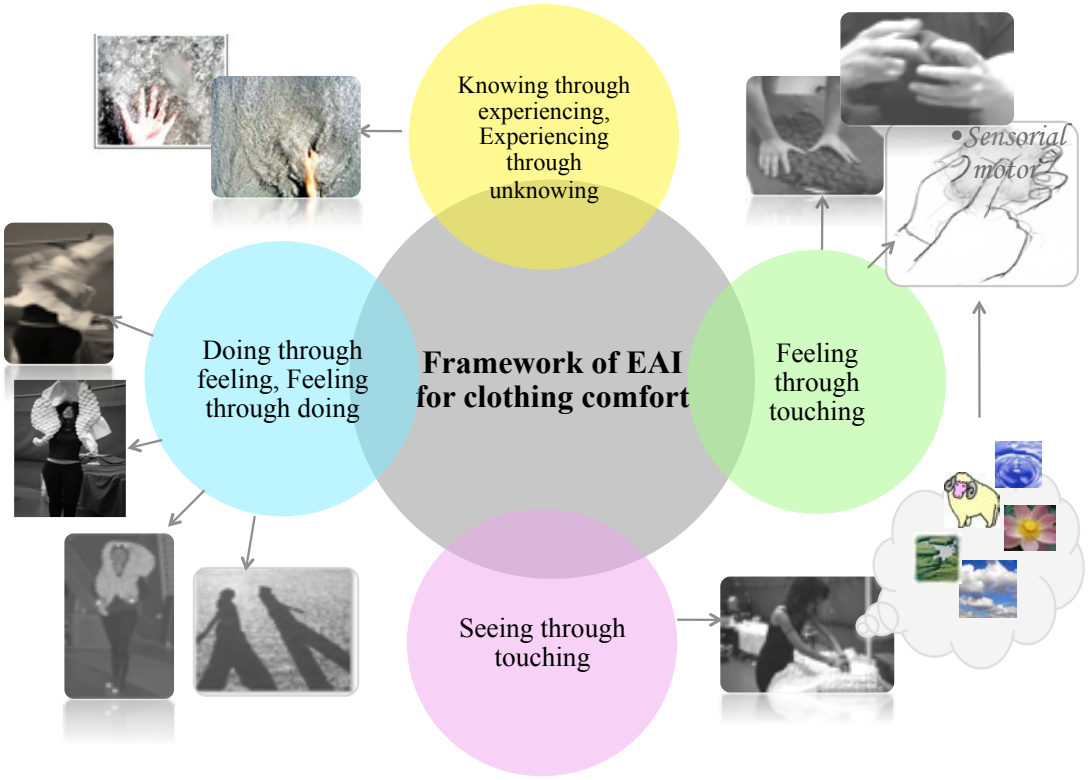


Figure 3. 2. Framework of EAI for garment design.
Source: drawing by the author.

The next chapter will discuss how nature is conceptualised through bodily interactions in the context of knowing through experiencing, experiencing through unknowing. This exploration of bodily experience in interaction with nature as the first phase of experimentation, and as the basis for the EAI framework, will offer an understanding of aesthetics in interaction, and shape the process of generating the concepts and design principles for integrating the senses, perceptions and emotions used to develop prototypes of clothing.

Chapter 4

Generating concepts

Chapter 4

Generating concepts[1]

4.1 Introduction

This chapter describes the process of generating creative and innovative design concepts. 'Knowing through experiencing, experiencing through unknowing,' was the first phase of experiment in research-through-design process and the basis for the framework of 'Enriched Aesthetic Interaction' (EAI). When I attended a workshop titled 'Fremantle on the Edge,' WA from 15-17 April 2009, I was able to engage in active experiment and interaction with nature via the body, sand, water, shadow, and movement. I draw upon the results from my own bodily experience in an attempt to contribute experiential understandings of certain aspects of aesthetics in interaction and embodied comfort. Reflection on the outcomes from this experiment, design concepts and methods influenced the context of further the initial EAI framework development. This experiment enriched my research by creatively straddling the gap between theory and practice.

Section 4.2 provides a background on how people understand comfort in everyday activities and how comfort can be evoked by the power of nature. This section includes an overview of the process of generating concepts for this research. Section 4.3 describes the aim and questions of this phase of the research. Section 4.4 describes the method used for the experiment. The results are discussed in sections 4.5 and 4.6, and conclusions are drawn in section 4.7.

4.2 Embodied comfort from the power of nature

A great many aesthetic emotions and in particular comfort can be evoked by our experience of movements during everyday activities. A walk in the park can make people feel happy and comfortable. But while it is comfortable look at the beautiful

[1] Part of this chapter formed the basis of a journal paper: Jeon (2013) 'Emotional object creation': Experiencing through unknowing and knowing through experiencing in *Design Principles and Practices: An International Journal of Design in Society* published by Common Ground at University of Illinois Research Park, USA.

scenery, it is even more pleasurable when people interact with nature, for example, jumping in the water, walking by a stream, smelling the scent of the flowers, splashing water, rubbing their feet on the sand, and hearing the sounds of the wind, rain, or birds. This is because our perception of comfort can draw from how our bodies experience the world or interact with the world, whether it is objects, living beings, situations, or events intermingled with sensory experience and action (Merleau-Ponty, 1962). Nature can be a particularly rich source of inspiration for people (including designers and artists) in her never-ending beauties of growth. The emergence of forms, which nature creates, evolves into other forms continuously through the eternal phenomenon of growth in time, and space. In the natural world there is a reciprocal relation between matter and energy and between form and environment. People tend to find positive energy such as 'feeling good' as a comfort deriving from nature. This is because the power of nature's beauty can invite people to feel, move, and even heal their bodies when they are physically and psychologically unwell. Nature brings forth an interactive powerful energy and empathy in individuals' difficult situations. Interestingly, the comfort felt while people interact with nature can be a universal sensation, in contrast to the absence of a universally accepted, operational definition of 'comfort.' This is because, despite people's different cultural backgrounds, such as Asian or Western, their different age brackets and different personalities, such as introvert or extrovert, interacting with nature seems to evoke 'good feelings.' For instance, we could feel comfortable and calm when interacting with nature: when we walk on the sand barefooted, or slowly along the shore of a beach or a flowery path way; when we jump into cool water; when we feel the sand and the water on our skins; and when we hear the sounds of the wind or of birds. Our body, consciously or unconsciously, is nourished by the heady perfume of roses, the fresh air, and the peaceful scenery. In this sense, Bissell (2008) describes comfort as:

> … a specific affective resonance circulated through a variety of tactile, visual and audio media… where the body has the capacity to anticipate and fold through and into the physical sensations of the engineered environment promoted. (pp. 1701-1705)

The concept of comfort in clothing design research needs to embody a certain depth of embodiment in the design of interaction (Dourish, 2004) and aesthetic experience in interaction (Shusterman, 2000). It also needs to be more integrated with multi-sensory and action involved in our everyday lives. In this sense, dynamic design approaches are required to develop aesthetic concepts and methods, which are reflected in people's (including designers') experience (Hummels et al., 2007). Here, it is also relevant to remember that 'man can interact with the world through doing and not through knowing' (Frens, 2006, p 37). This research project in the workshop considered the notion of *doing* and *experiencing* in order to generate ideas and concepts and designing for body-sense and movement-based interaction:

> 'Interaction creates meaning' does not only hold for users during interaction, but also for designers when generating ideas and developing concepts. Therefore, we postulate that if one truly likes to design for movement-based interaction, one has to be or become an expert in movement, not just theoretically, by imagination or on paper, but by doing and experiencing while designing. (Hummels et al., 2007, p. 677)

Accordingly, in order to generate design concepts and methods, this research project in the workshop explored nature's continuous creations and embodied comforts. In addition, this research investigated how the body senses and moves, and interacts with nature via water, movement, sand, and shadow. The outcomes of the experiment influenced the further development of initial EAI framework.

4.2.1 Knowing through experiencing, experiencing through unknowing

This chapter describes the 'knowing through experiencing, experiencing through unknowing' workshop I participated in.[2] In this context, the term 'experience' represents abstract, spontaneous, intuitive, and unplanned aspects of interactive

[2] The workshop was a part of large project titled 'Fremantle on the Edge,' which is described in a four-part series: Pictures from the Edge, Intertidal, Whirly Winds, and Conversations from the Edge (Spanbroek & Farren, 2011). I participated in a three-day Intertidal workshop, which was directed by Curtin University's International Visiting Artist, Maria Blaisse, from the Netherlands, 15-17, April 2009. The concept I describe in this chapter, experiencing through unknowing, knowing through experiencing, was inspired when Maria and a group of students (including me) had a discourse on issues of the power of the ocean in the first-day workshop, before experiments based on five elements – water, sand, shadow, movement, and body.

bodily movement. In other words, this is the self-knowing process, and represents a subconscious state, which is mostly an automatic, fluid experience, within which the person acts immediately without thinking. This is what Merleau-Ponty (1962) identified term as a 'perceptual field.' As discussed in Chapter 2, Merleau-Ponty's (1962) phenomenological standpoint has opened the door to reconsider how perception is formed by our bodily experience of knowing the world. He identified perception as a 'perceptual field' in which our lived awareness is not the sum of isolated sensory inputs but a dynamic commingling of sensory possibilities. He elaborated on the concept of the body-subject so that consciousness, the world, and human body as a perceiving thing, are intricately intertwined and mutually engaged. Through bodily perception, we immediately interact with and are aware of the thing because it mutually interacts with us to offer a reciprocating, pre-reflective sensibility and signification. This is how meaning arises in interaction in his phenomenological standpoint:

> How we think about the world is ... rooted in how we interact with it before we think, and so our intellectual thoughts cannot be used to explain away that pre-reflective experience. We move about the world, make use of the objects in it, respond to situations emotionally, act in order to change it, and so on. All these and other ways of interacting with the world give rise to its meaningfulness, so that the meaning of things in a sense, exist neither 'inside' our minds nor in the world itself, but in the space between us and the world, in the interaction. (Matthews, 2006, p. 33)

Here, the context of 'knowing through experiencing, experiencing through unknowing' in the research project in the workshop was linked to a philosophical aspect of Merleau-Ponty's (1962) phenomenology, which is centrally relevant to perception intermingled with sensori-motor concerns.

4.3 The research aim and questions

The research project explored bodily experience in nature to examine the initial EAI framework, specially, in the context of 'knowing through experiencing, experiencing through unknowing.' The research project in the workshop aimed to generate further

creative and innovative design concepts from aesthetic experience of manipulating and interacting with nature — water, sand, shadow, movement, and body.

Based on the research aim, there were three research questions to explore:

- How do we communicate our perceptions, senses, and emotions in the natural environment?
- How do we experience beauty and comfort from the unconscious, normally unnoticed environmental elements, such as movements of water, sounds from the ocean, and bodily responses?
- Can these aesthetic experiences inform the development of innovative design concepts in the design process?

4.4 Method

The research project was the first experiment in the research-through-design process. The significance of this research project was twofold: 1) this research was not initiated by user needs but by the research questions; and 2) this research was based on explorative experiments to obtain significant outcomes. These included reflection on how to define the feeling of comfort in the phenomenological and aesthetic perspectives of design and design research. In research-through-design approach, participation in this workshop was based on *doing* and *experiencing* first after then *thinking* as a methodology. In other words, the research-through-design process follows the sequence of: 'act,' 'reflect,' and then 'think,' rather than 'think,' 'act,' and 'reflect,' the traditional research method. Even though this research was linked to the theoretical idea of phenomenology of perception (Merleau-Ponty, 1962), the process of this phase of my research was aimed at shifting the focus away from knowledge-based theoretical research to exploring knowledge through sensorial and bodily activities. It was aimed at exploring the context of experiencing nature through bodily activities and discovering unexpected directions, which may not be identified by reviewing the literature only. The project was focused on bodily experience through touch and vision when interacting with nature; for example, movement in ebb and flow, light, body and shadow. In order to explore comfort, particularly through bodily experience, I looked at a set of affective resonances

arising from the integration of tactile and visual senses and bodily movements when experimenting with nature and the body; this involved an interplay between aesthetics and the feeling of comfort. The process therefore generated further design concepts and ideas, and influenced initial EAI and the development of design prototypes.

My central strategy for this experiment in this research project was to participate in the workshop in the dual roles of designer and researcher. As a researcher, I documented and reflected on my bodily movements and experience using audio and digital recording, photographs and transcription. As a designer, I provided a series of narratives of my embodied encounters with a variety of senses and perception. I described my experience as I walked from one place to another detailing in words and photographs. From a designer standpoint, intuition was used to sense and know nature. Intuition was a part of my research and design approach, tapping into my bodily awareness and bodily action. Intuition in phenomenology refers to the cases where the intentional object is directly present to the intentionality at play; if the intention is filled by the direct apprehension of the object, you have an intuited object (Merleau-Ponty, 1962). My intuitive bodily experience began with the sense of how nature invites my body to feel/ be felt and move/ be moved. This intuitive bodily experience further guided me towards what I senses was an unknown reality latent with possibility in the development of design concepts and methods, and design prototypes.

4.4.1 Participants

A group of 12 students from a range of disciplines (Departments of Architecture and Interior Architecture, Fashion and Design, Curtin University of Technology) engaged in active experimentation with five elements: water, sand, air, light, and body. In this research, I only use examples extracted from my work.

4.4.2 Stimuli

This research project draws heavily on journal reflections. Stories are not only important for storing and interpreting events, but for learning, sharing, and

communicating in the design process. The narration of stories in this workshop the research project was focused on bodily experience of knowing nature, which was a crucial method for developing concepts in the early phase of the design process. Through engagement with elements such as water, sand, air, light, and body, my subjective experience can be captured and interpreted in my journaling. Journal records were kept in the form of sketches and notes on paper. Images (photographs) were taken by camera and performance scenes were recorded in video film-clips. This research was primarily concerned with observations and the insights that can be gained through the use of written, graphic and digital records.

4.4.3 Procedure

The Intertidal workshop was held in conjunction with a large research project titled 'Fremantle on the Edge,' in Perth, WA, from 15-17 April 2009. This was a multi-disciplinary project with an international Netherlands-based artist, Maria Blaisse, as a mentor (see Figure 3.1). This research process was based on the notion of 'knowing through experiencing, experiencing through unknowing.' In an intensive three days workshop, participants were asked not to think but to experience bodily activities through the manipulation of five elements — water, sand, shadow, movement and body.

Maria described a set procedure for researchers to follow: to start from point zero, concentrate, and do research in the restricted field of ebb and flow:

> …in nature on many different levels simultaneously the exact right form is being formed in the most direct way… It is an energy that is connecting, creating coherence. When we experience these glimpses we get an idea of the awesome powers around us and how things are unfolding… Working with the restricted area of ebb and flow exploring movements, growing processes, forms and sounds in the sand and water one isn't usually aware of …then to slowly develop and realize these ideas… To sharpen perception, to become more sensitive, to explore movement, growing processes, forms and sounds with the sand, water and light that one is not aware of normally. To interact with the continuous changes in nature, connect to your own original energy,

which is your greatest potential. When you use that potential you realise that you precisely need the being different from the other with respect for one's own — and everybody's — qualities. (Cited in Spanbroek & Farren, 2011, p. 27)

Figure 4. 1. Maria Blaisse and a group of students reflecting on the issues of their experiences after experimenting with the power of the ocean.
Source: photo by the Kyugnhun Kim.

The exploratory objectives and procedures were as follows:

- Participants were required to observe nature and engage in active experimentation with five elements: water, sand, air, light, and body.
- They were asked to capture their conceptual visual images by photographs or performances by videotaped film-clips.
- They were asked to describe their experiences in terms of how they felt, what they saw, and what the meaning was associated with, as presented in their conceptual visual images or performances.

4.5 Exploration of aesthetic experience and development of conceptual images

This section describes in detail my aesthetic experience through manipulation and interaction with nature — water, sand, shadow, movement, and body. I elaborate on: how my senses, space, perception and emotion interface are integrated; how I enable

to communicate my perceptions intermingled with bodily sensory response and bodily action involved; how comfort can be embodied in the power of nature where we encounter makes the body immediate sense — whether seeing, smelling, hearing, or feeling — intermingle together; and how dynamic forms can be created in the process of interacting with an experience of nature.

The images I captured and the performances were associated with the emotions and meanings that embody the aesthetics of interaction. All information that I gleaned from nature came to me through my senses — sight, hearing, taste, touch and smell. Sensation involved my sense organs — eyes, hands, ears, nose, and feet — receiving physical stimuli such as sounds, waves, touch, and vibration from wind, and water. These stimuli were transmitted to my brain for processing, to create meaning through action involved. In this sense, perception seemed to be vitalised by certain stimuli, for example, pleasant touch through my hands and feet, the fierce sounds of the wind; these were selected, reorganised and associated with meaning as I experienced the specific situation. This bodily experience was organised and vividly memorised by my brain as emotional happiness and comfort.

In the next section, I will describe the documentation process and how I reflected on my bodily activities.

4.5.1 Form from emotion: image through story-telling

From my notes:

> Day one, 15th April 2009, was a fine day but with quite strong winds from the ocean. I arrived at the beach in the afternoon, at Woodman Park, located near Coogee beach, Fremantle, W.A. I had no idea what to do. I started walking on the sand without purpose, direction and intention. Unconsciously, I walked further toward the edge of the sand area. There were tiny plants. Nobody pays attention to these humble plants. Leaves were constantly moving in the wind, and it sounded like it was whispering something to me. Then I approached them much closer to listen to the rhythm of the sound, as if they were dancing. After that I saw and felt the movement they performed, like drawing

pictures on a sand screen. Flickering shadows on the sand screen were constantly moving, followed by the movement of the sun and the wind. I closed my eyes to feel, so as not to restrict my field by vision. Then my bare feet, fingers and whole body started feeling ticklish and even getting warm from being touched by the water, sand, and the wind from the ocean. I felt comfortable throughout my whole body and mind in that moment. A vibrating sound touched me and allowed me to heal, and to meditate on my body. My mind and body were steady even though my body was constantly moving in nature. It seemed that I was in a state of tranquillity and in chaos. I felt that I was in an atmosphere of peace and tranquillity, even though it was cold and there were fierce sounds around me. I had a feeling of all the senses being integrated, which evoked compounded emotion. The sensual experiencing was much clearer while my eyes were closed, for example, body temperature, and fierce sounds.

Figure 4. 2. Interpretation of each image in conjunction with emotional words (calm, fear anger, and happiness) and their meaning.
Source: photo by the author.

Figure 4.2 shows how my bodily sensations (sound, touch, movement) could be interpreted in visual images evoking emotion. I captured the images when I heard the sound of strong winds from the ocean. I interpreted each image in emotional words (angry, calm, happy, and fearful). For example, the fierce sound of the wind evoked emotions related to fear, and was captured as an image, such as needle shapes (b). The picture of soft shapes was like the painting of orchids in tranquility in the sand screen, and was interpreted as the emotion of feeling calm (a). Image (c) interprets my feeling of anger. My bare feet, which grabbed and squeezed the water, were imagined and felt as the ephemeral desires of humans. Image (d) describes how it is when human desire is released, and one can finally feel happiness.

The experience of these tactile senses, including multi-sensual feelings such as body temperature and fierce sounds, was much clearer while I was blindfolded. This finding raised the following research questions:

- How can touch be integrated, shared and united with other senses in the multi-sensory nature of the cognitive process?
- How do people feel and behave while they are interacting with an object when blindfolded, compared to when they are not blindfolded?
- How does the sense of touch, while interacting with an object, enhance positive emotions?

As discussed earlier, Merleau-Ponty's phenomenology of perception emphasises that, as sensory field, the senses intermingle and mutually resonate (pp. 229-230). He intensively discussed how the sensory is commingled with the lived body and things in the phenomenology of perception (pp. 229-230). He highlights that 'the senses intercommunicate by opening on to the structure of the thing' (p. 229). The result is what Merleau-Ponty calls 'synaesthetic perception' — 'a whole already pregnant with an irreducible meaning…' (p. 229). His statement reinforced further development of EAI framework; in particular the context of seeing through touching. Some design researchers (Marks, 1978; Updali, 2005; Schifferstein & Desmet, 2007) have argued for the unity of the senses and the application of multi-sensory cognitive processes to design methodology. For example, Schifferstein and Desmet (2007) suggest that designers need to be more sensitive to the non-visual impressions that

products can evoke. One of the methods they suggest is exploring the environment with eyes closed to facilitate this process. As taking further development of EAI framework into the context of seeing through touching, the integration of sensory modalities — sight, touch, movement, and body — was used to build a sense-driven design method, exploring user's experiences when blindfolded and not blindfolded. This research method was used in the haptic enquiry into users' experience through participant observation and interviews, described in Chapter 8.

4.5.2 The sense of discomfort evoked by fierce sound

In this experiment, I experienced a sense of unease and discomfort as I interacted with time and the environment.

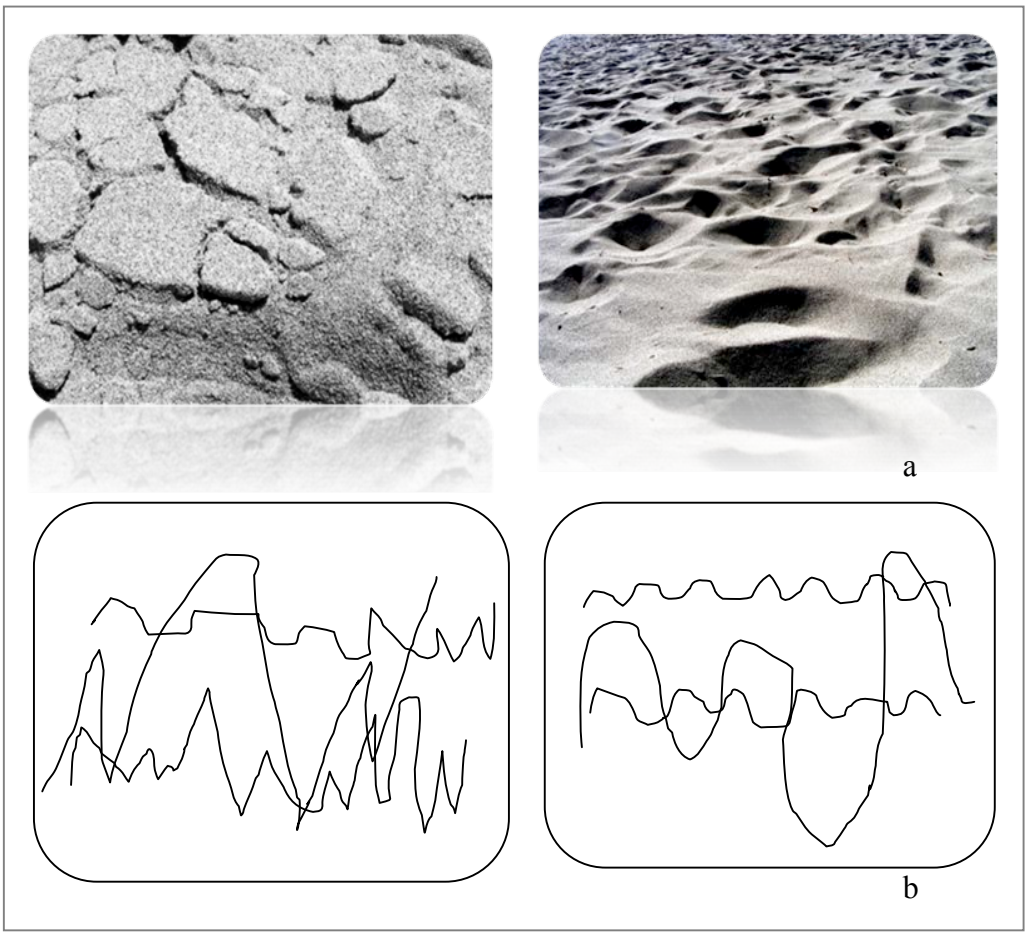


Figure 4. 3. (a) Emotions of fear and anger. (b) Interpretation of fear and anger from the images.
Source: drawing and photo by the author.

These images (Figure 4.3 a) show my interpretation of an outburst of the emotions of anger and fear. The feelings of discomfort and fear, and the sense of uneasiness made my heart leap. I interpreted that the sound of power from the ocean was stimulating the rate of my heart beat, while I felt nervous, angry and threatened. Nature, to me, became the heartbeat. In the line drawing, I drew an analogy between this sense of unease and a fast-beating human heart. Figure 4.3 (b) represents my interpretation of the heartbeat images.

4.5.3 Form from formlessness

From my notes:

> 17th April, 2009, was a fine day with clouds and a gentle breeze. I arrived at the same beach early in the morning. When I turned around, I observed a pair of pelicans sitting there peacefully (see Figure 3.4). They played with each other. I followed their steps. I concentrated on looking at the shadows they created when they moved.

Form is not to form for form's sake.
Form continues to form form's interrelation.

Figure 4. 4. Form from formless-ness: a pelican reflected in shadow on the sand. Source: photo by the author.

Finally, I took the image at the moment of the meeting point between the feet of the pelicans and the shadow (see Figure 4.4). As I observed the moment of the pelicans, the body (form) and their shadows (formlessness) were unified as oneness. There were vague boundaries — real-unreal, form-formlessness, and tangible-intangible.

4.5.4 Embracing water

From my notes:

> Touching the water and looking at the sand today enabled me to compare my feelings with the day before. I observed the bubbly waves coming onto the sand. Children were playing with their parents with happy smiles. Thousands and thousands of particles of water were dropping into the sea when the children jumped into the water. The movements of the children's bodies were like those of birds, freely moving with outstretched arms or wings towards the sky, with water constantly folding from their legs towards their trunk, as they jumped up and down, flapping their wings. Then I saw the footprints on the sand, slowly wiped away by water and wind. But I caught the trace of the moment in the footprints left on the sand, which made me think about the moment's happiness and comfort (see Figure 4.5 a).

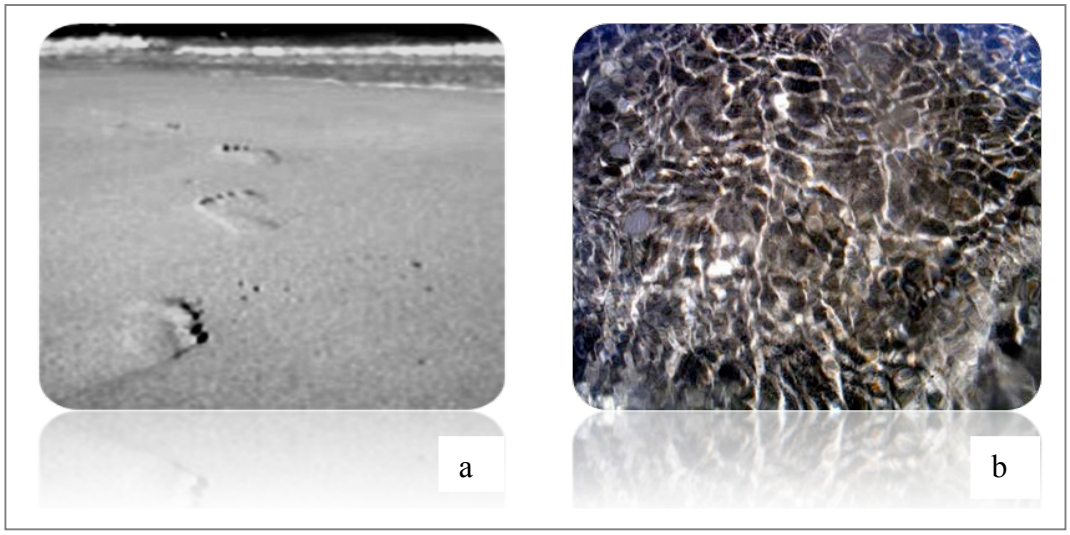


Figure 4. 5. Form from emotion (happiness and comfort), involved in memories. (b) The formlessness of phenomenological nature.
Source: photo by the author.

> Unconsciously, I walked into the water, which was warm and gently touched my body. The feeling of that moment was like embracing water, air, sound, and light. The abstract structure of the water was mysterious and looked like a clear and shining crystal. From the lens of the camera, the constantly changing structure of the water was even clearer, and phenomenal. I kept looking at the constantly moving water and its fluid formation (see Figure 4.5 b).
>
> Using my body to move in the water and sand started further experiment... I walked into the water, which was warm and gentle when it touched my body. The water invited me to unconsciously paddle my feet and hands to feel it. The experience of the power of the ocean was like a feeling of ease and comfort from touching, hearing and seeing the gentle waves, the ebb and flow, the light breeze… In this process, my intention was to feel the water and sand. For example, using my body's reflection — a shadow in the water — allowed me to embrace the water.

Through the movement of my legs, hugging, holding, and embracing the water (see Figure 4.6 a), I found that the forms of the water evoke happiness, awareness, and even fear. Interacting with form (body) and formlessness (body's reflection in shadows) through movement was seen as part of a unified whole, or a unity that pushes the boundaries between presence-absence, being-non-being, place-non place, matter-spirit, visible-invisible, and thing-thinglessness. This has an unexpected and unexplainable source, energy from the power of nature.

Figure 4. 6. (a) Bodily interaction with water, shadow, and movement.
Source: performance and photo by the author.

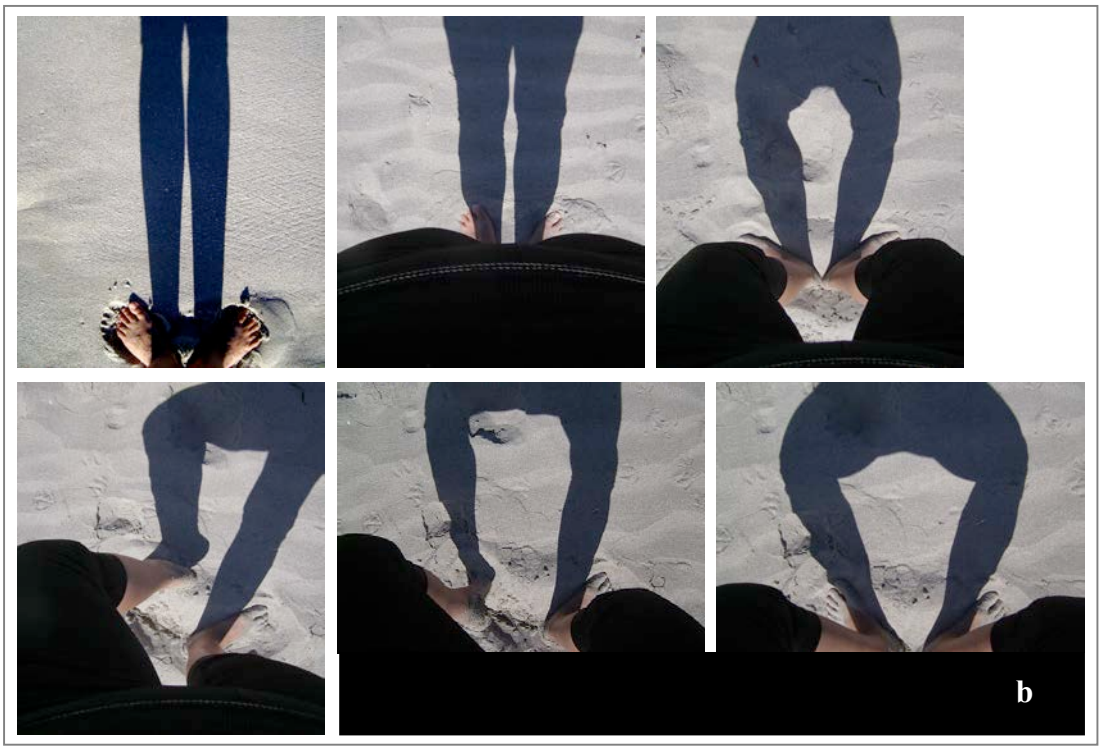


Figure 4. 6. (b) Bodily interaction with sand, shadow and movement.
Source: performance and photo by the author.

Figure 4.6 (b) shows how the sense of movement is related to space, and how perceptual space can be created through 'closing' and 'opening' body movements. As if I embrace sand, I slowly bend low to the sand, with my two legs moving outwards. In the following motion, with my right leg remaining curved, my curved left leg slowly stretches, opening towards the outside. The space created by the inside zone of the shadow can be referred to as personal space, which embraces the sand and feels like the place to hold and protect. In contrast, the whole space surrounding the outside of the shadow, that is, the environment in which the act of movement is viewed by other people and taking place, can be referred to as the general space. The performance, combining metaphor with shadow, movement, and space shows that my physical body plays a central role in shaping the experience of movement in space. This exploration shows that form is indefinite, unstable, imperfect and purposeless. An understanding of form-less-ness helps us to attain deeper emotional awareness. Continuously evolving forms enable us to see how meanings and senses interact in our everyday, embodied experience of space. These photographic images of enigmatic forms blur the distinction between the body and its reflection in the sand and water. Form (my body) and form-less-ness (its reflection in shadow) are shown to be dynamic and are eventually unified in oneness. This experience of choreography started with the exploration of design practice through the concept of form-less-ness, shape change, Trans-For-M-otion. The aim was to examine how people hold and wrap their bodies to create space, both personal and public, and how clothing can be manipulated by the wearer to create different volumes in those spaces. I will address this issue in more detail in Chapter 6.

4.5.5 A sense of beauty through bodily experience

Observing my multifaceted body shapes and movements reflected in the water and on the sand (see Figures 4.6 (a) and (b)) was not a humble and ordinary experience for me, but one of beauty. I realised how much I had criticised my body and sense of myself. We, in particular, women, spend a lot of time discovering and creating ourselves by criticising and admiring our own reflections. In fact, mirror images serve as bridges between mind and body and reflect how we perceive our sense of self through instant bodily reactions. The sense of self and self-awareness is closely related to how satisfied a woman is with her body in social interaction, when

focusing on her thoughts, feelings, behaviour or appearance, when she is reflecting, fantasising or daydreaming about herself, or when she is making decisions or plans that involve herself. Studies have shown that women, in particular, are dissatisfied with their bodies (Fisher, 1973). Schilder (1935) considers clothing as an extension of the body that may be used to change the body image. When I saw my body shape change through the lens of the camera, I realised that beauty doesn't exist until I feel it through the heart and not through the brain. Similarly, feeling comfortable in everyday activities can be linked to beauty, when a person puts a value on something. In other words, we can transform the ordinary sense of ourselves into the sublime, just as we appreciate the sublime in nature.

I explored the experience of my body in interaction with the shadows in the sand and water. The bodily experience, through sight, smell, touch, and sounds from nature, is saved in brain data and conjures up memories of happy and comfortable experiences. As we interact with an object and its related environment — an object-standing-beyond us — form interrelates with what we are experiencing. It is not solely a thing standing by itself; form is not making itself for form's sake. In my bodily experience, I strive to emphasise not just the obvious visual representation, but the underlying and integrated sensory and symbolic narratives of the work.

4.6 Insights from the workshop

In the workshop, my observation and experience of integrating my body with the water and sand enabled awareness and awakening, opening my eyes and body to a newly-born, intense experience of seeing, feeling, and breathing. At a given moment, my brain received and responded to an infinite variety of information in different configurations. I found that my body acted as an important kind of sensor, registering all the signals sent out by the natural environment and any changes that took place in it. It was evident, however, that I was only consciously aware of the information that I focused on, and the way I perceived it was heavily influenced by experience, environment and emotional responses. My own reflections as a researcher and practitioner have therefore provided some insights into understanding integrated senses, emotions, perception, and spaces. In my experience, while interacting with my body and the energy from nature, for example, water, sand, air, and light, which

is always in a state of flux, what I feel and how I might behave cannot be predicted before the physical engagement. My meaningful bodily engagement with the five elements, 'knowing through experiencing, experiencing through unknowing,' was an effective and eminently practical exercise, revealing:

- The meaning of my expressive behaviour in performance;
- An understanding of my expressive emotions, for example, comfort, discomfort, anger, panic, or love, experienced in interaction with motion and form; and
- The development of design concepts through meaningful perception.

In my reflection on the workshop, my research project, to design clothing for comfort, has sharpened its focus to three aspects of design:

- Exploring how a set of affective resonances, integrating sensory modalities (sight, hearing, touch, and movement) in situations such as being blindfolded and not blindfolded, can inform a body- and sense-driven design technique;
- How our everyday actions, for example, the way we wrap our bodies, hold ourselves, or walk, portray our aesthetic, interactive behaviour;
- Design that actively engages with affective states, where the body has the ability to anticipate both the physical sensation and the mental association.

4.7 Conclusion

This workshop explored the bodily aspects of human-to-object interactions that integrate phenomenological nature and everyday activities. The main aim of the research was to develop further concepts and design methods for integrating sense, space, perception and emotion. This aim extended to influence the initial EAI framework and development of design prototypes. Nature inspired me to develop the design ideas and design concepts for experiments based on five elements — water, sand, shadow, movement, and the body as an interactive object. There are two important aspects of design methods in the research. First, bodily movement, observed through interactive research, 'experiencing through unknowing,' reveals how actions (body movement) and emotions are integrated. This may in part be a

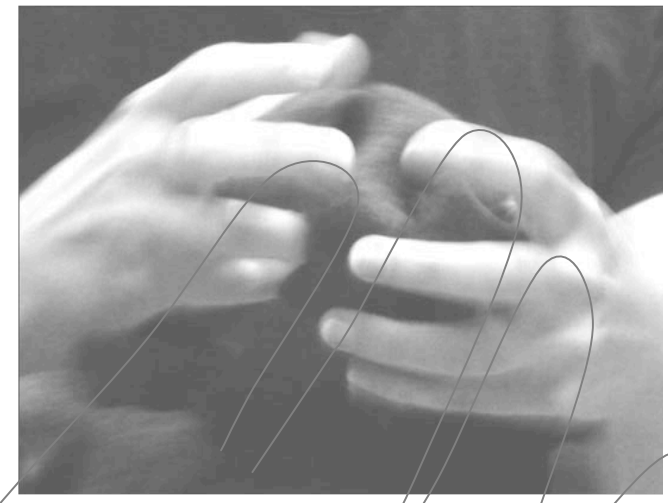
serendipitous process, when planned insight is coupled with unplanned events, and objects are created and appreciated in practice. As noted in Chapter 2, in Section 2.4.2, Shusterman (2000) emphasises that aesthetics has a practical use that should be integrated into the everyday experience of life and related to actual human needs, values and events. Defining comfort as an aesthetic emotion should take into account instrumental daily practice, focusing on our own experience of movement in everyday physical activities. Feeling comfortable in everyday activities can be linked to beauty, when a person puts a value on something. This aesthetic perspective has influenced the development of design concepts and conceptual prototype designs in my research. This will be discussed in Chapters 5 and 7.

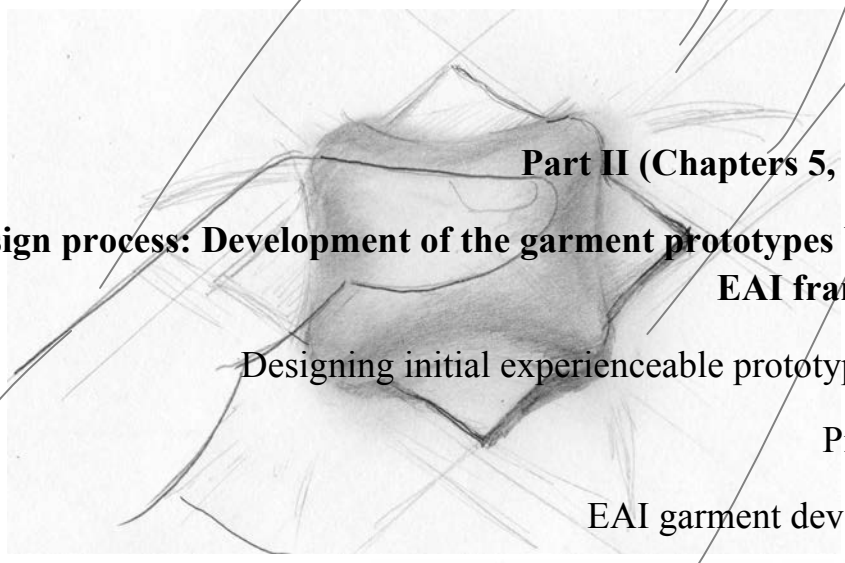
Secondly, reflection-based research in the EAI framework, 'knowing through experiencing,' explains how the body has its own kind of knowing. Consciously or unconsciously, this may be tapped into for new levels of understanding, and by manipulating the five elements. This approach outlines how the body and bodily movements are communicated through senses and in spaces. Merleau-Ponty (1962) states that space is not provided by one's senses (subjective), nor are it an intellectual construct (objective), but its main origin derives from the body. The body defines spatiality between form, movement and content, in relation to environment. His theory defines many ways in which spatial consciousness, movement, visibility and appearance all affect human action; recent emphasis on phenomenology and on the use of all senses continues to demonstrate the considerable significance of acting/being acted upon and seeing/being seen (Parviainen, 1998). Spatial perception, as applied to clothing, is about what can be perceived, and about visual, kinaesthetic, tactile and spatial aspects. In this account of this research, I have provided a series of narratives of my embodied encounters with a variety of spaces, detailing in words and photographs my experiences, as I walked from one place to another. This allows detailed consideration of how these spaces work on the body to create a particular understanding of senses and of place. This approach outlines how the body and bodily movements are understood through the senses and the meanings we incorporate from them. Bodily interaction with five elements could be related to 'meaning-carrying action' (Djajadiningrat et al., 2004), where the concept of affordance is a key element; that is, meaning is created in action (Gibson, 1977). As mentioned in Chapter 2, Gibson's affordance theory, which is closely related to

phenomenology (Merau-Ponty, 1962) is that the world is inherently meaningful for our body and, by moving we can get access to that meaning. Interacting with objects creates meaning for people. These methods have affected the development of prototypes and design techniques for the aesthetics of interactive behaviour in the participant phase of my study, described in Chapters 9 and 10.

The Intertidal workshop has been a catalyst for the development of ongoing design concepts, as part of the design prototype development, within the context of 'object playing with movement,' and garment design that is integrated with dynamic bodily expression, quality of movement, and emotion. In this context, holistic bodily expression in movement is treated as a source of comfort and enjoyment, and is called shape change, or Trans-For-M-otion (see Chapter 5). This has also influenced the study of participants' haptic experiences, for example, in the sense of touch and sense of movement (see Chapter 8).

This project has highlighted the potential of design practice that accounts for the interrelatedness of senses and perception, and of design elements that invoke such natural phenomena as water, sand, air and light in relation to bodily experiences in a creative design process. Here, I draw upon my embodied experience to contribute experiential understandings of key aspects of aesthetics in interaction and embodied comfort from how we understand nature through our bodily sensorial awareness. In particular, this project contributes to the interactive design field, illustrating how designers can incorporate a phenomenological representation of nature and the value of everyday activities into their design process.





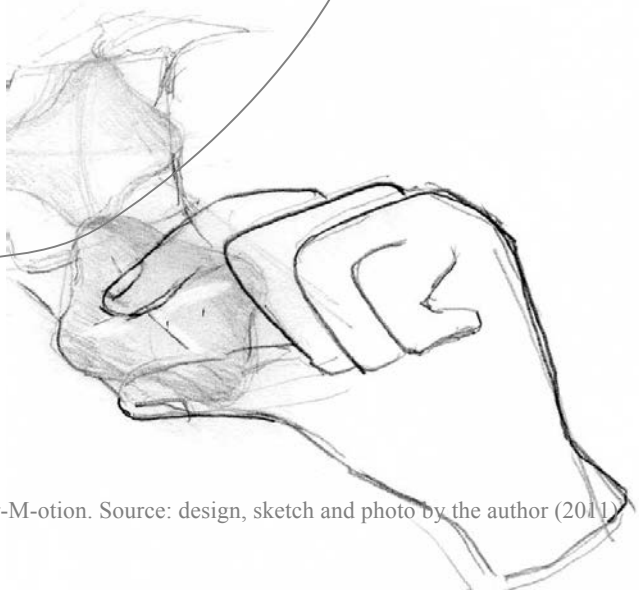
Part II (Chapters 5, 6, and 7)

Design process: Development of the garment prototypes based on EAI framework:

Designing initial experienceable prototype design

Pilot study

EAI garment development



Trans-For-M-otion. Source: design, sketch and photo by the author (2011)

Chapter 5

Designing initial experienceable prototype design

Chapter 5

Designing initial experienceable garment prototype

5.1 Introduction

Part II starts with this chapter and describes the design application, which reflects on the research-through-design cycle in Part I — the theoretical ideas, EAI framework, and a design workshop addressed in chapters 2, 3, and 4 — and which were applied in the design process. Part II sets out the design process and user involvement in the pilot study. The pilot study tested out an initial conceptual design in the context of the EAI framework: doing through feeling, feeling through doing (Chapter 6). The testing was critical to the design process to understand how people move and how they are moved in response to emotions. Outcomes of the testing resulted in a second iteration of the conceptual design and influenced other conceptual garment design ramifications (Chapter 7). The conceptual designs were conducted further with in-depth participant interviews and observations through three phases of experiment, which that will be addressed in chapters 8, 9, and 10 in Part III.

From the reflections on Part I, the initial conceptual design described as Trans-For-M-otion was developed and is presented in this chapter. Section 5.2 describes the validity of research-through-design as a process. Section 5.3 illustrates the initial experienceable design in terms of concept formation, design structure, and the use of materials in conjunction with how the EAI framework was implemented in design applications. Section 5.4 concludes with a description of how the conceptual design was used for the first experiment with user tests, as part of the proposed framework of EAI.

5.2 The research-through-design process

In Chapter 1, I described the significance of why and how I used the research-through-design process in my doctoral thesis. The research-through-design approach used follows the design process as a form of research and involves generating communicable knowledge through the act of designing (Archer, 1995; Frayling,

1993; Zimmerman et al., 2010). In other words, the aim of the research-through-design approach in my doctoral research project was to strike a methodological balance between the research and design; between a designer's intuitive, artistic skill and experience and the user's latent skills and ideas; and between tangible prototypes and intangible theories. The research-through-design process imposes systematic cycles. It follows action and reflection iteratively to build and test several conceptual garment designs. I will re-visit and elaborate in more detail how I take account of the process of the development of all of the conceptual garment designs used with a research-through-design approach in Chapter 7.

The initial experienceable prototype, entitled Trans-For-Motion, was primarily developed for movement-based interactions that respond to emotions. Felted wool was the interactive medium and used for material exploration. In the creative design process, the conceptual design development involves dialogue between theoretical ideas — embodied interaction inspired by Merleau-Ponty's (1962) phenomenology of perception and Gibson's (1979) idea of affordances (see Chapter 2) — in the context of the EAI framework for clothing comfort, doing through feeling and feeling through doing (see Chapter 3), and the design workshop exploring the nature of my experiential bodily knowing and understanding generated through the phenomenological way I touch, feel, and move in the process of interacting with nature (see Chapter 4).

In the next section, the design scenario, in explaining the design process, I explicate how theories expand the knowledge of my design practice. I also elaborate on how my bodily knowing and experiencing in the real context of environment influenced the development of design concepts and methods. Furthermore, I elucidate how the EAI framework was applied to the conceptual garment design and how innate materials, such as felted wool informs structure, in turn informs the shape. This perspective is a bottom-up design approach, asking questions such as: how can a material approach, prioritizing environmental and bodily performance and material behaviour over form, be accommodated by design? What new design possibilities emerge? And what theoretical background and bodily experience via nature can be

used for reference to support for this material exploration and emergence of new design of interaction?

5.3 Design of the scenario

5.3.1 Trans-For-M-otion

Figure 5. 1. Trans-For-M-otion is designed to test emotional responses through observation of body movement.
Source: design and photo by the author.

5.3.1.1 Concept formation

Trans-For-M-otion represents the concept of form-less-ness and shape change — the shift of clothing into an in-between transitional space through the integration of the processes of human interaction, associated movement and emotional response (see Figure 5.1). The aim of the conceptual design development was to research the following question:

- How do garments allow people to afford and adapt to constantly changing moods and emotions? (emotional affordance)

My bodily experience of choreography started with an exploration of the design process through the concept of form-less-ness and shape change, Trans-For-M-otion. As noted regarding the 'choreography of interaction' in which I participated through the workshop entitled' Fremantle on the Edge,' held in Fremantle Western Australia in 2009 (see Chapter 4), I explored my bodily experience through experiments based on the context of the EAI framework, knowing through experiencing, experiencing through unknowing, through body, sand, and movement as an interactive medium (see Figure 5.2).

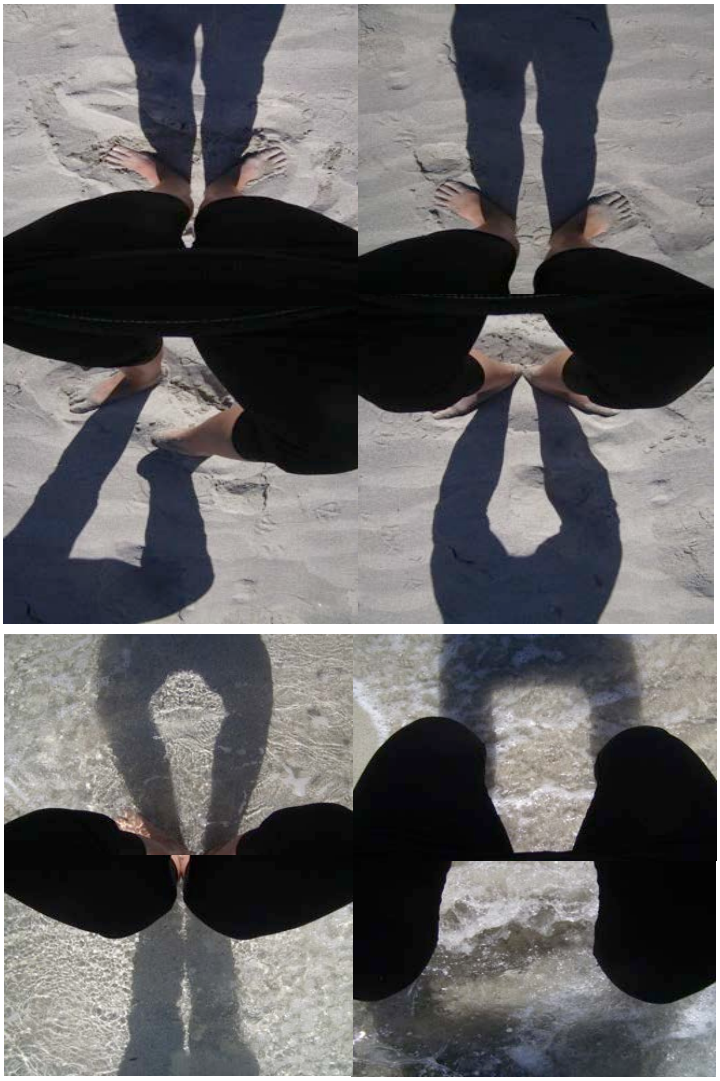


Figure 5. 2. Choreography in interaction: form and formlessness mediated by body, movement, water, sand, and shadow in 'Fremantle on the Edge' project in Fremantle, Western Australia, 2009.
Source: photo by the author.

The aim of the experiment was to explore spontaneous feelings in a natural environment using the conscious or unconscious bodily knowing process, which was a crucial method for developing the concepts in the early phase of the design process. Rather like the form is created in nature, which continuously evolves through the perpetual phenomenon of growth in time and space, the empowerment of form through bodily movement (i.e. hugging, holding, and embracing the water) continuously evolves to bring the meaning and sense in our everyday, embodied experience of space (see Figures 5.2). Just as water and sand change their fluid formation constantly, as adaptations of nature to environmental forces, our bodies know consciously and unconsciously how to adapt an object to adjust it for comfort in insecure/secure or various emotional situations. In this sense, form is indefinite and imperfect but it is ongoing, as it transforms from one from into another in relation to a space where the body perceives sense and emotion. Reflecting on this active bodily experiment with nature I was curious to explore further how a garment can encourage people to feel, move, and configure their own level of comfort in different emotional states and living environments.

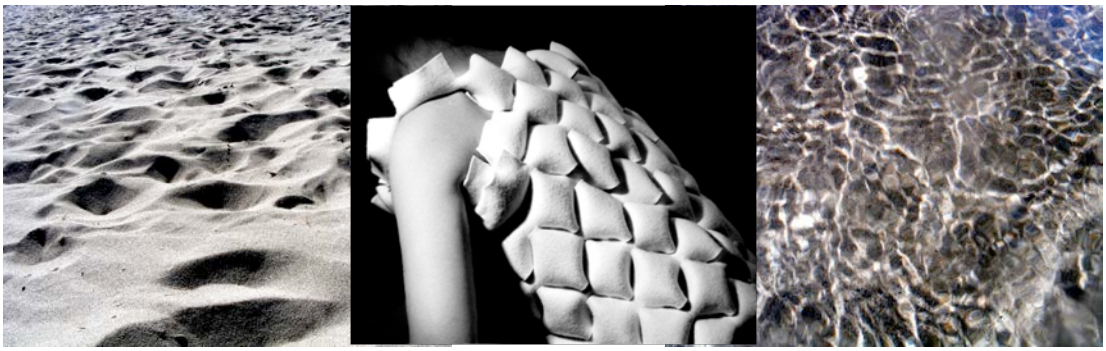


Figure 5. 3. Forming structure of Trans-For-M-otion inspired by constant changing form of the water and sand.
Source: design and photo by the author.

Our body becomes a primary source and an essential structure to create the new form of garment and to understand the nature of bodily interaction. This bodily experience can link to Merleau-Ponty's idea of phenomenology (1962) that emphasised the perceptual, bodily intertwinement between experiencer and thing. Reflection on the bodily experience through the nature of Trans-For-M-otion, wherein the textile is constructed, was inspired by the constantly changing structure of the water and sand

and their fluid formation, which I observed when participating in 'Fremantle on the Edge' (see Figure 5.3). Furthermore, this active bodily experiment with nature draws on my curiosity to explore how textiles enable people to feel, move, and configure for their own bodily comfort in different emotional experiences in the context of living spaces or the environment.

In relation to the design process as a design methodology, the conceptual design was developed on the basis of the EAI framework: doing through feeling, feeling through doing. As noted in chapter 3, in this EAI framework, the design process focuses on people's doing and feeling, not their thinking. This means that the conceptual design was designed through emotion-driven-action and action-driven-emotion. It considered the awareness of the body through how people move and they are moved to perceive senses and emotions. I particularly considered a kinaesthetic understanding of comfort in relation to negative and positive emotions, such as happiness and fear that tested how our body moves and is moved in response to these negative and positive emotions in spaces (see Chapter 6).

This context of the EAI framework: doing through feeling, feeling through doing, bridges theoretical design discourse in the creative design process. I adopted a theory of 'affordances' in phenomenological and ecological perspective in which meaning arises in interaction (Merleau-Ponty, 1962; Gibson, 1977, 1979). As highlighted in Chapter 2, Gibson's (1979) psychological concept of 'affordance' suggests that the world unfolds itself in potential for action. Therefore, we do not categorise products through product names, but rather through an intuitive bodily understanding of what we can do with them (cited in Dourish, 2004). In this sense, the world is inherently meaningful for the body and by moving we can gain access to that meaning. This conceptual idea can also link to that of Merleau-Ponty's (1962) phenomenology of perception, which emphasised how the environment and human body as a perceiving thing are intricately intertwined and mutually engaged in the concept of the body-subject that is consciousness. The phenomenal 'thing' is co-related to our body and its sensory-motor functions. Our body grasps things, while the grip itself is a function of our co-naturality with the world's things. The world and the sense of self are emergent phenomena in an ongoing 'becoming.'

In applying these phenomenological and ecological approaches in this conceptual garment design, the concepts of 'affordances' ('adaptability') and 'shape change' were applied. The theoretical application can explicate how the form and function of textiles become sensible and adaptable to people as bodily extensions, kinaesthetically and emotionally, and thereby integrating the body-subject and the space where our body perceives senses and emotions. We live in the shifting conditions of ~~a~~ contemporary culture and lifestyle and occupy the changing spatial sphere of a transitional, super-modern environment (Auge, 1997, p. 35). Women generally appreciate functionality in terms of sensory experience, performance, comfort or enjoyment. From this perspective, the content of affordance (adaptability) is related to a subject's well-being, and facilitates the senses and the bodily movements that enable flexibility of thinking, acting, and responding to their environment. In these spaces a garment's form needs to be changed to adapt to a person's mood and emotion. I looked at transitional spaces especially: airports, roads, and underground railways. In these spaces, the body needs more fluid and adaptable objects to enhance body movement and the use of space due to the fact that we encounter sudden temperature change, noise and pollution, stress, and even crime. In these spaces, women may experience not only actual physical harm, but also psychological dangers, such as fear of attack from other individuals, or feelings of insecurity.

Accordingly, Trans-For-M-otion was designed to be experienceable as an open design in order to explore people's reactions, their unexplored behaviours and speculative new ideas for conceptualising comfort. This was aimed at: 1) understanding textiles function related to emotional aesthetics and movement; and 2) exploring human perceptions and experiences phenomenologically in order to produce new forms and functions from a more holistic perspective. Therefore, the conceptual design offers how the form of the garment is empowered by an individual's body, which needs to adapt to their emotions and moods in an everyday changing environment. In this sense, the form of the textile was designed not to form for form's sake but to empower the form by form's inter-relation to space, movement, and emotion. Just as the form the body creates through interaction with nature is indefinite and imperfect, it is also ongoing and transforming one into another in relation to spaces where our body perceives senses and emotion. The form of the

textile is transforming one into another and then it is becoming tailored to the individuals' needs for their body. To sum up, Trans-For-M-otion is designed from the sensorimotor driven approach in conjunction with the EAI framework: doing through feeling, feeling through doing. The design approach proposes ways in which the body becomes an essential structure in creating the form of the garment. In this scenario, the garment is not static, but rather in a constantly interactive, hybrid state of flux, as it adapts to bodily transformation in response to the wearer's constantly changing moods and emotions.

5.3.1.2 Design structure and material

Structure: The theory of affordances (the interactive possibilities of a particular object or environment) implies that an object contains an infinite amount of information. For example, we can experience a feeling of comfort based on what we touch and how we interact with objects or materials. A soft, fluffy woolen blanket invites your hands to stoke the surface of the blanket and also invites you to wrap the blanket around your body and tuck yourself inside. The properties of the blanket elicit sensorial experiences, such as its soft warmness and bodily interaction, such as care-ness. This concept propounds the idea in textile design. To increase the level of sensory and movement interaction possibilities, the main structure of this conceptual prototype, Trans-For-M-otion, is designed with the idea of deconstruction and reconstruction. Created of simple felt units, Trans-For-M-otion replicates three-dimensional, regular polygonal shapes with the trapped air unit structure on the one side and flower-shaped pockets on the reverse side (see Figures 5.4 and 5.5). It is structured of regular geometric polygonal units, which are a combination of matter and form, and allow the transformation of form, while they stimulate air flow and enable wind protection. The principle of air layering allows for insulation and protection of the body in danger of attack in insecure spaces. For this reason, when someone wears the garment, she stands a better chance of staying warm and feeling secure. The unit size is 40 mm wide, 40 mm long and 35 mm high. The full size is 1200 mm (W) x 850 mm (L) x 35 mm (H). Its total weight is 600g.

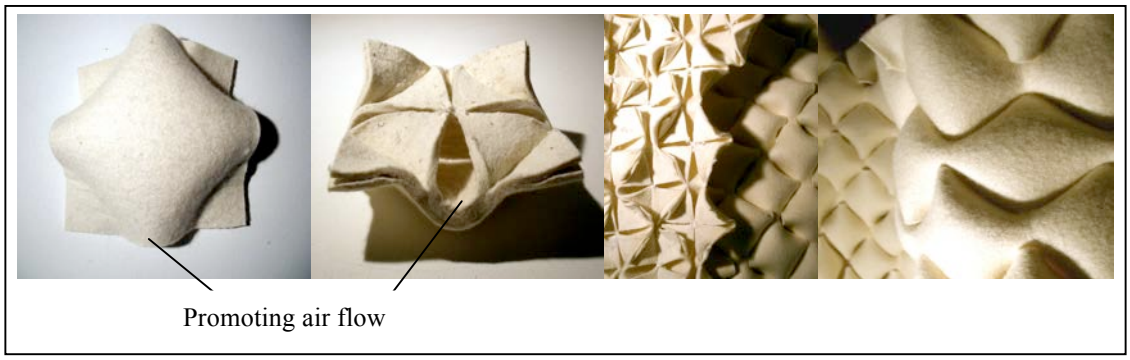


Figure 5. 4. Main unit structure of Trans-For-M-otion.
Source: design and photo by the author.

Material: In the design process I used not only my own senses and skills but also references from scientific research into the beneficial properties of wool for skin comfort by DEFWA in order to explore the innate properties of wool, as material exploration. Scientific wool research from the DAFWA on garment benchmarking has examined skin comfort in relation to wool fibre and its application in knitwear design using a knitting machine (Stanton, 2008). The concept of comfort is an ongoing research project for Australian Wool Innovation Ltd (AWI), which is in partnership with the Commonwealth (CSIRO) researching skin comfort. The aim is to expand economic benefits in terms of the promotion of the Western Australian wool industry and the Australian fashion industry into international markets (Australian Wool Innovation (AWI), 2008).

The beneficial properties and attributes of wool have been the subject of research by DAFWA. They have investigated absorbency, insulating performances, durability, resilience, positive tactility, and versatility (Stanton, 2008). In the assessment of comfort, to capture a wearer's response to the collected garments, DAFWA researchers have gathered everyday wearers' responses to garments and performed fabric appraisal surveys. These surveys have included: 1) being asked to rank fabrics on four components of satisfaction — *handle, comfort, appearance, and overall impression*; this data is then utilised to establish global benchmarking of fabrics; and 2) being asked to heat-rank eleven aspects of temperature — *absorbent; clingy; cold; damp; heavy; itchy; muggy; prickly; scratchy; sweaty; comfortable* — on inner garment surface when worn in cool rooms and hot rooms, using sensors on the body for body movement. The relationships between subjective human response and the

objective data extracted from the reverse engineering process have been sought to better understand fabric evaluation and also garment comfort for the wearer. Reverse engineering and fabric appraisal research has shown that the consumer responds to the combined effects of wool, fibre, yarn and fabric structure (Stanton, 2008). This scientific research into the beneficial properties of wool by DAFWA has influenced design development in the 'A Touch of Wool' project by Curtin University's Department of Design, which is part of the 'Design for Comfort' project (DAFWA, 2007). However, apropos of wool, this scientific data from research into design for comfort has not been fully integrated with artistic or innovative clothing design solutions.

I looked at what is inherent in the properties of wool, and felted wool. As highlighted already previous section, applying the concept of affordances in the design process involves understanding the intrinsic qualities of the chosen material, wool, its substance, together with devising the unit segment of the design to create potential form, and the resultant form's relationship with body and movement in space. Wool is only one kind of fibre that can be used in making nonwoven cloth. The felt technique is the most ancient of textiles. Wool felt has a number of other attributes and beneficial properties: 1) it resists flames and chemicals and dirt, air and water filtration; 2) it absorbs sound (acoustic performance) and insulates against heat and cold; 3) it has durability, positive tactility, and versatility; and 4) it evokes incongruent tactile feelings, such as roughness, but still has a feeling of softness and warmth (Brown et al., 2009). Wool felt is linked closely in the minds of consumers with terms used such as warmth, breathability, aesthetics, and performance — all properties associated with the comfort of clothing. This material has a long history of acceptance as a 'comfortable' and environmentally-friendly fibre, in particular when made from Australian Merino wool. Wool felt techniques were the idea generation, the starting point for the designs. Take some raw sheep wool, lay it out, sprinkle it with water, roll it up, apply pressure and, then, you have made felt. While experimenting with this felt technique, I explored new possibilities for how wool properties can create unexpected forms and textures. Trial and error was part of the process. My hands were my tools to make form and transform something from raw to made (see Figure 5.5).

Figure 5. 5. Form exploration through hand movements and wool felt techniques. Source: design by Kuemhee Oh and the author and photo by the author.

In addition, I employed engineering felt through shape exploration. The material contains beneficial properties, such as maximum durability, resistance, and more importantly, off-cuts of the material are normally discarded. The design strategy aimed for zero waste of resources (wool felt) but also to allow more designing experience with an object. The unit's modular segments were made out of wool felt. It was made from off-cuts of engineering felts composed of 70% wool felt combined with synthetic materials. I used the textile from felt industries in Perth, W.A. (*Felt sales*, n.d.). Material substances, such as engineering felt — being composed of the compound properties, which are tough, solid, rigid, but deformable, and still have a feeling of softness — inform structure — the trapped air units' modular segments combine craft skills with folding and sewing techniques which, in turn, inform the three-dimensional, regular polygonal shape. This shape can offer potential and dynamic movement-based on interaction possibilities, such as the shape's abilities of twisting, bending, deformability, manipulability, graspability, and flexibility. This shape tested how our body perceives, acts and feels comfortable (see Chapter 6).

The following Figures (5.6 to 5.14) show the process of making the form through sketching and wool felt modelling by taking photographic images.

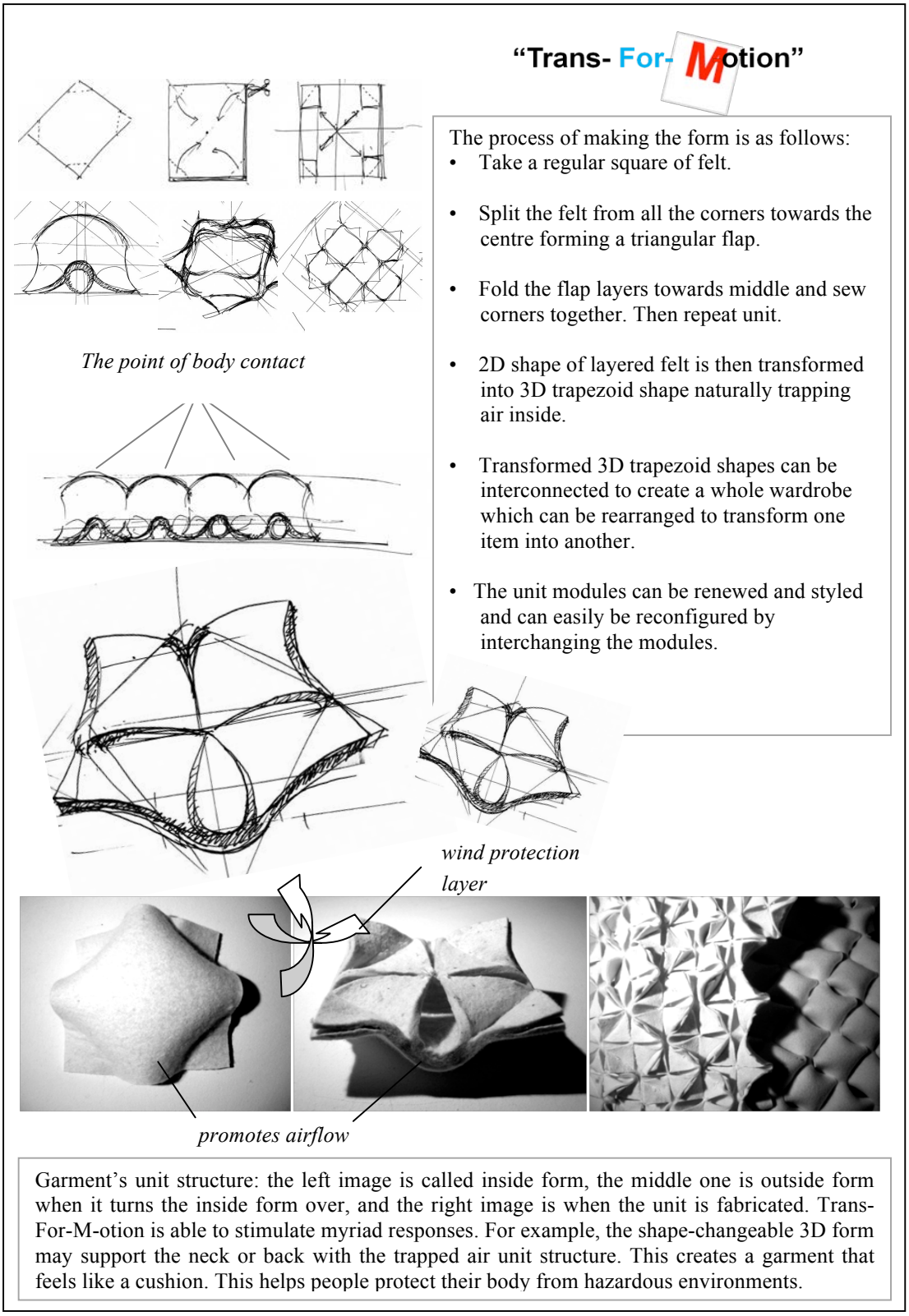


Figure 5. 6. The process of making the form of Trans-For-M-otion (I).
Source: design, sketch, and photo by the author.

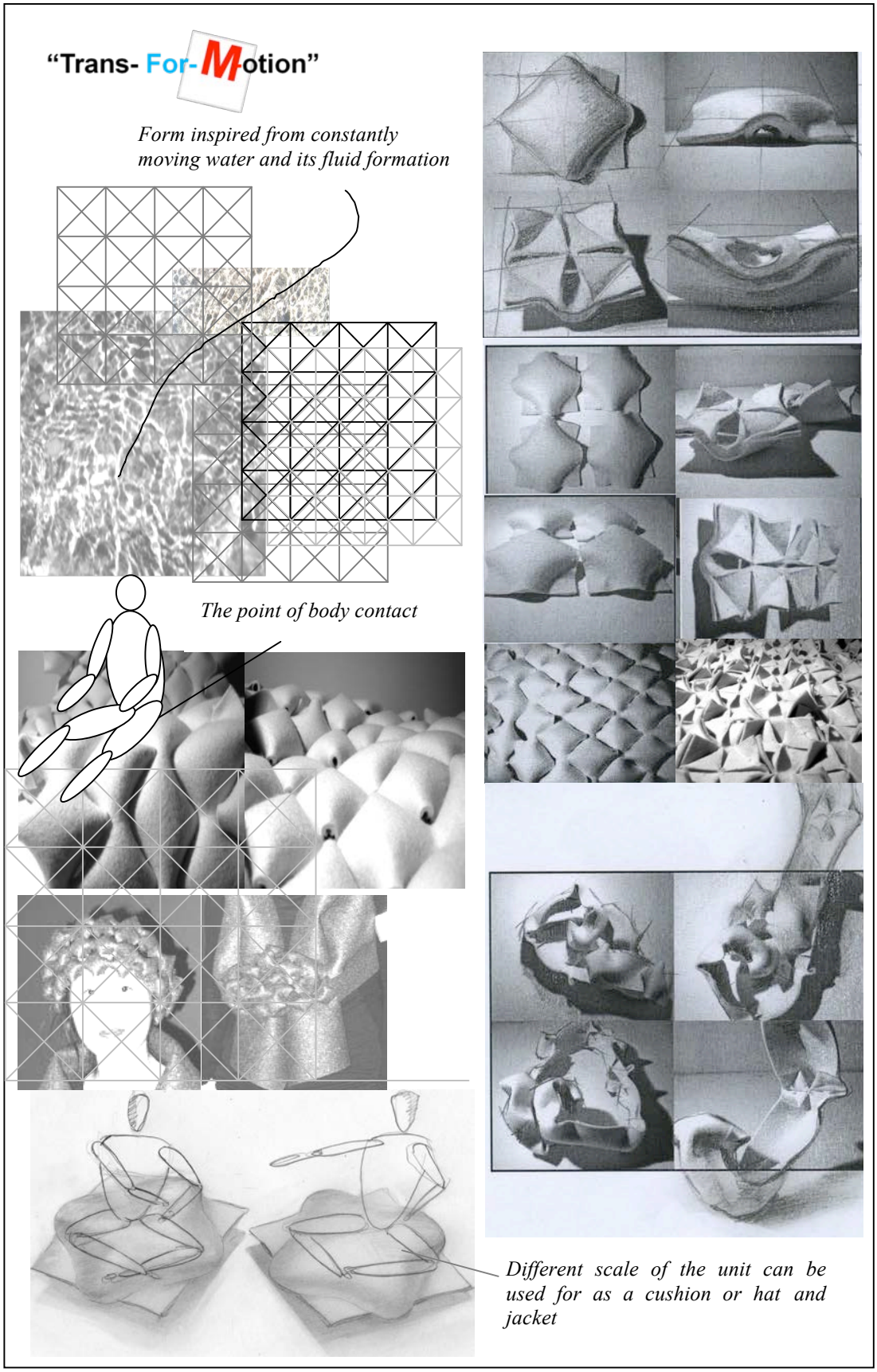


Figure 5. 7. The process of making the form of Trans-For-M-otion (II)
Source: design, sketch, and photo by the author.

Figure 5. 8. Innate materials, such as felted wool informs structure, in turn informs the shape.
Source: design and photo by the author.

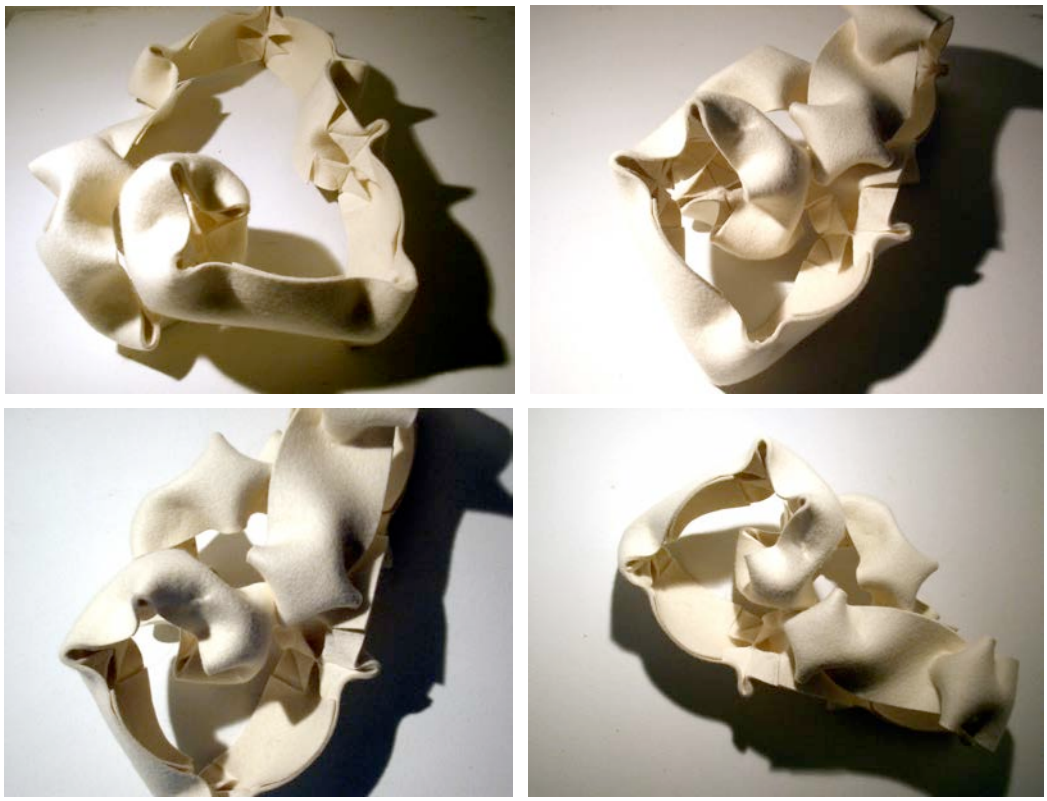


Figure 5. 9. Material substances, such as engineering felt — being composed of the compound properties, which are tough, solid, rigid, but deformable, and still have a feeling of softness — inform structure — the trapped air units' modular segments combine craft skills with folding and sewing techniques which, in turn, inform the three-dimensional, regular polygonal shape.
Source: design and photo by the author.

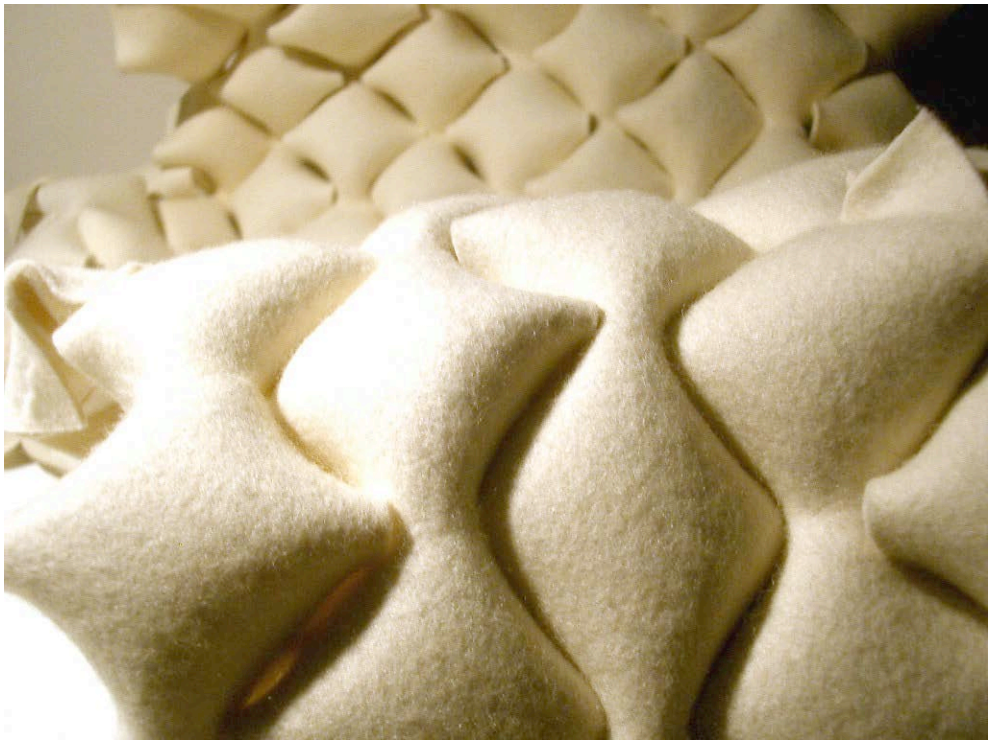


Figure 5. 10. Trans-For-M-otion can offer potential and dynamic movement-based on interaction possibilities, such as the shape's abilities of twisting, bending, deformability, manipulability, graspability, and flexibility (I).
Source: design and photo by the author.

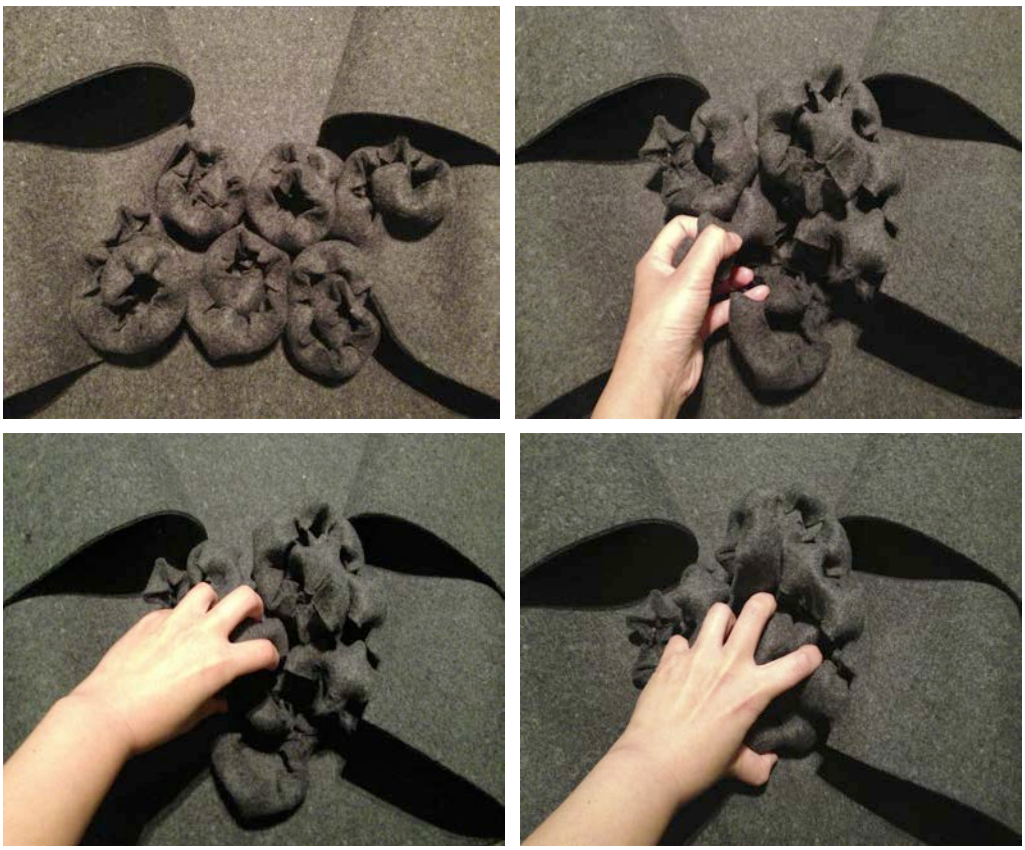


Figure 5. 11. Trans-For-M-otion can offer potential and dynamic movement-based on interaction possibilities, such as the shape's abilities of twisting, bending, deformability, manipulability, graspability, and flexibility (II).
Source: design and photo by the author.

Figure 5. 12. Trans-For-M-otion can offer potential and dynamic movement-based on interaction possibilities, such as the shape's abilities of twisting, bending, deformability, manipulability, graspability, and flexibility (III).
Source: design and photo by the author.

Figure 5. 13. Trans-For-m-otion can offer dynamic and potential forms and movement-based on interaction possibilities on the body (I).
Source: design and photo by the author.

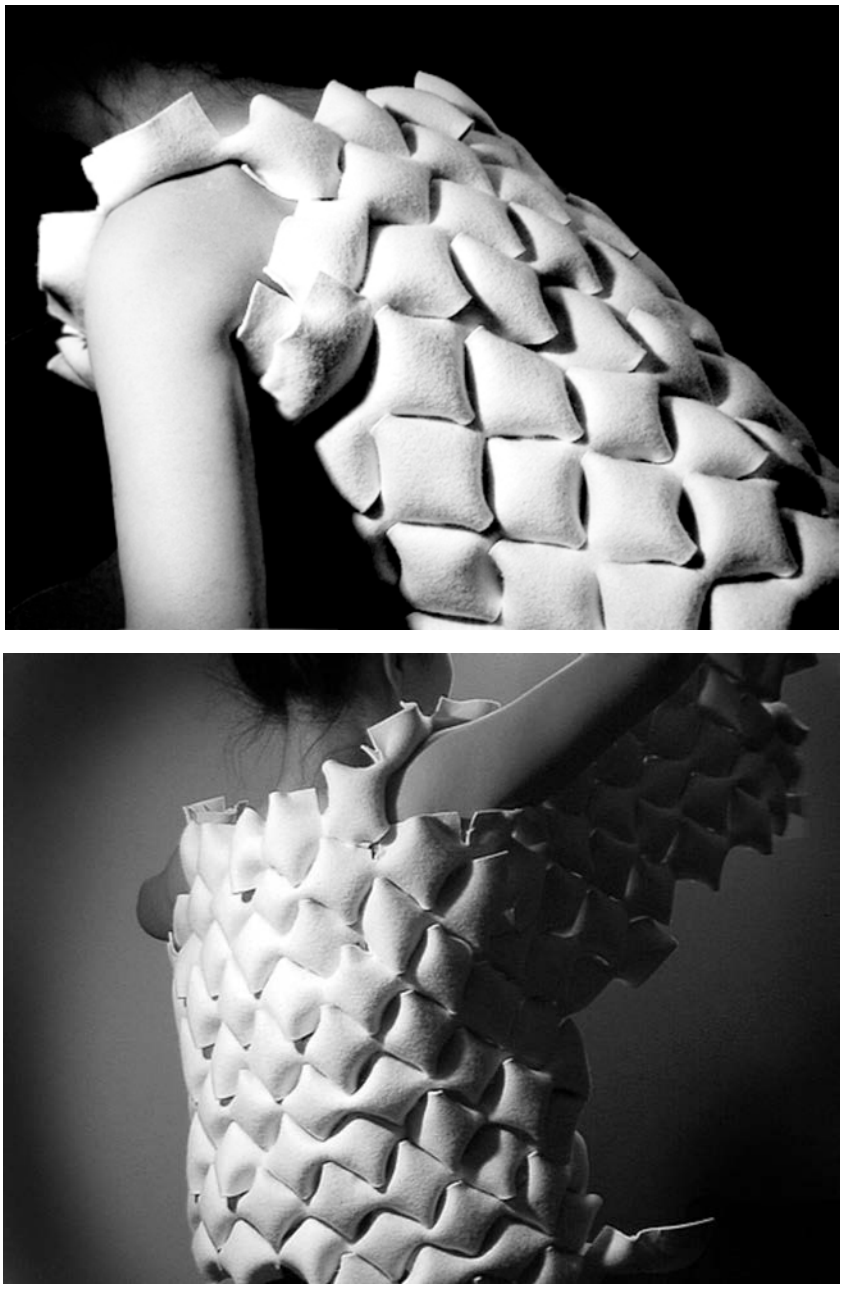


Figure 5. 14. Trans-For-m-otion can offer dynamic and potential forms and movement-based on interaction possibilities on the body (II).
Source: design and photo by the author.

Figure 5. 15. Trans-For-M-otion. Prototype for testing wearer's emotional expression through movement.
Source: design and photo by the author.

5.4 Test of the initial conceptual design

Trans-For-M-otion, the initial conceptual garment design was used for the first phase of user kinaesthetic tests in the context of the EAI framework (which will be addressed in Chapter 6). The aim of the experiment was to test out the validity of EAI framework and analyse and critique the findings of user behaviour and emotion study. The conceptual design in particular was tested out in the context of how emotional responses to the interaction are expressed in terms of how people hold and wrap their bodies. This is what enables people to reach out and grab something, for instance, but it also, and more importantly, allows for the possibility of changing their behavior and their point of view. This could help people differentiate one thing from another by the experience of moving it around, feeling senses intuitively, and seeing new aspects of it. The testing was critical to the design process to develop further conceptual garment designs.

Chapter 6

‘Object playing with movement’:

A source of comfort and enjoyment

(Pilot study)

Chapter 6

'Object playing with movement': A source of comfort and enjoyment[1]

6.1 Introduction

Chapter 2 described theoretical aspects of the concept of movement and the design approaches based on current emotion-based clothing practice as key ways of understanding the particular role of 'movement' in human-object-emotional interaction in the field of emotional design research. In Chapter 4 I addressed how my own bodily experience in interaction with nature informed the generation of concepts and the methods used to further influence contextually the EAI framework, and to develop Chapter 5's (Part II) initial conceptual design. Part II of this chapter presents research into the bodily aspects of human-to-object interaction in the first phase of the user participant pilot study conducted from July to August 2009. The aim of this research was to analyse and critique the findings of the study, which applied further design concepts and methods exploring kinaesthetic comfort and behavioural concerns to participant interviews and observations. The EAI framework, particularly in the context of doing through feeling, feeling through doing, was tested using the initial conceptual design, Trans-For-M-otion described in chapter 5.

Section 6.2 describes relevant and related work, followed by an outline of the research aims and questions in section 6.3, and methodology in section 6.4. Section 6.5 describes four outcomes related to a kinaesthetic understanding of comfort in the EAI framework in the context of doing through feeling, feeling through doing:

- The first outcome describes participants' recalled responses to happy and fearful experiences (Section 6.5.1);

[1] Part of this chapter formed the basis of a conference paper: Jeon (2009) 'Object playing with movement': A source of comfort and enjoyment at Design Rigor and Relevance, *International Association of Societies of Design Research (IASDR) Conference 2009* held in Seoul, Korea October 18-22 2009.

- The second outcome relates to the role the concept of movement plays in emotional interaction with objects, and how emotional responses to the interaction are expressed in terms of how people hold and wrap their bodies (Section 6.5.2);
- The third outcome describes non-functional movement of hands (Section 6.5.3);
- The fourth outcome relates to garment-wearing activities in unexplored conceptual spaces, that is, personal and public space, where someone is comfortable with a particular 'garment' in both secure and insecure spaces (Section 6.5.4).

Section 6.6 explicates the reflection from the kinaesthetic aspects of user tests. The initial conceptual prototype, Trans-For-M-otion was evaluated through reflection from the study of user tests, which lead to the amendment of the design structure (Section 6.6.1). This reflective section also elaborated on how the EAI framework was useful and validated by user tests and how the outcomes then, influenced the further development of conceptual garment designs. Based on critical reflection adjustments were made to complement the EAI framework (Section 6.6.2). Section 6.7 concludes the discussion by describing some outcomes of the design prototyping activity within the context of 'object playing with movement,' treated as a source of comfort and enjoyment.

6.2 Choreography in interaction

In Chapter 2 I found that comfort is not only based on human sensory responses to clothing materials, but is also determined by a variety of psychological, social, and emotional parameters. Comfort is an individual-dependent, experiential and situational emotion, specific to a domain (Pontrelli, 1997). One of the main challenges of this study was to take account of subjectivity and intersubjectivity, that is, personal emotional experience and mental states, such as feelings of 'being relaxed' and 'being confident,' as part of identifying the comfort dimension. In this research, intersubjectivity challenges the everyday sense of having women having their own personal experience, of them being a self-contained and perceiving a world of objects, particularly clothing and others (Merleau-Pointy, 1962). Intersubjectivity

can be derived from empathy in phenomenology (Merleau-Ponty, 1962), which refers to the experience of one's own body as an other. We often identify others with their physical bodies in terms of how they move and are moved in relation to self-expression. In this sense, we can perceive the subjectivity of others, as well as our intersubjective engagement with them. Our senses are built on the experiences of our own lived-body. The lived body is your body as experienced by yourself, as yourself. Your body is also experienced as a duality, both as an object — you can touch your own hand — and as your own subjectivity — you experience being touched. The experience of your own body as your own subjectivity is then applied to the experience of another's body, which, through apperception, is constituted as another subjectivity. You can thus recognise the other's intentions, emotions, and so on. This experience of empathy is important in the phenomenological account of intersubjectivity. In phenomenology, intersubjectivity constitutes objectivity — what you experience as objective is experienced as being intersubjectively available — available to all other subjects. In the experience of intersubjectivity, one also experiences oneself as being a subject among other subjects, and one experiences oneself as existing objectively for these others. Intersubjectivity is related to mental events or emotions, which can be visible by ways of our performances (Merleau-Ponty, 2002). Comfort as an empathic approach is explored through negative and positive emotions, such as happiness and fear, which can be generated by physical interaction with objects either in the real context of environment or even as even someone recalling his/her past experience. The study in this chapter was focused on women in the context of choreography in interaction. 'Choreography in interaction' refers to emotionally expressive movement as a basis of the EAI framework — doing through feeling, feeling through doing. This context is involved in intersubjective bodily expression, appraised as feeling happy or feeling fearful. 'Choreography in interaction' was inspired by Klooster and Overbeeke (2005), who remarked:

> We realize that theoretically describing this approach is a nearly impossible venture. In fact, only through movement, through practicing it, the idea can actually be grasped. (p. 23)

The central research focus in this study was the significance for design of rich, dynamic bodily expressions of two emotions, happiness and fear, while participants

were using the garment as an interactive object. The study also examined the validity of the EAI methodology and evaluated a prototype design, Trans-For-M-otion. In this chapter I also reflect on key concepts, and analyse how I incorporated behavioural concerns into my design process.

6.3 The research aims and questions

The research in this chapter focuses on emotion induced through movement-based interaction with clothing by undertaking a pilot study in the context of the EAI framework: doing through feeling, feeling through doing. The aims of this research are to explore and understand kinaesthetics through: 1) the integration between movement qualities, dynamic bodily expression, and emotion in garment design; 2) the way people perceive the function of clothing in relation to their spatial interactions; and 3) the interplay between object manipulation and movement. This part of the research addresses the following questions:

- How is the concept of 'movement' part of a person's emotional interaction with an object?
- How do people hold and wrap their bodies in relation to their interaction with an object? In particular,
- How do participants interact with the garment to transform their feelings of fear into a recognisable state of comfort?
- How do participants interact with the garment to reinforce their feeling of pleasure as a recognisable state of comfort?

The objective of my study was not to come to an understanding of biological movement, for example how the arm is moved, but to explore the nature of experiential bodily knowing and understanding generated through the participants' subjective experiences.

6.4 Method: Overview

The method in this study was based on the synthesis of the findings from semi-structured interviews with participants. Participants were asked open-ended questions

intended to explore: 1) their experience of the happiest and the most fearful events or things they have experienced, and 2) their sense of self and the clothing style that represents their personality. By engaging participants in the study, the research has aimed to keep the enquiry open and exploratory. This was aimed at developing concepts and conceptual prototype garments, rather than at clarifying user needs and final design features.

6.4.1 Participation

Fifteen participants (female, n=15, age of 20-40 years) participated in semi-structured interviews. Participants in the study were of a number of nationalities (Australian, Chinese, Canadian, Japanese, Indian, Korean, and Namibian), and were mainly university students from Curtin University, Perth, Western Australia. They were from a range of backgrounds including Architecture, Art and Design, Psychology, and professional wedding planning management.

In-depth observation involved selecting two participants out of fifteen participants to describe their distinctive behaviour by responding to interview questions in this study. One participant (J) is in her mid 30s, and she was born in Korea. She is a wedding planner and is energetic and sociable. She is also well organised and likes to achieve her goals. She is interested in eccentric styles, clothing, and ideas. The reason for choosing this woman to observe her garment-wearing behaviour is that she tends to select clothes carefully, as her sense of style is based on clothing function in relation to aesthetics; for example, simple yet elegant, distinctive and a bit quirky. The second participant (M) is in her early 30s. She was born in Australia. She is a PhD student in the Art Department, and works at Curtin University as a tutor. She is anxious and self-conscious but has a sociable personality. She likes to wear distinctive, dowdy, old, contrasting, bright patterns, for example big necklaces, red colours and so on. She is interested in creativity and conservation.

6.4.2 Stimuli materials - Design prototype

In this study, the initial experienceable prototype design as described in Chapter 5 was used for the participants to wear and their responses were recorded. This design

expressed the concept ‘shape change,’ described as Trans-For-M-otion. The aim of the conceptual prototype was to explore how garments allow people to afford and adapt to constantly changing moods and emotions. It was designed to investigate the bodily aspects of people’s interaction with clothing, applying the theoretical idea of affordances and the theory of phenomenology of perception and emotion in the context of EAI: doing through feeling, feeling through touching. As outlined in Chapter 5, applying Merleau-Ponty’s (1962) phenomenology of perception and Gibson’s (1979) theory of affordances to the design process involves understanding: (1) human experience through sensorimotor intertwinement, and (2) the properties of the intrinsic material, that is wool, to create potential form, and the resultant form’s relationship with the body and movement in space (environment) (see Figure 6.1). To create the conceptual prototype, I developed designs based on movement-based interactions that respond to emotions. Using wool as a base material I designed the conceptual prototype that interacted with the wearer. The concept of Trans-For-M-otion was also based on a reflection on my own body’s experience of nature through the senses (see Chapter 3).

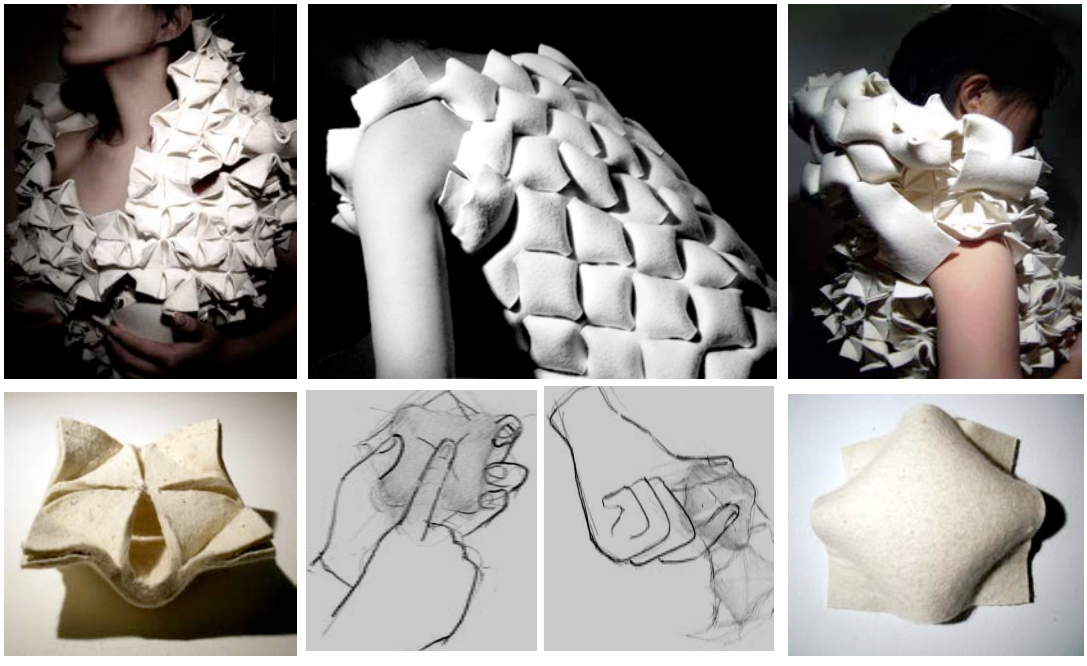


Figure 6. 1. Trans-For-M-otion garment. Conceptual prototype for testing emotional responses through observation of body movement.
Source: design and photo by the author.

6.4.3 Procedure

The experimental protocol procedure was explained to participants as follows:

1. A participant was asked to respond to the research questions: What is the most fearful experience you have had? What is the happiest experience you have had? What is your sense of self and sense of clothing style?
2. Two participants who volunteered to have their behaviour observed were asked to manipulate the conceptual prototype, Trans-For-M-otion, based on two research questions: How can you interact with the conceptual prototype to transform your feelings of fear into a state of recognised comfort? How can you interact with the conceptual prototype to reinforce your feeling of pleasure as a state of recognised comfort?
3. Participants were asked to express their impressions of the conceptual prototype in a spontaneous way.

6. 5 Discussion and results

6.5.1 Subjective experience of happiness and fear

In order to explore specific meaningful bodily expressive actions in relation to comfort, subjective felt experiences, for example, happiness and fear were explored with the participants. Twelve out of fifteen participants responded to the question:

- What is the most fearful experience you had?

Participants who responded to the question described various fearful experiences from different time periods, such as childhood, teenage and adulthood, and in response to different spaces, for example public, dark, unfamiliar. I collected a total of twelve episodes. Some experiences shared by the participants were similar in some episodes, for example, somebody stared fiercely at me at a railway station; somebody sprang at someone else on the street. Accordingly, I categorised the four distinctive and dramatic episodes as follows: 1) when a stranger approached from behind; 2) when being or walking alone in a dark space; 3) when wandering in an

unfamiliar space; 4) when boarding a flight (see more examples in Appendix to Chapter 6).

In addition, twelve out of fifteen participants also responded to the question:

- What is the happiest experience you have had?

Participants who responded to the question recalled various happy experiences from a range of time periods, for example childhood, teenage and adulthood, and different situations or events, for example meeting friends, interacting with nature, buying clothing and so on. I collected a total of thirteen episodes. After analysing the participants' responses, I categorised four distinctive episodes as follows: 1) interacting with nature (such as swimming at the beach, walking on the sand or in the water); 2) meeting with close friends and family; 3) being alone to make themselves calm; and 4) going shopping, for example for clothing, jewellery, and accessories (see more examples in Appendix to Chapter 6).

Based on the participants' responses to the interview questions, two scenarios were developed and used to observe their emotional responses when they were interacting with the initial conceptual garment:

(1) When a threatening person approaches in a public space;
(2) When meeting with close friends in a public space.

The aim of using scenarios in the pilot study was twofold: to investigate how women's actual autobiographical past emotional experiences, such as happiness and fear affect bodily expressive actions for comfort while interacting with the garment, and to examine the validity of this method for conducting further participant observation. In this approach, the participants were provided with the scenarios to elicit emotion, and instructed to recall these situations and act as if they were there. The concept of movement was an essential element of the design process, in order to analyse the following:

- The way people hold and wrap their bodies in relation to their interaction with garments;
- In particular, the way people interact with the garment to transform their feelings of fear into a recognisable state of comfort; and
- The way people interact with the garment to reinforce their feeling of pleasure as a recognisable state of comfort.

6.5.2 Emotion and movement in the wearing of clothes

This section describes how movement and emotion are integrated, and how they are communicated when we focus on clothing as an interactive object using the two scenarios outlined above. There seems to be a close relationship between emotion and movement, rather than a linear sequence. The human body is designed for movement. Movement is a part of the expression of emotion, and not a simple reaction. Emotion can be expressed through movement, which creates a particular bodily orientation to the world. I investigated emotional movements in the activity of wearing clothes in order to understand how people hold and wrap their bodies in the context of emotion. Two scenarios informed the participants' actions in this pilot study. Just as De Rivera (1977) described four basic emotional movements — 'towards out,' 'towards self,' 'away from self (against other),' and 'away from other' (Cited in Robbins, 1999) — when wearing clothing, people use their clothing to wrap or hold their body for the purpose of protection, self-expression and even to hide.

6.5.2.1 How do people interact with the garment to transform their feelings of fear into a recognisable state of comfort?

As shown in the picture (Figure 6.2), the participants (J) and (M) tried to close down their body with the garment towards the centre of their bodies when they recalled their past (autobiographical) experience, that is, a threatening person approaching. The emotion created can be associated with fear or threat. They tried to cover their body — in particular, their head, neck, and shoulder areas were covered by the garment. Their upper body (head and torso) slowly bent towards the ground, their gaze was towards the ground, and the arms were crossed. It appears that they wanted to escape the person's notice. The space created by the inside zone of clothes can be

referred to as the personal space, for this feels like a place to hold and protect. This set of movements is concerned with privacy and security. The way the garment is worn, together with the body's features, such as the position of the trunk, head, arms, and degree of openness and closed-ness, are important emotional cues. This behavioural response is referred to by De Rivera as a feeling of 'negative contraction' (De River, 1977). The participants mentioned that recalling a fearful situation evoked some sweating, muscle tension, and an increased heart beat.

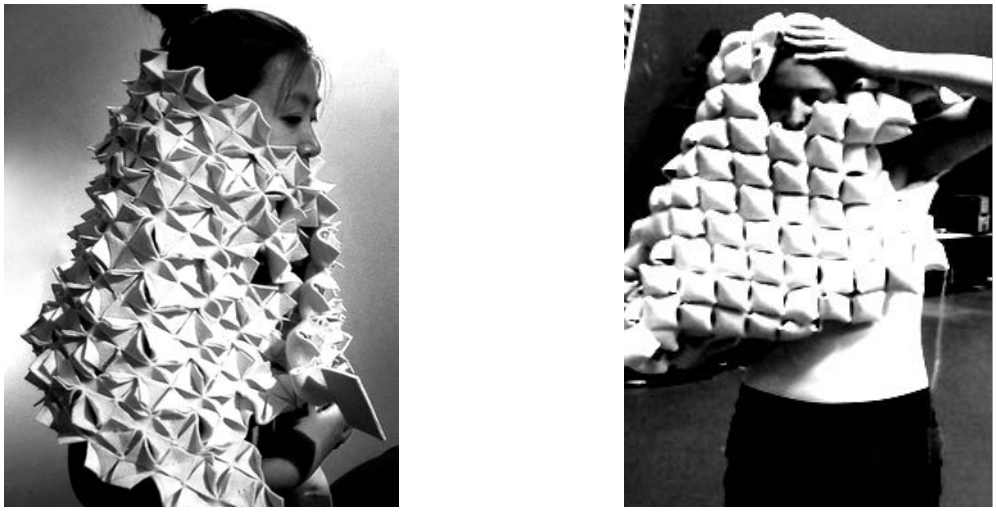


Figure 6. 2. The way the garment is worn in an insecure situation.
Source: design and photo by the author.

6.5.2.2 How do people interact with the garment to reinforce their feeling of pleasure as a recognisable state of comfort?

Figure 6.3 shows how participants manipulated the same garment on the body when they recalled meeting close friends. The wrapping of their body and associated movements showed a more open and expressive reaction. In this situation, evoked emotions are associated with a sensation of warm, relaxed emotional happiness and enjoyment. Revealing the head, neck and shoulder area, when manipulating this garment, seemed to be an important aspect of being comfortable and expressing the self. Free arm movements also showed how limbs, especially the arms, can be used to express emotion. Closing and opening the arms and associated movements may create personal and general space. For example, moving the arms creates a border for personal space against outer space. The whole space surrounding the outside of the

clothes can be referred to as general (public) space. In this study, body movements and behaviour in relationship to clothing illustrated the relationship between people's expressive characteristics and their bodily and emotional significance, which is referred to in De Rivera's term as 'towards other' or 'towards self.' The movement of emotion corresponds to 'positive extension' and to 'positive contraction' (De Rivera, 1977, p. 41).

Figure 6. 3. The way the garment is worn in a secure situation.
Source: design and photo by the author.

The results from this study show that, in insecure situations when a garment creates feelings associated with comfort, this reinforces feelings of relief and security. Conversely, in secure situations when a garment creates feelings associated with comfort, this reinforces feelings of pleasure and enjoyment. Further, the results indicate that certain bodily postures and movements, such as head up, down, tilted, or retracted between shoulders, together with arm movements, are in response to emotions. The results also show that past experience leads to psycho-physiological responses. For example, recalling a fearful situation evoked some sweating, muscle tension, and an increased heart rate. The evidence shows that there are mutual relationships between past experience (perception) and physical responses. In these enacted scenarios, the information encoded in recalling fearful and happy situations determined the operation of simultaneous and successive bodily actions.

6.5.3 Habitual movement

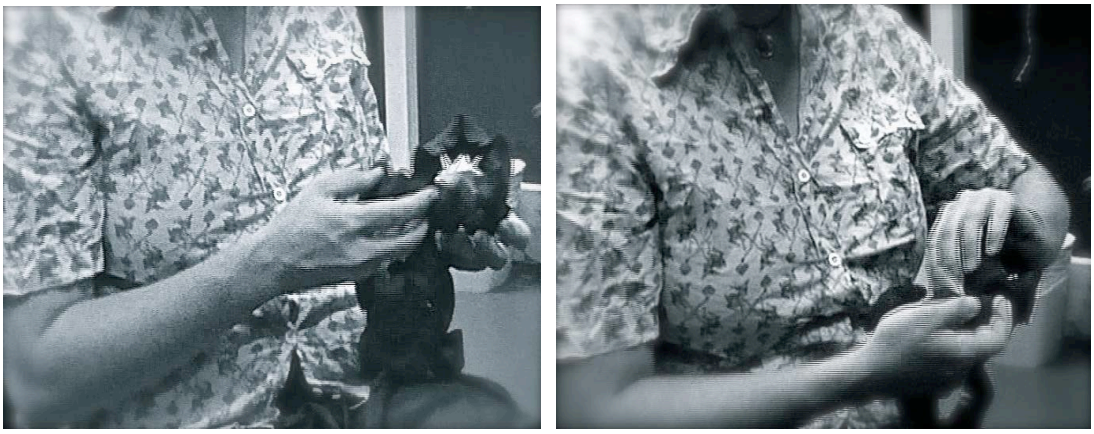


Figure 6. 4. The unconscious or conscious movement of hands.
Source: design and photo by the author.

People have emotions that influence their behaviour. Interacting with clothing, for example, can influence affective states that lead to conscious or unconscious behaviour. This study of a group of women shows that a negative mood, in particular, activates specific action tendencies and bodily behaviour. Figure 6.4 shows that the participant performed non-functional hand movements without a particular purpose, such as rubbing her hands, a cuff of her sweater, or pressing the prototype. Interestingly, their active hand and bodily movements when interacting with the object were contingent upon some in-depth interview questions that required some time to answer in order to explain their experiences or memories. The more they concentrated on recalling their memories and experiences about happiness and fear, the more actively they played with the object. Further investigation of this aspect of unconscious movements will be discussed in Chapter 8 (see Section 8.4.1.1).

6.5.4 Creating a space for comfort and protection when wearing clothing

In this section, I describe how bodily actions occur in the context of felt experience. Experience, perception and past experiences are activated not only in the mind, but also by bodily interactions with objects within the environment and in spatial situations. The central research focus of this study was the experience of kinaesthetic comfort in interaction with the conceptual design. The design concept explored was termed ‘emotionally expressive action when wearing a garment.’ The aim was to

identify how the participants manipulate the garment in relation to emotions and bodily activity when enacting the two scenarios outlined:

(1) When a threatening person approaches in a public space.
(2) When meeting with close friends in a public space.

In this study, the participants started to manipulate the initial conceptual design they were wearing when given the prototype, Trans-For-M-otion. The time taken for the manipulation of the garment was about an hour for each session. Figure 6.5 shows one participant (J) building her own garment for her body, with twenty forms composed of seven inside-out forms, eight outside-in forms, and five transitional forms which refer to the combination of inside-out and outside-in forms. Ten out of the twenty garment forms interacting with her body were based on the first scenario, when a threatening person approaches her in a public space. Only five garment forms interacting with her body were created, based on the second scenario, when she was asked to recall meeting close friends in a public space. Similarly, participant (M) built her own garment for her body, with twelve forms composed of six inside-out forms, four outside-in forms, and two transitional forms. Seven out of the twelve garment forms she created were based on the scenario of a threatening person approaching her in a public space. Five garment forms interacting with her body were built when she was asked to recall meeting close friends in a public space. In other words, the participants chose to make more forms within the fear scenario than the friendly scenario. From these responses to the exercise, it is assumed that the participants were more aware of garment forms when they recalled being in an insecure or fearful situation. This suggests that fear is not only the original experience of the emotion, or people's interpreted, intense memories from past experience, but also a fear of something unknown, that can be captured from reflecting on instinctive bodily responses to fear.

Figure 6. 5. Garment forms and body interactions as a response to secure and insecure situations.
Source: design and photo by the author.

In observing the participants' active bodily behaviour in the two scenarios, action tendencies were examined in terms of how people hold and wrap their bodies to create a space for comfort; and how these action tendencies may influence clothing design for comfort. The results suggest how the body interacts with space in an emotional situation. In the context of aesthetics, this aspect of behaviour is related to the perceived quality of performed movements. The sense of movement is closely related to space and how the space surrounding the objects defines them. Hall (1966) defines bodily recognition of the different surrounding zones as intimate, personal, social, and public, depending on who is approaching. In this study, it is apparent that the participant's bodily movement tries to perceive different zones (spaces) in secure and insecure situations while using the garment as an interactive object. Figure 6.5 shows that when the participant recalled meeting close friends, she created an open and intimate zone; she wore her clothing open, which seemed to welcome full contact reserved only for the closest people — family members and best friends. When the participant recalled a threatening person approaching in a public space, she created a public zone, arranging the garment to cover her body completely, especially the upper body area. The garment can act as the threshold of a safe comfort zone. These results suggest that women may have a safety or comfort zone around them in environments that arouse strong emotions, and intrusion into this zone, if unwelcome, arouses discomfort (see Figure 6.5).

People's behaviour is influenced by their emotions. A person's interaction with the garment they are wearing can impact on affective states that in turn, influence their behaviour. With negative emotions, especially fearful states, specific fear-related action tendencies are activated, such as preparation for concealment in order to protect the body (see Figure 6.6). The process of interacting with the conceptual garment, where it is formed, reformed, or deformed iteratively through space, means that the garment can be an interstitial cell between the body and its covering to construct a third skin (see Figure 6.6). In this study, these action tendencies may be interpreted from the responses of the participant (M) when she reflected on her unpleasant situation. It is significant that the participant experienced emotional changes within the interaction process: for instance, the experience of fear was transformed into calm when, through creating a personal space by enclosing the body within the garment, the garment provided a greater sense of security.

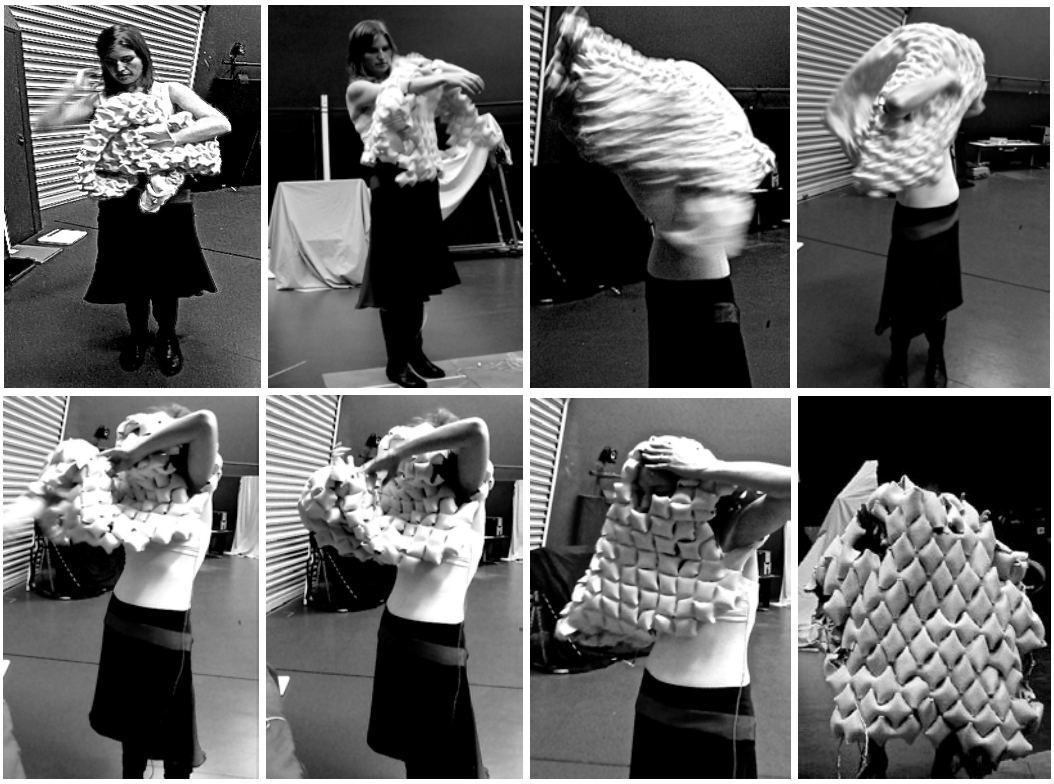


Figure 6. 6. Fear-related action tendencies.
Source: photo by the author.

Interestingly, this process of wearing activities can be involved in two main aspects of the body of a subject from a phenomenological standpoint:

- The live-body. This is the body as experienced from a first-person perspective. It is my ability and my power to perceive, to act and to feel comfortable.
- The body as an image. This is my body as it is an object in space, which can be perceived by others (Lenay, 2010).

Based on the participant's fear-related to action tendencies, the former aspect in the notion of the live-body suggests that her bodily intention can correspond to the passage from expressing a sense of herself in a fearful state. The garment invited her body to tug and to be held inside through movements such as enclosing, sinking, retreating, inward, and downward. These bodily movements were emergent phenomena in an ongoing way expressing transitional emotional states. In other words, her bodily intention through fear-related to action tendencies implied an

augmentation of her body's capacity to act and express. During this process of bodily action and expression, she seemed to change her emotion toward enhancing positive affects. The latter aspect, that is, the body as an image can describe how the process of the participant's wearing interaction could be involved in space. The space where she manipulated the garment was a dark space and a man (photographer) stood and stared at her behaviour. This space seemed to influence her body movements consciously. In other words, space organizes and seems to clarify the body and its actions by establishing a clear pathway or goal for movement.

These results suggest how clothing becomes sensible to people as bodily extensions and thereby integrate it body-subject and world. For example, clothing can have an important protective function and provide an inhabitable shelter in secure or insecure spaces. The protective function of clothing is not restricted to physical protection in climatic and environmental conditions. It extends to protecting the wearer against both physical harm and psychological dangers, whether attacks from other individuals or feelings of insecurity.

6.6 Reflection on user tests

6.6.1 Evaluation of the initial conceptual prototype design

This chapter addresses participants' subjective accounts of the process and descriptions of characteristic components of movement accompanied by emotions of happiness and fear while they interacted with the conceptual garment, Trans-For-M-tion. This part of the research sought to understand the dynamic expressiveness of bodily behaviour, and the fear, happiness, and comfort experienced by women when forms of clothing are configured for their bodies. The initial design, Trans-For-M-otion was evaluated through participant observation and interviews in this pilot study, which in turn led to a kinaesthetic interpretation of comfort and bodily experience in human-to-object interaction. This creates a design that aims to elicit physical and emotional responses from the wearer. The kinaesthetic experiences show that the garment is dynamic and interactive as they flex and bend on the body, and create kinaesthetic experience in the wearer (see Figures 6.7 to 6.10). Through manipulation of the garment, the wearer can create forms that accommodate their emotions and bodily movements and their spatial adaptation needs, for example, in

secure and insecure situations. Structured as modular units, Trans-For-M-otion allows a wearer not only to personalise her sense of self but also to protect her body from the danger of attack. The shape is a changeable, three-dimensional and geometrical unit structure, which traps air to support the neck, shoulder or back. This creates a garment that feels like a cushion. In fact, the unit can be made in different sizes and colours, and in variable elasticity, so has the attributes of versatility and expresses different properties when people look, touch, and interact with it. Through manipulation of Trans-For-M-otion, the wearer can be provided with a mechanism for the exploration and enhancement of self-expression through using such methods as wrapping, twisting, and rotating it onto the body, or transforming it into other shapes, such as rolling it into a cushion. The form of this prototype in interaction with the body can be an emotional anchor, interpreted within the framework of EAI in the context of doing through feeling, feeling through doing. The design was found to be effective, but the design structure was amended reflected from the outcomes of testing participants' behaviours, for example, smaller size of 3D unit structure and wider length. The size adjustments were aimed to trigger more potential bodily interaction possibilities, such as the shape's abilities of twisting, bending, deformability, and flexibility. This perspective expands the design discourse in terms of how garment design is more integrated with body consciousness, which links to a sense of physical and emotional wellbeing. This amended prototype, Trans-For-M-otion was used to further test participants' emotional states when wearing it, and their capacity to change their behaviour in response to it (see Chapter 8).

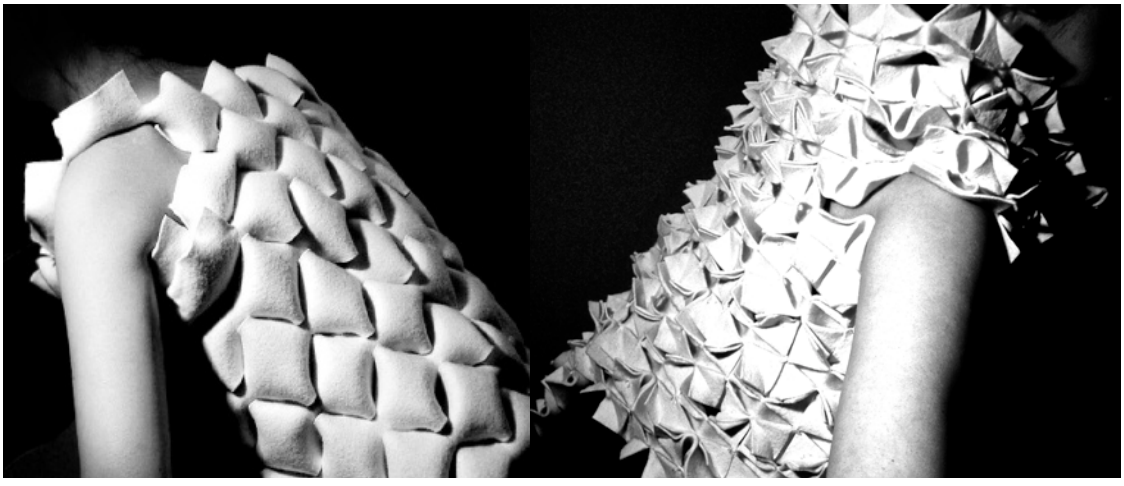


Figure 6. 7. Dynamic interaction possibilities of garment behaviours (I).
Source: design and photo by the author.

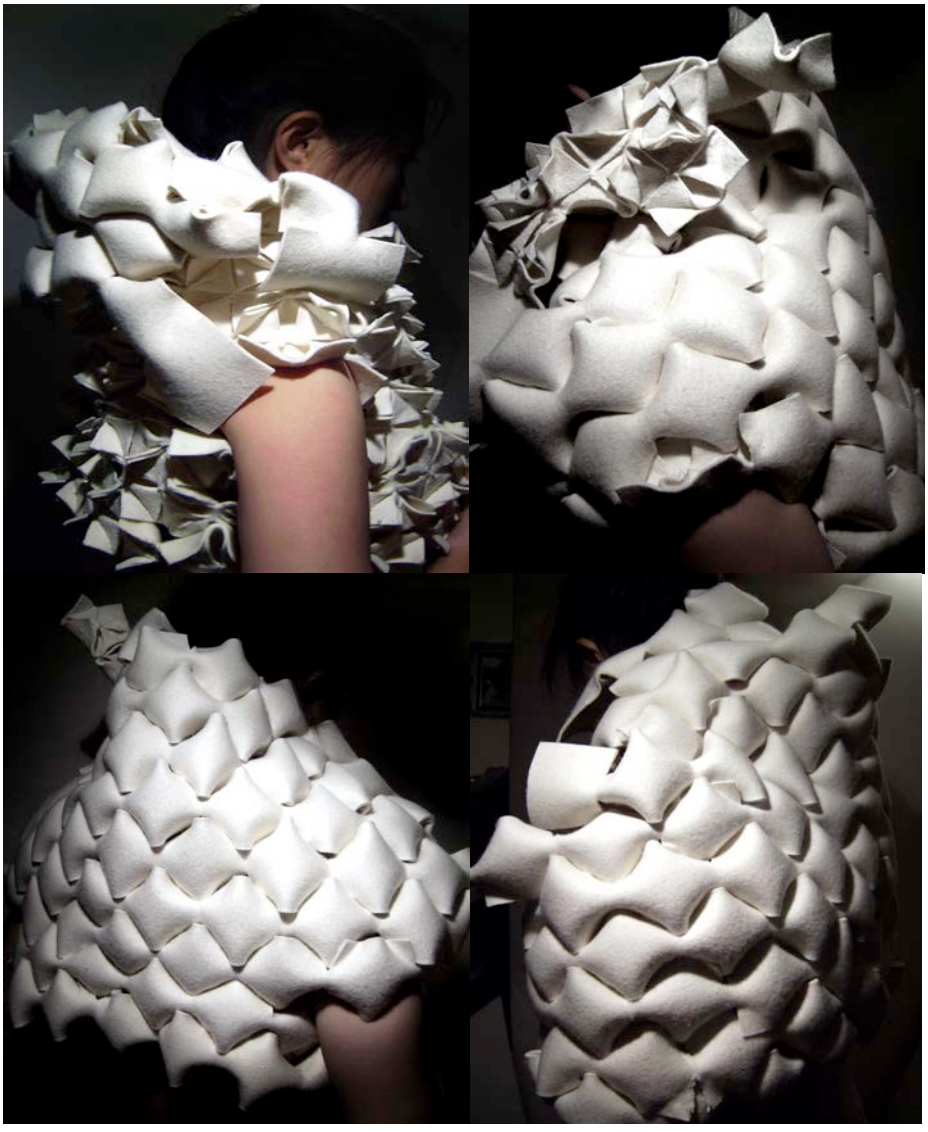


Figure 6. 8. Dynamic interaction possibilities of garment behaviours (II).
Source: design and photo by the author.

Figure 6. 9. Dynamic interaction possibilities of garment behaviours (III).
Source: design and photo by the author.

Figure 6. 10. Dynamic interaction possibilities of garment behaviours (IV): Experimenting with different inside and outside forms and functions of the uncompleted form, which can give more enjoyable and comfortable experiences to the wearer through the manipulation process.
Source: design and photo by the author.

6.6.2 Adjustments of the EAI framework

The EAI framework was validated by user tests. The methodology, especially the technique of scenarios to evoke emotions for participants' movements, was critically reviewed. Thereafter, further adjustments were made to complement the EAI framework.

I have analysed the results from two experimental scenarios, using clothing as an interactive object. The reflections on the study found how emotions are communicated through the manipulation of body covering, in conjunction with unconscious bodily movements, to protect the person from discomfort and heighten comfort; this occurs within a determined space and experiential scenario, within which body movements, clothing, emotions, and space interact. In this study, I focused on participants' experience expressed through physical movement. Bodily movements express the person's innermost feelings, the deep impulses of human nature. Exploring dynamic bodily expression through two scenarios as part of doing through feeling, feeling through doing in the context of the EAI framework was an effective method to better understand the nature of unpredictable bodily behaviour. In fact, in the context of emotion in relation to movement, most studies of emotional expression have encountered a number of problems, such as the use of semantics and language limitations. Often encoders (participants) are just given emotional labels to describe the emotional state they are to encode, for example 'read this text as if you were very afraid' (Wallbott & Scherer, 1986, p. 691). The problem is that different encoders may attribute different meanings to such labels and that they might envisage different situations inducing these emotions. Such problems can be partly avoided by using a scenario based on participants' actual experience. The technique of scenarios was used not only to guide participants so that obstacles, for example semantic confusion, were avoided, but also to enable the participant to interact with clothing in a way that involved her personal preferences and values. On reflection, even though the technique of scenarios reflected in the participants (female, n=15, age of 20-40 years)' actual past (autobiographical) experience was effective in evoking emotions, there is still a critical consideration that remains a question: how to evoke participants' emotions as if they are in real life situations? This is because people's kinaesthetic behaviours may be different from past experiences to what they are in real life experiences. If it is difficult for a researcher to observe people's

movement behaviours in real life situations, how can such methods as the scenario technique be used closely in the context of real life situations? Consequently, in order to collect the data more effectively and precisely, the scenarios technique used to evoke emotions was complemented and amended. For example, the space where participants are invited to observe their behaviours can control their moods by the light. When dimming the lights, participants may evoke a fearful state, whereas they may evoke a happy state in spaces where they are in bright light. In addition, considering the technique of a fearful scenario where a man suddenly follows closely behind where the participant walks and moves, this unexpected situation may help participants express and express their bodily movements in a fearful state. This amended scenario method has led to further investigation of dynamic bodily expression in the comparison of different types of walking (‘natural,’ ‘happy,’ and ‘fearful’) and different types of garment style (‘normal’, ‘happy’, and ‘fearful’), addressed in Chapters 9 and 10.

6.7 Conclusion

The study of movement is a resource for understanding and communicating about how we feel and what we experience. The results of this kinaesthetic user study in the context of doing through feeling, feeling through doing EAI framework tested with the initial conceptual and experienceable design, Trans-For-M-otion, show how movement and emotion are dynamically congruent. This aspect of kinaesthetics is related to the perceived quality of performed movements, which is closely related to space. The results suggest that movement is less a physiological activity and more about socially-psychologically-oriented emotional activity. The notion of movement is an important element for clothing design. Conceptualising movement is as an essential and necessary part of the design process for analysing: 1) the way people hold and wrap their bodies in their interaction with garments; and 2) the way people use an object such as clothing as a form of pleasurable expression. The study highlights how the participants manipulated the garment and wore it in an insecure situation or environment, such as facing a threatening person; participants covered their body, in particular the head, neck, and shoulder area, in order to feel emotionally held and protected. On the other hand, the way the garment is worn in a pleasant situation or environment, such as meeting with friends, creates feelings

associated with the sensation of warmth, and this relaxed happiness and enjoyment was reflected in more openness and self-expression through body movements such as revealing the head, neck and shoulder area, and free arm movements. In this sense, the participants seemed to be in relation to their exteriorised look — how they can be seen. This perspective can be interpreted from a phenomenological standpoint as the body as an image: how our body, as an object in space, moves and can be moved by how it can be perceived by others. The results show that, when wearing clothing in the context of comfort, the participants used their clothing to wrap or hold their body for the purpose of 'protecting,' 'hiding,' and 'disguising' themselves in insecure situations (evoking feelings of relief and security), and conversely, for 'self-expression' in secure situations (evoking pleasure and enjoyment). The results show that the way the garment is worn relates to the body's posture and movements as important emotional cues, and that the past experience of threatening situations led to distinct psycho-physiological responses.

This research also indicates that body features are important cues to emotion such as the position of the trunk, head, arms, and the degree of openness and closed-ness. Movements of the body also express spatial features, with the degree of openness and closed-ness creating personal and public space. Body movement in relation to the garment expresses the person's inner feelings, past experience and perceptions, and their bodily and emotional significance. It is important to point out that, in this study, the emotion the women experienced could change within an interaction process. For instance, the participants' movements were observed to transform from feeling physical discomfort to the positive feeling of calm. The participants enjoyed the experience, and shared their ideas of its significance. These findings will be used for informing designers about wearability and new kinds of functionality for clothing design. This chapter extends existing experimentation and exploration of design concepts and methods in conceptual clothing design through the use of design prototyping, within the context of 'object playing with movement.' The study has investigated movement as a source of comfort and enjoyment and emphasises the relationship of emotion and movement with clothing. From this theoretical and behavioural approach, the design prototypes using the concept of shape change described as Trans-For-M-otion were evaluated and further developed. The testing was critical to the design process to understand how people move and how they are

moved in response to emotions. Outcomes of the testing resulted in a second iteration of the conceptual design influenced other conceptual garment design ramifications. This next phase of the research explores how a unit/segment method of construction has the potential for design of different types of conceptual garments, and how these garments can be used to transform from one into another when used interactively with body, movement, and space. I will address these conceptual prototype designs in detail in the next chapter.

Chapter 7

EAI garment development

Chapter 7

EAI garments development[1]

7.1 Introduction

This chapter describes the further development of the design for the experienceable garments. The design development drew on the research-through-design process in the context of the EAI framework. In the research-through-design process in the EAI framework, in-depth investigation of the theory, a design workshop project, the initial development of the conceptual prototype, and a pilot study prepared for further development of the experienceable garments; the preceding phases have been documented in Chapters 2 to 6. In explaining the design process, I present sketches from the development of the designs, and three conceptual garments, which were recorded and documented through film clips and a large number of photographic images. Section 7.2 revisits and demonstrates the validity of research-through-design as a process. Section 7.3 illustrates three experienceable prototype garments in this chapter in terms of concept formation, design structure, and the use of material. This section also describes the experienceable prototypes by evaluation of the garments. Section 7.4 concludes with a description of the experienceable garments including the amended initial prototype for further experimentation, as part of the proposed framework of EAI for the next phase of the study involving participants.

7.2 The research-through-design process

In my doctoral research research-through-design refers to how the design process is used as a form of research and involves generating communicable or scientific knowledge through the act of designing (Archer, 1995). The research-through-design approach involved a methodological balance between the research and the design, between the designer's subjective intuition and experience and the user's skills and sensorial awareness, and between tangible prototypes and intangible theories. The

[1] The chapter is a development of the conference paper titled 'Aesthetic experience and comfort': garment design integrated with movement qualities, dynamic bodily expression, and emotion (Jeon, 2010). This was presented at *Kansei Engineering and Emotion Research (KEER) International Conference 2010*, held in Arts et Métiers ParisTech, Paris, March 2-4 2010.

research-through-design process imposes systematic cycles. It follows action and reflection iteratively to build and test several conceptual garment designs. As noted in chapter 1, I have used the term 'conceptual designs,' interchangeably, 'conceptual garments,' or 'experienceable garments' rather than simply 'prototypes' or 'garments' in this thesis, because designing the garments involved open and explorative elements. Further, four experienceable designs that are presented in this thesis were not designed as garments to be tested to develop a final product, but rather to explore further people's reactions, unexplored skills and speculative new ideas for conceptualising comfort. Each experienceable garment was based on specific research questions, which have been addressed in Section 7.3 on concept formation. These garments made users (all women in this study) think, raised awareness, stimulated their imagination and provoked action. The experienceable garments were also designed to differ in interactional style as the basis of the theoretical ideas and the EAI framework. As explained in Chapter 2 (see Section 2.4.1), I applied pragmatic aesthetics (Shusterman, 2000), the psychological concept of affordance (Gibson, 1977) and embodied experience (Merleau-Ponty, 1962) in the use of human skills (Overbeeke et al., 1999) to inform my design practice. The content of 'affordance or adaptability' in my design practice is related to subjective well-being, in conjunction with facilitating people's senses and bodily movements and flexibility in thinking, acting, and responding to the environment. The function of the conceptual garments' structure was designed to be perceived by the users as they interacted with the environment. The underlying concept is that people can interact with clothing as an object in space or in a situation. Based on these ideas of affordance and embodied experience, I developed experienceable designs with the following characteristics of interactional styles:

- The garment allows people to afford and be adaptable to constantly changing moods and emotions, particularly in places where women experience discomfort (emotional affordance);
- The garment stimulates emotional resonance, by which women are able to recall their nostalgic memories (cognitive affordance);
- The garment invites people to touch, move and feel for their comfort (sensorial affordance);

- The garment allows people to be functionally and emotionally adaptable when making their own stories through bodily interaction in everyday activities that lead to dynamic interaction possibilities (functional affordance).

In the evaluation section, each of the conceptual prototypes is elaborated on in terms of how the characteristic of the interactional style is taken into account in the design process in conjunction with the EAI framework. Table 7.1 shows the process of development of four conceptual design prototypes — initial conceptual design of Trans-For-M-otion (see Chapter 5); Jigsaw-Puzzle; Disguise Garment; and Touch me, Feel me, Play with me — with which the design process followed building and testing several conceptual garment prototypes iteratively. These conceptual design prototypes were developed from a theoretical and the experimental EAI framework informed by the selected literature, a design workshop, the initial conceptual garment and a pilot study (see Chapters 2, 3, 4, 5 and 6).

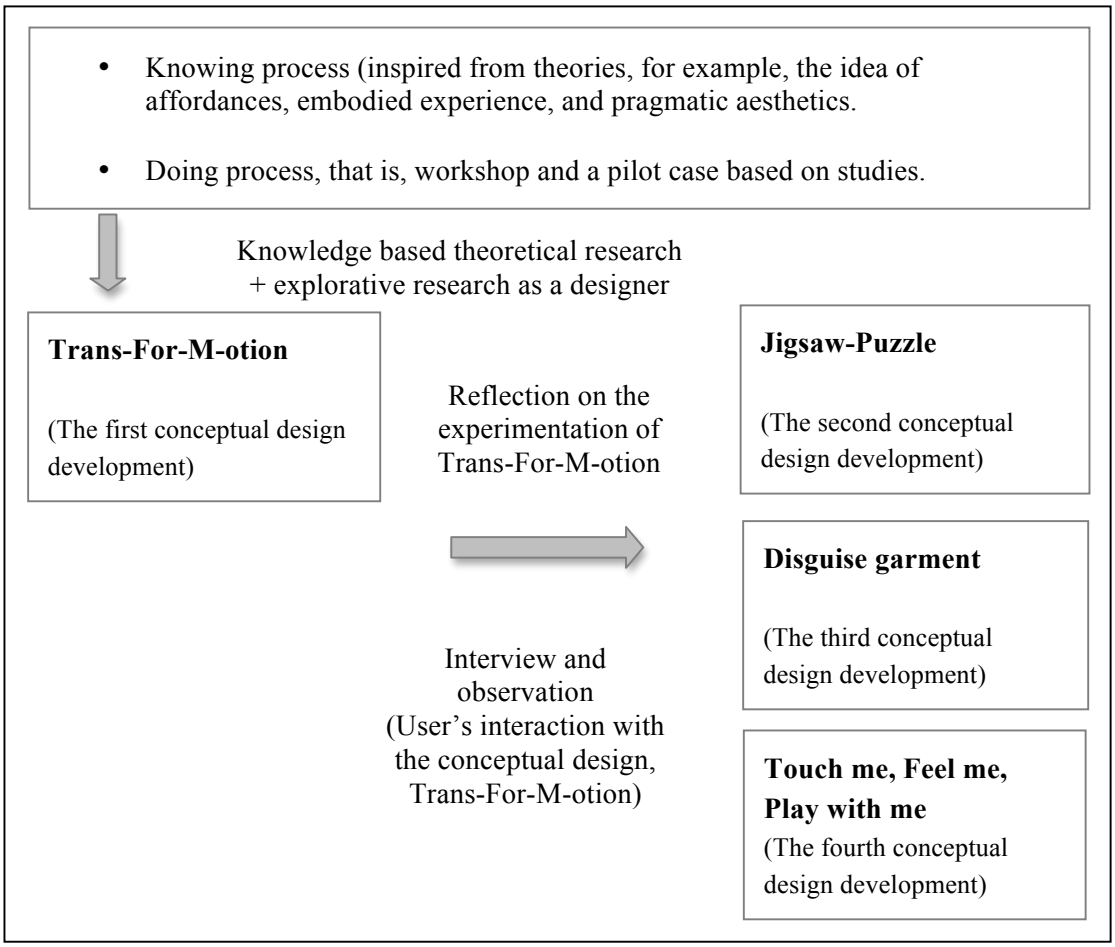


Table 7.1. Flow chart of the process of developing the conceptual prototype designs.

The design explorations were done in an experiential manner. In the design process, the designing of each conceptual garment evolved through the action research cycle of action and reflection (see Table 7.1). The initial conceptual design, Trans-For-M-otion, was developed by reflection on theories, which were then applied to the new concept of conceptualising comfort in a 'designerly' manner (see Chapter 5). The process for the design incorporated reflection on the outcomes from the earlier experiment with my bodily experience and that of a user group. This involved interacting with nature in the context of sensory and synaesthetic understandings of comfort (see Chapter 4). Chapter 6 described how participants embodied human-to-object interaction in the context of a kinaesthetic understanding of comfort. Chapter 6 addressed participants' accounts of the process and descriptions of characteristic components of movement accompanied by emotions of happiness and fear while they interacted with garments. In the context of the EAI framework, design structure of initial Trans-For-M-otion was amended reflected from the outcomes of testing participants' behaviours (see Chapter 6). After the first the conceptual design was developed, the other designs — Jigsaw-Puzzle; Disguise Garment; and Touch me, Feel me, Play with me — were developed by reflection on these observations of movement arising in human-to-object interaction and the bodily experience of comfort (see Chapter 6). This next phase of the research-through-design process focused on a combination of the knowing process, that is, knowledge-based theoretical research, and the doing, feeling process, that is, bodily activities based on exploratory research. The contexts of the EAI framework were tested out with aforementioned four conceptual garments through experiments in terms of feeling through touching, touching through feeling; seeing through touching; and doing through feeling, feeling through doing (see Chapters 8 to 10).

In the design process I used a combination of sketching, engineering felt modelling, and felted wool modelling techniques for idea generation as a starting point for the designs. In addition, dynamic forms created by bodily interaction with the conceptual designs were recorded and documented through film clips and a large number of photographic images. Step-by-step combinations of concept formation, design structure (including style of interaction, and function), and wool felt were researched. Four conceptual designs were critically verified in conjunction with the EAI framework. Trans-For-M-otion was evaluated by user tests addressed in Chapter 6.

Prior to the evaluation, the designs were reviewed by Dr. John Stanton (Scientist of Skin Comfort with Wool Test Specification, Department of Agriculture and Food, Western Australia (DAFWA)), Professor Suzette Worden (School of Design), Senior Fashion Lecturer Anne Farren (School of Art and Design), staff at DAFWA and myself (an experienced designer) for their appropriateness as stimuli for further experiments. The appraisers concurred that the four conceptual designs were valid to investigate human behaviour in conjunction with the framework of EAI and to be tested further in experiments on user participation (see Chapters 8 to 10). In Chapter 2, I introduced a theoretical framework for exploration. In this chapter I explain the way that I used the EAI framework to design three further conceptual designs as the second iterative designs. All four fields of theory — pragmatic aesthetics (Shusterman, 2000), affordance (Gibson, 1979), and embodied interaction (Merleau-Ponty, 1962; Overbeeke et al., 1999; Dourish, 2004) — need to be explored in order to create rich interactive clothing. Conceptually, I had the goal of developing them from the concepts of 'adaptation' and 'playfulness' combining research into sensorimotor, cognitive, and emotional experience through the design process.

7.3 Design of three scenarios

7.3.1 Jigsaw-Puzzle

Figure 7. 1. Jigsaw-Puzzle for testing the wearer's adaptability in everyday activities. Source: design by the author and photo by Kyunghoon Kim.

7.3.1.1 Concept formation

Jigsaw-Puzzle is an adaptable and transformable forms that was developed to accommodate the wearer's needs in a day-to-day and moment-to-moment environment. The garment was created to answer the research question:

- How do garments allow people to be functionally and emotionally adaptable when making their own stories through bodily interaction in everyday activities that lead to dynamic interaction possibilities? (functional affordance)

The design of Jigsaw-Puzzle is based on the idea of less matter but more experience, and less designing but more dynamic interaction with the body through movement and space. Jigsaw-Puzzle is a geometrical drawing within a rectangular shape, mounted on felted wool. Multiple cut Jigsaw-Puzzle pieces can be used to create various forms — such as a hat, long or short sleeve jacket — or can be transformed to provide an entirely new function, becoming, for example, a chair. The interlocking geometrical shapes are cut to fit together and can form a big rectangular shape like abstract art.

This concept was inspired by experiments on dynamic bodily movement when I interacted with nature. My entire body and the choreography of body movements became design tools to create forms. We, especially women, normally criticise our body shape or size in relation to stereotypes of beauty and body image. My intention for the conceptual design was to make the wearer rethink their body shape in an aesthetic way without reference to these stereotypes. In this way, they may enhance physical engagement and mental enjoyment so that they feel a sense of comfort. The prototype was also designed from the concept of transformable fashions, which experiment with space and construction, allowing women to refine and maximise the wardrobe beyond its usual wearable potential, as they transcend established boundaries and challenge the conventions of fashion (Evans et al., 2005; Hodge, 2006).

The following scenario, developed by the author, describes how Jigsaw-Puzzle can be used by the wearer:

> In the morning when Susan wakes up, she is not in a good mood because she is starting her period. So she needs a garment close to her body. For that purpose, she cuts a shape out of the puzzle for making a cloak connected with a big hat. During work, she becomes energetic and this lifts her mood. Her cloak is changed into a vest. In order to have a social meeting after work, she changes the vest into an elegant dress. When she gets back home after this social meeting, the shape is fitted back into the rectangular puzzle on the wall.

Jigsaw-Puzzle reflects a woman's personality, her sense of self, and her emotions. The created form is malleable and incomplete. The form is ongoing and changeable to suit the physical and interactive needs of the body. However, the form requires the wearer's bodily interaction, since it is only through a process of manipulation that the wearer is able to fully use and enjoy the piece. The form is only considered to be a complete form, once the wearer has determined its shape and size. Jigsaw-Puzzle enables women to feel, move, and configure a garment for their own body comfort. In this sense, the garment is not centred on the functional mechanics of comfort, but the emphasis is placed on narrative use, that is, how the form is performed, felt, and configured and how its meaning of comfort is experienced by individual bodily interactions. The garment is designed to be experiential, so that it may enrich, to inspire, and to strengthen an individual's identity, sense of self, and personality. Accordingly, the function of the garment is designed to be rich and intellectual, existing not in a final material form but rather as a garment open to experience.

7.3.1.2 Design structure and material

The choreography of my own body's movements was documented by video recording and photographic images (see Chapter 4). Hard copies of the photographic images were then manipulated and printed within the bold lines of the drawn dress shape as the initial design process. After that the conceptual prototype applied simplified the pattern in felted wool (see Figures 7.2 to 7.5). Jigsaw-Puzzle is structured by a flat sheet combined with the half-cut oval shape, which is a

fabricated, three-dimensional, geometric-shaped unit. The unit size is 25 mm wide, 25 mm long, and 15 mm high. It is composed of 100% wool felt. Its property is flexible and versatile to wear, but not elastic. The full size is 1200mm (W) x 600mm (L) x 25mm (T). Its total weight is 400g.

7.3.1.3 Evaluation of the conceptual prototype design

Jigsaw-Puzzle, was a design that takes into account how people embody form through senses and bodily interaction. The design process focused on an understanding of the experiential process of knowing through experiencing, experiencing through unknowing, within the framework of EAI (see Chapter 3). The fact that the garment was designed to be very abstract means the wearer is able to bring to bear her basic perceptual capabilities. These abilities mean that she is unconsciously drawing on her experiences and thoughts of wearing, by responding spontaneously with the garment in the space. This EAI category can be related to intuitive experiences, those that have been formalised not in the user's head, but even more can be expressed intuitively through bodily movement. Examples of intuitive experiences are the garment's set of features and affordances, which suggest a narrative of use (Blumer, 1969; Forlizzi & Ford, 2000). Everybody has dreams based on their intuition and their sense of self. Most people's sense of style tends to be latent. People are beginning to use their influence to get what they want for comfort, when they want it, and how they want it. They can become participants, even idea generators, in the design development process. In this active position, they can manipulate the conceptual design and say words about what the ideal object is to suit their body for comfort. The design strategy I used was aimed at exploring people's new ideas and unexamined behaviour in conjunction with their sense of comfort in interacting with functional objects. The designed garment required the participant to interpret and interact with it and with the space they are in, but how they wear, interact with, and appropriate the garment was left open to them. Taking into account the open and explorative design therefore leads to functionally dynamic possibilities of interaction in this EAI framework. By these dynamic interaction possibilities, the garment was designed to blur the boundaries between clothing and accessories, between clothing and other forms of objects, and between clothing and art. The

garment becomes enriched with interaction and becomes garment-ness, so it can be beyond garment.

The following Figures (7.2, to 7.5) depict how the process of dynamic form is enabled when the wearer is interacting with the garment.

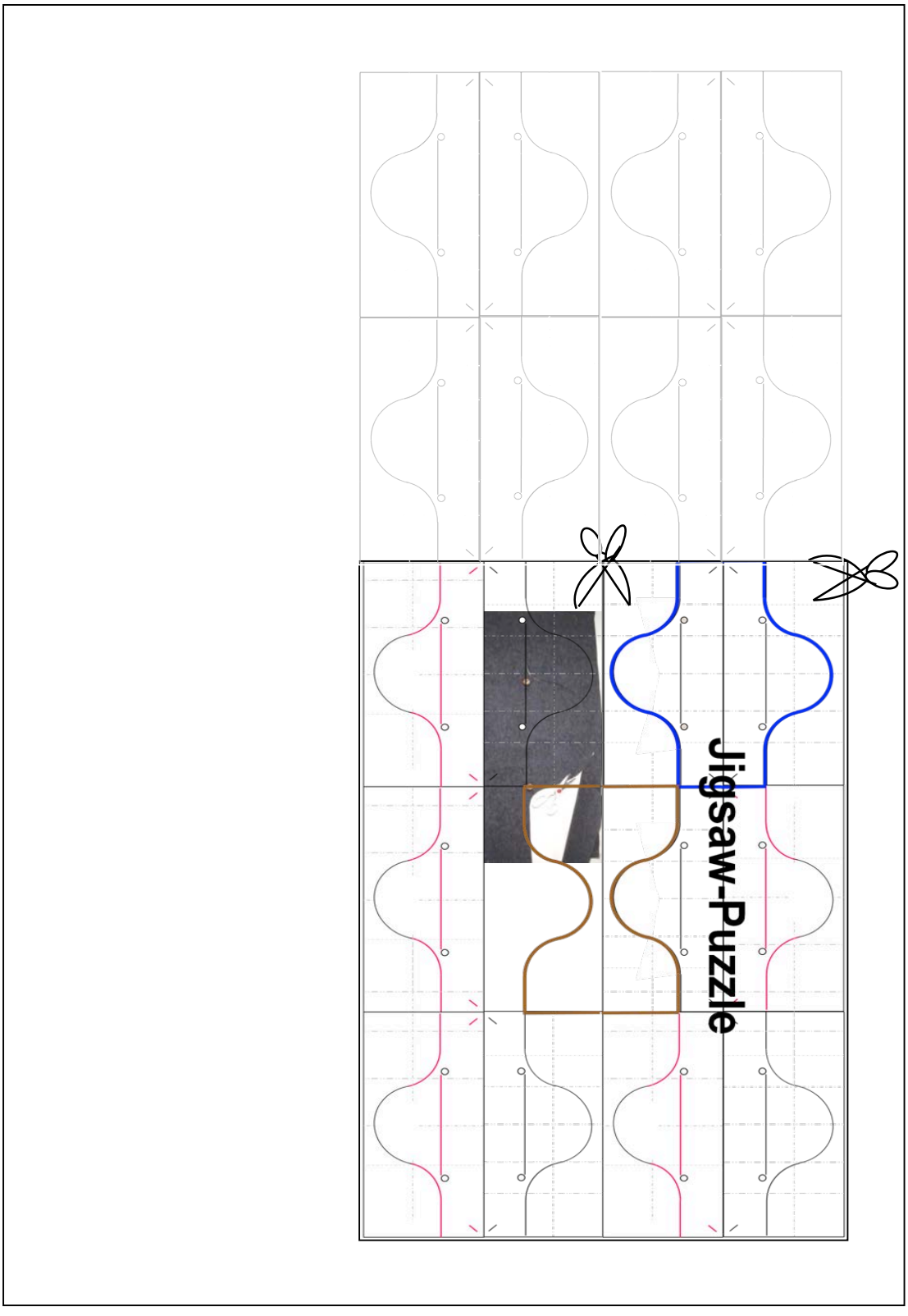


Figure 7. 2. The process of making the form of Jigsaw-Puzzle (I).
Source: design, sketch, and photo by the author.

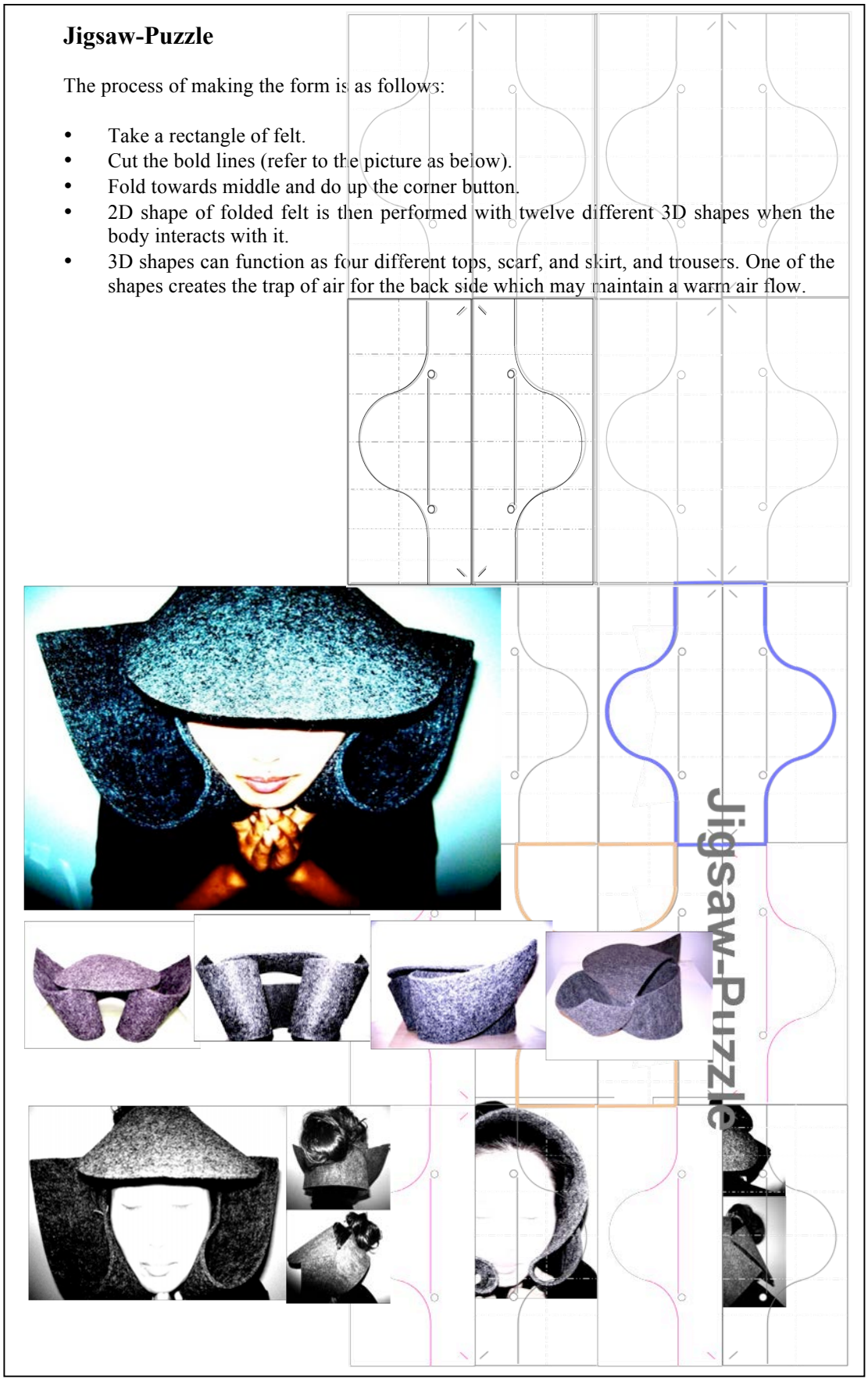


Figure 7. 3. The process of making the form of Jigsaw-Puzzle (II).
Source: design, sketch, and photo by the author.

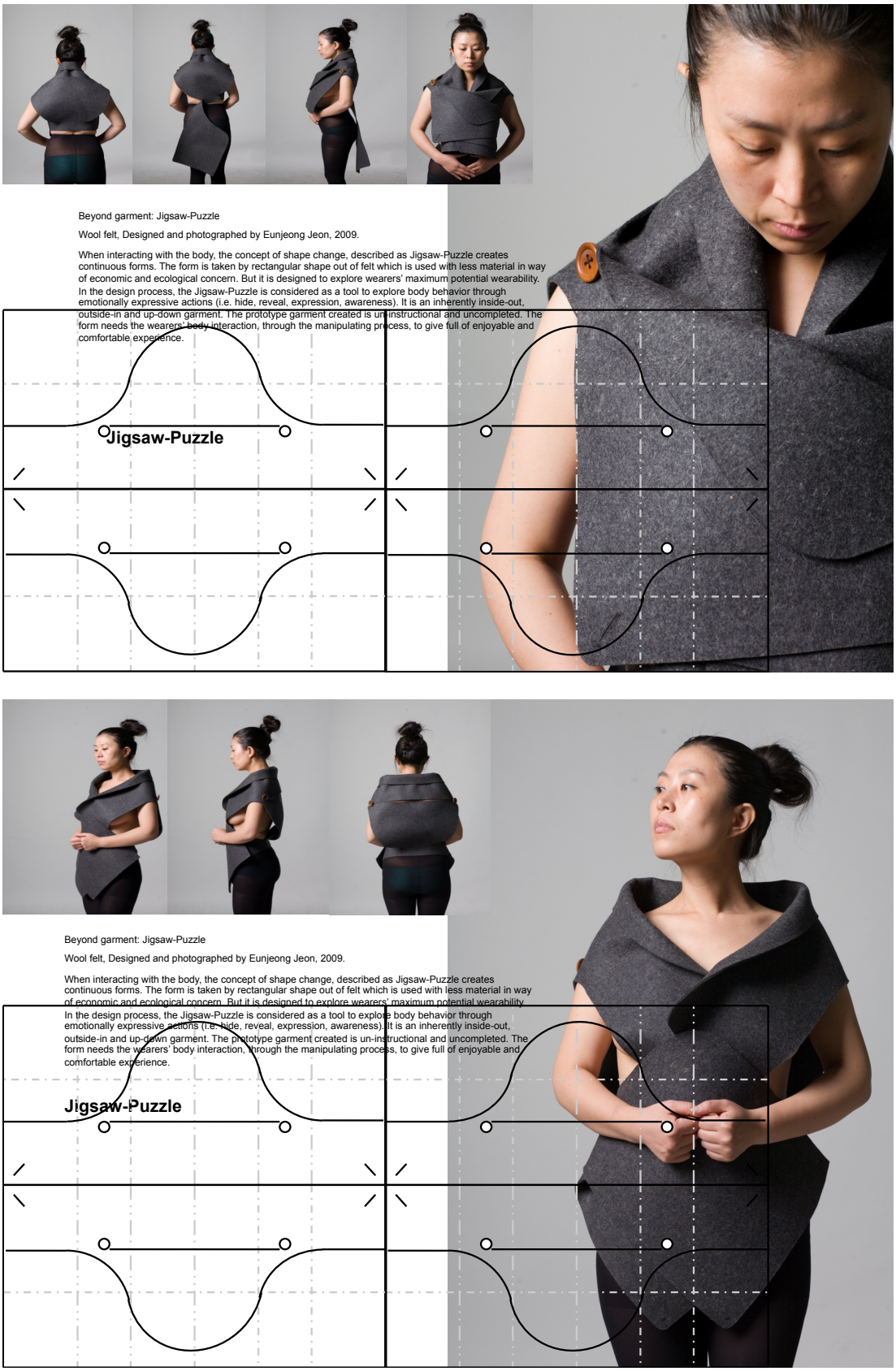


Figure 7. 4. The process of making the form of Jigsaw-Puzzle through bodily interaction (I).
Source: design, sketch, and photo by the author.

Figure 7. 5 The process of making the form of Jigsaw-Puzzle through bodily interaction (II).
Source: design, sketch, and photo by the author.

7.3.2 Disguise Garment

Figure 7. 6. Disguise Garment for testing wearer's behaviours in insecure situations. Source: design and photo by the author.

7.3.2.1 Concept formation

People, in particular women, at times imagine they can disappear, to be like a ghost, in order to protect or hide themselves from threatening people approaching them in insecure situations. If their body is able to disappear when wearing garments in such threatening situations, a sense of comfort may be achieved. The dictionary definition of comfort is '… when you feel better after feeling sad or worried, or threatened, or something that makes you feel better' (*Definition of comfort*, n.d.). The concept of the disguise garment was developed as a result of the participant observations and interviews with a group of participants who engaged in the manipulation of the initial conceptual garment, Trans-For-M-otion (see Chapter 6). The participants in the pilot study were observed to be more aware of garment forms when they were placed in fearful and insecure situations, and in response, the design concept evolved from the following research questions:

- How do feelings of fear or threat in insecure situations turn into comfortable, enjoyable, and playful emotions? (cognitive affordance);

- How can the garment stimulate emotional resonance, enabling women to recall their nostalgic memories? (cognitive affordance);
- How does the experience of the garment act as a mood-altering material when stimulated by cognitive image processing? (cognitive affordance)

As mentioned in Chapter 1, women in transitional public spaces such as railroads and airports have a narrow focus on their experiences of fear. The body needs to adapt its movements and make use of external clothing functions to feel comfortable when inhabiting spaces where there are extreme temperature fluctuations, noise, pollution, and even stress and crime. The design process for the garment focused on a fictional scenario of 'using a garment to disguise the body like a ghost' in insecure situations.

7.3.2.2 Design structure and material

The conceptual prototype Disguise Garment is based on the same unit structure as the first prototype, Trans-For-M-otion, but it is embedded with attached LED light technology fixed inside the pockets (see Figure 7.7). The full size is 1200 mm (W) x 850 mm (L) x 35 mm (T). Its total weight is 690g.

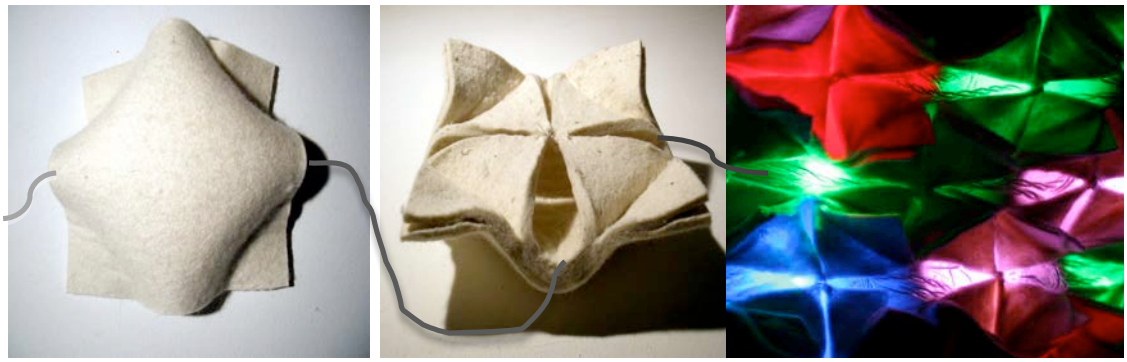


Figure 7. 7. Disguise Garment is made from engineered felt embedded with LED lights. Source: design and photo by the author.

7.3.2.3 Evaluation of the conceptual prototype design

Disguise Garment was designed in the framework of EAI, seeing through touching. That is, the concept of the design process was an integration of the senses of touch, sight and movement with perceptual cognition to evoke empathy and recalling

images. The purpose of combining the garment with LED technology was to explore the kinetic behaviour of a garment in its moving form. It also acts as a mood-altering material by stimulating cognitive image processing, such as empathy, childhood and nostalgic memories associated with pleasure, reassurance, and fantasy. This can alleviate threat and reduce fear so that a woman can make herself calm.

Embedding the garment with LED light technology enhances its function as a mask to hide, protect and distort the self when the wearer is in danger of attack. The wearer can move the garment themselves to position it in a way that makes them feel protected. Some of the women I interviewed and observed when interacting with a garment, Trans-For-Motion in insecure situations (see Chapter 6 and Appendix to chapter 6), wanted to be able to disguise themselves or hide their identity, so I designed the garment to be pulled upwards so that the collar can conceal part of the face. In this sense, the garment interacts dynamically with the boundary between personal and general space. These experiments indicate the garment enables the reclaiming of private space to protect the wearer from insecure situations. The garment can become a form of kinesthetic behaviour, in response to interactions with narrative structures of bodily absence in threatening situations. From being a part of the body to becoming a part of our living environment, clothing can interact with the space between our bodies and our environments. In addition, in a situation where a threat from the rear is imminent, the garment's built-in LED light with electronic vibration is generated. In this context the garment can enable the wearer to find out how feelings of fear or threat can be transformed into comforting. Therefore, the garment can be used as a self-help therapeutic tool as the mood-altering materials. Accordingly, the garment combined with LED lighting can enable the wearer to find out how feelings of fear or threat in insecure situations can be transformed into comfortable, enjoyable and playful emotions (see Figure 7.8). In addition to the protective qualities, the garment creates a feeling of playfulness and whimsy. When the woman presses the LED sensor, the lights are on in a dark space, so that the Disguise Garment acts as a kinetic object and as a form of visual expression as it changes shape. Created from felted wool layered units that trap air, and embedded LED lights and sensors, the illuminated garment is designed to morph and change colour to help the wearer feel simultaneously protected, safe, and confident. (see Figure 7.8).

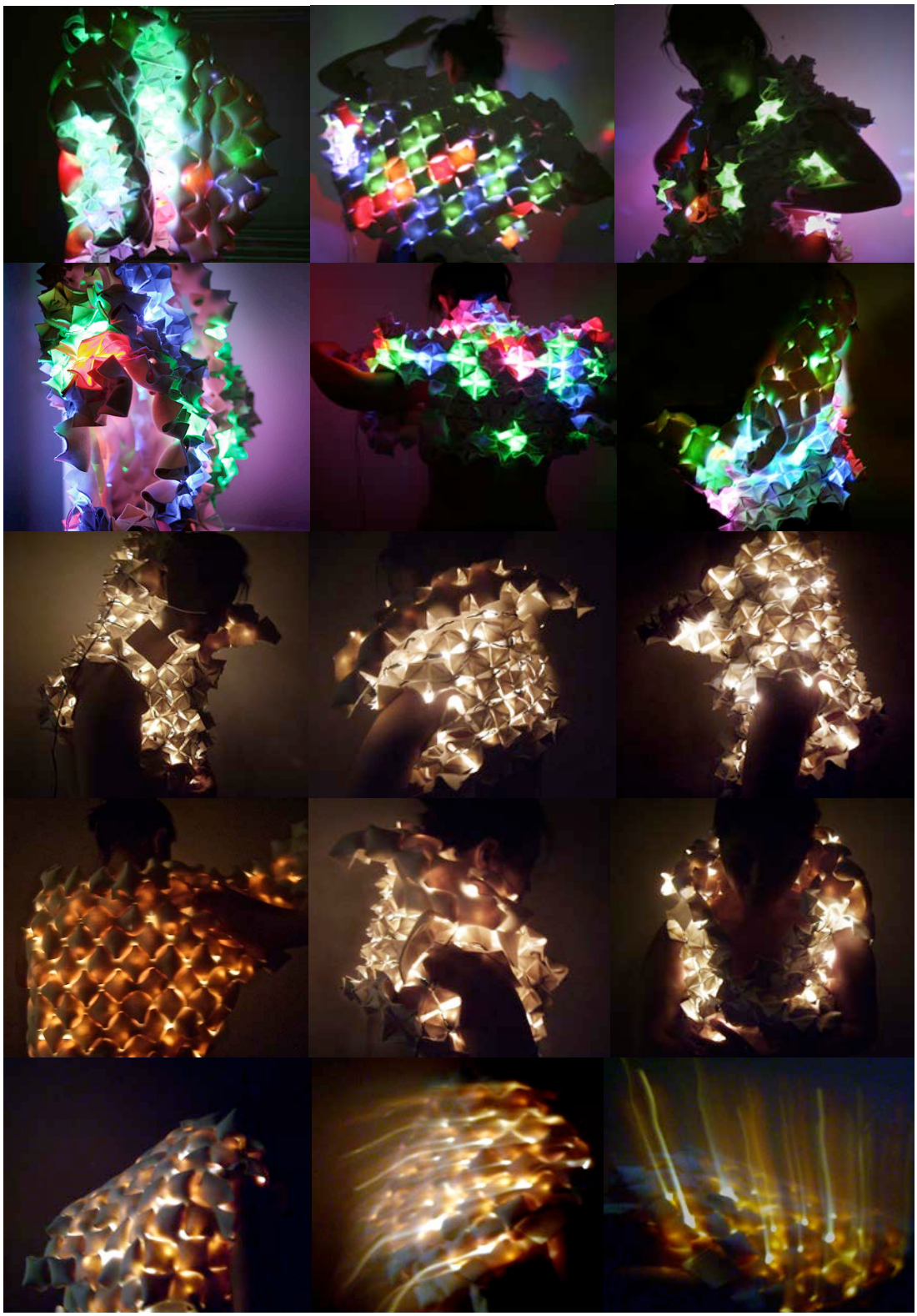


Figure 7. 8. The use of Disguise Garment is for protecting the body, reclaiming private space, and as a therapeutic aid that can change the mood of the wearer in insecure situations. Source: design and photo by the author.

7.3.3 Touch me, Feel me, Play with me

Figure 7. 9. Touch me, Feel me, Play with me is designed for having different inside and outside textures and forms that allows the wearer to elicit various sensorial experiences. Source: design by the author and photo by Kyunghoon Kim.

7.3.3.1 Concept formation

The development of the experienceable prototype, Touch me, Feel me, Play with me stems from a reflection on the outcomes from the philosophical and theoretical concept of phenomenology. In addition, the development of this conceptual prototype extended further some of the ideas generated by the Trans-For-M-otion experiment (see Chapter 5) and reflected people's touching and movement behaviour through observation (see Chapter 6). The design process used follows a research-through design approach explored rich and dynamic bodily expression through the following research question:

- How can the garment empower the body to touch/ be touched, feel/ be felt, and move/ be moved to enhance and explore self-expression and self-therapy? (sensory affordance)

The design process involves a methodological balance between research and design, between the designer's skills and the user's sensorial awareness. The prototype was designed not only in an exploration of the innate properties of wool — resilience,

durability, and versatility — but also of the movement of air and the sense of touch at points of body contact when users interacted with the garment (see Chapter 6). Different points of body contact with the 3D concave and convex structure of the textile — the arms, legs, back, neck, head, and hand — may influence the different levels of enjoyment or comfort for the wearer (see Figure 7.9).

7.3.3.2 Design structure and material

The garment was made out of a sheet of 100% wool felt and another sheet of engineering wool felt composed of 70% wool felt combined with synthetic materials. It replicates a three-dimensional, irregular polygon, both concave and convex, with a unit structured to trap air on one side and geometric pockets on the reverse side. It is not only flexible and versatile to wear but also very elastic. The unit size is 30 mm wide, 30 mm long, and 25 mm high. The full size is 1200mm (W) x 1450mm (L) x 25 mm (T). Its total weight is 500g.

Figures 7.10 and 7.11 show how the garment is structured in relation to notion of tactile experience. Figures 7.12 to 7.15 show the process of making the form through sketching and wool felted modelling. Theses figures elaborate on how the prototype's dynamic and diverse forms can be creatively manipulated by the wearer. In particular, in the design approach, the aim was not only to enhance a paradoxical sense of touch, but also to evoke emotional associations. The wearer can experience various feelings and emotions while interacting with the conceptual prototype, for example, the garment reminded them of a lamb, which evoked the sensation of touching a warm, woolly body. When the design structure was made of three layers of wool felt, combining two sheets of natural ivory colour felt with a layer of vivid yellow dyed felt in between, the prototype replicates the three-dimensional, irregular concave and convex polygonal shapes with the trapped air unit on the one side and flower-shaped pockets on the reverse side. The flower-shaped pockets combined with different colour accents are able to evoke a synaesthetic experience of comfort, such as the smell of flowery perfume and the feeling of warm touch (see Figure 7.17).

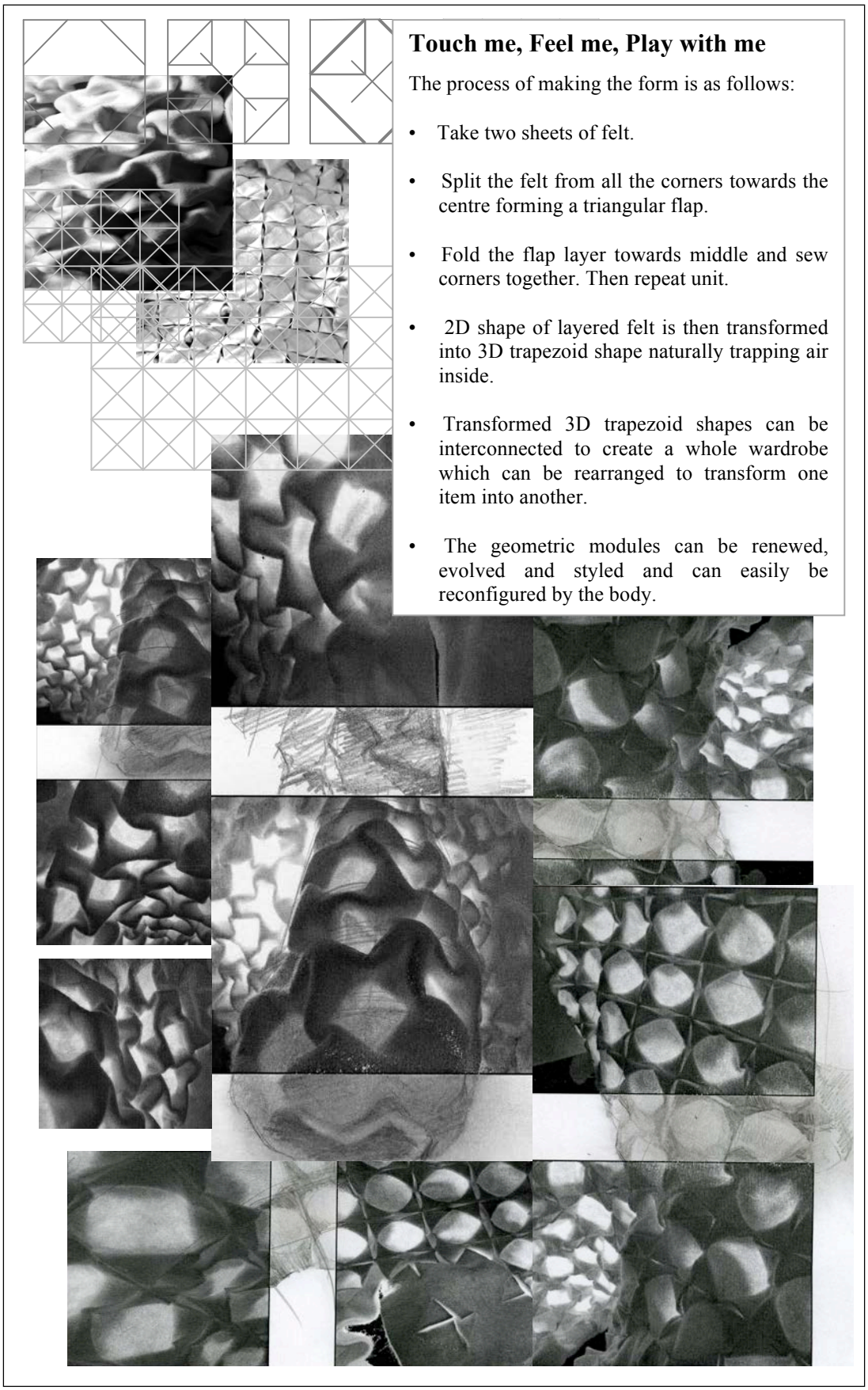


Figure 7. 10. Structure of Touch me, Feel me, Play with me (I).
Source: design, sketch, and photo by the author.

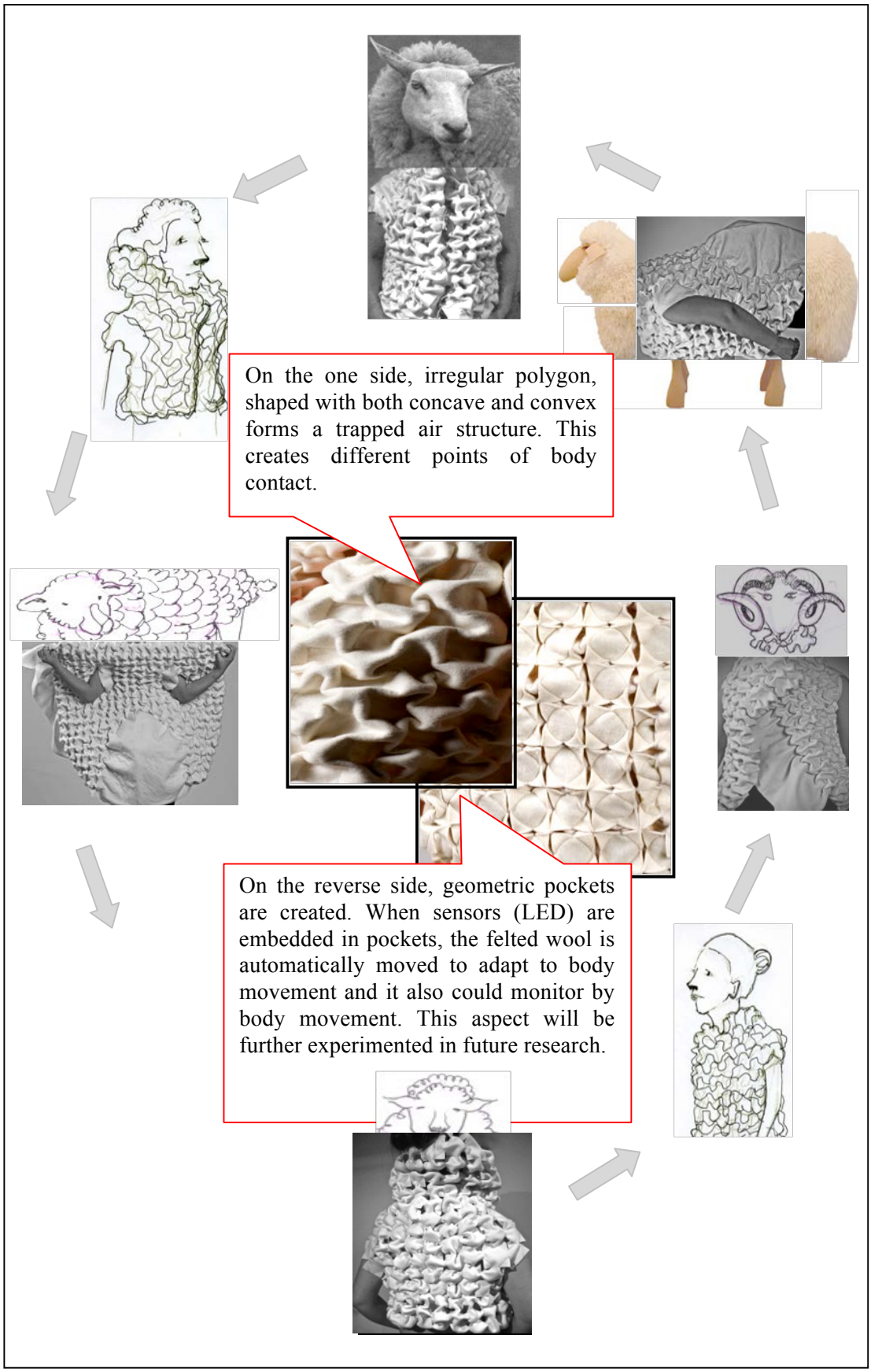


Figure 7. 11. Structure of Touch me, Feel me, Play with me (II).
Source: design, sketch, and photo by the author.

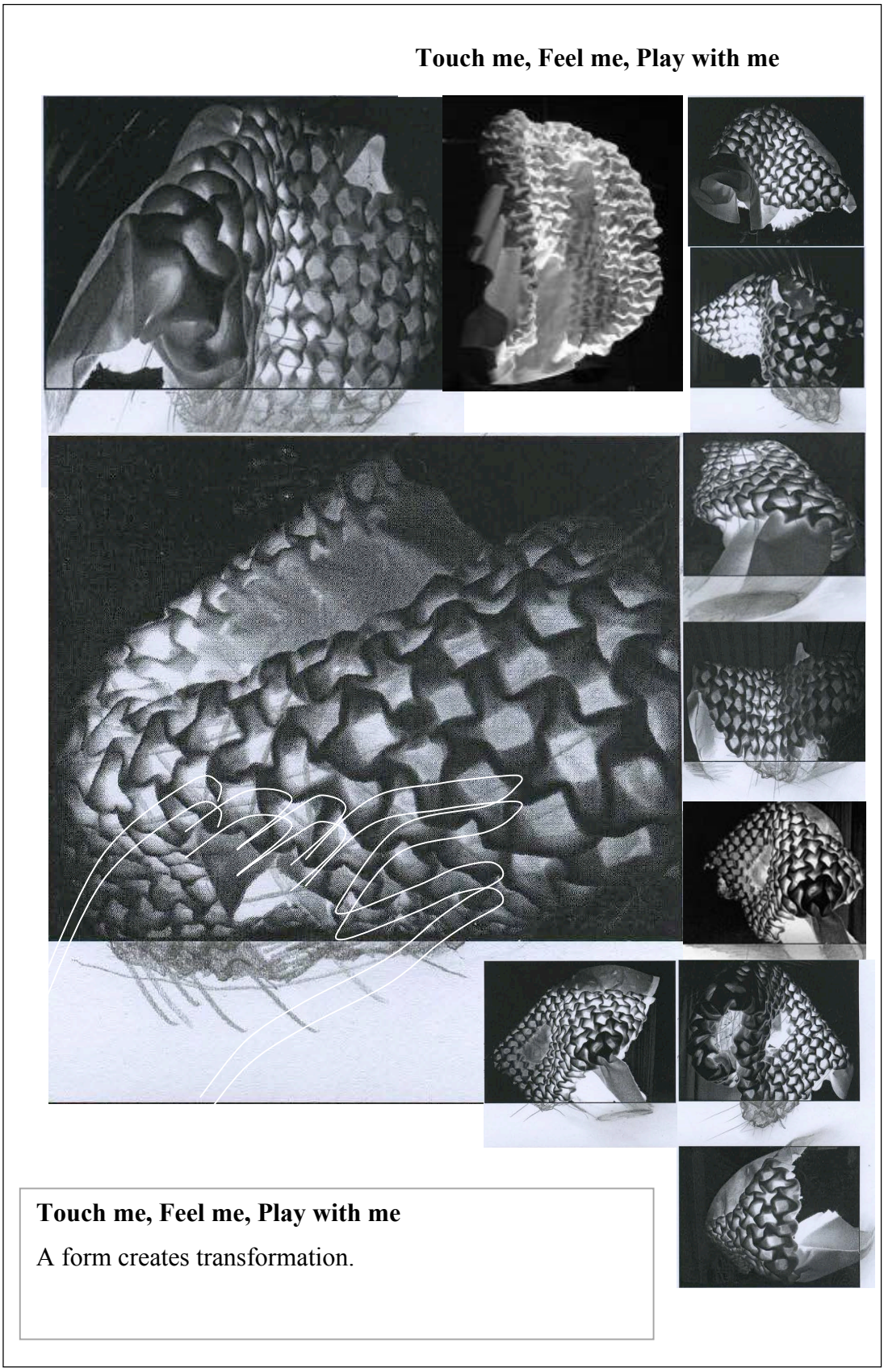


Figure 7. 12. The process of making the form of Touch me, Feel me, Play with me (I). Source: design, sketch, and photo by the author.

Figure 7. 13. The process of making the form of Touch me, Feel me, Play with me (II). Source: design and photo by the author.

Figure 7. 14. The process of making the form of Touch me, Feel me, Play with me (III). Source: design and photo by the author.

Figure 7. 15. The process of making the form of Touch me, Feel me, Play with me (IV). Source: design and photo by the author

7.3.3.3 Evaluation of the conceptual prototype design

The conceptual prototype brought forward a haptic (tactile) design approach, which is linked to the feeling through touching interaction characteristic in the EAI framework. The aim of this experienceable design was to explore further experiments to the discourse on comfort by investigating the influence of haptic experience, kinetic interaction, and emotion. In order to design a prototype for active exploratory touch that may enhance dynamic bodily expression, I applied concepts of exploratory perception combined with haptic touch, influenced by Gibson's theory of haptic systems in psychology (1966, pp. 123-135), Merleau-Ponty's (1962) sensorimotor intertwinement with perception and haptic experimental research (Marks, 1978; Lederman & Loomis, 1986; Lederman & Klatzky, 1987; Lederman & Jones, 2006; Upali, 2008).

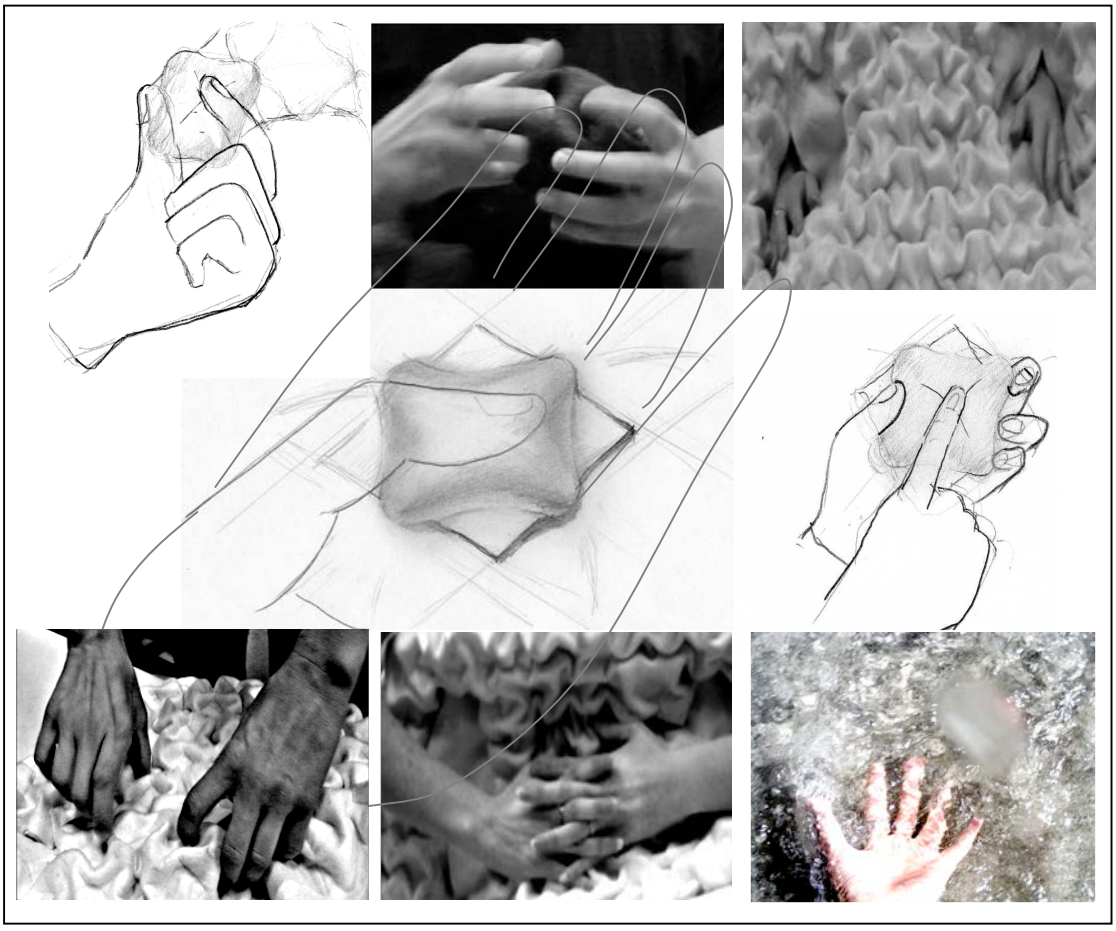


Figure 7. 16. The modes of touch: hand and body movements to feel an object.
Source: design, sketch, and photo by the author.

In order to create a design that elicits a tactile and emotional response from the wearer, Touch me, Feel me, Play with me was designed to incorporate dialogue between material explorations and bodily sensorial awareness leading to: (1) incongruent tactile feelings of the properties of felted wool; and (2) haptic experience that consists of both touch and seeing, an act that involves not only the hand but also the entire body (Craig & Rollman, 1999). In the context of haptic touching, the conceptual prototype invites the wearer to create dynamic modes of touch. Dynamic modes of touch can stimulate different levels of sensorial responses. Looking at the related concept of 'playfulness', people like to play with objects to make themselves calm or to help them face their challenges and meet their goals. We often see that people have unconscious behaviours, such as swinging a pen in their fingers, which seems to enhance emotional affects. Different senses of touch, for example, active or passive touch, actually can enhance different levels of emotional affect. This was used to test participants' modes of hand movement and dynamic bodily movements in response to bodily sensations and to enhance psychological comfort (see Chapter 6). The felted wool textile was developed to consider these dynamic touches and was structure to incorporate an irregular polygon, shaped with both concave and convex forms, to trap air on one side and create geometric pockets on the reverse side. This 3D structure expends as different points of body come in to contact with the skin stimulating and enhancing a sensorial experience. The quality of the textile is also designed to be open to diverse experiences. For the reason, the conceptual prototype can be configured in various ways through different bodily interactions, which allows the wearer to express individuality. In the context of haptic seeing, the focus was on texture and crafting. Therefore, the body itself become an essential structure in crafting the form of the textile design.

In the context of haptic seeing the textile is focused on texture and crafting. Touch me, Feel me, Play with me is produced using crafting techniques such as sewing, folding, and engineered felting, which used conventional craft skills during the felting process. Craft techniques are used in the making of the textiles so that the texture projects a sophisticated aesthetic while maintaining a soft texture. In addition, the prototype is designed to enhance personal tactility by encouraging the wearer to move over and interact with the textile surface. At the outset of the design process it was important to encourage the wearer to engage with the textiles and become

involved in the creative process, as a way to stimulate an interpersonal dialogue between wearer and garment. This dialogue can lead the wearer to develop an attachment to the garment since personal stories become embedded in the prototype.

Figure 7. 17. Touch me, Feel me, Play with me (II) is made out of three sheets of wool felt: two sheets of natural ivory coloured felt with a layer of yellow dyed felt in between.
Source: design by the author and photo by Kyunghoon Kim.

7.4 Summary

Three experienceable prototypes[2] were addressed in this chapter as the second design project. Initial conceptual prototype, Trans-For-M-otion and these three prototypes were used for in-depth investigation through participant observation and interviewing. These conceptual garments, described as Trans-For-M-otion, Disguise Garment, Touch me Feel me Play with me, and Jigsaw-Puzzle were developed for the participants to wear, and their emotional responses were recorded.

The four conceptual prototypes were designed differently to incorporate four essential components: 1) shape variation from three-dimensional, irregular polygonal surfaces on one side of the garment to regular circle-like surfaces inside rectangles, so that when the garment is fabricated, it has geometric-shaped pockets on the reverse side; 2) texture variation from roughness to softness due to changes in the shape; 3) material and structural variations with elasticity and versatility; and 4) different interactional styles.

The following Table (7.2) summarises the main characteristics of the four conceptual prototypes in terms of essential components and properties and interaction style.

[2] Four conceptual prototype garments were invited to the 'Beyond Garment' exhibition at the Western Australian Museum, 3 September and 30 November, 2010. These garments were also selected for publication in: *Advanced Textiles for Health and Well-Being* (Marie O'Mahony 2011), *Fashion Futures* by Bradley Quinn (2012), *Textile Visionaries: Innovation and Sustainability in Textile Design* by Bradley Quinn (2013) (See Appendix to Chapters 5, 7), and forthcoming *Fashion Design for Living* edited by Alison Gwilt (2014).

Four conceptual prototypes	**Properties of conceptual prototypes**
Trans-For-M-otion  	*Design structure*: a regular geometric polygonal unit. The unit size is 40 mm wide, 40 mm long, and 35 mm high. Created from simple felt units, Trans-For-M-otion replicates three-dimensional, geometric shapes with the trapped air unit on one side and flower-shaped pockets on the reverse side. The full size is 1200 mm (W) x 850 mm (L) x 35 mm (H). Its total weight is 600g. *Material*: made of off-cuts of engineering wool felt composed of 70% wool felt combined with synthetic felt. *Properties:* three-dimensional regular geometric components with the trapped air offering potential in the transformation of form. Its properties are flexibility and versatility in wear, but not much elasticity. *Style of interaction* (doing through feeling, feeling through doing): the garment allows people to afford, and be adaptable to, constantly changing moods and emotions, particularly in places where women experience discomfort (emotional affordance).
Disguise Garment 	*Design structure:* based on the same unit structure as Trans-For-M-otion, but it is combined with attachable or detachable LED technology, which is fixed inside the pockets. The full size is 1200 mm (W) x 850 mm (L) x 35 mm (T). Its total weight is 690g. *Material*: made of off-cuts of engineering wool felt composed of 70% wool felt combined with synthetic felt. *Properties:* the same as Trans-For-M-otion. *Style of interaction* (seeing through touching): the garment stimulates emotional resonance, by which women are able to recall their nostalgic memories (cognitive affordance).

Table 7.2. (a) The main characteristics of the four conceptual prototypes.

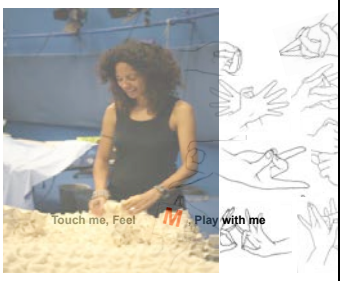
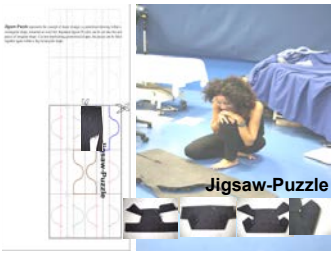
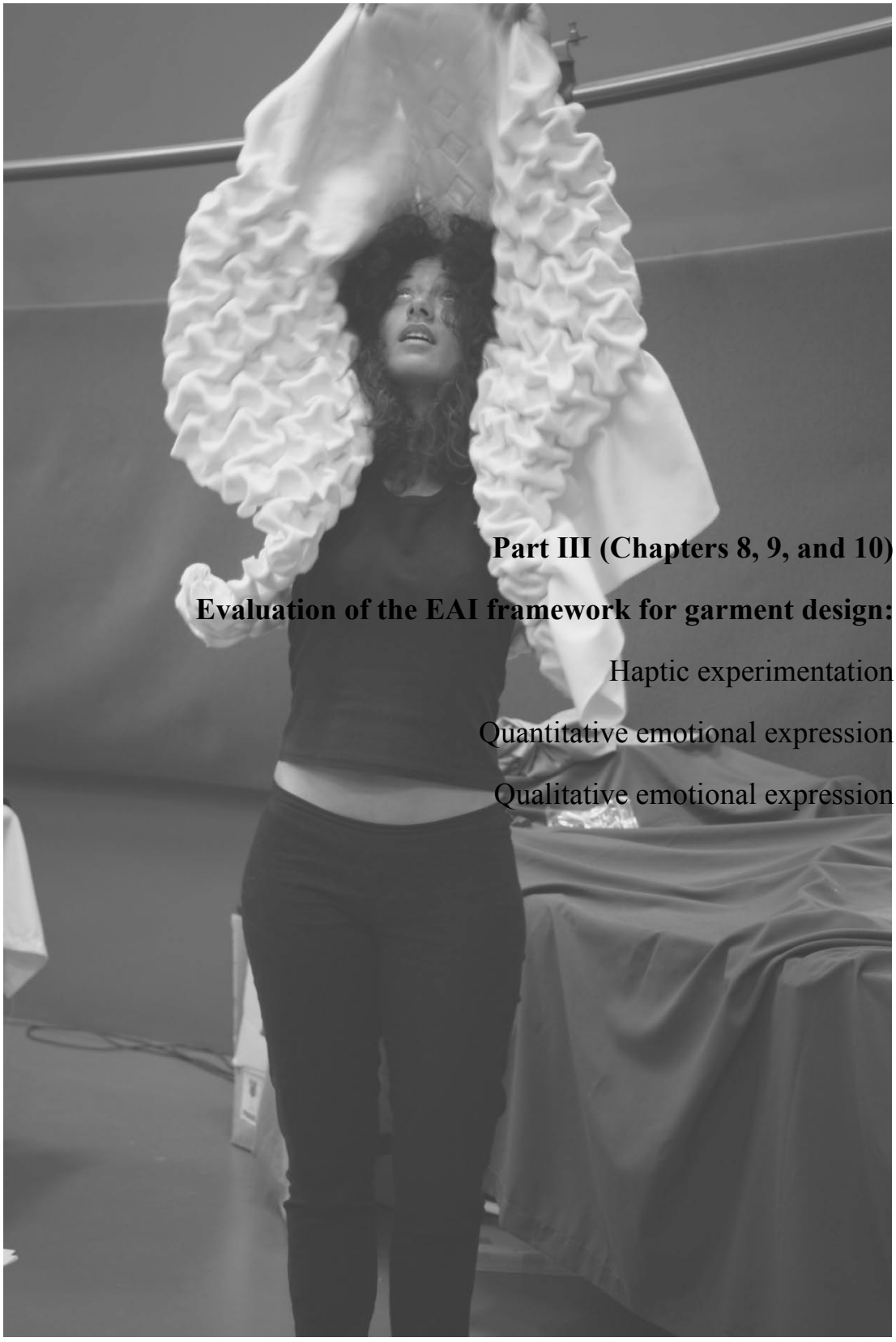
Four conceptual prototypes	**Properties of conceptual prototypes**
Touch me, Feel me, Play with me 	*Design structure*: three-dimensional, irregular polygons with the trapped air unit on one side and geometric-shaped pockets on the reverse side. The full size is 1200mm (W) x 1450mm (L) x 30 mm (T). Its total weight is 500g. *Material*: it was made out of a sheet of 100% wool felt and another sheet of engineering wool felt composed of 70% wool felt combined with synthetic felt. *Properties:* three-dimensional irregular geometric components with trapped air offering potential for the transformation of form and sense of touch. It is not only flexible and versatile to wear but also very elastic. The form expresses abstract, open and flexible dimensions of personality. Forms can be created by the ways people interact with the prototype. *Style of interaction* (feeling through touching, seeing through touching): the garment invites people to touch, move and feel for their comfort (sensory affordance).
Jigsaw Puzzle 	*Design structure*: a flat sheet combined with a fabricated three-dimensional, geometric unit. The unit size is 25 mm wide, 25 mm long, and 15 mm high. The full size is 1200mm (W) x 600mm (L) x 25mm (T). Its total weight is 400g. *Material*: 100% wool felt. *Properties:* flexible and versatile to wear but not elastic. The form expresses abstract, open and flexible dimensions of personality. Various forms can be created according to how people interact with the textile. *Style of interaction* (knowing through experiencing, experiencing through unknowing): the garment allows people to be functionally and emotionally adaptable and to make their own stories through bodily interaction in everyday activities that lead to dynamic interaction possibilities (functional affordance).

Table 7.2. (b) The main characteristics of the four conceptual prototypes.

The following three chapters will review the findings from in-depth participant observations and interviews, interrogating how participants interacted with these four conceptual prototype designs through three steps of experimentation:

1. Chapter 8: Haptic visuality tested the integration of touching, feeling and seeing, in order to investigate the comfort factors of users' 'feeling good or bad.'
2. Chapter 9: Motion Capture Experiment (MCE) tested participants' (n=8, age (20-40)) physical movement in order to understand human gait behaviours, correlating and comparing three different walk types ('natural,' 'happy,' and 'fearful') and garment types ('normal,' 'happy,' and 'fearful').
3. Chapter 10: Laban Movement Analysis (LMA) (Laban, 1960) was utilised in the correlation and comparison of three different walk types ('natural,' 'happy,' and 'fearful') and garment types ('normal,' 'happy,' and 'fearful'). This chapter extends the theoretical investigation outlined in Chapter 9.

The three steps of experimentation were based on the framework of EAI: feeling though touching, seeing through touching, doing through feeling, feeling through doing.



Part III (Chapters 8, 9, and 10)

Evaluation of the EAI framework for garment design:

Haptic experimentation

Quantitative emotional expression

Qualitative emotional expression

Participant's bodily articulation. Source: photo by the author (2011)

Chapter 8

Haptic experimentation

Chapter 8

Haptic visuality experimentation[1]

8.1 Introduction

Part III of the study starts with this chapter, elaborating the testing of the EAI framework through user participant involvement, which was conducted in three phases of experimentation (see Chapters 8, 9, and 10). The reflections on the outcome of these experiments lead to answer my second thesis question:

- What design principles can be developed to provide aesthetic comfort for the user in clothing as it is worn in daily life?

This chapter addresses the methodology of haptic experimentation using in the EAI framework: doing through feeling, feeling through doing; feeling through touching; and seeing through touching. Within haptic experimentation in the framework, this chapter considers how to connect with people's emotions when they touch the textiles. The chapter also describes how different senses, for example touching and seeing, were integrated when participants (female, n=15, age of 20-40 years) interacted with four conceptual prototypes (Trans-For-M-otion, Touch me, Feel me, Play with me, Jigsaw-Puzzle, and Disguise Garment). The main aim of this haptic experimentation was to investigate the comfort factors associated with users 'feeling good or bad'; knowledge thus gained can guide design principles for clothing comfort. There were two phases to the investigation. The first phase of qualitative investigation (Phase I) was based on three contexts of the framework of EAI described above. Based on the evaluation of haptic experience and various qualities of the target prototypes established in Phase I, the second phase of investigation used the Semantic Differential (SD) test in quantitative analysis, to explore the relationships between design attributes and users' perceptions. The in-depth

[1] This chapter is based on a conference paper titled 'Enriched aesthetic interaction through sense from haptic visuality' (Jeon, 2011). This was presented at the *International Design Alliance* (*IDA) Congress of Education Conference 2011*, held in Taipei, Taiwan, October 24-26 2011.

observations and interviews with participants in this phase of the study were conducted over five months from November 2009 to March 2010.

Chapter 9 of part III addresses quantitative emotional expression using the 3D Motion Capture (MC) data analysed by a random effect regression model with mixed procedures in statistical analysis software and statistic analysis of variance. In this context the EAI framework was based on doing through feeling, feeling through doing. Participants' (female, n=8, age of 20-40) quantitative physical movement was tested in conjunction with the movement data for analysis of step, velocity and body position of hands, head, legs, and trunk. The experiment aimed to understand human walking behaviour, correlating and comparing three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful'). This experimentation therefore, can assist in scientific testing of the performance of garments in relationship with the way a person walks.

Chapter 10 of part III sets out to test qualitative emotional expression using 2D video data analysed by Laban Movement Analysis (LMA) — *Body, Space, Effort, Shape* — in the EAI framework in terms of doing through feeling, feeling through doing. This LMA experiment was in conjunction with an MC experiment (see Chapter 9). Identifying the qualitative and dynamic character of the participants' (female, n=8, age of 20-40) movement system was analysed by comparing three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful'). These experimental MC techniques and LMA theoretical approaches, which were conducted from March to May 2010, were used with stimuli, such as amended scenarios (addressed in Chapter 6). The aim of using the scenarios technique was to trigger emotions (happy and fearful) with which emotionally inflected walking behaviours were analysed, quantitatively and qualitatively. Thereafter, collecting both theoretical qualitative data and scientific and statistical quantitative data provided in-depth knowledge and a balanced understanding of human senses, experiences, and bodily movement.

The aim of the three phases of experimentation was to use the research-through-design approach in part III to build an understanding of how the nature of human interaction is experienced in use. Reflection on evaluation of these experiments led to

guidelines for design principles that provide aesthetic comfort for the user, in clothing as it is worn in daily life.

This chapter addresses haptic experimentation in the EAI framework in terms of doing through touching, touching through doing; seeing through touching; and doing through feeling, feeling through doing. This haptic experimentation was aimed at testing the phenomenological way participants (female, n=15, age of 20-40 years) move, feel, and touch the four conceptual prototypes, the connection with affective emotion, and the integration of senses and perception. Section 8.2 defines the terms EAI and 'haptic visuality' in the context of the senses of touch and movement. Section 8.3 presents the aims, objectives and questions. Section 8.4 describes the method, outlining the use of qualitative and quantitative data collection and analysis for the experiments. The resulting data analysis and discussion are presented in Section 8.5 and 8.6. The conclusion in Section 8.7 provides answers to the research questions raised in order to find design principles for clothing comfort.

8.2 Defining EAI in the context of haptic visuality

As explained in Chapters 1 and 3, the term EAI used in my thesis title represents the affective experience stimulated through the senses when a person interacts with an object for enjoyment, for comfort or for pleasure. This can only occur through the senses of touch, sight, smell, taste, and movement, which generate a meaningful perception, as sketched in Chapters 2 and 4. The focus in this chapter is on testing women's haptic experience, that is, the integration of feeling, touching, and seeing as one part of the complex phenomenon of EAI. The awareness that we often 'see' an object through 'touch' is the inspiration for this investigation of the haptic experience, which expresses unity of tactile and kinaesthetic phenomena and unity of touch and sight (Merleau-Ponty, 1962). The term haptic visuality is adapted from Marks's (2004) definition. He describes haptic visuality as a kind of seeing that uses the eye like an organ of touch, and containing some of the following formal and textual qualities:

> …grainy, unclear images; sensuous imagery that evokes memory of the senses (i.e. water, nature); the depiction of characters in acute states of

> sensory activity (smelling, sniffing, tasting, etc.); close-to-the-body camera positions and panning across the surface of objects. (pp. 79-82)

Haptic visuality consists of both touching and seeing, an act that involves not only the hand (the hand is a perceptual and manipulative organ) but also the entire body (Craig & Rollman, 1999; Merlear-Ponty, 1962). Haptic touching requires proximity, so that sensations can flow from the point of contact to the rest of the body. Haptic seeing, on the other hand, represents the act of skimming or moving over the surface of objects so that form becomes discernible. It focuses on textures and crafting. Haptic experience through body enactments makes people more creatively active (Deleuze, 2003), because they must draw on their imagination to fill in what is unsaid or unfinished in the image in their head. People also focus on the image itself; that is, on the physical configuration which, in turn, may elicit a sensuous response.

In Chapters 2, 3, and 6 I considered forms of touch in conjunction with the performance of our hands as they explore how to move, feel, and evaluate an object. Three theoretical and experimental considerations were discussed, drawn from: Merleau-Ponty's (1962) term 'embodied experience'; Gibson's (1962, 1966) term 'active and passive touch'; and, Mark's (2004) term 'haptic visuality.' Based on the theory of haptic perception, active or haptic touch in this study is defined as moving a hand over a stimulus object consciously or unconsciously, thus affecting and enhancing compound emotions. Conversely, passive touch was defined as moving a stimulus object over stationary hands consciously or unconsciously, thus affecting and enhancing a single emotion.

8.3 The research aim, objectives, and questions

The main aim of the haptic experiment — in terms of the phenomenological way women touch the conceptual prototypes, the connection with affective emotion, and the integration of senses and perception — was to investigate the comfort factors of users' 'feeling good or bad,' which could then provide design principles for clothing. In particular, the research explored women's perception and experience of haptics and was undertaken to research in the following the three contexts of EAI

framework: doing through feeling; feeling through touching; and seeing through touching.

Doing through feeling and feeling through doing as kinaesthetic sense refers to hand function and performance on an aesthetic level of experience. The research examined the performance of hand movements and resulting affective responses through in-depth observation, based on the following questions:

- How do women touch and move to feel?
- How do they touch each conceptual prototype (Trans-For-M-otion, Touch me, Feel me, Play with me, Jigsaw-Puzzle, and Disguise Garment) to feel through different touches (active and passive) and movements?
- How do unconscious and unintentional movements influence affective states, such as users' degree of comfort when they are 'feeling good,' and of discomfort when they are 'feeling bad'?

Feeling through touching refers to an emotional understanding of comfort and the evocation of emotion by movement and manipulation of an object. This refers to what a person does with an object and how they interpret their feelings. In particular, the set of experiments aimed to investigate the following research questions:

- Can the touch of women's hands be related to the body parts being emotionally touched? If so,
- How can an actual body part be felt and touched emotionally?

Seeing through touching describes the multisensory nature of experience, wherein touch is integrated with other senses. The investigation of seeing through touching set out to answer the following research questions:

- How does what women touch affect what they see?
- How do they integrate the experience of touch into their perceived images in their head when blindfolded as compared to when they are not blindfolded?

- What do they feel, say and imagine while they are interacting with the four conceptual prototypes in two sets of conditions — blindfolded and non-blindfolded?

From this perspective, I have conducted further research to consider what actual part of the body is being touched emotionally, perceptually, and psychologically.

Based on the three contexts of doing through feeling, feeling through doing; feeling through touching; and seeing through touching, the main objectives were:

- To explore the forms of touching behaviour, such as active and passive touch, in order to examine interrelationships between touch, action and emotion;
- To explore the differences in feelings of touch through words and evoked image perceptions with and without blindfold, through interaction with the four conceptual prototypes described in Chapter 7.

The first qualitative phase of the investigation was focused on the evaluation of haptic experiences in the context of the various qualities of the target prototypes. The second quantitative phase of the investigation used the Semantic Differential (SD) test to analyse the relationship between design attributes and users' perceptions.

8.4 Method: overview

As mentioned there were two phases:

Phase (I) was a qualitative analysis of material gathered from interviews and in-depth observations. As described in Section 8.3, the aim of the experiment was to explore and investigate the three contexts of haptic experience: doing through feeling, feeling through touching, and seeing through touching. The haptic experiment was set up by comparing blindfolded and non-blindfolded touch, and active and passive touch. The whole experiment with participants was videotaped. Participants did blindfold first, then non-blindfold. For example, their blindfolded behaviour was observed and recorded using the following procedure:

1. Participants were asked to close their eyes;
2. Participants were asked to touch each conceptual prototype freely;
3. Participants were asked to say out loud what they were feeling while touching them;
4. Participants were asked to verbalise what they imagined while touching the prototypes.

Qualitative methods, such as the evaluation of the relationship between words, perceived images, and hand and bodily movements, were used to analyse data in a descriptive way while participants touched the four conceptual prototypes. The open-ended questionnaires were based on the four prototypes, and questions included participants' words for describing their instinctive impression of the four conceptual prototypes (see Figure 8.3). Adjectival words, phrases and perceived images were collected while participants touched the conceptual prototypes under two conditions: (a) the touched surface was invisible to the subject; or (b) it was visible. The idea was to collect a set of words capable of describing any possible perception about a specific prototype's properties. The most important thing when carrying out the haptic experiments was not to test an object, but to build an understanding of how the nature of interaction was experienced in use.

Phase II evaluated haptic experiences and various qualities of the target prototypes obtained from Phase I. Phase II used the Semantic Differential (SD) test (Osgood et al., 1957) as quantitative analysis to explore the relationships between design attributes and users' perceptions. Employing a self-report method, participants were asked to rank each conceptual prototype on a seven-point scale to evaluate their haptic experience.

8.4.1 The research technique

The focus of this haptic experiment was to investigate how people feel through touch and movement and identify the artefacts that trigger and mediate emotional responses through dynamic bodily experiences expressed as behaviour and feelings. Kansei Engineering proved to be an effective tool in this research, as it provided an understanding of both aesthetic aspects of behaviour and feelings, because it is a

design approach aimed at capturing the participants' expected feelings (Kansei) when they perceive images and objects, and then embedding emotion into the conceptual prototypes. Kansei Engineering offers a method for translating consumers' psychological feeling and impressions about a product into perceptual design elements (Nagamachi, 2002). Kansei Engineering is also sometimes referred to as 'sensory engineering' or 'emotional usability.' This technique involves determining which sensory attributes elicit particular subjective responses from people, and then designing a product incorporating the attributes that elicit the desired responses (Nagamachi, 2002; Lévy et al., 2007).

To investigate the users' instinctual sense of feeling while interacting with the conceptual prototype garments, the Semantic Differential (SD) scale (Osgood, 1957) was employed. The SD scale was developed by Osgood to measure the emotional content of a word. Osgood called this method the 'Semantic Differential technique,' which became one of the foundations of Kansei Engineering (Schütte & Eklund, 2010). The SD scale (Osgood, 1968) was used to construct two antonymic axes of the key terms of the research, in this case, comfort and discomfort. However, it was difficult to find words having exactly opposite meanings. In fact, the word comfort/discomfort needs to be differently defined in each contextual case and can therefore not be used as an antonym for comfort in this type of scale (Zhang et al., 1996). For this reason, the haptic experimentation was conducted on the sense of touch and movement utilising a self-report method, that is, SD method (Osgood et al., 1957) using a seven-point scale to evaluate the subject's haptic experience. The Kansei word, for example, comfortable, was placed on top of the middle of the scale, while the two extremes were labelled 'not at all' (related to 'feeling bad') and 'very much' (related to 'feeling good'). This comparison delivers good data distribution, as proved by Schütte (2005) and Schütte and Eklund (2010). Seven-point or five-point scales are foundational methods used by Kansei Engineering for ranking products, when asking people to record their impressions of a product in terms of each adjectival word; an odd number allows for a neutral response, for example, 0 on a scale from −2 to +2 or −3 to +3). The reason I chose the seven-point scale is that it allows more sensitive and reliable ratings than the five-point rating scale. With the five-point rating scale, distribution of the data is difficult to determine and the

experiences are too narrow, in particular when a neutral point is located in the middle (Schütte & Eklund, 2010).

Not at all	Comfortable						Very much
	−3	−2	−1	0	+1	+2	+3	

Table 8. 1. Seven-point rating scale used for semantic evaluation in the experiment in this study. The scale ranged between -3 and 3 (-3, subject totally disagrees with the affirmation, 'feeling bad'; 3, subject totally agrees, 'feeling good,' and 0, subject neither agrees nor disagrees).

Accordingly, in this research, the subjective emotional information about the effect on user's haptic perception of interacting with the four conceptual prototypes was based on an overall assessment of four qualities — *functional*, *aesthetic*, *mood evoked*, and *enjoyment* — using a seven-point rating scale. The analysis was performed using a program called SAS (version 9.1). An Analysis of Variance (ANOVA) for repeated measures was used to analyse the different qualities. The 'repeated measures' type of analysis was performed in order to take into account the correlations in the data due to the multiple assessments made by each participant. The analysis was implemented using a random effects regression model with the SAS statistical software program. The results of the data will be presented in Section 8.5.2.

8.4.2 Participants

The haptic experiment were evaluated through interviews and in-depth observation of the fifteen female participants who came from different races (Australian, Indian, Namibian, Japanese, Dutch, Chinese, Bosnia, South African, and English) and educational backgrounds, from college to graduate school (Interior Architecture, Urban Regional Planning, Psychology, Art, Fashion, and Communication and Cultural Studies), and were of ages ranging from 20 to 40 years. They were given AU$ 50 gift vouchers to cover travel expenses. All subjects gave their informed consent to participate one week before the experimentation.

8.4.3 Stimuli: Experimental samplings

As described in Chapter 7, the experimental samples of the four conceptual prototypes (Trans-For-M-otion; Touch me, Feel me, Play with me; Jigsaw Puzzle; and Disguise Garment) were used to observe haptic sense, perception, experience, and bodily expression in the participants, under controlled conditions. These four prototypes were designed to elicit tactile, bodily movement as emotional responses from the participants. The prototypes (see Figures 8.1 and 8.2) were used in particular for evaluating essential components of garments in a projected design strategy, namely:

- Shape variations, from three-dimensional, irregular polygonal surfaces on the outside to regular, circle-like surfaces inside rectangles, so that when the garment is fabricated it has geometric pockets on the reverse side;
- Texture variations from roughness to softness, due to variations in shape;
- Size variations;
- Weight variations, from 400g to 680g; and
- Variations in the properties of garments, according to different interactional styles: emotional, sensorial, cognitive, and functional affordances (see Chapter 7); this was the primary, holistic evaluation which the research aimed to elicit from the observations.

The four conceptual prototypes have been described in detail in Chapter 7. To recap, the main styles of their interactions with the subjects are summarised below:

- Trans-For-M-otion: the garment allows people to afford, and be adaptable to, constantly changing moods and emotions, particularly in places where women experience discomfort (emotional affordance);
- Touch me, Feel me, Play with me: the garment invites people to touch, move and feel for their comfort (sensorial affordance);
- Jigsaw-Puzzle: the garment allows people to be functionally and emotionally adaptable when making their own stories through bodily interaction in everyday activities that lead to dynamic interaction possibilities (functional affordance);

- Disguise Garment: the garment stimulates emotional resonance, by which women are able to recall their nostalgic memories (cognitive affordance).

Figures 8.1 and 8.2 explain in more detail properties of the four conceptual prototypes: (a) Trans-For-M-otion, (b) Touch me, Feel me, Play with me, (c) Jigsaw-Puzzle, and (d) Disguise Garment.

a. Trans-For-M-otion

b. Touch me, Feel me, Play with me

Figure 8. 1. Garment's unit structure: (a) Trans-For-M-otion — the left-hand image replicates a three-dimensional, geometric structure; the middle one shows flower-shaped pockets on the reverse side; and the right-hand image depicts when it is folded; (b) Touch me, Feel me, Play with me — the left-hand image shows the fabrication of irregular convexities and concavities, polygonal shapes on one side of the surface; the middle image shows geometric-shaped pockets on the reverse side; and the right-hand image shows the garment when it is folded.
Source: design and photo by the author.

b. Jigsaw-Puzzle

c. Disguise-Garment

Figure 8. 2. The garment's unit structure: (c) Jigsaw-Puzzle shows how the garment combines a sheet of the rectangular felt, replicating three-dimensional unit components. The same principle applies as to Trans-For-M-otion's geometric convexities and concavities, but these are of a different size, colour, and weight, presumably attributable to different properties when people look and touch; (d) Disguise Garment is one of the Trans-For-M-otion series. It is the same structure as Trans-For-M-otion, but is embedded with LED lights.

Source: design and photo by the author.

8.4.4 Procedure

The study took place in the Motion Capture Lab at the School of Physiotherapy, Curtin University. The researcher and participants were standing at a table and all prototypes were placed on the table.

The experimental protocol, shown in Figure 8.3, was explained to participants as follows:

1. Four samplings (conceptual prototypes) were covered by a white sheet and were set up on the table.
2. Each participant was blindfolded and required to touch each prototype by hand for five minutes. She was then asked to say aloud her subjective feeling/sensation, using adjectival, emotional words, and to imagine she was perceiving a mental visual object while touching each conceptual prototype.
3. Each participant was required to open her eyes and then asked to say aloud her subjective feeling/sensation, using adjectival, emotional words, and to imagine she was perceiving images while touching each conceptual prototype.
4. Each participant was asked to freely wrap around her body each prototype.
5. Each participant was asked to complete an open-ended questionnaire, expressing her impressions of the prototypes.
6. Each participant was asked to rank the comfort level of the conceptual prototypes, following the seven-point scale (see Table 8.1) in order to describe the various qualities of the conceptual prototypes and give an overall assessment with and without a blindfold.

Figure 8. 3. Setup and procedure to assess tactile perception in the participant observation study.
Source: photo by author.

All experiments were videotaped. During the procedure, detailed notes were made about the participants' behaviour and verbal responses in describing the properties of each object. The experiment took approximately 40 minutes for each subject. In total, collection of data was carried out from November 2009 to March 2010, and analysis of data was carried out over a period of four months from July to November 2010.

8.5 Findings and evaluation

8.5.1 Phase I: qualitative haptic analysis

8.5.1.1 Doing through feeling: how they move to feel (1)

The observation started by identifying and evaluating the way the sample group of women touched a series of objects, and the emotions aroused when each object was touched, stimulating sensory experiences. There were two phases of the haptic experimentation when these observations were made, that is, first, when participants were blindfolded, then when they were not blindfolded. The primary research questions were: how do women touch and move to feel? How do different touches (both active and passive) and movements feel? And how do unconscious and unintentional movements influence affective states, such as the degree of comfort experienced when users 'feel good,' compared to the degree of discomfort they experience when they 'feel bad'?

Salient characteristics were analysed in terms of two typical features: active touch and passive touch. As mentioned earlier, in the exploratory study, active and passive touch were used to categorise the participants' hand movements and their association with emotion. Active touch, in this study, is defined as moving a hand over an object (conceptual prototype) consciously or unconsciously, which affects enhanced, compound emotions. Conversely, passive touch is defined as moving an object over stationary hands consciously or unconsciously, which affects enhanced, single emotions. Passive touch is also defined as whether or not participants' active hand touches were related to the body part being emotionally touched, which may contribute to the overall impression of 'feeling good or bad.'

As shown in Figure 8.4, I observed both active and passive touches during the interview and observation process in both blindfolded and non-blindfold conditions. Participants moved their hands freely and unconsciously without a particular purpose, such as rubbing a cuff of a sweater, or rolling the fabricated units of the conceptual prototype. This non-functional movement seemed to influence positive affective states, that is, 'feeling good.' As an example of active touch, a couple of participants were observed playing with the object during the interview. They manipulated it with their hands unconsciously, using such methods as rolling, wrapping, grabbing, pressing, and fumbling.

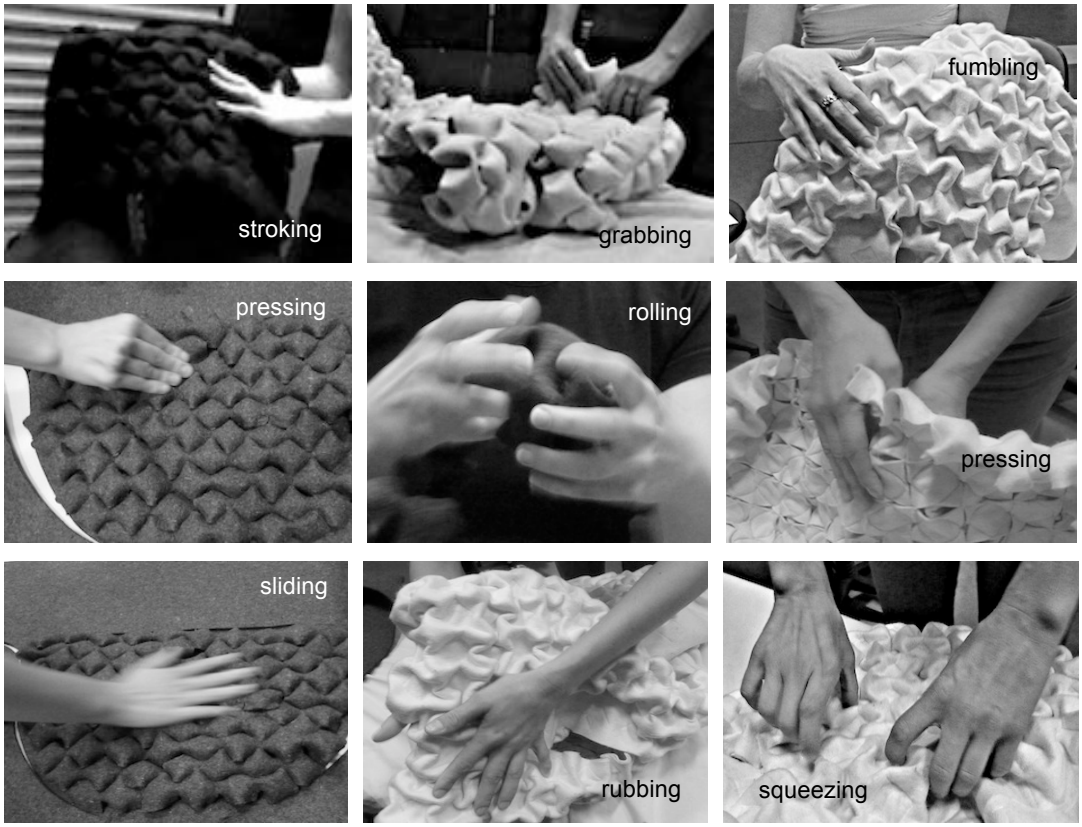


Figure 8. 4. Categories of modes of movement: fifteen participants were observed for dynamic touches: comfort based on softness, vibrations, warmth, and heaviness were associated with the touch feelings of sliding, stroking, grabbing, pressing, rolling, rubbing, fumbling and squeezing.
Source: design and photo by the author.

These gestures were identified and observed when reviewed in the video recording. The women didn't seem to know their hands were constantly playing with the object during the observation and interview. Interestingly, their active hand touch and movements when interacting with the object were in response to some in-depth

interview questions that required some time to answer in order to explain their experiences as described in Chapter 6. The more they concentrated on recalling their experiences about happiness and fear, the more actively they played with the object. This specific character of 'playfulness' seemed to make participants calm, and soothing their state of discomfort, anger or annoyance, or to aid concentration, for example, when focusing on interview questions. Such unconscious movements seemed to be of the nature of habitual and thoughtless touch, because participants did not consciously know about their hand movements. This aspect could be related to Merleau-Ponty's (1962) statement — that every perceptual habit (read skill) is related to a motor habit. The noted gestures, such as striking, rubbing, grabbing, pressing, and fumbling, were related to everyday actions. In the experiment, it became apparent that such habitual and thoughtless movements could assist people to evoke positive emotions that modified their negative affective states and changed them into positive emotions, moods, or sentiments. From these observations, it is concluded that the way the touching process is used in everyday life, in habitual and thoughtless gestures, can activate the state of 'feeling good.' Therefore, designers should give greater consideration to what seems a central feature of the touching process as it occurs in everyday life, and which can be fruitfully employed in the interactive design process.

8.5.1.2 Doing through feeling: forms of movement and related emotional effects (2)

I observed that participants' hands made dynamic movements in order to make the touch evaluation of an object's properties when they were blindfolded. Thus, the roughness or softness of a material's substance is registered when forces are exerted on it by the hand. I found that active and passive touch by the hands were linked with perception and emotional effects. The results suggest that experiences of bodily sensations were related to the specific type of movements: active touch, such as stroking, squeezing, rubbing, and lifting; passive touch, such as sliding, pressing, and fumbling. Figure 8.4 and Table 8.2 show that most of the participants easily experienced passive touch, such as sliding, pressing, and fumbling. However, when the participants exerted active touch, such as stroking, squeezing, pressing, and lifting, they seemed to engage in more sensory experiences. As highlighted in Section 8.5.1.1, active touch, in this study, is defined as moving a hand over an

object (conceptual prototype) consciously or unconsciously, which affects enhanced and compound emotions. Conversely, passive touch is defined as moving an object over stationary hands consciously or unconsciously, which affects enhanced, single emotions. This observation is based on the fact that participants responded to conceptual prototypes with various emotional words, for example, sincere, calm, excited, fearful, and perceived images, for example, 'sponge,' 'cloud' etc. In particular, active touch, such as the movement of squeezing (see Figure 8.4 and Table 8.2), when the five fingers of the hand compress the surface (detected texture) of a conceptual prototype, indicates the strongest bodily sensory-tactile experience for 'feeling good' while also, paradoxically, 'feeling bad.'

Examples of movement (touch isolated from vision)		Example of interaction	Possible benefits and effects
Active touch	*stroking*		'I am not only feeling sincere and excited but also fearful at the same time.'
	squeezing		'It is an interesting but scared sensation and I am strangely enjoying it.'
	rubbing		'Makes me feel calm and unique.' 'It feels obscure but protective so I am interested.'
	lifting		'It feels light and the textile invites me to keep touching so I am having fun with playing with it.'
Passive touch	*sliding*		'It is striking, up and down sliding which makes me calm.'
	pressing		'It feels really smooth but it has a bumpy surface to touch.'
	fumbling		'It is confusing and jumbled.' 'I love to touch it. It is something like a cloud or sponge, which make me feel very easy and comfortable.'

Table 8. 2. Active and passive touch, the possible benefits and effects in a blindfolded state. Source: design and photo by the author.

In one example, a participant described her feelings during interaction with the conceptual prototypes as follows:

> …I liked to interact with all pieces of the object (particularly, the object Touch me, Feel me, Play with me) eliciting a different level of 'feeling good or bad.' I became addicted by playing with them, like squeezing, or pressing, stroking...Strangely, feeling fun, relaxed, calm, interested, and fearful.

This result was presumably due to interacting with the object through being in contact with it, first with the whole palm (including the web of the fingers), then in dynamic movements (involving the joints of the finger, wrist, elbow, and shoulder). Free, active touch seemed to influence a dynamic changing pattern of pressures on the skin, causing subtle shape changes. This can be interpreted as being like a lovers' clasp, which locks and moves the fingers together. In other words, stimulation through the dynamic pressure on the skin between the five fingers may stimulate more enhanced positive, negative, or compound emotions, for example, pleasantness, calm, fear, and comfort. Gibson (1962) studied the tactile form of perception by comparing active and passive touch for twenty subjects. Active touch was defined as when the form was held above the palm and explored by the fingertips, while passive touch was compared when the form was pressed into the palm of the hand. Although Gibson referred to a tradition of experiments on cutaneous localisation, whereby 'fingertips are more "sensitive" than the palm of the hand, meaning that localization is better' (p. 487), he concluded that tactile forms of perception in active touch do not depend on the pattern of skin contact. Rather, these forms of perception depend on the hand in connection with bodily dynamic movements (involving the joints of the finger, wrist, elbow, and shoulder) that stimulate 'a change pattern of pressure' (p. 487). So, it could be said then that tactile (haptic) perception takes place not only through skin contact, but when people touch in conjunction with movement to feel. These aspects will be explained in more detail in Section 8.5.1.4.

A further interesting observation from this phase of the study is that participants who have cold hands seem to have a greater sense of tactile perception and experience, such as 'feeling good' or 'feeling bad.' For example, four out of fifteen participants, who responded that they had cold hands and feet (something I checked after the

experiments), identified these enhanced experiences, as compared to the others who did not, when the video recording was reviewed. They were observed with such characteristic hand movements as lacing fingers, kneading hands, clenching and opening fists continuously in unconscious behaviour. The participants with cold hands responded very actively with their hand movements and expressed various feelings in both the blindfolded and non-blindfolded phases of the experimentation, as compared with other participants who seemed to have warm hands. This finding can be compared to a similar study. R.H. Gibson and A. Sztepa (unpublished study, cited in Taylor et al., 1973), in their experiment in sensory psychology, observing tactile perception of roughness, reported that there was a substantial difference between warm hands on a warm textured surface and cold hands on a cold textured surface. For example:

> …the subject of a perceived roughness function is not influenced by the temperature (within 10°C of room temperature) of the textured surface. With a warm hand on a warm textured surface, the whole function was the same as that found with stimuli and hands at normal room temperature. However, when the stimuli and hands were cooled 10°C, the function was substantially lowered with no change in the subject. (p. 260)

Just as Gibson and Sztepa found, the subject's response to a perceived roughness function was different for a cold hand on a cold textured surface, so it seems likely that the participants with cold hands responded with more sensitive feelings and emotions than did participants with warm hands. The fact that human body temperature varies from 27.3 to 31. 95 C means there is a high concentration of temperature receptors in the hands and feet compared with the rest of the body. In fact, when vasoconstriction occurs as a result of exposure to cold, blood flow to the hands or legs is drastically reduced and so the hand cools quickly. In these situations human body comfort decreases, manual dexterity is affected, visual attention is reduced, the human body posture becomes unstable, and the range and limits of tiredness increase (Arens & Zhang, 2006). Blood is the main source of heat input into the hands and legs. This means that, from a design point of view, if an object fits into the hands nicely and comfortably to play with, the object enables the body to increase blood flow circulation so that there is a warming and calming effect.

8.5.1.3 Feeling though touching: how participants feel through touch and the body part being touched

The set of experiment was designed to determine whether or not participants' active hand touches were related to the body part being emotionally touched — defined as passive touch — which may contribute to the overall impression of 'feeling good or bad.' In order to do the experiment, the participants were asked to wear a black top and leggings, which indicated that their body could not feel the stimulus object because of indirect skin contact, while their hands were able to feel the conceptual prototypes directly.

Table 8.3 shows a sample range of visual representations of the movement sequences that were extracted from the video footage and photo documentation of a participant manipulating the conceptual prototype in an improvisational way. When the participant was required to improvise and freely interact with, for example, the conceptual prototype Touch me, Feel me, Play with me, her bodily position, for example, of fingers, hands, arm, head, shoulders and so on, and her bodily movements were observed to change in a typical manner, but not stereotypically, or occurring in any fixed sequence, as follows:

	(a) She curled her fingers around the conceptual prototype Touch me, Feel me, Play with me's surface. Her shoulders moved downwards, her arms were slightly lifted, and she tried to fit all her fingers into the cavities.
	(b) She moved her fingers in a way so that she could press it using both hands.
	(c) She lifted it closer to her neck and mouth, as if to smell it and feel it with her neck area.

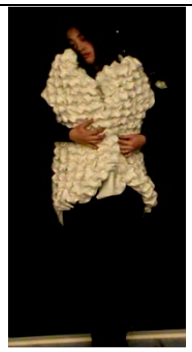
	(d) She wrapped it around her face and torso area with a range of movements, for example, pressing, squeezing, rubbing, and stroking.
	(e) She actively squeezed it in a gentle to aggressive way as if to express her emotional condition, for example, discomfort and anger. In fact, as she pressed and moved, her fingertips were forcefully squashing the fabric inwards and sideways.
	(f) She actively played with Touch me, Feel me, Play with me as if to play hide-and-seek and to find a way to be emotionally at ease. She also tried to intellectually engage with the prototype to figure out two holes.
	(g) She put her arms into two holes and wrapped it around her like a coat. She bent her knees. She glided her fingers over the surface, which seemed to include lateral force due to friction between her fingertips and the surface.
	(h) She turned Touch me, Feel me, Play with me in a clockwise rotation. She bent her right knee and her left leg was bent to take a step forward. Simultaneously, her fingers continuously slid, stroked, pressed and squeezed the conceptual prototype while making contact with its surface on her stomach and chest area. She tried the dress on and it fitted.
	(i) She used her right fingers (in particular her thumb, forefingers and palm) to pull up the collar of the prototype, which came to the front, and her left fingers were located under the right collar of the prototype. She wrapped it around her comfortably and kept squeezing it gently.

Table 8. 3. The process of emotional manipulation, observed in the participant's dynamic bodily movements and the hands and body's sense of touch in relationship with the conceptual prototype, Touch me, Feel me, Play with me.
Source: design and photo by the author.

As can be seen in Table 8.3, observation of a participant interacting with the conceptual prototype, Touch me, Feel me, Play with me shows that she used her hands and bodily movements to touch the prototype actively. In this experiment I sought to decouple active hand touch from the body being touched passively. Interestingly, the results of this work reveal that her body seemed to feel the prototype passively. When she ran her fingers over the protuberances of the conceptual prototype, the rotation of the joints (body posture) appeared to be combined with her hand movements. In other words, the process of obtaining a sense of hand touch was coordinated with her body movements. To put this in a similar context, Gibson (1962, p. 483) contends that:

> Evidently three anatomically different receptive systems, two in the skin and one in the joints, can be functionally equivalent for the experience of objective motion when they are passively stimulated by an external agency.

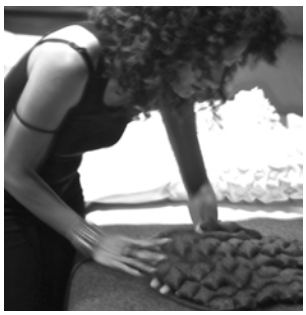
Accordingly, the results from observing the participants' movements suggest that hand function is the primary sense detector, indicating how much people rely on their hand function to feel and evaluate various emotions, consciously or unconsciously. In other words, the study found that hand movements were the primary pathway to pass connecting feelings on to her whole body.

8.5.1.4 Seeing through touching: what participants feel, say and imagine (1)

The haptic experimentation was also further used to determine whether the hands doing the touching are related to the body part being perceptually touched, which may contribute to the overall impression of 'feeling good or bad.' The observations were made when subjects were blindfolded first, then when they were not blindfolded. In the study of haptic experience in the context of what people feel, say, and imagine, one thing that was immediately obvious was that participants were intrigued by the objects (conceptual prototypes), in particular when they were not allowed to see them while they were touching them. One of the participants responded by saying 'I am scared and fearful to touch while blindfolded. Do I have to touch?' 'What is it?' They expressed an emotional response quite quickly in a blindfolded condition. As soon as they started touching each conceptual prototype,

they immediately expressed their feelings using emotional words. At the same time, they also described certain visualised images while touching. Below are some examples of responses comparing tactile experiences in both blindfolded and non-blindfolded conditions:

Subject	**How they move**	**What they feel, say, and imagine while touching**
Participant (G)	 Participants' hands touch articulation	Touch me, Feel me, Play with me: I am very surprised[1] by texture[2] in a blindfolded condition. It feels like a 'ripple in water'[3] so it reminds me of beach and sand. It is soft, with strangeness, which makes me feel mysterious and comfortable. In addition, I am very surprised by the actual shape and form in a non-blindfolded condition. In particular, the opposite side of the object is totally different than I expected. It is more structured and detailed. It looks beautiful but less comfortable to touch. I felt it to be very smooth in a blindfolded condition.
Participant (T)	   	Trans-For-M-otion**:** In a blindfolded condition, there is a sensation of something in this piece that is an unfamiliar exploration. It is really intriguing in terms of texture. It feels rough. It feels like I am touching animal skin like an armadillo. However, it takes away from my curiosity in a non-blindfolded condition. It is not as strong a sensual feeling in a non-blindfolded condition. Touch me, Feel me,Play with me: it is intriguing and the form seems to be easier to define, and to follow the texture in a blindfolded condition. Loved the inside texture… it feels like 'grass' which enhances a very calming effect… when striking in a blindfolded condition. Conversely, it makes me feel a certain level of positive surprise because, initially, I perceived the 'grass' texture as stitches. It looks much rougher in a non-blindfolded condition. Looks rougher but feels smooth. Jigsaw- Puzzle: It was very smooth, feels like a 'female body' in a blindfolded condition. But I am surprised that I was not expecting the straight line, which I felt like a curve in a non-blindfolded condition.

Participant (V)	 	Trans-For-M-otion**:** It also makes me feel surprised by the texture, which feels like a mattress but has fluidity like a 'snake' in a non-blindfolded condition. Touch me, Feel me, Play with me: I love to feel, to touch in a non-blindfolded condition. It is something like a 'cloud' or 'sponge,' which makes me feel very easy and comfortable. I also think that comfort and pleasure come together. Jigsaw- Puzzle: It makes me feel calm because of being soft like a 'sheep's skin hair' in a blindfolded condition.
Participant (M)	   	Trans-For-M-otion**:** the piece felt funny, humorous, comfortable, and playful and it feels like a 'military jacket of Australia' because of feeling heavy in a non-blindfolded condition. Comparably, some anticipatory dread, as I don't really like to look at the piece in a non-blindfolded condition. Touch me, Feel me, Play with me: It is soft but I am slightly perplexed as the piece felt complicated in a blindfolded condition but I felt some excitement, as I find the piece is beautiful in a non-blindfolded condition. Jigsaw-Puzzle: …feels serious, as the piece felt flat and …it does not look fun, neither blindfolded nor non-blindfolded. Disguise garment**:** it is intriguing and entrancing in the light. When the light is on, I didn't want to interact, I just wanted to look at the light. It evoked childhood, nostalgia associated with 'Christmas.'

[1]The emotional words are represented by single underlining when a participant described her feelings while touching stimuli. [2]Properties of design elements are in lighter print. [3]Words, which are highlighted in grey indicate how participants imagined an object as a perceived image when they touched stimuli.

Table 8. 4. Participants' responses to what they feel through touch and what they see through touch.

Source: design and photo by the author.

The quotations in Table 8.4 describe participants' responses to the haptic experience in the contexts of what they feel, say, and imagine. Most of the participants responded that, in a blindfolded condition, they felt more sensuous qualities that led to mixed emotions, from negative feelings of being scared and afraid, to positive emotional responses for example, exciting, interesting, calming and soothing. For instance, a participant responded to her tactile experience in the blindfolded and non-blindfolded condition as follows:

> …when touching an object with closed eyes, all objects felt intriguing, comfortable, and playful which made me feel pleasant, calm and had a soothing effect. Conversely in a non-blindfolded condition, I didn't like to touch some of the objects for example, conceptual prototypes Trans-For-M-otion and Jigsaw-Puzzle, and there was anticipatory dread as I didn't even really like the look of the piece...

Thus, the haptic experience they had in both blindfolded and non-blindfolded conditions was an illusion and created imagined states, as if they were touching some kind of familiar object. Most of the participants described this in terms of the image evoked when they were touched. The results shows that surprisingly nine out of fifteen participants responded that the sense of touch when the sense of sight is shut off was a harmonious sensorial modality in a blindfolded condition. The result may pinpoint how physical touch and associated mental visual images could be interrelated in perceptual cognition. For example, when touching a conceptual prototype — Touch me, Feel me, Play with me — in a blindfolded condition, a participant felt like touching 'grass,' which elicited a calming and soothing effect, and significantly enhanced a state of 'feeling good' (soft = 'grass' = texture = calming/shooting/comfort). In a similar manner, another participant responded to the same conceptual prototype — Touch me, Feel me, Play with me — by suggesting it elicited a physical and mental comfortable state because it felt soft, like touching 'ripples in water' ('ripples in water'= soft = surface = 'feeling good'). This reminded her of being at the beach and of the sand. It seems to be related to tactile experiences of 'feeling good or bad.' A participant also responded that, when touching a conceptual prototype — Trans-For-M-otion — in a blindfolded condition, she felt pleasant and fearful simultaneously, as if she touched an animal skin ('armadillo'=

rough + pleasant + fearful = texture = unfamiliar/ interesting). The sensation of roughness evoked mixed emotions. In addition, a participant responded that when she touched the conceptual prototype Jigsaw-Puzzle, she had a feeling of softness which enhanced a positive emotion of calmness. She also imagined simultaneously that she was touching 'sheep's skin' ('sheep's skin'= soft = texture = calm). Surprisingly, some of the participants described their feelings as if they touched prototypes with their eyes open. For example, a participant felt softness when she touched a conceptual prototype — Touch me, Feel me, and Play with me and responded that she imagined the prototype felt like a creamy ivory colour, as it actually was. She might have a sense that the colour creamy ivory is soft.

Accordingly, the results from the participants' haptic perceptions and experiences indicate that sensory modalities were connected perceptually: what they touched affected what they saw. In addition, the results reveal that participants seemed to have their own perceptual images related to 'feeling good or bad.' For example, the tactile experience seemed to create an illusion, as if they touched some kind of a familiar object, which they described in terms of the image evoked ('ripples in water'= soft = surface = 'feeling good'). Its effect may be like being momentarily under the illusion that they were somewhere familiar or were touching a familiar object. This increased their state of comfort, although they didn't know what it was that they had touched. Their intuitive response in relation to the environments they are in, or past positive or negative experiences, seem to be reflected in the effects of the object on their tactile perceptions and experiences.

8.5.1.5 Seeing through touching: what participants' feel, say and imagine (2)

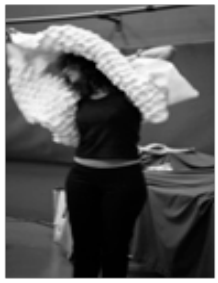
This is shown by the quotations in Table 8.4, describing participants' responses to the bodily experience in terms of what they feel, say, and imagine. In this context, participants responded with variations in emotional arousal. The four conceptual prototypes aroused the participants' emotions in response to the various design elements. These are summarised below:

- Trans-For-M-otion evoked compound emotions. One reason for this was that while wrapping it around their body, some participants felt physically

uncomfortable due to the heaviness of the design; but they also felt safe and protected.

- Touch me, Feel me, Play with me evoked variable feelings while participants were interacting with it in terms of confidence, elegance, glamour, showing off, warmth, protection, and safety and it also evoked a sense of self-worth. It evoked variable feelings, which influenced dynamic bodily movements, for example of arms, head, and upper body. Touch me, Feel me, Play with me invited participants' touches, for example squashing, pressing, striking, and rubbing, and welcomed their body comfortably. In the touching process, participants enjoyed physically playing with it and experienced and described calm, relaxed and soothing states.
- Jigsaw-Puzzle enabled exploration of so many possibilities in relation, not only to adapting the body to functional design ideas, for example transforming one form into another, but also in using their skills, which were put to the test in relation to emotions, for example happiness, comfort, and fear. In addition, Jigsaw-Puzzle enabled the participants to engage with the prototype with their imagination and intellect, due to the abstract and open structure.
- The Disguise Garment, embedded with LED light technology allowed them to laugh, smile, and have fun. It also enabled their body to be camouflaged by light and movement.

Table 8.5 explains this relationship in more detail:

Four conceptual prototypes	How participants move	What they feel and say when interacting with the prototypes
Trans-For-M-otion ‘	 	‘It was difficult to handle so was not very comfortable because of the fact that it was a bit heavy… however, strangely, because of being designed with heaviness, I felt my body was protected and safe.’ ‘It doesn’t fit well to body contours and was slippery so it was not comfortable.’
Touch me, Feel me, Play with me	   	‘When wrapped around me I felt comfortable like a blanket.’ ‘Different points of body contact from the concave and convex shape gave me full excitement as I felt the piece gave a beautiful sensation and it felt good to touch, wrap, and be safe.’ ‘It led me to touch and it moved my body.’ ‘It is soft, hard, squashing, squeezing, and resisting, so it is fun to touch and feel, good through touch.’ ‘It wraps comfortably around my body – is protective and is very glamorous and show offish.’ ‘I felt this piece gives reassurance …something to hide under.’ ‘I felt nice with this piece. In fact, it comforted me and made me feel safe. I became addicted to it by playing with it, like holding, pressing, squeezing, or fumbling.’ ‘This object led me to touch, and it welcomed my body. Strangely, I didn’t feel comfortable when I only touched. It looked quite interesting and felt soft... so, enhanced comfort on my body.’

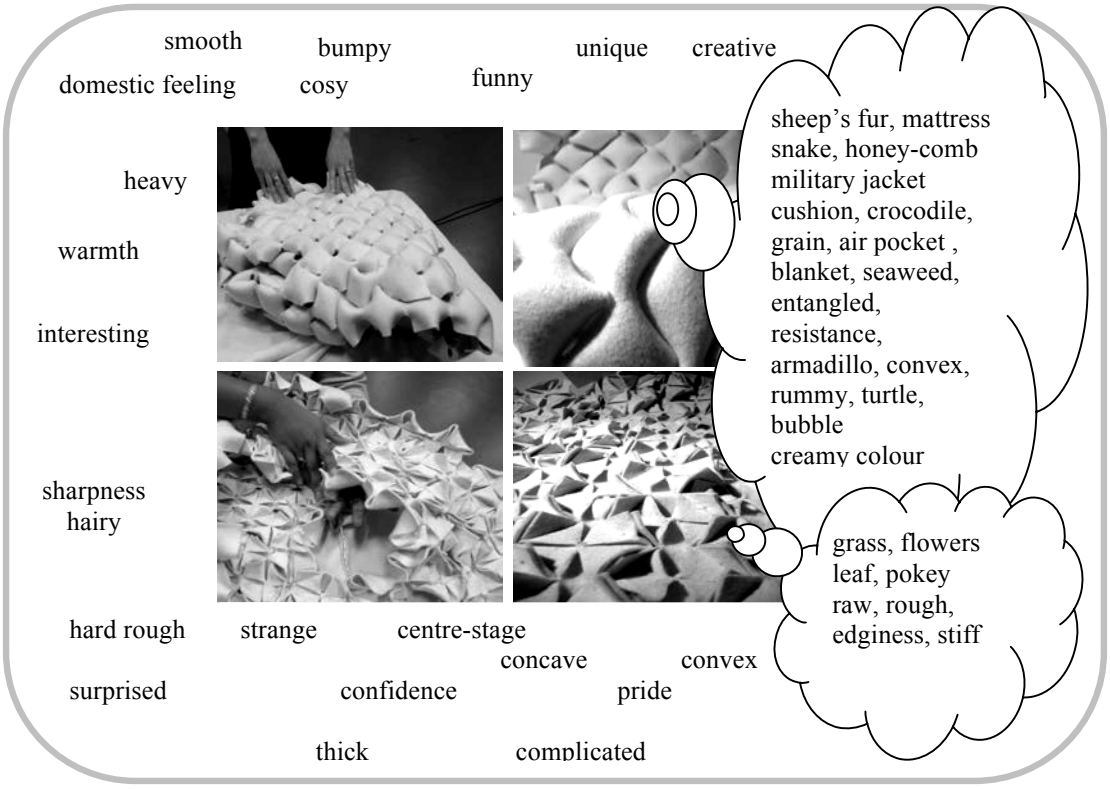
Jigsaw-Puzzle	   	'It is different than the others because during interaction it makes me more engaged like a puzzle, to find a way to wear it.' 'I feel it is unusual and unfamiliar.' 'I am enjoying interacting as it allows me to solve a problem.' 'It is intellectually engaging.' 'My problem-solving skills are put to the test as there are so many possibilities in relation to emotion (e.g. happiness and fear) and space (e.g. public and private), where I imagine if I was in there.' 'I like it more during the interaction.' 'It is playful.' 'I love the possibilities it offers and it is very arty, edgy, and functional.' 'I am feeling this object inviting my body. I am able to adjust the style until I find my body feels comfortable. In particular the piece of felt is good to support my back.'
Disguise Garment	 	'It makes me smile, have fun and is enjoyable because lights make it look like a lovely lizard on my body.' 'The piece of felt makes me feel pride, confidence and being on centre-stage.' 'It evoked warmth and closeness, due to recalling memories or images such as childhood, nostalgia, and playfulness...it also enabled my body figure to be camouflaged by light and light's movement.'

Table 8. 5. Participants' responses to what they feel through touch and what they see through touch while interacting with the four conceptual prototypes.
Source: design and photo by the author.

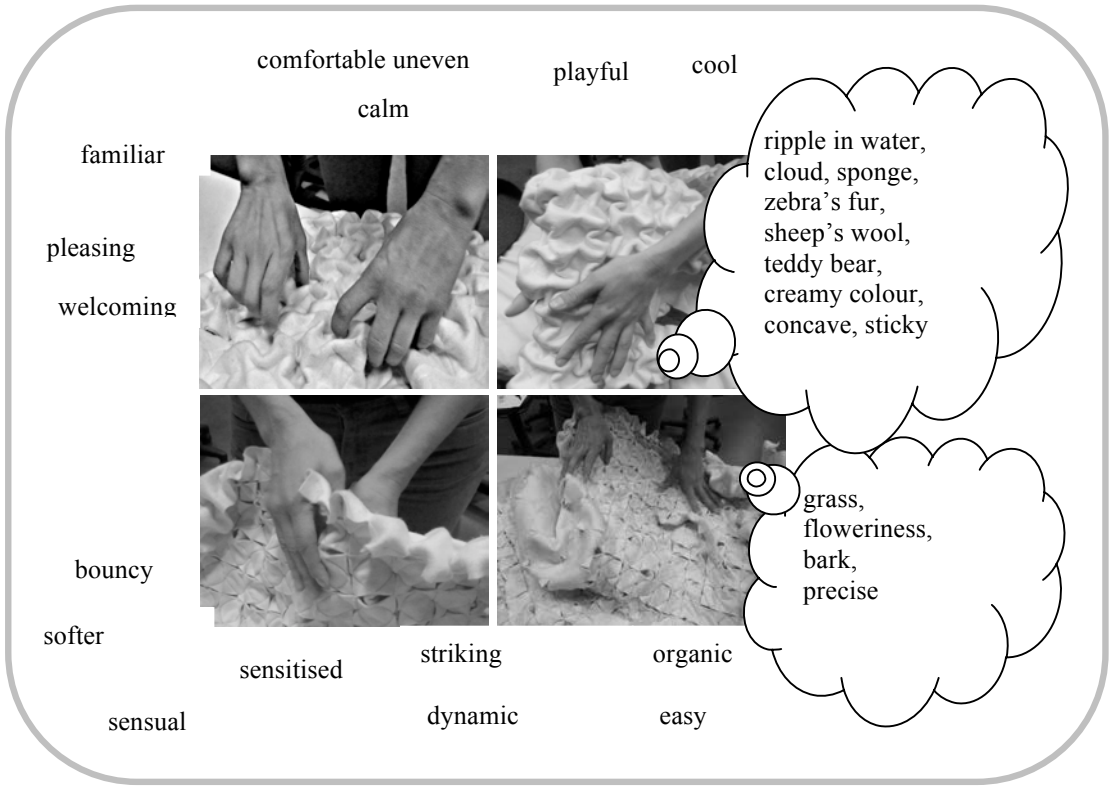
8.5.1.6 Collecting words from what participants feel, say and imagine

Figure 8.5 shows the emotional words collected while participants described how they felt about each conceptual prototype in a blindfolded condition. In Figure 8.5 (a) and (b), the cloud shape shows words collected from what participants perceived images to be while they interacted with each conceptual prototype.

In total, 53 emotional words and 41 nouns describing perceived images were collected from the fifteen participants, who touched and manipulated four different conceptual prototypes in two sets of conditions — blindfolded and non-blindfolded. Table 8.6 shows the emotional words and words involved in participants' perceived images obtained from the two sets of conditions. Words elicited from the participants' perceived images are printed lighter in Table 8.6. The results show that participants' responses to their tactile feelings and perceived images were much more variable in a blindfolded condition. Table 8.6 shows that 39 tactile adjectives and 29 (mostly) nouns of perceived images in a blindfolded condition were collected, while 26 tactile adjectives and 18 nouns of perceived images were collected in a non-blindfolded condition.

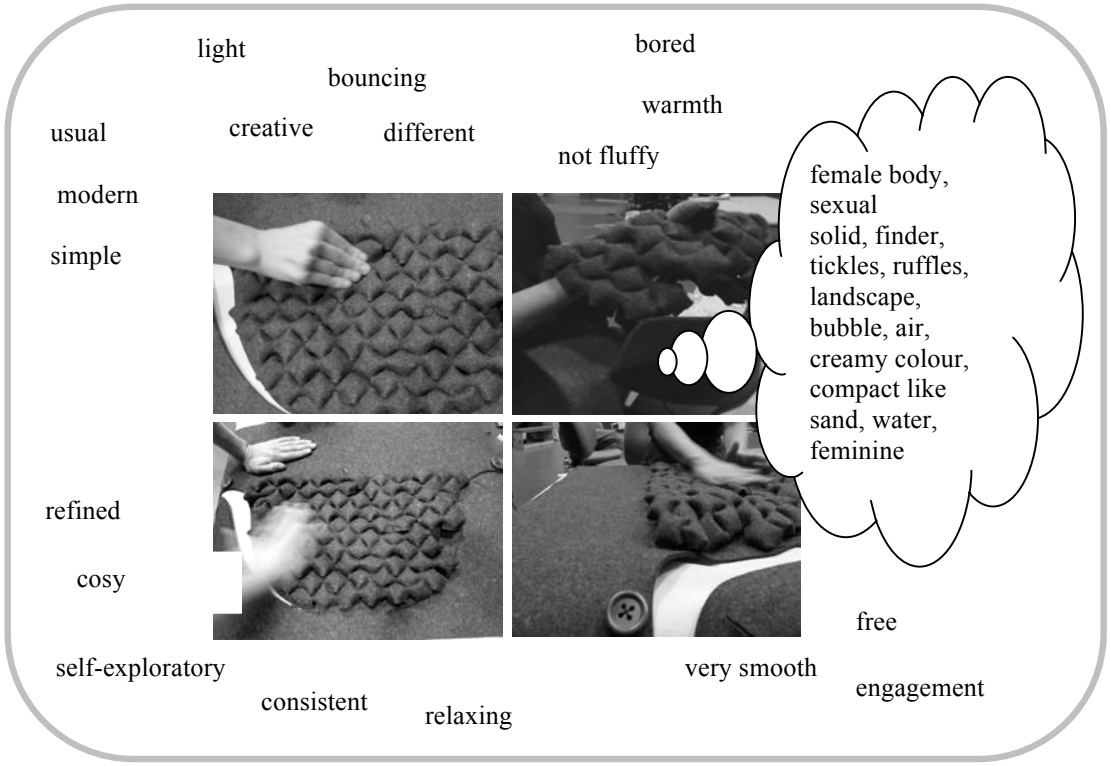


Trans-For-M-otion

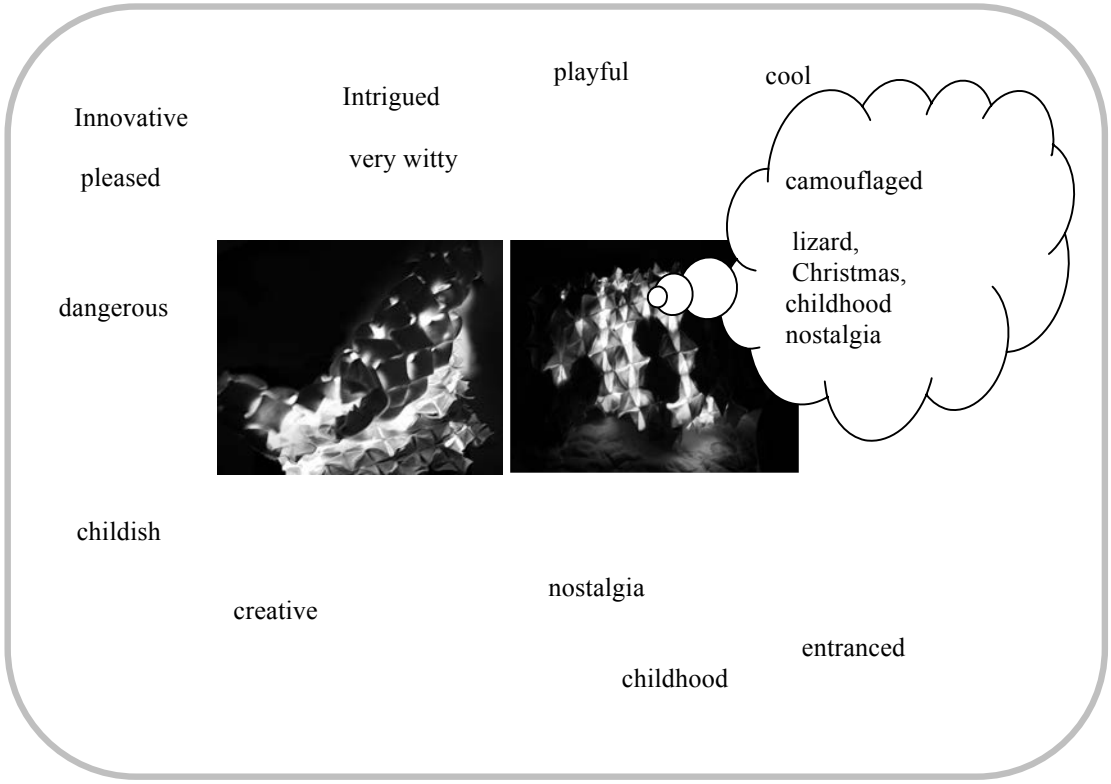


Touch me, Feel me, Play with me

Figure 8. 5. (a) Illustrating words in the context of tactile experience, expressing positive and negative feeling responses from the fifteen subjects in a blindfolded condition.



Jigsaw-Puzzle



Disguise Garment

Figure 8.5. (b) Words used in the context of tactile experience, expressing positive and negative feeling responses from the fifteen subjects in a blindfolded condition.

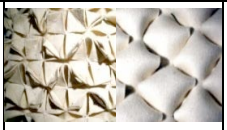
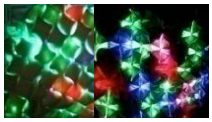
Type of condition	Trans-For-M-otion	Disguise Garment	Touch me, Feel me, Play with me	Jigsaw-Puzzle
	 one surface-reverse side surface			
Invisible condition (touch isolated from vision)	humorous, comfortable, playful, hard, rough, heavy, domestic feeling, intriguing, interesting, sharpness, hair, cosy, warmth, thick, complicated, funny, rocky wild, surprised (texture like a snake), convex, concave, mattress, soft like sheep, bumpy, military jacket, crocodile, armadillo, bubble, turtle, grass, pokey, edginess, stiff, creamy colour, seaweed	humorous, comfortable, playful, soft, warmth, heavy	playful, familiar, calm, slightly perplexed, soft + smooth + rough, pleasing, welcoming, bouncy, cool, active sensitised, sensual, bouncy, dynamic, striking, rippled in water, beach, sand, sponge, cloud, sheep's wool, teddy bear, creamy colour, very calming effect when striking, organic, bumpy	serious, light, very smooth, (like a female body) soft cushion, ruffles, heal, relaxing, cosy, not fluffy, consistent, free, warmth, refined, natural, easy female body, solid, water landscape, bubble, water, creamy colour, feminine
Visible condition (touch with vision)	anticipatory, dread, creative, rough, stiff, interesting, grass, flowers, pokey, edginess, stiff, honey-comb, air pocket	intrigued, very witty entranced, innovative, creative, childish, pleased, playful, cool, dangerous Christmas, lizard, childhood nostalgia,	excitement, beautiful texture, shape, resist, soft+ mood, squash, organic, unique bark, grass, floweriness, concave, convex, protuberances, precise	serious, board, unique, different, creative, modern, simple compact like sand
Interaction with body 	enjoyed, problem solved, intellectually engaging, strange, sensation, unfamiliar, unique, creative, uncomfortable,	protecting, pride, confidence, unique, centre-stage, self-assurance, camouflaged	safe, comfortable, a blanket, something to hide under when in danger, self-contained, reassurance, show-offish, very glamorous, elegant, romantic	strangely enjoyed, problem-solving skills, stylised, practical like puzzle, unique adjustable (adjust it to different moods & environment), showy, different, unusual, creative, engagement, abstract, self-explanatory, uncomfortable, for not-determined function, loved the possibilities it offered, arty, edgy

Table 8. 6. Emotional words in the context of 'feeling good or bad' responses from the fifteen subjects while experiencing tactile blindfolded and non-blindfolded conditions.

8.5.1.7 Feedback on the properties of balance and harmony in the haptic aesthetics of interaction

The participant observations and interviewing process yielded interesting feedback on the aesthetic qualities of balance and harmony that emerged in the haptic process of interaction with prototypes, particularly in a blindfolded condition. These qualities were evoked in the complex experiences of feeling strange and intrigued, unfamiliar and curious, heaviness and safety, calmness with warmth and touching softness and positive roughness. Thus, the results indicate that affective states related to the haptic experience of 'feeling good' were influenced by how participants perceived their tactile experiences of active or passive touch, and visible or invisible touch, in relation to various material attributes of the prototype, such as texture, surface, weight, pattern, and shape. Free, active touch when blindfolded, such as grabbing, squeezing, and palpating, stimulated much stronger sensuous responses, which led to compound emotions. This was because this free, active touching involved a dynamic changing pattern of pressures on the skin surfaces, which in turn provide an important pathway for feelings to connect with the whole body. In addition, many of the participants mentioned that, when blindfolded, 'feeling good' responses were caused mostly by texture, for example, softness, warmth, dynamic surface while touching; shape, weight, and size, and material were also significant, but less so than texture. On the other hand, in a non-blindfolded condition, shape, for example, floweriness, protuberances, concavity, convexity, produced the strongest 'feeling good' sensation. For example, a participant responded that the texture of the prototype Touch me, Feel me, Play with me evoked comfort by its softness, as well as an emotion of surprise, because the actual feeling of touch from its shape and form was totally different when she was blindfolded from her experience in a non-blindfolded state. Comfort was aroused when she touched it blindfolded, whereas she felt differently non-blindfolded.

The Touch me, Feel me, Play with me conceptual prototype, designed with three-dimensional, abstract, and irregular shapes, seemed to evoke higher levels of dynamic tactile perception — softness, warmth, roughness, interesting, surprising, calm — in both blindfolded and non-blindfolded conditions. In addition, the greater the flexibility and elasticity of the structure, as with Touch me, Feel me, Play with

me, the more strongly participants' senses of touch and sight were sensitised in both blindfolded and non-blindfolded conditions. Furthermore, participants' haptic sense and perception seemed to be commensurate with the size of the object. The surface for the larger fabricated units, such as Trans-For-M-otion, which is 40 mm wide, 40 mm long, and 35 mm high, evoked 'feeling bad,' compared to Touch me, Feel me, Play with me (30 mm (W) x 30 mm (L) x 25 mm (H)) and Jigsaw-Puzzle (25 mm (W) x 25 mm (L) x 15 mm (H)). On the other hand, participants' 'feeling bad' factors were dependent on the weight of the stimuli. The heavier the weight — Trans-For-M-otion (600 g) and Disguise garment (680g) — participants felt, the less they were likely to feel good and comfortable, when compared to the other two prototypes — Touch me, Feel me, Play with me (500g) and Jigsaw-Puzzle (400g) — particularly in a non-blindfolded condition.

From the results of the qualitative analysis, it is concluded that the effect on the participants' responses to the haptic perception of 'feeling good or bad' came from the following design aspects: function, aesthetics, evocation of mood, and enjoyment. These aspects will now be explained in more detail, using the quantitative analysis, in the next section.

8.5.2. Phase II: quantitative haptic analysis

To quantify the subjects' feelings, the Semantic Differential method was used to explore the users' tactile perceptions, in particular the level of comfort scores. To analyse comfort levels associated with 'feeling good or bad,' a seven-point rating scale was used, ranging between -3 and 3: -3: totally disagree with the affirmation 'feeling bad'; 0: neither agree nor disagree; and +3: totally agree with 'feeing good.' The analysis of responses to the four conceptual prototypes was performed using the program SAS (version 9.1). Assessments were made of various qualities of the target prototypes and responses to them: *functional*, *aesthetic*, *mood evoked*, and *enjoyment*. These aspects were obtained from qualitative analysis of the participants' responses while interacting with the four conceptual prototypes in Phase I. The 'repeated measures' type of analysis was performed in order to take into account the correlations in the data. This was because of the multiple assessments made by each

subject. The analysis was implemented using a random effects regression model, using the SAS statistical software program.

8.5.2.1 Comparison of the functional assessment of conceptual prototypes

In the evaluation, functional assessment was related to the degree of adaptability and flexibility of the conceptual prototypes' properties. The ANOVA showed a significant difference between conceptual prototypes for the functional assessment (p=0.0083), with a summary of the mean scores and their differences below:

Prototype	Mean functional assessment	Prototype (p-values* for pairwise comparisons)		
		JP	TFP	TFM
DG	0.20	0.019	0.056	0.566
JP	1.60		0.646	0.004
TFP	1.33			0.015
TFM	-0.13			

* The results of the functional assessment for pairwise comparisons are significant if the p-value is less than 0.05. The results of the functional assessment for pairwise comparisons are of borderline significance if the p-value is around 0.05. The results of the functional assessment for pairwise comparisons are not significant if the p-value is more than 0.05.

Table 8. 7. Fifteen participants' functional comfort rates in a comparison of the four conceptual prototypes (Disguise Garment (DG), Jigsaw-Puzzle (JP), Touch me, Feel me, Play with me (TFP), and Trans-For-M-otion (TFM)) in statistical Analysis of Variance (ANOVA).

Table 8.7 shows that Jigsaw-Puzzle (m = 1.60) appeared to evoke a higher degree of 'feeling good' than others, while Trans-For-M-otion (m = -0.13) scored lowest, with a clear difference between these two extremes. There are also statistically significant differences between Jigsaw-Puzzle and Disguise Garment (p = 0.019) and Jigsaw-Puzzle and Trans-For-M-otion (p = 0.004). In addition, a comparison of the p-value of the Disguise Garment and Touch me, Feel me, Play with me was shown to be of borderline significance (p = 0.056) but there is a statistically significant difference between Touch me, Feel me, Play with me and Trans-For-M-otion (p = 0.015).

In short, results of the data indicate that for a greater number of participants, Jigsaw-Puzzle evoked the highest level of 'feeling good' in the functional assessment. The reason was that the Jigsaw-Puzzle enabled exploration of so many possibilities.

Participants used their skills and ideas, which were put to the test in relation to emotions, for example happiness, comfort, and fear.

8.5.2.2 Comparison of the aesthetic assessment of conceptual prototypes

The aesthetic score was an important index of the extent to which a conceptual prototype attracted touch and comfortable interaction. In the evaluation, aesthetic assessment was also linked to the degree of sense of self-worth reflected in responses to the prototypes' properties. The ANOVA showed a significant difference between prototypes for the aesthetic assessment ($p = 0.0001$), with a summary of the mean scores and their differences outlined below:

Prototype	Mean aesthetic assessment	Prototype (p-values for pairwise comparisons)		
		JP	TFP	TFM
DG	1.33	0.030	0.092	0.028
JP	2.20		0.608	<0.0001
TFP	2.00			0.0002
TFM	0.40			

Table 8. 8. Fifteen participants' aesthetic comfort rates comparing four conceptual prototypes (Disguise Garment (DG), Jigsaw-Puzzle (JP), Touch me, Feel me, Play with me (TFP), and Trans-For-M-otion (TFM)) in ANOVA.

Interestingly, results of the data as seen in Table 8.8 show that the aesthetic qualities of all four conceptual prototypes evoked the response of 'feeling good.' Table 8.8 reveals that Jigsaw-Puzzle ($m = 2.20$) scored the highest on aesthetic assessment, and Trans-For-M-otion ($m = 0.40$) scored the lowest. However, comparison between Jigsaw-Puzzle and Touch me, Feel me, Play with me, was not significantly different. Trans-For-M-otion was statistically different from all the other prototypes, and the difference between Disguise Garment and Jigsaw-Puzzle was significant ($p = 0.030$).

In evaluating the aesthetic assessment, Jigsaw-Puzzle evoked the most variable feelings, when participants were interacting with the prototype in terms of the confidence, elegance, glamour, intellectual engagement, warmth, protection, and safety they felt, with an overall sense of self-worth.

8.5.2.3 Comparison of the evoked mood assessment of conceptual prototypes

In the evaluation of 'feeling good or bad,' the mood evoked was related to the degree of emotional anticipation and imagination. The ANOVA showed a significant difference between prototypes for the mood evoked (p=0.0157), with a summary of the mean scores and their differences as follows:

Prototype	Mean aesthetic assessment	Prototype (p-values for pairwise comparisons)		
		JP	TFP	TFM
DG	1.00	0.405	0.405	0.041
JP	1.40		1.0	0.005
TFP	1.40			0.005
TFM	0.0			

Table 8. 9. Fifteen participants' comfort rates associated with moods in a comparison of the four conceptual prototypes (Disguise Garment (DG), Jigsaw-Puzzle (JP), Touch me, Feel me, Play with me (TFP), and Trans-For-M-otion (TFM)) in ANOVA.

The data in Table 8.9 show that Trans-For-M-otion scored the lowest (m = 0.0), and was different from Jigsaw-Puzzle (m = 1.40), Touch me, Feel me, Play with me (m = 1.40), and Disguise Garment (m = 1.00). However, the difference between Jigsaw-Puzzle and Disguise Garment (p = 0.405) and Jigsaw-Puzzle and Touch me, Feel me, Play with me (p = 1.0) was not statistically significant. The difference between Touch me, Feel me, Play with me and Disguise Garment was not also statistically significant (p = 0.405).

Results of the data show that a large number of participants experienced 'feeling good' from interacting with three of the conceptual prototypes — Jigsaw-Puzzle, Touch me, Feel me, Play with me, and Disguise Garment. One reason why Jigsaw-Puzzle assisted the participants with their imagination and intellectual engagement in interaction was the abstract and open structure of the design. Participants also engaged with their personal tastes and stories while interacting with Jigsaw-Puzzle, which enabled them to transform a negative mood to a positive one. In other words, respondents seemed to face a greater challenge exploring an unfamiliar object, as with Jigsaw-Puzzle, which seemed to evoke variable emotions, for example, happiness, comfort, or fear. Touch me, Feel me, Play with me made them feel calm

and soothed as it invited touch, for example, squeezing, pressing, and so on. In addition, while interacting with Touch me, Feel me, Play with me, most of the participants experienced positive aesthetic feelings such as elegance, glamour, showing off, warmth, protection, and safety, enabling positive moods. The Disguise Garment that was embedded with LED light technology allowed participants to enter into playful and enjoyable engagement, as well as recalling certain memories and experiencing nostalgia and fantasy. While interacting with the Disguise Garment, participants experienced various emotions and moods aroused by memories of their personal stories.

8.5.2.4 Comparison of the enjoyment assessment of conceptual prototypes

In the evaluation of 'feeling good or bad,' assessment of enjoyment was associated with the degree of playfulness aroused in participants. The ANOVA showed a significant difference between prototypes for the enjoyment assessment (p=0.0047), with a summary of the mean scores and their differences as follows:

Prototype	Mean aesthetic assessment	Prototype (p-values for pairwise comparisons)		
		JP	TFP	TFM
DG	1.13	0.311	0.884	0.012
JP	1.60		0.384	0.001
TFP	1.20			0.008
TFM	-0.07			

Table 8. 10. Fifteen participants' comfort rates involved in enjoyment assessment in a comparison of the four conceptual prototypes (Disguise Garment (DG), Jigsaw-Puzzle (JP), Touch me, Feel me, Play with me (TFP), and Trans-For-M-otion (TFM)) in ANOVA.

Results of the data (Table 8.10) show that Jigsaw-Puzzle scored higher (m = 1.60), whereas Trans-For-M-otion (m = -0.07) scored the lowest. Participants responded with some reasons why they enjoyed interacting with the Jigsaw-Puzzle prototype. One of the interesting reasons was that they enjoyed the range of possibilities offered by increased bodily engagement and finding their own sense of style. Although some participants mentioned that too many variations can be tiring, most of the participants tried to puzzle out specific forms to suit their body comfort. Participants not only enjoyed the various forms Jigsaw-Puzzle offered, but the process of how they

engaged with it and found solutions. Touch me, Feel me, Play with me invited participants' dynamic touching, for example, squashing, pressing, striking, and rubbing. In the touching process, participants enjoyed physically playing with the prototype and it evoked calming and relaxing states. The Disguise Garment embedded with LED light enabled them to laugh, smile, and have fun.

8.6 Discussion

The results show that 'feeling good or bad,' is qualitatively, experientially, and emotionally different in terms of visible vs. invisible touch (when subject is not blindfolded, compared to when she is). First of all, in both blindfolded and non-blindfolded states, participants moved their hands in order to undertake a touch evaluation of the objects' properties. The specific types of movements they performed were composed of: active touch, such as stroking, squeezing, rubbing, and lifting; and passive touch, such as sliding, pressing, and fumbling. Their playing movements seemed to have a specific character: (1) physically moving and interacting with the object, for the sake of the resulting bodily sensation; and (2) a transient appraisal effect to make themselves calm and sooth themselves as opposed to their state of discomfort, anger or annoyance. This interaction is an unconscious playing with the object and is related to habitual and thoughtless touch, because it is not functional and purposeful manipulation. The participant observation indicates the importance of hand movements as a sensory detector, and pinpoints how much people rely on their hands to feel and evaluate various emotions, consciously or unconsciously.

Secondly, based on the participants' responses (what they feel, say, and see) to the relationship between touching and seeing, most responded that, in a blindfolded state, they felt more sensuous qualities that led to compound emotions, from negative — feeling scared and afraid — to positive — excited, interested, calmed and soothed. In addition, in terms of haptic visuality, they seemed to have the imaginary or illusory experience of touching some kind of familiar object, which they described in terms of the image evoked. The effect seemed to be that of being momentarily under the illusion that they were somewhere familiar, or were touching a familiar object, which increased their state of comfort, even though they didn't know what it

was that they had touched. In other words, participants' past positive or negative experiences were reflected in the effects of the object on their sense of touch. Accordingly, from this experience of haptic visuality, reflected in what they feel, say and see, the results indicate that the feeling of touch can evoke both physical sensation and perceptual images and thus enhance emotion, whether negative or positive. This sense of touch informs how our body obtains much of our sensorimotor information about the state of the physical and psychological world. This is what Merleau-Ponty (1962) elucidates that as a sensory field where, 'the senses intermingle and mutually resonate' (pp. 229-230). He highlights that 'the senses intercommunicate by opening on to the structure of the thing' (p. 229). His philosophical idea stresses unity of tactile and kinaesthetic phenomena, and unity of senses. In other words, this theory indicates that, for example, contact between the perceived object and the person perceiving is closely interlinked. Wherein, we are able to 'see' an object sensuously and perceptually through the hands touch, which are a perceptual and manipulative organ and the entire body (Gibson 1966). In addition, perceiving sense is through action (touch and movement) as a reciprocal system. We feel comfortable intuitively through touch and through the way our body moves or is moved by finding individual own body comfort. This perspective is significant for the design of body-cantered and sense-driven clothing. Especially, it is worth noting that how the intertwining of senses and motor skills enhances our emotions.

Thirdly, from the results of both the qualitative and quantitative analysis, the effect on the participants' haptic perception of 'feeling good or bad' came from the following design elements: texture, shape, size, and weight. A large number of participants mentioned that when blindfolded, 'feeling good' effects while touching were caused mostly by texture, for example, softness, warmth, vibration and dynamic surface, followed by shape, weight, and size. In the non-blindfolded condition, shape, for example, floweriness, protuberances, concavity, convexity and so on, followed by texture, size, and weight, produced the strongest 'feeling good' sensations.

A summary of the participants' responses to hand and bodily sensations and the perception of 'feeling good' is presented below. I propose these as essential design principles, based on haptic perception:

- Texture: when they touched a stimulus object, they had a sensation of 'feeling good or bad' in response to the object's softness, hardness, or roughness. Texture was the essence of touching. Different senses of touch (active or passive touch) actually enhance the level of emotional effect. Active touch evoked a greater variety of emotions than passive touch. Touch me, Feel me, Play with me was designed to incorporate an irregular polygonal, concave and convex structure with a trapped air unit and elicited various emotional responses. These elements were designed to stimulate bodily sensations as well as psychological comfort in the participants, and were used to test participants' modes of hand and body movement.

- Warmth: when they touched an object, a feeling of warmth made them feel relaxed and calm, both physiologically and psychologically, in an uncomfortable or unfamiliar environment. The place where the experiment was conducted was in a dark laboratory. Thus, some of participants were very sensitive to thermal conductivity, for example, having cold hands. This seemed to influence their positive haptic experience in touching with their hands the object, a three-dimensional, convex and concave, abstract organic form. Material like felt enhanced a feeling of warmth.

- Vibration: is the sine qua non for tactile perception. When they interacted with an object, particularly in a blindfolded condition, the hands rubbed, stroked, squeezed and slid along the object to feel the texture of the surface, so a vibration arose. Something touched seems to be at once sensed as a vibrating object, its qualities perceived as warmth, hardness, roughness, softness. They could feel more than a sense of warmth.

- Shape: haptic touch yields the shape of objects. The shape has a strong influence on 'feeling good or bad.' The object Touch me, Feel me, Play with me was designed with irregular, convex and concave, corrugated, polygonal surfaces on the outside, and regular circle-like surfaces on the inside rectangles, like a pattern of flower-shaped pockets. This design enhanced

positive emotions. With this shape, the participant's haptic experience produced very dynamic touch and movement, for example, grabbing, squeezing, palpating, and sliding, which enhanced 'feeling good.'

- Weight: when they held and lifted an object, they felt good when the object was light, but not when it was heavy. In fact, a sensation of heaviness took the positive sense away, evoking negative emotions such as unpleasantness or annoyance, or even anger. Some of the participants, however, mentioned positive heaviness in connection with the conceptual prototype Trans-For-M-otion, which gave them positive feelings of being protected, guarded, and safe, as if they were under a shadow.

The haptic perception experiment found evidence for the relevance of other related 'feeling good or bad' design factors — function, aesthetics, evoked mood, and enjoyment. These are summarised below:

- Flexible function: the experiment explored many possibilities for functional design ideas; for example, Trans-For-M-otion and Jigsaw-Puzzle's transformation of one form into another enhanced 'feeling good.' In addition, the participants' skills and intellectual engagement were tested in relation to emotions aroused by functionality of the designs, such as happiness, comfort, and fear in response to functional design; for example, Jigsaw-Puzzle enhanced 'feeling good.'

- Aesthetics: people experienced 'feeling good' when an object enabled them to feel confident, elegant, glamorous, show-offish, warm, protected, and safe, enhancing their sense of self-worth. Results indicate that participants were more likely to manipulate conceptual prototypes such as Touch me, Feel me, Play with me and Jigsaw-Puzzle to construct and express their self-identity, as well as to create a desirable image to project to others. This aspect is related to feeling 'confident' within the comfort dimension. More importantly, making participants comfortable in uncomfortable situations, for example, psychological uncertainty in unfamiliar spaces, should be considered. This aspect is related to feeling 'calm' within the comfort

dimension. In this respect, the prototype, Touch me, Feel me, Play with me, invited participants' passive and free active touch, whether consciously or unconsciously. Design elements such as the concave and convex shape, along with texture, greatly influenced 'feeling good.'

- Evoking mood: people experienced various emotions and positive moods when an object was closely connected to their personal stories, memories or imagination. For example, people related personal stories while interacting with the conceptual prototypes Jigsaw-Puzzle and Disguise Garment, which enabled them to transform a negative mood into a positive one. In addition, the conceptual prototype Touch me, Feel me, Play with me made them feel calm and soothed, due to its invitation to touch by squeezing, pressing, and striking. Touch me, Feel me, Play with me also made participants feel elegant, glamorous, confident and safe, and thus promoted a positive mood.

- Enjoyment: people seemed to be more challenged in exploring an unfamiliar object, such as Jigsaw-Puzzle, which evoked great enjoyment through a range of emotions such as happiness, comfort, or fear. People also enjoyed playing with the possibilities it offered for bodily engagement, finding a sense of their own style. More importantly, they greatly enjoyed the process of engaging with it and finding solutions. Touch me, Feel me, Play with me positively invited people to touch it by squashing, pressing, striking, and rubbing; they enjoyed physically playing with it and found it evoked emotional calmness, relaxation, and soothing states of mind.

8.7 Conclusion

This chapter has explored how women experience comfort in terms of 'feeling good or bad' when they participate in enriched and dynamic bodily expression, by engaging with and wearing conceptual prototypes that are designed to stimulate haptic visuality in the EAI framework: doing through feeling, feeling through doing; feeling through touching; and seeing through touching. The significance of the experiment was to contribute to the discourse on comfort by investigating the influence on haptic experience, kinetic interaction, and emotion. Haptic experience

inspired me with the philosophical ideas based on perception of phenomenology (Merleau-Ponty, 1962), expressing a unity of tactile and kinesthetic phenomena and a unity of the senses. Results obtained from the qualitative (Phase I) and quantitative (Phase II) data indicate that the participants' haptic perception and emotional experiences were qualitatively different in these conditions: active vs. passive touch, and visible vs. invisible touch. For example, in active touching, such as grabbing and squeezing while blindfolded, most of the participants had feelings not only of a calming effect, but also of enhanced pleasurable emotions. In other words, various emotions can be adapted by the way people touch, which is significant for the design of comfortable clothing. The research suggests that participants' hand movements correlate closely with their emotions, which throw light on how we can evaluate the desired feeling of comfort in wearing clothing, and create designs accordingly.

Designers should think of the hands as exploratory instruments for the emotions, even though their movements are non-purposeful in the absence of vision. The experiment highlights the need for design methods that have multi-sensory applications. In fact, design for aesthetic interaction in the field of clothing or related products still relies on the visual sense. But results from the method of blindfolding participants suggest the importance of other sensory modalities in the interactive dimension, for example, touch, movement, smell, and so on.

Finally, the study reveals how the different senses are integrated. For example, results show that feelings, whether 'good or bad,' are reflected in how people touch and affect what they see. In this respect, perceived images evoked by touch relate to sensory experiences that may have originated in the past. The value of the research on haptic experience is to consider the relationship between figurative expressions (words) and perceived images while responding to stimuli. Designers need to take this into account in the design process. This study establishes that there is significant potential for exploring subjects' sensory experience in order to further develop the design process. For instance, personal taste formed by personality or different cultural backgrounds would be worth future study (Govers, 2005).

To sum up, if an object invites touch, it helps people appreciate the object better. The fact that people can appreciate small differences in touch enhances their

psychological benefits from interaction with objects. This may be beneficial in helping to relieve depression and increasing a general sense of well-being. The study's investigation of 'feeling good' as a comfort factor revealed the subjects' engagement with complex emotions such as surprise, excitement, pleasure and calmness. Therefore, the haptic experiment indicates that we are able to 'see' an object sensuously and perceptually through our hands and body. It follows that, when designing an object, designers should consider the way people touch it to feel and appreciate it, and then how the sense of touch evokes a sense of well-being. These factors offer insights for designers who aim to design for comfort, not merely in terms of clothing, but also in more various creation of products.

Chapter 9

Quantitative emotional expression

(Motion Capture experiment)

Chapter 9

Quantitative emotional expression[1]

9.1 Introduction

This chapter describes the Motion Capture (MC) phase of the experiment, which was conducted from March to May 2010. This MC phase tested the EAI framework in the context of a kinaesthetic understanding of comfort — doing through feeling, feeling through doing. Kinaesthetics is an important aspect of design for comfort and evoking emotion, as it provides us with our self-perception of movement, the felt sense of our bodies in motion (Laban, 1960). The main aims of testing the EAI framework in this MC experiment were: 1) to understand human walking behaviour, correlating and comparing three different walk styles ('natural,' 'happy,' and 'fearful') and three different garment styles ('normal,' 'happy,' and 'fearful'); and 2) to apply the concept of movement for designing interactions that enhance clothing comfort. The outcome of this experiment proposes that dynamic bodily expression and emotion in everyday walking activities can be a rich source of the development of innovative design concepts in the design process. Wherein, the outcome of this experiment offers the design principles of aesthetic comfort for the user in clothing as it is worn in daily life that leads to answering my second thesis question. There are two connected parts to this investigation. One part, presented in this chapter, is the quantitative analysis of participants' emotional expressions and physical movements using 3D MC data. The second part, reported in Chapter 10, is a qualitative analysis of participants' emotional expressions and dynamic movements in relation to the different walk styles and different garment styles using Laban Movement Analysis (LMA).

Section 9.2 provides an overview of the literature and related work on human rich, dynamic bodily expression in walking, in relation to emotion and clothing design.

[1] Part of this chapter will be published in forthcoming a conference paper titled 'Enriched aesthetic interaction' through sense of dynamic emotional bodily expression with garment: quantitative analysis with Motion Capture (MC) data (Jeon, 2012). This will be presented at *Proceedings of 8th International Design and Emotion Conference 2012*, 11-14 September, held in London.

Section 9.3 describes the aim, questions, and objectives of this phase of the experiment. Section 9.4 eluciates the method used for the experiment and explains how emotional walking behaviours were calculated by the MC technique, using a random effect regression model with 'mixed' procedure in Statistical Analysis Software (SAS) and statistic Analysis of Variance (ANOVA). Sections 9.5 and 9.6 present results and discussion; I identify how specific emotions (happy and fearful) affect walking styles, and how different types of a garment affect walking styles ('normal,' 'happy,' and 'fearful'). Conclusions are presented in Section 9.7.

9. 2 Walking styles related to emotions and clothing

As noted in Chapter 2 (see Section 2.4.2.1), I found that some interesting research has been done in the identification of walking styles and patterns in relation to emotions (James, 1890; Wallbott, 1982; Birdwhistell, 1970; Henley, 1977; Montepare, 1985; Montepare & McArthur, 1986; Montepare & Dobish, 2003). The literature establishes that a person' walk is influenced by emotions and personality (Dittrich et al., 1996; Walk & Homan, 1984; Montepare & Dobish, 2003). Changes to walking patterns have been shown to change perceptions of an individual's emotional state (Dittrich et al., 1996; Walk & Homan, 1984). According to Torresani and his colleges (2006), the perception of human motion can be classified into two factors. One factor is content. The other is style. They propose that content generally refers to 'the nature of the action in the movement (e.g. walking, reaching, etc).' On the other hand, 'style denotes the particular way that action is performed' (Torresani et al., 2006, p. 1939).

In the light of this research, I considered both content and style in observations of human motion. I will focus on the relationship of clothing with the way people walk in the context of emotional engagement. Different walking patterns may be influenced by different garment styles. For example, if a person wears her favourite dress to meet a close friend in a public space, she may walk gracefully with a steady pace. Or, if a person wears jeans and a T-shirt, she may be more likely to walk energetically with a striding step. Walking patterns have a certain quality, attitude or tone. Although a person's walking has an important relationship with clothing and specific emotions, there is a lack of research investigating this within the field of

clothing design. Because of this lack of research, this study has been a challenging, but interesting and important area to explore.

9.3 The research aims

The Motion Capture (MC) experiment in the context of the EAI framework tested participants' physical movements in the context of their bodily expression of emotions when wearing different styles of garments. The major tasks in this experiment were to understand human walking behaviours in the context of emotion, and to correlate and compare three different walk types ('natural,' 'happy,' and 'fearful') with three different garment types ('normal,' 'happy,' and 'fearful').

9.3.1 The research questions and objectives

These key questions and focus were identified:

- How does a specific emotion, for example, fear or happiness, influence walking behaviours when people are interacting with a conceptual prototype garment?
- How do different styles of a conceptual prototype garment affect walking behaviours in terms of 'natural,' 'happy,' and 'fearful' walks?

The objectives of the research using MC were to investigate:

- What body positions do participants use — such as movement of head, hands, and legs?
- This included observations of:
    1) Range of body movement, such as side-to-side, up-down, forward-backward, in the context of different garment styles and different emotions;
    2) Velocity or speed of walk, influenced by emotion while wearing three discrete styles of a garment; and,
    3) Step or ways of stepping.

9.4 Method: overview

To address the above research questions and objectives, I used both quantitative and qualitative methods. For the quantitative method, described in this chapter, I employed Motion Capture (MC) data, which is a specialised scientific research technique designed to measure a wide range of human activities and human body motion, for example, arm swing and leg and head movements. The MC experiment tested human walking behaviours by correlating and comparing three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful'). In order to analyse collected motion data quantitatively, the random effect regression model using the 'mixed' procedure in SAS statistical analysis software and in statistic Analysis of Variance (ANOVA) were used to compare three or more mean scores. For the qualitative method, I employed Laban Movement Analysis (LMA) in order to analyse the inner quality and characteristics of human movement in terms of the relationship between different walk types and different garment types, and the quality of movement, and this will be addressed in the next chapter.

In the next section, I will explain the MC technique for gathering computational data in more detail.

9.4.1 The use of Motion Capture technique in this research

In this study, the Motion Capture (MC) technique was used for the data collection and analysis of body position of head, hands, velocity, and step length when participants performed three types of walking while interacting with three types of garment. MC methods have been widely and successfully used for measuring human body motion and performance capture when applied to such areas as 3D animation, movie production, cultural activities such as dance and performing arts, gait analysis for clinical medicine, and recognition of emotion (Unuma et al., 1995; Zhao et al., 2000; Hachimura & Nakamura, 2001; Bianchi-Berthouze et al., 2006).

In this study, the technique involved videotaping individuals with reflective dots attached to participants' joints or skin. Markers attached to the participants' skin (forehead, back of left and right hand, instep of the feet) were used to calibrate the

cameras and capture the positions of the body parts; they were recorded by computer graphics, and when connected form a diagram. The MC technique and videotaping took place in the School of Physiotherapy, Motion Capture Analysis Laboratory, Curtin University, Western Australia.

Figure 9. 1 shows the main laboratory apparatus of the MC Analysis, which comprised the following equipment:

- 1 Quad-core Data Acquisition computer System + Vicon Ultranet MX HD, for Real-Time motion-capture and 64 channels of Analog Data Collection, and Vicon Nexus 1.4 software (see above left image in Figure 9.1);
- Vicon Motion Analysis System, with 10 advanced semi-infra red Vicon F40 cameras (see above right image in Figure 9.1);
- Blue wall suitable for Chroma-Key (see right image in Figure 9.1);
- 2 AMTI force platform in the floor, allowing for walk-through motion analysis (*Curtin School of Physiotherapy*, n.d.).

Above left image shows the optical motion capture computer, which is used for real-time 3-dimensional motion analysis.

Above right image represents one of the 10 infrared cameras that forms part of the real-time motion capture system.

Right image shows the motion capture laboratory with blue wall and 2 AMTI force platforms in the floor. The force platforms are visible in the centre of the floor.

Figure 9. 1. The main laboratory apparatus of the Motion Capture Technique. Source: Curtin School of Physiotherapy, n.d.

Figures 9.2 and 9.3 show a sample of a participant's normal walk trial while interacting with the 'Fearful Garment.' The graphic images represent a trajectory of how she moved in terms of velocity and path, after markers were attached to her skin as described above. Her bodily movements were recorded by digital video camera and the data translated, providing moving points in space in a 3D computer graphic representation. As seen in Figure 9.2, two parallel blue free lines represent her movement trajectories in terms of speed and path in space when she walked. Figure 9.3 shows motion capture by labelling of markers, with the dot points and lines outlined by the marker positions.

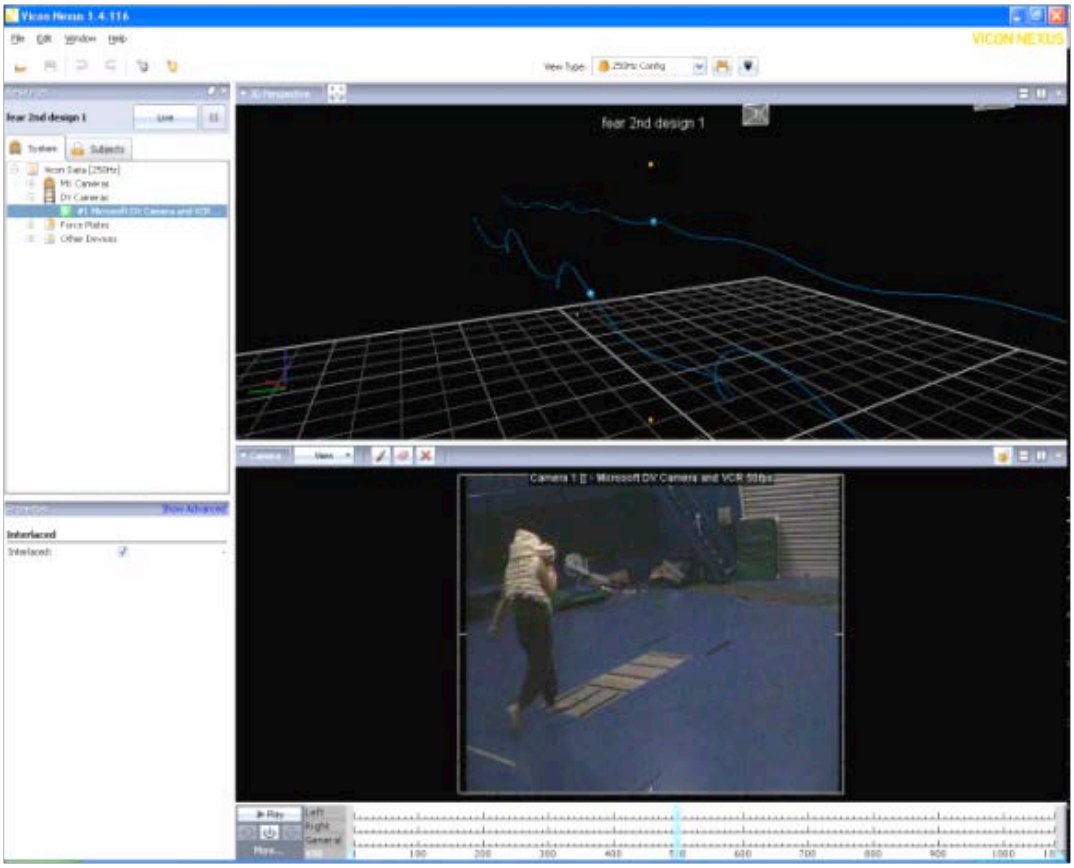


Figure 9. 2. Example of the 'Fearful Walk' trial where a person performed while interacting with the 'Fearful Garment.'
Source: 3D computer graphic images by the author and Amity Campbell (Curtin School of Physiotherapy).

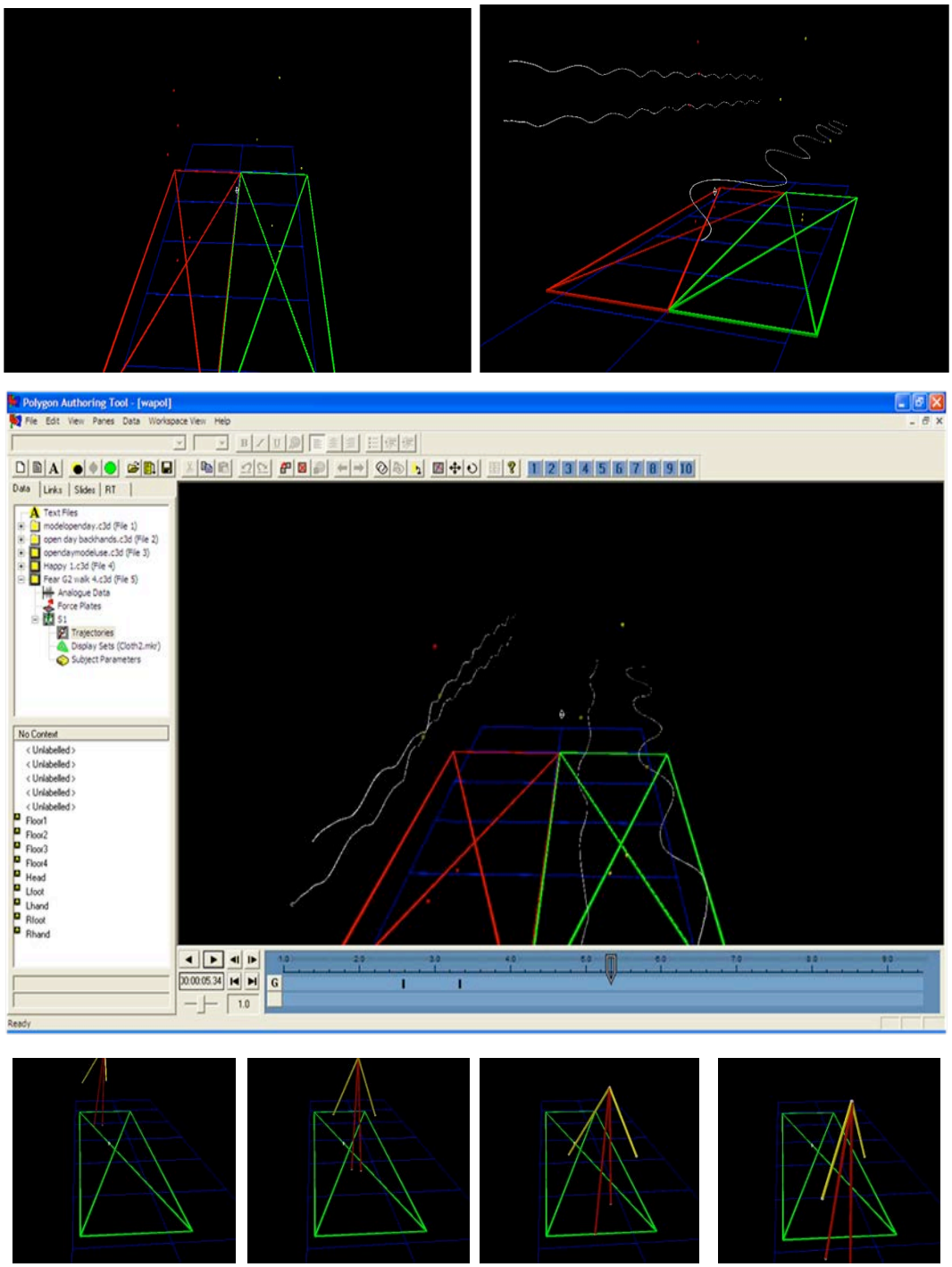


Figure 9. 3. Trajectories of movement: example of the 'Natural Walk' trial where a person performed the 'Natural Walk' trial while interacting with the 'Fearful Garment.' Using labelled markers, motion capture technology visualizes the outline of the body position as a way to map the body's movements.
Source: 3D computer graphic images by the author and Amity Campbell (Curtin School of Physiotherapy).

9.4.2 Participants

Eight females participated in the study. They were between 20 and 40 years of age and were selected from among fifteen participants who participated in previous haptic experimentation. The different participants represented different races (Australian, Indian, and Namibian) and diverse disciplinary background (Interior Architecture, Urban Regional Planning, Psychology, Art, and Communication and Cultural Studies).

9.4.3 Development of stimuli

9.4.3.1 Scenarios

In order to conduct the 'Fearful and Happy Walk' trials effectively, before the experiment participants were asked to retrieve autobiographical experiences according to two scenarios: the happiest and the most fearful events in their past experience. This material came from the participant interview sessions I conducted earlier, described in Chapter 6. Based on the participants' interviews and reflections on their observation responses, two short scenarios were developed for this participant observation, as follows:

- Scenario 1 (the 'Happy Walk' trial): please recall your happiest experience, such as meeting close friends whom you haven't seen for a long time. Then you are walking in this situation.
- Scenario 2 (the 'Fearful Walk' trial): please recall your most fearful experience, such as walking along a dark street when someone is following behind you. Then you are walking in this situation.

In reviewing the literature discussed in Chapter 6, I employed 'an alternative emotion manipulation technique' suggested by Montepare et al. (2003). The technique is to allow participants to think of a personal situation in which they have experienced a particular emotion, in order to help them recall emotions so that they perform emotional walk trials efficiently (Malatesta & Izard, 1984). The research considered only two basic emotions, happiness and fear, because normally people remember their happiest and the most fearful events vividly, so they can

communicate and decode the emotions efficiently (Montepare et al., 2003). Talarico and Rubin (2003) found that people claimed to remember the emotional events more vividly than everyday events. The validity of the scenarios technique was tested and this method was found to be effective (see Chapter 6). However, I also found that having participants evoking their emotions and their bodily expression in these scenario approaches would have been more effective and precise in real life situations. The MC and LMA experiments (Chapter 10) required the use of special apparatus such as sensors (reflective dots), real time 3D motion capture technique, and the multifaceted perspective of videotaping (addressed in 9.4.1) in order to collect the data effectively. This meant that collecting movement data aforementioned above two scenarios in real life situation experiments was difficult. For that reason, the scenario techniques for evoking emotions were complemented and amended as if participants were close to the real context of the situations (see Chapter 6). For example, light can be used in the space where participants are placed in to observe their behaviours to influence their moods. Bright light can lead participants to evoke happy emotions, whereas darkness can induce fearful moods. In addition, images were provided to evoke fearful emotions. Prior to this phase of the study, the scenarios were reviewed again by Professor Leon Straker (School of Physiotherapy), Professor Suzette Worden (School of Design), and an early career research fellow and biomechanic, Dr. Amity Campbell (School of Physiotherapy) for their appropriateness as descriptions of situations associated with the intended emotions. They concurred that the scenarios were realistic and valid exemplars of the intended emotions.

9.4.3.2 Picture

The image below was used as the stimulus for the 'Fearful Walk' trials in order to help participants recall their past fearful experiences (Figure 9.4). In emotional and psychological research, pictures have been widely used as an effective stimulus to evoke peoples' memories of past experiences and to express their emotions though bodily gestures and movements (Brown & Kulik, 1977; Roediger et al., 2007, p. 263).

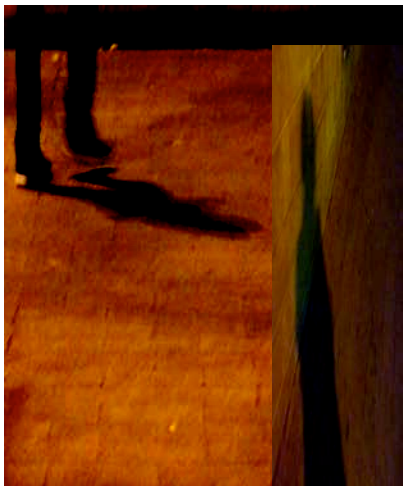


Figure 9. 4. Image for the 'Fearful Walk' trial.
Source: photo by the author.

9.4.3.3 Conceptual prototype garment: Touch me, Feel me, Play with me

In this study, three distinctive styles of the garment were provided for the participants. One, the 'Normal Garment,' was black leggings or jeans and a black tight, stretchable top. The other, which doubled as the 'Happy Garment' and the 'Fearful Garment,' was the conceptual prototype garment, Touch me, Feel me, Play with me (Figure 9.5).

Figure 9. 5. The first image on the left side shows the 'Normal Garment'; centre is the 'Happy Garment,' and on the right is the 'Fearful Garment.'
Source: photos by the author.

Touch me, Feel me, Play with me was designed not only to invite touch but also to transform into various shapes and styles depending on what moods or emotions a person experiences, and how a person wraps and uses it in various ways, for

example, a sleeveless half coat, a short hooded jacket, a skirt, and a cushion. The 'Happy Garment' was a sleeveless-half-length-coat and was defined as inviting touch through interesting textures and making participants feel glamorous and express their self-identity, so as to reinforce their feeling of pleasure in a recognisable state of comfort. The 'Fearful Garment' was a sleeveless jacket with a hood and was defined as mysterious textures and making participants wrapped their bodies completely, and this style helped them control their state of fear by forming a shelter, so that they transformed their feeling of fear into a recognisable state of comfort (Figure 9.6).

Figure 9. 6. Different inside and outside forms of the conceptual prototype, Touch me, Feel me, Play with me: the first image on the left is the 'Happy Garment.' The second image on the left is the 'Fearful Garment.'
Source: design and photo by the author.

The reason why I selected Touch me, Feel me, Play with me to conduct the test, and named it the 'Happy Garment' and 'Fearful Garment' respectively was that the overall rating showed generally high scores for this garment, when the fifteen participants rated various qualities of the four target prototypes in terms of the aspects *functional*, *practical*, *aesthetic*, and *mood*, as stated in Chapter 8. For example, participants were more likely to manipulate the conceptual prototype, Touch me, Feel me, Play with me: 1) to construct and express their self-identity; 2) to create a desirable image to project to others; and 3) through passive and free active touch, whether consciously or unconsciously, to evoke emotional calmness, relaxation, and soothing states of mind. In addition, in exploring how participants

manipulated the garment in relation to emotions and bodily activity, the results showed that a large number of participants (nine out of fifteen) adopted the form 'Happy Garment' when they intended to express a happy emotion. Also, eleven out of fifteen participants created the form 'Fearful Garment' when they intended to express a fearful emotion (see Chapter 8 and Appendix to chapter 8).

9.4.4 Procedure

The participants performed twenty-seven trials in the course of the experiment, using three different walk types ('natural,' 'happy,' 'fearful'), and three different garment types ('normal,' 'happy,' 'fearful').

- Participants were asked to perform the three trials of the 'Natural Walk' when worn with the 'Normal Garment,' 'Happy Garment,' and Fearful Garment' (3 + 3 + 3).
- Participants were asked to perform three trials of the 'Happy Walk' when worn with the 'Normal Garment,' 'Happy Garment,' and 'Fearful Garment' (3 + 3 + 3).
- Participants were asked to perform three trials of the 'Fearful Walk' when worn with the 'Normal Garment,' 'Happy Garment,' and 'Fearful Garment' (3 + 3 + 3).

Figure 9. 7. Left image shows stimuli for the experiment, which consisted of pictures and the garments ('Natural Garment' and the conceptual prototype, Touch me, Feel me, Play with me). Right image shows a participant wearing the 'Normal Garment,' that is, black jeans and a black tight, stretchable top with eight markers attached on their skin.
Source: photo by the author.

The ‘Natural Walk’ was defined as the way participants walked with no intended expression of emotion. The ‘Happy Walk’ and ‘Fearful Walk’ were defined as the way they walked when they intended to express the emotions of happiness and fear. ‘Happy Walk’ participants were not allowed to float their feet in the air, as in jumping. The activity of this phase of the research took place in the Motion Capture Laboratory. Dressed in a black top and leggings with eight markers located on the hands, feet and head, each subject performed three trials (Figure 9.7).

The protocol for the trials was explained in detail to each walker. For example, for the ‘Fearful Walk’ trial:

- Participants were asked to begin with a warm-up for five minutes, for example, stretching and breathing exercises.
- Participants were asked to recall their most fearful experience and look at a written copy of a scenario and the accompanying picture (see Figure 9.4), recalling their fearful experiences.
- When participants were ready to be filmed, the light in the lab was dimmed.
- Participants were asked to walk on the platform (see Figure 9.7, right-hand image).

The ‘Happy Walk’ trial was carried out after the ‘Natural Walk,’ followed by the ‘Fearful Walk’ in a similar manner. However, the order in which walkers enacted the three walk types and three garment types was applied differently in each set of trials, to prevent walkers performing a routine. Before conducting each walk trial, participants were given approximately five minutes before the walking exercise in order to make them feel easy in the lab environment so that they were able to walk naturally and emotionally. In particular, before conducting the ‘Happy Walk’ and ‘Fearful Walk’ trial, each participant was asked to recall (based on their past experience) how she would feel in the situation. After this each walker was given a written copy of a scenario and a photographic image in order to help them evoke a feeling of happiness and fear, as mentioned above (see Section 9.4.4). In addition, the light in the lab was dimmed during the ‘Fearful Walk’ trial to create a dark environment in which subjects evoked their fearful feelings, so that it affected the

way they walked. Each walker was allowed the opportunity to ask questions for clarification; however, none did so and all indicated that the context and intended emotion was clearly understood. When the participant was ready to be filmed, the participant began walking. During each walking trial, participants were not allowed to talk. MC and videotaping of three walk types ('natural,' 'happy,' and 'fearful') for each participant were done in a single session. All walkers were individually filmed and their positions recorded by the computer program.

The experimental procedure was modified slightly for participants, after receiving feedback from the first participant's performance. She observed that she had difficulty in switching emotions quickly while interacting with the 'Happy Garment' in the initial sequential procedure: the 'Happy Walk,' followed by the 'Fearful Walk' and then the 'Natural Walk.' She suggested that sustaining the same emotion while interacting with three different garments was a more effective method to perform each walk trial ('natural,' 'happy,' and 'fearful') (see Appendix to chapter 10).

I discussed the whole range of procedures again with Professor Suzette Worden (School of Design), Professor Leon Straker (School of Physiotherapy), an early career fellow and biomechanic, Dr Amity Campbell (School of Physiotherapy), after the first participants' trial, to check that the collection of data was effective and correct. Dr Amity Campbell, who is an expert on MC data collection, assisted in recording the participants' emotional gait behaviours. The MC process with each participant took approximately one hour. All experiments were videotaped. The average duration of each film clip was 8.3 seconds with the 'Natural Walk' trials, 7.2 seconds with the 'Happy Walk' trials, and 9.2 seconds with the 'Fearful Walk' trials. During the procedure, detailed notes were made about the participants' behaviours and responses. After the experiments, the participants sat down to discuss their experiences with the researcher.

9.4.5 Data analysis: quantitative analysis of variance (ANOVA)

A total of twenty-seven trials for each subject were achieved. In total, two hundred sixteen walking gestures were collected and analysed in two ways:

1) To determine whether participants were able to use information provided by their gait to identify emotions, Analysis of Variance (ANOVA) with repeated measures was used to analyse the different qualities. The 'repeated measures' form of analysis was performed to correlate the data, due to the multiple assessments made with each participant. The analysis was implemented as a random effect regression model using the 'Mixed' procedure in the Statistical Analysis Software (SAS). For each analysis, the person was labelled as the random effect, while garment and walk types were the fixed effects. The interaction between garment and walk types was initially included in the model, but was found not to be statistically significantly in each outcome. It was subsequently dropped from the model, and the results presented below were obtained without any interaction terms (see detailed sample of raw data in Appendix to Chapter 9).

2) To check that the model was suitable for each of these measures, the logarithm of the measure was analysed as well. This would have the effect of removing any skew in the data if it happened to be present. In all cases, analysis of the log (measure) yielded the same conclusions about the significance (or otherwise) of the garment and walk types.

Occasionally (when there were large differences between group means), the interaction effect appeared to be significant as well. However, the magnitude of the interaction effect was usually very small in relation to the differences between groups, so it was considered clearer to focus on the differences between garment and walk types in the absence of the relatively minor interaction term.

In statistics, ANOVA is a collection of statistical models, and their associated procedures, in which the observed variance in a particular variable is partitioned into components to show different sources of variation. In its simplest form, ANOVA provides a statistical test of whether or not the mean scores of several groups are equal, and therefore generalises *t*-test to more than two groups. ANOVA tests possess an advantage over a two-sample t-test (Rencher, 2002). For this reason, ANOVAs were useful in comparing three or more mean scores.

9.5 Analysis of results

9.5.1 Comparison of the SSMH (*side-to-side movements of the head*)

In the quantitative analysis, the ANOVA showed that SSMH differed between walk types ($p = 0.002$), but not between garment types ($p = 0.798$). As I already mentioned above in section 9.4.5, the p-value associated with the interaction term was 0.308, so it was dropped from the model, as it was not statistically significant for each outcome. The summary of the mean scores and their differences for different walk and garment types are as follows:

	LS Mean*	p-values* for pairwise comparisons	
Walk type		Happy	Natural
Fearful (FW)	54.2	0.213	0.005
Happy (HW)	48.2		0.020
Natural (NW)	36.9		

	LS Mean	p-values for pairwise comparisons	
Garment type		Happy	Normal
Fearful (FG)	45.0	0.510	0.818
Happy (HG)	48.1		0.668
Normal (NG)	46.1		

* Mean represents a measure of the central tendency between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') in the context of SSMH) calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of SSMH is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

Table 9. 1. Mean score and p-value comparing the SSMH (side-to-side movements of the head) between walk types and garment types in ANOVA.

Analysis of the data (Table 9.1) showed that there were significant differences in how much the head moved (side-to-side) between walk types in conjunction with emotions. It appeared that the style of the 'FW,' which was emotionally translated into fearful gaits, showed significant difference in a higher score (m = 54.2). In this sense, the mean score (m = 54.2) refers to how much the head moved (side-to-side) in a fearful walk type. The 'NW' style was different from the other walk types in a lower score (m = 36.9). This statistical data of mean scores represents that large numbers of participants moved their head more from side-to-side during the 'FW' than the others. In comparison, the 'HW' and 'NW' ($p = 0.020$) and the 'FW' and

'NW' (p = 0.005) were found to be significant for side-to-side movements of the head. Comparing walk styles, participants moved their head more from side-to-side during the 'FW' than in the 'NW.' Furthermore, participants moved their head more from side-to-side during the 'HW' than in the 'NW.' Conversely, though there were significant differences in walk styles between the emotional scenarios, there were no significant differences in walk styles between garment types in each scenario.

9.5.2 Comparison of the UDMH (*up-down movements of the head*)

The ANOVA showed that UDMH differed between walk types (p = 0.001), but not between garment types (p = 0.971). The p-value associated with the interaction term was 0.980, so it was dropped from the model. A summary of the approximate mean scores and their differences for different walk and garment types is as follows:

	LS Mean	p-values for pairwise comparisons	
Walk type		Happy	Natural
Fearful (FW)	40.9	0.019	0.144
Happy (HW)	52.0		0.0003
Natural (NW)	34.0		

Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Normal
Fearful (FG)	42.2	0.887	0.921
Happy (HG)	42.9		0.809
Normal (NG)	41.8		

* Mean represents a measure of the central tendency between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') in the context of UDMH calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of UDMH is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

Table 9. 2. Mean score and p-value of comparison of the UDMH (up-down movements of the head) between walk types and garment types in ANOVA.

Analysis of the data (Table 9.2) indicates that the style of the 'HW' was significantly different from the others (higher score, m = 52.0), but there were no differences between garment types. This statistical data of mean scores represents that a large number of participants moved more their heads from up-down during the 'HW.' Comparisons of the 'HW' and 'FW' (p = 0.019) and the 'HW' and 'NW' (p = 0.0003) were found to be significant for head up-down movements. In the 'HW'

style, the walk type emotionally associated with a state of happiness, participants moved their head more in an up-down way than in both 'FW' and 'NW' styles.

9.5.3 Comparison of the FBVHM (forward-backward velocity of the hand movements)

The ANOVA showed that FBVHM differed between walk types (p = 0.001), and also between garment types (p < 0.0001). The p-value associated with the interaction term was 0.215, so it was dropped from the model. Below is a summary of the approximate mean scores and their differences for different walk and garment types:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fearful (FW)	715.2	0.0007	0.899
Happy (HW)	1149.8		0.001
Natural (NW)	730.6		

Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Normal
Fearful (FG)	607.2	0.922	<0.0001
Happy (HG)	595.3		<0.0001
Normal (NG)	1393.0		

* Mean represents a measure of the central tendency between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') in the context of FBVHM) calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of FBVHM is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

Table 9. 3. Mean score and p-value of comparison of the FBVHM (forward-backward velocity of the hand movements) between walk types and garment types in ANOVA.

Analysis of the data (Table 9.3) shows that, when considering the walk types in the context of emotions, there were significant differences in how much the hands moved (forward-backward velocity) between walking types. It appeared that the 'HW' type (higher score, m = 1149.8) was significantly different from the others. In comparing the 'HW' and 'FW' (p = 0.0007) and the 'HW' and 'NW' (p = 0.001), there were significant differences. In other words, participants' hands (arms) moved much faster in a forward and backward way during the 'HW' than in both the 'NW'

and ‘FW.’ Moreover, hands speed (forward and backward) varied significantly between the ‘FW’ and ‘HW,’ and between ‘NW’ and ‘HW.’

Conversely, considering the garment types in association with emotional engagement, there was a significant difference in how much the hands moved (in terms of velocity of forward-backward movements) between the ‘NG’ and both the ‘FG’ and the ‘HG.’ The statistical data indicates that the ‘NG’ score (m = 1393.0) was higher than both the ‘HG’ and ‘FG.’ In other words, participants moved their hand (arm) movements faster in a forward and backward way when wearing the ‘NG’ than the ‘HG’ and ‘FG.’ However, there was no significant difference in the speed of the hand movements between the ‘HG’ and ‘FG.’

9.5.4 Comparison of the SSVHM (*side-to-side velocity of the hand movements*)

The ANOVA showed that SSVHM differed between walk types (p = 0.0003), and also between garment types (p = 0.013). The p-value associated with the interaction term was 0.249, so it was dropped from the model. Below is a summary of the approximate mean scores and their differences for different walk and garment types:

	LS Mean	p-values for pairwise comparisons	
Walk type		Happy	Natural
Fearful (FW)	272.0	0.0009	0.637
Happy (HW)	472.3		0.0002
Natural (NW)	244.8		

	LS Mean	p-values for pairwise comparisons	
Garment type		Happy	Normal
Fearful (FG)	251.8	0.298	0.004
Happy (HG)	312.0		0.053
Normal (NG)	425.3		

* Mean represents a measure of the central tendency between three different walk types (‘natural,’ ‘happy,’ and ‘fearful’) and three different garment types (‘normal,’ ‘happy,’ and ‘fearful’) in the context of SSVHM) calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of SSVHM is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

Table 9. 4. Mean score and p-value of comparison of the SSVHM (side-to-side velocity of the hand movements) between walk types and garment types in ANOVA.

Analysis of the data (Table 9.4) indicates that the 'HW' type (higher score, m = 472.3) was different from the others. The 'NG' was different (higher score, m = 425.3) to both the 'HG' and the 'FG.' The statistical mean scores show that participants used their hands much faster in the side-to-side movement during the 'HW' and while wearing the 'NG.' In addition, comparison of the 'NG' with the 'FG' (p = 0.004) showed a significant difference in how much faster participants moved their hands in a side-to-side movement. In other words, considering the side-to-side velocity of hands, participants used their hands (arms) much faster in the 'HW' type than the 'FW' and 'NW' types. Conversely, participants moved their hands (arms) faster using side-to-side movement while wearing the 'NG' type.

9.5.5 Comparison of the UDVHM (*up-down velocity of the hand movements*)

The ANOVA showed that UDVHM differed between walk types ($p < 0.0001$), and also between garment types ($p = 0.0001$). The p-value associated with the interaction term was 0.293, so it was dropped from the model. Below is a summary of the approximate mean scores and their differences for different walk and garment types:

	LS Mean	p-values for pairwise comparisons	
Walk type		Happy	Natural
Fearful (FW)	417.6	<0.0001	0.184
Happy (HW)	690.1		<0.0001
Natural (NW)	332.6		

	LS Mean	p-values for pairwise comparisons	
Garment type		Happy	Normal
Fearful (FG)	412.0	0.657	0.0005
Happy (HG)	383.7		0.0001
Normal (NG)	644.7		

* Mean represents a measure of the central tendency between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') in the context of UDVHM) calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of UDVHM is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

Table 9. 5. Mean score and p-value of comparison of the UDVHM (up-down velocity of the hand movements) between walk types and garment types in ANOVA.

Analysis of the data (Table 9.5) shows that the 'HW' type (higher score, m = 690.1) was different to both the 'NW' and 'FW.' In addition, comparing the 'FW' and

'HW' ($p < 0.0001$) and the 'HW' and 'NW' ($p < 0.0001$) showed significant differences in how much faster participants moved their hands in an up-down movement, with more movement in the 'HW' than in both the 'FW' and 'NW.'

Based on the garment types, the 'NG' was different (higher score, m = 644.7) from both of the other garments. Results of the data also showed significant differences between the 'NG' and 'FG' ($p = 0.0005$) and between the 'NG' and 'HG' ($p = 0.0001$) in how much faster participants moved their hands in an up and down movement. Participants moved their hands faster when wearing the 'NG' than the others. However, there was no significant difference between the 'HG' and 'FG' in the speed of hands' up and down movements.

9.5.6 Comparison of the FBRHM (forward-backward range of the hand movements)

The ANOVA showed that FBRHM differed between walk types ($p < 0.0001$), and also between garment types ($p < 0.0001$). The p-value associated with the interaction term was 0.264, so it was dropped from the model. A summary of the approximate mean scores and their differences for different walk and garment types appear below:

	LS Mean	p-values for pairwise comparisons	
Walk type		Happy	Natural
Fearful (FW)	175.8	<0.0001	0.020
Happy (HW)	335.2		0.002
Natural (NW)	243.5		

	LS Mean	p-values for pairwise comparisons	
Garment type		Happy	Normal
Fearful (FG)	162.3	0.665	<0.0001
Happy (HG)	174.6		<0.0001
Normal (NG)	417.5		

* Mean represents a measure of the central tendency between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') in the context of FBRHM) calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of FBRHM is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

*Table 9. 6.*Mean score and p-value of comparison of the FBRHM (forward-backward range of the hand movements) between walk types and garment types in ANOVA.

Analysis of the date in Table 9.6 reveals that there were significant differences between all three walk types — between 'HW' and 'FW' ($p < 0.0001$), 'HW' and 'NW' ($p = 0.002$) and 'NW' and 'FW' ($p = 0.020$) — in how much participants moved their hands in a forward and backward way. 'HW' type (higher score, m = 335.2) was different to both the 'NW' and 'FW.' In other words, in the 'HW' style, the walk type emotionally associated with a state of happiness, participants moved their hands more in a forward and backward way than in both the 'NW' and 'FW' types. Furthermore, comparison of the 'NW' with 'FW' showed that in the 'NW' style, which was defined as the way participants walked with no intended expression of emotion, participants moved their hands more in a forward and backward way than in 'FW.'

Considering garment types, the 'NG' was significantly different (higher score, m = 417.5). Comparison of 'NG' and 'HG' ($p < 0.0001$) and 'NG' and 'FG' ($p < 0.0001$), showed significant differences in how much participants moved their hands in a forward and backward way. In other words, when participants wore the 'NG,' which was black leggings or jeans and a black tight, stretchable top, their hands moved more in a forward and backward way than when wearing both the 'FG' and 'HG.'

9.5.7 Comparison of the UDRHM (up-down range of the hand movements)

The ANOVA showed that UDRHM differed between walk types ($p < 0.0001$), and also between garment types ($p < 0.0001$). The p-value associated with the interaction term was 0.195, so it was dropped from the model. A summary of the approximate mean scores and their differences for different walk and garment types appear below:

	LS Mean	p-values for pairwise comparisons	
Walk type		Happy	Natural
Fearful (FW)	73.7	<0.0001	0.616
Happy (HW)	138.7		<0.0001
Natural (NW)	78.6		

	LS Mean	p-values for pairwise comparisons	
Garment type		Happy	Normal
Fearful (FG)	78.9	0.787	<0.0001
Happy (HG)	76.3		<0.0001
Normal (NG)	135.9		

* Mean represents a measure of the central tendency between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') in the context of UDRHM) calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of UDRHM is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

Table 9. 7. Mean score and p-value of comparison of the UDRHM (up-down range of the hand movements) between walk types and garment types using ANOVA.

Analysis of the data shows that the 'HW' was significantly different (higher score, m = 138.7) to the other two walk types. In a comparison of the 'HW' and 'FW' ($p < 0.0001$) and the 'HW' and 'NW' ($p < 0.0001$), there were significant differences in how much participants moved their hands in an up-down way. In other words, in the 'HW' type, which was defined as the way participants walked when intending to express a happy emotion, participants moved their hands more in an up-down way than in 'FW.' Furthermore, in the 'NW' type, which was defined as the way participants walked with no intended expression of emotion, they moved their hands more in an up-down way than in 'FW.'

Comparing the garment types, the 'NG' was significantly different (higher score, m = 135.9) to both the other garments. Comparing the 'NG' with both the 'HG' ($p < 0.0001$) and 'FG' ($p < 0.0001$) showed significant differences. In other words, in the 'NG' style, their hands moved more in an up-down way than for both the 'FG' and 'HG.'

9.5.8 Comparison of the SSRHM (side-to-side range of the hand movements)

The ANOVA showed that SSRHM differed between walk types ($p = 0.0005$), and also between garment types ($p = 0.0008$). The p-value associated with the interaction term was 0.214, so it was dropped from the model. A summary of the approximate mean scores and their differences for different walk and garment types is given below in Table 9.8:

	LS Mean	p-values for pairwise comparisons	
Walk type		Happy	Natural
Fearful (FW)	62.0	0.0004	0.687
Happy (HW)	118.7		0.0013
Natural (NW)	68.0		

Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Normal
Fearful (FG)	58.9	0.340	0.0003
Happy (HG)	73.3		0.0054
Normal (NG)	116.6		

* Mean represents a measure of the central tendency between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') in the context of SSRHM) calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of SSRHM is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

*Table 9. 8.*Mean score and p-value of comparison of SSRHM (side-to-side range of the hand movements) between walk types and garment types using ANOVA.

Analysis of the data shows that there were significant differences in how the hand movements (side-to-side) varied between walk types in conjunction with emotions. It appeared that the style of the 'HW' showed significant difference, with a higher score (m = 118.7). In addition, comparison of the 'FW' and 'HW' (p = 0.0004) and the 'HW' and 'NW' (p = 0.0013) showed significant differences in how much participants moved their hands in side-to-side movements. In other words, in considering mean scores and comparing walk styles, participants moved their hands more from side-to-side during the 'HW' type than in the 'FW' and the 'NW' types.

Of the garment types, the 'NG' was different (higher score, m = 116.6) to both the other garments. The results of the data also showed significant differences between the 'NG' and 'FG' (p = 0.0003). But in comparing the 'NG' with 'HG' (p = 0.0054) there was marginal difference in how much participants moved their hands in a side-to-side movement. Overall, participants moved their hands more in a side-to-side way in the 'NG' type than in both the 'HG' and 'FG' types.

9.5.9 Comparison of the WALKV (*walk velocity*)

The ANOVA showed that WALKV differed between walk types (p = 0.007), but not between garment types (p = 0.766). The p-value associated with the interaction term was 0.968, so it was dropped from the model. Below, in Table 7.9, is a summary of the approximate mean scores and their differences for different walk and garment types:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fearful (FW)	1.17	0.169	0.063
Happy (HW)	1.27		0.0017
Natural (NW)	1.03		

Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Normal
Fearful (FG)	1.18	0.823	0.477
Happy (HG)	1.16		0.625
Normal (NG)	1.12		

* Mean represents a measure of the central tendency between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') in the context of WALKV) calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of WALKV is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

*Table 9. 9.*Mean score and p-value of comparison of WALKV (walk velocity) between walk types and garment types in ANOVA.

Analysis of the data shows that the 'HW' type was different (higher score, m = 1.27) to the other walk types. In addition, comparison of the 'NW' and 'HW' ($p = 0.0017$) showed significant differences in how much faster the participants walked. Overall, comparing walk styles, participants walked faster during the 'HW' than in both the 'FW' and the 'NW.'

As for the garment types, there were no significant differences between garments.

9.5.10 Comparison of the STEPL (*step length*)

The ANOVA showed that STEPL differed between walk types ($p = 0.0004$), but not between garment types ($p = 0.571$). The p-value associated with the interaction term was 0.999, so it was dropped from the model. Table 9.10 gives a summary of the approximate mean scores and their differences for different walk and garment types:

Walk type	LS Mean	p-values for pairwise comparisons	
		Happy	Natural
Fearful (FW)	632.9	0.0038	0.296
Happy (HW)	672.5		0.0001
Natural (NW)	619.1		

Garment type	LS Mean	p-values for pairwise comparisons	
		Happy	Normal
Fearful (FG)	638.6	0.872	0.410
Happy (HG)	636.4		0.325
Normal (NG)	649.5		

* Mean represents a measure of the central tendency between three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful') in the context of STEPL) calculated by dividing the sum of the scores in distribution by the number of scores in the distribution.

* The results of pairwise comparisons between three walk types and three garment types in the context of STEPL is significant if the p-value is less than 0.05. The results of the context described above are of borderline significance if the p-value is around 0.05. The results are not significant if the p-value is more than 0.05.

*Table 9. 10.*Mean score and p-value of comparison of STEPL (step length) between walk types and garment types in ANOVA.

Analysis of the data shows that there were significant differences in step length between walk types in conjunction with emotions. The style of the 'HW' indicates significant difference with a higher score (m = 672.5). In addition, comparison of the 'FW' and 'HW' (p = 0.0038) and the 'HW' and 'NW' (p = 0.0001) showed significant differences in the length of participants' steps. In other words, in comparing walk styles, participants walked using longer steps during the 'HW' than in both the 'FW' and the 'NW' types.

As for the garment types, there were no significant differences between garments.

9.6 Discussion

In the context of testing EAI, a kinaesthetic understanding of comfort — doing through feeling, feeling through doing — this study explicates that different walking styles, including bodily expression, can be affected not only by specific emotions but also by specific garment types. More specifically, the quantitative emotional expression experimental study has compared several walking characteristics and body movement patterns, which differentiated between naturalness, happiness, and fear, as revealed by observations of walking patterns using Motion Capture data.

There were unique patterns based on: range of hand movements: forward-backward, side-to-side, up-down; hand velocity: forward-backward, side-to-side, up-down; head and arm movement; walk velocity; and step length, all tested with three different

walk types (‘natural,’ ‘happy,’ and ‘fearful’) and three different garment types (‘normal,’ ‘happy,’ and ‘fearful’).

Results obtained in this study for the ‘Happy Walk,’ which was the walk type emotionally associated with a state of happiness, indicate: participants moved their head more in an up-down way; had their arms swing more in a side-to-side, up-down, and forward-backward way; and appeared to be relatively faster-paced with longer stride lengths than in the other walking styles. Conversely, for the ‘Fearful Walk,’ which was the walk type emotionally associated with a state of fear, it was found that participants moved their head more in a side-to-side way than in the other walking styles. In addition, when subjects wore the ‘Normal Garment’ it was found that they swung their hands more and faster in a side-to-side, up-down, and forward-backward way than for the other garment styles.

In addition, results show that there were significant differences between garment types in conjunction with emotions in the extent of the participants’ range of hand movements: for example, in the velocity of hand movements from side-to-side, up-down, and forward-backward. In terms of the different garment types (‘normal,’ ‘happy,’ and ‘fearful’), when participants wore the ‘Normal Garment,’ their hands moved faster side-to-side (high score, m = 425.3), up-down (high score, m = 644.7), and forward-backward (high score, m = 1393.0) than when wearing both the ‘Happy Garment’ and the ‘Fearful Garment’. Also, when participants wore the ‘Normal Garment’ their hands moved more from side-to-side (high score, m = 116.6), as well as up-down (high score, m = 135.9), and forward-backward (high score, m = 417.5) than when wearing the other garments.

The results suggest that the reason why both the ‘Happy Garment’ and the ‘Fearful Garment’ were worn with less arm movement, for example, in terms of arm swing, speed, position, and so on than the ‘Normal Garment’ is related to the hand position. For example, participants’ hands (whether left or right hand or both hands) were positioned to cross and go around the body and to interact with both the ‘Happy Garment’ and the ‘Fearful Garment’, as observed by video recording. This aspect indicates that when participants wear a garment, which helps them to feel happy, they may have more bodily engagement and interaction with the garment. The results

reveal a marked discrepancy between happy walking when subjects wore a 'Normal Garment' and 'Happy Walk' when they wore a happy garment. In the latter case, they seemed to have a single focus on the garment, related to its unfamiliarity, as compared to the 'Normal Garment.' In a similar manner, when participants wore the 'Fearful Garment,' they seemed to be more aware of their body, with slower steps of shorter length. Their bodily tension was expressed in controlled and restrained movements, as if watching out for somebody in order to defend themselves against social-psychological danger. Participants' bodily behaviours indicate that their hands were folded or firmly grasping the garment, which influenced the arm movements, causing less use of arm swing, speed, position, and so on. These dynamic, non-cyclical movements were analysed from 2D video data. This aspect will be explained in more detail in Chapter 10.

This phase of the study revealed participants' walking characteristics in relation to their emotions. The results obtained for emotionally-involved walking characteristics in the 'Happy Walk' and 'Fearful Walk' corresponded with previous research on emotion detection from gait characteristics (Montepare et al., 2003). For example, results obtained in this study for the 'Happy Walk' indicate the participants moved their head more in an up-and-down way; had their arms swing more in a side-to-side, up-down, and forward-backward way; and appeared to be relatively faster-paced, with longer stride lengths, than in the other walking styles. Montepare et al. (2003) found that happy walking subjects appeared to be faster-paced than in other emotionally-triggered gaits, such as when they are expressing anger, sadness, and pride. However, unlike Montepare et al.'s study of emotional walking, which is not associated with wearing different garment types, in this study the pattern of walking characteristics associated with wearing different garment types differed across the emotional scenarios for each walker. A likely explanation for this discrepancy is the extent of difference in the hands' range of movement. For example, participants' hands moved faster in a forward-backward, side-to-side, and up-down way when they wore the 'Normal Garment' than when wearing both the 'Happy Garment' and 'Fearful Garment.' When participants wore the 'Normal Garment' their hands produced more forward-backward, side-to-side, and up-down movements than they did when wearing the others.

Finally, the 'alternative emotion manipulation technique' (Montepare et al., 2003) employed was found to be valid and effective as a way of incorporating personal subjective experience into walking trials, retrieving autobiographical memories from the happiest and the most fearful events in their past experience. Participants were comfortable when recalling the emotions and associating them with meaningful tasks during walking trials (see Appendix to chapter 6). However, the initial sequential procedure revealed a difficulty for the first participant to switch emotions quickly while interacting with three styles of a garment. This problem arose in the 'Happy Walk' when she interacted with the 'Normal Garment,' followed by the 'Fearful Walk' when she interacted with the 'Normal Garment,' and then the 'Natural Walk' when she interacted with the 'Normal Garment.' After receiving her feedback, the order was modified slightly for participants. From this perspective, the method used to evoke emotion may require further research in a real-life situation in order to collect the data more effectively and precisely. For example, the technique of considering a fearful scenario where a man suddenly follows closely behind where the participant walks and moves may help participants express and express their bodily movements in a fearful state. In addition, it would be useful to record some video footage of an actual fearful or 'happy' scenario, that is, feeling fearful in an alley-way at night, feeling happy in a park or shopping mall, and so on.

9.7 Conclusion

The aesthetic continuum of everyday life is how we move to perform our day-to-day activities. In this context, we experience a diversity of feelings in association with our actions, reactions, and reflections in responses to circumstances. The characteristics of human motion or movement, particularly walking, express our responses to sensory perception in association with inner mental experiences, which are sometimes triggered by external circumstances and may be influenced by material conditions, such as the garments we are wearing. The study suggests that a walker's movements, influenced by specific emotional experiences and scenarios and the style of garment worn, may express enhanced emotions, such as happiness and fear. Three different garment styles, designed to afford states of happiness, fear, and no specific emotion (naturalness), were found to have different effects on how a person walked and behaved. In other words, the garments styles influenced the styles

of walking. Moreover, the three walking types were found to be significantly different from each other depending on the emotion ('natural,' 'happy,' and 'fearful') people felt. In other words, the more participants felt happy, the more they moved their head in an up-down way and their hands from side-to-side, up-down, and forward-backward. The more participants felt fearful, the more they moved their head in a side-to-side way. When wearing the 'HG' and 'FG,' participants' hands (including arms) were more actively or passively engaged in the garment while walking, which manifested in slower walking and bodily expression for example, speed and position.

The results of the experiment suggests that understanding a person' walking pattern in terms of the relationship between emotions and garments can be an important research area for design. For example: the shape a body adopts and the pattern of bodily movement can inform designers how movement is affected by a person's emotions and type of garment they are wearing. This experiment was also designed to assist designers and researchers whose interest is in movement within interactive design. Interactive design is linked to maximising feelings of comfort in the user. In the next chapter, I will discuss the concept of movement, such as walking, in designing clothing for comfort.

The method of quantifying bodily movement through 3D Motion Capture (MC) data is not able to fully cover a person's qualitative dynamic movement, including features such as people's gaze. This limitation is because MC data is simply and quantitatively characterised in terms of biomechanical or physical speed, direction or path. Therefore, I also reviewed the 2D video data using Laban Movement Analysis (LMA); this method is designed to afford rich interpretations and yield qualitative descriptions of movements, in addition to the physical.

In the next chapter, I will elaborate on the participants' qualitative, dynamic characteristics of movement, comparing three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful'). From the results of the two studies (MC experimentation and LMA), I will propose design principles, which are based on the concept of design for movement, to produce clothing that has an intended emotional impact.

Chapter 10

Qualitative emotional expression

(Laban Movement Analysis)

Chapter 10

Qualitative emotional expression

10.1 Introduction

This chapter is the second part of testing the EAI framework in the context of a kinaesthetic understanding of comfort — doing through feeling, feeling through doing — analysed by comparing different walk types ('natural,' 'happy,' and 'fearful') and different garment types ('normal,' 'happy,' and 'fearful'). In this context, this phase of the study identifies the characteristics of participants' emotional body movements using Laban Movement Analysis (LMA). The LMA approach functioned as a complementary investigation of qualitative emotional expression and human movement in conjunction with the Motion Capture (MC) experiment, which enabled subsequent quantitative analysis of body movements using 3D Motion Capture data and ANOVA (see Chapter 9). In this chapter, Section 10.2 gives a detailed description of Laban's theory of movement and explicates how to apply LMA for analysis of bodily movements in the context of emotion and garments. The aim and questions are outlined in Section 10.3. Section 10.4 describes the method used for the experiment, explaining how emotionally triggered walking behaviours were analysed qualitatively. In Section 10.5, I discuss how specific emotions (happy and fearful) are incorporated into walking styles in the trial, the responsive character of bodily movements, and how different types of a garment can affect walking styles in the 'normal', 'happy' 'and 'fearful' experiential scenarios. Section 10.6 summarises this phase of the experiment and discusses how the concept of design for movement in clothing design can be implemented to enhance comfort; from this overview, recommendations are made, based on findings from the Motion Capture and Laban movement analysis. Conclusions are presented in Section 10.7.

10.2 Applying Laban Movement Analysis (LMA) to analysis of bodily movements in the context of emotions and garments

This study utilises the theory of Laban Movement Analysis (LMA), which comprises the basic elements of four interrelated categories — *Body, Space, Effort, Shape* — with which the qualitative and dynamic character of the participants' movement system was analysed by comparing three different walk types ('natural,' happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful'). Rudolph Laban[1] introduced the basic framework of movement theory, which made a significant contribution to the study of movement and the observation of human movements in dance, performance of industrial work tasks and in everyday situations. There are two systems in the work of Laban for capturing the quality of movement: Labanotation and Laban Movement Analysis (LMA) (Laban, 1960, 1963; Laban & Lawrence, 1947). The principle aim of Labanotation is to record by means of symbols the physical and structural aspects of such movements as direction, place, position and involved body parts, whereas LMA is concerned more with a qualitative description of the movement, not simply the physical characteristics.

The Laban Movement Analysis (LMA) that I employed in this study is designed to provide rich interpretations and significant qualitative descriptions of movements (1960). The theory of LMA uses four interrelated categories — *Body, Space, Shape*[2]*, Effort* — to describe movement systems. The four components can be broken down into separate elements. In this chapter, I will describe LMA and the validity of using selected elements to analyse the qualitative and dynamic characteristics of the participants' movements, by comparing three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful'). A detailed explanation of selected LMA elements follows (Laban & Lawrence, 1974; Bartenieff & Lewis, 1980; Hackney, 1998; Fagerberg et al., 2003; Ross, 2008).

[1] Rudolph Laban (1879-1958) was an Austrian-Hungarian dancer, choreographer, teacher, philosopher, theorist and writer. He is still considered the most important movement theorist of the 1900s. The overarching theme of Laban's work was in terms of how people's movements and behaviour are affected physically and emotionally by physical conditions, environment, cultural issues, and in communication with their bodies and the universe at large (Adrian 2008). In this study, I did not investigate in detail his historical background as this was beyond the scope of this study, but focused on the LMA system to develop a movement framework for observing qualitative bodily changes in movement.

[2] Throughout this document I capitalise and italicise key terms (main components) and only capitalise sub-components defined by LMA, to distinguish them from their common English language usage.

Body is the connectivity and organisation of the whole body. Analysis of *Body* primarily involves determining body part usage and phasing, subcategorised as initiation, connection, and sequencing, but also looks at the body patterns (body attitude)[3] in movement (head-tail, upper-lower, body-half, etc.).

Space is the person's use of their body in the surrounding space, which includes whole body use, interaction with the environment, and personal space. In other words, space organises and clarifies the body and its actions by establishing a clear pathway or goal for movement. *Space* includes the size, approach to and use of one's kinesphere or personal space, and also defines a clear spatial matrix around the body.

Shape, in general, includes the forms, or changing forms, that a person's body makes in space. *Shape* analysis provides a set of descriptors for dynamic, fluctuating shape characteristics, classified into categories of Basic Shapes/Forms, Shape Flow Support, Mode of Shape Change, and Shape Quality. In this study, Basic Shapes and Shape Quality were used to analyse body movements. These are described in detail below.

Basic Shapes describe the static shapes that the body takes, for example, wall-like, pin-like, ball-like, or screw-like. Each of the names is defined by specific use of space along the planes of horizontal (left-right), vertical (up-down), and sagittal (up-down and forward-backward). For example, the pin body form is characterised by use of the vertical plane. The wall body form is characterised by use of both the vertical and the horizontal plane. Thus a person who uses the wall body form may move up-down in the vertical plane, but also side-to-side, taking up more personal space. The ball body form uses the sagittal plane by rounding inward. The screw body form uses all the planes with a general body twist in all directions (Bartenieff & Lewis, 1980). This element of *Shape* was selected because it is relevant to analysis of body forms in a range of movement sequences that were extracted from the video footage of participants, as they performed each walking trial when interacting with three different garment types ('normal,' happy,' and 'fearful').

[3] The term Body attitude categorised in *Body* is also used in the *Space* category (Campbell, 2005).

Shape Quality was particularly important for this study, as it gives information about shape change in relation to the environment or an object (garment) in the environment. Shape Quality is concerned with how the body changes its shape and unique direction toward some point in space, with opening-closing pairs of movement sharing the same plane. Opening and closing, indicating the degree of extension or contraction in the body as it changes shape, can be described in three different planes: horizontal, vertical, and sagittal. As shown in Figure 10.1, a horizontal plane is called the table plane, as adapted by Davies (2001, cited in Fagerberg et al., 2003). It is presented on a scale from spreading to enclosing, that is, enclosing something or someone, or an opposite movement. Movements about the horizontal plane also reveal the general closing and opening of the body, which indicates the degree of an outward and inward direction along the horizontal axis. The vertical plane, which is also called the door plane, includes rising to sinking movements, which indicates the degree of upward and downward movement in the vertical axis of the body, rising or sinking in relation to something or someone. The sagittal plane, also called the wheel plane, involves body movements of advancing and retreating, which define the degree of forward and backward direction of the body in the sagittal axis, meaning advancing to or retreating from someone or something in the environment (Fagerberg et al., 2003).

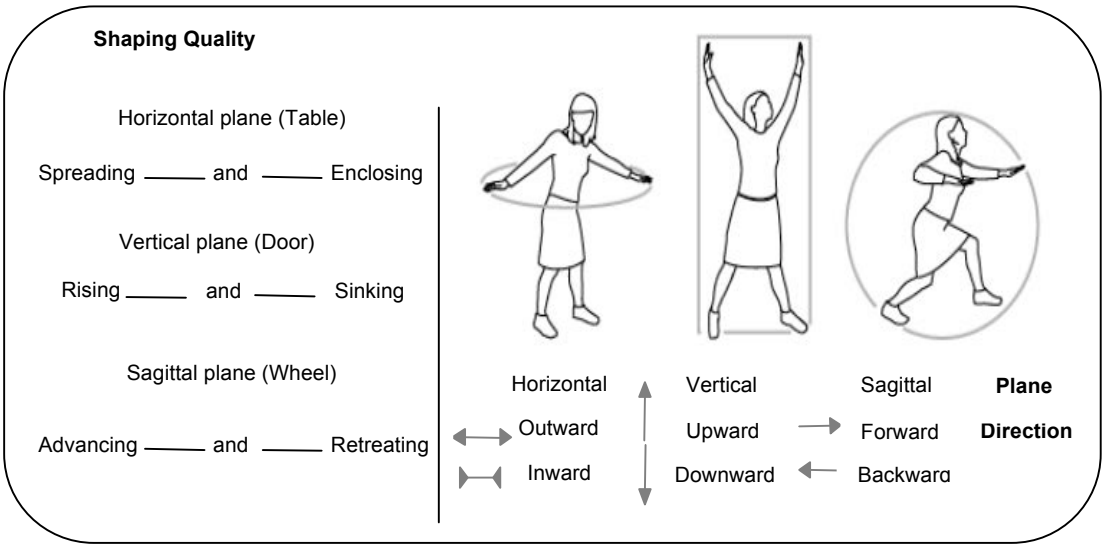


Figure 10. 1. The three different planes of *Shape*, as adapted by Davies.
Source: Fagerberg et al., 2003, p. 60.

Figure 10.1 shows the Shape Qualities described in the three different planes of shape. The left side in Figure 10.1 shows that each shape factor is a continuum between two extremes, for example, spreading-enclosing, rising-sinking, and advancing-retreating. The right side in Figure 10.1 has images of torso and limb movements in conjunction with three shape elements. Hackney (1998) asserts that these three shape elements are related to 'social relevance' (Ross, 2008, p. 132). 'Arm movements are for example based on opening up or crossing around the body to the environment indicating self-defense' (cited in Ross, 2008, p. 132). Shape Qualities signal not only specific body use, but also the inner intent of the person. In this study, Shape Qualities were selected to analyse walkers' dynamic qualities of body movements because this assists in the observation of walkers' movements and how these express their emotional intent.

Effort primarily describes the expressive content or style of one's movement, its changing, dynamic quality and the person's inner attitude towards using energy. Laban considered the *Effort* component to be the most telling expression of a mover's intention: '[…*Effort* is] indicative of the state of mind of the mover' (cited in Bartenieff & Lewis, 1980, p 53). This is associated with social and emotional activity levels. The LMA *Effort* factors have four elements: Flow, Space, Time, and Weight. The intensity of the *Effort* components varies and is measured on a bipolar scale, the extreme values of which represent opposite qualities along each axis. The eight *Effort* elements are: Free/Bound, Indirect/Direct, Sustained/Sudden, and Light/Strong. The eight elements can be combined and sequenced for many variations of phrasing and expression. Tables 10.1 to 10.4 show the LMA *Effort* elements with the extremes for each motion factor, including key words and examples (cited in Ross, 1980, pp. 126-128). These are described in detail below each table.

Table 10.1 lists the key words and examples of the quality of Flow Effort:

Effort Motion Factor	**Flow Effort** Amount of control and bodily tension	
Quality of Element	**Free**	**Bound**
Key Adjectives	Open Released Outpouring Loose Fluid	Restricted Contained Controlled Tight Careful
Examples	Waving wildly, shaking off water, flinging a rock into a pond (Zhao, 2001). Swinging a heavy object before flinging it away, a child's relaxed whirling in delight (Ross, 2008).	Moving in slow motion, fighting back tears, carrying a cup of hot tea (Zhao, 2001). Gesture of cautious refusal, tightening one's chest in a state of fear (Ross, 2008).

Table 10.1. The characteristics of Flow Effort, as adapted from LMA.
Source: Ross, 2008, p.127.

Flow Effort is mainly concerned with the amount of control and bodily tension, and is comparable with Shape Flow. It defines the continuity of a movement, such as 'goingness,' from free through to bound, or continuity of the movement that results from muscle tension, coordination and personal expressivity. The free quality of flow describes movements that are loose and freely flowing and is associated with expressivity that is open, released, and outpouring. The bound quality of flow represents movements in association with expressivity that are restricted and controlled. Analysis of body movements in Flow Effort for this study was important, because I was able to identify the differences in bodily features and expressions between the 'Fearful Walk,' which showed fearful gaits, and the 'Happy Walk,' which showed happy gaits.

Table 10.2 lists the key words for the two extremes of Space Effort and gives examples of the quality of the Space motion:

Effort Motion Factor	**Space Effort** Attention to the surroundings	
Quality of Element	**Indirect**	**Direct**
Key Adjectives	Spiralling Deviating Wandering Multi-focused Flexible attention All-round awareness	Straight Undeviating Single-focused Channelled Pinpointed Laser-like
Examples	Waving away bugs, surveying a crowd of people, scanning a room for misplaced key (Zhao, 2001).	Threading a needle, pointing at something specific, describing the exact outline of an object (Zhao, 2001).

Table 10.2. The characteristics of Space Effort, as adapted from LMA.
Source: Ross, 2008, p.128.

Space Effort refers to one's attention to the surroundings, which is sometimes referred to as focus. The space motion factor describes the directness or otherwise of the movement and the path followed, in terms of 'how the mover gives attention to space. It is not about the place in space,' but rather, how one moves through it (Ross, 2008, p. 127). Space Effort varies from indirect to direct. Indirect movement is flexible, spiralling, deviating, wandering, and with multi-focused attention. Direct space motion is straight, smooth, undeviating, channelled, and with single-focused attention. Analysis of body movements in Space Effort was particularly important, because additional expressive features such as eye gaze could not be analysed using 3D Motion Capture data.

Table 10.3 lists the key words and gives examples of the quality of the motion factor in Time Effort:

Effort Motion Factor	**Time Effort** Lack or sense of urgency	
Quality of Element	**Sustained**	**Sudden**
Key Adjectives	Leisurely Gradual Lingering Prolonging Indulging	Urgent Quick Instantaneous Staccato Fleeting
Example	Stretching to yawn, striking a pet (Zhao, 2001). Embracing a dear friend, prolonged farewells (Ross, 2008).	Lunging to catch a ball, grabbing a child from the path of danger, making a snap move (Zhao, 2001). Response to the unexpected, such as the touch of fire (Ross, 2008)

Table 10.3. The characteristics of Time Effort, as adapted from LMA.
Source: Ross, 2008, p.126.

Time Effort describes the person's inner attitude towards the time available, but not how long it takes to do a movement. That is why the terms in the two opposing poles are 'sustained' (stretching the time, indulging) and 'sudden' (urgent, quick) rather than 'slow' and 'fast' (Ross, 2008, p. 126). Moreover, in a sequence of movements, each of them has a given duration in time, which gives the time-rhythm. In this study, I included the two opposing extremes of 'sustained' and 'sudden.' Analysis of Time Effort in body movements was useful to identify the different inner attitudes and expressions through time, between the 'Fearful Walk,' which was characterised by fearful gaits, and the 'Happy Walk,' which was characterised by happy gaits.

Table 10.4 lists the key words and gives examples of the quality of the motion factor in Weight Effort:

Effort Factor	**Weight Effort** Attitude to the movement impact	
Quality of Element	**Light**	**Strong**
Key Adjectives	Airy Delicate Fine touch Buoyant Weightless	Powerful Forceful Firm touch Impactful Vigorous
Examples	Dabbing paint on a canvas, pulling out a splinter, describing the movement of a feather (Zhao, 2001). Picking up a very small, delicate object, (Ross, 2008).	Punching, pushing a heavy object, wringing a towel, expressing a firmly held opinion (Zhao, 2001). Smashing an object with a fist, playing forte on a piano (Ross, 2008).

Table 10.4. The characteristics of Weight Effort, as adapted from LMA.
Source: Ross, 2008, p.127.

Weight Effort refers to the body's responses to gravity and the impact of one's movement, and also to pressure. It is classified into two types: Active Weight and Passive Weight. Active Weight is about a person's intentions in moving, while Passive Weight is about the relationship of the movement to gravity (Ross, 2008, p. 126). In this study, I measured only Active Weight, because it would be too difficult to measure a person's gravity. Active Weight dynamics range from 'light' to 'strong.' 'Light' movements are gentle, delicate, with fine touch, easily overcoming gravity, and with decreasing pressure, whereas 'strong' movements are powerful, forceful, with firm touch and impact, and involve putting one's weight into the movement.

In general, Shape changes occur with corresponding Effort, as outlined in Table 10.5, below.

Dimension	Shape	Effort
Vertical	Sinking	Weight: Light
	Rising	Weight: Strong
Horizontal	Enclosing	Space-Direct
	Spreading	Space-Indirect
Sagittal	Retreating	Time-Sudden
	Advancing	Time-Sustained

Table 10.5. Shape and Effort Affinities.
Source: Zhao et al., 2000.

Each walker has her own unique repertoire of, and preferences for, combinations of these basic elements, which can be sequenced, phased, patterned and organised together in a particular personal, artistic, or emotional way. In this study, I have mainly focused on *Shape* and *Effort* among the four LMA fundamental elements, because these apply to the patterning of movement throughout the whole body and are related to internal feelings and intentions. Further, these elements function as a useful, comprehensive and valuable set of parameters for describing the form and execution of the qualitative aspects of movement, and the emotional expression conveyed by gestures, while the participants interacted with garments in this study.

Table 10.6 gives an overview of the LMA fundamental elements and selection of elements for this study:

Laban Movement Analysis (LMA) Fundamental Elements			
Body	**Space**	**Effort**	**Shape**
The connectivity and organisation of the whole body. • Body attitude • Active/held body parts • Initiation & follow through • Pattern of total body connectivity	The psychological and physical use of the body in the surrounding space. • Kinespheric Reach • Approach to Kinesphere	A description of the energy invested in a movement or series of movements. • Flow Effort • Time Effort • Weight Effort • Space Effort	A description of the constantly changing forms that the body makes in space. • Basic Forms • Shape Flow Support • Modes of Shape change • Shape Qualities Rising Sinking Advancing Retreating Widening Narrowing

Table 10.6. Overview of the fundamental elements of LMA and those selected to analyse the patterns of bodily movement in conjunction with clothing. I focus on the elements of *Effort*, *Space* and *Shape* (in particular, Basic Forms and Shape Qualities). Other LMA elements, which are in lighter print, were not used.

10.3 The research aim

Qualitative identification of the character of body movements was done in conjunction with the quantitative analysis that used 3D MC data (see Chapter 9). The specific aim of this phase of the study was to understand and identify the qualitative, dynamic character of the movements of participants in relation to three different walk types ('natural,' 'happy,' and 'fearful'), and three different garment types ('normal,' 'happy,' and 'fearful').

10.3.1 The Research questions and objectives

The research questions that determined the focus of the LMA phase of research were as follows:

- What are the characteristics of people's movements (female, n=8, age of 20-40 years), in a comparative study of different walking types ('natural,' 'happy,' and 'fearful') in association with garment types ('normal,' 'happy,' and 'fearful')?

And specifically:

- What are the body positions and movement patterns of participants' head, hands, legs, and trunk, in different emotional scenarios?

This included:

- How is a body attitude expressed in walk style, compared to a ball and a pin and compared to a pin and a screw?)
- How is a whole body shaped and how does it move in different circumstances? For example, how are Shape qualities expressed in different areas of the body when it is opening-closing, rising-sinking, and advancing-retreating?
- How does a person use her body in terms of Time, Flow, Space, and Weight in *Effort* motion?

10.4 Method

In the following sections I summarise the methods and procedure of the qualitative analysis, using data collected in the MC experiment in Chapter 9, then give an overview of the procedure.

10.4.1 Participants

The method I used in the participant observation study was to collect 2D video data in order to assess how participants moved and performed. Eight participants (female, age of 20-40 years) participated to enable an analysis of the variations between their emotions and their movement characteristics when they interacted with three garment types.

10.4.2 Stimuli

As mentioned in Chapter 9, three stimuli were used for building a picture of the 'Fearful Walk' trials, along with two scenarios, and the garment. The research considered two emotions in particular, 'happiness' and 'fear,' in order to observe the comparable qualities of movement. Two short scenarios were developed for participants as follows:

- Scenario 1: (the 'Happy Walk' trial): please recall your happiest experience, such as a meeting with close friends you haven't seen for a long time in a public space. Then you are walking in this situation.
- Scenario 2: (the 'Fearful Walk' trial): please recall your most fearful experience, such as walking along a dark street when someone is following behind you. Then you are walking in this situation.

Three distinctive styles of garment were provided for the participants to interact with while wearing the garments in different scenarios, as I mentioned in Chapter 9 (Section 9.4.3.3). One, the 'Normal Garment,' was black leggings or jeans and a black tight, stretchable top. The 'Happy Garment' and 'Fearful Garment' were both formed by wrapping the conceptual prototype, Touch me, Feel me, Play with me in

different ways. The ‘Happy Garment’ was a sleeveless, half-length coat style. The ‘Fearful Garment’ was a sleeveless jacket style with a hood.

10.4.3 Procedure

Eight participants performed the experiment in twenty-seven trials, using three different walk types (‘natural,’ ‘happy,’ and ‘fearful’), and three different garment types (‘normal,’ ‘happy,’ and ‘fearful’). Specifically, they performed three trials of the ‘Natural Walk’ when wearing the ‘Normal Garment,’ ‘Happy Garment’ and ‘Fearful Garment’ (3 + 3 + 3). They then performed three trials of the ‘Happy Walk’ when wearing the ‘Normal Garment,’ ‘Happy Garment’ ‘Fearful Garment’ (3 + 3 + 3). Finally, they performed three trials of the ‘Fearful Walk’ when wearing the ‘Normal Garment,’ ‘Happy Garment,’ and ‘Fearful Garment’ (3 + 3 + 3). The ‘Natural Walk’ was defined as the way participants walked with no intended emotion, while the ‘Happy’ and ‘Fearful’ walks were defined as the way they walked while expressing the intended emotion (happiness or fear).

To establish and maintain emotionally involved walking, the participants began with a warm-up. Before each trial walk, it was useful for participants to do stretching or breathing exercises and spend time (five minutes) experiencing certain emotions (‘happy’ and ‘fearful’) with focused attention. When participants were ready to be filmed, I read the scenario out loud and then the participant began walking. When being filmed, the participant was not allowed to talk. Videotaping of the three walk styles (‘natural,’ ‘happy,’ and ‘fearful’) for each subject was done in a single session. The twenty-seven trials took about an hour for each participant. All walkers were individually filmed and their body positions and movements obtained. The average duration of each film clip was approximately 7.2 seconds with the ‘Happy Walk,’ and 8.2 seconds with the ‘Fearful Walk.’ The video recordings and video clips of participants’ actions were viewed a number of times individually by the researcher, in order to identify and evaluate the specific qualities of movements associated with the three walk types (‘natural,’ ‘happy,’ and ‘fearful’), and three garment types (‘normal,’ ‘happy,’ and ‘fearful’).

10.4.4 Movement analysis

In total, 216 video clips from the performance of the eight subjects were recorded with the Vicon Motion Analysis System, using 10 advanced semi-infrared Vicon F40 cameras. The video recordings and video clips of participant's performance were viewed a number of times by the researcher in order to observe their performance in terms of LMA components. There were two ways of proceeding:

- View one performance at a time, observing the same video several times from the viewpoint of *Space*, *Effort*, and *Shape*.
- View many performances, looking at each performance from the viewpoint of one of the LMA components. That is, observe all of the videos looking at Shape. Then observe all of the videos looking at *Effort*.

After having completed the observations of each walking performance in order to analyse the LMA's *Body*, *Space*, *Shape* and *Effort* attributes across different walking types ('natural,' 'happy,' and 'fearful') and different garment types ('normal,' 'happy,' and 'fearful'), the movement analysis aimed to answer the following research questions:

- How are Body Attitude and patterns of movement different in each type of walk? (e.g., head-tail, upper-lower, legs and arms);
- Regarding the *Shape* component, in terms of the Basic Form/body Shapes (pin, ball, wall, and screw) how is body attitude different in different walk styles, in terms of wall compared to ball, and pin compared to screw?
- Regarding Shape Qualities in the *Shape* component, how is the whole body's movement different in different walk styles (e. g., locating the shape qualities in different areas of the body, such as opening-closing, rising-sinking, advancing-retreating)?
- Regarding Quality of Time, Flow, Space, Weight in the *Effort* component, how does a person use her body in terms of time, flow, space, weight motion factors?

When considering the participant's body movements in different walking types ('natural,' 'happy,' and 'fearful') when interacting with three different garment types ('normal,' 'happy,' and 'fearful'), one participant out of the eight was selected to present the results because she had much in common across a variety of dynamic and definite body movements. In addition, AnCamera 3.4 software program was used to capture part of the trajectory of the subjects' bodily movements (*AnCamera*, n.d.).

10.5 Analysis and discussion of results

10.5.1 Qualitative LMA analysis of emotional expression in body movements and garment interaction

In this section, I will present a range of visual representations of the movement sequences, which were extracted from the video footage and photo documentation of participants performing each walk type when interacting with three different garment types. These comparative movement sequences allowed a closer analysis of the moving body in its trajectory through space and time, and also enabled an analysis of movement phases, postures of the body, the organisation of the body and its parts, the shape of the body and the relationship of the body to emotion. Analysis of the character of the body movements revealed that there were significant differences between the two emotional walk types ('Happy Walk' (HW) and 'Fearful Walk' (FW)) and the walk type with no intended emotion ('Natural Walk' (NA)) when participants interacted with three different garment types ('Normal Garment' (NG), 'Happy Garment' (HG), and 'Fearful Garment' (FG)). In addition, results showed that participants performed a wider range of bodily movements and engaged and played more with the 'Happy Garment' than with the others ('Normal Garment' and 'Fearful Garment') while in the 'HW.' Similarly, subjects' bodily movements with the 'FG' showed more dynamic and blended qualities while in the 'FW.' In addition, even though the eight participants' bodily expressions and walking types were slightly different and variable, there were common and salient expressive movements. I have selected the participant' characteristic dynamic and diverse bodily movements to be examined further in the results and discussion section.

10.5.1.1 Participant's movement sequence in the 'Happy Walk' when interacting with three different garment types ('Normal,' 'Happy,' and 'Fearful')

Considering the 'Happy Walk,' Figures 10.2 to 10.4 show a sample of the participants' movement sequences while interacting with three different garment types ('Normal Garment' (NG), 'Happy Garment' (HG) and 'Fearful Garment' (FG)). The movement sequences in the time of each image frame in the sequence lasted approximately 0.22 seconds. The dots and lines highlight the changing body positions of the head, centre of torso, and limbs. For the 'Happy Walk' type, this participant performed flowing and unrestricted bodily movements. In addition, her performances in the movement sequences were stylistic and fluent, showing distinct changes in the character of kinaesthetic movements, which could be translated into a sense of telling a story. In further qualitative analysis, as seen in Figures 10.2 to 10.4, the participant swung her arms more in side-to-side, up-down, and forward-backward motions, and she opened and clapped her hands when she performed 'Happy Walk.' In addition, her arms swung clockwise while holding the 'Happy Garment,' as if she was playing with the garment. Her body was held erect and upright and her upper body was thrown backwards and rolled from side-to-side. She moved with faster, longer stride lengths than in other walk types ('Fearful Walk' and 'Natural Walk').

In addition, concerning the distinctive character of movements in the 'Happy Walk' type when wearing the three different garment types, her sequential movements, (for example, hand, arm, and head movements and positions) engaged more with the garment, in particular the 'Happy Garment.' For example, as can be seen in Figures 10.2 to 10.4, the participant's arms (whether left or right or both of them) spread out and were raised in various side-to-side, up-down, and forward-backward movements. Her hand movements involved smoothly grasping and gently touching the 'Happy Garment.' The participant was focused on the garment and her head moved up and down. She behaved gracefully and walked as if she was a charming lady. These results suggest that the experience of the 'HW' in association with the properties of the 'HG' may evoke self-assured or self-centred characteristics.

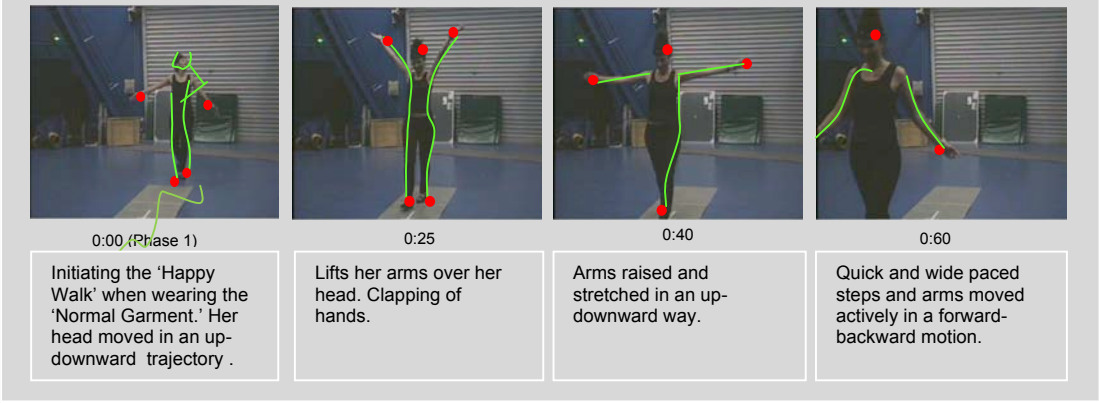


Figure 10.2. Participant's movement sequence in the 'Happy Walk' when interacting with the 'Normal Garment.'

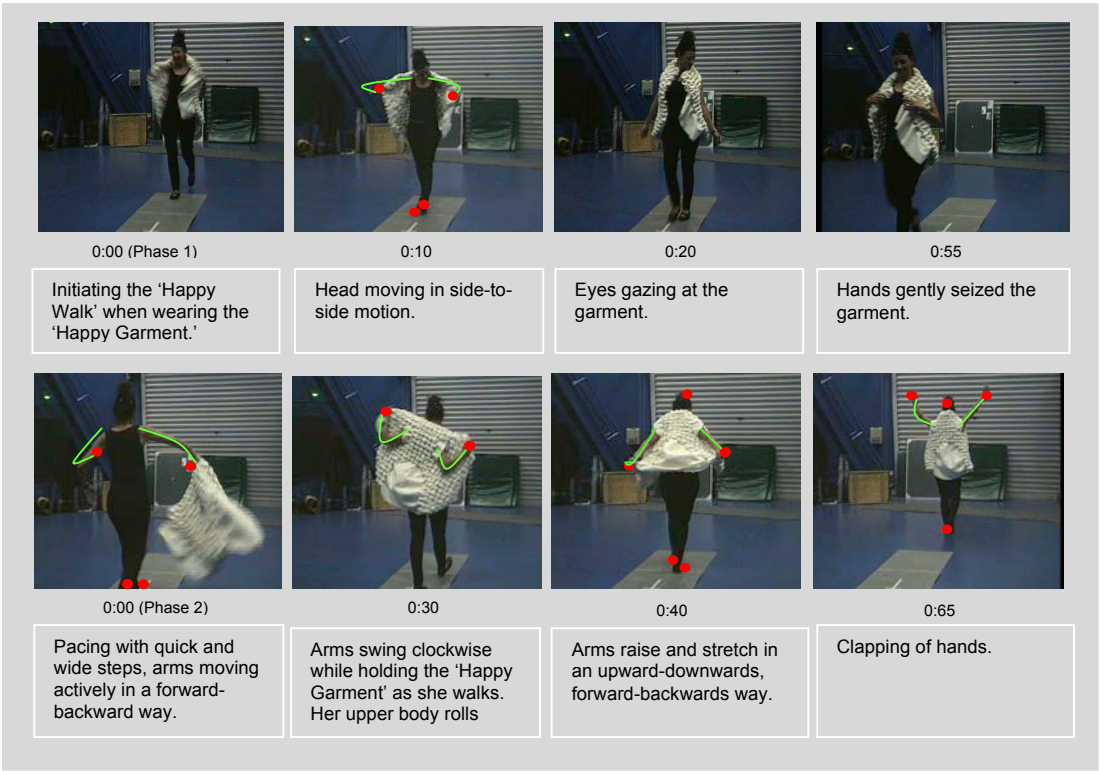


Figure 10.3. Participant's movement sequence in the 'Happy Walk' when interacting with the 'Happy Garment.'

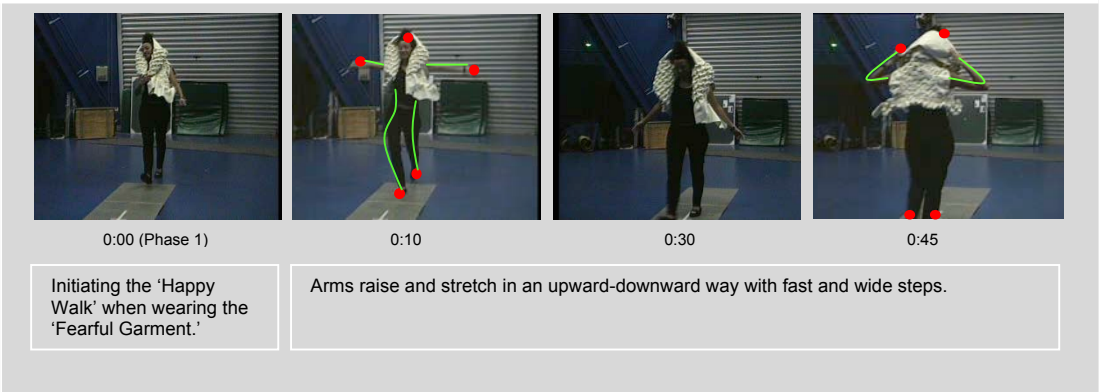


Figure 10.4. Participant's movement sequence in the 'Happy Walk' when interacting with the 'Fearful Garment.'

Figures 10.5 to 10.7 show a series of human figures as illustrations of the movement sequences shown in Figures 10.2 to 10.4. The illustrated human figures are showed over time to indicate the progression of movement in the 'Happy Walk' when the participant interacted with three different garment types ('Normal Garment,' 'Happy Garment,' and 'Fearful Garment'). In addition, the series of figures elucidate how the body was shaped through movement, using the concepts of Body Form, Shape Quality, and Effort adapted from Laban Movement Analysis (LMA). A range of different parameters was derived from the changing positions of the head, centre of torso, arms and feet. These parameters include the trajectory of the body, the changing position and relation of body parts along the trajectory, and the dynamically changing pattern of spatial shaping, timing, rhythm, and character of the movements. In order to distinguish each garment type, the 'Normal Garment' is pigmented in grey (Figure 10.5). The 'Happy Garment' is illustrated with grey human figures wearing a yellow short jacket style (see Figure 10.6). The 'Fearful Garment' is pigmented in grey with the human figures wearing a blue hooded jacket style (see Figure 10.7).

Applying *Shape* and *Effort* analysis, the three representations of the character of the body movements indicate that there were significant differences among the three walk styles, no matter what kind of the garment the subjects interacted with.

First of all, in the 'Happy Walk,' the participant had a specific pattern of movements that were linked to *Shape*. *Shape* analysis provided a set of descriptors for dynamic, blended, and fluctuating shape characteristics, classified into categories of Basic Forms and Shape Quality (other categories exist but have not been used in this research). Details of Basic Forms and Shape Qualities in the *Shape* component of this analysis are described below.

Basic Forms in the *Shape* category describe static shapes; thus, the bodily *Shape* in the first parameter, the trajectory of the body, began pin-like, which is characterised by the vertical plane, often moving up-down and taking up little surrounding space. In the second parameter, the changing position and relation of body parts along the trajectory, it became wall-like, moving up-down in the vertical plane and also side-to-side. In the third parameter, the dynamically changing pattern of spatial shaping,

timing, rhythm, and character of the movements in the emotional movement sequences, each snapshot in time was spread out spatially in the illustration so that the participant' use of her body in the surrounding space, interaction with the garment and environment, and personal space could be clearly seen at that instant.

Each rectangle in Figures 10.5 to 10.7 surrounds the illustrated human figures. It represents the physical kinesphere, which is the changing area that can be reached by the participant's full extension of her limbs, and also depends on the use of the body, changing from outward reach to full extension upward. For Basic Forms in *Shape*, it was found that the participant's use of body forms (attitudes) in space exhibited a characteristic kind of 'showing off' when wearing the 'Happy Garment.' This aspect of body attitude can be interpreted not only as an expression of happy emotions, but also of the person's personality, as it is the dominant way a person chooses to use her body and present herself to the outer world (Hackney, 1998). In particular, Basic Forms, when looked at in terms of the size of squares in Figures 10.5 to 10.7, seemed to occupy wide spaces in terms of a person's kinesphere — the area in which a person operates physically and psychologically. This aspect may be an important clue to determining how the user, wearing a happy garment, accommodates to and uses personal space (kinesphere) emotionally. In particular, the body forms and phases, for instance, showed dynamic and various *Shapes,* from pin-like to wall-like, particularly while interacting with the 'Happy Garment.'

Shape Quality describes how the body changes toward some point in space, for example, opening or closing, indicating the degree of extension or contraction in the body. In the Shape Qualities category, the participant's body movements were rising, advancing and spreading, no matter which garment they interacted with. Figures 10.5 to 10.7 show the movements of a participant who used a large variety of Shaping Qualities in 'Happy Walking' trials when interacting with three garment types ('normal,' 'happy,' and 'fearful'). When the participant was asked to walk as if she were in a happy situation, that is, 'meeting with close friends you haven't seen for a long time in a public space,' the trajectory sequences show a repetitive sweeping and rocking gesture through the entire performance. More specifically, Shaping Qualities show the dynamic character of the limbs, torso, and head movements such as the upward, outward, and forward direction of shape. Her torso is generally erect with

her arms' dynamic movements in an upward, outward, and forward direction. Shaping Qualities, which refer to a body-centred coordinated system with horizontal, vertical, and sagittal planes, revealed the general opening of the body when expressing the emotion of happiness: advancing, rising and spreading when walking happily. In addition, the participant's use of space was three-dimensional, as she made weight transfers in some directions, often in conjunction with various Shaping Qualities.

Effort is the energy expended in performing the movement or external expression of the inner attitude of the mover. The qualitative, dynamic character of a participant's 'Happy Walk' was found to be quick and buoyant within a released, gradual ascent. As shown in Figures 10.5 to 10.7, the corresponding *Effort* was found to be direct in Space, quick in Time, light in Weight, and bound in Flow.

The following figures illustrate how the body is shaped through movement, analysed in terms of *Shape* and *Effort* and using LMA as a conceptual framework.

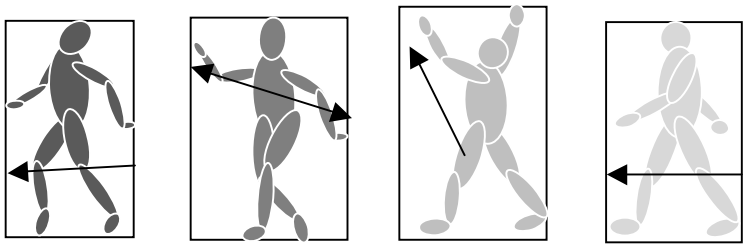
Effort	Direct in Space, Quick in Time, Light in Weight, Free in Flow			
Shape				
Form of body makes in space	Pin-like	Wall-like	Pin-like	
Quality	Spreading	Aadvancing	Rrising	Spreading

Figure 10.5. Changing body shape in space in the 'Happy Walk' when interacting with the 'Normal Garment.'

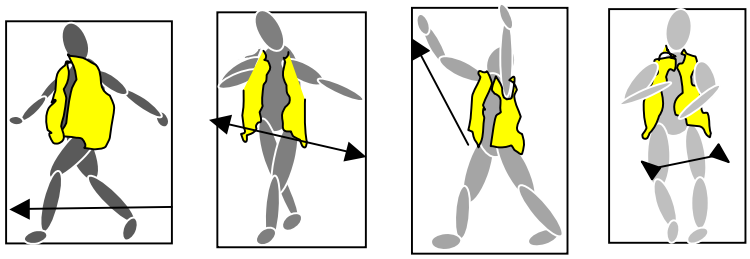
Effort	Direct in Space, Quick in Time, Light in Weight, Free in Flow			
Shape				
Form of body makes in space	Pin-like	Wall-like	Pin-like	
Quality	Spreading	Advancing	Rrising	Spreading

Figure 10.6. Changing body shape in space in the 'Happy Walk' when interacting with the 'Happy Garment.'

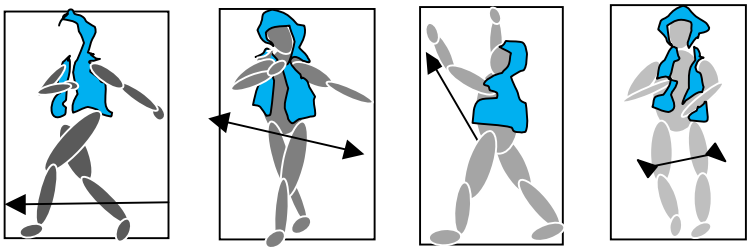
Effort	Direct in Space, Quck in Time, Light in Weight, Free in Flow			
Shape				
Form of body makes in space	Pin-like	Wall-like	Pin-like	
Quality	Spreading	Advancing	Rrising	Spreading

Figure 10.7. Changing body shape in space in the 'Happy Walk' when interacting with the 'Fearful Garment.'

10.5.1.2 Participant's movement sequence in the 'Fearful Walk' when interacting with three different garment types ('Normal,' 'Happy,' and 'Fearful')

In the 'Fearful Walk' (FW), Figures 10.8 to 10.10 show a sample of video clips based on the participant's movement sequences while interacting with three different garment types ('Normal Garment' (NG), 'Happy Garment' (HG), and 'Fearful Garment' (FG)). The time between each image frame in the movement sequences was approximately 3.2 seconds, which means that body attitudes were more sustained and took longer to change. The dots and lines highlight the changing positions of the head, central torso, limbs, arms, and feet. Results show that the participant performed various blended bodily movements and engaged more with the 'FG' than with the others ('NG' and 'HG') while in the 'FW.' For example, the participant folded her arms (left, right or both arms) towards the centre of the body while bending her upper body (head and torso) downwards. Her hands firmly seized 'FG.'

In addition, the 'FW' was found to change Basic Form in three distinctive steps or phases. As can be seen in Figure 10.10, in the first phase, she shook her head from side-to-side and sank her head between her shoulders, or crouched down with a bent body. Her whole body slumped downwards. In the second phase, her hand movements were found to alternate between clenching or firmly seizing the garments ('HG' and 'FG'). Her arms moved and were thrown wildly over her head. Then, her whole body shrank. She raised both shoulders with bent arms pressed closely against her sides or chest and she spiralled in the middle of the walk, turning slowly in a 180° movement. She was seen to be aware of her body in place with slower steps and shorter stride length than for the 'HW' in the third phase. The most distinctive character of movement in the 'FW' type was her body's sequential movements: for example, hands, arms, and head movements and positions. She seemed to act as if watching out for somebody in order to be protected against danger, or looking for relief or escape from danger or fear, when her body shape corresponded closely with enclosing, descending, and retiring movements. This placement of the head, torso, and limbs while walking expressed emotions related to fearful walking, for example how she swayed her head side-to-side and how her arms were bent towards the centre of her body.

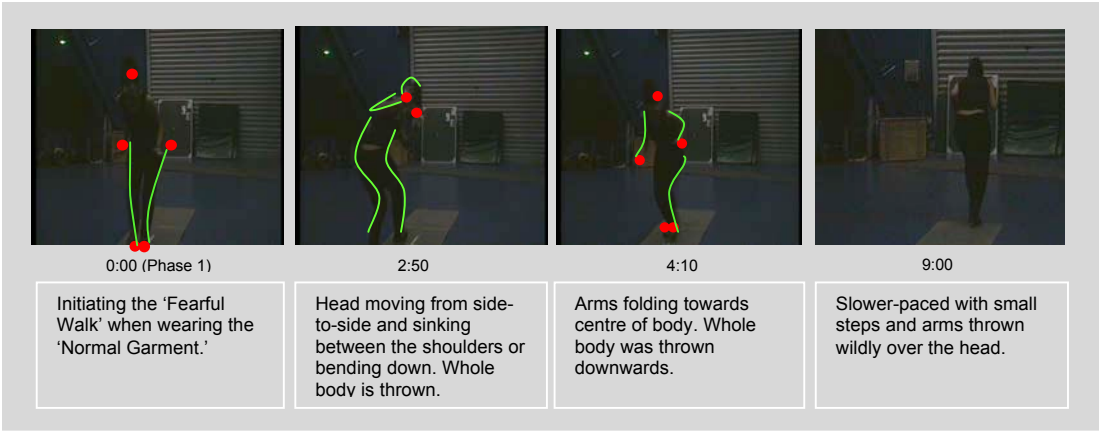


Figure 10.8. Participant's movement sequence in the 'Fearful Walk' when interacting with the 'Normal Garment.'

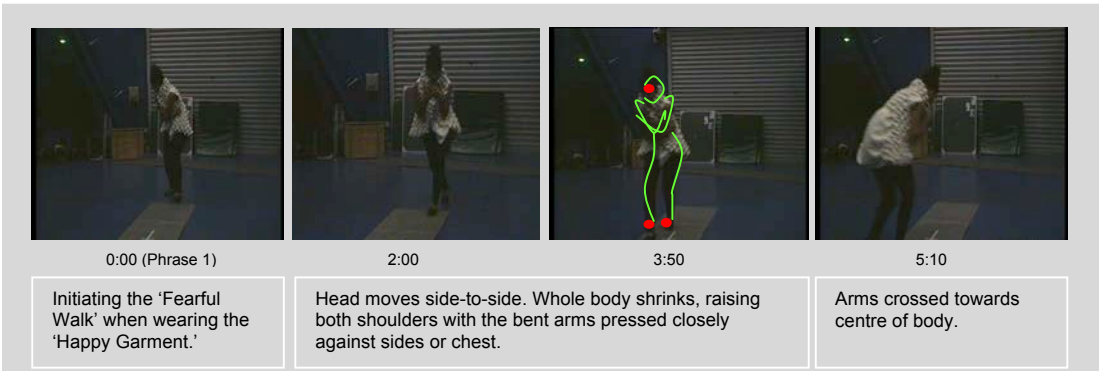


Figure 10.9. Participant's movement sequence in the 'Fearful Walk' when interacting with the 'Happy Garment.'

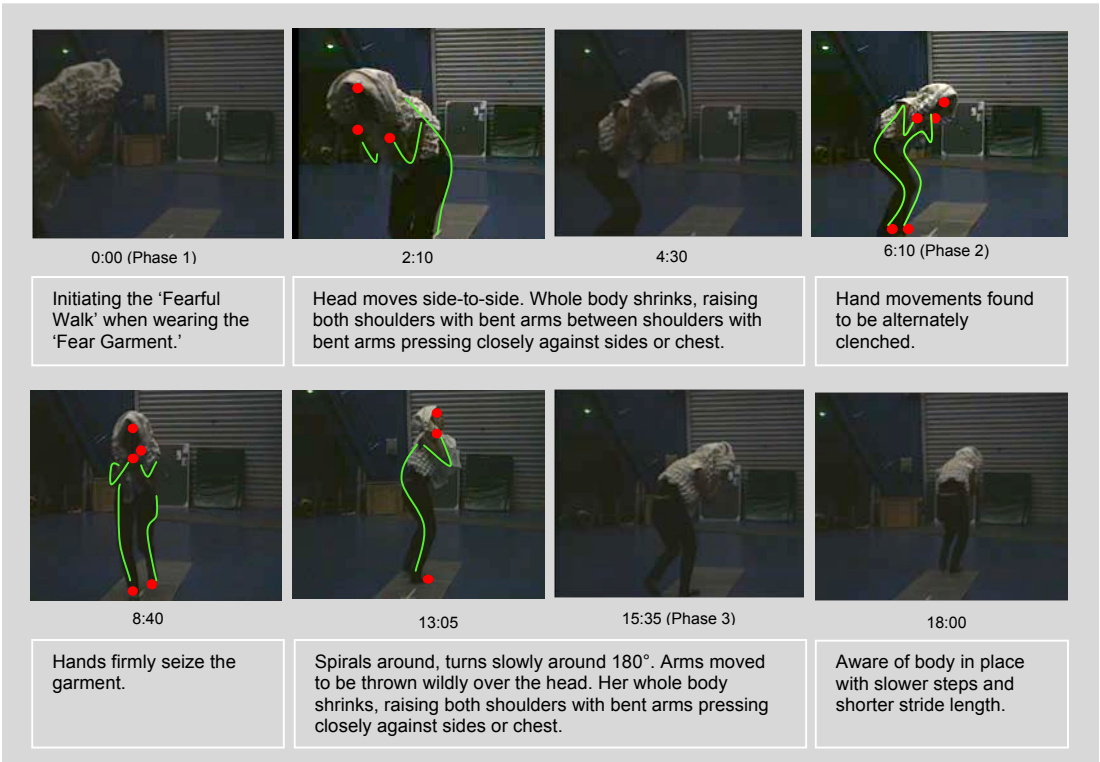


Figure 10.10. Participant's movement sequence in the 'Fearful Walk' when interacting with the 'Fearful Garment.'

A series of sample drawings of human figures were based on visual representations of the movement sequences, as shown in Figures 10.11 to 10.13. The series of drawing of human figures is shown as the series unfolds, to indicate the progression of the movement of 'Fearful Walk' (FW) as the participant interacted with three different garment styles types ('Normal Garment' (NG), 'Happy Garment' (HG) and 'Fearful Garment' (FG)). In terms of Shape and Effort analysis, the representations of the character of the body movements indicate that there were significant differences in the 'Fearful Walk' (FW) while interacting with the 'FG' as compared to with the 'NG' and 'HG'.

In the 'FW,' the participant had a specific pattern of movements that were linked to *Shape*. Figures 10.11 to 10.13 illustrate the Basic Shapes/Forms and Shape Quality in the 'FW', which are described in the following section.

Basic Forms in the *Shape* category describe the static shapes of the body. The *Shapes* assumed by the body in the trial of 'FW' began as wall-like, following the vertical and horizontal plane, moving often to the left and right, and up and down. Then, the *Shape* was ball-like, as the participant moved up and down and forward and backward in the sagittal plane. Next, taking up the wide surrounding space, her *Shape* transformed to the screw form, in which she turned slowly around 360°. As for the emotional movement sequences, each snapshot in time was spread out spatially in the representation, so the participant's use of her body in the surrounding space, interaction with the garment, environment and personal space could be clearly seen at that instant. Each rectangle in Figures 10.11 to 10.13 surrounds the illustrated drawing of human figures and represents the physical kinesphere, which is the changing area that can be reached by the participant's contraction and extension of her limbs, and also depends on the use of the body, changing slowly from upward to downward. In terms of *Shape* and *Space*, Basic Body Forms within this changing kinesphere move from wall-like to ball-like to screw-like forms; in this pattern, the torso gradually descends as the spine contracts, and limbs are moved towards the body's centre, closing the shape. It was found that the participant's pattern of Body Forms in space was as if she tried to watch out for somebody in order to protect herself against danger, and she seemed to feel relieved or ready to escape from danger or fear when her body shape corresponded closely with enclosing,

descending, and retiring movements. This pattern of bodily movement and shape could be linked not only to the expression of fearful emotion, but also to the person's introverted personality (Hackney, 1998). In addition, she seemed to use less personal space than in the 'HW'; this is related to the composition of a person's kinesphere, the area in which a person operates physically and psychologically. This may be an important clue to interpreting the lesser use of personal space when she walked as if she was in a fearful situation.

Shape Quality describes how the body changes in reference to some point in space, such as opening or closing, indicating the degree of extension or contraction in the body. Figures 10.11 to 10.13 show a drawing sample of a participant who used a large variety of Shaping Qualities in her bodily movements in the 'FW' trials when interacting with three garment styles ('NG,' 'HG,' and 'FG'). When the participant was asked to walk as if she was in a fearful situation, called the 'Fearful Walk,' the trajectory shows repetitive flapping, clumsy gestures through the entire performance. More specifically, Shaping Qualities show the dynamic character of the participant's limbs, torso, and head movements, such as the downward-inward, and forward direction of shape. Her torso is generally shrunk, with her arms moving to enclose and protect her centre. Shaping Qualities reveal the general closing of her body, retreating, sinking and enclosing in the emotional scenario of fearful walking, especially when wearing the 'FG.' In addition, the participant's use of space was three-dimensional, as she frequently made weight transfers in all directions, often in conjunction with varied Shaping Qualities.

Considering *Effort*, the qualitative, dynamic character of the participant's 'FW' was found to be sustained and restricted within a gradual descent. As shown in Figures 10.11 to 10.13, the corresponding *Effort* was found to be indirect in Space, sustained in Time, strong in Weight, and bound in Flow.

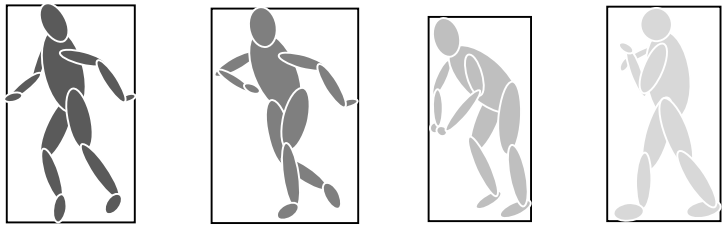
Effort	Indirect in Space, Sustained in Time, Strong in Weight, Restricted in Flow			
Shape				
Form of body makes in space	wall-like	ball-like	screw-like	wall-like
Quality	retreating	enclosing	sinking	

Figure 10.11. Changing shape of the body in space in the 'Fearful Walk' when interacting with the 'Normal Garment.'

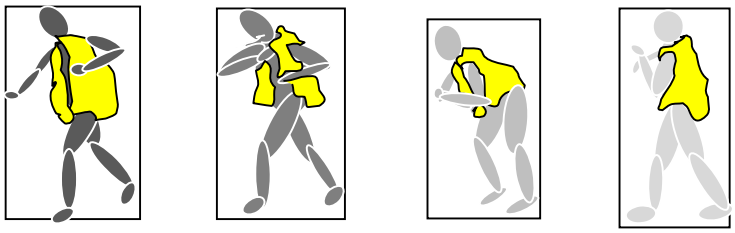
Effort	Indirect in Space, Sustained in Time, Strong in Weight, Restricted in Flow			
Shape				
Form of body makes in space	wall-like	ball-like	screw-like	wall-like
Quality	retreating	enclosing	sinking	

Figure 10.12. Changing shape of the body in space in the 'Fearful Walk' when interacting with the 'Happy Garment.'

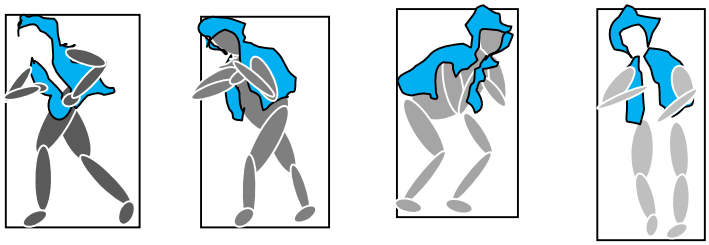
Effort	Indirect in Space, Sustained in Time, Strong in Weight, Restricted in Flow			
Shape				
Form of body makes in space	wall-like	ball-like	screw-like	wall-like
Quality	retreating	enclosing	sinking	

Figure 10.13. Changing shape of the body in space in the 'Fearful Walk' when interacting with the 'Fearful Garment.'

10.5.1.3 Participant's movement sequence in the 'Natural Walk' when interacting with three different garment types ('Normal,' 'Happy,' and 'Fearful')

In the 'Natural Walk,' Figures 10.14 to 10.16 show a sample of the participant's movement sequences while interacting with three different garment types ('Normal Garment' (NG), 'Happy Garment' (HG) and 'Fearful Garment' (FG)). The time between each image frame in the movement sequences was approximately 0.26 seconds. The dots and lines highlight the changing positions of the head, centre of torso, and limbs. In the 'NW,' the participant performed flowing and restricted bodily movements. Her performances in the movement sequences were plain in style.

In Figures 10.14 to 10.15, the participant swung her arm in a simple forward-backward motion. Figure 8.16 shows that her left arm is bent towards the centre of body, holding the 'FG.' Her body was held erect and straight. Figures 10.17 to 10.19 present a series of illustrated drawings of the human figures, representing the movement sequences in Figures 10.14 to 10.16. In terms of *Shape* and *Effort* analysis, the representations of body movements indicate that there were no significant differences in the 'NW' while interacting with three different garment types ('NG,' 'HG,' and 'FG').

Considering Basic Forms in *Space*, in the 'NW,' there seemed to be less use of personal space than in the 'HW,' but more than in the 'FW'; this refers to the rectangular composition of a person's kinesphere, the area in which a person operates physically and psychologically.[4] Shape Quality describes how the body changes toward some point in space, for example opening or closing, indicating the degree of extension or contraction in the body. The trajectory sequences show repetitive, plain gestures through the entire performance. Shape Qualities reveal the movement between retreating-advancing, spreading-enclosing, and advancing-retreating. The participant's use of space was two-dimensional, as she didn't make weight transfers. Considering *Effort*, the qualitative, dynamic character of the participant's 'NW' was found to be sustained and restricted. The corresponding *Effort* was found to be direct in Space, sustained in Time, light in Weight, and bound in Flow.

[4] Each rectangle in Figures 10.17, 10.18 and 10.19 surrounds the illustrated human figures and represents the physical kinesphere.

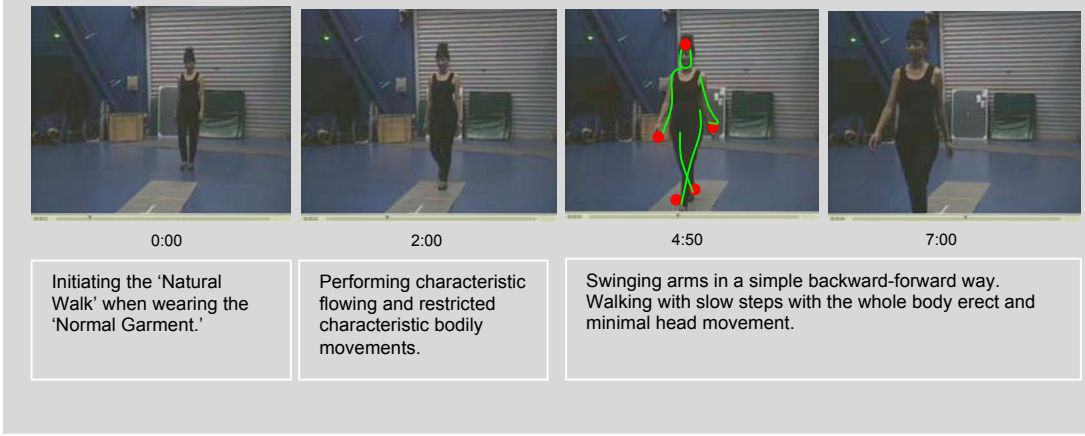


Figure 10.14. Participant's movement sequence in the 'Natural Walk' when interacting with the 'Normal Garment.'

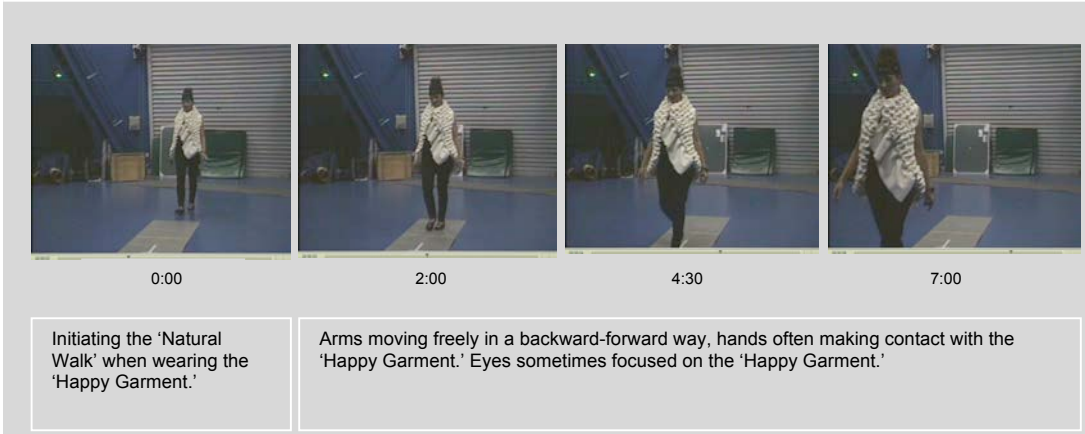


Figure 10.15. Participant's movement sequence in the 'Natural Walk' when interacting with the 'Happy Garment.'

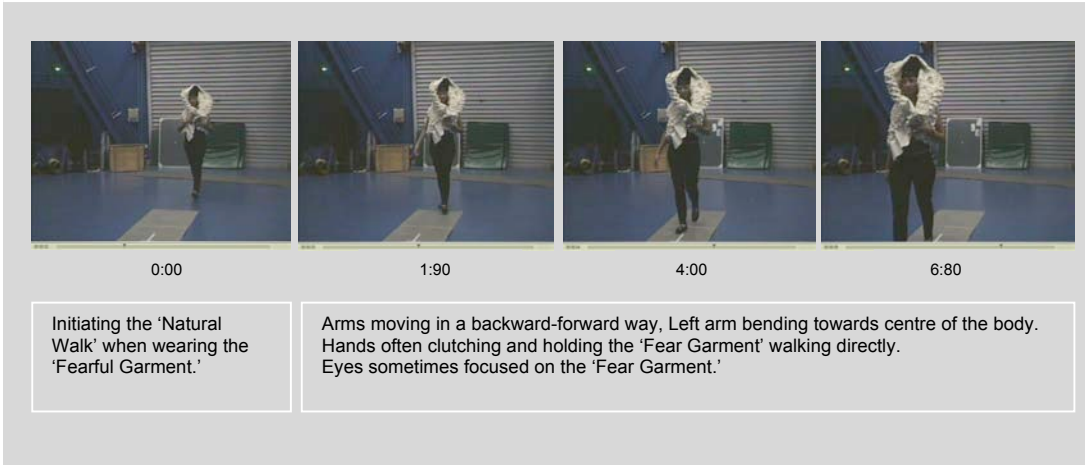


Figure 10.16. Participant's movement sequence in the 'Natural Walk' when interacting with the 'Fearful Garment.'

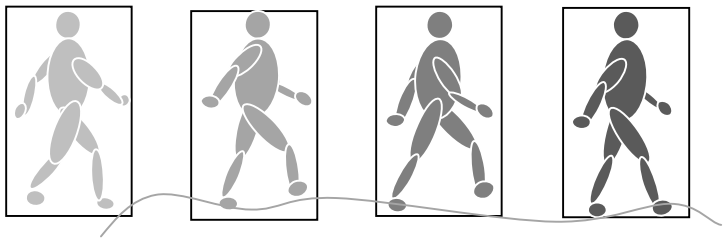
Effort	Direct in Space, Sustained in Time, Light in Weight, bound in Flow			
Shape				
Form of body makes in space		Pin-like		Pin-like
Quality	In between	Spreading-Enclosing	Advancing-Retreating	Rrising-Sinking

Figure 10.17. Changing shape of the body in space in the 'Natural Walk' when interacting with the 'Normal Garment.'

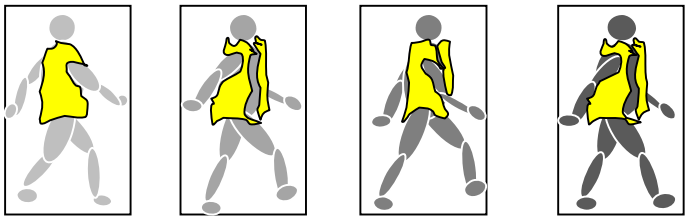
Effort	Direct in Space, Sustained in Time, Light in Weight, bound in Flow			
Shape				
Form of body makes in space		Pin-like		Pin-like
Quality	In between	Spreading-Enclosing	Advancing-Retreating	Rrising-Sinking

Figure 10.18. Changing shape of the body in space in the 'Natural Walk' when interacting with the 'Happy Garment.'

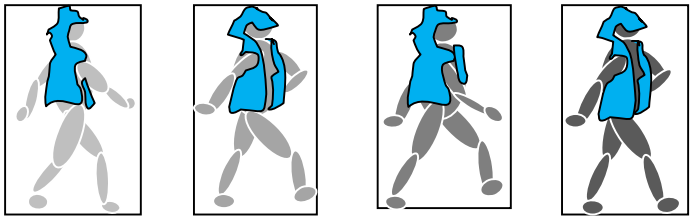
Effort	Direct in Space, Sustained in Time, Light in Weight, bound in Flow			
Shape				
Form of body makes in space		Pin-like		Pin-like
Quality	In between	Spreading-Enclosing	Advancing-Retreating	Rrising-Sinking

Figure 10.19. Changing shape of the body in space in the 'Natural Walk' when interacting with the 'Fearful Garment.'

10.6 Reflection on the Motion Capture data and Laban Movement Analysis

In this study, LMA theory provides a methodology and descriptive system that enables a characterisation of expressiveness and symbolic description of movement qualities, as the basis for further classification of movement and behaviour in terms of *Body*, *Shape*, *Space*, and *Effort*. This qualitative analysis has investigated a range of different results from the trial of the 'Natural Walk' (NW), 'Happy Walk' (HW), and 'Fearful Walk' (FW), providing a detailed analysis of bodily expression and movement in emotional scenarios, with the participants interacting with three different garment types ('Normal Garment' (NG), 'Happy Garment' (HG), and 'Fearful Garment' (FG)).

The qualitative analysis was complemented by quantitative Motion Capture data analysis (see Chapter 9). Together, these analyses provide a range of complementary understandings of the characteristics of the moving body in response to emotional scenarios and three types of garment worn by participants in the trial.

As discussed in Chapters 9, there were unique characteristics of movements: hand range of movements, for example, forward-backward, side-to-side, and up-down; hand velocity, for example, forward-backward, side-to- side, and up-down; head and arm movement; walk velocity; and step length in comparison with three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful').

The 'HW,' particularly while participants were interacting with the 'HG,' reveals the participants moved their heads more in an up-down way, with more arm swing from side-to-side, up-down, and forward-backward, and appeared to be relatively faster-paced, with longer stride lengths than the other walking types. When participants wore the 'HG,' which made them feel happy, they showed more bodily engagement and interaction with the garment. For example, their hands gently seized and touched the 'HG' and their arms swung clockwise while holding it. Their heads moved side-to-side and eyes gazed at the garment. They behaved gracefully and walked in a charming way. The properties of the 'HG' evoked self-assured or self-centred characteristics. The *Shape* of the 'HW,' which describes the changing forms that the

body makes in space (Laban, 1960), showed extreme 'spreading,' 'rising' and 'advancing,' no matter what types of garment participants interacted with. The qualitative, dynamic character of a participant's 'HW' was found to be active and buoyant within a released, gradual ascent trajectory. Considering Laban's *Effort* analysis, participants' use of the Space in the 'HW' had a single and direct focus. The participants moved more quickly in Time, were lighter in Weight, and more bound in Flow than for other walks, for example, 'Fearful Walk' and 'Natural Walk.'

Conversely, for the 'Fearful Walk,' particularly while participants were interacting with the 'Fearful Garment,' it was observed that participants moved their head more in a side-to-side way and their heads sank between their shoulders or were bent down in comparison with the other walking types. They were slower paced and used smaller steps, and their arms were thrown wildly over their heads. When participants wore the 'FG' they seemed to be aware of their body, with slower and shorter step length. Their hands firmly seized the 'FG.' They spiralled around the middle of the walk and turned slowly around 180°. In other words, their bodily tension controlled and restrained their movements, and they acted as if watching out for somebody, adopting a self-defence posture against danger. The 'FW' was found to be extremely 'enclosing,' 'descending,' and 'retiring' when analysed in terms of Laban's *Shape* movement. Concerning Body Form, the torso gradually descended as the spine contracted, and limbs moved towards the body's centre, closing the body. Concerning *Effort*, bodily movements were sustained and restricted within a gradual descent movement, and showed awareness of Space, being sustained in Time, strong in Weight, and bound in Flow. In particular, participants' hands (whether left or right hand or both hands) were positioned to cross and go around the body and to interact with the 'FG.'

For the 'Normal Garment' (NG), it was found that participants swung their hands more and faster in a side-to-side, up-down, and forward-backward way than for the other garment styles. In the 'Natural Walk' (NW), no matter what type of garments they wore, participants performed flowing, repetitive, plain and restricted movements, characterised by being in between retreating-advancing, spreading-enclosing, and advancing-retreating in Shape Quality. The Body Form showed their heads and shoulders were up. Considering *Effort*, the qualitative, dynamic character

of the participant's 'NW' was found to be sustained and restricted. The corresponding *Effort* was found to be direct in Space, sustained in Time, light in Weight, and bound in Flow.

The following Tables 10.7 (a) and 10.7 (b) presented and discussed in the concluding section, summarise the characteristic body movements of all participants, revealing the comparison of the pattern of movements in three different walking types ('natural,' 'happy,' and 'fearful') with participants wearing three different garment types ('normal,' 'happy' and 'fearful'), based on 3D Motion Capture data and 2D Laban-*Shape Effort* analysis. For example, for the 'Happy Walk' (HW) in relation to the 'Happy Garment' (HG), participants walked with flowing, unrestricted bodily movement. Detailed characteristics of the body in 'HW' movements were noted as follows:

- Participants' arms spread out and were raised in various forms of side-to-side, up-down, and forward-backward movements, including opening and clapping their hands and gently grasping and touching the 'HG.'
- Participants' dynamic upper body moves from holding the body upright to throwing it backwards and rolling from side-to-side.
- Participants increased walking speed, with longer stride lengths than in the 'FW' and 'NW.'

These dynamic bodily movements in comparison with the three walk types and three garment types can be explained by Laban's *Shape*, *Space*, and *Effort* analysis. With the Time Effort motion factor, the 'HW' was found to be typified by 'sudden' movement, while both the 'NW' and 'FW' were found to be typified by 'sustained' movements. Considering the Flow Effort motion factor, both the 'NW' and 'HW' were shown to be 'free,' while the 'FW' was found to be 'controlled' and 'restrained.' Based on Space Effort analysis, both the 'HW' and 'FW' were found to have 'indirect' movement, while the 'NW' appeared to be 'direct.' Considering Shape Quality, which describes the changing forms that the body makes in space, the 'HW' body shape corresponded with considerable 'spreading,' 'rising' and 'advancing' movements, no matter what types of garment participants interacted with. Conversely, the 'FW' was found to be extremely 'enclosing,' 'descending,' and

‘retiring’; meanwhile the ‘NW’ was revealed to be in between retreating-advancing, spreading-enclosing, and advancing-retreating. In addition, there were some differences in Basic Form when participants interacted with the ‘HG’ and ‘FG.’ In particular, participants’ side-to-side head movements were noticeable while they performed the ‘FW,’ no matter what different type of garment they interacted with.

Tables 10.7 (a) and 10.7 (b) give an overview of how the three walk types and garment types differ in terms of the dimensions revealed by the Motion Capture data and Laban Movement Analysis.

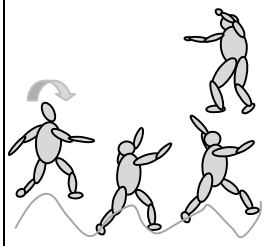
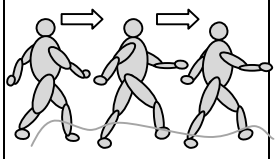
Walk Type	Laban Shape/Effort	Characteristic movement analysed by 3D Motion Capture data + 2D video data	Drawings
Happy	Extremely spreading, rising and advancing Direct in space Quick in time Light in weight Free in flow	**Head**: Up-down movement. **Hands (Arms)**: Lifts arms over head. Clapping hands. Arms move in an up-down, side-to-side, forward-backward way. **Legs**: Quick and wide-paced steps **Amount of Energy:** Energetic and active. **Degree of body Constraint:** Whole body opening outwards, very relaxed, and loose.	
Fearful	Enclosing, descending retiring Multi-focused, all-round awareness of space Sudden in time Strong in weight Restrained in flow	**Head**: Side-to-side and sinking between shoulders or bending down. **Hand (Arms)**: Folding towards centre of body. Thrown wildly over the head **Legs**: Slower-paced, small steps. **Amount of Energy:** Lethargic, passive. **Degree of body Constraint:** Whole body thrown downwards, constrained, tight, and closed.	
Natural	Between spreading-enclosing rising-descending advancing-retiring Direct, focused in space Sustained in time Light in weight Light in flow	**Head:** Minimal movement **Hands (Arms)**: Very backward-forward, side-to-side way. **Legs**: Slow steps, legato. **Amount of Energy:** Not much energy **Degree of Body Constraint:** Whole body erect, relaxed and loose.	

Table 10.7. (a) Comparison of the pattern of movements in three different walking styles ('natural,' 'happy,' and 'fearful') based on 3D Motion Capture data and 2D video data, analysed by Laban-*Shape Effort* theory.

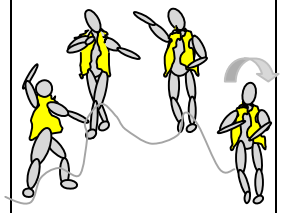
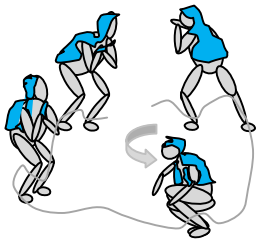
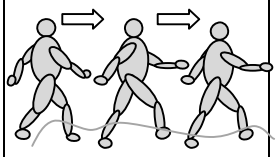
Garment Type	Laban Shape/Effort	Characteristic movement analysed by 3D Motion Capture data + 2D video data	Drawings
Happy	Somewhat spreading, rising and advancing Direct in space Somewhat quick in time Light in weight Free in flow	**Head**: Up-down, side-to-side. Eyes gazing at the garment. **Hands (Arms)**: Lifts arms over head. Clapping of hands. Arms moving actively in a forward-backward way. Arms swing clockwise while holding the garment. Gently seizing the garment. **Legs:** Pacing with quick and wide steps. **Amount of Energy:** Very energetic and active. **Degree of Body Constraint:** Whole body open, relaxed, and loose.	
Fearful	Extremely enclosed, descending and retiring Very multi-focused, all-round awareness of space Sudden in time Strong in weight Restrained in flow	**Head**: Side-to-side. Eye gazing around the space and sometimes the garment. **Hands (Arms)**: Hands firmly seize a garment, arms crossed. Pressing closely against sides or chest. **Legs**: Short-paced, slow steps. Spirals and turns slowly around 180°. **Amount of Energy:** Very lethargic and passive. **Degree of Body Constraint:** Whole body shrinks, raising both shoulders with bent arms, very constrained, tight, and closed.	
Normal	Between spreading-enclosing rising-descending advancing-retiring Direct, focused in space Sustained in time Light in weight Light in flow	**Head:** Minimal movement **Hands (Arms)**: Very backward-forward, side-to-side way. **Legs**: Slow steps, legato. **Amount of Energy:** Not much energy **Degree of Body Constraint:** Whole body erect, relaxed and loose.	

Table 10.7. (b) Comparison of the pattern of movements with participants wearing three different garment styles ('normal', 'happy,' and 'fearful') based on 3D Motion Capture data and 2D video data, analysed by Laban-*Shape Effort* theory.

Based on the results of the two studies (Motion Capture experiment and Laban Movement Analysis), I have identified the general considerations and principles for design of clothing that is functional and enables expressive movement across a range of emotional situations.

Kinetic variation of self-awareness: this refers to whether women feel satisfied, calmed or protected within their bodies in ever changing phenomenological and emotional circumstances such as 'secure' and 'insecure' situations. When women moved their body, they demonstrated spatial characteristics in response to whether they are placed in happy or fearful situations, including from degree of opening to closing, from rising to sinking, from advancing to retreating, from outward to inward, from upward to downward, and from forward to backward. This shape quality of bodily movement could express the relationship of conscious intention and subconscious or emotional reaction. In this sense, the way the garment is worn indicates important emotional cues visible through the position of the trunk, head, arms, and degree of openness and closedness. For example, as noted in Chapters 6, 9 and this chapter, the participants' use of open body forms in space exhibited a characteristic akin to showing off, in particular while they were interacting with 'Happy Garment' (HG). Body forms that emerged while participants were interacting with 'HG' could be linked not only to an expression of happy emotions, but also to the person's self-aware, self-assured or self-centred characteristics, which is expressed in the way a person chooses to present the body to the world (Hackney, 2002). Conversely, the participants' use of closing (including enclosing, descending) body forms indicated they were wary, relieved or in need of escape / protection from danger or fear. This expressive body can be linked not only to the expression of fearful emotions but also to the inner intent of the person such as a person's introverted personality (Hackney, 2002). In this respect, I propose further investigation into the sensorimotor-driven design approach, combined with technology will extend the research into the emotional aspects of the form and function of clothing. For example, Disguise Garment particularly can be further designed iteratively to detect feelings such as fear, and react by closing around the wearer to foster a greater sense of security when sensors are integrated in the textiles. Sensors also can monitor muscle tension, breathing, heart rate and temperature to

detect when the wearer experiences discomfort and fear. The garment can react automatically by closing around the wearer to foster a greater sense of security. In this sense, the garment design can be made to respond to these emotional situations and spaces where we encounter sudden temperature changes, noise and pollution, as well as stress and even crime or the fear of attack. Apart from the garment's protective function, it can also be endowed with the means of facilitating personal expression and whimsy. In an interactive design, the shape of the silhouette relates directly to the wearer's sense of emotional and physical wellbeing.

Kinetic variation of scale: refers to the variations of scale (from small to large) in how the body produces different patterns, dynamics and qualities of movement. Movement characteristic of this context can be elucidated from indirect attention to direct attention. The indirect attention can be described as spiralling, deviating, wandering, multi-focused, and all-round awareness motion whereas the direct attention can be identified as straight, undeviating, single-focused, and pinpointed motion. The scale variation for designing for movement in clothing therefore is not a size differentiation, but is related to the use of space; for example, personal, social, and public space. An instance of this is how the space created by the inside zone of clothes can be referred to as the personal, inner space, a place to emotionally hold and protect oneself. This perspective relates to privacy and security. This personal space can organise and clarify the body and its actions by a certain goal for movement. The garment can be the threshold to a safe comfort zone. In that sense, the results show that women have a safety or comfort zone around them in environments with strong emotional characteristics, and intrusion into this zone arouses discomfort. However, this can be an important clue to determining how a happy garment needs to accommodate emotional comfort in personal space (kinesphere).

Kinetic variation of speed: refers to how the speed of everyday walking, such as slow walking, fast walking brings sharply into focus how our body organises itself when walking and how the act of walking relates to the design of a garment to allow for a negotiation of weight shift and time balance. This context of kinetic variation of speed can be linked to attitude to the movement impact from light to strong. The properties of light motion can be described as delicate, fine touch, and light touch

whereas strong motion can be identified as powerful, forceful, firm touch, and vigorous movement. For example, when wearing the 'Fearful Garment' participants' hands (including arms) were more actively and firmly grabbed and engaged in the garment while walking, which manifested in a strong attitude to the movement impact such as slow walking, retreating, inward, and downward movement. This context can also be associated with movement with a lack or sense of urgency from sustained exposure to sudden motion. Sustained motion can be linked to the properties of gradual, prolonged, and indulgent properties, whereas sudden motion can be described as urgent, quick, and fleeting. 'Happy Walk' for example was found to have the participants moving very quickly while 'Natural Walk' found participants' moving gradually.

Kinetic variation of transitional emotions: this refers to how the emotion women experienced can change within an interactive process. With negative emotions, especially fearful states, specific fear-related action tendencies are activated, such as the preparation for concealment in order to protect the body (see Chapters 6 and 8). These action tendencies could give essential information about shape change in relation to the garment in the environment. As noted in Chapters 6, the process of interacting with the garment, where it is formed, reformed, or deformed iteratively through space, means that the garment can empower forms the body and for and its covering to construct a third skin (Figure 9). The participant's experience of fear was transformed into calm through the creation of a personal space by enclosing the body within the garment. The results indicate that the garment can have an important protective function and provide a habitable shelter in secure or insecure spaces. The protective function of clothing is not restricted to physical protection in climatic and environmental conditions. It extends to protecting the wearer against both physical harm and psychological dangers, whether under attack or feelings of insecurity. As remarked in Chapter 8, in the interactive process, the affect of negative emotion was changed through movement, such as going from bound through to free, or continuity of the movements that could lead to muscle tension, coordination and personal expression. The bound quality of movement elucidates restricted, contained, controlled, and careful bodily expression. The free quality can be described as movements that are loose and freely flowing, and can be associated with expression that is open, released, and outpouring. Participants' bodily intention corresponded to

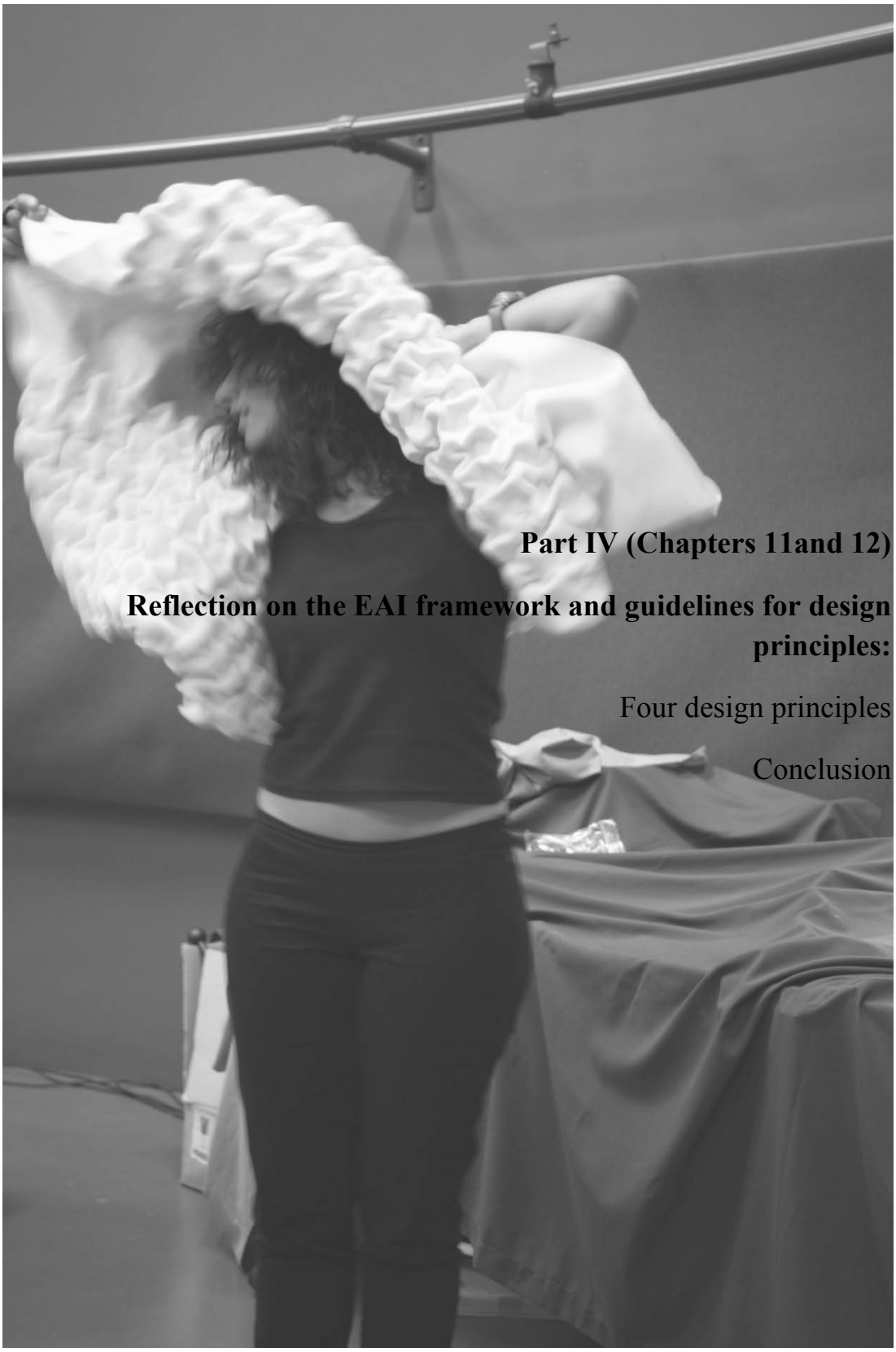
the passage from expressing a sense of them particularly in a fearful state. In the sense of the process of interacting with the garments, the garments invited their body to be tugged and to be held inside through movements such as enclosing, sinking, retreating, and inwardly and downwardly. These bodily movements were emergent phenomena in an ongoing way expressing transitional emotional states. The participant's experience of fear was transformed into calmness through creating a personal space by enclosing the body within the garment.

10.7 Conclusion

LMA has been used effectively in this study because it analyses the phenomenon of quality of movement from the point of view of lived experience in terms of the physical as well as mental, emotional, social and spiritual aspects (Laban, 1960). Secondly, this approach is appropriate and necessary to giving a correct description of people's movements as an emotional aesthetic expression, such as the person's style of walk, which is not simply and quantitatively characterised in terms of biomechanical or physical speed, direction or path. Rather, LMA uses meaningful symbolic language and thought-provoking interpretation to describe the character of body movements, and such aspects as how the body moves and changes in space, as well as how the body uses energy. For example, if the movement follows a smooth direction in space, it is considered to be indirect and flexible; whereas if it tends to move in a straight trajectory, it is called direct. In a similar manner, a movement is considered not in terms of physical speed alone, but as leisurely or urgent in character, and as sustained or quick. Thirdly, the LMA approach encompasses the whole complexity of human movement, and is not only focused on dance expression, but also extends to the natural or organic movements of everyday life. In this way it is relevant for how the body moves in the real world, accomplishing real tasks, like those performed by workers in their usual activities, such as walking types.

In Part III of two studies, Motion Capture data analysis (see Chapter 9) and Laban Movement Analysis (see Chapter 10) have been fruitfully exploited in concrete applications to analyse characteristic movements. These comparative trials allowed a closer analysis of the moving body in its trajectory through space and time, and also

enabled an analysis of movement sequences, such as movement phases, postures of the body, the organisation of the body and its parts, the shape of the body, and the relationship of the body to emotion. Determining how to physically express the scene required a certain amount of movement analysis. In this respect, LMA provided a lens through which I could look at a scene in terms of movement sequences and patterns of the moving body. I also could look at a scene through silhouettes of changing spatial shapes of the moving body, in order to explore elements (*Shape*, *Space*, and *Effort*) of LMA. Exploration through the frameworks of MC data and LMA helped reveal a working set of movements that allowed subjects to manipulate a garment and reflected their emotional state. These findings can in turn be used as a resource for designers to systematically map the trajectory of the moving body, in order to design not only the garment, but also products that are related to body- and movement-centred design. This study aimed to assist designers and researchers who work in the context of movement for interactive design, and has focused on everyday walking experiences and changes in body movements that are no longer just functional, but an aesthetic expressive movement.



Part IV (Chapters 11and 12)

Reflection on the EAI framework and guidelines for design principles:

Four design principles

Conclusion

Participant's bodily articulation. Source: photo by the author (2011)

Chapter 11

Evaluation of the EAI framework

Guidelines for design principles

Chapter 11

Evaluation of the EAI framework and guidelines for design principles

11.1 Introduction

In Part IV of this chapter, I reflect on the findings of my research-through-design project for Parts I, II, and III from which I propose design principles of garment comfort. In Section 11.2, I begin with how my thesis research questions lead to investigating the concept of 'Enriched Aesthetic Interaction' (EAI), which informs this project. In Section 11.3, I revisit four ways of understanding human aesthetic experiences of comfort proposed in the EAI framework: knowing through experiencing, experiencing through knowing; feeling through touching; seeing through touching; and doing through feeling, feeling through doing. This section reviews the framework of EAI interpreted through experimentation on the four dimensions of the experience of comfort that informed the research. Within the EAI framework exploration, I also summarise how several key theories — phenomenology of perception, embodied interaction, aesthetic interaction, the idea of affordance, and the quality of movement — inspired the design knowledge and practice that produced and tested the conceptual prototypes. In Section 11.4, I dig deeper into the reflection on the EAI framework. In Section 11.5, I address design principles as applied to EAI in the field of clothing design for comfort. Part IV of chapter 12 concludes with a discussion of the significance of my research-through-design practice and how this project has defined new directions for further research.

11.2 'Enriched Aesthetic Interaction (EAI)' in the context of comfort

11.2.1 Discussion of research questions

This thesis set out to reconceptualise and investigate the concept of clothing comfort through the research question:

- How can design for comfort be incorporated into aesthetic experience in the context of clothing?

The research question provided the initial focus for the study of the relevant literature, development of the EAI framework, and design of the workshops (see Part I of Chapters 2 to 4). In Chapter 2, I discussed the research problem, definition and questions, and analysed the larger theoretical foundation of this thesis using Merleau-Ponty's (1962) phenomenology of perception and embodied experience, Gibson's theory of affordances (Gibson, 1977), and Shusterman's (2000) pragmatist aesthetics. This theoretical foundation reconceptualised the comfort factors of clothing in terms of:

- Users' aesthetic experience in daily activities such as interacting with nature, touching, and walking;
- Subjective individual experiences such as fear and happiness, associated with changes in socio-cultural lifestyle, technical developments and an urban nomad lifestyle;
- Making dynamic form explicit in design by applying the ability of clothing to stimulate behaviour and feelings in people and evoke senses and moods; and,
- Involving human skills of doing, feeling, knowing in design for clothing (Overbeeke et al., 1999).

To reflect on the theoretical investigation, the EAI framework was developed and the term EAI was used to explore the concept of aesthetic comfort, as well as to develop experiential garment designs and the framing of the design of experiments. The term EAI was defined as the properties of an object with which people enact and, in doing so, create their own meaningful action and experience for comfort. In addition, EAI in this thesis emphasises an individual's subjective experience and rich emotions in relation to their use of skills — how they feel, do, know, and express through their bodies while interacting with an object; in other words, how people act and feel or how are they are acted upon in the process of interacting with an artefact. In the research, experiments with participants were combined with interviews and observation of a group of women participants (n=15, age of 20-40 years). In

considering comfort in the context of EAI, this thesis aimed to open up lines of investigation into socio-cultural, physical (sensorimotor) and psychological comfort in the context of the synaesthetic, kinaesthetic, and emotional senses.

11.3 Framework of EAI

One of the contributions this thesis makes to design theory and research is to explore new interactive design for comfort within the framework of EAI using the research-through-design process. The research-through design process involves a combination of knowledge-based theoretical research and the feeling, doing, and knowing process, involving bodily activities based on exploratory research and design. The research explores behaviour in action, reaction, and interaction and suggests new viewpoints in answer to the second research question:

- What design principles can be developed to provide aesthetic comfort for the user in clothing that is worn in daily life?

The four contexts of the framework of EAI to understand comfort are as follows:

1) Knowing through experiencing, experiencing through unknowing: this refers to the self-knowing process, and represents a state of sub-consciousness, which is an automatic or fluid experience, so the body acts immediately and intuitively without thinking. This context of the framework indicates a view of emotion and felt experience in respect to a person's intuition, which leads to bodily understandings of multi-sensory comfort.

2) Feeling through touching: this refers to an emotional understanding of comfort, which focuses on emotion evoked by movement and manipulation of an object — what women do and what their feelings tell them in response.

3) Seeing through touching: this refers to a synaesthetic understanding of comfort, meaning the ability of the body to integrate all the different sensual qualities and perception. Synaesthetic sense is defined as the experience involved with more than one sense, and integration of the information gained

by the senses of touch, sight and movement in perceptual cognition, for example, memories and images.

4) Doing through feeling, feeling through doing: this refers to a kinaesthetic understanding of comfort, an aesthetic experience received through hand function and bodily performance. Comfort includes negative and positive emotions, for example, fear and happiness, which can be generated through someone's recall of a past experience in a cognitive reasoning process, even without physical interaction.

I now expand on how these four aspects have informed the work done in the research project.

(1) Knowing through experiencing, experiencing through unknowing

In Chapter 4, I described my bodily sensory experience in an active experiment and interaction with nature through sand, water, shadow, and movement by being attentive to feelings, emotions of immediacy, and the conscious or unconscious bodily knowing process. The aim of this context of the research was: (1) to sketch insights of understanding human experience in terms of how the body's senses and mental apperceptions are intricately woven into the real context; and (2) from the reflection on the experiment, to develop the concepts and methods utilised by a body-centred and sensorimotor-driven design technique in the early phase of the design process. The primary research questions were as follows: how do we communicate our perceptions, senses, and emotions in the natural environment; how do we experience beauty and comfort from environmental elements that are not normally consciously processed, such as movements of water, sounds from the ocean, and our bodily responses; and can these aesthetic experiences inform the development of innovative design concepts? (see Chapter 4, Sections 4.3)

This experiment involved using my bodily experience in order to sharpen the focus of the research questions by recognising the researcher's role in inquiry as a skilled designer and participant. This leads to a research balance between users and the designer, both of whom play an important role in documenting their behaviours and

understanding their unexplored skills, emotions and bodily experiences. In fact, the nature experiment brought a greater focus on three aspects of design principles in the wider research project: 1) exploring how a set of affective resonances that integrate sensory modalities, for example sight, hearing, touch, and movement in situations such as being blindfolded and not blindfolded can inform a body- and sense-driven design technique; 2) how actions in our everyday lives, for example, the way people wrap or hold garments around themselves or walk, portray behaviour in aesthetic interactions; and 3) a focus on affective states where the body has the ability to anticipate the physical sensation and the mental association, in order to explore ways in which the body becomes an essential structure in creating the form of the garment. Accordingly, this research has highlighted the need for design practice to consider factors such as touch, body, movement, and creative responses to nature, so that it is informed by research into the part played by the senses and perception in human behaviour and experience. This context of the EAI project therefore contributes to the interactive design field, illustrating how designers can incorporate a phenomenological representation of nature and the value of everyday activities into their design process.

(2) Feeling through touching

Feeling through touching refers to an emotional understanding of comfort, which focuses on emotion arising from movement and manipulation in relationship with an object when a person approaches and feels it. This refers to what a person does with an object and how they interpret their feelings (see Chapter 8). In this context, the methodology of haptic experimentation used in this project applied to the way women (n=15, age of 20-40 years) touch and move consciously or unconsciously and actively or passively while interacting with four conceptual prototypes (Trans-For-M-otion, Touch me, Feel me, Play with me, Jigsaw-Puzzle, Disguise Garment). In particular, the set of experiments was designed to determine whether or not participants' active hand touches were related to the body part used, and how this may contribute to the overall impression of 'feeling good or bad.' The results revealed that participants' active hand touches were related to how the body part is sensorially intertwined. This is because the process of obtaining a sensory experience from hand touching was coordinated with whole body movements. Therefore, this

haptic experimentation contributed to the overall impression of 'feeing good or bad.' To support this argument, Kimura and Archibald (1974) suggest that the hand functions as a second brain, because, when working with the hands, many bones as well as nerves work together in close cooperation; more than thirty percent of the cerebral cortex is activated when we use our hands, and this can be termed the 'projected brain,' because the process of touching involved movements of the whole body in order to feel. As remarked, Merleau-Ponty (1962) elucidates how perceiving sense through action (touch and movement) is a reciprocal system. We feel comfortable intuitively through touch and through the way our body (hands) moves or is moved by finding our own individual levels of comfort. It is argued that this process of interaction sheds light on how our body, in particular hands, can perceive the senses, which can evoke emotions. This perspective is significant for the design of body-centred and sensorimotor-driven clothing, especially when the intertwining of senses and movements enhance our emotions. This perspective can therefore contribute to new ways of designing sense-action-driven clothing for comfort (see Chapter 8, in Section 8.5.1.3).

(3) Seeing through touching

The context of the EAI framework refers to a synaesthetic understanding of comfort, meaning the ability of the body to integrate all the different sensual perceptions. Synaesthetic sense is defined as experience derived through more than one sense. The seeing through touching process, which can be explained in terms of the multi-sensory nature of cognitive science, was explored to investigate the following research questions: how does what women touch affect what they see (see Chapter 8, Section 8.5.1.4); how do they integrate the experience of touch into their perceived images in their head when blindfolded, compared to when they are not blindfolded (see Chapter 8, Section 8.5.1.5); and, what do participants feel, say, and imagine while they are interacting with the four conceptual prototypes in two sets of conditions, blindfolded and non-blindfolded? (see Chapter 8, Section 8.5.1.6).

The study reinforced that different senses are integrated, shared and united with other senses differently in blindfolded and non-blindfolded conditions (Reiber, 1903; Merleau-Ponty, 1962; Gibson, 1962, 1966; 1966; Marks, 1978; Upali, 2008). The

participants' touch, particularly in a blindfolded condition, significantly affected the nature of their sensory perception, which seems to influence more than one emotion (compound emotions). In addition, feelings, whether 'good or bad,' were reflected in the way the participants' touch affects what they see. In other words, it was revealed that sensory modalities were connected perceptually. For example, when participants touched the conceptual prototype Touch me, Feel me, Play with me, whilst blindfolded, they described their conscious images as evoking 'ripples in water = soft = surface = feeling good.' These results revealed that what participants touched affected what they saw. On this subject, Reiber (1903) pointed out that there are illusions that are congruent between different types of sensory experience; that is, illusions that are produced tactilely by patterns of skin stimulation and illusions that are evoked visually in particular emotional contexts. Moreover, according to Levy (1985), most people use both hemispheres of the brain to do any complex activity. For example, when reading a book, people use both hemispheres: the left to read the words and find meaning and the right to respond emotionally to the story or to visualise scenes. These results seem to be related to Levy's (1985) statement. That is, people seem to use both hemispheres: the left to touch in order to detect an object's properties and to find information, and the right to respond emotionally and to visualise scenes. Furthermore, people's past positive or negative experiences seem to be reflected in the effects of the object on their haptic perceptions and experiences. Merleau-Ponty's (1962) philosophical concept of phenomenology of perception also supports this multi-sensorial experience. He explains that, when establishing a sensory experience, '…the senses intermingle and mutually resonate…' (pp. 229-230). Moreover, he expands by adding that '…the senses intercommunicate by opening on to the sturcture of the thing' (p.229). The results from the multi-sensorial experiments and theoretical ideas reinforce how human exprience stresses unity of tactile and kinaesthetic phenomena, and unity of senses. We are able to 'see' an object sensuously and perceptually through the hands, which are a perceptual and manipulative organ that connects with the entire body (Gibson 1966). In this sense, we are able to touch and be touched by the same action, and this causes certain sensations and emotions. This skin sensation in the context of tactile perception can also transcend one sense to another sense; for example, seeing through the ways people touch. Accordingly, the results suggest how physical sensation and the associated visual images can be interrelated. This is seen in the

way we relate to natural elements via the body, for example, kicking and rubbing the sand and splashing water, which we store in the brain as data and then conjure up memories of happy and comfortable experiences.

(4) Doing through feeling, feeling through doing

These contexts, which are based on kinaesthetic sense, refer to an important aspect of the movement based on the experience that evokes emotion, since it provides us with our self-perception of movement, the felt sensation of our bodies in motion (see Chapters 6, 8, 9, and 10). The contexts of the framework, particularly, are intended to investigate how meaningful bodily expressive actions are manifested by emotional experiences (for example happiness and fear) while interacting with a garment. The study involved observing a group of women engaging in a series of choreographic interactions as a way of exploring behaviour and performance in relation to different forms of garment (see Chapters 6, 8, 9, and 10).

Chapter 6 documents the first phase of an interactive choreographic pilot study entitled 'object playing with movement.' The aim of this choreographic study was to understand the emotive movement of women (n=15, age of 20-40 years) and in particular their responses to how they interact with a garment to transform their feelings of fear into a recognisable state of comfort; and how they interact with a garment to reinforce their feeling of pleasure as a recognisable state of comfort. Based on the pilot study, I reported on the tests of the idea of 'affordance' (adaptability) in two different emotional situations, feeling secure and insecure. This part of the study sought to understand the dynamic expressiveness of bodily behaviour, and the satisfaction and comfort experienced by women when they formed and configured the garment for their body using a process of wrapping. This part of the study also aimed at investigating how women's past emotional experiences, such as 'happiness' and 'fear,' affect specific bodily expressive actions while interacting with the garment. A key outcome from the study revealed that, when wearing clothing in the emotional context of comfort, the participants used their clothing to wrap or hold their body, both to evoke feelings of relief and security for the purpose of protecting, hiding, and disguising themselves in insecure situations, and also for self-expression in secure situations, that is, to express feelings of

pleasure and enjoyment. The study suggests that movement is less a physiological activity and more about psychologically-oriented emotional activity. In addition, it is important to point out that the emotion experienced by the women tended to change within an interactive process. For instance, the participants were observed for their unconscious or conscious movements, which seemed to transform from feeling physical discomfort into feeling calm. Exploring dynamic bodily expression by using two scenarios, feeling secure and insecure, helped to understand the pattern of unpredictable body behaviours. For that reason, this scenario method was used for further investigation of the choreographic study called 'emotionally expressive action with garment,' which led to the development of the conceptual design, such as Disguise Garment (see Chapter 7). In addition, this scenario method was utilised to further investigate dynamic bodily expression in a comparison of different types of walking style ('natural,' 'happy,' and 'fearful') and different types of garment style ('normal,' 'happy,' and 'fearful') (see Chapters 9 and 10).

In Chapter 8, the second phase of the kinaesthetic study as a part of haptic experimentation considered forms of touch in the ways that hands perform in detecting and evaluating an object. I explored the various sensory experiences observed in the sample group of women as they touched a series of objects, and the emotions aroused when each object was touched. In this context of the framework, the research questions were as follows: how do women (n=15, age of 20-40 years) touch and move to feel; how do they touch each stimulus to feel through different touches (active and passive) and movements (see Section 8.5.1.1); and how do unconscious and unintentional movements influence affective states, such as users' degree of comfort when they are 'feeling good,' and of discomfort when they are 'feeling bad'? (see Section 8.5.1.2).

Results of the experiment revealed that the participants' individual sensory and emotional experiences of touching and movement tended to differ qualitatively as they felt the object, through active vs. passive touch and visible vs. invisible touch. That is, they felt more compound emotions in active touch, such as grabbing, squeezing, and palpating while blindfolded. This was because free active touch stimulated much more sensory response and seemed to exert a changing pattern of pressures in skin contact. Furthermore, the results suggest that the way the touching

process is used in everyday life, such as in habitual and unconscious movements, could assist people to evoke positive emotions, which could alter their negative states by changing them into positive emotions, moods or sentiments. In addition, participants perceived 'feeling good or bad' in response to material attributes differently in blindfolded and non-blindfolded conditions. The effect on the participants' responses to the haptic sensation of 'feeling good' resulted from the following design elements: texture, shape, size, and weight. In other words, results show that 'feeling good' while touching in a blindfolded condition was in response mostly to texture, for example, softness, warmth, vibration, dynamic surface; on the other hand, in the non-blindfolded condition, it was predominantly shape that produced the strongest sensation of feeling good. Furthermore, participants' responses to the haptic experience of feeling good or bad came from the following design aspects: function, aesthetics, mood evoked and enjoyment (which are further discussed in Section 11.5).

In Chapters 9 and 10, the third phase of the kinaesthetic and choreographic study in the EAI framework: doing through feeling, feeling through doing involved observing the characteristic bodily movements of women (n=8, age of 20-40 years) such as body positions, attitude, shapes and movement patterns of their head, hands, legs, and trunk in a comparative study of different walking styles ('natural,' 'happy,' and 'fearful') in association with garment styles ('normal,' 'happy,' and 'fearful'). The two connected parts of this investigation are outlined in Chapters 9 and 10 (using both quantitative and qualitative emotional analysis). I have explored the following research questions: how does a specific emotion such as fear or happiness influence walking behaviours when people are interacting with a conceptual prototype garment; and how do different styles of a conceptual prototype garment affect walking behaviours in 'natural,' 'happy,' and 'fearful' walks? The results of this phase of the investigation are discussed in Chapter 9 (see Sections 9.5 and 9.6) and Chapter 10 (see Sections 10.5 and 10.6).

The first part of the quantitative analysis, discussed in Chapter 9, was the Motion Capture (MC) experiment. 3D MC data was used to collect and analyse the various head, hand and leg movements of participants when interacting with a garment in different emotional scenarios. The observations were focused on a range of body

movements, such as side-to-side, up-down, forward-backward, in the context of different garment styles and different emotions; the velocity of motion while wearing each garment style; and ways of stepping. In the observations, the three walking types revealed significantly different bodily movements, showing that they can be affected not only by specific emotions but also by specific garment types. For example, the happier a participant felt, the more the head moved up-down and the hands from side-to-side, up-down, and forward-backward. When a participant became fearful, the head moved in a side-to-side motion. In addition, the garment styles influenced the styles of walking. For example, when a participant wore the 'Normal Garment' the hands notably swung more, and faster, in a side-to-side, up-down, and forward-backward motion. This expression was much more increased than for the other garment styles, including the 'Happy Garment' and 'Fearful Garment.' The results suggested that both the 'Happy Garment' and the 'Fearful Garment' were worn with less arm movement, for example, in terms of arm swing, speed, position, and so on, than the 'Normal Garment.' This aspect indicates that participants wearing a garment, which helps them to feel 'happy' may have more bodily engagement and interaction with the garment. The results revealed a marked discrepancy between 'happy' walking when participants wore a 'Normal Garment' and 'Happy Walk' when they wore a 'Happy Garment.'

The second part of the qualitative analysis, addressed in Chapter 10, used Laban Movement Analysis (LMA) to understand and interpret 2D video data, particularly in terms of *Shape*, *Space*, and *Effort*. The aim of this part of the study was to identify the characteristics of the participants' movement system by comparing three different walk types ('natural,' 'happy,' and 'fearful') and wearing three different garment types ('normal,' 'happy,' and 'fearful'). These comparative movement sequences allowed a closer analysis of the moving body in its trajectory through space and time, and also enabled an analysis of sequences, such as movement phases, postures of the body, the organisation of the body and its parts, the shape of the body and the relationship of the body to emotion. For example, in the 'Happy Walk,' in terms of Shape Quality, which describes the changing forms that the body makes in space, there was a pattern of extreme 'spreading,' 'rising' and 'advancing,' regardless of the type of garment with which the participants interacted. It was found that the participants' use of body attitudes in space exhibited a characteristic kind of

showing-off while they were interacting with 'HG.' This aspect of body attitude tended to be linked not only to the expression of happy emotions, but also to personality, as body attitude is the dominant way a person chooses to use her body and present herself to the outer world (Hackney, 1998). In particular, the body forms showed dynamic and various shapes, from pin-like to wall-like, especially while interacting with the 'Happy Garment' with which participants used a wider Space (kinesphere). Effort is the energy expended in performing the movement, or the external expression of the inner attitude of the mover. The dynamic characteristics of the participants' 'Happy Walk' were found to be quick and buoyant within a released, gradual ascending trajectory, and direct in Space, quick in Time, light in Weight, and bound in Flow.

Conversely, the 'Fearful Walk' patterns of movement, particularly while participants were interacting with the 'FG,' were found to be extremely 'enclosing,' 'descending' and 'retiring' in Shape Quality. As for Body Forms in Shape and Space, within this changing kinesphere, the torso changed shape from wall-like to ball-like to screw-like and gradually descended in a spinal contraction, while limbs moved towards the body's centre in a closing movement. The pattern of the participants' use of Body Forms in Space signaled caution, as the participants appeared to protect their bodies against impending danger. In this pattern, their body shape expressed enclosing, descending, and retiring movements. This aspect of body attitude can be linked not only to expression of fearful emotion, but also to a person's introverted personality (Hackney, 1998). In terms of Effort, bodily movements were sustained and restricted within a gradual descent trajectory, and were indirect in Space, sustained in Time, strong in Weight, and bound in Flow.

These two connected experimental and theoretical study using Motion Capture data analysis (see Chapter 9) and Laban Movement data analysis (see Chapter 10) provided a range of complementary observations and understandings of the moving body in the context of emotional experience and garments worn by participants. It emerges from the MC data analysis that understanding a person's walk characteristics and their relationship with emotions and garments worn is an important research area for design. The shape a body adopts and the pattern of bodily movement reflect how movement is affected by a person's emotions and the type of

garment they are wearing, and this can inform design for clothing. Laban Movement Analysis (LMA) particularly provided a lens for determining how an emotional experience is physically expressed through the movement elements of *Shape*, *Space*, and *Effort*, observed in different emotional scenarios. Reflection on the outcomes from these two quantitative and qualitative kinaesthetic experiments and their validation was implemented as an general consideration of the design principles of movement based on garment comfort: kinetic variation of self-awareness; kinetic variation of scale; kinetic variation of speed; and kinetic variation of transitional emotions (see Chapter 10, Section 10.6). The findings can be used to inform designers who can systematically map the trajectory of the moving body when they are designing garments and products that are related to the body, and more generally, in movement-centred design.

11.4 Reflections on EAI in the movement study

In interpreting the kinaesthetic study results, the four contexts of understanding comfort described above are intertwined with each other, involving body, mind, action, interaction, and perception, as elucidated by Merleau-Ponty (1962). EAI is defined as 'the creation, manipulation, and sharing of meaning through engaged interaction with artefacts' (Dourish, 2004, p. 126). From experiments through the four contexts of the EAI framework, four important reflections have emerged.

(1) First, it is worth noting that a sensorimotor-driven design approach, such as dynamic modes of touch in garment design, could assist people to elicit senses and positive emotions that can modify their negative affective states to become positive emotions or moods. Designers should give greater consideration to the significance of the touching process, and engage this with an interactive design process. This perspective to clothing and product design directs a completely different methodology than a material-oriented one does. The sensorimotor-driven approach takes into account what makes the body feel 'good or bad' and integrates understanding of our physical and mental nature in the design. For this method, the design process needs to take into account such design principles as congruence of the senses, such as touch and sight. In particular, the value of the research on haptic experience showed the relationship between figurative expressions (words through

action) and perceived images while responding to stimuli. Results from the haptic experimentation method I used, comparing sensory responses in blindfolded and non-blindfolded conditions, suggest the importance of other sensory modalities such as touch, movement, smell, and so on, which are still undervalued in emotional design research. Designers need to take this into account in the design process.

(2) The second reflection I emphasise is that various emotions can be adapted by how people handle the fabric with either an active or passive touch. In fact, the way the touching process is used in everyday life, such as in habitual and thoughtless gestures, can activate the state of 'feeling good.' These interpretations about how various emotions can be enhanced and adapted by the way people touch are significant for the design of comfortable clothing. The research suggests that users' hand movements correlate closely with their emotions, and this throws light on how we can evaluate the desired feeling of comfort in wearing clothing, and create designs accordingly.

(3) The third reflection I emphasise is that investigating movement with the garment, as one of the kinaesthetic elements of bodily interactions with objects offers a way of understanding the particular role of 'movement' in human-object-emotional interaction. New forms can emerge when exploring body movements and identifying properties of comfort that occur in bodily interactions between people and their environments, especially when observing how a body is shaped and patterned, or how people wrap their bodies through wearing behaviour. This analysis is a tool for discerning the hidden meanings and conceptual space within which people are comfortable with or enjoying the clothing. This methodology offers insights into how a garment can be designed precisely to adapt to people's body movements and bodily transformations in an environment where moods and emotions are constantly changing. From the results of these investigations, I propose that design principles for clothing should focus on: movement sequences of the body; changing spatial shapes of the moving body; women's closed and open body movements, for example in secure and insecure situations; and their walking patterns in terms of scale, balance of weight, and speed variation. It is argued that the quality of these movements can inform and steer design practice towards an emotion- and sensorimotor-driven approach in fashion design since it provides a rich source of

stimuli for the creation of new garment forms that establish the body as a primary source and an essential structure from which to understand the nature of bodily interaction. The body in this sense is the intimate structure of an organism on which to configure the garment form. The body is a living organism to reconfigure the garment form for maintaining comfort zone from the outside hazardous environment. The interactive design seeks to maximise feelings of comfort in the user. The findings from these studies will also assist designers to enhance wearability and functionality in innovative clothing design.

(4) Finally, it is worth noting that how the EAI framework and design practice synthesizes theories — phenomenology of perception (Merleau-Ponty, 1962), idea of affordances (Gibson, 1979), and pragmatist aesthetics (Shusterman, 2000) — and experiments through user participant in the research-through design process. When these theoretical references are made to a thing seen as being only these sides and aspects, these surfaces, it does not mean that the thing is only and exclusively what is described here: the ultimate goal of this was to understand how these different aspects are constituted into the actual thing as experienced by the person experiencing it, such as haptic experience with an object (textiles) and dynamic movement when the person interacted with conceptual garments. As a philosophical perspective, phenomenology is the method, though the specific meaning of the term varies according to how it is conceived by a given observer. As envisioned by Merleau-Ponty specifically, phenomenology is a method of philosophical inquiry that rejects the dominant rationalist bias, suggesting that consciousness is not in the mind but rather conscious of something through action involved.

Informed by this theoretical ideas in the design process, the design explorations were carried out in several experiential forms through a process of action and reflection, particularly women's responses to how they touch and move; what they feel through touch; how and what they see through touch and how this affects their thinking; and how touching by hand relates to the touching of other parts of the body. Therefore, four experienceable garment designs in this thesis were developed iteratively through a reflection on the experiments in the four contexts of the EAI framework. Using a process of designing, building, and testing, the conceptual garments were highly

experiential and interactive, so that they increased the sensorial, emotional, and functional experience. Chapters 5 and 7 describe how, in the design of the experienceable prototype garments, sensory, cognitive, emotional, and functional ways to enhance the wearability and functionality of clothing were constructed using felted wool modelling composed of 100% wool felt and engineering felt modelling composed of 70% wool felt combined with synthetic materials techniques. Textile designs as a form of garment were also constructed using engineering felt with craft techniques such as folding, sewing, and embedding with LED lighting technology. One of the central elements of my application of the concept of affordances was drawing on the concept of 'adaptability' in how people touch, move, feel, and what they experience, and the integration of cognition and emotion in interactions with clothing in everyday activities. This design concept led to analysis of different interaction possibilities within the four contexts of the EAI framework. Outcomes of these four contexts of the garment designs through the EAI framework experiments resulted in design principles for garment comfort (see in Section 11.5). In addition, the design strategy stresses that how the experienceable garments I designed invite people to actively participate in forms that create sense and meaning. The form of garments on the body reflected differently on how the wearers interpret and interact with the form within the space they inhabit, but how they wear, interact with, and appropriate the garments is left open to individual experience. The garment designs intend to evoke people's emotions by challenging their wearing experience, stimulating their imagination, and enhancing their interaction practices rather than concentrating on style, visual expression and appearance. Accordingly, my garment designs empower users to think, raise their sensory awareness, and provoke them into action. Thus, my implementation of these concepts was inspired by the intricacies of emotion-driven action and interaction.

11.5 Design principles

The three parts of the study — the theoretical investigation, establishing a conceptual EAI framework, and the design workshop (Part I: *generating ideas*); design practice and experimenting through the pilot study (Part II: *designing experienceable prototypes*); and user interviews and observations through three phases of experiment (Part III: *evaluation*) — enabled intensive and extended exploration of the framework

of EAI. In Part IV of this chapter, elaborating the overall reflections on the whole study in Parts I, II, and III, the study incorporated four design principles:

(1) *Serendipity* refers to ideas about poetic practicality. No matter how elegant and functional a design is, it will not win a place in our lives unless it can appeal at a deeper level, to our emotions (Fay, 1998). The body has its own way of knowing, consciously or unconsciously, which we may tap into for new levels of understanding through related manipulation of garments. In the dynamic bodily movement and haptic experimentation (see Chapters 6 and 8), I explore how people use their skills, imagination, and intellectual engagement in relation to an unfamiliar object. For example, Jigsaw-Puzzle in the context of the EAI framework: knowing through, experiencing through unknowing, were put to the test in relation to emotions, such as happiness, comfort, and fear. In the observational study the participants had a clear idea of what, when and how they required for comfort and they and their bodies became idea generators in the design development process. The flexible and open structure of the functional designs enhanced 'feeling good,' not by various uses of the garment's function, but by participants creating their own meaningful narrative or intuitive bodily engagement through the manipulation of garments. Accordingly, the experienceable garment allowed the wearer to refine and maximise the wardrobe beyond its usual wearable potential by transcending established boundaries and challenging the conventions of fashion. The garment became enriched with interaction and became garment-less as it moves beyond traditional forms.

(2) *Kinaesthetics in self-awareness* refers to how women are satisfied or calmed when their body is in ever-changing phenomenological and emotional situations, such as 'secure' and 'insecure' situations. Women are more likely to choose a fashion product that depicts and construct their identity, as well as creating a desirable image to project to others. This aspect relates to 'feeling confident,' as part of the comfort dimension in happy or secure situations. More importantly, making women comfortable in uncomfortable situations, for example, when they experience psychological danger in unfamiliar spaces, is an important consideration in design of clothing, because such a situation creates a highly undesirable sensibility. This is related to feelings of 'being relaxed' as part of another comfort dimension in fearful

or insecure situations. Clothing for comfort should take account people's thoughts, feelings, and behaviours, reflected in their awareness, fantasies or daydreams in the everyday activities and emotional situations they are in. In this sense, the phenomenological perspective can be linked to Merleau-Ponty's (1962) interpretation of perception, involving a lived dynamic between the perceptual body and the world as two aspects: the live-body and the body as an image. In reflections from the user study (see Chapters 6, 9, 9, 10) considering the live-body, women seemed to know their ability and power to perceive, to act and to feel comfortable through how they wear the garment and when they wear it. Their body manifests themselves to them as their possibilities of acting in the different emotional experiences or different environmental situations. This is what enables women to reach out and grab something, for instance, but it also, and more importantly, allows for the possibility of changing their point of view. This could help them differentiate one thing from another by the experience of moving around it, feeling senses intuitively, seeing new aspects of it. The different emotional situations and the sense of self are emergent phenomena in an ongoing 'becoming.' Furthermore, considering the body as an image, women seemed to experience the use of their own bodies as their own subjectivity, which means they feel comfortable through what form of the garment they like on their body. This bodily knowing subjectivity seemed to reflect on a person's self-identity and, then, they simultaneously applied this to the experience of another's body. This was implemented to constitute another subjectivity, which means how they also feel comfortable in the various spaces or situations they are in. This perspective of their bodies as an image seemed to be an essential consideration as the means of social, psychological, and emotional engagement in the field of clothing design. Women can thus recognise their intentions or emotions and their sense of self through the body as an image. This experience can be important in the phenomenological account of intersubjectivity. In phenomenology, intersubjectivity constitutes objectivity; that is, what you experience as objective is experienced as being intersubjectively available — available to all other subjects.

Trans-For-M-oton was developed on the basis of the EAI framework: doing through feeling, feeling through doing. In this context of the EAI framework, by designing the garment design to open up opportunities for different wearers' experiences, it

provided the prospect to project a personal dynamic self-expression and sense of self-worth through various dynamic movements. Just as the body moves in various emotional situations, from closing to opening, from rising to descending, from quick to sustained, and from small to large (see Chapters 6, 8, 9 and 10), interactive clothing should enable people to adapt their body in these situations, so that their sense of self-worth is supported, and they can feel appropriately confident, elegant, glamorous, show-offish, protective, safe, personal, social, and public in changing situations (see Chapters 6, 8, 9 and 10). This study has shown that garment forms are able to foster a sense of security in an insecure situation. Apart from the garment's protective function, it can also facilitate personal expression and whimsy. Garment designs need to accommodate and interact emotionally with personal space. This finding can inspire further worthwhile research into the interactive relationship of the characters of objects' personalities and of people's identities (Wolff, 1943; Govers, 2005).

(3) *Evoking mood*: participants experienced various emotions and positive moods when an object was closely connected to their senses, personal stories, memories or imaginations. The object can act as a mood-altering material by stimulating cognitive image processing, such as childhood and nostalgic memories associated with pleasure, reassurance, and fantasy. This can alleviate threat and reduce fear so that a woman can make herself calm. Disguise Garment was based on the EAI framework: seeing through touching. In the context of the EAI framework, the garment was designed to stimulate emotional resonance, by which women are able to recall their nostalgic memories through cognitive interaction. In other words, the garment designed to evoke mood was created through an understanding of emotional aesthetics and of how human interactions, associated movements and responses are cognitively processed. Participants seemed to relate personal stories while interacting with the conceptual prototype, Disguise Garment, which enabled them to transform a negative mood into a positive mood, for instance, from feeling scared to having fun. In addition, Touch me, Feel me, Play with me, which was designed in the context of the EAI framework: feeling through touching, seeing through touching showed that the conceptual garment invited people to touch using a variety of touching modes, which aimed to intensify the emotions and feelings of the wearer. The garment made the participants feel calm and soothed by inviting touch such as squeezing, pressing,

and striking. Interaction with Touch me, Feel me, Play with me involved participants' hands and their bodies, in movements of wrapping, rotating, rubbing, pressing, sliding, squeezing, and fumbling. The garment evoked calming and soothing bodily sensations and also created a 'transient appraisal effect,' enabling participants to calm and to soothe themselves from venting states of discomfort, anger or annoyance. If the garment invites touch, this helps women appreciate the garment better. Appreciation of small differences in touch enhances the psychological benefits of wearing such a garment, helping to relieve depression and increase a general sense of well-being.

(4) *Enjoyment*: this refers to the idea that, if objects are 'playful,' 'funny,' 'warm,' or 'friendly,' they actually reach out to people who actively engage in manipulating them and begin a conversation with them (see Chapters 6 and 8). This dimension of design significantly enhances the comfort experience of 'feeling good.' I found that people were more challenged in exploring playful objects, such as the conceptual prototype garments Trans-For-M-otion, Touch me, Feel me, Play with me, and Jigsaw-Puzzle. These garments seemed to evoke great enjoyment, involving various emotions, for example happiness, comfort, or fear. In other words, the more people interact with an object in a playful manner, the more they have mixed emotions, such as feeling pleasure, calm and warmth. Specifically, the conceptual garment, Touch me, Feel me, Play with me invited participants to touch and move and feel using toughing methods — squashing, pressing, striking, and rubbing. Participants enjoyed physically playing with it and they found it evoked calmness, relaxation, and soothing states. More importantly, participants enjoyed the process of engaging with it and finding solutions. These observations can contribute to further research into emotions and design for having fun (Blythe et al., 2003; Wensveen et al., 2004). The case studies indicate that movement is not only a physiological activity but also about emotional activity. People had better emotional engagement when the garment played with multiple possibilities that offered more bodily engagement and the freedom to find a sense of their own style.

Chapter 12

Conclusion

Chapter 12

Conclusion

In this thesis, I have elaborated re-defining comfort through the nature of experiential bodily knowing and understanding generated through the phenomenological way in which people touch, move, and feel in the process of interacting with an object. The body-centred and sensorimotor-driven interaction research then implemented four contexts of the Enriched Aesthetic Interaction (EAI) framework: knowing through experiencing, experiencing through knowing; feeling through touching; seeing through touching; and doing through feeling, feeling through doing. This EAI framework involved in the research-through-design approach used multifaceted methodological approaches — theories, a workshop project, a pilot study, design activities, and experiments. This approach is designed to gain knowledge through a methodological balance between: the research and the design; the designer's skilled ability and the user's unexplored skills and ideas; tangible prototypes combined with intangible theories; and scientific validation and a theoretical foundation. This set of diverse theoretical and methodological perspectives were brought to investigate a complex, wicked problem that of aesthetic interaction with garments. In particular, based on the EAI framework, the experienceable garments were developed by a process of designing, building and testing highly experiential prototypes that incorporated different interactional ideas. Providing these different levels of interaction possibilities of the human experience of comfort, the experienceable designs were used for speculating on users' ideas, skills, and bodily interactions, and not for evaluating a final product. In addition, through several phases of experiments, I have interpreted the findings in relation to the emotion aroused in specific scenarios, within the parameters of secure vs. insecure situations, blindfolded vs. non-blindfolded, and happy vs. fearful states. Accordingly, in the research-through-design process, design methodology is coupled with research methodology, offering the methods to conduct experiments and draw knowledge from these experienceable prototypes. These experienceable garments therefore showcased how to draw valid and relevant design principles — serendipity, kinaesthetic, evoking mood and enjoyment — from experiments within the framework of EAI.

In conclusion, I refer back to the primary research question: how can design for comfort be incorporated into the principle of aesthetic interaction in clothing design? I have explored the notion of comfort as a multi-faceted phenomenon experience through four contexts of the EAI framework described above. The aim was to recognise the importance of everyday activities, such as characteristic styles of movement including touching, wrapping, and walking. These human senses and behaviours in design research explore suitable theoretical and scientific methods to study the characteristics of sensorial awareness, emotional expression, and bodily movements. The journey of my explorative, experiential, theoretical, and experimental investigations in this thesis has led me to understand the concept of comfort in aesthetic interaction with a garment that is comfort is an individual, experiential, and situational emotion specific to the domain the individual inhabitants. Exploration of the concept of comfort in aesthetic interaction acknowledges the value of learning about people's senses, perception and behaviour in their rich aesthetic interaction with the environment and with material objects. Aesthetic comfort is then defined as existing for us only when we appreciate it during the process of interaction, such as when our senses are gratified (feeling), the meaning we attach to the product (knowing), and the way we experience comfort, satisfaction or pleasure through bodily action (doing). Vink (2005) emphasises 'the comfort of the product can be evaluated only by the user' and he contends that 'a product in itself can never be comfortable' (p. 8). On reflection from the outcome of the EAI framework study, I have found that people's bodily experience was strongly influenced by their own ideas and behaviour in relation to comfort.

> 'Comfort is like drinking a cup of tea while pleasure is like drinking a glass of wine.'

Through interviewing and observation, I explored the difference between the reality of comfort and the image of comfort. The above comment was made by one of my participants in responding to the question: what is the meaning of comfort and pleasure in everyday life? My intention here is not to focus on the differences between the concepts of comfort and pleasure, but to emphasise how much people are aware of the value of comfort in everyday activities, whether consciously or unconsciously.

Creating comfortable clothing may not mean the same thing as creating pleasurable clothing. However, if a garment is comfortable for users, then one can make users feel pleasure simultaneously. So it is, of course, also possible that comfort and pleasure in clothing interaction are directly related, and that making a clothing item comfortable will guarantee that it is a pleasure to use. As I already mentioned in Chapter 4, people's experience of beauty does not exist until they feel it does, through their heart and not through their brain. In a similar way, feeling comfortable in everyday activities can correspond to beauty when a person places a value on something. In other words, we enable the transformation of the ordinary sense of ourselves into the sublime, just as we appreciate a sense of nature.

There is always an interaction of inner experiences with outer bodily expression when we put garments on, wear them, desire them, strive to get them, take possession of them, discard, store and inherit them. Clothes adorn and protect bodies; they are closest to them, next to the skin, what absorbs its smell and sweat (Kim, 2003). By adding human interaction, clothing is converted into a three-dimensional form with function, aesthetic sense, and emotional interaction. The external aspect of movement focuses mainly on the structure of the body and physical activity, whereas the internal aspect focuses on the mental aspect and movements originating from inside meaning (Skjaerven et al., 2003).

In this thesis, I have considered the relationship between comfort and aesthetic interaction in the context of clothing design. I have found that the emotional-aesthetic experience of comfort is more valued and enhanced when there is mental and bodily being-in-engagement and being-in-interaction with objects. We then must better understand how the sensory and motor dimensions of the lived body contribute to an object like clothing making, inhabitation, and human well-being. For Merleau-Ponty (1962), phenomenology offers a way to bring out the latent, undisclosed dimensions of human experience. His discoveries and interpretations offer much in better understanding how our body and environment contribute integrally to human *being-in-the-world*. Therefore, when designing clothing for comfort, researchers and designers should consider the nature of people 's ideas, feelings, movement and every day experiences observed through earlier research processes in the design project, rather than their evaluation of the final product for the use of functional

purposes. To sum up, then, this exploratory study adds to a growing body of research into design of emotional objects with multi-sensory tactile and kinaesthetic sensory qualities, through investigating complex phenomenological activities and human behavioural processes. In doing so, it contributes to the interactive design field and shows how designers can incorporate behavioural concerns into a synergistic design process. The research also shows how designers can incorporate phenomenological nature and the value of everyday activities into their design process. Furthermore, this study contributes to wool clothing research for the ARC Linkage project 'Wool Garment Comfort though Design.' This larger project brings together aspects from current research into wool comfort, related to the investigation of fibre properties and fabric construction, garment innovation, human behaviour (movement), senses, and cognition. The outcomes of the research demonstrate how 'value-adding' from creative production can assist wealth generation from raw materials production, and explores the comfort attributes of WA wool fibre for clothing in conjunction with human behaviour, senses, and perception; this will be of benefit to Department of Agriculture and Food, Western Australia (DAFWA).

The study demonstrates that there is further potential to examine subjects and their sensory experience in the design research process. For instance, future study of tactile (haptic) and movement research could investigate how personal taste is reflected in personality or in different cultural backgrounds in everyday activities. In addition, further investigation into sensorimotor-driven design combined with technology, such as woven sensor fibres, and light emitting diodes, will extend the research into the emotional dimensions of the form and function of clothing. For example, it will be worthwhile to experiment further with embedded sensors that monitor the wearer's muscle tension, breathing, heart rate and body temperature to detect when they feel uncomfortable. As the garment is manipulated to close around the wearer, the shape of its silhouette can relate directly to the wearer's sense of emotional and physical well-being, literally enabling them to wear their heart on their sleeve.

A great deal of aesthetic emotion, comfort in particular, can be derived from our own experience of movement in everyday activities, such as when: we drink a cup of tea; we touch the water; we hear sounds of birds; we smell flower scents; we walk by a

stream; and rub our feet on the sand. The conception of comfort in clothing design research needs to embody these aesthetic experiences in interaction and to be more integrated with phenomenological nature and our everyday lives. The human body in particular is designed for movement. Just as water and sand change their fluid formation constantly in adaptations of nature, our bodies know consciously and unconsciously how to adapt an object for our comfort. When a garment invites touch and movement; when it evokes emotions; when it triggers nostalgic memories; when it provides shelter against the weather or noise; when it provides protection against danger in street crime — in all these cases, it helps people appreciate the objects they interact with and their environment better. Clothing that helps people to appreciate these small differences enhances the physical and psychological benefits from interaction with objects, helping to relieve depression and increase a general sense of well-being. Thus, these objects and clothes offer rich aesthetic interaction to the user.

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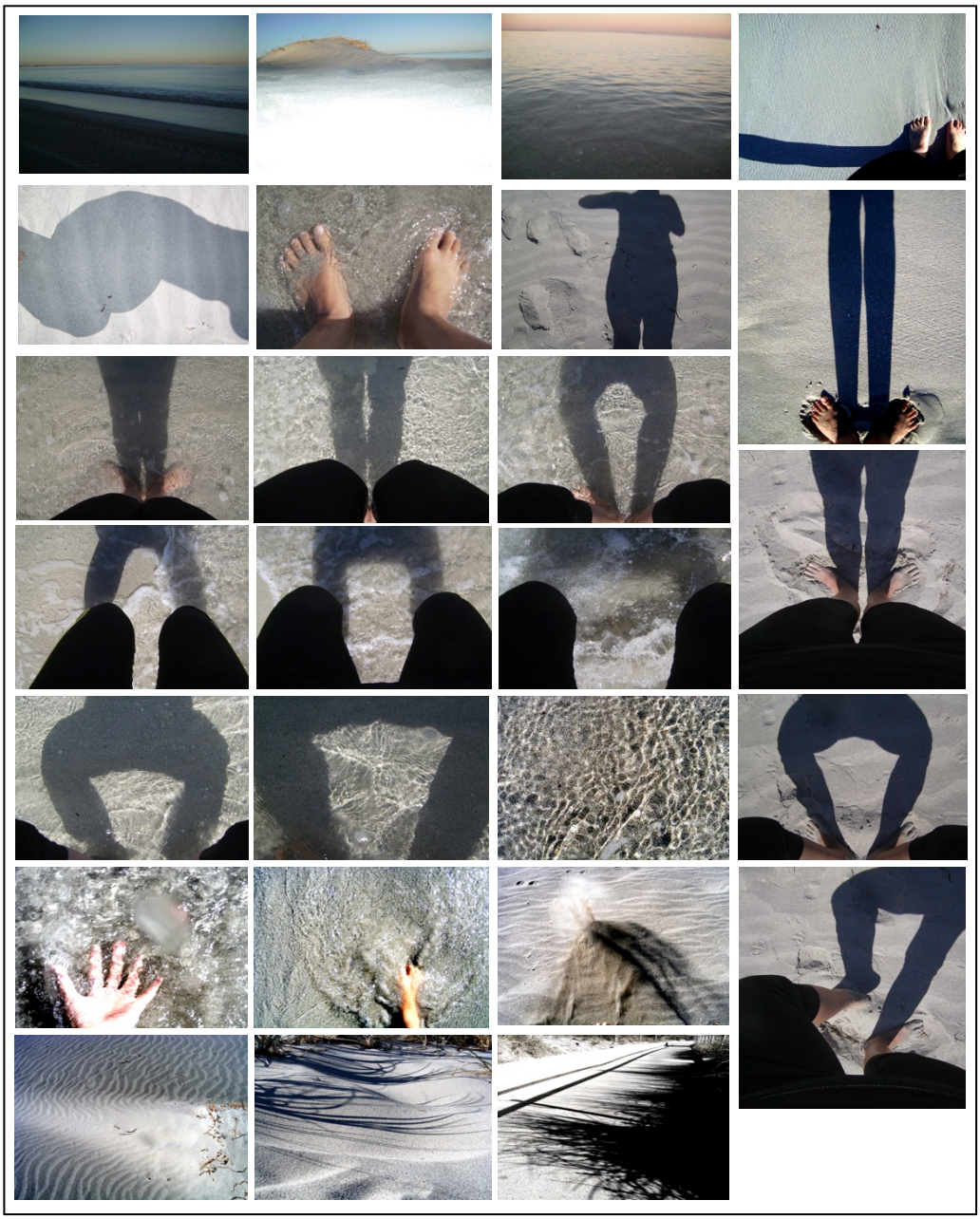
Appendices

Appendices

Appendix to chapter 4

The photographic images the author captured and the performances were taken when attended in a workshop titled 'Fremantle on the Edge,' WA, from 15-17 April 2009. The author was able to engage in active experimentation and interaction with nature via the body, sand, water, shadow, and movement.



Interaction with nature via the body, sand, water, shadow, and movement.
Source: photos by the author.

Appendix to chapter 6

6.1 Participants' reported experience of happiness and fear in response to open-ended questions: what is the most fearful experience you had; and what is the happiest experience you have had?

6.1.1 What is the most fearful experience you have had?

Below are the examples of the words used by the twelve participants out of fifteen who responded with memories of their most fearful experience:

(1) When a stranger approached from behind:

> P (A): The most fearful experience for me in my mid twenties was walking in the countryside at night…there was silence, but somebody's footsteps echoed in the silence and the sound get close to me.
>
> P (B): When I was in my twenties, somebody followed behind me and suddenly took my bag and ran away.

(2) When alone[1] or walking alone in a dark space:

> P (A): The most fearful experience that I remember is probably 'separation' from my father, who passed away when I was in high school. I felt alone in the world.
>
> P (B): I hate being in a dark space alone, it makes me very scared, so that I often turn the light on even when I'm sleeping at night.
>
> P (C): The most fearful experience for me was walking in the countryside at night.

(3) When wandering in an unfamiliar space:

> P (A): I felt uncomfortable and even scared when I was driving in an area that I was not familiar with or when I was being driven by a stranger, for example, in a taxi. In relation to public transport, I have to say that I don't like it very much when random

[1] *Being alone* no matter where they are: this aspect is related to the important clue of social engagement with other people. In fact, this aspect leads to emotional discomfort and even psychological depression. This notion of 'loneliness' has become an emergent lifestyle phenomenon; this is an idea that struck me in reviewing the literature on being fearful and making oneself afraid. Paul Edwards of the Henley Centre observed that loneliness is becoming a new lifestyle experience; he argues that 'More of us will have to go it alone in the future – not just emotionally, but financially and socially – as traditional networks break down and we have to rely on our self-resilience' (cited in Bolton, 2002, p. 84).

strangers sit next to me, particularly on planes. The main reason why it is uncomfortable is that I find when a stranger is sitting next to me that he or she is encroaching on my personal space.

(4) When boarding a flight.

P (A): My most fearful experience was air plane travel…as part of a 'fearless flying' course. I am often petrified of flying. Because I have psychological issues with flying I am scared of planes, which I think may crash…

P (B): In relation to public transport, I am scared to use it at night. It often feels insecure. I don't like it very much when random strangers sit next to me, particularly on planes. I also find the seats in cars/planes to be rather uncomfortable. The main reason why it is uncomfortable is that the distance between the seats on planes/buses is very minimal and I find when a stranger is sitting next to me that he or she is encroaching on my personal space. In regards to car seats, I don't think that they are designed very well; very often when driving I get a feeling that my spine is twisting towards one side which makes me feel very uncomfortable and agitated.

6.1.2 What is the happiest experience you have had?

These are some examples from the twelve participants' responses to memories of their happiest experience:

(1) When interacting with nature:

P (A): It is very relaxing and comfortable for me to walk to university because the nature, sunlight, colour and sounds in my walk bring joy and happiness.

P (B): I particularly enjoy seeing flowers and I enjoy painting landscapes, which makes me feel comfortable and happy.

P (C): I like swimming, which makes me feel fit and healthy. I also like to do any form of physical activity as a way of de-stressing, and my favourite is going for a walk, doing yoga and Chinese massage. I love to meditate, do gardening and listen to the music. I like to spend free time doing outside work.

P (D): I like to walk about in dense urban places (e.g., the city) because I like being part of a complex, vibrant, changing, beautiful place.

P (F): I am happy to enjoy the scenery while walking, which makes me feel comfortable.

(2) When meeting with their close friends and family:

P (A): I like to meet friends face to face for coffee and have friends over for dinner parties.

P (B): I like to meet people. I like socialising with different age groups.

P (C): I also like to talk, which refreshes body and mind and feel free with when I'm doing that.

P (D): I like to meet up with my friends, because it keeps me in touch with people I care for, and sometimes we have something to eat together, have drinks, or go to the movies…I like these activities because they make me feel connected to others and to myself.

P (F): I like talking and interacting with many people, because many years of moving during my childhood has meant that I can talk easily with people.

(3) Being alone to make themselves calm:

P (A): I more and more feel that I want to value the time I can be spiritually at peace. Nowadays I spend more time at home, enjoying tranquillity.

P (B): I like to spend time alone and be in the outdoors.

6.1.3 Participants were asked open-ended questions intended to explore their sense of self and the clothing style that expresses their personality.

Twelve out of fifteen participants responded to the research questions: (1) who are you; (2) what are you doing; and (3) what is your lifestyle, including a sense of your style in conjunction with clothing?

P(M): I am 30 years old and born in Australia, and a PhD student in the Art Department. I am working at University as a tutor. I use my car usually to go to work but sometimes catch a bus or walk when my car breaks down. I teach online, thus

interact with people mainly over the Internet. I like to meet friends face to face for coffee and have friends over for dinner parties. Although I am quite *anxious* in some ways, which can also lead to feeling *self-conscious*, I am also quite *social* and happy with my friends. I am approachable and friendly most of the time. I like big, loud, and bright patterns, and I wear skirts and tops usually. I often use red to accentuate an outfit. I like big necklaces. My style changes according to mood and clothing availability. My emotional lifestyle words, which represent my sense of personality, are *creative*, *containing, conservative, dowdy, formal, casual, and old.*

P(R1): I am 28 years old and born in Australia. I am a PhD student and a university tutor in the Urban Regional Planning Department. My clothing should be comfortable, easy to wear, resilient, and playful. Looking good on me of course! My emotional lifestyle and personality words are *adventure, travel, explore, relate, engage, and play*.

P(N): I am 26 years old and was born in India. I am a Masters student in the Urban Regional Planning Department. Most of the time, I work at the uni. Whatever I wear is not very different from most students. For example, my clothing is very casual, i.e., jeans and a shirt or t-shirt with a jacket over it and thongs or sneakers. My sense of style is that of a tom-boy. I merges with other students at uni and on my way to uni or home. I prefer to wear comfortable and warm clothing mostly because I am very active and prefer running most of the time. Secondly, my workstation is cold, that's why I like warm and functional clothing, for example, jeans, and t-shirt to adapt to different temperatures and movement. My previous work environment, which was mostly site work, demanded clothing which was comfortable and subtle, and needed to be functional. I am *active and energetic*.

P(Sa): I am 34 years old, born in India, and a full-time international PhD student. I walk or take the bus to go to uni. It is very relaxing and comfortable for me to walk to the university because the sunlight, colour, nature and sounds on my walk bring joy. I like to travel, meet people and build on knowledge, which brings positive change and growth through risks and challenges. My clothing is usually formal yet elegant in public settings. I like casual style for work requirement. Considering my emotional words and personality, I like to bring a sense of *integrity*, *charm*, *grace and seriousness* in all or most of the work I undertake.

P(Y): I am 30 years old and born in Japan. I am a PhD student. I often feel a sense of needing to rush as I have many things to do every day. My brain is simply too exhausted at the end of the day because of much tough theoretical work. By birth, I am accustomed to *socialising,* meeting people, and talking about academic issues. But in recent years, I more and more feel that I want to value the time I can be spiritually at peace. Nowadays, I spend more time at home, enjoying tranquillity. Working does not directly influence my personality, but I suppose the way I work or travel reflects my character. The question about how my clothing fulfils my personality depends on the mood of the day/morning; I pick up the clothes that I want, with colours that probably mirror the ontological condition of my being on that day as well as my objectives on that day. My personality is *cooperative and trusting*.

P(D): I am in my mid 30s, and am from India. I am a PhD student. I walk to university and like to enjoy the scenery while walking. I also like photographing things I see, in particular flowers, and enjoy painting landscapes, which makes me feel comfortable. I like to meet people. I like *socialising* with different age groups. My clothes should be in colours that match or complement each other so that they are protective, practical, casual, comfortable, elegant, feminine, simple, distinct, and smart. They boost my self-confidence. My personality can be *well organised* and I like to *achieve my goals*.

P(V): I am in my mid 30s and a student at the Department of Interior Architecture. I like to spend time alone and to be in the outdoors because I can think about my life, and my dreams. I design a lot when I am alone. I reflect on my philosophy of living, design, and existence. I *let the native environment inspire* me. I like clothing that is comfortable, adaptable to weather changes, and flattering.

P (K): I am in my mid 30s, a teacher at university, and a designer. I am comfortable in my car, that is, in a secure place with my own car, listening to beautiful music. I am happy generally, but sometimes stressed by driving (traffic, tardiness). I like talking and interacting with many people because many years of moving during my childhood meant that I can talk easily with people. My clothing should be comfortable and subtle with a slight edginess. My emotional lifestyle words can be *soothing*.

P (H): I am in my mid 30s and was born in Australia. I am an artist and teacher. I ride a bike, catch a train, or use my own car to go somewhere. I like swimming, which makes me feel fit and healthy. I also like to talk to socialise, which refreshes my

body and mind, and I feel freedom with that. My clothing should be functional and practical for varied tasks in work situations. My sense of style can be fairly *conservative and straight*, due to being disciplined in a Catholic school environment.

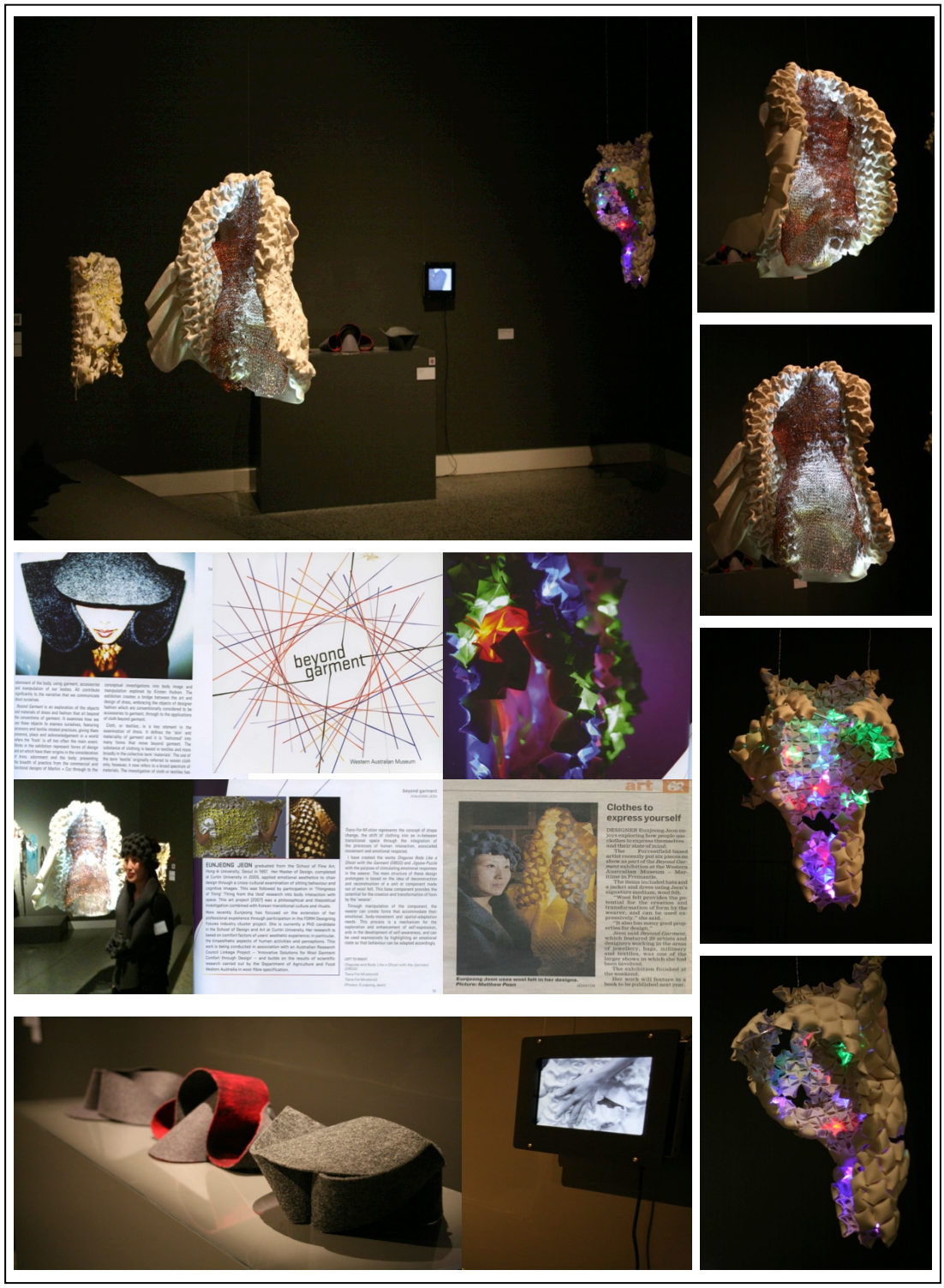
P(Sha): I am an international student from Namibia, pursuing postgraduate studies in counselling at Curtin university. I am in my mid 30s. I like to meet up with my friends, because it keep me in touch with people I care for, and sometimes we have something to eat together, have drinks, or go to the movies. I also like to do any form of physical activity as a way of de-stressing and my favourites are going for a walk, doing yoga, and Chinese massage. I like these activities because they make me feel connected to others and to myself. These activities are also relaxing and are my antidotes to stress from academic work. I want products that are comfortable for my students to use and/or my role as well as for my favourite activities I engage in. Clothes should also be functional as student life can get quite hectic, so simple products that don't need high maintenance (such as cleaning, ironing, etc) would be ideal for me. My emotional lifestyle words and personality are: *comfortable, functional, and distinctive* so that they portray who I am as a person.

P(S): I am a post-graduate student at the Department of Urban Regional Planning. I was born in India and came to Australia four years ago. I am working at university at a workstation. I work on a computer, read and writes notes. I go to uni first by car (my husband drives me) to the train station, which take normally takes five minutes; then I catch a train. In my experience of commuting, overcrowded trains or buses are uncomfortable for me. In particular, I experience pain from standing or when the vehicle is in motion. The reason is that chronic pain makes it difficult for me to manage my bag, books and self in crowded transport. I like to meet many people but I prefer being a '*listener* or *observer'* rather than the 'centre of attention' when in a group. Also I love to meditate, do gardening, read books and listen to music. I like to spend my free time doing outside work. I have always enjoyed travelling in public transport and have developed a habit of observing people, for example, clothes, expressions, behaviour, languages and so on. I like clothing to be no-nonsense; feminie yet not make me look vulnerable. I do not need to make a bold statement, just to be clean, relaxed and comfortable. Functionality is of utmost importance. I need pockets to store bus passes etc. My emotional lifestyle words and personality could be: *freedom, non-constrictive, breathable, and functional*.

P(T): I am a postgraduate student in Urban Regional Planning. I am 30 years old and born in Bosnia. I am working at the university as a lecturer. I am mainly working from home these days, trying to write my thesis because I find the space in my Postgraduate office too limiting (only about 2m). I am only in two days a week at my PG office where I mainly conduct reference searches, copying, reading – activities that do not require much space, i.e. many papers to be scattered around). I generally drive wherever I go, except when I am overseas or interstate. I love driving and travelling in general. I feel more uncomfortable when I am wearing skirts, dresses and high heels because they limit my movements to some extent and make me very conscious of how I look (sitting properly etc). To relax, I try to go to the gym at least two to three times a week and I have dance classes once a week. When I am at uni I try to catch up with most of my friends (fellow PG students) for lunch and see how they are and what they are up to. I also am trying to diversify my activities, to learn new things and stay fit. That way I feel more relaxed and psychologically balanced, which helps me focus better on my work, that is, writing my thesis. I tend to wear more casual, functional clothing like jeans and t-shirts or a sweater. I feel relaxed and comfortable in such clothes because I don't have to worry about how I look, sit or walk. From time to time I would wear something more distinctive, but that would generally depend on how I feel that day. I have a dress that is very simple yet a bit distinctive so that I like wearing (it makes me feel very young and comfortable). But other dresses that I have are a bit more stylish so I don't tend to wear them all that often because I don't feel as comfortable in them. I only wear them on some occasions. I don't like being overdressed in general. My emotional lifestyle words and personality could say well *organised* and *achieving goals*. I like clothing that is comfortable*, functional, protective and simple yet elegant*, *distinctive and bit quirky*.

Appendix to chapter 7

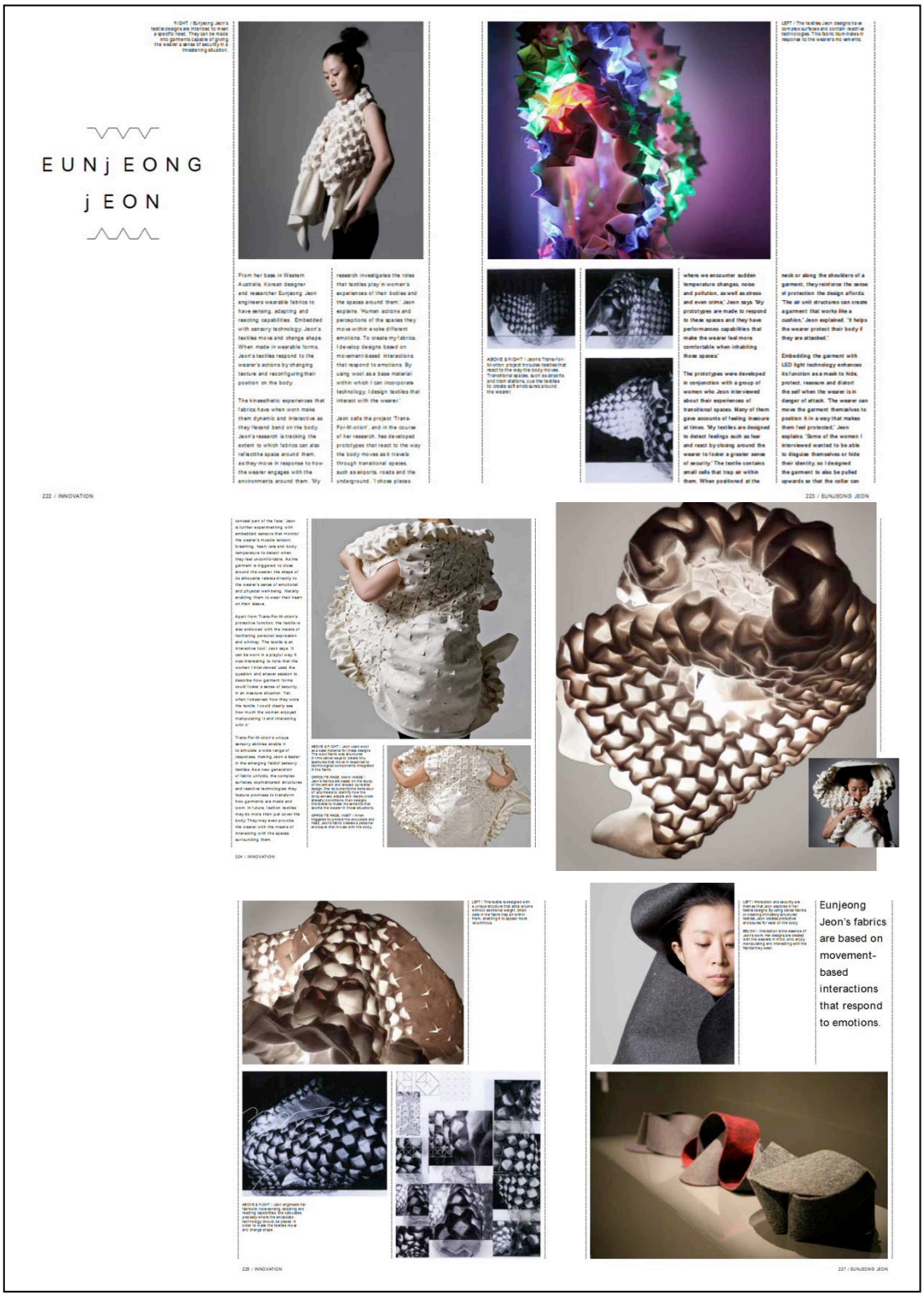
Four conceptual prototype garments (Trans-For-M-otion; Feel me, Touch me, Play, with me; Jigsaw-Puzzle; Disguise Garment) were invited to the 'Beyond Garment' exhibition at the Western Australian Museum, 3 September and 30 November, 2010.



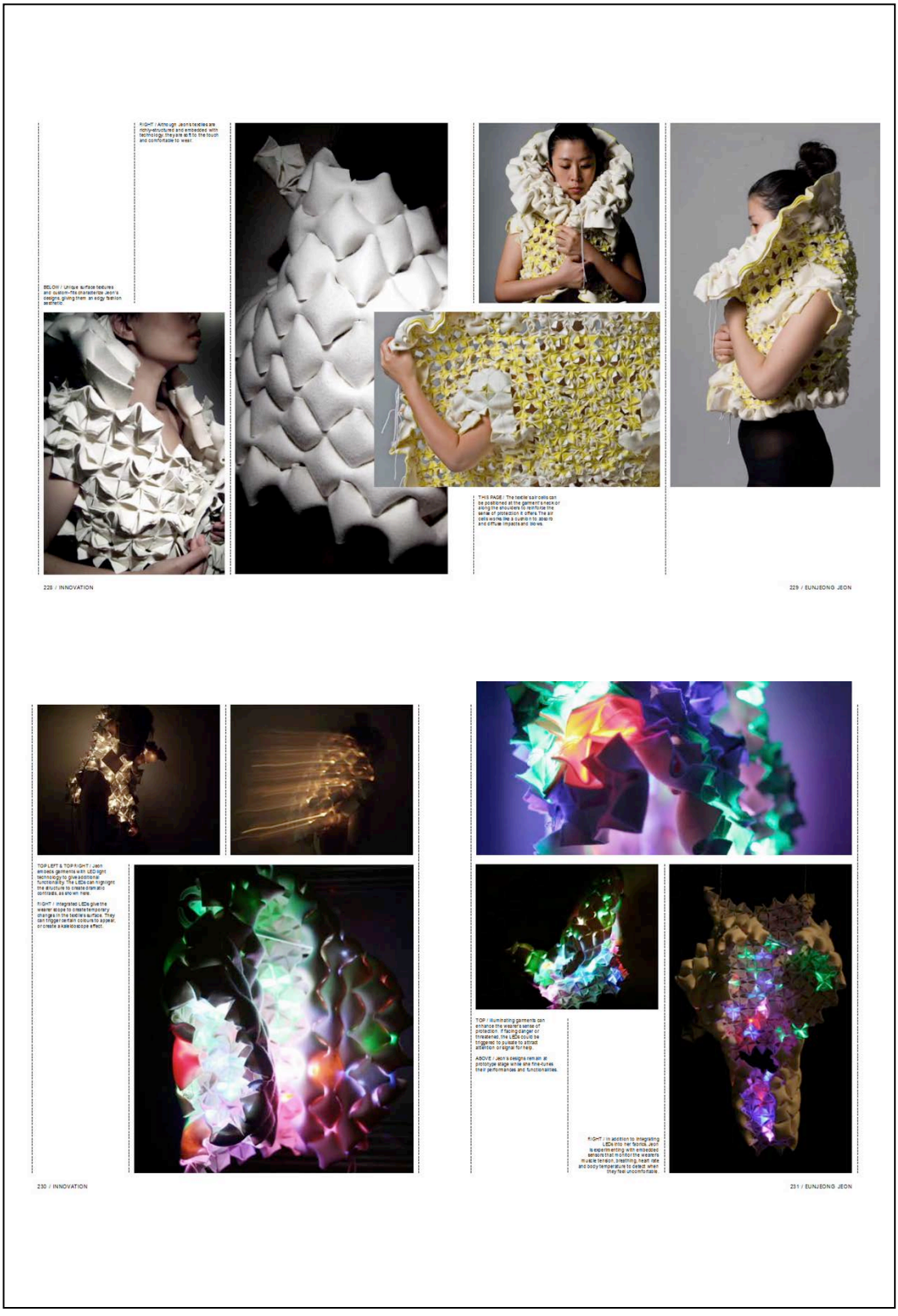
'Beyond Garment' exhibition at the Western Australian Museum, 3 September-30 November, 2010. Source: photo by Kyunghoon Kim, catalogue by Ann Farren (2010) and Stirling Times by Nicole Harrison (2010).

These garments were also selected for publication in: *Australian Council of University Art and Design Schools (ACUADS) Research* by Ross Woodrow (2009), *Advanced Textiles for Health and Well-Being* (Marie O'Mahony 2011), *Fashion Futures* by Bradley Quinn (2012)

and *Textile Visionaries* by Bradley Quinn (2012, pp. 222-231). The following images are illustrated in the book, *Textile Visionaries: Innovation and Sustainability in Textile Design* by Bradley Quinn (2012).



The conceptual garments were selected for publication in *Textile Visionaries: Innovation and Sustainability in Textile Design.*
Source: Bradley Quinn (2012, pp. 222-231).



The conceptual garments were selected for publication in *Textile Visionaries: Innovation and Sustainability in Textile Design.*
Source: Bradley Quinn (2012, pp. 222-231).

Appendix to chapter 8

The haptic experimentation was conducted by comparing blindfolded and non-blindfolded touch, and active and passive touch. Participants did blindfold first, then non-blindfold. In a blindfold condition their blindfolded behaviour was observed and recorded using the following research questions:

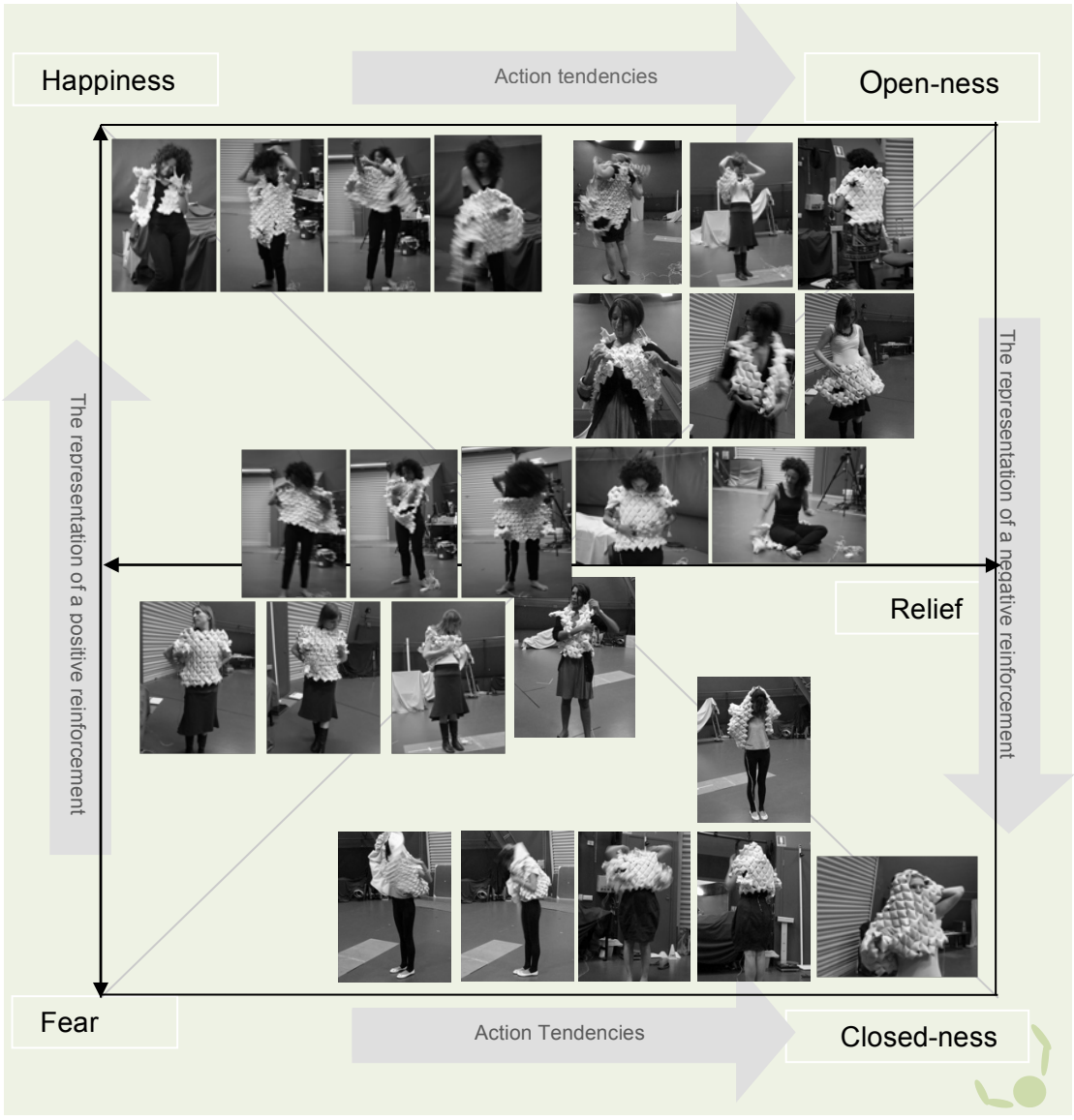
1) Can you close your eyes?
2) Can you touch each object?
3) Can you say out loud what you were feeling while touching them?
4) Can you say out loud what you imagined while touching the object?

In a non-blindfold condition participants' blindfolded behaviour was observed and recorded using the following research questions:

1) Can you open your eyes?
2) Can you touch each object?
3) Can you say out loud what you are feeling while touching them?
4) Can you say out loud what you imagine while touching the object?
5) Can you wrap around your body each prototype freely?
6) Can you select the prototype that is the most comfortable when you manipulate it on your body? Why have you chosen this one?
7) Can you wrap each prototype around your body in response to question: how do you interact with the object to transform your feelings of fear into a recognisable state of comfort?
8) Can you wrap each prototype around your body in response to the question: how do people interact with the garment to reinforce their feeling of pleasure in a recognisable state of comfort?
9) Can you rank the comfort level of the objects, following the seven-point scale, comparing your experience in a blindfolded and non-blindfolded condition?

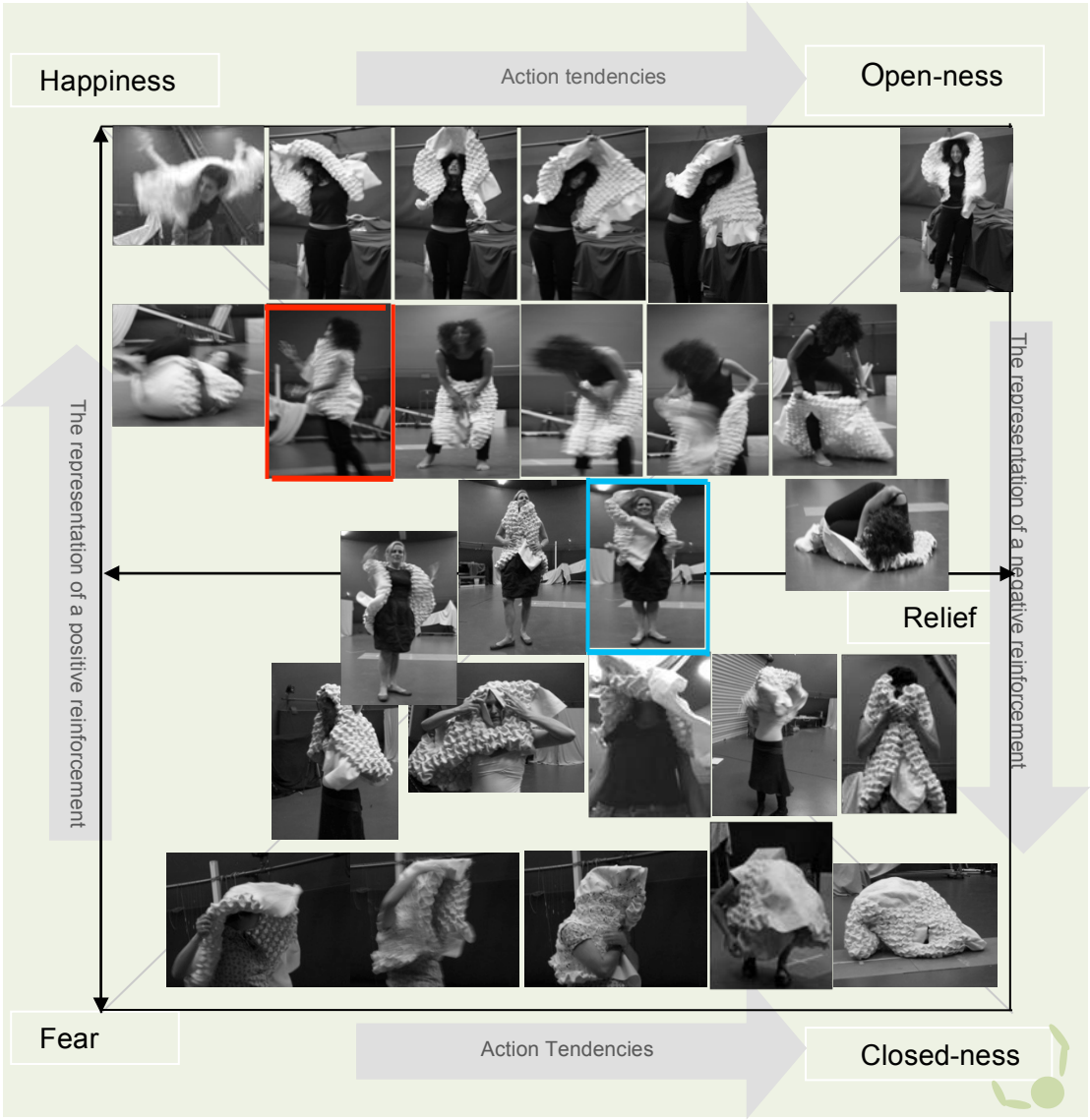
8.1. Participants' bodily movements and actions expressing their emotional responses (happiness and fear) when they interacted with each conceptual prototype: Trans-For-M-otion, Touch me, Feel me, Play with me, Disguise Garment, and Jigsaw-Puzzle.

8.1.1 Participants' bodily movements and actions expressing their emotional responses (happiness and fear) when they interacted with Trans-For-M-otion



Trans-for-M-otion

8.1.2 Participants' bodily movements and actions in response to their emotions (happiness and fear) when they interacted with Touch me, Feel me, Play with me



Touch me, Feel me, Play with me

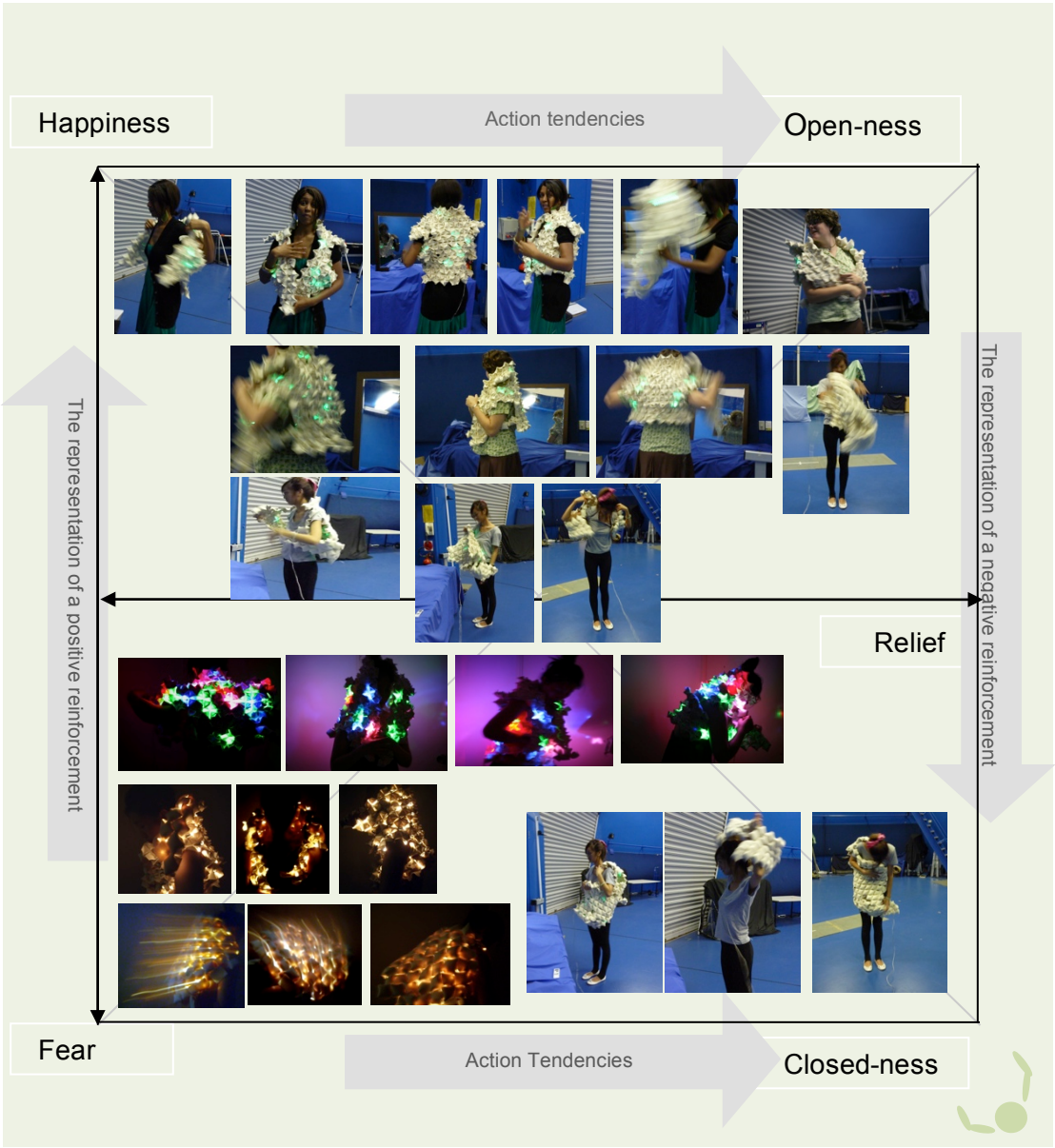
The photograph surrounded by red borders represents 9 out of 15 participants manipulating the conceptual garment when they intended to express a happy emotion. This form is therefore called the 'Happy Garment.' The photograph surrounded by blue borders represents 11 out of 15 participants manipulating the conceptual garment when they intended to express a fearful emotion. This form is therefore called the 'Fearful Garment.' The 'Happy Garment' and 'Fearful Garment' were formed by wrapping the conceptual prototype, Touch me, Feel me, Play with me in different ways. The 'Happy Garment' was a sleeveless, half-length coat style. The 'Fearful Garment' was a sleeveless jacket style with a hood. The conceptual prototype was used to test: 1) human walking behaviour, correlating and

comparing three different walk types (‘natural,’ ‘happy,’ and ‘fearful’) and three different garment types (‘normal,’ ‘happy,’ and ‘fearful’); and 2) to apply the concept of movement to design of interactive garments that enhance comfort (see Chapters 9 and 10).

8.1.3 Participants’ bodily movements and actions in response to their emotions (happiness and fear) when they interacted with Jigsaw-Puzzle

Jigsaw-Puzzle

8.1.4 Participants' bodily movements and actions in response to their emotions (happiness and fear) when they interacted with Disguise-Garment



Disguise Garment

8.2 Analysis of comfort experienced in interaction with four conceptual prototypes: Trans-for-M-otion, Touch me, Feel me, Play with me, Disguise Garment, and Jigsaw-Puzzle

Haptic experiences in response to various qualities of the target conceptual prototypes were quantitatively evaluated using the Semantic differential (SD) test (Osgood et al., 1957) to explore the relationships between design attributes and users' perceptions. Participants were asked to rank each conceptual prototype using a seven-point scale to evaluate their haptic experiences. The emotional effect on users' haptic perceptions of interacting with four conceptual prototypes (Trans-For-M-otion, Touch me, Feel me, Play with me, Jigsaw-Puzzle, Disguise Garment) was based on four assessments — *function, aesthetic, mood, and enjoyment* — using a seven-point rating scale, as shown below.

Not at all	Function						Very much
	−3	−2	−1	0	+1	+2	+3

Not at all	aesthetic						Very much
	−3	−2	−1	0	+1	+2	+3

Not at all	Mood						Very much
	−3	−2	−1	0	+1	+2	+3

Not at all	Enjoyment						Very much
	−3	−2	−1	0	+1	+2	+3

The analysis was done using a program called SAS (version 9.1). 15 participants assessed various qualities of the target prototypes, and made an overall assessment of each prototype with and without a blindfold. An Analysis of Variance (ANOVA) for repeated measures was used to analyse the different qualities. ANOVA was also used to identify if the blindfolded effects varied overall, and also between prototypes. This 'repeated measures' type of analysis was performed in order to correlate the data from the multiple assessments made by each subject. The analysis followed a random effects regression model, using the SAS program.

The table below shows a sample of raw data and ANOVA analysis of tactile evaluation of four conceptual prototypes in a blindfolded condition.

Prototype comparison

10:32

Monday, November 22, 2010

The Mixed Procedure

Model Information

Data Set	WORK.EUNJEONG
Dependent Variable	BLINDFOLD
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information

Class	Levels	Values
PROTOTYPE	3	Jigsaw-Puzzle (JP) Touch me, Feel me, Play with me (TFP) Trans-For-Motion (TFM)
ID	15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Dimensions

Covariance Parameters	2
Columns in X	4
Columns in Z	15
Subjects	1
Max Obs Per Subject	45

Number of Observations

Number of Observations Read	45
Number of Observations Used	36
Number of Observations Not Used	9

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	107.65854374	
1	1	107.65854374	0.00000000

Convergence criteria met.

Covariance Parameter Estimates

Cov Parm	Estimate
ID	0
Residual	1.2197

Fit Statistics

-2 Res Log Likelihood	107.7
AIC (smaller is better)	109.7
AICC (smaller is better)	109.8
BIC (smaller is better)	110.4

Solution for Fixed Effects

Effect	PROTOTYPE	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		0.9167	0.3188	11	2.88	0.0151
PROTOTYPE	JP	0.9167	0.4509	22	2.03	0.0543
PROTOTYPE	TFP	0.9167	0.4509	22	2.03	0.0543
PROTOTYPE	TFM	0	.	.	.	.

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
PROTOTYPE	2	22	2.76	0.0855

Least Squares Means

Effect	PROTOTYPE	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha
PROTOTYPE	JP	1.8333	0.3188	22	5.75	<.0001	0.05
PROTOTYPE	TFP	1.8333	0.3188	22	5.75	<.0001	0.05
PROTOTYPE	TFM	0.9167	0.3188	22	2.88	0.0088	0.05

Least Squares Means

Effect	PROTOTYPE	Lower	Upper
PROTOTYPE	JP	1.1722	2.4945
PROTOTYPE	TFP	1.1722	2.4945
PROTOTYPE	TFM	0.2555	1.5778

Differences of Least Squares Means

Effect	PROTOTYPE	_PROTOTYPE	Estimate	Standard Error	DF	t Value	Pr > |t|
PROTOTYPE	JP	TFP	0	0.4509	22	0.00	1.0000
PROTOTYPE	JP	TFM	0.9167	0.4509	22	2.03	0.0543
PROTOTYPE	TFP	TFM	0.9167	0.4509	22	2.03	0.0543

Differences of Least Squares Means

Effect	PROTOTYPE	_PROTOTYPE	Alpha	Lower	Upper
PROTOTYPE	JP	TFP	0.05	-0.9350	0.9350
PROTOTYPE	JP	TFM	0.05	-0.01838	1.8517
PROTOTYPE	TFP	TFM	0.05	-0.01838	1.8517

Appendix to chapter 9

Analysis of variance (ANOVA) was used: 1) to analyse human walking behaviour, correlating and comparing three different walk types ('natural,' 'happy,' and 'fearful') and three different garment types ('normal,' 'happy,' and 'fearful'); and 2) to implement the concept of movement in designing interactive clothing for comfort.

A total of 27 trials for each subject were carried out. In total, 216 gait gestures were recorded and analysed in two ways:

1) To determine whether subjects were able to use information provided by their gait to identify emotions, ANOVA with repeated measures was used to analyse the different qualities. The 'repeated measures' form of analysis was performed to correlate the data, due to the multiple assessments made with each subject. A random effect regression model was employed, using the 'Mixed' procedure in the SAS software. For each analysis, the person was labelled as the random effect, while garment and walk types were the fixed effects. The interaction between garment and walk type was initially included in the model, but was found not to be statistically significantly in each outcome. It was subsequently dropped from the model, and the results presented below were obtained without any interaction terms (see detailed sample of raw data below).
2) To check that the model was suitable for each of these measures, the logarithm of the measure was analysed as well. This would have the effect of removing any skew in the data if it happened to be present. In all cases, analysis of the log measure yielded the same conclusions about the significance or otherwise of the garment and walk types.

Occasionally (when there were large differences between group means), the interaction effect appeared to be significant as well. However, the magnitude of the interaction effect was usually very small in relation to the differences between groups, so it was considered clearer to focus on the differences between garments and walk types in the absence of the relatively minor interaction term.

The below table shows a sample of raw data and analysis of ANOVA for side-to-side head movement.

The MEANS Procedure

Analysis Variable: SSHEAD

WALK	GARMENT	N Obs	N	Mean	Std Dev
Fearful	Fearful	8	8	50.73	11.69
	Happy	8	8	63.75	36.26
	Normal	8	8	47.96	20.45
Happy	Fearful	8	8	49.73	17.53
	Happy	8	8	44.94	11.46
	Normal	8	8	49.95	10.55
Natural	Fearful	8	8	34.54	5.24
	Happy	8	8	35.70	6.12
	Normal	8	8	40.37	7.18

The Mixed Procedure

Model Information

Data Set	WORK.WOOLDATA
Dependent Variable	SSHEAD
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information

Class	Levels	Values
SEQUENCE	8	01 02 03 04 05 06 07 08
WALK	3	Fearful Happy Natural
GARMENT	3	Fearful Happy Normal

Dimensions

Covariance Parameters	2
Columns in X	16
Columns in Z	8
Subjects	1
Max Obs Per Subject	72

Number of Observations

Number of Observations Read	72
Number of Observations Used	72
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	552.89245978	
1	1	552.06893968	0.00000000

Convergence criteria met.

Covariance Parameter Estimates

Cov Parm	Estimate
SEQUENCE	18.2031
Residual	263.58

Fit Statistics

-2 Res Log Likelihood	552.1
AIC (smaller is better)	556.1
AICC (smaller is better)	556.3
BIC (smaller is better)	556.2

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
WALK	2	56	7.01	0.0019
GARMENT	2	56	0.23	0.7955
WALK*GARMENT	4	56	1.23	0.3084

The p-value associated with the interaction term was 0.308, so it was dropped from the model and adjusted.

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
WALK	2	60	6.91	0.0020
GARMENT	2	60	0.23	0.7982

Least Squares Means

Effect	WALK	GARMENT	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha
WALK	Fearful		54.1500	3.6565	60	14.81	<.0001	0.05
WALK	Happy		48.2054	3.6565	60	13.18	<.0001	0.05
WALK	Natural		36.8736	3.6565	60	10.08	<.0001	0.05
GARMENT		Fearful	45.0015	3.6565	60	12.31	<.0001	0.05
GARMENT		Happy	48.1312	3.6565	60	13.16	<.0001	0.05
GARMENT		Normal	46.0962	3.6565	60	12.61	<.0001	0.05

Least Squares Means

Effect	WALK	GARMENT	Lower	Upper
WALK	Fearful		46.8358	61.4641
WALK	Happy		40.8912	55.5196
WALK	Natural		29.5594	44.1878
GARMENT		Fearful	37.6873	52.3157
GARMENT		Happy	40.8170	55.4454
GARMENT		Normal	38.7821	53.4104

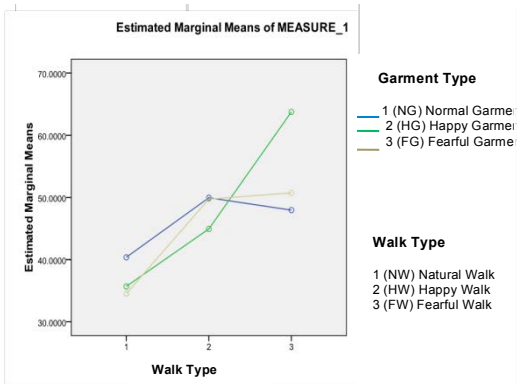
Differences of Least Squares Means

Effect	WALK	GARMENT	_WALK	_GARMENT	Estimate	Standard Error	DF	t Value	Pr > |t|
WALK	Fearful		Happy		5.9445	4.7225	60	1.26	0.2130
WALK	Fearful		Natural		17.2764	4.7225	60	3.66	0.0005
WALK	Happy		Natural		11.3319	4.7225	60	2.40	0.0195
GARMENT		Fearful		Happy	-3.1297	4.7225	60	-0.66	0.5101
GARMENT		Fearful		Normal	-1.0947	4.7225	60	-0.23	0.8175
GARMENT		Happy		Normal	2.0349	4.7225	60	0.43	0.6681

Differences of Least Squares Means

Effect	WALK	GARMENT	_WALK	_GARMENT	Alpha	Lower	Upper
WALK	Fearful		Happy		0.05	-3.5020	15.3910
WALK	Fearful		Natural		0.05	7.8299	26.7229
WALK	Happy		Natural		0.05	1.8854	20.7784
GARMENT		Fearful		Happy	0.05	-12.5762	6.3168
GARMENT		Fearful		Normal	0.05	-10.5412	8.3518
GARMENT		Happy		Normal	0.05	-7.4116	11.4814

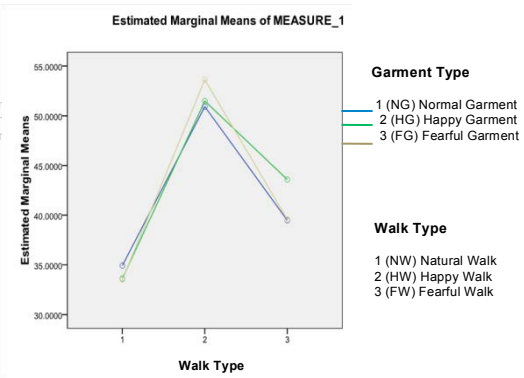
Below, graphic images show the mean score and the patterns of walk velocity, step length, and range of hand movements and velocity comparing three different walk types (‘natural,’ ‘happy,’ ‘fearful’) and three different garment types (‘normal,’ ‘happy,’ ‘fearful’).



Head: side-to-side range of movement

Summary of statistics:

- Overall walk type difference (p=0.002),
  No garment type difference (p=0.798),
  Walk* G=garment (p=0.308)
- Post-hoc P-value for pairwise comparison:
  Walk type: 1&2 significant difference (p=0.020)
  1&3 significant difference (p=0.005)



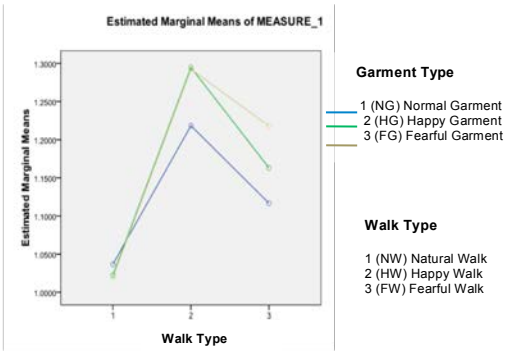
Head: up and down range of movement

Summary of statistics:

- Overall walk type difference (p=0.001)
  No garment type difference (p=0.971),
  Walk* garment (p=0.980)
- Post-hoc P-value for pairwise comparison:
  Walk type: 1&2 significant difference (p=0.0003)
  2&3 significant difference (p=0.019)

*The blue graph is the ‘Normal Garment’ and the green graph is the ‘Happy Garment.’ The yellow graph represents the ‘Fearful Garment.’

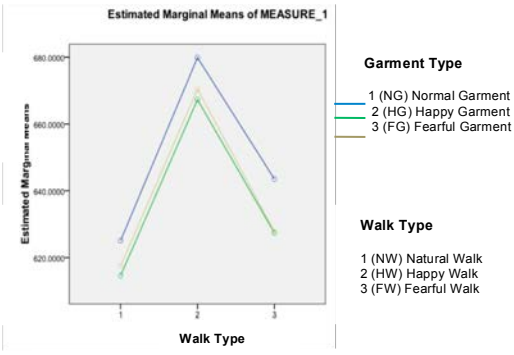
The mean scores of compared head side-to-side movements with up-down movement in three different walk types (‘natural,’ ‘happy,’ and ‘fearful’) and three garment types (‘normal,’ ‘happy,’ and ‘fearful’).



Walk velocity

Summary of statistics:

- Overall Walk type difference (p=0.007)
  No garment type difference (p=0.766)
  Walk* garment (p=0.968)
- Post-hoc P-value for pairwise comparison:
  Walk 1&2 significant difference (P=0.017)

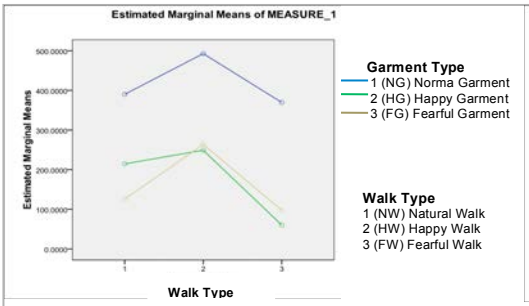


Step Length

Summary of statistics:

- Overall walk type difference (p=0.0004)
  No garment type difference (p=0.571)
  Walk* garment (p=0.999)
- Post-hoc P-value for pairwise comparison:
  Walk type 1&2 significant difference (p=0.0001)
  2&3 significant difference (p=0.038)

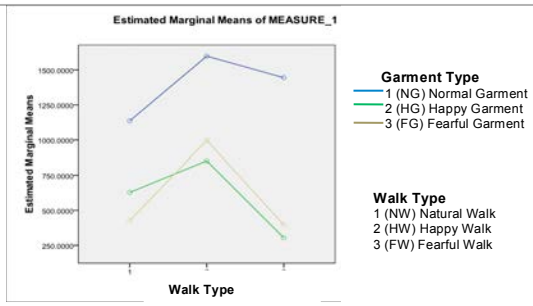
The mean scores of walk velocity and step length in three different walk types (‘natural,’ ‘happy,’ and ‘fearful’) and three garment types (‘normal,’ ‘happy,’ and ‘fearful’).



Hands: forward-backward range of movement

Summary of statistics:

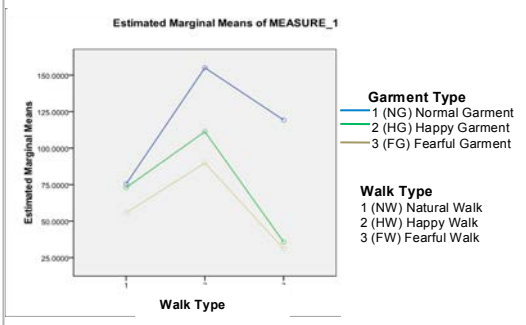
- Overall: walk type (p=<0.0001),
  garment type (p<0.0001)
  Walk* garment (p=0.264)
- Post-hoc P-value for pairwise comparison:
  Walk 1&3 significant difference (P < 0.002)
  Walk 3&2 significant difference (P < 0.001)
  Garment 1&2 significant difference (p=<0.0001)
  Garment 1&3 significant difference (p=<0.0001)



Hands: forward-backward velocity

Summary of statistics:

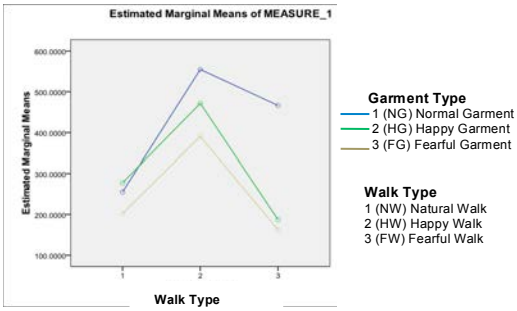
- Overall: walk type (p=0.001),
  garment type (p<0.0001)
  Walk* garment (p = 0.215)
- Post-hoc P-value for pairwise comparison:
  Walk 1&3 significant difference (P=0.001)
  Walk 2&3 significant difference (P=0.0007)
  Garment 1&2 significant difference (p<0.0001)
  Garment 1&3 significant difference (p<0.0001)



Hands: side-to-side range of movement

Summary of statistics:

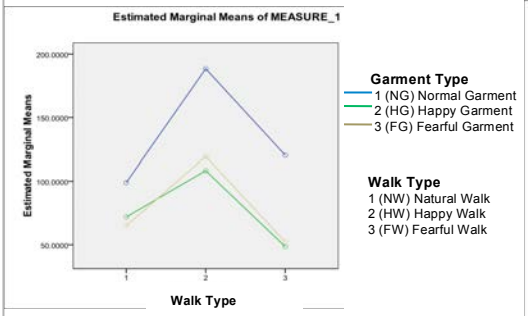
- Overall: walk type (p=0.0005)
  garment type (p=0.0008)
  Walk* garment (p = 0.214)
- Post-hoc P-value for pairwise comparison:
  Walk type 1&3 significant difference (p=0.013)
  Walk 2&3 significant difference (p=0.0004)
  Garment type 1&2 significant difference (p=0.0003)



Hands: side-to-side velocity

Summary of statistics:

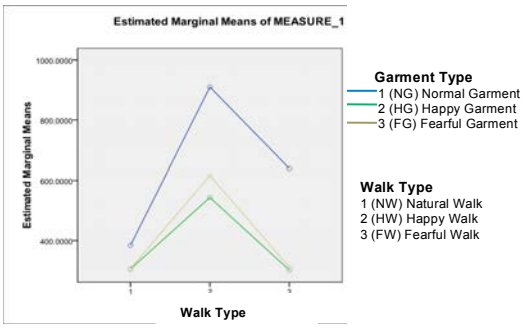
- Overall: walk type (p=0.0003)
  garment type (p=0.013)
  Walk* garment (p = 0.249)
- Post-hoc P-value for pairwise comparison:
  Walk 2&3 significant difference (p=0.0009)
  Walk 1&3 significant difference (p=0.0002)
  Garment 1&2 significant difference (p=0.004)



Hands: up-down range of movement

Summary of statistics:

- Overall: walk type (p<0.0001)
  garment type (p<0.0001)
  Walk* garment (p=0.195)
- Post-hoc P-value for pairwise comparison:
  Walk type 1&3 significant difference (p<0.0001)
  2&3 significant difference (p<0.0001)
  Garment type 1&3 significant difference (p<0.0001)
  2&3 significant difference (p<0.0001)



Hands: up-down velocity

Summary of statistics:

- Overall: walk type (p <0.0001)
  garment type (p=0.0001)
  Walk* garment (p=0.293)
- Post-hoc P-vale for pairwise comparison:
  Walk type 1&3 significant difference (p<0.0001)
  2&3 significant difference (p<0.0001)
  Garment type 1&3 significant difference (p=0.0001)
  2&3 significant difference (p=0.0005)

The mean scores of hand range of movements and velocity in forward-backward, side-to-side and up-down ways in three different walk type ('natural,' 'happy,' and 'fearful') scales for three garment types ('normal,' 'happy,' and 'fearful').

In terms of analysing Motion Capture data, Statistical Package for the Social Sciences (SPSS) repeated measures ANOVA was changed into using Statistical Analysis System (SAS) due to simply recommendation by SAS statistic software analyst. The intriguing thing is that the p-values still differed somewhat, and this may be because of the inclusion of the interaction terms in the SPSS repeated measures in the ANOVA analysis. As a further investigation, Richard Parsons (SAS statistic software analyst), Professor Leon Stracker (ergonomist, Curtin School of Physiotherapy), Dr. Amity Campbell (expertise and with Motion Capture techniques), and researcher re-ran the SPSS analysis for one of the endpoints, formulated as a random effects regression model (mixed model). By explicitly including the main effects only, we obtained identical results to the SAS analysis. In conclusion, we agreed that the random effects model approach is the one we should adopt, as none of the interaction terms appeared to be significant and therefore should be dropped for simplicity. We also agreed that I would enquire of my statistical colleagues why the repeated measures ANOVA produces different p-values to the mixed model (just to check that it is to do with SPSS's method of including the interaction terms). My understanding is that these models should come up with identical results (just different model formulations but the same error structure), provided they are both based only on the main effects.

Appendix to chapter 9

In 2010, you participated in an interview and observation conducted by Curtin University research student (EunJeong Jeon) about your clothing experience, emotions involved in interaction with prototypes, and your gait behaviour while interacting with the prototypes. I would like to thank you again for your participation; your interview and observation responses were very much appreciated. I have developed principles and methods to design clothing for comfort, based on your and other interview and observation responses.

I am sending this letter because I would like to receive your feedback in particular to the Motion Capture Experimentation (MCE) that tested gait behaviours (normal, happy, and fearful walks) while you were interacting with the prototype. Please answer the following questions:

1) Did you have any difficulty during MCE (e.g., evoking memories of happy and fearful emotions, times, and environments)?
2) Do you have any other comments on MCE, to help us improve our methodological approach?

I know it has been a while since you participated in the follow-up-study (MCE) and you may have forgotten about the study. But I hope to receive your precious feedback. Any of your responses will support my thesis. This will be the final stage of my PhD degree, and your participation would be greatly appreciated. .

Below are examples of the words used by six out of eight participants, in their responses to the following research questions:

1) Did you have any difficulty during MCE (e.g., evoking memories of happy and fearful emotions, times, and environments)?

> P (A): No, I didn't have any difficulties evoking memories. During the performances I only sometimes drew from specific memories. Most of the time I imagined I was in a particular scene, which I knew would evoke a certain response within me. For instance, to evoke the fear response I imagined that I was at home alone at night with someone trying to break into the house. This evoked the desired response as it is something that sometimes genuinely worries me. The dim light within the motion analysis centre allowed me to visualise such scenes with ease, as I was not distracted by visual elements within my actual surroundings. I was also comfortable with the dim light as it made me feel less 'watched.'
>
> P (B): For this part of the experiment, I didn't have any trouble evoking memories of the different emotions. I did wonder though, whether I was being genuine in the way I walked, because I was trying to act out what I think I do when I feel sad, happy, or afraid. I'm not sure whether I would do the same thing in a real-life situation.
>
> P (C): To comment on the last activity of your research, I didn't have problems with the whole process, it went well for me.
>
> P (D): It took me a little while to 'get into' it. I realised part way through I was not really interacting with the garment. I found fear quite easy to evoke/act. One of the outfits was very suitable for a fearful situation. I found a few of the sensors on my feet fell off several times which didn't bother me, but may have affected the analysis.
>
> P (E): I didn't have any difficulty during MCE, but to be honest, I had not evoked any happy or fearful memory. Of course I had a lot of fun and I was concerned that my motions be captured, because I wanted to benefit you in your later stages of

research. I am sure you are aware, that to evoke memories, a suitable environment is necessary and that is what happened in my case.

2) Do you have any other comments on MCE to improve our methodological approach?

P (A): No, I felt I was given enough direction in the follow up study. However, in the first study I participated in, I was not really sure what was expected of my performance, and initially felt that perhaps my actions weren't meeting expectations. I felt much more confident when performing in the follow-up trial.

P (B): As for the approach, I didn't have any problems with this, although you may remember that I suggested using the same emotion for each stage of the experiment would have been easier for me. I found it a bit difficult to keep switching from 'happy' to 'sad' to 'afraid' to 'happy' again. Of course, this could have been just me...but it was emotionally exhausting to do so many changes.

P (C): Maybe some video footage could also be taken, simulating a fearful or 'happy' site...fearful in an alley-way at night, happy in a park or shopping mall...

P (D): Perhaps some 'mood music' could help participants get in the mood.
I must say, you have done a very good job. You made sure every participant was comfortable. You were always punctual and ready with equipment, which is remarkable.