The Intimate Habitat:

Fibres, Comfort and Wellbeing in the Context of Fashion.

A thesis submitted in fulfilment of the requirements for the degree of Master of Arts

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In memory of John and Barbara Bayes
The Intimate Habitat:

*Fibres, Comfort and Wellbeing in the Context of Fashion.*

I certify that except where acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement of the approved research program; any editorial work, paid or unpaid carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.
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0.0 Introduction

0.1 Contextualizing the research
The primary purpose of this Masters Research is to raise awareness of a possible connection between fibres worn on the body and wellbeing. It is generally acknowledged that Fashion changes in response to cultural change. Today, fashion responds to global issues such as sustainability, a catch cry of the last two decades (McDonough 2002 and Fletcher 2007). The research investigates whether fashion fibres are a detrimental or positive contributor to human physiology and psychological wellbeing. Wellbeing is important and raising awareness of any elements in daily life that could impinge upon maintaining wellbeing is useful for health professionals, the larger community and fashion designers.

As momentum in public concerns have gathered respect, various issues have had to be addressed as manufacturing industries, including fashion, searched for ways to make consumption both environmentally and economically sustainable. The face of fashion in the context of environmental wellbeing is being closely examined and profound changes are imminent both in Australia and globally, as new paradigms are explored and adopted. This research explores a paradigm that is related closely to environmental wellbeing. It is more than twenty years since connections between fibres and behavior were recognized and yet Western culture has refused to recognize their documented threat to personal health (Clement & Clement 2011). Clothing the body does not need to come at a cost to wellbeing if fibre selection works in harmony with the body's own life energy. This study explores this hypothesis.

The research tests the hypothesis in two parts: a literature review and an action research project. The concepts of comfort and wellbeing have been extensively researched as will be demonstrated through part one of the thesis. However, the review of available material revealed that there were few research findings that made clear any subjective connections between the human experience of wearing fibre and wellbeing. The action research involved a wear trial which was accompanied by a questionnaire that focused on sensory perception as a way forward and to start to re-dress the current situation. The findings from data collected were analysed in the context of comfort, to enable connections to be made to wellbeing. This research suggests that fashion fibres used to clothe the body are rarely chosen in sympathy with the body's physiological or psychological wellbeing. In the absence of scientific evidence that fibres have the potential to create 'dis-ease' the research does pose more questions than it answers. What is known from reading the Australian Well-being Index is that the fibres we choose to clothe our bodies in can be a pre-requisite to wellbeing, just like any other determinant. In order to increase understanding of some of the issues that impact upon society, the Australian Government commissioned a seven year project in conjunction with Australian Unity (an insurance company) and Deakin University into the lives of every-day Australians. The report resulted in the Australian Well-being index which is still respected today as the nation's most comprehensive measure of how the average Australian feel about themselves and their lives ('What Makes Us Happy' Deakin University 2001). A person who experiences a degree of comfort, health and happiness acceptable to themselves, in most of the aspects of their lives that they have some control over, is able to function to the best of their ability. When this state is achieved the human experience is described as one of overall wellbeing. The challenge is in providing enough information against which fashion purchases can be made that consider individual preferences in respect of this wellbeing.
The natural environment incurred the cost of industrialization; the human body is incurring the cost of synthetic chemical production. Rapid technological advances have meant that detection is possible of minute particles of over two hundred toxic chemicals in the human bloodstream. There is evidence of the damage that has already been done to human sexual development and reproduction by the ocean of synthetic chemicals produced by industry each year (Smith and Lourie 2009). Despite the evidence, the large chemical companies continue to synthesize fibres from chemicals. According to Theo Colborn, co-writer of the book ‘Our Stolen Future’ (Colborn 1996) this is understandable since the wealthiest energy corporations that mine for oil and natural gas from which these chemicals are derived, have long put their profits above matters of public health. In light of this, it is also understandable that twenty years after they were first implicated in the disruption of human and animal hormone systems, fashion designers are still using fabrics made from them to clothe the body. The public simply does not know the dangers according to Clement & Clement as they have been deliberately kept in the dark (Clement & Clement 2011).

This research can make designers aware of their role in countering the invasion of chemicals in our wardrobes. The informed consumer is a formidable adversary. In the face of fierce public censure, similar to that incurred by designers who chose to use fur, the fashion consuming public will eventually force designers to use safer alternatives. There are signs that the fashion industry is slowly acknowledging its part in wasteful consumption through sustainability initiatives. It is hoped that the acknowledgement of human health issues will not have such a long and protracted gestation. It is anticipated that the scientists responsible for developing many of the emerging technologies will do so in full knowledge of any cost to human health and put this above profit.

Fashion will need to position itself in readiness for a possible shift in the collective consciousness. Once populations have answered the questions surrounding environmental damage, a reverence for the natural world will lead them to question the connection between synthetic fibres (the production of which compromises the earth’s natural environments) and quality of life.

0.2 The research objectives

Fashion is a cultural phenomenon that prior to 1997 had lacked a formal structure against which critical analysis could take place. The discourses around fashion theory are complex and have taken many forms. This research sits comfortably alongside health as one such discourse. Here, fashion and health are the topics of a conversation in which fibre is the conduit that facilitates the connection between these two separate disciplines.

It became apparent through the selected literature that fashion and health have more in common today than at any other time in history. The end of the twentieth century saw the eradication or control of fatal diseases and this allowed people’s health focus to change dramatically. From a goal of being healthy to stay alive, to being healthy to look good (Featherstone 1991), a consumer emerged driven by appearances. ‘Looking good’ which had previously been the domain of fashion became of primary interest to health professionals. Body maintenance with its diet and exercise regimes, cosmetic, massage and various other ‘therapies’ were all employed to improve the inside and outside body. The body however has largely been ignored by fashion
academia (Entwistle 2000). Fibres are at the interface between the body and fashion. The research model suggests a way for a conversation between the two to go forward by raising awareness of the contribution that fibres make to physiological and psychological wellbeing. The key objectives stated here formed the foundation of exploration of the research hypotheses:

1. To explore the concepts of comfort and wellbeing in the context of fashion fibres.
2. To synthesize the above objective in order to propose a strategy for establishing ‘healthy’ fashion practice.
3. To analyse and evaluate the success of the research wear trial as a model for raising awareness.

0.3 The research method

The thesis is in two parts. Part one provides the background and informs the action research which forms part two. The thesis crosses over the two academic disciplines of fashion and health. The findings are documented and explored through the combination of a literature review and wear trials necessitating exploration of each of these disciplines. The research does not attempt to address the wide range of literature, encompassing the cultural, sociological, economic and ethical aspects that surround fashion theory.

The thesis identifies how fashion as a social construct can embrace the concepts of comfort and wellbeing as a design tool. There are different ways to interpret comfort and wellbeing and the complexities of this are explored and clarified in the first and second part of the thesis. The first part of the thesis reviews the fibres used specifically in the production of fashion clothing starting from an historical perspective. The connection between a fibre’s chemical composition and its various properties, for example how a fibre feels against the skin, are straightforward and any evidence of negative physiological responses to any one property can be directly attributed to its molecular and morphological structure. The research hypothesises that fibre compositions can be a major contributor to the enhancement of psychological and physiological wellbeing.

The second part of the thesis consists of action research, the purpose of which was to test the research hypothesis that a fashion consumer’s wellbeing could be affected by their choice of fibre composition. An abstract of the thesis wear trial can be viewed in Appendix 1. A method had to be developed that could test the validity of this hypothesis.

The primary objective of the action research was to increase designer understanding about the effects of fibre compositions on wellbeing by providing data that can be interpreted in the light of information provided by the literature review which had provided the trajectory for the research hypothesis.

Small wear trials, accompanied by a questionnaire (see appendices) were chosen as the preferred method for testing the hypothesis. These were designed according to the format established in health science research after consultation with the School of Health Sciences. The trials consisted of a pilot and an actual wear trial. Data was generated by the trials and used for the purpose of analysing the results.
0.4 The significance of this research

0.4.1 Contextualizing the researcher

Life experience led the researcher, who has a background in fashion design, to question how much was known about the effects of fabrics on human health and well-being. The study was initiated with a view to exploring why particular fibres were intuitively preferred over others, for fabrications employed in an holistic design practice that spanned thirty years. The research began with studies in fibre science which entailed collecting and reviewing any information on the fibres used in design for the body in order to gain a thorough understanding of their chemical compositions (fibre science). Design, and particularly fashion design academics, suggested that the investigation of the problems had synergies with Eastern philosophies and the health sciences (Chinese Medicine).

0.4.2 Significance within the fashion discourse

The discourse around the concept of ‘healthy’ fashion is not established within fashion academia, being mostly limited to the protective and safety function of clothes. Literature on the topic shows that the fashion industry, which is largely driven by consumption, was unlikely to be in the same arena as the scientific community as they would generally have opposing agendas. Designers appear to have limited information about what are considered to be the more obscure properties of the generic fibres that have been used in fashion since the industrial revolution so this research provides a model to redress the situation whilst adding to the body of knowledge about fabrics.

0.5 Thesis outline

This research is an investigation that targets the interplay between fibre, the basic unit of matter and the human experience. The two separate disciplines of fibre science and human physiology have been brought together in order to explore the complexities of interconnectivity between fibres and the body. The thesis suggests that fibres worn on the body that constitute our intimate habitats may be implicated in issues around personal wellbeing.

Chapter One provides background information about fibre compositions. It begins with an explanation of the chemical compositions of the four fibres used in the garment trials. The morphological and molecular structures and their resulting properties apropos the fibres used to test the research hypothesis follows. This information will inform the reader about the nature of fashion fibres so that they can more fully appreciate the interplay between fibre compositions, their structures, and properties in the context of comfort and wellbeing.

Chapter Two, part one of this thesis, hypothesizes that the ‘dressed body’ (Entwistle 2000) needs to be about more than the aesthetics of dressing, expanding to consider comfort. To provide the necessary background the basics of human physiology and psychological are addressed. The purpose of the
discussion is to examine some of the issues that surround comfort in the context of wearing fashion fibres so it is not intended to be definitive. This necessitated some exploration of the ergonomic principles used in design practice to accommodate the comfort of a moving body which include anthropometry, physiology, psychology and practicality. These were adopted to be used in responding to the research hypothesis that individual responses to fibres have the ability to affect perceptions of comfort. The research hypothesis could then be explored in the context of comfort in a later chapter. The concept of comfort provides the background to facilitate an understanding of its significance in the achievement of wellbeing, which is explored more fully in Chapter Three.

In order to propose that wellbeing can be affected by the wearing of fashion fibres, Chapter Three needed to thoroughly consider the social significance of the concepts surrounding wellbeing or risk it being rejected as a desired goal in fashion design practice. The notion that fashion fibres can accommodate wellbeing is fundamentally important. Indications of the problems with defining wellbeing are confirmed in this chapter which reveals that achieving overall wellbeing requires satisfying a number of pre-requisites. The chapter explores some of these precursors to substantiate their relevance and to provide a rigorous framework for exploring the role that fibre selection plays. The question of how much is known about the effects on human wellbeing of fibres used to produce fashion clothing arises in this exploration. To substantiate the argument that fashion fibres are capable of damaging wellbeing, a popular wardrobe staple garment is used to demonstrate the physical and psychological effects of fibre production on eco systems, the food chain and the body’s immune system.

Part two of this thesis begins in Chapter Four and describes the action research in which a set of wear trials was used to not only glean information to support the research but also to establish a method which could be used in further research on the subject. A blind study was initiated to assess human responses to wearing unknown fibres, a method used in science research which eliminates pre-conceived ideas. The method used is explained in terms of both its design and the various stages of its development and implementation. This included a questionnaire tool to elicit the subjective responses of a group of volunteers to a wear experience. The purpose of the trials was to explore if the scientific method used could be appropriated for capturing evidence that fibres contribute to comfort and therefore wellbeing. The action research wear trial consisted of an experiment that was designed and developed specifically to explore and capture human responses in relation to a garment wear experience. This method was chosen to elicit and record the phenomenological experience.

Chapters Five and Six discusses the data generated from the trials and forms an analysis of the results. The thesis concludes in Chapter Seven by discussing the effectiveness and significance of the wear trials and the literature review in establishing the feasibility of a healthy fashion discourse. The entire process revealed some possibilities in the use of this model that could be expanded for future research. It contains an analysis of the results from the research trials and a discussion of the findings. It finishes with some recommendations for further research in Chapter Eight.
1.0 Part 1: Fibre structures and properties

1.1 Introduction

This chapter of the thesis has been written to aid in understanding how some fibres perform differently when worn to clothe the body and why this may be the case. The complexity of the four fibre compositions used in the action part of the research, that informed part two of this thesis, are analysed individually. They are discussed in the order in which they were placed for the purpose of recording the trial findings. The explorations in each case, address the fibres morphological and complex molecular structures which together, help to define their essential nature and explain their properties. Not everything is known about fibres, and the explanations used here are not irrefutable since new discoveries about fibre continue to evolve.

The information for this chapter was borrowed from ‘Textile Science an explanation of fibre properties’ by EPG Gohl and LD Vilensky (1989) as it was found to be a reliable and essential resource, for the study of fibre sciences. The information provided in this chapter is not conclusive as it is limited to the four fibres trialled in part two of the thesis. For background purposes, some knowledge about the basic unit of matter that is fibre, is provided next.

1.2 Definition of fibre

Fibre is the basic unit from which yarn and then fabric is produced. At the molecular level of fibre study, fibres are units of matter made from atoms, linked into long chains and arranged in different ways. Depending upon the length of each chain of atoms and the way these chains are held together and arranged (Gohl and Vilensky, 1989), determines the properties of the individual fibre compositions. The molecular textile fibres have long linear molecules known as polymers which are held together by various bonding agents. The polymer arrangements are predominantly either ordered and parallel (crystalline) creating strong structures, or random (amorphous) creating weak structures. Molecular structures are not visible to the naked eye or even under microscopy as they are scientifically determined. Detailed explanations of the molecular reasons for fibre properties can be found in the textile science textbook mentioned earlier. They do not inform this research.

The units of matter that are fibre are categorized according to their chemical composition, so whether a fibre is a protein, cellulose or synthetic composition, is dependent upon whether it is sourced from animals, plants or from petro-chemicals. The essential nature of a fibre is predominantly determined by these chemical groups.

A fibres external appearance (morphological structure) can be viewed under magnification. The longitudinal features and its cross sectional views are readily visible and provide a reliable tool for identifying a fibres origins under magnification Knowing both the molecular structures and their distinctive morphological features allows certain assumptions to be made about the fibre properties. Fibre properties for the purpose of this exploration will be divided into three categories according to how comfortable a fibre feels against the
body. They are sensorial, which relates to skin sensation and perception; mechanical which refers to cling and weight; and lastly thermal which relates to temperature modulation, warmth etc.

The next section contains an explanation of the four fibre groups used for this research.

1.3 The fibre categories

Nine generic textile fibres can also be divided into the natural, man-made and synthetic groups, depending upon their chemical composition. The natural group is further divided into cellulose and protein and a fibre composition was used from each to facilitate an exploration of volunteer preferences in a wear trial. Four fibres altogether were reviewed, selected primarily because they represent the most popular fibres used in fashion garment production. Any four of the nine generic fibres could have been selected for the trials; however, the fibres chosen were cotton from the cellulose group, wool from the protein group, viscose and polyester respectively. The decision to use one fibre over another was partly determined by the fibres similarities in appearance and weight. Viscose was chosen in consideration of its ‘man-made’ or regenerated cellulose nature. It is however a fibre manufactured from pure cellulose. The fibre contents of the trial garment were 100% compositions, for example the cotton garment was made from 100% cotton fibre. There were deliberately no blends for example polyester and cotton, used in this wear trial, despite its popularity as a fashion fibre, as this would have confused the results.

This completes the relevant information for understanding the next section that explores what is known about the four trial fibres.

1.4 Property ‘terms’ explained

Vocabulary is used to describe the characteristics of a fibre that is sometimes peculiar to textiles necessitating the inclusion of a brief ‘glossary’ which can be referred to for the purpose of this chapter. A concise glossary of terms is provided in the thesis appendices. Six properties were chosen for exploring the four fibres below. These have been selected out of an approximate thirty used in textile sciences, as they were relevant for the discussion relating to the fibres sensorial, mechanical and thermal properties. The six properties were hand, absorbency, thermal retention, modulus, elongation and texture and they will be presented in that order for the rest of this chapter.

‘Hand’ is a term used to describe the way a fabric rests in the hand or on the body e.g. full, limp, crisp.

‘Absorbency’ refers to a fibres ability to take up vapour from the body. Some fibres are described as hydrophobic meaning they are unable to absorb vapour or water whilst other fibres are hydrophilic and readily absorb.

‘Thermal retention’ is a term used to convey the ability of a fibre to store body heat e.g. cool, warm.

‘Modulus’ refers to fibre stiffness or its ability to bend e.g. rigid, pliable.
‘Elongation’ is a fibre’s ability to be lengthened under pressure, which creates ‘ease’ by accommodating body movement.

‘Texture’ is what is felt with touch and perceived by the brain as a sensation e.g. rough, smooth.

1.5 The fibres exposed

The four fibre compositions used in the action part of the research, are now individually analysed. They are presented in the same order they were placed in for the purpose of recording the trial findings. As mentioned in the introduction of this chapter, the explorations in each case, address the fibres morphological and complex molecular structures (briefly) helping to define their properties. The explanations used here do not address every property, only the ones that are relevant. The six relevant properties discussed are ‘hand’, absorbency, thermal retention, modulus, elongation and texture. These are addressed in this order for each fibre composition.

1.5.1 The cellulose fibre – cotton

Fibre morphology and micro-structure

Cotton is a natural fibre that originates from the burst seed pod of a cotton plant family. Its chemical group is therefore cellulose, so it has a dense structure, making it the heaviest of the four fibres in the trial. The molecular structure of cotton fibre has long linear polymers held together by countless hydrogen bonds making it a 65-70% crystalline and 30 – 35% amorphous arrangement. The morphological structure is distinguishable by its convoluted longitudinal view and its ‘kidney bean’ shaped cross section. Of further interest is the hollow central core (lumen) and its outer skin (cuticle). Cotton is a fibre of pre-determined length (staple), meaning that it is short with tapered ends.

![Morphological Structure of Cotton Fibre](image)

Figure 1. The morphological structure of cotton is showing its cross section and its longitudinal views.
Performance properties of cotton

The six relevant properties to be outlined here are: ‘hand’, absorbency, thermal retention, modulus, elongation and texture.

The ‘hand’ of cotton is ‘fuzzy’ and ‘full’, meaning it is bulky due to its complex cellulose composition and staple fibre structure. Due to its twisted ribbon like structure (convolutions) and its hollow central core (lumen) the cotton fibre is highly absorbent. It is quick to absorb moisture from the skin which conveys a feeling of dryness to the wearer. It is a conductor of heat energy and there is no satisfactory explanation for this. It is cool to wear (low thermal retention). The combination of high absorbency and low thermal retention also prevents the fibre developing static electricity. Cotton is a relatively stiff fibre (high modulus) compared to the others due to its rigid crystalline polymer system. The inability to elongate (grow) of cotton is due to its crystalline polymer system resulting in cotton having little ‘give’. This polymer system also creates a sensation of crispness. Its texture is ‘dry’ and ‘grippy’ and it does not make complete contact with the skin due to its convoluted morphology.

1.5.2 The protein fibre – wool

Fibre morphology and micro-structure

Wool is another natural fibre but it originates from sheep therefore its chemical group is protein (keratin). Its polymers are spring like (helical) in appearance and held in place by a number of chemical bonds including chains of hydrogen bonds. The molecular structure of wool is 70 - 75% amorphous and 30 – 35% crystalline. The morphological structure is distinguishable by its overlapping scales, giving it a serrated appearance. It also has a naturally occurring wave (crimp) and an irregular curl (crimp). Wool has an oval cross section and a thick outer edge (cuticle). Wool fibres have the most complex structure of all textile
fibres and cannot be mimicked by fibre engineers. Wool is also a staple fibre, with the lightest weight of the four fibres used in this research although it is regarded as medium weight compared to others.

![Morphological Structure of Wool Fibre](image.png)

Figure 3. The morphological structure of wool is showing its cross section and longitudinal view.

![Wool Polymer Structure](image.png)

Figure 4. The polymer structure of the wool fibre represented as an image.

**Performance properties of wool**

In the ‘hand’ wool feels bulky and fuzzy due to its staple fibre structure, natural curl (crimp) and overlapping scales. It is fuzzier than cotton. Wool is a highly absorbent fibre explained here by its amorphous polymer system, its overlapping scales and crimp, which together trap moisture. Wool has a unique ‘heat of wetting’ property (explained in the prescribed text) that prevents the wearer feeling chilled even when wet and until the wool is saturated. Thermal retention of wool is high due to the amorphous regions of the polymer...
structure and the scales and crimp create the opportunity to trap air and therefore keep the wearer warm. Also of note is that wool can release its energy back to the wearer when their body begins to cool. This is another unique property of wool. Static electricity is not generally a problem unless there is not enough water molecules present between its polymers. Wool is not stiff in the hand (low modulus) due to its amorphous polymer system where many spaces are available between the polymers to withstand pressure. A flexible and resilient fibre it has high elongation and recovers well from pressure due to the nature of its helical polymers. The texture of wool is soft due to its complex molecular and morphological structure.

1.5.3. The synthetic fibre – polyester

Fibre morphology and micro-structure

The polyester fibre was the synthetic fashion fibre of choice. It originates from coal, air, petroleum and water and is rated third heaviest fibre following cotton and viscose in this research. Its polymers are long and its molecular structure is 65 - 85% crystalline and 35 – 15% amorphous. The polymers are bonded in place largely with van der Waal forces which are very weak electro static charges. Its morphological structure is featureless, being fine, regular and translucent. All synthetic fibres are created in factories through the synthesizing of chemicals. Polyester can therefore be engineered to a variety of cross sectional shapes to produce variations in properties. However, regular polyesters are circular in shape and unless specially engineered, has no hollow core. The ends of the fibres are blunt as a result of the spinning process. Polyester is a filament structure from which staples can be cut, depending upon the end use.

Performance properties of polyester

The ‘hand’ of polyester is smooth due to its smooth morphology and filament structure. Even when chopped into staples the fibres retain their smoothness. It is a hydrophobic fibre, due to its molecular and polymer structure which resists entry of the water molecule. It is the least absorbent textile fibre used in the study. The thermal retention of polyester is low and it is a poor conductor. There is no satisfactory explanation as yet for the poor heat conductivity of polyamide (Gohl & Vilensky 1989, p.109) and the same is said for polyester (Gohl & Vilensky 1989, p. 116) and its low heat resistance. An explanation was not revealed in any of the literature further reviewed. It is classified as the superior thermoplastic as it melts with the application of heat and sets permanently into its new configuration on cooling. This is due to its weak bonding system, which is readily broken with heat, causing the fibre to melt and naturally due to its petro-chemical composition. Its modulus is also low meaning the it had good drape, primarily because of its long filament structure. Regular polyester has the hardest ‘hand’ of all four fibres and this is due to its crystalline polymer system which prevents the polymers from giving way under pressure. The polyester fibre is described as being plastic, meaning that it loses shape (distorts) with stretching as the weak bonding cannot prevent polymer slippage under pressure. Its texture is described as ‘waxy’ due to its petrochemical composition.
1.3.5 The regenerated cellulose fibre – viscose

Fibre morphology and micro-structure

Viscose is a regenerated fibre that originates from wood pulp. Its chemical group is therefore cellulose. It has relatively short polymers so its polymer system is mostly amorphous with only a small amount of hydrogen bonds to hold the structure in place. The molecular structure of viscose is 35 - 40% crystalline and 65 – 60% amorphous. The morphological structure of viscose is fine and regular, distinguishable by its tiny grooves (striations) longitudinally and a serrated perimeter on its round to oval cross-section. Viscose fibre can be in filament or staple structures depending upon its end use. It is rated the second heaviest fibre after cotton.
Performance properties of viscose

As with the other fibres, the six relevant properties outlined below are: Hand, absorbency, thermal retention, modulus, elongation and texture in that order.

Viscose has a ‘dry’ and limp hand (low modulus) due to its amorphous polymer system. It is quick to absorb moisture from the skin which conveys a feeling of dryness to the wearer. It is a conductor of heat energy, meaning that it is cool to wear (low thermal retention). However there is no satisfactory explanation for this (Hatch 1995). The combination of high absorbency and low thermal retention also generally prevents the fibre developing static electricity. Viscose is a limp fibre (low modulus) that falls freely on the body. The inelastic nature (low elongation) of viscose is due to its amorphous polymer system resulting in is propensity
to distort with heat pressure and pulling forces. It has no ‘give’. Being a staple fibre structure viscose texture is ‘fuzzy’. Filament viscose is relatively smooth but fuzzier than synthetic filaments due to its cellulose composition.

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2.0 Part 1: Fashion fibres and the design of comfort

2.1 Introduction

In this research where fashion design is inclusive with the personal experience of wearing fibres, comfort is the primary focus. The purpose of this chapter is to open up a conversation between the body and fibre selection, which has largely been overlooked by fashion theory (Entwistle 2000). To do this, it was necessary to first explore the concept of comfort, to allow a critical analysis to take place later about the role that fibre selection plays in wellbeing. The chapter opens with an explanation of the evolution of comfort theory so as to better understand how consumer attitudes have evolved. This is then followed by a broad explanation of what constitutes comfort theory, given that interpretations abound, before a pertinent definition in the context of this research could be elucidated.

It is important to stress at the outset, that this chapter does not attempt to address the concepts of comfort as they pertain to fashion ‘garment’ design. This ‘intimate habitat’ fashion research is about the impact of fibre compositions on the body and explores the importance of fibre selection principles. It is undertaken in acknowledgement of Zhang’s observation into the influence of clothing material properties where he states that “comfort is a very important subject for both the clothing and physiological sciences” (Zhang et al 2002 p.1). All fashion designers are responsible for the choices that are made at the fabric selection stage of design.

There are respected designers, who regard fabric as the single most important element on which to base their entire range. On choosing fabrics for a range Christian Dior once said “Fabric not only expresses a designers dream, but also stimulates his own ideas. It can be the beginning of an inspiration” (Gale & Kaur, 2004). The inherent properties of fibres such as drape, luster, cover, textural appearance and ‘hand’ contribute to garment design outcomes. Above all these fibres have an intrinsic capacity to create a micro-climate for the body which is determined by temperature and vapour transmission, two of the primary properties that define comfort.

The first of the objective, as stated in the objectives at the beginning of this thesis, asks if the fibres used in the manufacture of fashion clothing affect the body’s physiological and psychological comfort. Through the process of researching comfort and in order to address this question, a methodology started to emerge that suggested a model for facilitating the investigation of comfort in the context of this research question. The methodology was based on the science of Ergonomics. Ergonomic principles provided the framework to work with because they are used widely wherever problems need to be solved in relation to designing for a moving body, which includes fibre selection. The bulk of this chapter provides an explanation of four ergonomic principles that are used to explore the physiological and psychological concepts of comfort in order to respond to the first research objective stated in the objectives section. A discussion about the connection between comfort and fashion ensues.
2.2. Exploring the evolution of comfort theory

Crowley states that comfort as a concept is relatively new by twenty first century standards as in its current form it had not begun to be recognized until the middle of the nineteenth century. Prior to this, any discussions around comfort as a term referred to the state of being empathetic towards a person’s spiritual or psychological needs. It was, according to Crowley, apparent that mankind had survived for hundreds of years with no theoretical discourse regarding physical comfort (Crowley 2001). One could argue that this is contrary to the common understanding of the word today, where the importance of the need for physical comfort is mostly understood and catered for.

It was not until the latter part of the eighteenth century (Crowley 2001) that a condition of comfort started to emerge. This was the result of a growing middle class who, for the first time had the luxury of leisure time as opposed to the working classes and they started to coin a specific language in recognition of the experience. The disagreeable nature of a state of ‘dis’comfort such as that experienced when wearing prickly wool fibres, also began to be recognized and concepts surrounding discomfort became endowed with a new sense of importance. Along with the specific descriptive language that began to emerge to describe these bodily sensations, a theory of comfort started to evolve. The pursuit of this new found ‘comfort’ then started to spread eventually to all privileged societies regardless of their socio-economic status (Crowley 2001).

It is four decades since Victor Papanek observed (in an industrial design context), that the designers of the time knew nothing of what people really wanted or needed. He also wrote that design for comfort is sophisticated design, discriminating against ‘dis’comfort for a consumer that knows what they want, as opposed to the “totally unsophisticated possessed of neither taste nor discrimination” (Papanek 1972). Since Papanek’s damning observation, design has evolved into a complex and sophisticated discipline, so much so that his statements may sound somewhat outrageous against the background of today’s design education. As mentioned earlier it has generally been agreed today, through extensive research into consumer behaviour, that comfort has become one of the most important prerequisites demanded by the modern consumer of clothing (Yi Li & Wang 2007). It is what people want and need.

Designers of clothing other than fashion clothing, in areas such as performance wear, health and in the safety and service industries have long recognized the importance of comfort. They strive to achieve comfort through their choices of fibres and fabrics, mandatory for maximum performance, which relies upon the right decisions being made at the design stage. In the context of fashion, this is rarely the case; it appears that not a lot has changed since Papanek’s observation for the majority of modern consumers of fashion clothing. Designers can, if they choose, aspire to achieve comfort through the fibres they select for their creations.

Dialogues about comfort are understandably ‘cloudy’ and unless the terms of reference are clarified at the outset, guided and informed discussions cannot occur. The purpose of the next section is to define comfort in the context of this research in order to establish its limitations and facilitate a robust debate.
2.3 Comfort defined

For the purpose of clarifying comfort, a definition is borrowed from Katherine Hatch in which it is understood that achieving a state of comfort requires the absence of discomfort (Hatch 1993). Hatch further infers that clothing that imparts enjoyment, as opposed to clothing that disturbs ‘peace of mind’, is by definition, ‘comfortable’. The discussions in this chapter, will propose that ‘comfortable’ fashion is fashion clothing that considers factors governing the maximum efficiency of the moving human body despite the limitations imposed on it by what are essentially the body’s closest environments, micro-climates or intimate habitats. It is also proposed that fashion, designed to accommodate the body’s physiological and psychological requirements at the design stage is fashion that is considerate of well-being, which is discussed in the next chapter.

Comfort sensations are received and registered by the human brain when a moving body is dressed in a garment that does not cause any discomfort. At that point a person’s body is perceived as ‘comfortable’. Put simply, this clothing is not too hot, too cold, too wet, too prickly, and too heavy or constraining. A state of ‘comfort’ is expressed through the use of a specific language and can be readily articulated when required. At first glance it would appear that a designer, who considers comfort as a key driver behind their work, or their design philosophy, does so simply by attending to the properties of the fibres they select to use, in conference with their clientele. This is however, a complex process because language can be misinterpreted and therefore the methodology cannot be relied upon.

Different words may be used by several individuals to convey the same or similar experience of comfort (Laughlin 1991). This was confirmed through the analysis of the wear trial questionnaire responses that are explored in more detail in Chapter Four. If fashion clothing is to be physiologically comfortable and the experience is expressed verbally then it can be extrapolated that the person experiencing the comfortable state is at ease in their body. However it needs to be remembered that words are arbitrary as the acquisition of any language develops when others experience the same sensations. This is also the case with the development of a language of comfort.

Much research has been undertaken on the role of comfort itself, particularly in relation to fabric technology, considering that, as a concept, it is relatively new and as such, subject to many different meanings. The notions are generally easily understood (despite the many and varied connotations) and the basic elements that contribute to attaining comfort, does provide a useful tool for designers to use at the fibre selection stage of design.

2.4 Fashion in the context of comfort

It has been already stated here that the pursuit of comfort is almost universal, although not mutually inclusive. In fashion theory for example, the body has simply not mattered (Entwistle 2000) as long as the fashion garment looks good ‘on’ the body; how it makes the wearer ‘feel’ in terms of their physiological comfort has rarely been a subject of discussion.
Evidence abounds that the word ‘comfort’ has been imbued with many subtleties of meaning. The meanings become even more complex in fashion clothing which is often worn for reasons other than the definition used in this study. A person's individual differences are determined by factors which include their age, gender, personality type, value system, or their world view, to name a few. Comfort is experienced in different ways and in different degrees depending upon these factors. All this means is that a state of ‘being’ which is physically ‘comfortable’ for one person may or may not be psychologically comfortable for another.

The phrase 'feeling good' has been used in academic conversation around the comfort phenomenon in relation to fashion. It is inarguably true that fashion is about 'feeling good' but the phrase should not be confused with comfort. The phenomenon of emotional or 'feeling good' comfort refers to an expression of 'self' which is accommodated by fashion. It is not the same as physiological comfort although it can contribute. Physiological comfort in the majority of cases is scientifically determined and therefore both more specific and objective. The perceptions that surround 'feeling good' are not a subject of discussion in this research because, as stated in the introduction, the research is limited to the parameters of fibre chemistry. It is not concerned with interpreting the different kinds of 'feeling good' that come from wearing Polyvinylchloride (PVC), synthetic rubber or corsetry among other fashion items thought to cause ‘dis’ comfort, that do not fall within these parameters. It is argued, in the context of a moving body, regardless of whether or not the body is being fashioned or dressed, designers need to at least consider the determinants of comfort postulated through this research.

Fashion in the context of this research is about the intimate connection between fibre and the human body. It has been shown scientifically that a fully functioning human body can achieve its maximum potential both physically and psychologically, when it is unimpeded by clothing (Hatch et al 2003). However, this state is impractical and rarely achieved in a fashion context, so comfort has to be pursued in other ways. Fashion clothing more than any other forms of clothing, often impedes the body from functioning to its maximum ability, as can be witnessed at the majority of ‘high’ fashion catwalk shows. Designers who create these garments are choosing to challenge not facilitate ease of movement. In these cases, it is argued that fashion does not aim or profess to be comfortable. However, whilst creating a state of physiological ‘dis’ comfort for the body displaying the fashion garments, designers inadvertently may cause unintentional psychological ‘dis’ comfort for the audience (their customer) observing the show. This of course is a designer’s prerogative; however, whatever intention they have requires this to be considered at the design stage.

In fashion the body has largely been ignored beyond its purpose for display. This may be because, from its earliest inception as a phenomenon, fashion has predominantly been about other things. When it first became a subject for discourse, it had been about decoration, modesty and protection. According to the early fashion theorist Flugel, the primary purpose of fashion clothing, as opposed to clothing for practicality, quickly became one of competition and all that competition entails (Flugel 1930). Understandably, then, Entwistle’s observation that the literature around fashion in the past has rarely provided an account of how it is experienced and practiced in everyday dress (Entwistle 2000) is accurate. However, if it is conceded that the ‘Fashioned body’ is a clothed body and that the clothed body needs to be unimpeded to be able to achieve its maximum potential then fashion discourse cannot continue to ignore the concepts of comfort. Fashion that is designed to suit the moving body regardless of all its complexities which include
considerations of age, occupation, gender, health status, upbringing and / or tolerances (Papanek 1972) is
good design intrinsically.

It is important to point out at this juncture that whilst the following discussions, do not explore the complex
discipline of garment design, they do borrow from a garment design model. They do this in order to discuss
how the choice of fibres used to create fashion fabric can affect comfort.

2.5 Ergonomic principles and design for comfort

The body is a complex organism and the relationship between its physiology and its psychology is still being
explored. However, although the ‘human-ness’ of the body is still largely a mystery, (Stockbridge1985)
suggested nearly thirty years ago, as a result of his research into the harmony between the body’s complex
subjective and objective interactions, that ergonomic principles be used as a tool when designing for the
body. Ergonomic principles are now explored.

The term ‘Ergonomic’ comes from the Greek word *ergon* meaning a unit of work or energy and ergonomic
principles address the ‘study of the relationship between workers and their environment’ (The Collins English
Dictionary 1984). The principles can be applied to all areas of design that involve the human body although
they do not refer specifically to fashion design. There appears to be agreement in the body of literature on
the subject of comfort, that human or ergonomic factors overwhelmingly determine its concepts essentially
encompassing everything to do with the body. The perception of comfort is achieved through attending to
ergonomic principles since the brain is also a part of the body.

Ergonomic design was first adopted as a methodology in furniture design when it was realized that by simply
accommodating individual body comfort at the design stage, specifically with table and chair heights,
productivity could be improved in the workplace (Tilley & Dreyfuss 1993). Since first being recognized as an
important design principle in 1959, Ergonomics’ quickly translated to all other areas of design. Ergonomics
can be used as a methodology for fashion design in the same way as it was first used in furniture design by
addressing the connections between a garment and the wearer as they go about their daily lives.

In order to use ergonomics as a tool, some of its principles that are relative to this research are now explored
and form part of the overall discussion on comfort. Ergonomic principles address several specialized
disciplines. Four of these are most relevant in the context of design for the body: anthropometry; physiology;
psychology and practicality, all of which are discussed in the following sections.

2.5.1. Anthropometrics and design for the body

If comfort is an important for good design, then knowledge of how to make the right decisions is also
imperative and a tool for achieving this is indispensable. As mentioned earlier in this chapter, garment
design per se is not at the centre of this study. Nonetheless a garment had to be specifically designed in consideration of collecting data on the body’s reactions to a wearing experience. The garment was designed in consideration of anthropometric principles so a brief overview of these is provided here. Detailed discussions of the wear trial garment design are in chapter three of this thesis which documents the elements that were considered at the design stage.

Anthropometrics is a tool that addresses the essential elements of the body silhouette relating to its size and shape. Originating from the Greek *anthrop* centering in man and *ometry* to do with measurement, the term anthropometry refers to the study of the size and measurement of the human body (Oxford Dictionary 1989). An understanding of anthropometry facilitates comfort in garment design. In 1993 Henry Dreyfuss compiled a dossier of established measurements to help designers working with the body, regardless of all its faults and variations. Through wide ranging research across a large population with many variations in size, shape and proportion, three body silhouettes were quarantined. A table of measurements was then compiled to accompany each body type. This table of measurements provided an indispensable template for clothing manufacturers and informed the pattern-making process. More than this however, it provided a tool which allowed designers to extrapolate some solutions for design problems associated with body shape and size regardless of whether the body was overweight (an endomorph); underweight (an ectomorph); or muscular (a mesomorph) rectangular; hippy, large-chested, square or round.

The following discussion briefly addresses physiology which is the second of four ergonomic disciplines chosen for this chapter on comfort.

2.5.2. Physiological comfort in fibre selection

The research suggests that it is possible to design for the body, in the context of fashion design. The design of garments that are both fashionable and comfortable (allowing that degrees of comfort vary from one person to another) requires the designer to address some mandatory pre-requisites.

The first of two of these are a rudimentary understanding of how the body works or its physiology. The word physiology comes from the Greek *Physis* meaning nature (Collins 1984). This section explores the fundamental physiological requirements of the body to establish its importance in respect to achieving optimum physical functioning but particularly through the process of fashion designing for body comfort. The literature search into fibres, trials and physiological comfort revealed a vast array of studies that relate to physiological comfort. According to Hatch (1993), this determinant of body comfort can be divided into three broad groups: thermal, mechanical and sensory or tactile perception.

The second mandatory pre-requisite for the achievement of positive comfort outcomes is an understanding of fibre science and fibre properties. The groups mentioned above also provide a useful template for discharging information relating to fibre properties. Scientific findings from research undertaken in laboratory conditions into both the body and fibre in the context of physiological comfort prove that poorly sourced fabrics create discomfort. This is a state to which both humans and animals are quick to react as extensive
research by the eminent animal behaviouralist, scientist and researcher Grandin (2009) shows. Physiological comfort is achieved through natural functioning of the body, unimpeded by clothing.

Human beings, like any animals, need to move about in order to survive and some individuals need to, or are only able to, move about a little, yet others are always moving, some fast, some slow (Papanek 1974). In order to be comfortable in a garment and allowing that degrees of comfort vary from one person to another (whether young, elderly, disabled or any of a number of other profiles), some of the activities undertaken will make particular and specific demands on a fashion fabric. Physiologically comfortable garments can be attained at the fibre sourcing stage of design since fibres alone can accommodate a vast range of variables in human performance.

In respect to performance and comfort, fibres alone can accommodate a vast range of variables in human performance including working in an office, modeling the latest fashions on the world’s catwalks and space exploration. The designing of fashion need not be any different to designing for any other site of human endeavor and whilst sportswear design is not the subject of this research it warrants mentioning, to illustrate that if fabrics can be designed specifically to win Olympic medals and be ‘comfortable’, then they can be designed to enhance performance in any other field. A discussion of the three determinants that govern physiological comfort follows, beginning with thermal comfort.

2.5.3 Thermal comfort

Thermal comfort governs the body’s physical functioning and in the context of this research refers to how the clothed body responds to temperature. From the Greek *thermos* meaning warm, thermo-physiological comfort considers the natural ability of the human body to maintain a balanced temperature. The body has been likened to an internal combustion engine in the way that it steadies heat production and heat loss (Zhang 2002). How each body deals with the transmission of heat and vapour determines comfort, and translates to how warm or how cool the body feels. It is believed that in order to be comfortable, a body’s thermo physiological requirements need to be met (Hatch et al 2003).

It is apparent that fibres play an important role in the transmission of heat and vapour because fabrics, made from fibres cover the body. All clothing fibre provides a thermal interface between the body and its external environment. The fibres used to create fashion clothing are no exception. Some fibres used in fashion, by the nature of their composition and their morphology, are more efficient than others at trapping air so provide more thermo physiological comfort (Gohl & Vilensky 1983). Viewed in this way designers require an understanding of how the exchange between heat production and heat loss takes place if they are to source fibre compositions that provide comfort.

The human body exudes 0.71 litres of moisture every twenty four hours through the pores of the skin and even when it is stationary. Clothing is expected to cope with this energy transmission, transporting heat and subsequently moisture from the body, through conduction, convection and radiation. This natural exchange can be prevented by a layer of fabric which provides an excellent barrier to the flow of air. Air, being the best
insulator is an important contributor to thermal comfort. It is contained within the fibres, yarns and fabric interstices as well as creating a boundary space between a fabric layer and the skin. A fibre that efficiently traps air, in turn, keeps the body warm as it slows the transfer of heat from the skin to the environment. The converse is true for fibres that conduct heat away from the body.

No longer seen as merely a passive cover for the body, the innate thermal ability of a fibre automatically interacts with the skin to modify its temperature. This fact was apparent in the research wear trials discussed in Chapter Four.

2.5.4. Mechanical comfort

The second group of properties that govern the physical functions of a body in an ergonomic model addresses mechanical comfort. The way mechanical comfort is perceived in a garment is most obvious through its ‘cut’ or ‘fit’ and although garments are unlikely to ‘be’ comfortable in themselves some garment types generate a more favourable comfort response. Research has shown that this is dependent upon proper tailoring, the nature of the surrounding environmental conditions as well as the positive emotional state of the wearer. It is also influenced by the fabric’s (and fibre’s) ability to satisfy the garment requirements (Hollies 2005). This is seen in the case of a wool fibre, for example, with its elastic properties that accommodate body movements or body mechanics more readily than cotton fibre which is more stable and provides less ‘give’. The ‘cut’ of a garment further contributes to a body’s available range of movement, minimizing abrasion and cling and generating either positive or negative comfort responses.

Apart from ‘cut’ or ‘fit’ other determinants of mechanical comfort include elongation, weight, flexibility, stretch, compression and pressure. These are of interest as they are properties exhibited to varying degrees in fibre compositions. Some fibres can elongate and flex more than others which allows them to accommodate a broader range of body movements. In the case of the elastomeric fibre that has outstanding mechanical properties, it is able to accommodate any contortion of the human body and still retain its integrity. Through the blending of this one fibre with those that have less stretch, the overall mechanical comfort of clothing has been improved exponentially in the last twenty years. Designers who are unaware of the limitations that fibres can put on a moving body, are unwittingly designing garments that limit the potential of comfort. Whilst the disadvantages of some fibre properties can be overcome in, for example, the case of a cotton fibre, which has little elongation and no elastic properties, a knit construction, can be used to compensate. Another way to achieve comfort is through skillful cutting. However designers, patternmakers and garment manufacturers will generally attest that choosing fibres for their innate comfort properties makes designing for comfort easier to achieve.
2.5.5 Fabric ‘hand’ or tactile perception

The last of the three determinants of physiological comfort is fabric ‘hand’ which has long been used in the textile and clothing industries to describe fabric quality and prospective performance (Steans 1988). The simple cognition of an object, in this case a trial garment may leave us feeling cold (Sully 1898) and is an example of how a fabric ‘feels’ will affect our emotions. Mere cognition of fibre is not of interest in this research but the emotional impact associated with textile fibres is. They mark off the interesting side of our experiences and for this reason responses to several questions about how a fabric feels against the skin (its ‘hand’) were sought.

Whether a cloth is rough, feels prickly to the touch or against our skin, is too cold or too warm, too clammy or too slippery, is different and widely so from one person to another. This is because the three sensory receptors (touch, pain, heat) are directly connected to the brain by nerve fibres which are responsible for individual perception. The differences in perception are therefore greatly influenced not only by the differences in clothing materials (Ha et al 1995) but also by the differences in individual perceptions. Touching fabrics or experiencing the tactile properties of fabrics in the absence of sight, allows a full understanding of fabric perception in respect to their variations to take place, because “the sense of touch seems of all our senses to bring us into the closest relation to external things” (Sully 1898 p. 125)

For those who work within the confines of objective measurement, the thermal, mechanical and some of the sensorial properties of particular fibres can be quantifiably measured, by special testing using climate controlled environments, instruments and machines. If fashion clothing is to be comfortable then the expressions of a positive experience will expect that the person experiencing the comfortable state is at ease in both their body and their mind. The third ergonomic principle is psychology in which perceptions, energy and ethics are discussed in the context of fibre, for their capacity to affect psychological comfort. Although research on whether or not fibres used in fashion have the capacity to affect our psychological comfort is inconclusive, the possibilities are explored in the next section.

2.6 Psychology and its role in comfort for the clothed body

2.6.1 Perceptions

A lesser understood comfort determinant is to do with perception. Perceptions can be explored through some of the ‘feelings’ associated with the wearing of cloth. Fashion fabrics have a value for us psychologically in many complex ways simply because the fibre compositions they are made from touch our ‘feelings’. These perceptions are not to be confused with the state of ‘feeling good’ mentioned earlier in this chapter. Perceptions of comfort were regarded as a subjective measure of textile performance in the past because perceptions are just that, they are not necessarily objective in their origin. Every individual will have a different ‘sense’ of an experience which they then perceive as comfortable or not.
Perceptions are generated by the mind which is not fully understood as mentioned earlier. Therefore they have been largely ignored in scientific research, a fact borne out by the absence of animal studies. Whilst there is limited scientific research, there can be only limited findings and therefore little evidence into the long term effects of wearing fashion fibres on either the body’s physiological or psychological systems. What is known is that individual mind ‘perceptions’ vary with each individual. Research into skin allergies has demonstrated that some of the population do experience skin ‘changes’ and irritations which are visually obvious (as seen with eczema and dermatitis). It is not understood if the evidence is the result of irritation to the skin’s epidermis or due to an unpleasant emotional experience. The brain may, in its efforts to alert the wearer of discomfort, cause skin permutations to appear.

For the purpose of this research investigating psychological comfort, it was understood that ‘modesty’ referred to the individual’s comfort around body exposure. As with all human behaviours, the range of experiences, therefore perceptions in this area is vast so the parameters needed to be clearly defined. They ranged from no exposure of the body, including the body silhouette against a light source to minimum exposure. Underwear visibility was also taken into consideration as its inclusion was unavoidable in the majority of cases. This was regrettable, given that the responses to wearing the T-shirt could have been misinterpreted, possibly relating to the comfort of the underwear as opposed to the comfort of the T-shirt worn over the underwear. It was decided at the time of confusion regarding the question of modesty that any reluctance to continue to wear the garment after its initial ‘donning’ at the start of the eight hour wear period could, in this case, be interpreted as psychological discomfort.

The ‘anxiety’ response was defined in terms of the volunteers ‘anticipated’ discomfort of the wear experience. This could be the result of many things, including the individual’s ‘stored modifiers’ discussed earlier in this chapter. It is known that sensations are experienced by the body that are interpretations of the brain. The sensations experienced through wearing particular fibres against the skin are like any other, the result of a number of obscure reasons that are capable of being interpreted as one of comfort or discomfort. Scientific and medical research continues into the possible connections between fibre compositions, the mind and skin integrity. This may have resulted for any number of reasons all of which would go beyond the limitations of this research.

2.6.2. The recognition that ‘energy’ is a determinant of psychological comfort

A lesser understood area of fibre perception relates to ‘energy’ a word used here to describe any noticeable behavioral and mood problems that may be associated with the wearing of particular fibres next to the skin. A number of questions were crafted to explore the energy phenomenon. They were: a willingness to continue to wear the garment beyond the trial period; a ‘sense’ of having more energy; relief on removal of the garment; a perception of being able to sustain concentration over an eight hour day and finally, the feelings associated with being wrapped & nurtured.

The cumulative effects on behaviour of wearing fibres are not known. However a connection between the fibres that are known to accumulate electrostatic charges, that is, the synthetic fibres, and behaviour in small
children is known. At a time when the first questions were beginning to be asked about sensitivities to chemicals found in food, air, and water, a study was undertaken by a former primary school teacher who went on to have a successful private practice in clinical nutrition and clinical ecology. (Samways 1989). Perplexed by the number of children in her classroom exhibiting poor attention or increased fatigue, Samways undertook research into what was known about the cumulative effects of wearing synthetic fibres. She quickly realized that her suspicions were not unfounded.

Research into the natural, manufactured and synthetic fibres, their molecular and morphological structures and resulting properties are contained in Chapter Three of this thesis. The information generated in that chapter provided the necessary background against which discussions take place about the findings of the wear trials. The wear trials were initiated to raise awareness that a model exists for further research.

2.6.3 Recognizing the collective responsibility

The third argument in support of healthy fashion suggests that the collective psyche can be affected by the ethical choices made surrounding the three pillars of sustainability, namely people, planet and profit (Farrer 2009). The way whole populations interpret the damage that has occurred to both people and planet resulting from the unsustainable production practices of the past, is evidenced by the plethora of reports that have been written on the subject in the last forty years (Farrer & Fraser 2009). Ignorance could have been to blame when the issues surrounding how fibres were grown were not considered important. Today the copious quantities of chemicals, pesticides and herbicides used to produce fibres are being questioned as organic alternatives become available (Clement 2011 p. 113). The relatively new concepts of fair trade, sustainable product lifecycles and corporate responsibility, no longer curiosities, have been suggested and are slowly being developed and adopted as business paradigms.

Governments are stepping up to make industry accountable. The power industry which is essential to all industrialized societies that manufacture goods, is working to find clean, green alternatives to coal and gas to minimize the proven effects of ‘green-house gases’ on the world’s environments (World People's Conference on Climate Change and the Rights of Mother Earth Building the People's World Movement for Mother Earth 2011). Uranium, which had been touted as the cleanest and safest form of energy for the future, is coming under scrutiny in the wake of the recent explosion in a nuclear plant brought about by an unavoidable natural disaster in Fukushima (2011). The resulting environmental disaster served as a timely reminder that uranium is not a necessarily ‘safe’ alternative. The long term effect on population health will take decades to uncover although the effects of radio-active fall-out has been tragically realized (Hiroshima, Nagasaki, and Chernoble) in the past.

When manmade fibre developments, contribute to the destruction of natural environments, its ‘footprint’ and all that entails is a reality, albeit uncomfortable that carries with it evidence of far reaching ramifications for population health that Western culture can no longer refuse to recognize (Clement 2011). The evidence of major and widespread damage caused by industrialization has long been known. Take for example, the
case of the Chernobyl disaster in the Ukraine where the nuclear fall-out was evidenced in the polluted water of the Lakes District in the United Kingdom. It is indisputable that the environment and personal health are the victims of ill-considered choices that affect not only physical health but impact upon the collective psychologically comfort of many people in Western societies who are at the forefront of these issues.

Natural disasters are a reality and their effects cannot be avoided. However, in the last five years, as a response to widespread concern regarding the world’s environments, various local and international, government and non-government systems have been established. Growing numbers of interested manufacturers, producers and communities are kept informed by lobby groups like the Environmental Justice Foundation, the Pesticides Action Network (PAN UK) and various testing authorities or standards associations. One such European organization ‘Oko-Tex Standard 100’ was established in 2008 by the Association for Research and Testing in the Field of Textile Ecology, in Zurich. It is a highly respected group that through its work, promotes environments that provide products which are free from toxic chemicals. Fashion designers mindful of their environmental ‘foot-print’ can be supported to design from a whole new perspective and can closely scrutinize new developments or directions using the existing safe guards before they consider adopting them.

With more awareness of the issues, it is anticipated that demand will eventually lead to broadening the standards to include properties not addressed currently regarding the use of chemicals. In the case of ‘Oko-Tex Standard 1000’ it is admitted that the standards do not guarantee quality and only apply to the ‘as-produced’ state of the textiles. That is to say that they do not guarantee that the properties of most interest to fashion designers, which are fitness for use or physiological behavior in respect of the clothing (Oko-Tex Standard 100). In order to secure the psychological comfort and wellbeing of future generations, these issues may need to be researched so they can be vigilantly monitored.

2.6.4. The mind-body connection

The mind-body connection is the last of the four determinants of psychological comfort to be explored in this thesis. Thoughts and emotions influence the body directly. They are intimately connected (Boeree 2009) and this fact needs to be considered when designing for the body’s psychological comfort. Garments that are perceived by the wearer to be ill fitting, too heavy or too tight can lead some muscles of the body firstly to react to the discomfort. It is to be remembered that for some, tight fitting garments or heavy weight fabric may be infinitely comfortable, even desirable if their body movements need (or prefer) to be restricted for any number of physical or psychological reasons. Discomfort, however it is perceived, eventually causes a state of disharmony for the whole body, seriously compromising body function.

At any one time during a wear experience, clothing that is perceived as uncomfortable will contribute to wearer fatigue especially if the neck, shoulders and arms are affected (Stockbridge 1958) because the body works hard in some cases to compensate and re-balance. Those who are cognizant with relaxation techniques know that if a body is experiencing discomfort, a ‘domino effect’ ensues. As muscles start to contract, this causes the blood vessels to contract which in turn affects other systems of the body including
the nerve supply and the lymphatic system. Eventually the digestive and eliminatory systems of the body are compromised (Boeree 2011). A person’s ‘whole’ quality of life can be improved simply by attending to the comfort of the clothes they choose to wear.

A designer should consider psychological comfort in relation to understanding what is important to their consumers. They can continue in this quest from an empathic perspective, and produce garments that generate comfort in the mind, provided that they vigilantly monitor what is being offered.

2.7 Practicality and its place in fashion design

A hypothesis of this research is that a thorough understanding of comfort is mandatory for designers who intend to use it as a key driver behind their work towards designing for wellbeing. For the purpose of exploring the research question that asks if fashion clothing can affect the body’s physiological and psychological comfort, the previous sub-chapters addressed three ergonomic principles. The last of the ergonomic principles in this chapter refers to the notion of ‘Practicality’ which raises awareness that fibre needs vary, depending upon individual differences.

The literature on comfort revealed that practicality is important for clothing design although it is not always in evidence in western and non-western, traditional and non-traditional dress where many styles are not practical, often causing bodily discomfort reminiscent of earlier centuries (Entwistle 2000). An example of this is the low cut or the low slung jeans phenomena of the last decade. The body, a woman’s body in particular, has often been forced into unimaginable shape with no regard to comfort but to suit the current fashion dictates. This is evidenced in the early 1800s when women were forced into the hourglass silhouette, or the curious S shaped, sway back figure created by the ‘Blanchet’- a vertical steel stay which minimised the abdomen, shifting fullness upwards and backwards. Practicality is important for the design of fashion clothing and therefore warrants discussion.

The term ‘practicality’ refers to the functional (practical) aspects of fibre selection. Fibres that allow for the full range of physical movements unimpeded and over extended periods of wear are therefore in essence practical. The thermal, mechanical and sensory determinants of physiological comfort are part of practicality but they are not the only part. Practicality considers purpose and function at the design stage. It is about recognizing differences and accommodating them in regard to the wearer’s gender, race, age and physical prowess. Taking into account the needs of various people their requirements, wants and occupational limitations are all considerations embodied in design practicality.

To illustrate practicality in the fibre selection stage of design, compare the needs of a motorcycle rider and a pre-school student or the needs of a very young child compared to those of an elderly person. How do they differ from one another? Garment design by its very nature needs to consider the ease of putting on and taking off (donning and doffing) clothing (Stockbridge 1985). The simple process of dressing and undressing can cause difficulties for some where fine motor skills, poor eyesight, or even lack of patience are issues. It is quickly realized that there are strong practical reasons for preferring different methods of fastenings. In the
same way, certain fibres are preferred over others and knowing which fibres are preferred by whom and why is a matter of practicality.

The easiest garments to get into are usually the garments we wear most often. This is not just because they are easy to put on and take off but because this ease brings comfort, improves our levels of performance and efficiency and thereby contribute to an overall feeling of wellbeing in our daily lives. These garments are considered to be ergonomically practical and therefore comfortable. If these same garments are made from fibres that have excellent mechanical properties for example tenacity, elongation and flexibility they will contribute to greater ease, be ergonomically practical and therefore deemed as more comfortable.

To demonstrate how fibre selections consider ergonomic principles of practicality, a specific example of clothing worn by a ballet dancer can be used. If knowledge of the ballet discipline is not possible, questions can be asked to ascertain what type of garments are to be designed and the dancer’s requirements, for example, what range of movements need to be accommodated and which parts of the body will be most affected. To inform the fibre selection process, it is also important to ascertain at what level the ballet is undertaken, whether the dancer is amateur or professional or whether they are dancing for leisure or competition. Some fibres will create an efficient interface between heat production and heat loss, as was discussed in the section discussing thermo-physiological comfort. This exchange is exaggerated in the case of ballet dancing where incorrect sourcing may affect the performance outcome, as some fibres are more effective at accommodating a dancer’s needs than others.

Any garment that restricts movement will impede the maximum potential of the body. The resulting discomfort leads to an inability to perform simple or complex tasks and prevents the dancer (or fashion consumer) from enjoying or fully participating in their lives. Ballet garments have different expectations to those garments worn by fashion consumers but there is no evidence that suggests why similar considerations cannot be made at the start of any design practice involving the human body. In respect to the final outcome, a designer can question how functional their garments are; how the clothing ‘works’; whether they are easy to put on and take off and if the clothing allows for a full range of anticipated body movements without constriction.

The chapter concludes that ‘practical fashion’ need not be the oxymoron in clothing design practice that it currently is. Some designers have proved it possible to blend practical considerations with cutting edge design, including Akira Isagawa, Kirily Johnston and Dion Lee.

2.8 Conclusion

The complex interactions that take place between a range of physiological, psychological, and physical factors that contribute to achieving a state of comfort (Slater 1977) were considered in this chapter. This is a challenge for all those who choose to design fashion clothing for the body. In the view of the researcher, the idea that fashion can be both ‘fashionable’ and ‘comfortable’ physiologically and psychologically is
challenging for a large number of designers. It seems that in popular design culture, designers of fashion are often aberrant in providing what makes people comfortable.

The fashion designer of the twenty-first century has long recognized that people want fashion that makes them look good. A hypothesis of this thesis is that looking good need not come at the expense of comfort and wellbeing and this chapter has explored the way comfort can be achieved in design. Ultimately the designer who is cognizant of both fibre knowledge and comfort principles may be in a position to offer their customers fashion that considers their wellbeing. The following chapter tests the concepts of wellbeing.
3.0 Wellbeing in the context of fibres used in fashion

3.1 Introduction
The purpose of the following discussion is to explore the notion that fashion fibres have a potential to contribute to wellbeing. It explores the question of whether fashion fibre choices made at the point of deciding what to wear can impact upon the body’s ability to function to its optimal level. Some issues arising from the production of fashion fibres are outlined to help raise designer awareness. To contextualize this question, an outline of the concepts of comfort and wellbeing has already been undertaken. In order to explore the research hypothesis that human wellbeing may have already been jeopardized by the fibres commonly used in the production of fashion fibres, a condensed history of fibre is provided. This is followed by a brief discussion on the effects of fibre production on global wellbeing. The chapter concludes with an example of a garment life-cycle to illustrate how fibre selection can impact upon individual wellbeing.

The World Health Organization (W.H.O.) defines wellbeing as the state of being in good health. When a human body experiences an acceptable degree of comfort, health and happiness in all aspects of life, it is able to function to the best of its ability. When a body is functioning to the best of its ability it has achieved a state in which the body’s ‘needs’ are met and the human experience is described as one of overall wellbeing. ‘Needs’ relate to what the American psychologist Abraham Maslow expounded as the body’s physiological requirements necessary for survival. Maslow (1954) undertook studies on the healthiest 1% of a college student population in which he expounded his hierarchy of needs theory (see Figure 9.). According to Maslow, the physiological ‘needs’ of food, water and shelter, can be prioritized in order of importance for survival, in any number of disparate contexts. His theories have been used by other disciplines concerned with the subject of human motivation and were explored for this fashion research as they refer to clothing which provides the body’s closest shelter or micro-climate.

![Figure 9. Maslow's hierarchy of needs ‘triangle’](http://en.wikipedia.org/wiki/Maslow's_hierarchy_of_needs)
3.2 The origins of the term ‘wellbeing’.

In order to explore the research hypothesis that fibres used to produce clothing can contribute to ‘healthy’ fashion, a set of principles was required. In seeking to establish these principles, research into the concepts that relate to a state of ‘feeling well’ proved to be a useful beginning. Language that is used to describe the human experience of feeling well includes ‘quality of life as a whole’ (Withey 1976) and wellbeing. Wellbeing as a concept is not new and even Aristotle may have been referring to the state when he suggested that a ‘happy’ life is one which must include ‘pleasure’. Not surprisingly then, both happiness and its close relative pleasure are both pre-requisites of wellbeing. The concept of wellbeing is imbued with integrity because economists, sociologists, political scientists, psychologists and behavioural geneticists all recognized its importance. According to Eckersley (2008), contemporary interest and subsequent re-evaluation of the concepts surrounding wellbeing can be attributed to an increase in scientific enquiry. The state of feeling well itself eventually evolved into a science (Schimmack 2008) where it benefited from research into its concepts culminating in the ‘Wellbeing Index’ (Cummins 2001). Unlike other sciences, wellbeing is interdisciplinary and therefore its inclusion is further justified as worthy of consideration in this research which also crosses the disciplines of fashion and the sciences of textiles and health.
3.3 ‘Wellbeing’ defined

Since the late nineteenth century, many definitions and formulas for the phenomenon of wellbeing have been coined and various philosophers have agreed that the concept can mean many things depending upon the context in which it is used. It became clear during the literature review that there appears to be general agreement that a partial formula for high well-being is to have reasonable health and to be able to access treatment for both psychological and physiological problems (Eckersley 2008). Nearly two centuries ago, the words ‘well’ and ‘being’ had started to be merged into one with the use of a hyphen and first emerged at the same time as the concept of happiness in the late 19th century (Collard 2006). The two words eventually became one, much like the word ‘wellness’. ‘Wellness’ is a term that is popularly used to define an individual’s health status and in a sense it appears to mean the same thing. The two terms are not mutually inclusive however. The term ‘wellness’ is used to describe a person’s human experience and infers that all is medically sound. ‘Wellbeing’ as a term is more complex and therefore susceptible to being misinterpreted. A person’s wellbeing status can include health, however there are more determinants to wellbeing than health alone and the achievement of a wellbeing state attends to these other sometimes more subtle nuances.

The earliest philosopher that could be considered to be committed to public wellbeing was Jeremy Bentham. Many of his observations are still relevant in everyday life and current research. He became the father of utilitarianism, when he expounded the theory that the way to the greatest happiness for the greatest number came about as the result of choosing the right acts or policies (Bentham 1897). The principles of utility that he explored essentially became known as the principles of the greatest happiness. In contemporary life, utilitarianism equates to making informed decisions in all aspects of life that are recognized as having a capacity to affect human wellbeing. Bentham’s utilitarianism philosophy led others and soon wellbeing was recognized as the state of achieving pleasure over pain. In deference to the early researchers concerned with the human experience, the pursuit of wellbeing governs what we do, what we ought to do as well as our standards of right and wrong, governs all we say and do and sets off chains of cause and effect (Andrews and Withey 1976). Wellbeing is a potent motivator.

The contemporary philosopher Ulrich Schimmack has refined Bentham’s belief that the way to happiness was the result of choosing the right act or policy by defining wellbeing as ‘preference realization’ (Schimmack 2008). He observed that defining wellbeing is problematic because the human experience is very complex. It is difficult to judge which person has higher ‘overall’ wellbeing, the one with more financial resources, or better health, or the one with more spiritual awareness. Design in an academic arena is often about challenging what we should and should not do in terms of the fashioned body. The pursuit of fashionable outcomes may be either pleasurable or painful in terms of comfort to the wearer. In the case of this research wellbeing is measured against the physical and psychological concepts of comfort relative to fibres and the body.
Having explained the parameters, discussion now turns to measuring wellbeing using specific examples. In the terms of preference realization, the blind study undertaken for this research which informs the thesis is a good illustration. In consideration of Schimmack (2008), and Bentham’s (1897) observations, all decisions on fibre compositions made at the design stage are governed by positive or negative feelings towards them. In this case, preferences towards a particular fibre composition can be evaluated using a questionnaire tool. The responses gathered will guide what is chosen in the same way as standards of right and wrong guide us in all the other aspects of life. Any differences between the fibres in the recorded results indicate that individuals weight fibres differently according to their individual perception of comfort. The degree to which each fibre preference is realized is ‘preference realization’ or ‘wellbeing’.

Knowledge empowers most people to make their own preferences based on the perceived benefits they have attached to them. This is also the case in regard to fibre selection where fibres are preferred or chosen according to their perceived benefits. The preference for one over the other helps make sense of the stories ‘written’ on the individual subconscious mind. A person’s preferences are determined by a number of things including their value judgements, health status and belief systems. Other determinants include how an individual sees the world, their place in it, as well as gender, age or even nationality.

Various philosophers have agreed that wellbeing can mean many things and the achievement of a state of wellbeing depends upon many factors. There are some things that we have no control over because they are genetically determined. An individual’s personal circumstances, including their socio-economic status, may or may not be the result of choices that have been made. Despite these variables, the complex way in which they interact all contribute to the subjective nature of the concept of wellbeing. Perhaps sociologist Richard Eckersley, best encapsulates the myriad of expectations attributed to wellbeing when he wrote that wellbeing is about finding something that not only fulfils individual potential but makes the individual feel worthwhile (Eckersley 2008). The following section explores the relevance of well-being in fibre selection.

### 3.3.1 The relevance of wellbeing in fibre selection

The selected literature of Bentham, Sully, Eckersley and Schimmack all appear to agree that the goal of individual wellbeing, in itself, is a worthy one and needs to be actively pursued. The majority of wellbeing literature states that it is indisputably important in virtually all modern societies. It has also been agreed that making informed decisions in all aspects of life has the capacity to affect human wellbeing. Fashion is no exception. One question however remains unanswered. The problem of ‘how’ wellbeing can best be measured has not been solved. A methodology for solving this problem is suggested here.

The growth of human knowledge proceeds from our problems and from our attempts to solve them according to the philosopher Karl Popper (Thornton 2011). It is easier to discuss wellbeing using explicit examples (Schimmack, 2008) so it is proposed that fibre be used to explore as a means to measure wellbeing. Selecting fibres for their suitability to be worn on the body is a problem that fashion designers need to solve at the design stage. The collaboration between a School of Health Science and Fashion is
unique, resulting in a thesis supported by research wear trials that provides some illuminating findings about the human experience (as discussed in Chapter Six). The trials employed an established method for testing and recording the ‘wellbeing’ responses associated with wearing fibres.

By understanding the basic information about fibre compositions addressed in Chapter One, the more subjective properties of fibres can be explored. Concepts of comfort and its pre-determinants have been researched by many in the last century. The contributions that fibres make to comfort were explored briefly in the previous chapter in order to justify their inclusion in this thesis. The concept of wellbeing is relatively new so a similar breadth of knowledge regarding its pre-determinants does not yet exist. More knowledge is needed of the elusive nature of the human experience in relation to selecting fibre micro-climates and this research serves to raise awareness of some of the possibilities amongst fashion designers and their public.

It can be argued that any fibre properties that contribute, either in a positive or negative way to comfort will contribute to wellbeing. It is also argued that the state of wellbeing can be achieved by making informed decisions about the fibres that are selected to be worn on the body. This section explores the wellbeing concept and the action part of the research, and examines if wellbeing itself can be measured using a research instrument. The design of the research is explained in Chapter Five.

### 3.3.2 Fashion affects wellbeing

Wellbeing is the product of informed decision making. The decisions that are made in all aspects of life therefore have a capacity to affect it. Fashion designers are no strangers to the business of making decisions. Not all decisions however are informed in the context of fibre selection, possibly due to a lack of understanding the implications of those choices.

Eckersley defines wellbeing as a state of being attached to various others. Whether these others are people or interests, it is in the act of being comforted by them that life is given its meaning (Eckersley 2008). Designers that acknowledge the importance of understanding the interface between fibre selection and the human body can choose to become attached to a quest to achieve well-being in their practice. The act of choosing fibres for design outcomes is intrinsic to fashion design, indeed many designers are inspired purely by the fabrics themselves (Dorner 1975). Fibre sourcing can play an important role by connecting designers to the principles of comfort. In so doing, they can contribute an extra dimension to the already complex area of fashion theory by endowing it with a ‘Well-being’ context whilst improving their own wellbeing. Any concept needs a language to express it and the role of language in expressing wellbeing is the next subject to be discussed.
3.3.3 The role of language in expressing wellbeing

Dressing the body requires the making of decisions. Choosing what to wear and what not to wear are questions that are asked every day and answers are mostly made based on past experiences. Each individual coins special words in an attempt to describe all their positive and negative experiences of dress. These experiences are expressed with a language of feelings that is peculiar to them. The interpretation of any response to something that happened in somebody’s past is problematic if it relies solely upon language to explain it. The problem is that the words which have explicit meaning for the person experiencing them is often subsequently misinterpreted by others. The business of wearing clothing, especially fashion clothing, engenders feelings that affect decision making. The feelings are usually in response to the effects of the thermal, mechanical and sensory discomfort emitted by fibres which cause the body to respond accordingly. Effects last until the experience is replaced with another so they may be long lasting. The experiences are retained by the mind and are known as ‘stored modifiers’ (Hollies and Goldman 1977). The decisions involved in getting dressed are determined by an individual’s stored modifiers and these contribute to wellbeing.

Decision making takes into account the physiological and or psychological aspects of an individual. Consideration of how an individual’s body reacts and what a mind thinks, enables them to answer questions such as ‘what can I wear that will make me feel ‘good’? Is this garment ‘nurturing’? Is this ‘comfortable’, ‘cosy’, ‘cool’ or ‘warm’ enough? Does it ‘prickles’, does this garment make me ‘sweat’ and so on. Through the grasp of ‘sensation specific’ language, observations become meaningful and a state of wellbeing can be assessed. The following discussion explores how the stored modifiers resulting from physiological or psychological discomfort can affect wellbeing. A familiar example of a stored modifier is used to illustrate the phenomena.

The wool fibre is used here to illustrate how language used to describe the body’s responses to wearing wool in the past may no longer apply. Wool is a natural fibre; subject to the vagaries of climate, disease and quality but it was its association with discomfort that researchers at the Commonwealth Scientific and Industrial Research Institute (CSIRO) to investigate the reason. The adjectives that have been used by individuals in response to the wearing of wool fibres have been synonymous mostly with discomfort. They included words like prickly, itchy, scratchy and even allergic. Prior to the CSIRO Division of Wool Technology research into the diameter of wool fibre that took place in the late twentieth century (Garnsworthy 1988) little was known about the reasons why some wool was less ‘prickly’ than others. Not all wool was able to be worn against the skin and people were naturally wary of wool garments for this reason. Research confirmed that the finer diameters provide the most skin comfort. Unfortunately it only takes one rogue fibre in a fabric to make a garment prickle. The manufactured fibre industry came into its own with more predictable alternatives. Synthetic fibres followed and soon monopolized the fashion industry.

Responses to this wearing experience lead to deeply held and mostly inaccurate assumptions about wool that lasted for decades. The stored modifier would remain in some people’s memories until a more positive
experience of the wool fibre could take its place. It was some decades before the value of fine diameter fibres was realized and not before machine washable wool was trialled in Australian school uniforms. Until then the language used to describe wool remained.

In 1980 the Australian wool industry suffered the consequences of a rise in floor price that took it took two decades to recover from. The Australian wool fibre industry worked hard to find a way of making wool more acceptable to the consumer to ensure its future. Market research into customer perception of wool product was undertaken in this cause. It was perceived that a major hurdle in promoting wool as a preferred fibre for fashion end uses, related to the somewhat cumbersome issues surrounding its maintenance. Incorrect washing of wool often had disastrous results, with felted, matted and shrunken examples abounding. In an attempt to address the wool stockpile, manufacturers sought advice and decided that they could use the product up quickly while at the same time respond to customer disenchantment by developing an enhanced wool product. The new technological development was machine washable wool, (a previously unheard of concept).

This new development was introduced on a large scale. During the 1970’s school children across Australia, had the opportunity to experience the properties of a machine washable school jumper. Providing the washing machine was suitable, wool washing disasters became a thing of the past, and in 2001 the last of 4.7 million bales of unwanted wool was sold ending an era of stockpiled wool.

The early achievements in machine washable wool through application of coatings as a finishing process were, by today’s standards, disappointing as they resulted in a stiff ‘board like’ hand. The application of a special finish to the wool fibre coated the naturally occurring scales creating a ‘slick’ fibre hand (Wool Producers Australia 2011). This eliminated the wool fibres susceptibility to felt when in the presence of water, agitation and heat. Jumpers lacked the desirable qualities associated with better quality wool jumpers. Significant research and development (CSIRO 2003) has resulted in improved hand since then but the early experiments left a legacy. New words were used, among them stiff, hard and board-like as another generation turned away and delegated their experience to their bank of stored modifiers. Wool was still regarded with suspicion as it had been by their parents for a different reason fifty years earlier. These discussions demonstrate the importance of fibre properties in wellbeing and the relevance of a suitable language with which to couch the concept. The following discussions explore other determinants for the attainment of wellbeing, namely happiness and health, in the context of fibre selection.

### 3.3.4 Happiness and wellbeing

People who are encouraged to function physiologically and psychologically unimpeded are happy according to a survey from which The Australian Well-being Index was developed. During this seven year research project spearheaded by the Australian Government, volunteers were asked to respond to questions by listing the choices against which they judged their overall ‘happiness’ or ‘quality of life’ (Cummins & Eckersley 2001). They found that quality of life equates to wellbeing, and in fact these terms are used interchangeably throughout the literature. From the accumulated data, wellbeing researchers were able to discern what
constitutes happiness and provide comprehensive insights into the human experience which influenced government policy in relation to economic activity and output. It also provided insights that informed this research in that happiness is another dimension against which fibre selections can be measured.

Shopping for fashion items is a popular pastime of consumers in the developed world, who spend around $1 trillion (US) worldwide on the purchase of clothes (Fletcher 2007). It can be argued that this rate of consumption may be driven by the pursuit of happiness (pleasure) as humans are ultimately motivated by pleasure in everything they do. This fact has been recognized by philosophers throughout history (Diener 1984). However, according to the philosopher Ulrich Schimmack happiness and pleasure are clearly components of well-being but they do not equate to it (Schimmack 2008). He suggests that the mere act of shopping for new fashion clothing, does not guarantee a person’s wellbeing, thus wellbeing is far more complex than what can be accommodated by the pleasures of shopping.

In the nineteenth century, a study exploring human intellectual development described feelings, whether they are positive or negative, as being intrinsically bound up with individual elements of happiness or unhappiness that are unique to each individual (Sully 1886). Seen as expressions of pleasure, pain, joy, grief, and anger they contribute intrinsically to an individual’s mental health life. According to Sully:

> Our pleasures and pains make up the interesting side of our experience. The objects of the external world only have a value for us in so far as they touch our feelings. Since, moreover the feeling-tone of our experience determines its character as happy or the opposite the clear understanding of its conditions forms an important part of the science of well-being. (Sully 1886, p. 408)

A later and important contributor to the research on happiness or the enjoyment of life, the sociologist Ruut Veenhoven (2006) defines happiness as the degree to which an individual judges the overall quality of his life-as-a-whole positively, in short: how well one likes the life one lives in consideration of all its complexities. Whilst Eckersley (2008) argues that happiness may be an indicator of wellbeing it is not necessarily a pre-requisite as many happy people can have serious health issues. Designers who consider the happiness of their customer will not only sell more garments, they will be considering overall wellbeing for people who may not be in peak health. Health is next explored in the context of the present research.

### 3.3.5 Human health and wellbeing

In the late 19th century Bentham wrote that health is an ‘indicator’ of wellbeing. The World Health Organization (W.H.O.) define health, as a state of complete physical, mental and social well-being, pointing out that this does not mean merely the absence of disease and infirmity. The result of considerable research by groups like the Heart Foundation also agree that good health is a determinant of wellbeing, the logic being, that if an individual is well she or he has a better quality of life and therefore a stronger likelihood of having positive wellbeing. The following section explores the hypothesis that fashion can contribute to human health and therefore wellbeing.
Wellbeing in this research is taken to mean an absence of physical and mental problems. If there is consensus, then in order to achieve wellbeing an individual's health status must be of primary concern, and anything that impinges on an individual's capacity to thrive must be treated with caution. Fashion that does not inhibit health outcomes can be achieved through the understanding that comes from concerns about the environment and disease. The primary subject of discussion in this chapter concerns the possible connections between human health and fibres.

The popular media has made information readily available to the general public about the possible connections between human health and the various sources of pollutants in their immediate environments. In a report published by the lobby group, Pesticides Action Network in response to investigations into the widespread use of insecticides and pesticides, it was recorded that: “hazardous pesticides form the root cause of substantial environmental and human suffering”. (PAN 2003 p.28). The report states that the harm caused by pesticide poisoning leads to acute and chronic symptoms which at best include headaches, vomiting, tremors, a lack of consciousness, seizures and at worst death. The widespread use of chemicals has been proven to have contaminated everyday food items, from vegetables and fish, to animal feeds and meat, in turn compromising human health. The combination of past evidence and more transparent product disclosures has resulted in an informed public that are justifiably watchful and concerned. It is argued that this concern should include fibres in the same way as it considers food, as a source of contamination to human health.

The next section comprises a brief exploration of some of the background to fashion fibre production from an historical perspective that is relative to wellbeing.

3.4 Historical perspective of fibre selection

The next three sub-chapters explore wellbeing in the context of fibre production. A brief history of textile fibres is placed at this point in the thesis to furnish some background in readiness for discussions that take place later in the thesis about fibres contribution to wellbeing. The thesis explores the idea that there could be a connection between fibres that are a product of technological developments and twentieth century health syndromes. Humans had survived for thousands of years using the fibres that occurred naturally in the environment. This chapter tracks the major shifts the fibre industry has undergone since its early beginnings.

Fibres have been used to clothe the human body since the dawn of civilization. The wool fibre was recognized by early man for its insulation properties and it soon became a staple to use for protecting the body against prevailing weather conditions. Wool which was originally gathered from wild animals, collected and then felted into the first cloth soon grew into an industry when spinning was discovered. Fibres were twisted together, and the resulting yarns could then be interlaced into woven cloth. The wild animal was domesticated and the wool fibre became a staple commodity widely desired for its outstanding properties. For the next two hundred years, human needs were serviced by the wool, flax, cotton and silk fibres which all
had their own sets of properties desired for different purposes. All that changed with the industrial and technological revolutions that followed.

### 3.4.1 Industrial revolution

The Industrial Revolution heralded the beginning of a new era of mass production processes. Prior to the invention of machines, which resulted from the industrialization of fabric manufacturing, every family was responsible for producing enough raw products for their own needs. With the demise of these cottage industries machines started manufacturing fabric and wool began to compete with cotton as factory production was born (McDonough & Braungart 2002). With the new technologies that emerged it was possible to easily satisfy demand as with large scale production came instant gratification and clothing moved from being a need to being a want. These processes sped up the ability to manufacture textile goods which came at a cost to the planet’s ecosystems (Fletcher 2007). The results of large scale environmental damage have been accumulating ever since and would have continued had it not been recognized as a major problem in the last twenty years of the twentieth century.

### 3.4.2 Second World War

Prior to the Second World War (1939 – 1945) consumers of fashion clothing were content with the natural fibres: generally wool for winter and cotton for summer. Silk and linen were considered to be luxury fibres that few could afford. The need for reliable supplies of large quantities of fibre to replace the silk that was used to manufacture parachutes drove the chemists of the day to research the development of synthetic substitutes. Polyamide or nylon as it is commonly known, was an unmitigated success as it was a fibre that rivalled steel of the same diameter for strength with high elastic stretch and recovery and resilience. It could be produced in factories from plentiful supplies of coal in copious quantities and so was inevitably used to manufacture everything from parachutes to tyres cords. The Second World War benefited from the scientific research and with the arrival of peace, the fashion industry benefited from the now surplus over supply (Handley 1999).

Traditionally, women were the primary home keepers and makers, but during the war, they had been sequestered into work outside the home. They replaced the men on the factory floor and in heavy industries and the general public had become accustomed, to a more practical dress code. Temporarily released from their duties as ‘housewives’, women soon realized the advantages of the new easy care synthetic fibre which could be machine washed and needed no ironing. Ease of maintenance for clothing became a mandatory requirement and when released from their jobs in industry, the practical, new fabrics drove up the synthetic fibre production.

The implications for environmental and human health associated with the wearing of these ‘new fashion’ fibres were not widely questioned. The result of this is that the cumulative effects of wearing fabrics that
were developed in the middle of the last century appear to be still little understood despite the technologically sophisticated methods available for testing (Samways 1989).

3.4.3 Technological revolution

The ability to manufacture fabrics that have extraordinary properties should be pursued with consideration of the environment and human health. If people value wellbeing or freedom from pain and discomfort; coupled with personal control and peace of mind, then the capabilities exist today more than at any other time to pursue the goal of wellbeing.

The clothing consumer’s love of easy care fabrics remained after the cessation of the Second World War in 1945. The fabric ‘wants’ of the generations that followed steadily continued with further advances in technology, and the list of what the industry is capable of providing is long. The fashion consumer of the early twenty-first century does not only expect their garments to be low maintenance. Today, they expect that their clothing purchases will make them look beautiful (Moeran 2010) as well as perform useful functions.

Fashion may present the perfect vehicle for assisting people to achieve wellbeing, because and despite of its reputation as a purveyor of trends. New developments in textiles are the outcome of the technological revolution and have been available (but not common in mainstream fashion) since the late twenty first century. Designers particularly in the fashion industry are generally eager to embrace these new technologies in their ranges as it creates novelty. They are also in the business of creating desirable therefore economically successful outcomes. As technologies become smaller and more sophisticated, the fashion designer is enabled to create garments that can be vehicles for the latest trends. It is possible to imbed technologies in clothing that can monitor vital signs, facilitate personal area networking, global positioning systems and interactive communications to mention a few (Braddock et al 1998).

At the forefront, they are developing design concepts that are, for the first time capable of performing functions with the express purpose of streamlining individual lives to improve wellbeing. The following chapter explores some of these issues as well as discussing the known health effects of some common textiles, mindful that the unknown effects of others are cause for concern.

3.5 Investigating fibres for their contribution to wellbeing

It is only in the latter part of the twentieth century that consumers have questioned if there was a time when raw materials could be produced into cloth without damage to the environment and as a result of this reflection, some accepted practices have been exposed. It is suggested that homo sapiens, in their demand for clothing that is easy care, brightly coloured, aesthetically different with each new passing fad and in unlimited supply may have contributed to an overall reduction in their quality of life or wellbeing. The result, as Fletcher states: “Fashion is eating itself. It has become so disconnected from reality that many of the key
issues of our times—such as climate change, consumption and poverty—barely register their presence on the high street or the catwalk” (2007, p.119).

It is not known if the health ‘syndromes’ that puzzle the medical profession today were around prior to the development of manmade fibres but we do know they are becoming more prevalent (Australian Government draft of health report Multiple Chemical Sensitivities 2010). Adopting any new class of technologically advanced fabrications, often promoted by textile manufacturers, may not be in the interests of human wellbeing.

3.5.1 Eco systems

The latter part of the twentieth century heralded the beginning of an awakening to environmental problems both globally and domestically and in the attempt to address these problems, ‘Global warming’ became a phrase that was used to embrace any issues that related to environmental damage. The phenomena gained currency amongst various groups like the Pesticide Action Network in the United Kingdom (PAN 2003), when business leaders industry and eventually governments attempted to make consumers more aware of the environmental issues that faced them.

In a ground breaking book for the times, ‘Cradle to Cradle—remaking the way we make things’ (McDonough and Braungart 2002), a scientist and an environmentalist wrote that there was a time, in the nineteenth century when matters of the environment were not a widespread concern simply because resources were regarded as infinite. Ten years later the evidence of environmental damage brought on by the industrialists, engineers, inventors and other minds behind the first Industrial Revolution indicates that society’s thinking has to change. Fletcher states that “Current evidence suggests that the fashion and textile sector is among the most environmentally damaging, judged on a par with the chemical industry” (Fletcher 2007 p.120).

Textile fibre production has been targeted and new practices continue to emerge wherever resources are available. Growers and manufacturers seek to make big changes to old practices in response to consumer demand as is currently being witnessed with the organic cotton industry leading the way. The consequence of industry and government recognising the effects of environmental damage is that the clothing contribution to environmental degradation is now known and multi-million dollar manufacturing plants across the world producing textile fibre twenty four hours a day seven days a week can make informed decisions with regard for both environmental and human wellbeing.

3.5.2 The ‘Food’ Chain

In acknowledgement that the manufacturing of commodities has the potential to harm the environment, various environmental groups continue to lobby business and government making consumers more aware of the issues that face them both globally and domestically. Toxic chemicals in the environment can be eradicated over time so that man’s basic needs of clean air, fresh water and healthy food can be restored. Food, regarded by Maslow as the most important physiological human need along with water and shelter, is
a commodity that has undergone close scrutiny in recent times. The widespread use of chemicals has been proven to have contaminated everyday food items, from vegetables and fish, to animal feeds and meat, in turn compromising human health (PAN 2003). All who are involved in its production have been made aware of the importance of safeguarding it from industrial contamination. Chemical free, organic and ‘free range’ are familiar terms today and there is enough evidence available to support the food consumer, empowering them to make healthy choices.

The business of ‘what to eat today’, as with any problem is made easier to solve if one has enough available information. Guiding people to make healthy choices is a professional practice in the case of illness where hospitals have long recognized the role of a good nutritionist. They know what constitutes a healthy diet, what foods to eat plenty of, which ones to avoid and how much to consume. Many would agree that the campaign to encourage healthy lifestyles through healthy eating has been most successful. If people, through making suggested choices can be protected in this way in respect of the food industry, then it should be possible to protect them in the same way, through public awareness on matters regarding their choices of ‘what fibre to wear today’.

The evidence of the damage done to the environment of unrestrained production of commodities since the onset of the Second World War can largely be attributed to the extraction of non-renewable resources such as coal and petroleum. These are the essential ingredients for the production of the most popular fashion fibres and the industry, in response to global shortages has been forced to find alternative fibre supplies. This is a good thing in respect of human health and wellbeing.

3.5.3 The body’s immune system

There is evidence that seriously compromised environments lead to serious compromises in food, air and water supplies; they may also result in compromised immune systems and irreversible consequences for both physical health and psychological wellbeing. If the research findings from studies into cell phone usage are correct then some of the new technological developments, including many of the new materials that have become commonplace in the last century, including fashion fibres may be responsible for physical and behavioral changes. If this is so then a whole post war generation may already be suffering negative effects (Davis 2011).

3.6 Textile fibres and the intimate habitat

The connection between wellbeing and fibre industrialization has been clarified and awareness has been raised into the potential of hazardous materials, heavy metals and toxic chemicals to harm human health in the previous section. The invisible particles of grit or hard inorganic matter that permeate the environment, home and office in the form of gases, dyes and chlorinated additives are inhaled on a daily basis and have become a part of life in the twenty first century (Colborn 2008). The production of fashion clothing fibres contributes to the toxic overload of the environment and may well be contributing to a toxic burden being
borne by the human body (Clement 2011.) This sub-chapter now takes a closer look at fashion clothing fibres that provide the body’s closest habitat.

In order to safeguard wellbeing, the individual has a responsibility to find out all they need to know about the raw materials and the processes that are used in its production. What the individual puts ‘on’ their body should be treated with the same seriousness as what they put ‘in’ their body. This can be achieved with transparent product disclosure, similar to that used today with food product labelling. If there are any impediments to consider with fashion clothing from the products environmental impact to the end of its life cycle, then the consumer is entitled to know about them.

3.6.1 Fibre production

There are a number of worries surrounding the production of fashion fibres, many of which are being addressed in response to overwhelming evidence that industrial development has had a devastating impact on the world’s eco systems, its food chain and the human immune system. As mentioned earlier, there was a time when fibre production did not require the use of hazardous chemicals, before mass production, when people only produced what they could grow and the land was not depleted. It is unlikely that the majority of today’s average consumers of fashion garments would be content with fabric like Gandhi’s ‘Khadi’ handspun cloth which he made famous last century. Made from cotton fibre that had undergone little to no processing the homespun cloth would be aesthetically unattractive by today’s definition of what constitutes fashion fabric (Selvedge 2004).

In response to consumer demands, manufacturers today produce clothing fabrics that are elegant, sophisticated and technologically advanced which has necessitated the reliance on the use of hazardous chemicals and hydro carbons. The production of fashion fabric today is fraught with issues affecting the environment, starting with the growing or synthesizing of raw fibre.

We know that the fashion industry has been implicated as a major contributor to accumulated environmental damage (Fletcher 2007). Natural fibres are grown with the aid of the widespread use of insecticides and pesticides for soil and crop improvement. In response to investigations into this practice, a report was published by the lobby group, Pesticides Action Network (PAN). In it they recorded that populations living near, and people using these chemicals were not thriving since pesticide poisoning had been suspected to be the cause of acute symptoms which at best include headaches, vomiting, tremors, and a lack of consciousness, seizures and at worst death. (PAN 2003).

After harvesting, fibres are spun into yarn then created into structures by inter-lacing, inter-looping or meshing into webs. These ‘fabrics’ are then dyed, printed and finished into desirable commodities for the consumer. At each stage from the growing and manufacturing of fibres to the finished product, fashion as an industry consumes vast resources from the natural world and many of these resources are non-renewable.
As already mentioned commodities of all types are being scrutinized for ways to improve their production and fibres are no exception. The growing, harvesting, and production of the naturally occurring fibres and the synthesizing of others contribute in varying degrees to environmental damage. Cotton production has been singled out in the last two decades as the biggest perpetrator and consequently significant improvements are being made regarding its environmental ‘footprint’. Wool production has also been evaluated as it has its own set of problems for the environment. Sheep and their methane gasses; husbandry requiring a demand for drenching and other chemicals; pesticides and herbicides; acids; detergents energy and heavy metal dyestuffs are all unavoidable so best practices are being applied.

The fibres developed and manufactured in the middle of the twentieth century, the man-made fibres also have a story to tell with logging practices and chemical wastes. The production of synthetic fibres emits chemical toxins that pollute soils, air and waterways. From the non-renewable crude oil cradle to the incineration grave, the basic ingredients for some of these fibres necessitates the drilling of sea beds for petroleum or coal, burning of fossil fuels, disturbing water ways, creating oil spills and disposal problems. The environmental problems are being taken care of.

A garment life cycle is outlined next to demonstrate the complexities of garment production in the context of its ecological ‘footprint’ using as an example, a white cotton T shirt.

3.6.2 T shirt life cycle

To demonstrate how the production of a piece of fashion clothing contributes to environmental damage this last section examines the life cycle of a T shirt. A white cotton T-shirt has been chosen because it is a familiar garment owned by all genders and ages regardless of means. Above all it has been chosen because it appears to be relatively benign in comparison to most other types of fashion garments, yet has what is considered to be an enormous environmental ‘footprint’. The basic essences of life namely, soil, seed, air and water, have all been severely compromised by the growing and processing of this wardrobe staple.

The Pesticide Action Network rates cotton as the world’s most important non - food agricultural commodity (PAN 2003) and it is also a major fibre used in the fashion industry. The global consumption of cotton has doubled in the last 30 years, with demand now in excess of 25 million tonnes annually. Consumers buy more cotton than ever before, accounting for around 80% of the world fibre market.

Production of the cotton fibre into fabric is the result of a culmination of chemical and other ‘brute forces’ imposed by the textile sector. The cotton plant is vulnerable to disease and its growth is dependent on uncontrollable factors like the weather. This has led to investment in advanced biotechnologies, including genetically modified (GM) seeds, intensive use of chemical herbicides and pesticides and a high degree of automation (Allwood 2006). It is a demanding crop, depleting the soil of nitrogen and other nutrients and requiring copious quantities of water. As a crop it is responsible for the release of $2 billion of chemical
pesticides each year, within which at least $819 million are considered toxic enough to be classified as hazardous by the World Health Organization.

Defoliants, energy and solid waste from production; making up; disposal and packaging processes all add their load to the environment. The production of a T-shirt fabric represents a substantial threat to global air, soil and freshwater resources but this is not the whole story. Bleaching the naturally cream coloured fibres to make them the white desired by consumers has mostly been done in the past with chlorine bleach with the potential to create dioxins, the most toxic man-made substances in the world and linked to many of the world’s most notorious environmental poisons Chlorinated compounds have been linked to animal hormone disruption and persist in the environment for decade’s even centuries. From the North Pole to the Antarctic, organo-chlorines can be found in the air, water and food chain (Smith and Lourie 2009).

The West's obsession with hygiene has led to the startling fact supported by Fletchers findings (2007) that the energy needed to wash this staple garment through its life span is about six times that needed to manufacture it. The maintenance of a white T shirt (necessitating frequent washing with optically enhanced detergents) inevitably damages the environment. Along with disposal challenges, this T-shirt is destined to add to the ‘landfill fashion’ phenomena. According to Allwood “The combined waste from clothing and textiles in the UK is about 2.35 million tonnes, 74% (1.8 million tonnes) to landfill” (2006, p. 16).

3.7 Chapter conclusion

Fashion designers face daily dilemmas surrounding the consumption of their product and need to be aware of many complex issues. This chapter identified how the production of fashion fibres contributes to environmental and human wellbeing for the purpose of raising awareness of some of the issues that surround the effects of fibres upon human physiology and psychology.

This completes the thesis exploration of wellbeing in the context of fashion fibres. The next section of the thesis documents the action research.
4.0 Part 2: Design of research blind study

4.1 Introduction

As mentioned in the introduction to this thesis, the 'intimate habitat' consists of two parts. Part 1 conjectured, explored and discussed how the way in which fashion fibres feel next to the skin impacts upon the senses, affect people's comfort and therefore contribute to their overall wellbeing. This research crosses over the academic disciplines of health and fashion, as is reflected in the methodology used to gather evidence to support the hypotheses.

The research hypothesis, by suggesting that some fibres are more comfortable than others both in terms of skin comfort and ability to contribute to emotional wellbeing, presented a challenge. A profile of fibre comfort was required that would provide evidence of their performance ratings in respect to the comfort determinants prescribed through the first part of the thesis. A blind trial, in which no details of fibre composition were revealed, was deemed to be most appropriate. This would test and record whether a fibre rated poorly in any one of the comfort determinants, by the majority of participants. Findings would be compiled into a fibre comfort dossier that supports or rejects the hypothesis and informs designers who are interested in designing for wellbeing.

In the early stages of developing a suitable instrument with which to investigate the effect fibres have on physiology and psychology, it was thought that animal studies would provide some interesting data. Collaboration with a university zoological school was initiated and discussions took place which involved the feasibility of 'dressing' piglets in garments made from some of the fibres used commonly by fashion. Piglets were the preferred choice as research had proven that humans had a lot in common with pigs simply because pigs and humans are mammals meaning that they share some genes. (ABC 2010). There was no doubt that the data would have been illuminating if the research was primarily concerned with garment comfort.

However, the 'intimate habitat' research whilst attending to concepts of comfort is more acutely interested in addressing the sensations created by textile fibres as they are perceived by the brain and interpreted as pleasant or unpleasant. These properties of fibre performance are not easily measured scientifically and the answering of a number of carefully considered questions relating to a wear experience involved a high degree of sophisticated articulation which necessitated human participation. It was decided to use a questionnaire instrument for this purpose.

The challenge was to design a wear trial with the necessary academic integrity to be used to garner evidence of a connection between fibre compositions used in the production of fashion clothing and 'dis-ease'. A sensitively devised trial which concentrated on sensations and perceptions was expected to reveal enough evidence to allow the research hypothesis to be accepted. An established scientific research model was borrowed through collaboration with the Centre for Applied Social Research at RMIT University, School of Chinese Medicine.
The textile and related industries rely primarily upon objective measures to assess fibre performance in relation to comfort. These measures were useful as they demonstrated scientific ways of gaining results and proving hypotheses that are acceptable in a scientific arena. In an earlier chapter addressing wellbeing, it was revealed that subjective measures, such as those used in the 'intimate habitat' research trials, need to be regarded similarly to objective measures, because they too can be responsible for feelings of wellbeing.

The aim of this chapter is to document the part of the research that explores the comfort and wellbeing phenomenon which used a group of volunteers and a set of T-shirts accompanied by a questionnaire. It documents the method for initiating, designing, developing and implementing the research that captured volunteer (participant) responses to support the 'intimate habitat' research hypothesis.

Figure 10. Wear trial presentation packs containing four T-shirts, wear protocol and questionnaire surveys.
4.2 Developing the research instrument

4.2.1 Ethics approval

The ‘intimate habitat’ project required human participation which involved interviews and questionnaires necessitating the disclosure of personal information. Ethics approval was therefore required that sought the necessary assurances before the project could begin.

The research was conducted ethically and confidentially with an ethics committee determining the various protocols under which the research had to be administered (see Appendix 2 and 3). A plain language statement was issued to each participant outlining the research and their part in it (see Appendix 4). Participant privacy was protected at all times in regards to any information collected including contact details, signed letters of consent (see Appendix 5) and questionnaire responses. The participants were not in a dependent relationship with the researcher, which could render them vulnerable to suggestion in any way. The nature of voluntary participation meant there were no payments to be made although some reward could be construed from the allowance made for volunteers to keep favourite garments on completion of the research.

The risk to participants was minimal because their participation was voluntary, no payments were made and responses were based on their own experiences. Some adverse reaction may have occurred with participants that had an existing sensitivity to certain fibre compositions, but it was not anticipated that the reactions would be severe or long term. In any event, participants experiencing any discomfort were advised to contact their personal physician. All information was held in a locked cabinet in the researcher’s office where the information would be retained for five years after the research was undertaken at which time the material will be shredded or deleted.

The research consisted of a garment wearing trial used to explore the research objectives. Therefore the next stage in the design of the research project involved establishing volunteer profiles in respect of their gender, age, body size, health status and occupation.

4.2.2 Defining a volunteer wear trial cohort

A participant profile had to be developed first, in terms of suitable age, gender, size and health status, before a recruitment process could take place. The test site preferred for the trials was a workplace as this was considered most convenient. The ‘intimate habitat’ trials assumed adult participation therefore the questionnaire instrument would be appropriate for gathering responses.

Other criteria for defining a suitable group were more sensitive in terms of both determining the point of advertising for suitable candidates and also their suitability for recruitment. The aim was to recruit approximately twenty participants interested in taking part in a fashion project. Although the campaign did
not specify the concepts that were being explored, it did specify that they would be involved in an experiment that involved the wearing of four T-shirts in a workplace over the course of ten days and then accurately completing a short questionnaire. It was decided that the cohort of participants would be female, aged between eighteen and thirty five and healthy non-smokers. Reasons for the various criteria, discretely and sensitively ascertained during private interviews, are explained next.

Originally, females were chosen for purely pragmatic reasons as females outnumbered males in the sedentary administrative areas of the urban setting in which the research was conducted. However, a study on fabric ‘hand’ as perceived by American and Korean males and females conceded that females may respond more intensely to textile ‘hand’ than males, which may be culture related (Kim & Winakor 1996). The research revealed that overall, more females than males have been involved in quantitative research trials used to test fabric performance, with the exception of research involved in testing fabrics for the extreme sports. It appears that the female gender may be more able to engage in the nuances of language to explore skin responses to fabric if it is conceded that they are generally more comfortable communicating through the written word than their male counterparts and therefore more able to describe any nuances in sensory perception. A final rationale for choosing the female gender was based on market research which identified that more females than males purchase clothing for family members other than themselves, which is predicated on an assumption that they have a better understanding of preferences. However, these are merely assumptions.

A further consideration for the choice of participants involved the preferred age of the female participants. The literature shows that gender has a significant influence in some areas of fabric testing for comfort, whereas age does not (Lan et al 2008). However in relation to this particular study, where the thermal regulatory functioning of the body was explored and then tested through the wear trials, as a determinant of comfort, both the gender and age of the participants were contributing factors. The hormonal disruptions experienced by women at a particular stage of their lives, can be the cause of sometimes extreme temperature fluctuations. No clothing is perceived as comfortable on these occasions as any fibre worn on the body will create an unwelcome barrier and prevent the natural passage of heat and therefore vapour. The trials were conducted in air conditioned environments because they best represented a laboratory setting, but allowances could not be made for volunteers whose age prevented them experiencing regular temperature levels throughout any given day of the wear trials. These participants had to be excluded on the grounds that they could not be relied upon to give accurate indications of comfort in relation to the trial garments hence mature female subjects under the age of thirty five were preferred.

Body size was a criterion for choosing suitable participants, as the garments were all produced as a standard size 12 and any ill-fitting garment could skew the findings to reflect comfort in relation to garment fit rather than the focus on fibre compositions. The human body comes in all shapes and sizes (Dreyfuss 2002) and this was considered prior to the personal interviews, where the participants were discretely assessed for size suitability. Despite this caution the choice of trial garment fabrications needed to afford enough stretch to fit the range of body sizes within the chosen group.
In respect to the health status criteria it was assumed that any female participant with serious health conditions would not be engaged in work that involved an eight hour working day, which was the trial period for each T-shirt. For similar reasons to those discussed regarding the age criteria, pregnant candidates were eliminated due to possible similar fluctuating body temperatures which could impede the findings. Participants presenting with a known history of skin conditions either childhood or adult onset were also eliminated as some individuals are more susceptible to skin sensitivities than others. Often these eruptions occur through wearing particular fabrics that have been treated with chemicals and despite all measures taken to eliminate this possibility it was impossible to guarantee that the trial garments did not contain residual amounts of chemicals that would skew the fibre findings.

The occupation of the participants was necessarily limited to those who worked eight hour days in air conditioned environments so employees in administrative roles that felt comfortable wearing a T-shirt in the workplace were the ideal recruits providing that they fulfilled the criteria and had the confidence to assess their body’s responses to wearing particular fibre compositions.

4.2.3 Establishing a volunteer data base

A system for the collection of the trial participants personal details needed to be established to facilitate the recording of confidential information in accordance with the ethics protocol. For this purpose collaboration was sought with experienced administration staff on a method for capturing this important information. A data base of potential participants was suggested for the purpose of recording names and contact details; an ongoing message board was established to record appointment times and to track volunteer availability; and a file was kept of volunteer email correspondence and telephone conversations.

Once all the paper work had been satisfactorily established, the remaining resources were researched and gathered. These included an advertising campaign, a questionnaire, a trial garment, and a branded presentation pack for housing the material, posters and banners. Details of the various components of the research instrument follows.

4.3 Questionnaire model

4.3.1 Introduction

The ‘intimate habitat’ research employed a questionnaire to gauge individual responses to the experience of wearing particular textile fibres against the skin during an eight hour sedentary day working in an air conditioned environment. The questionnaire model that was employed was similar to those used in the collection of immunological data from wear trials investigating skin integrity for research into eczema.

Once the campaign had commenced for the call for participants and the posters rolled out (see Appendix 6) attention was turned to the trials themselves and the formatting of the questionnaire was the first of two tools to be finalised. The purpose of employing a questionnaire tool was to facilitate the gauging of responses to
the subjective experience of wearing four trial garments made from different fibres thereby testing the research hypothesis that fibres have a capacity to contribute to overall well-being by creating either negative or positive perceptions. Although the questionnaire document was used for three separate data collections: a pilot study, a base study and an actual trial study, the questions remained the same.

4.3.2 Composing the questions

This research trial was not interested in skin responses to the wearing of particular fibre compositions, as readings undertaken for this thesis confirmed this had already been done many times and in different circumstances by several research bodies concerned with skin integrity. The ‘intimate habitat’ did not purport to reflect the scientific studies, however reflecting upon them was useful for the purpose of understanding the wear trial process. A set of questions was composed, mindful of the work of the philosopher Sully (1898) who recognized the fact that the idea that subjective ‘well-being’ that was intrinsically bound up with a person’s feelings had to be the focus of a large body of work, before it came to be regarded with anything other than scepticism in scientific circles. The research questions were posed in the light of Sully’s experience and the study, despite its limited size, did provide some information relative to the human subjective response to the wearing of fibres.

Participants were asked to respond to 41 questions (see Appendix 8). The first section of the questionnaire contained preliminary questions which aimed to establish ambient conditions within the test environment. Eight questions in all were asked in this section beginning with one to establish if the workplace in which the trials were being conducted had a controlled environment and if so what the temperature range was within that environment. The sedentary status of the work was established next followed by questions asking about the expendable energy of each participant on the morning of the trial resulting from a long walk or cycling to work. Other questions aimed at providing background information in the event of any highly unexpected responses included the following: the fibre compositions of both the undergarments being worn under the test garment and the office floor surfaces; whether the work day was spent in artificial light; whether the participant usually wore fitted clothing to work; and finally if they ever wore T-shirts.

The second section asked carefully worded questions to assess participant awareness of the garments being worn. These questions assessed responses to the mechanical, thermal or sensory properties of fibres that would be useful in the research context. The questions were deliberately randomized as any groupings into those with similar properties may have elicited responses reflecting pre-existing attitudes from the participants which would have defeated the purpose of the trials.

4.3.3 Organizing a method for collecting the findings

On completion of the wear trials, the questionnaire data was entered onto an excel file by two independent operators who had no vested interests in the research. This process was crucial to the integrity of this study
as it involved entering the quantitative data essential for research (see Appendix 9). A statistics programme was used to generate the data (see Appendix 10). The data was collected in three stages (see Appendix 11) which was then analysed and formed the basis of the discussions in Chapter Five. As mentioned earlier, the wear trials required the administration of a number of documents which needed to be stored according to the protocol set down by the ethics committee.

4.4 Collaborative design studio

4.4.1 Introduction
At this juncture of designing the research, collaboration was sought with a graphic design studio to help raise interest and professionally brand the wear trials. It became apparent that they would be best equipped to design the necessary components and oversee the document generation. The various components required for the package included a poster calling for volunteers (see Appendix 6) a questionnaire leaflet (see Appendix 8) a banner (see Figure 11) and a presentation box (see Figure 12).

4.4.2 Design consultancy
A consultancy was sought to undertake an advertising campaign for the purpose of recruiting volunteers. An earlier call for people interested in taking part in a fashion project had been partly successful but the pool of volunteers needed to be expanded to allow for some rejections on the grounds of unsuitability. It was realized that a professional studio would be better equipped to prepare the material. For this purpose email correspondence was undertaken involving two possible design studios and a connection was established. Following a consultation it was decided to proceed with the ‘Meanwhile’ visual communication studio. Through a consultative process, it became apparent that various other elements would be required to facilitate the research trials and the brief was soon expanded to include the advertising poster; the questionnaire; the banner and the garment pack.

The various collaborators met to discuss the proposed advertising campaign, examine the material to be branded and were briefed about the nature of the trials. After some discussion to clarify and refine the details, they then undertook to complete a proposal by the commencement of the following university semester. Another consultation took place to discuss the team’s concept, amendments were undertaken and the project was taken through to the final stage. The resulting computer generated documents were finalized, disseminated and, with final payment, the ‘intimate habitat’ research was branded and the project was signed off. The following discusses elements of the various components of the design package created for the ‘intimate habitat’ brand.
4.4.3. The recruitment process

The research necessitated raising awareness of a wear trial in which a number of recruits were required to take part and a system had to be devised for this next step in the development of a research wear trial. A sufficient pool from which to choose the suitable candidates for two different sized trials, each with different agendas had to be generated.

A three pronged method was employed to call for volunteers across the central business district of Melbourne, but particularly in the university precinct, for both its convenience and high anticipated likelihood of success. The first and the least effective method involved cold canvassing all the administrative areas within several schools of the university. Permission to attach posters had to be attained through various authorities and this had been granted for the earlier attempt, so the new posters produced in collaboration with the visual communication design studio could be immediately placed at strategic points around the university campus, with a view to capturing interest. The last method required placing an advertisement in the RMIT newsletter, on two separate occasions with a three week interval. This method proved to be the most productive and not only confirmed the office bound nature of the volunteers but also required the least amount of effort.

Auditions were undertaken to select suitable participants and individual appointments for consultation were made and duly conducted. Each of the volunteers who had expressed an interest in the practical nature of the research was carefully assessed for suitability. The purpose of personal consultations was to instil confidence and encourage transparency in what otherwise may have been an unfamiliar process. The wear protocol was explained in detail and each volunteer was briefed on the purpose of the different sized questionnaires.

It was mandatory that a set of base data be captured for a wear trial. For this purpose, a copy of the same questionnaire in a smaller format was provided for each wear trial and the purpose of this extra document
was explained to each participant in the wear trial. This separate questionnaire needed to be filled out by the volunteers prior to the wearing day for the actual T-shirt trial. This questionnaire related to the garment the participant chose to wear on the days between the research trials. The purpose of this questionnaire was to collect typical individual responses to the wearing of a preferred textile fibre composition.

During the consultations, questions were encouraged and were forthcoming as clarification was sought that helped refine the process for the future trials. Through the course of these private consultations it became apparent that a number of people were interested in partaking in the trials because of a particular interest in wellbeing. Three of the volunteers worked in a building environment that had recently undergone investigation as the result of an unacceptable number of its employees being diagnosed with breast cancer. The building was shut down and the employees were re-located during the alert so their involvement came about through a heightened awareness of their personal vulnerability.

From the available pool, three participants were required that would be available during the university summer break as this time was considered to be most convenient with fewer distractions anticipated. Subject to suitability these volunteers would take part in a pilot trial, the purpose of which was to expose any unforeseen problems resulting from the trial procedures. These would become apparent through the process and allow for any adjustments to be made prior to commencing the larger trial. The larger trial group consisted of twelve volunteers primarily selected in respect of their immediate availability to partake in the trials.

These consultations provided valuable feedback for the ‘actual’ trials. As it was preferred that all three pilot trials would be run simultaneously for economy of time, availability was assessed and suitable dates arranged. Participants were required to be available for approximately half an hour to receive the T-shirts and accompanying questionnaires both in advance of the trials and after the workday specified. It was explained that the questionnaire would require approximately half an hour of their time to complete. Plain language statements were issued, witnessed and signed individually and the documents filed for safe keeping in readiness for the commencement of the trials.

Several ideas were presented by the design studio as possible options in the call for volunteers including an ‘online’ search. Although this would have been an efficient method, it represented a change in research method that would have necessitated ethics approval for which there was no available time. It was decided to use printed posters to advertise the project and call for volunteers and a suitable image was created in anticipation that it would be used for all other elements of the research package. Posters were produced in collaboration with the RMIT Visual Communications Department and spread across several key congregating areas, once permission had been granted by the appropriate authorities. A second round of advertising in the RMIT newsletter proved to be the most productive method for the purpose which was to capture as many volunteers as possible in order to make the selection process easier.
4.4.4 Preparation and collation of necessary documents

Individual appointments were made with the fifteen recruits of average body size that confessed to being of good health and non-smokers. During the assessment interviews, the volunteers had to be ‘signed up’ according to procedure. This necessitated the administration and reading of mandatory paperwork consisting of two documents stating conditions that had to be agreed upon. The first was the plain language statement that simply introduced the researcher; explained the research and the role of the wear trials; introduced the supervisor’s; provided all contact details and thanked the volunteers for considering their participation in the trials (see Appendix 4). The second document was the prescribed consent form that needed to be signed and witnessed by participators (see appendix 5). The signed and witnessed documents were filed for safe keeping in accordance with ethics approval protocol. The wear protocol was explained in detail, to be later reinforced closer to the date of the trial launch.

4.4.5 Meeting and thanking volunteers

Appointments for the purpose of personalizing interviews to initiate a rapport with the interested parties were arranged and conducted during which time the administration of paper work was undertaken, the health status of each participant was ascertained and smokers were eliminated. Any volunteers presenting with health issues such as chronic breathing difficulties or visible skin conditions apparent at the time of the interview were also not eligible to take part. The mandatory paperwork was explained in detail at the time of the interview and the time commitment was outlined. The participants in the trials had to be available to collect the T-shirts and accompanying questionnaires in advance of the trials and deliver the completed packs for storage after the wear days specified on the accompanying timetable. The questionnaire would take an estimated half hour to complete.

A further set of documents needed to be prepared including a volunteer data base; a wear procedure timetable with an accompanying set of instructions (see Appendix 7) and an excel data file for capturing responses (see Appendices 9 and 10). A series of time-tables were plotted for the wear and non-wear days that staggered their timing in order to facilitate ease of collection and exchange.
5.0 The wear trial garment production process

5.1 Introduction
The process began by defining the fabrics that would be suitable for testing the wear trial participant perceptions of a fibre wearing experience.

5.2 Exploring the fibres and fabrics suitable for a wear trial
The personal experiences of wearing the generic fabrics available to the fashion consumer, allowed the researcher to make a choice of which ones would be most suitable for the purpose of capturing any differences in performance. As already addressed in chapter 1.0 for the purpose of this research project, it was decided to choose one fibre composition from each of the three chemical groups as well as one manufactured fibre. There was no particular market area that helped justify the four final fibres chosen. It is worth mentioning at this juncture that since the research wear trials were focussed upon the differences in physiological and psychological comfort of wearing fibres, a wholesaler who specialized in supplying to the sportswear industry was sought. This was justified for the purpose of procuring the four fabrics used, since the researcher acknowledges that good sportswear design depends upon providing maximum comfort for the athlete, in order to achieve the best performance. This is especially apparent at any professional level of play such as is demonstrated in the Olympics. The fabrics developed for sports, are developed in consideration of human physiology and the fashion industry is often the benefactor. The decision to use this one wholesaler, in hindsight may have been erroneous as it did limit the choice of available polyester.

The basic unit of fabric is fibre, and as stated at the outset, the different chemical compositions of fibres produce different properties that determine their suitability for particular end uses. Some of the differences in properties contribute in a positive way, some in a not so positive way to discomfort. For example, a standard synthetic fibre composition such as polyester is inherently hydrophobic, that is, it does not absorb water, and so would not be a good choice for a garment that is expected to readily absorb vapour from the body. In such a case, evidence is manifested in physical symptoms which enhance or eventually impede the body's natural functions.

The protein fibre composition chosen was wool as significant research was readily available which had been undertaken and is ongoing into wool fibre through the CSIRO. Cotton was chosen as the most common cellulose fibre. Viscose rayon was chosen as the most common regenerated cellulose fashion fibre and polyester as the most popular synthetic fashion fibre.

The four fibre compositions would give enough information from which some data could be extrapolated for this trial that is essentially testing the differences in wearer responses, both psychologically and physiologically to the different chemical compositions. The information provided by this research into the effect of fibres on the human body will help to contribute to the designer responsible for making decisions at the design stage.
5.2.1 The yarn structures

The yarn structures of a fabric will impact upon its ‘hand’ or the way it feels against the skin. In consideration of this, two of the fibre compositions have filament yarn structures, namely polyester and viscose, and two have spun staple yarn structures, namely cotton and wool. The viscose filament has been chopped into staples before being spun into a yarn to improve its ‘hand’ and make its performance more in keeping with the natural fibres.

5.2.2 The fabric constructions

There are many fabric constructions used in the production of fashion garments but they essentially fall into two groups, the weaves and the knits, both of which are chosen dependent upon their very different properties and according to their end uses. The weaves are capable of some degree of ‘give’ dependent upon the dimensional stability of the individual fibre compositions and the type of weave; however they do not allow the full range of body movement. As stated earlier, when considering the body size of the wear trial volunteers it was decided that the wear trial garment should be produced in order to fit a number of different body shapes and for this purpose the fabrication should have a sufficient degree of stretch.

5.2.3 Colouration

A final decision had to be made regarding the colour choice for the trial garments. The research was undertaken in a Melbourne university setting, hence the choice was straightforward. Black was chosen without reservation since it is an accepted colour choice in the city both within academic and student environments and worn across all seasons. The research trials were conducted in summer due to the limitations of available time during the academic year, however the climate within the university where the trials took place, is different to the prevailing outdoor climate throughout the year. Black may have been perceived as a ‘hot’ colour so any effects of the colour on wellbeing would be a purely one of individual perception. As explained in an earlier chapter (Chapter 2.6) people have different perceptions of colour depending upon their personal experiences or stored modifiers.

The T shirt like any other ‘product’ has properties that are inherent to it such as shape, size, proportion, and colour and studies have been undertaken in some of these (Fiore et al 1997). A study undertaken into the effects of different classes of dyestuffs on human physiology states in the rare cases where skin disorders do occur from the wearing of textiles the colorants used are the chief sensitizers (Estlander 1999). However, none of these other properties of the T shirt garment used in the trials are the subject of discussion in this research which focuses on subjective effects of fibre compositions on the human body.
5.3 Garment design and production of a trial garment

5.3.1 Design of a suitable garment

It was decided early in the research that in order to test any physiological discomfort, for example prickle or itch, the fibre compositions needed to be worn close to sensitive areas of the body, such as the inner elbow and under side of the arm. Research studies at the CSIRO twenty years ago into wool comfort confirmed that long sleeves which exposed the inner elbow and underside of the arm would be mandatory for this study (CSIRO report no.G64 1988). The preferred style was chosen because it conformed to the research criteria and the fact that it was a long sleeved crew neck T-shirt style was coincidental. The type of person that would choose to wear wool jersey may not be the same type of person that would wear polyester but that conjecture goes beyond the limits of this research.

A professional pattern maker was employed to draft and produce a prototype garment. In addition to the long sleeves, a crew neck style was chosen as it would cover more of the body than a ‘V’ or scoop neckline. The size of the T-shirt pattern did not pose a problem as the garment was loose fitting; it was made from a knit construction therefore it was able to stretch, and the size of the pattern used was a casual fit, size twelve.

5.3.2 Purchase of suitable wholesale fabrics

The production of the wear trial garments necessitated the purchase of enough jersey weft knit fabric in four different fibre compositions to produce sixty T-shirts. A local fabric wholesaler was found that could supply the comparatively small quantities of fabric and three of the four fabrics sourced presented no problems. However the supplier was unable to provide a polyester fibre composition in a plain jersey construction because there was no demand for such a cloth for sportswear use due to its reputation in the textile industry as a poor comfort performer. It was encouraging that the poor properties of a fibre composition had been recognized, but the fabric was designed for sportswear where fabric selection affects athletic performance. It was not designed for fashion use. The substitute fabric was purchased as its difference (a tuck stitch creating a small space) was considered to be so minor it would be of small consequence for the purpose of the trial. Any outcomes that were unexpected could be attributed to the different fabric construction detail which was claimed to prevent the build-up of perspiration. The findings in chapter 6.5 defy this presumption. The visual differences are evident between the four different T-shirt fibre compositions as seen in Figure 12.
5.4 T-shirt manufacturing process

5.4.1 Pattern maker, cutter and machinist
Once the T-shirt design that would satisfy the requirements for the wear trial had been decided upon, the business of producing a suitable pattern could take place. A toile was produced using a generic knit fabric in a polyester fibre composition. This was trialled for size and shape because the garment needed to fit a number of different body types. It also needed to be of a generous ‘cut’ for the same reasons and an average size twelve ladies block was decided upon which would accommodate some minor variations. Some of the volunteers who had longer than average body or arm lengths, felt that the T-shirt lengths were not entirely to their liking. This could have prejudiced them in determining discomfort had they not had the objectives of the wear trial re-enforced prior to the outset of the commencement of the trials.

The T-shirts were produced on the premises of a small, local garment manufacturing factory. The production process required the services of professionals to trace, cut and sew and tag the sixty T-shirts in four batches according to their different chemical compositions. An ethical practice was sought for manufacturing a small ‘run’. In a city where the bulk of clothing manufacturing has been sent ‘offshore’ this became a difficulty that was eventually overcome but time had been lost in the search. It would have compromised the integrity of the study, which is primarily concerned with wellbeing, if the garments had to be produced in poor conditions by people working long hours on little remuneration.
5.4.2 T-shirt tagging

The T-shirt trials had to be randomised and this necessitated tagging the garments in a suitable way. Consultation with the machinist ensued and it was decided that a soft cotton tape and indelible ink was the preferred medium. The kind of tape and its placement was important in the context of this research where comfort is being assessed as the majority of tags, labels, instructions for care and so forth, used in clothing are made from materials that cause skin irritation on wearing. The trials would have been compromised had these same materials been used in the trial T-shirts. The tape was sewn into the side seam close to the hem line where it was agreed it would be unobtrusive and least likely to cause any discomfort to the wearer.

Each of the fibre compositions, cotton, wool, polyester and viscose were designated a number and labelled T1 to T4 respectively. No care labels that state fibre compositions were included as the volunteers were involved in 'blind' trials meaning they could not know the fibre compositions.

5.4.3 Garment pre-washing

An excursion to a textile testing authority confirmed the need to pre-wash the T-shirts in order to remove residual finishing chemicals and dyestuffs. This was particularly important given the nature of this research into fibre performance, where any surface irritation may have been misinterpreted as the fault of the fibre composition. The prescribed three washes were carried out and an extra two were done. The garments were hung to dry then stored in an air conditioned environment in readiness for packaging into the boxes. All research material was stored according to ethics protocol.

5.5 Trial pack production

The wear trials required a number of elements to be housed and a suitable method had to be designed for this purpose. The collaboration with a design consultancy had been employed earlier for this purpose. Various documents had been printed in readiness for the wear trial campaign which included a clear set of instructions setting out the wear protocol, the questionnaires in two different formats and a timetable to establish the wear days.

A suitable pack for housing the separate components of the trial was researched and purchased. The design studio suggested flat opaque boxes which were surrounded by the research banner. Various symbols were devised for labelling the boxes according to the volunteer’s number (no names were used to ensure confidentiality), the day of wear and the coded randomized scheme used for determining the order. The boxes were assembled and surrounded by the campaign banner in readiness for the trial commencement (See figure 13).
The first step in assembling the trial packs was establishing an order of wear for the T-shirts. They had to be randomized to conform to the blind trial method being used. A scheme for establishing the order was undertaken in accordance with the Chinese medicine formula provided by Associate Professor Chun Guang Li. Codes were established for labelling the research packs to avoid confusion for example, where the letter ‘T’ denotes T-shirt, the order for wearing had been established for volunteer number one as T2, T4, T3, T1. Number two volunteer was T3, T1, T4, T2 and number 3 was, T1, T2, T4, and T3.
5.6 The T-shirt wear-trials

5.6.1 Introduction
The research entailed wear trials which were held in three stages altogether. When all of the rehearsal trials were completed and amendments had been to both the questionnaire and the collection of packs procedure, the actual trials involving twelve volunteers commenced.

5.6.2 The T-shirt trial rehearsals
The research tool needed to be trialled for any potential flaws and this was undertaken in two parts. The first part was a single trial run by the researcher to not only test run the garment design and size and the questionnaire but also to get a sense of the process. Some improvements were made at this juncture in preparation for the next stage which involved initiating a pilot study. Three participants from the existing data base were selected who would be available during the university summer break. The pilot volunteers would undergo the same procedures: test the same number of “T-shirts over the same number of days and completing the same questionnaire as the ‘actual’ trial volunteers. Any oversights would be exposed and rectified prior to the commencement of the ‘actual’ trial. The following details the pilot trial process.

5.6.3 Allocation of trial ‘packs’
The first of the T-shirt packs (see Figure 14) were presented personally and each participant was given both verbal and written instructions regarding the wear protocol at the time of presentation to eliminate any chance of misunderstanding before commencing the trials. Each of four T-shirt packs containing one T-shirt; a timetable with instructions for wearing protocol; a small format base study questionnaire and a large format post wear questionnaire were received with clear verbal and written instructions regarding the wearing procedure (see Figure 14). The individual time spent with this formality, presented the opportunity for any questions to be asked in anticipation of the trials proceeding with confidence.

Figure 15. Four T-shirt packs each contained T-shirt; timetable, instructions and wear protocol.
5.6.4 The trial protocol briefing

It was explained that the T-shirts were to be worn over a period of ten days and there had to be two days of rest between each of the four wear days during which time the pre-wear questionnaire had to be completed which provided the mandatory base line data.

Clear written instructions were provided for the eight hour wearing days and these accompanied the wear time table. Included were instructions that the T-shirt was to be ‘donned’ or put on half an hour after arriving at work to allow for body calming to take place. Volunteers were instructed to stay in the same air conditioned environments and to try not to remove the T-shirt for the entire eight hour day so that comparisons in performance could be accurately measured. It was preferred that underwear was kept to a minimum so that there could be less doubt that it was the T-shirt responsible for comfort perception and not the underwear. For the same reason, volunteers were invited to wear only their most comfortable underwear. Any meals and drinks, of necessity, had to be consumed within the limits stipulated in the wear protocol (see appendices).

5.6.5 The Trial procedure

The T-shirts were wear trialled simultaneously, for economies of time, over a period of ten days after which the volunteers were asked to record their experiences using a questionnaire that had been especially designed to capture both physical and psychological responses in the context of comfort perception.

The trial ran over an extraordinarily hot summer and heat exhaustion was experienced by one of the three volunteers due to poor air conditioning in their city accommodation resulting in postponement of one wear day. Some volunteers were unable to conform to the timetable regime due to unscheduled meetings so not all T-shirts were worn on the same day and no illnesses were reported as a result of wearing the T-shirts. All pilot trial participants were based within close proximity to the research site and consequently all the trials ran smoothly. There were no problems with data collection and volunteers were able to comply with the protocol.

5.6.6 Completed packs returned for data collection and storage

The completed T-shirt packs were returned after ten days and the volunteers were discharged with thanks and the assurance that they could collect and keep the T-shirt of their choice on completion of the research. On conclusion of the trials, as expected, it became apparent that some refinements would be necessary both with the wear trial process and the questionnaire. The following discusses some shortcomings of the pilot trials and the improvements that could be made prior to the ‘actual’ trial launch.
5.7 Assessment of procedure and amendments

In the early days of the pilot trial it became apparent that a lot of movement between the volunteer’s offices and the research centre could be eliminated simply by giving a boxed set of T-shirt packs to the volunteers as opposed to allotting them one at a time. Mindful that the research was being carried out in less than perfect conditions, (in an office as opposed to a laboratory) and in the interests of the volunteer cohort and the extraordinary weather conditions, the collection of packs was reviewed and the remaining three packs were given out at the same time.

5.7.1 Time management
The first improvement regarded time management. An approach was taken for the purpose of briefing the pilot volunteers that may have appeared cumbersome at the time. Individual meetings clearly personalized what may have otherwise been a purely clinical exercise and the participants were more relaxed which created an ideal environment in which to ask any questions. The time spent in personal contact with each participant enhanced the volunteer experience and helped to make the completion of questionnaires and other associated paper work less onerous.

5.7.2 Wear protocol
The trials were carried out over a ten day period which allowed for two days of rest between each wear in which time the volunteers were required to complete a duplicate questionnaire relating to the chosen tops they wore to work on that day. It became apparent that there was some room for clarifying the briefing process when one of the volunteers became unwell. Through telephone conversation the necessity for the minimum of two days of rest was explained. The two days mandatory rest between wears could be extended to accommodate any number of days as long as there were more than two. Less than two days would not give enough time between the wears to achieve a neutral state. This personal contact soon reassured and allayed the volunteer abandoning participation in the trial altogether.

5.7.3 Questionnaire data
The third improvement was in relation to the questionnaire. A flaw was exposed early in the pilot trials and this became the subject for review in the hope of making an improvement prior to the ‘actual’ trial commencing. Explanation of this and other observations follow.

First and most importantly, concerns the collection of base line data. In communicating this requirement of the trials it became evident that the volunteers were mostly confused by its relevance which indicated an ineffective briefing process. As mentioned earlier the rest days between the wear trials presented the volunteers the opportunity to respond to a duplicate questionnaire relating to the garment they wore to work on either of the two available days. This information provided the base line data against which the trial T-shirts could be examined. A shortcoming of this process lay in the questions being asked, which referred to a T-shirt which may not have been the garment being worn on the days of the base study testing. The questions were identical to the research T-shirt questions so did not specify which garment was being assessed. This confusion would be avoided in future trials. The second improvement concerns the lay-out of
the questionnaire. A number of the respondents suggested a designated section could have been included on the questionnaire for capturing their personal experiences of the wear associated with peripheral responses as they felt that the depth and breadth of their experience was not fully exploited by the trial questions. It is acknowledged that a larger space would have allowed for the inclusion of peripheral responses that could have been a source of useful data for this study. However the objectives were satisfied without their inclusion.

5.8 Commencement of actual T-shirt trial and conclusion

On completion of the pilot trial analysis, including discussions with the participators, the suggested improvements were made. Primarily, the pilot trial had shortcomings in its instigation, in that unnecessary time was spent with the volunteers explaining the procedures. The wear protocol was explained verbally to each volunteer and time was given listening to their understanding of what was required of them before they proceeded. The research trials commenced shortly after the pilot and ran smoothly as a result of the modifications.
6.0 Analysis of the results

6.1 Introduction

This chapter analyses the volunteer response to each of the four wear trial fibres for the purpose of establishing an outcome. The first twelve questions are the preliminary questions in the scientific model adopted to generate the comfort questionnaire. From the remaining questions a number had been selectively chosen as they best reflected the objectives of the research thesis. Many of the questions were necessary for preparing the volunteers for answering the remaining questions to the best of their ability although they may not have been directly used to inform the actual results.

Three groups were designated for capturing the results of the wear trial experience. They were determined according to the fibres sensorial, mechanical and thermal properties. Within these three groups, some of the questions directly targeted physiological comfort and others targeted psychological comfort. The questions for physiological comfort were addressed mainly in the thermal and mechanical groups and the psychological comfort was addressed predominantly in the sensorial group.

Chapter one of the thesis, provided the morphological and molecular structures of the trial fibres against which the following analysis of results are set. Chapters two and three provided background about comfort and wellbeing, to help to synthesize this analysis in a broader context. The discussions were informed by a data analysis process that examined the results collated by a computer generated programme. Various steps were taken in the collation of the data before any analysis of the findings could begin. The documents that were generated through this exercise are held in the appendices. This discussion begins with an analysis of the volunteers thermal comfort responses to the questionnaire.

6.2 The role of thermal comfort in clothing the body

Essentially the thermal environment provided by fabric creates a microclimate around the body that effectively stores any excess heat produced by the body as a result of the normal physiological fluctuations that occur during any eight hour period. This heat can then be used by the body when the temperature drops which allows the body to maintain a comfortable state.

Temperature modulation

The first question in this group asked if the volunteers considered the t-shirt prevented their body’s natural ability to modulate temperature. Data collected from the trials indicated that out of the four fibres trialled in this research, polyester was least able to modulate temperature, meaning that the thermal environment provided by the T-shirt did not adequately accommodate temperature fluctuations. The viscose T-shirt was the most effective fibre composition in relation to this property.

It is at this point that three of the four fibres trialled in this action research will be discussed as they showed significant differences in volunteer responses in relation to the temperature modulation question. The
differences warranting attention occurred between two sets of fibres; polyester and viscose and cotton and viscose, indicating that wool was adequate.

It was explained in the chapter that documented the trial design that it was not possible at the time of sourcing the fabrics to source a one hundred percent polyester composition in the same jersey weft knit a the other T-shirts and a compromise had to be made. The marked difference between polyester and viscose would be attributed less as a result of the differences in their chemical composition, as in the differences in their fabric construction, which was the result of the compromise. The polyester had been designed to improve vapour transmission in response to customer dis-satisfaction with the plain jersey structure and the resulting fabric had a noticeably different fabric aesthetic. The wear trial findings revealed that this fabric construction did not satisfy temperature modulation expectations

This is not the case however with cotton and viscose fibres where the knit structures were identical. In this case, the marked differences between these two fibres are attributed directly to the different fibre morphological and molecular structures. The morphology of the cotton fibre is convoluted so the fibre has the ability to trap body heat. It also undergoes more spinning to create yarn and this pre-disposes its ability to trap body heat and provide a micro-climate. Viscose is smooth and the structure requires less twisting to create a yarn, which means that the transfer of heat from the body should be more efficient.

**Coolness**

The second and third question asked if the T-shirt made the volunteer’s body feel cool or warm to which there were no marked differences. The result indicated that the air conditioned environments of the administration offices were efficient and therefore the volunteer’s body temperatures were maintained. In physiological terms an unclothed body is thermally comfortable in twenty eight degrees. It was presumed that a twenty one degree temperature was maintained at a consistent level throughout the eight hour working day of the trials thereby ensuring that a comfortable state was achieved that required no ‘donning’ and ‘doffing’.

It is worth noting that polyester was considered to be cooler than cotton by the majority of volunteers which would once again largely be attributed to the nature of the knit constructions although yarn structures and fabric density would have played a part to some degree. The cotton T shirt was more dense and therefore a heavier weight than the polyester T shirt thereby creating a more efficient barrier to the passage of air. The polyester fabric whilst specifically engineered to overcome its hydrophobic nature, also improved air permeability.

It is sufficient to state that discussions comparing responses in regards to either the cool or warm properties are not warranted due to the lack of marked differences.

**Warming up**

Of interest however is the ranking in order of temperature perception where the fibre that warmed up the most was wool, followed by cotton then polyester and lastly viscose which was perceived as the least
efficient in this property performance, with the majority of volunteers agreeing that viscose demonstrated least ability to warm up, maintaining its base body temperature. In the light of wooll's chemical composition, morphology and resulting properties being the fibre most likely to warm up during the trial although fastest to warm up on contact with the body was predictable however it did not appear to be sufficiently different in this property performance, compared to the other fibres to warrant further discussion

Clammy or sweaty
Of more interest to this research were the responses to sensations of 'clamminess' or 'sweatiness' where there were marked differences between wool and polyester and polyester and viscose. The data findings warrant discussion if for no other reason than because polyester is a major fashion fibre, desired by fashion designers and their customer's for its easy care and thermoplastic properties. Manufactured by chemical companies that produce many fashion fibres which are collectively known as synthetics, polyester is a readily available easy care fibre with thermoplastic properties, therefore highly sought after by fashion designers for their novelty effects. The chemical companies that manufacture polyester continue to research new ways to ameliorate customer dissatisfaction in regards to its hydrophobic properties, which prevent it from absorbing vapour from the body.

Polyester was the only hydrophobic fibre in the wear trial and despite being a knit construction specifically engineered to improve vapour transmission it still proved to be the clammiest of the four fibres trialled and markedly so compared to wool and viscose. Unabsorbed vapour creates a 'clammy' sensation so naturally the most hydrophilic fibres, viscose and wool, are the most efficient at removing this vapour from the skin's surface before it builds up between the skin and the fabric and turns to the discomfort of sweat. Cotton, whilst efficient at absorbing moisture from the skin, is unable to give up this moisture readily which results in a chill factor for the wearer whilst viscose dries faster due to its morphology. Contrastingly, wool, despite taking longer to dry than all other fibres, even cotton, has a 'heat of wetting' property that keeps the wearer warm even when the fibre is wet from exertion.

Initial coldness
The final question relating to the thermal properties of fibres as perceived by the trial participants asked 'did the T shirt feel cold when it first made contact with their body. Polyester was rated as the fibre with the coldest 'hand' and cotton was regarded as having the least cold sensation on first contact with the body. There were marked differences (borne out by the data) experienced between these two fibres as will be discussed further in the analysis of the findings. It is suggested that the results were due to the perceived differences in their textural qualities.

The second group contributing to the physiological comfort provided by fibres related to their mechanical properties.
6.3. The role of mechanical comfort

The questions in the questionnaire that correspond to this property were weight and cling. There were many differences in volunteer responses to these properties necessitating further exploration.

Weight.
The weight of textile fibres varies depending upon their chemical composition, with the cellulosic fibres weighing the most and the synthetic fibres weighing the least. However differences in yarn structures and the fabric ‘count’ or number of yarns to the centimetre also make their contribution to the finished overall weight of the fabric.

In response to the question regarding weight viscose was rated as heavier than would normally be worn to work, followed by wool, polyester and then cotton. Perceptions in weight differences were marked across all four fibres. It would appear that volunteer perceptions were determined by the fibre’s tactile and visual properties rather than by their actual experience of ‘weightiness’ so any ‘in-depth’ discussion may be counterproductive. One of the many marked biggest differences was between wool and viscose which both had a similar ‘light in the hand’ aesthetic. This may have been the result of the perceived textural differences between the two T-shirts as a result of their different morphologies. As stated in chapter one, wool is a fuzzy fibre and viscose is smooth. This difference may have been interpreted in terms of weight depending upon how each volunteer perceived them.

In the case of viscose being rated a heavier garment than would normally be worn to work where cotton was perceived as lighter, the marked incongruences are explored further in the results findings.
It appears on analysis of the results, that weight may not be different enough across the four fibres to impact the findings of the trials.

Cling
‘Cling’ as explained to the participants in the questionnaire, is a mechanical property that describes the grip that occurs between a given fabric and the skin’s surface which hampers movement. Fabric ‘cling’ is experienced when a fabric ‘grips’ the skin’s surface and prevents the free movement of the body between the skin surface and the fabric causing discomfort and limiting movement. A fabric will cling to the body or not depending upon its chemical composition and yarn structure. The smoother fibres, generally the filament structures, have a greater capacity to cling as they can make complete contact with the skin surface, unlike the textured fibres that make random contact. Fabric cling is also exacerbated by hydrophobic fibres which accumulate a static charge that cause the fabric to grip to the skin.

There were marked differences in volunteer perceptions between three of the four trial fibres for this fabric performance property. Warranting discussion were differences between wool and polyester; polyester and viscose and wool and viscose, with cotton recording no marked difference when compared with all other fibres. Wool has a morphological structure that pre disposes it to sitting away from the skin’s surface whereas polyester is a smooth filament fibre that makes complete contact. Polyester is a synthetic
composition with hydrophobic properties pre-empting static build up, so will have superior clinging properties compared to viscose which explains the marked difference.

6.2.3 The role of sensorial comfort

Sensorial comfort, as explained in the chapter dedicated to exploring comfort, this property, encompasses both texture and perception. Four questions related to fibre texture and they were namely, smoothness; prickle; itch and slippery. The morphological structures of the fibres accounted for half the differences in responses.

Smoothness
The first of the questions examining volunteer responses to the sensorial properties asked ‘does the T-shirt feel smooth against the skin?’ Viscose was the smoothest fibre as perceived by the majority of participants and wool was the least smooth. The marked, or biggest differences in responses as indicated by the collected data, were between: polyester and viscose; wool and viscose and cotton and viscose. There were no differences between cotton and wool; wool and polyester and cotton and polyester.

Unexpectedly, cotton was perceived as the next smoothest ahead of polyester despite its convoluted fibre morphology. The T-shirt made from the polyester fibre had a slightly different construction to the other T-shirts and this would possibly account for its being perceived as less smooth than cotton as would normally be the case with a fibre with a convoluted morphology preventing it from making as complete a contact with the body.

In the context of smoothness, readings indicate that polyester and viscose are not dissimilar despite their different chemical compositions, as they are both smooth fibres, viscose having a softer hand. As was discovered when analyzing the data it appeared that some participants confused smoothness with softness and it is conceded that these properties of fabric are not dissimilar, their differences being subtle and discernable only with experience in fabric analysis. Whilst the research was concerned with the sensory perceptions of wearing different fibre compositions, and due care was taken to use similar knit constructions as far as possible, this was not achieved with the polyester T-shirt (as explained earlier) and any marked differences between polyester and viscose garments could be attributed to this slight but not insignificant difference.

Easier to explain are the differences in smoothness performance between wool and viscose. These two fibres are very different both in terms of chemical composition, fibre structure and therefore a number of properties. Wool has a naturally occurring crimped structure of overlapping scales with fibres that protrude onto the surface creating a less smooth tactile experience whereas viscose in comparison has a smooth striated and regular surface. The staple fibres of wool are also twisted together to create a continuous yarn for knitting whereas the viscose fibres are simply bundled with a negligible twist into multi filaments and are consequently smoother in the hand.
The final marked difference in responses occurred between the cellulose fibres cotton and viscose. The major difference between these two fibres is their morphology’s. Cotton is a convoluted ribbon-like fibre with a naturally occurring kidney bean cross section whereas viscose is straight with a circular cross section. Whilst the cotton fabric used in the trials is of a good quality, being made of long fibres resulting in less surface ‘fuzz’ (which is perceived as absence of smoothness) all cotton is naturally convoluted or twisted and it is these twists that would explain the less smooth nature of the fabric when compared to viscose.

The data indicated that there were no notable differences in smoothness between both cotton and wool and wool and polyester which is curious given that each of these fibres has a different chemical composition and wool is particularly unique morphologically in terms of its surface scales. The language used to describe perceptions may again be the underlying explanation as the cotton, wool and polyester T-shirts all have a ‘soft’ hand and lack any underlying harshness which as discussed earlier can equate to ‘smoothness’ and could explain the discrepancy.

**Prickle**

For the question that asked volunteers if the T-shirt prickled the respondents experienced marked differences in performance between: wool and cotton; wool and viscose and polyester and viscose. The volunteers experienced the most ‘prickle’ from the wool fibre and the least from the viscose. Noticeably, the mean volunteer response to wool prickle was high. The results are in keeping with the background reading on wool and the ‘prickle factor’. Polyester scored second highest for prickle and this would have been as a result of its chemical composition where synthetic is being compared to cellulose. All the T-shirts were pre-washed four times as explained in chapter five, which would have significantly softened the cotton fibre. Viscose is a naturally soft fibre. Polyester is a durable fibre that would not have been softened by the number of washes undertaken for these trials.

Prior to sourcing suitable fibres for this project it was anticipated that wool, out of all the available fibres would elicit the most negative responses in the context of ‘prickle’ comfort due to both its unique overlapping scales and naturally variable diameter’s and fibre lengths which can create discomfort and in some cases unbearable irritation. This anticipated outcome was born out in part only, by the trial data where notably, the mean volunteer response to wool prickle was high. Whilst the differences in responses were most marked between wool and cotton and wool and viscose, wool was not considered to be more or less prickly than polyester, which merely provided more evidence that the term ‘prickle’ needed clarification. It may have been interpreted as ‘hardness’ as opposed to ‘prickle’.

Viscose is considered to be the softest fibre of the four sourced for the trials and this is due mostly to its cellulose composition. Polyester being a synthetic fibre is naturally harsher in the hand because of its morphological structure as explained in chapter one. Both polyester and viscose are relatively soft fibres with viscose considered to be the softest of the four fibres trialed in this research, however, as any comparison between a cellulose fibre and a synthetic fibre will show, synthetics have an underlying harsh handle which the volunteers may have inappropriately interpreted as ‘prickly’.
The data showed that cotton and polyester displayed little difference, inferring that the cotton garment was also scratchy. Responses to the ‘prickle’ of cotton and viscose were similar understandably, as they are both derived from the same chemical group and therefore share many of the same performance properties.

**Itch**
The next question asked the volunteers if the T-shirt itched. Findings are expected to be similar to the previous performance property, given that language used to describe some sensations may be an issue and where prickle and itch may equate to the same sensation for some of the volunteers. The experience of prickle drives the wearer to scratch the site and can eventually lead to skin damage whereas itch is a less severe reaction to a textural irritation. As expected however unlike the last question, where polyester and viscose were markedly different, they are not sufficiently different in terms of itch to warrant discussion. The marked biggest differences in responses were between cotton and wool, and wool and viscose.

The following fibres warrant further discussion because they showed significant differences between the volunteer responses. The marked differences in the experience of ‘itch’ between cotton and wool were predictable and no doubt the result of the wool fibres scales. The same rational can apply to wool and viscose. In response to the ‘itch’ experience, as mentioned earlier when discussing ‘prickle’ there was similarly no marked difference between wool and polyester; cotton and polyester or cotton and viscose. Interestingly, there were not sufficient differences between polyester and viscose in respect to ‘itch’ to warrant discussion which is in sharp contrast to the data on ‘prickle’ where the differences were marked, further indicating that the language used to describe the two sensations need to be clarified.

**Slippery**
The last question relating to the tactile performance of a fabric asked, ‘does the t-shirt feel ‘slippery’ to wear’ to which the participants responded that polyester was the most slippery and cotton the least which directly corresponds to the expected properties resulting from the morphological structure of the fibres. Polyester and viscose are smooth filament structures and wool and cotton are staple fibres with unique morphology’s. Smooth filaments are prone to sliding across a surface, whereas staple fibres have an innate ‘grip’. The following fibres warrant further discussion because they showed significant differences between the volunteer’s responses. The biggest differences were between wool & polyester; cotton & polyester; wool & viscose and cotton & viscose. No marked differences were reported between cotton and wool as both are natural staple fibres therefore ‘grippy’ in the ‘hand’ and similarly there were no reported differences between polyester and viscose which are both filament structures so prone to be slippery.

**Perception**
Sensorial comfort also encompassed perception. This last of the three groups established for the purpose of exploring comfort, encompasses perception which is phenomenological in nature, making it more open to conjecture. Questions related to eight performance indicators that were included to capture these responses. Namely they were, awareness, modesty, extended wear, energy, anxiety, relief, concentration...
and nurturing. It was not possible to ask for responses to some of the factors discussed in the comfort chapter that contribute to psychological comfort through this blind study.

**Awareness**

If the memory of an experience is vague then this is an indicator of a lack of awareness of the wearing experience. As such it is a non-state.

The first of the sensorial perception questions asked the volunteers to record on a scale of one to seven how aware they were of the T-shirt as they worked. The T-shirt participants were most aware of polyester followed by wool then cotton, with the least awareness being attributed to viscose. As with all discussion on reasons for any marked psychological differences in wear responses, they can only be conjecture at this point. The polyester fibre would be more memorable than viscose in comparison because it has a more plastic ‘hand’ originating as it does from petroleum synthesis.

Viscose, which is a low density regenerated cellulose fibre in contrast has a particularly soft ‘hand’ due to its short polymers (see chapter one). Marked differences in responses were combinations of all four fibres: cotton and wool; polyester and viscose; cotton and polyester and wool and viscose. Polyester as the only synthetic fibre trialled was the most hydrophobic of the trial fibres with the lowest vapour transmission and in the office environment it would become more dry and therefore prone to collecting static electricity. This would have contrasted significantly with viscose which is the most hydrophilic of the fibres tested so most able to absorb vapour from the body making it less prone to an electrical charge build up.

The significant differences in responses were between: cotton and wool; polyester and viscose; cotton and polyester and wool and viscose. The size of the trials and the scaled measure for capturing responses are unable to pick up any but the most obvious of experiences so there were no marked differences between cotton and viscose or polyester and wool. In the case of cotton and wool the awareness of comfort would have been expected given the different properties associated with the two different chemical compositions: cellulose and protein respectively. i.e. density, electrical conductivity, elasticity, absorption and thermal retention. Other properties that would be different include the visual or aesthetic properties. The volunteer responses to wool would have varied since all participant’s would have been aware of wool’s unique texture (woolly hand) resulting from its scaled and crimped morphology. There would have been some similarities between these two fibres particularly with the drape; texture and lustre.

Marked differences in comfort properties (particularly absorbency and electrical conductivity) between cotton and polyester would be attributed to their different chemical compositions. An awareness of a lack of absorbency can be readily experienced over the eight hour trial period. The evidence however of any built up electrical charges which occur when a fibre is particularly dry (typically synthetic chemical compositions) are hidden and therefore may not be as apparent. These particularly ‘dry’ fibres have little moisture available to disperse the charges and so contribute to a buildup in some individuals whose store of electricity in their body (the ‘load’) is higher than others. Some participants in the trials may have been more aware of the effects of this build up on their personal wellbeing.
Both cotton and polyester fibres create fabrics with diversely different drape which would have been a major reason for differences in perception and therefore awareness. Cotton creates a crisp silhouette due to its staple twisted ribbon morphology whereas polyester with its smooth filament structure will lie closer to the body. The two fibres wool and viscose have different chemical compositions and therefore exhibit some different properties although they also share some properties for reasons other than their chemical composition in that they are both highly absorbent; flexible; have high elongation and low dimensional stability.

There were no marked differences between wool and polyester or cotton and viscose. Wool is a protein fibre and polyester is synthetic which would indicate the evidence of some marked differences, which was not the case. The cotton and viscose fibres while being the same chemical composition had very different yarn structures so although they shared many properties relating to comfort i.e. density, electrical conductivity, elasticity, absorption and thermal retention their ‘hand’ which includes drape, cover and texture are very different so the fact that these fibres showed no marked differences was also unexpected. To hazard an explanation for the lack of marked differences one could take into account the wide range of possible individual perceptions.

Modesty
In respect to the next question that asks if the volunteers considered that the T-shirt gave them enough modesty, volunteers felt that the cotton T-shirt offered them the most modesty and viscose the least. Differences would be largely due to the inherent density and to a lesser degree the drape of the two knit fabrics used in the trials. Cotton is a dense cellulose fibre composition with high cover and a sharp silhouette whereas viscose which is regenerated cellulose has low density and therefore low cover with an almost ‘liquid’ drape, causing the fabric to run close to the contours of the body.

Due to the absence of marked differences between cotton and wool; wool and polyester and polyester and viscose it can be said that they all offered similar degrees of modesty with cotton offering the most followed by wool then polyester with viscose offering the least.

Three of the four fibres used in the trials exhibit similar ‘cover’ against the body but the polyester fabric is quite noticeably different to the viscose fabric due to the tuck stitches in the construction which allows the light to penetrate. The viscose T-shirt drapes closer to the body which is possibly perceived as affording less modesty. Despite this however the volunteers felt that the polyester offered them more modesty. Cotton and polyester due to their different silhouettes (polyester runs closer to the body than cotton) may have been perceived as not offering the same ‘protection’ simply because the cotton fabric would drape from the shoulders and polyester would rest against the body’s contours.

Wool offers more modesty than viscose because of the difference in drape but the difference is not sufficient for discussion as the fabrics are the most alike out of all the trial T-shirts in relation to this property.
Anxiety
In reference to the question asking ‘did you feel more anxious when wearing this T shirt’ the participant’s rated polyester as the most anxiety producing fibre followed by wool then cotton and lastly viscose. These responses were understandable given the responses reported earlier that indicated that polyester was least able to modulate temperature and created a clammy environment around the body; wool is prone to creating an itch or prickle in the majority of cases and viscose is the fibre most like a second skin. There were no marked differences between cotton and wool; wool and polyester; wool and viscose or cotton and viscose which may indicate one of two things. Either that the fibres were too similar to each other or that they were perceived to be so by the majority of volunteers. The latter would appear the most plausible if taking into consideration the obvious differences in properties between the fibres.

Extended wear
In question number twenty four, the volunteers were asked if they considered the t-shirt would be comfortable to wear over an extended period for example, for more than eight hours. The viscose T-shirt was considered the most comfortable to wear over an extended period and polyester the least. The marked differences in responses were between, polyester and viscose; cotton and polyester and wool and viscose. There were no differences between cotton and wool or wool and polyester.

The morphological differences between wool and polyester, and cotton and viscose, are marked (see Chapter One) which did not reflect in the findings from the wear experience, indicating that they are not contributing factors in the context of wearing a garment over an extended period. Therefore the prickle recorded for wool and the slippery hand of viscose were not significant enough to cause discomfort.

Energy
Question number twenty six asked if the experience of wearing the T-shirt left the volunteer feeling more ‘energised’ to which the volunteers responded that wearing the viscose T-shirt made them feel more energised and polyester made them feel less energised. The marked biggest difference in response was between cotton and polyester. No marked differences were experienced between cotton and wool; wool and polyester; wool and viscose and cotton and viscose. The single marked differences indicates that volunteers were mostly unaware of this particular measure for assessing fabric performance.

Relief
In response to question twenty nine, asking whether they felt relieved to take off the T-shirt and question thirty, asking if they felt better able to concentrate at work, the biggest marked differences were across all fibre compositions. However as has been observed on several occasions, here again, the polyester and viscose were at opposite ends of the spectrum. This result cannot be rationalized using fibre structure knowledge.

Nurtured
The final question assessed how wrapped and nurtured the volunteers felt wearing the T-shirt and the results reflect the same as the above two questions, further indication that the questionnaire tool used in this
comfort research was unable to capture the nuances of a human experience regarding the perception of sensorial comfort.

### 6.5 The findings that ensued from the analysis

#### 6.5.1 Introduction

This sub-chapter analyses the results to establish the outcomes. For the purpose of analysing the findings, the questions were grouped according to their sensorial, mechanical and thermal properties. The following discussions start with the first of these, thermal comfort, followed by mechanical and then sensorial. The next sub-chapter analyses these results, only where comment is warranted to avoid any unnecessary duplication of the above information.

#### 6.5.2 Thermal comfort findings

There were five questions on the questionnaire for the purpose of assessing volunteer responses to thermal comfort. Questions asked refer to temperature e.g. how warm, cool, or clammy the volunteers felt whilst engaged in the wearing experience of the particular fibre composition.

**Temperature modulation**

Starting with question sixteen, volunteers were asked, ‘do you consider the T-shirt prevents your body’s natural ability to modulate temperature?’ They chose viscose as the best fabric and polyester was considered the least. The result does not reflect the morphological or molecular properties of viscose (see chapter one) according to the surveyed literature reviewed on this subject. The limp hand of viscose and its lack of bulk create a ‘second skin’ aesthetic that is perceived to be ineffective as a barrier to the natural exchange that takes place between body temperatures and the prevailing external environmental temperature. Polyester is the least temperature modulating fibre as was expected due to its chemical composition, filament structure and hydrophobic properties.

**Cool**

The question that asks ‘does wearing the T-shirt make your body feel cool’, number twenty two, saw viscose scoring lowest and wool highest. The molecular structures of both these fibres pre-empted this result. The viscose structure is unable to store body heat or block the passage of cool air. Wool's crimped and scaled morphology will conserve body temperature, if the wear experience is within a temperature controlled environment.

**Warming up**

In question twenty seven, where the volunteers were asked, ‘did the T-shirt warm up during the wear trials?’ The results reflected the structural differences between the two fibres. Wool warmed up the most and viscose the least. The properties of wool fibre create an excellent insulator, trapping body heat, making it...
less desirable to wear in a temperature controlled office environment. Viscose does not warm up as has been explored through the earlier discussions in both this chapter and supported by the fibre property chapter at the beginning of this thesis.

**Clammy or sweaty**

Question twenty three, asked ‘does wearing the T-shirt make your body feel sweaty or clammy?’ The results in performance were the same as the temperature modulation question (number sixteen), with viscose creating least clammy, sweaty conditions and polyester most. Unlike temperature modulation this result does reflect the fibre science. As one would expect, viscose, a hydrophilic fibre, is able to absorb vapour from the body whereas polyester, being a hydrophobic fibre is not. The unexpected outcome is that cotton was not the preferred fibre, given a second place. Cotton is an excellent conductor, allowing body heat transfer and preventing the build-up of vapour. It is considered to be an ideal fibre to wear in humid conditions for this reason.

**Initial coldness**

Question twenty five asked, ‘did the T-shirt feel cold when it first made contact with the body?’ Cotton was the least cold on first contact and polyester was the coldest. This was an expected outcome in respect to their structural differences (for further clarification see chapter one of this thesis). Cotton makes less contact with the skin surface whereas polyester makes complete contact wherever the fabric sits close to the body. The overall high performance indicated by viscose in the thermal comfort assessment indicated that it is the fibre of choice in this particular property. Polyester was the second most preferred, wool the next and cotton the least of all four fibres trialled. The particular polyester T-shirt fabric used in this trial had been engineered for comfort as has been mentioned earlier and its ability in thermal comfort is evidenced here. Wool was expected to perform better in respect of both its morphological and molecular structure. Cotton is a good conductor and the results were anticipated in its thermal comfort performance in this section of the trial.

The evidence from responses to modulating temperature (question sixteen); cool (twenty two); sweaty or clammy (twenty three) and warming up (twenty seven) respectively, strongly suggests either an absence of knowledge about fibres within the volunteer cohort or an absence of scientific evidence about the properties of this fibre. The latter is expected to be the case as “No satisfactory explanation can be given for the fact that regenerated cellulose fibres have a lower heat resistance and poorer heat conductivity”(Gohl & Vilensky 1989, p.59).

A number of bar charts accompany the findings in this sub-chapter that analyses the results, to help the reader visualize the outcomes. The following (See Table 1 a) is the first of six of these that represent the participant responses to the four wear trial fibres, according to their perceived thermal comfort properties. In each of the tables, a rating of 4 is the most preferred; 3 second best; 2 is the third most preferred and 1 is the least preferred.
Table 1. A visual representation of thermal comfort that compares participant responses to the four wear trial showing how each fibre performs in relation to the perceived thermal comfort.

<table>
<thead>
<tr>
<th></th>
<th>Temperature modulation</th>
<th>Coolness</th>
<th>Clamminess</th>
<th>Initial coldness</th>
<th>Warming up ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>4</td>
<td>3.5</td>
<td>3</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Wool</td>
<td>3.5</td>
<td>3</td>
<td>2.5</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Polyester</td>
<td>3</td>
<td>2.5</td>
<td>2.5</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Viscose</td>
<td>2.5</td>
<td>2</td>
<td>2</td>
<td>1.5</td>
<td>1</td>
</tr>
</tbody>
</table>

6.5.3 Mechanical comfort findings

In respect to the questions assessing mechanical comfort, two were chosen that best reflect the research enquiry. They were weight and cling.

**Weight**
The first of these, weight, asked ‘do you consider the T-shirt to be a heavier garment than you would normally wear to work’ to which the volunteers experienced viscose as being heavier than what they were used to wearing. This was followed by wool, polyester and lastly cotton. This result was unexpected as the viscose and wool T-shirts were the lightest weights of the four and the viscose T-shirt was, by far, the lightest in cover for the body in comparison. One factor that may have contributed to this difference in results lies in the trial expectations, where the volunteers were asked to compare their perceptions when wearing a non-trial garment with a trial garment.

**Cling**
The second mechanical comfort question, number twenty asks ‘does the T-shirt create unwanted cling?’ Wool scored highest, cotton, viscose and polyester followed in that order. Wool with its helical polymers, crimp and scales created a garment that flows freely around the body. Cotton makes random contact with the skin due to its convoluted fibre structure. The first three fibres are hydrophilic and therefore do not collect static electricity which is the major contributing factor of cling. Polyester is a hydrophobic fibre that collects static electricity readily due to both its chemical composition and its filament morphology.
No comparisons can be drawn between these two diverse properties as weight and cling are not synonymous with each other. A heavier weight fabric generally falls straighter on the body while a lighter weight tends to cling to the body’s contours. It is unusual to find a heavy weight fabric that clings.

Table 2. A visual representation of mechanical comfort that compares participant responses to the four wear-trial fibres indicating how each fibre performs in relation to the perceived mechanical comfort.

<table>
<thead>
<tr>
<th></th>
<th>Weight</th>
<th>Cling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wool</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyester</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscose</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The sensorial comfort results are presented next and they constitute the largest group that explores the subjective experience of wearing fibre on the body.

### 6.5.4 Sensorial comfort findings

**Smoothness**

Questions seventeen, eighteen and nineteen, asked “does the T-shirt feel smooth against your skin, does it prickle, or itch respectively all exhibited the same responses from the volunteers with viscose being most positive in its comfort and wool being the least. This would be explained by their different morphology’s where wool has scales and crimp creating a coarser hand compared to the smooth regular fibre surface features of viscose. In this wear trial these two fibres are the most markedly different in both their morphological and molecular structures. The slick hand of polyester lends itself well to a business environment so a possible explanation for the result is that the volunteers experience with polyester is familiar to them, being a widely used fibre in women’s fashion clothing.

**Awareness**

Starting with question thirteen which asked, ‘during the trial period, how aware’ were you of the T-shirt as you worked, polyester was the least preferred fibre and viscose was the most. We can postulate that the reason for the negative response to the polyester T shirt is as a result of its morphological filament structure which pre-disposes it to being a static fibre and shiny in appearance. It would also be the result of its...
molecular structure which is reflected by other responses to sensorial comfort. All very low except for question thirty which will be discussed later. The reason viscose was unmemorable is because of its fibre structure. As a regenerated cellulosic fibre the amorphous structure makes it comfortable to wear which is reflected in fourteen out of nineteen questions, and polyester is the least preferred.

Modesty
Question fifteen asks ‘do you consider the T-shirt gives you enough modesty?’ It is of little surprise that cotton, was the most favoured fibre due to its twisted ribbon like morphological structure and long polymers that create a crisp silhouette and prevents the fibre from making complete contact with the skin (See chapter one on fibre structures for further details). Viscose was considered to be the least modest due its fine limp handling properties that cause it to have a body revealing nature, further contributed to by the jersey weft knit construction.

Slippery
Question twenty one asks ‘does the T-shirt feel slippery?’ The results reveal that polyester is most slippery and cotton is least. This reflects the morphological and molecular structural differences between the two fibres. This is a unique finding as it appears nowhere else in the sensorial comfort group. An interesting observation on analysing the findings reveals the polarised differences between cotton and polyester, in results in this property.

Concentration
The question number thirty, asks volunteers to respond to the statement, ‘I felt less able to concentrate at work wearing this T-shirt’. The responses reflect an anomaly with polyester being the preferred garment with viscose being the least. This result exposes an anomaly as there are no correlations between these two results. There is no apparent reason for this. The same volunteers have identified polyester as the fibre that gives them most anxiety; saps their energy; is slippery to wear; makes them most conscious of wearing it, and it was not considered to be a nurturing experience.

The analysis of sensorial comfort revealed that viscose faired best and polyester worst. The major anomaly regarded question number thirty to do with concentration. Cotton only scored highest in modesty where viscose was the lowest and slipperiness where polyester scored lowest. Cotton was considered the second most favoured fibre with two highest cores (modesty and slippery) however it was rated third place in nine questions, recording the highest number of second places without one first place.

For the purpose of comprehending the differences, sensorial comfort is divided into two parts. The tables generated for this purpose, clearly represent the difficulties experienced in analysing the particular sensorial comfort properties in question. Part one addresses six concepts of sensorial properties that appear to be less easily understood by the participants in this research wear trial. Coincidentally they constitute the area of most interest to the research on fibre properties in the context of fashion as they are concerned with feelings. The findings suggest that a focus group may be a preferred method for capturing participant perceptions to these concepts.
Table 3. **Part 1.** A visual representation of sensorial comfort that compares participant responses to the four wear-trial fibres indicating how each fibre performs in relation to the perceived sensorial comfort.

The table for part two, addresses the findings that demonstrate some real differences in perceived performance.

The following table represents the six remaining sensorial comfort determinants that compare participant responses to the four wear-trial fibres.

Table 4. **Part 2** A visual representation of sensorial comfort (in two parts) that compares participant responses to the wear-trial fibres and shows how each fibre performs in relation to the perceived sensorial comfort.
OVERALL OUTCOME

Conclusion

In conclusion, viscose is the most outstanding fibre and polyester is regarded as the poorest functioning fibre, in respect of the sensorial, mechanical and thermal comfort determinants used in this research. Viscose is not considered a comfortable fibre to wear in the literature reviewed for this study (Hatch 1993) so its status in the context of fibres and the body is a phenomenon worth recording here. The poor performance of polyester however is supported by the reviewed literature but is not indicative of the market popularity with this fibre. It is therefore clear that a disparity exists between the popularity of polyester as a fashion fibre and its performance in the context of comfort.

Whilst the trials were conducted in a controlled environment, there is a chance that the results could have been different if the trial was conducted at a different time of the year. The T-shirts were black and as such, could have been construed as a hot colour to wear in the summer. Colour perceptions were not being trialled in this research therefore were not a subject of discussion in this research.

The final table demonstrates visually, how each fibre performs in relation to the perceived overall comfort.
List of Tables in this chapter:

Table 1. A visual representation of thermal comfort that compares participant responses to the four wear-trial fibres showing how each fibre performs in relation to perceived thermal comfort.

Table 2. A visual representation of mechanical comfort that compares participant responses to the four wear trial fibres showing how each fibre performs in relation to the perceived mechanical comfort.

Table 3. Part 1. A visual representation of sensorial comfort, (in two parts) that compares participant responses to the four wear trial fibres showing how each fibre performs in relation to the perceived sensorial comfort.

Table 4. Part 2. A visual representation of sensorial comfort that compares participant responses to the four wear-trial fibres and shows how each fibre performs in relation to the perceived sensorial comfort afforded by them.

Table 5. A visual representation that compares participant responses to the four wear trial fibres and shows how each fibre performs in relation to the perceived overall comfort afforded by them.
6.6 Assessing the process

The purpose of this section is to discuss how effective the wear trials were in assessing fibre performance and identify whether the exploration of comfort, wellbeing and fibre performance in Part 1 of the thesis adequately supported the trials in achieving the research objectives.

The first part of the thesis explored fibre structures and comfort and wellbeing concepts, and this, along with the findings from the action research in Part Two, informed the exploration of the thesis hypothesis. Responses to a wear experience both in terms of their physiological and psychological performance were gathered and the data was analyzed to assess the various outcomes. The objectives of the wear trial were firstly, to raise awareness of the possibility that fibres can contribute to wellbeing. Secondly the trials were initiated to explore a suitable method for collecting individual responses to the experience of wearing fashion fibres. The data is real and available as a reference tool, contributing to a body of knowledge about the sensorial performance of wearing fibres. The primary tools used in the research were comprised of a set of T-shirts in four different fibre compositions and a questionnaire.

In order to assess how effectively the two parts were in realizing the objectives of the research hypothesis, an assessment of the process follows, starting with the T-shirt wear trial.

The perception of discomfort that comes from wearing fabric close to the skin can be either the result of the garment design, the fibre composition, the fabric construction or the finishes used in its production. To judge the effectiveness of any garment being used to assess fibre performance requires analysis of two separate aspects, namely the style of the garment and the construction of the fabric. As discussed in Chapter Three (design of trials), the garment was a generic style of long sleeved T-shirt that would provide specific coverage for the sensitive inner elbow and chest areas of the body. A crew neck long sleeved T-shirt was decided upon in the hope that any aggravation experienced, would be swiftly registered by the brain and then interpreted as an indication of a state of discomfort. The T-shirt also needed to be of a sufficiently loose ‘cut’ and design to accommodate an expected range of differences in the body shapes of the volunteers whilst allowing the full range of body movements. As anticipated, there were no problems associated with the size or generic design of the garment.

In this research the gathering of data from a select group of volunteers of their responses to different fibre compositions meant that it was imperative to carefully select the type of fabric to use for the wear trials. For this, two aspects of the T-shirt fabric had to be researched before the fabric could be purchased for the trials. Firstly, the fibre compositions to be trialed were determined, and secondly the constructions to be used needed to be considered. Both of these aspects are detailed in Chapter Three but briefly outlined here.

The fibre compositions of cotton, wool, polyester and viscose adequately represented the range of fashion fibres, and were needed to allow differences in predicted responses to be assessed. To eliminate any opportunity of preferences being based upon the actual construction of the fabric as opposed to its fibre composition, the construction had to be sufficiently unremarkable so as to escape the participant’s notice. As the fabric would be worn close to the skin, anything other than a smooth aesthetic would have resulted in
responses being recorded in relation to the textural properties of the fabric constructions alone and therefore not relevant for this study.

The garments used in the wear trials had to make absolute skin contact wherever possible which necessitated that the participant’s wear minimum underwear. This meant that the fabric was required to be of a density that gave enough coverage for it to be worn modestly as the test site was in an office environment. Any reticence on the part of the volunteers to wear the garment in their work place would have been interpreted as discomfort with the fabric construction not the fibre composition and therefore also irrelevant in the context of this study. The jersey weft knit fabric construction that was selected, was unremarkable in both its texture (hand) and density (cover) and therefore any misconstrued responses were avoided.

The last fabric sourcing consideration involved the analysis of suitable available fabrications used in the fashion industry. Bringing the two elements of fibre composition and fabric construction together successfully was straightforward except in relation to one of the fibres being trialed. A large supplier of fashion fabric was unable to provide a 100% polyester fibre in a jersey knit construction simply because there was no market demand for it. It was not the intention to pre-empt any findings, but the managing director of the company from which the fabric was being sourced, did say this was due to its hydrophobic properties which made it uncomfortable to wear over an extended period. This fact was born out by the literature reviewed on the thermal properties of fibres which is thoroughly documented (Gohl & Vilensky 1995)

The closest construction available that had the same appearance as the generic jersey knit structure was substituted, in full knowledge that the compromise would have later consequences. The fabric had been specifically designed to permit the passage of vapour from the body which meant that the thermal comfort responses associated with the wearing of polyester would not be reliable when compared to the other three fibre compositions used in the trials. The research, whilst addressing the volunteers’ responses to the thermal properties of any one given fibre, did not intend to make this a focus of the research as literature is readily available that addresses the thermal properties of all the available textile fashion fibres. Whilst this is the case, using this slightly different fabric construction may be interpreted as bias on the part of the researcher. However any analysis of the research data would reveal that the outcome from the experience of wearing the polyester T-shirt does not support this. Its inclusion in the trials necessitated constant reference to its difference in construction compared to the other three fibres, which although cumbersome, was of no great concern in respect to the larger research objective.

Overall the T-shirt style and the fibres and fabrics chosen for its manufacture provided a suitable tool for the assessment of fibre performance. T-shirts had been designed, fibre compositions chosen and fabric constructions ascertained all for the purpose of establishing a tool that could be used to test a method for establishing volunteer perceptions of fashion fabrics. A questionnaire was used to generate data that would be employed to analyze the volunteers physiological (thermal, mechanical and tactile) and psychological (perception, energy and the mind body connection) responses to comfort. It was therefore vital for ascertaining the performance of the four different T-shirts. How effective it was in itself, at assessing the objectives of the wear trials is revealed in the next section of this discussion.
Designing of the questionnaire in itself was not problematic as it is a tool which is widely employed in research where blind trials are used to produce data for the purpose of assessing differences in performance. An oversight early in the piloting of the trials, where a separate set of questions had not been prepared for the purpose of collecting base data, was unfortunate but a briefing session for all volunteers prior to commencing the actual trials soon allayed any confusion. At the outset, the composing of suitable questions for the physiological properties of comfort was less problematic than the psychological aspects. Using the criteria established, by the literature, for determining fabric comfort, a set of questions readily emerged.

However, despite the positive beginning, the trial results demonstrated that the participants were confused about the subtle differences in meaning of some of the terms used (explanations had necessarily been provided on the questionnaire). Consequently the responses based on each individual's interpretation varied. For example, in questions number eighteen and nineteen which relate loosely to two forms of skin aggravation, prickle and itch were perceived to be the same sensation by the majority of participants. The two sensations are not the same although their differences are subtle. This outcome did cast some doubt as to the accuracy of the findings for the rest of the questions.

The framing of questions that would provide some insights into the more elusive and therefore less easily understood properties of fibre perception was where difficulties arose. As mentioned at the beginning of this chapter and of great interest in the research, the third objective of the wear trial was to attempt to collect responses to some of the possible psychological effects of wearing fashion fibres. Given the difficulties that emerged with the simple concepts surrounding the physiological aspects of comfort, it was no surprise that the questions around psychological comfort were harder to compose, correspondingly trickier to answer and ultimately vulnerable to misinterpretation. The properties that were being tested related to electromagnetic energy levels, awareness, anxiety, stress, and feelings of being nurtured which are all necessarily more complex concepts accompanying psychological comfort. The language was limited to frame the questions and what was available was naïve and failed to extricate any of the possibly more interesting responses.

The questionnaire succeeded overall in the first research objective which was to provide data from which an analysis on the experience of wearing fashion fibre could be undertaken. The second objective which was to contribute to a body of knowledge about the effects of wearing fibres on human physiology was also realized. However doubts exist as to the reliability of the responses to some of the questions, as discussed above. The human trials also revealed the inconsistencies of the human element which is judged on the responses and lack of responses to some of the questions. The questionnaire did collect data as to some of the possible psychological effects of wearing fashion fibres, despite it failing in its attempt to capture responses to the more subtle manifestations of comfort and well-being. The difficulties in framing the questions as explained earlier did diminish the integrity of the responses. Volunteers were required to answer eight questions to concepts that they may have had little understanding of and for which there was a high probability of misinterpretation despite it failing in its attempt to capture responses to the more subtle manifestations of comfort and wellbeing.
7.0 Thesis conclusion

7.1 Introduction

The purpose of this chapter is to explore the notion that fashion, which is about the body, is rarely in the same conversation as body comfort and human wellbeing. This thesis makes a contribution to an existing body of knowledge about fashion fibres comfort and wellbeing. It contains discussion which examines the results of the explorations in the light of the literature reviewed on fibres, comfort and wellbeing. This discussion led to the development of a model which was evaluated to see how effectively it achieved what the research set out to achieve. It is suggested that the model can be used in further research and eventually lead to the development of a theory for wellbeing in fashion. This model is suggested in anticipation that further research will lead to the development of a theory for design wellbeing. The discussion and evaluations are drawn together to produce the conclusion.

7.2 Confirming the context for ‘healthy’ fibre choices

Currently, comfort and wellbeing are not prioritized as a methodology by elite fashion designers who limit their creativity to how successful their designs are, judged on a catwalk model. In the context of high fashion, the body is often treated as a vehicle for display purposes that ignore comfort. The mention of the word ‘comfort’ can be derogatory, so firmly is it relegated to a particular genre of clothing which is seen as having no relationship to fashion. This may not be what consumers of fashion are looking for, especially the large proportion of the fashion forward, design conscious middle aged who led their generation through the turbulent 1960s. Despite the continuing unsatisfactory current practice in designing for the body, this study warranted its investigation as efforts continue to identify ways in which fashion and comfort can co-exist.

7.3 The role of fibre compositions in comfort and wellbeing

The aim of this research in two parts was to explore a method for understanding if there is any connection between the chemical compositions of fibres and the concepts of comfort and wellbeing. Its purpose was to create awareness that the choices made when purchasing fibres worn against the body have the ability to create balance in the way we live our lives in the same way as food choices create balance and help us to maintain our health. Part one of the research, explored three areas, namely the fibres commonly used in the production of fashion clothing that were chosen for the wear trial T-shirt, comfort in relation to fibre selection and wellbeing in the context of fibres used in fashion.

The thesis began by furnishing some fundamental information about four common fashion fibres to illustrate the complexity of the units of matter that produce fashion. There is a large body of knowledge about textile fibres and although this chapter is not representative, it serves as a reference point to help with
understanding of the performance properties relative to each of the three fibre groups included in part two of the research.

7.4 Developing a theory of ‘healthy’ fashion

The purpose of the second chapter was to explore the first of two complex concepts to inform the interconnectivity between fashion fibres and the body. The research proposed that fashion design should be in sympathy with the body. The concepts of comfort were researched from an existing body of knowledge that needed to be explored to facilitate a conversation in the context of fashion. The literature review revealed that both physiological and psychological comfort could be explored using ergonomic principles that are widely employed in other areas of design for the body. The principles accommodate the moving body as they are founded upon a sound understanding of how the body works. The research revealed they can also be used as a key driver for addressing any fashion design issues to do with fibre selection, if they are used in tandem with knowledge of fibre structures.

The other complex concept that was explored was wellbeing. Discussions on wellbeing are pivotal to the exploration of the research hypothesis that design can be ‘healthy’. The chapter started by defining wellbeing by limiting it to the specific area of fibres used in fashion. Happiness and health were explored as pre-requisites for wellbeing and the connection was made between fibre production, happiness and health arguing that they are all connected to peace of mind (wellbeing). The discussions borrowed from theorists in psychology, philosophy and sociology.

7.5 Designers and the environment

The last exploration in part one of the thesis, was a discussion of the effects that fibre developments have had on the world’s eco systems was used to raise awareness that damage may have been incurred to human health in the wake. Changes have taken place with a basic commodity, taking it from primitive rawness to technologically advanced sophistication. A historical perspective of fibre tracked the development of textile fibre from the industrial revolution to the current day. The chapter concluded with an illustration of the life cycle of a wardrobe staple on which to reflect about the contribution that fashion fibres make to the twentieth century phenomena’s of depleted eco-systems and compromised immune systems.
8.0 Limitations of the research

The research revealed some ideas for further research which may be helpful and so are suggested here, commencing with the questionnaire part of the tool.

Questionnaire tool

A questionnaire tool was provided in two formats to accompany the wear trials. One was an actual T-shirt questionnaire and the other was a smaller formatted questionnaire for capturing the base study required for this research.

Any trial that collects data for recording and assessing of outcomes necessitates establishing a base line. In the case of this trial, the responses to the experience of wearing clothing made from the volunteers own wardrobe on the days between the T-shirt trial wears, were collected using the same questionnaire as the one being used in the T-shirt trials. This resulted in confusing some of the participants at the time of responding to the questions as the wording was specific to the T-shirts used in the trials and was taken literally, making no allowance for other types of clothing worn to work.

It is therefore suggested that a separate questionnaire and protocol be prepared for this purpose that would use a language specific to the situation. For example there would be no mention of a T-shirt.

Some of the questions could be eliminated, in consideration of the blunt tool it was, to make way for others that would reflect the nature of the research more accurately. For example seeking responses to the differences in thermal comfort of a fibre composition was of limited interest to this research. Also, there is no justification for more findings of this kind when there are already enough research references available.

As mentioned earlier difficulties arose in composing questions for the purpose of gathering responses to psychological comfort. In the case of this research this was due to a lack of knowledge of a sophisticated language that could be used to describe the concepts. More research is need in this area to facilitate accurate responses from participants in future trials.

Although the questionnaire was a professionally prepared document, there are nonetheless some suggestions for ways it can be improved. An instruction written in bold at the end of the questionnaire asked the participants to put the garments in the order in which they were preferred. It was assumed this was done, but reflecting upon each participant’s responses to the questions, combined with the order in which they placed the T-shirts did not support this assumption in every case. A written record of preferred order would be more reliable and a questionnaire could easily accommodate this inclusion.

The use of a science research model requiring formalized questions had some disadvantages. On completion of the exercise, when verbal feedback was invited it appeared that many of the participants would have welcomed the opportunity to provide more discussion of their personal experiences of the various T-shirts. To this end, a space on the questionnaire could be provided to harness these responses. However,
to be truly mindful of the human centredness of this research, a few focus groups held in an informal setting would provide some interesting insights to add to the findings.

Overall, the questionnaire revealed three suggestions for further research. Firstly, a larger trial using more participants would provide more conclusive findings into the physiological effects associated with wearing different fashion fibres. Secondly, the scope of questions that could give insights into psychological effects of wearing fibres needs to be broadened. Lastly, the inclusion of a number of focus groups would enhance the wear trial experience and provide added insights into the effects both physiological and psychological of wearing fashion fibres.

The research trials sought to provide some evidence that fibre contributes to comfort and wellbeing. Comfort parameters as set down in the thesis and established through the questions posed about the wearing experience, did provide evidence of effects. However the parameters discussed around the psychological effects of wearing fibre were not conclusively tested in the trials. This may have resulted from too little available literature on the psychological effects of wearing fibre which include electromagnetic energy levels, awareness, anxiety, stress, and feelings of being nurtured which are all discussed briefly in the thesis. The shortcomings may have been because many of the concepts go beyond the limitations of this research.

The volunteer cohort

Within the volunteer cohort, there are five areas that could be addressed in further research. Firstly, the process of searching for volunteers needed attention, although this was refined eventually through ‘trial and error’. The resulting best method would be used again in further research. Determining a suitable profile for the volunteers is clearer as a result of this first trial and more stipulations would be applied if a similar trial was attempted in the future.

Some of these stipulations would address differences in the volunteer profile. It is known that the way a fibre is perceived is determined by an individual’s personal views which may be culturally defined or resulting from their upbringing or their experiences of various aspects of their life. Responses can be more closely predicted if a cohort is chosen with this in mind. Individuals who have some understanding of the esoteric and those who subscribe to the belief that the mind contributes to the health of the body would respond differently to the same question as those without those underlying beliefs.

Working with a human element meant that there needed to be more than one approach for the briefing process. This created a situation where some volunteers received more assistance than others and the question of how much briefing is too much arose. This highlighted the need for a process where somebody other than the researcher would be responsible for interfacing with the volunteers.

During the wear trials, several of the volunteers reported that many of their male colleagues would have willingly partaken of the study and appeared vitally interested in the trials. A study using male volunteers would provide useful data for comparison especially in the area of perception.
The final suggestions for further research would involve considering and employing a focus group and a larger sample size as a way of adding both a qualitative element and richness to the data.

**The thesis**

There are also suggestions for further research that came from the thesis which constituted the first part of this research and which provided the background information for the design of the wear trials.

The arguments put forward in the thesis support a holistic approach to fibre selection, suggesting that some fibres can be preferred over others for a range of different reasons that are broadly relative to comfort. The comfort concept, which may be physiological or psychological, is explored as are the fibres commonly used in the fashion industry, from an historic perspective starting with the industrial revolution and culminating in the technological revolution. The various perspectives discussed include the impact of fibre production on the environment, the food chain and the body's immune system.

The idea that fibre can be selected for its health benefits, suggested by the thesis, is new and more research is needed before it can be considered as a therapy which can be used in the mainstream along with other therapies to calm the mind, nurture the soul and restore balance.

A wear trial was suggested as a tool that could be used to further test the health benefits of fibre. It proved that the method, which was borrowed from another discipline, was suitable to be used in further fashion research. It was mentioned in an earlier chapter that the research could be undertaken with volunteers with different profiles for example males, or different ages, for example the elderly or women of a different age to those used in these trials. The possibilities are endless but the process would be the same. The trials did reveal that questions can be misunderstood and the importance of using carefully crafted questions for the more obscure properties of fibres. They did not prove or disprove that fibres could be selectively chosen.

Questions need to be asked about the danger of producing fashion clothing that has not been proven to be safe to wear. Research is needed to find out about the effects of fibres on human physiological and psychological wellbeing. There is evidence emerging that will add to a body of enquiry so while this research is inconclusive, it is ongoing. It has raised awareness in fashion fibres, contributed some findings about the human experience, and identified some areas for further exploration. Above all it has demonstrated how it may be possible for two separate disciplines to work collaboratively by bringing together the phenomenological with the objective in the pursuit of wellbeing.

Through a process that involved the projecting of a hypothesis, crafting its objectives, and researching existing knowledge, a project was developed to capture the human experience. This project in seeking to raise awareness of the consequences of fibre selection for fashion revealed that more knowledge needs to be disseminated regarding the nature of fibre. Through the research, written language has proven to be problematic in conveying the nuances of fibre performance. This could be addressed firstly through informal living and learning centres of enquiry where verbal exchanges could take place through the personal experience of touching fabric.
The curious would seek further knowledge, the less curious would have a heightened awareness but both would be better placed to make informed decisions about the choices they make when purchasing fashion clothing.
9.0 Appendices

1. Abstract pertaining to wear trial
2. Application for ethics approval
3. Ethics approval document
4. Plain language statement
5. Prescribed consent form
6. Advertising fly seeking volunteers
7. Instructions and wear schedule.
8. Questionnaire survey
9. Data collection
10. Data Analysis
11. Analysis of data in three stages
Appendix 1

Abstract of thesis wear trial

The intimate habitat – selection of natural fibres in clothing to enhance psychological and physiological wellbeing.

I am currently researching the hypothesis that the fibres and clothing made from chemicals (our synthetic fabrics) could be creating hostile environments, leading to human physiological and psychological ‘dis-ease’.

In the research around this hypothesis the connections between our physical and mental health and the clothes we wear will be explored. The feel of cloth next to the skin impacts upon the senses (consider the prickle factor). It may also have an impact on our physical and psychological health.

Both these concepts will form part of the discourse for this research. However, what is more interesting and little researched is the proposition that the clothes we wear may affect how we understand ourselves and the world in which we live. How do we feel about a fabric that is sourced from non-renewable resources and can we feel this dis-ease in the clothes that we wear? I will investigate the different tenets of wellness and how fashion fabrics made from textiles in common use (manufactured and synthetic), compare to natural sustainable fibres. Proposed is that the information gained from investigating these concepts will contribute to international discourse on the relationship between fabric and wellbeing, giving a concrete base from which informed design decisions can be made.
Appendix 2

Application for ethics approval of research involving human participants.

2008
Application for ethics approval of research involving human participants

1. This form is to be used by students and academic staff undertaking research in the ‘Risk level 1’ and ‘Risk level 2’ categories as described. All applications must be emailed to: DSCethics@rmit.edu.au They are then registered by the Portfolio office, and considered at the next available meeting. A signed hardcopy of the form is also required by the secretary before the meeting date. Enquiries should be directed to the secretary, Cheryl de Leon, on 9925 2974.
2. ‘Risk level 3’ applications must be completed on the RMIT Human Research Ethics Committee HREC Form 1.
3. Please insert the version number and date in the footer of the document.

Section A: Approvals and declarations

1. Project Title: ‘Natural fabric selection in clothing to enhance physiological and psychological well being’

<table>
<thead>
<tr>
<th>Research Degree</th>
<th>Staff Research Project</th>
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<tbody>
<tr>
<td>Complete this column if you are undertaking research for a degree at RMIT or another university.</td>
<td>Complete this column if your research is not for any degree.</td>
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<table>
<thead>
<tr>
<th>Investigator</th>
<th>Principal investigator</th>
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<tbody>
<tr>
<td>Name: Diana Klein</td>
<td>Name:</td>
</tr>
<tr>
<td>Student No: 3143484</td>
<td>Qualifications:</td>
</tr>
<tr>
<td>Qualifications</td>
<td>School:</td>
</tr>
<tr>
<td>Diploma Fashion Design &amp; Production</td>
<td></td>
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<tr>
<td>Trained Technical Teacher’s Certificate</td>
<td></td>
</tr>
<tr>
<td>School: Architecture and Design</td>
<td>Phone:</td>
</tr>
<tr>
<td>Address: 46 York avenue East Ivanhoe</td>
<td>Email:</td>
</tr>
<tr>
<td>Phone: 99252781</td>
<td></td>
</tr>
<tr>
<td>Email: <a href="mailto:diana.klein@rmit.edu.au">diana.klein@rmit.edu.au</a></td>
<td></td>
</tr>
<tr>
<td>Degree for which research is being undertaken: Bachelor of Design (Fashion)</td>
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<tr>
<th>Senior Supervisor</th>
<th>Other investigator/s</th>
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<tbody>
<tr>
<td>Name: Sue Thomas</td>
<td>Name/s:</td>
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<tr>
<td>Qualifications:</td>
<td>Qualifications:</td>
</tr>
<tr>
<td>MA Film Studies, BA Textiles / Fashion</td>
<td></td>
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<tr>
<td>School: Architecture &amp; Design</td>
<td>School:</td>
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<tr>
<td>Phone: 99252784</td>
<td>Phone:</td>
</tr>
<tr>
<td>Email: <a href="mailto:sue.thomas@rmit.edu.au">sue.thomas@rmit.edu.au</a></td>
<td>Email:</td>
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</tbody>
</table>
2. Declaration by the investigator(s)

I/We have read the current NH&MRC National Statement on Ethical Conduct in Research Involving Humans 1999, and accept responsibility for the conduct of the research detailed in this application in accordance with the principles contained in the National Statement and any other conditions laid down by the RMIT Human Research Ethics Committee.

Signed: ___________________________ Date: ______________
(Signature of investigator)

Signed: ___________________________ Date: ______________
(Signature of senior supervisor if applicable)

3. Declaration by the Head of School/Centre

The research project set out in the attached application, including the adequacy of its research design and compliance with recognised ethical standards, has the approval of the School/Portfolio. I certify that I am prepared to have this project undertaken in my School/Centre/Unit.

Signed: ___________________________ Date: ______________
(Signature of Head of School or approved delegate)

Comments:

School/Centre: _______________________ Extn: _______________________
Section B: Project particulars

NB: The bolded headings and numbering in this form must remain in your completed application for ethics approval. Please leave these headings and delete the detailed guidelines as you go through and complete the form. If a heading is not relevant write ‘Not applicable’ underneath it.

1. Title of Project : ‘Natural fabric selection in clothing to enhance physiological and psychological well being’

2. Project description: for HREC assessment of ethical issues

Research aims and significance

This project is an investigation into the possibility that our intimate habitat (which is our clothing) could be a hostile environment contributing to the psychological and physiological dis-ease of the human population. The findings will add to discourse into well being.

Research methodology

The key elements of the research methodology involve the undertaking of questionnaires, corresponding trials into the performance of commonly used clothing fibres, studies in material science and the analysis of published data surrounding the phenomena of comfort as it relates to clothing.

Volunteers will be sought to participate in the trials whereby they will be given four T shirts to wear made from different fibre compositions and these will vary (e.g. one cotton, one polyester, two wool). They will be required to wear the shirts over an eight hour work day within a work environment. It is anticipated there will be 20 participants in all.

The results of the trials will be collated and findings recorded as part of a thesis on comfort and well being.

Participant requirements

Participants will be required to be available for approximately half an hour to receive the T shirts and accompanying questionnaires both in advance of the trials and after the workday specified. The questionnaire will take approximately one hour to complete.

3. Research timetable

- Pilot trial 3 people: June
- Advertise for volunteers: August
- Screen for volunteers: August
- Source appropriate garments: August
- Commence questionnaires: August
- Commence trials: September

4. Research funding

N/A
**Section C: Details of participants**

1. **Number, type, age range, and any special characteristics of participants**

   Trials will be carried out on 15–20 healthy volunteers. Mature female subjects (30+) will be used because of their understanding of sensory perception and highly developed communication skills. Candidates are required to be not pregnant or menopausal (due to fluctuating body temperatures which could impede the findings and experience) with no history of skin conditions either childhood or adult onset. Participants will be screened for known existing skin sensitivities.

2. **Source of participants (attach written permission where appropriate)**

   Interview participants will be sourced from the RMIT administration staff.

3. **Means by which participants are to be recruited**

   The investigator will be advertising for participants on the RMIT web site. And through pre-existing relationships with administration staff.

4. **Are any of the participants ‘vulnerable’ or in a dependent relationship with any of the investigators, particularly those involved in recruiting for or conducting the project?**

   Participants are not vulnerable nor in a dependent relationship with the researcher.

**Section D: Estimation of potential risk to participants & project classification**

1. **Please identify the project classification by assessing the level of risk to participants**

   Risk classification 1

2. **If you believe the project should be classified category ‘Risk level 1’ or category ‘Risk level 2’ please explain why you believe there are no risks or minimal to the participants.**

   The risk to participants is minimal because their participation is voluntary and is based on their own experiences. Some adverse reaction may occur with participants that have an existing sensitivity to certain fibre compositions, but it is not anticipated that the reactions will be severe or long term. The research will be conducted ethically and confidentially and their privacy will be protected.

3. **Please explain how the potential benefits to the participant or contributions to the general body of knowledge outweigh the risks.**

   The benefits of this research outweigh the risks. The potential benefits are that it will add to the body of knowledge about fabrics and their relationship to human physiology and psychology and it has the potential to influence future design decisions.

4. **Contingency planning: first aid / debriefing**

   Participants experiencing any discomfort will be advised to contact their personal physician in any event.
5. **Adverse Events:**

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<th></th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td>a) Does the data collection process involve access to confidential data without the prior consent of participants? If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this:</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>b) Will participants have pictures taken of them eg, photographs or videos? If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this:</td>
<td></td>
<td>x</td>
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<tr>
<td>c) If interviews are to be conducted will they be tape-recorded? If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this: <strong>NB</strong> if interviews are being conducted please attach a list of proposed interview questions/themes to this application.</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>d) Are the participants in a dependent relationship with the investigator/s? If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this:</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>e) Is deception to be used? If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this:</td>
<td></td>
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<tr>
<td>f) Do you plan to use an interpreter? If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this:</td>
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<tr>
<td>g) Does the research involve any tasks or processes which participants may experience as stressful or unpleasant during or after the data collection? If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this:</td>
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<td>x</td>
</tr>
<tr>
<td>h) Does your research involve the participation from anyone from an ATSI (Aboriginal and Torres Strait Islander) community? If so refer to the guidelines at: <a href="http://www.aiatsis.gov.au/research_program/publications">www.aiatsis.gov.au/research_program/publications</a> If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this:</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>i) Are participants asked to disclose information that may leave them feeling vulnerable or embarrassed? If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this:</td>
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<tr>
<td>j) Are there in your opinion any other ethical issues involved in the research eg is it possible that you will be collecting/disclosing information about a third party not involved in the research? If ‘Yes’ please give details of any actions you will take to ensure that participants are not compromised by this:</td>
<td></td>
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</table>
Section E: Informed consent

NB: The numbered bolded headings in this form must remain in your completed application for ethics approval. Please leave these headings and delete the detailed guidelines as you go through and complete the form. If a heading is not relevant write ‘Not applicable’ underneath it.

1. Attach to your application
   (a) a copy of the letter to participants providing plain language information about the research. See attachment 1.
   (b) a copy of the Consent form. See Attachment 2.

2. Dissemination of results

   Results of the research will be disseminated in the following ways:
   - Participants will be contacted via email at the conclusion of the trials and upon request.
   - Outcomes will be published in academic journals and the Master of Design thesis.
   - Presentation of papers at relevant conferences and forums.

Section F: Research Involving Collection, Use Or Disclosure Of Information

Please note that if you propose to collect information about an individual from a source other than the individual, or to use or disclose information without the consent of the individual whose information it is, you will also have to complete the Special Privacy Module as well as the questions below. Under statutory guidelines a HREC may approve some research where the public interest outweighs considerations of privacy, however a researcher must make a special case for such approval. The Special Privacy Module is the starting point for preparing such a case.

For a more detailed guidance and definitions for each of the question below, see Notes to assist in completing HREC Form 1. They are applicable to the DSC form as well as the University form.

1 Does this Section have to be completed?

   Does the project involve the collection, use or disclosure of personal information (includes names & contact details), health information including genetic information, or sensitive information?

   ☐ No – you do not have to answer any questions in this section. Go to Section G.
   ☑ Yes – you must answer questions in this section. Go to Question F2.

2 Type of activity proposed

   Are you seeking approval from this HREC for:
   (a) collection of information?
       ☑ Yes – go to Question F3
       ☐ No – go to Question F4
   (b) use of information?
       ☑ Yes ☐ No
   (c) disclosure of information?
       ☑ Yes ☐ No
3 Collection of Information

(a) Does the project involve collection of information directly from individuals about themselves?

☐ No – (i.e., collected from a third party/existing records). You must fill out the Special Privacy Form as well as this form.

☒ Yes – answer the following questions:

(b) What type of information will be collected? (Tick as many as apply)

☒ personal information (e.g., name, contact details etc)

☒ sensitive information (e.g., affiliations, income values, attitudes etc)

☒ health information

(c) Does the plain language statement explain the following:

The identity of the organisation collecting the information and how to contact it?

Yes ☒ No ☐

The purposes for which the information is being collected?

Yes ☒ No ☐

The period for which the records relating to the participant will be kept?

Yes ☒ No ☐

The steps taken to ensure confidentiality and secure storage of data?

Yes ☒ No ☐

How privacy will be protected in any publication of the information (i.e., how is anonymity of participants is guaranteed)?

Yes ☒ No ☐

The fact that the individual may access that information?

Yes ☒ No ☐

4 Use or Disclosure of Information About Individuals

(a) Does the project involve the use or disclosure of identified or potentially identifiable information?

☒ No – go to Question F5.

☐ Yes, answer the following questions.

(b) Does the project involve use or disclosure of information without the consent of the individual whose information it is?

☒ No - go to Question F5.

☐ Yes, you must fill out the Special Privacy Form, as well as this form.
5 General Issues

(a) How many records will be collected, used or disclosed? Specify the information that will be collected, used or disclosed (e.g. date of birth, medical history, number of convictions, etc)

<table>
<thead>
<tr>
<th>Number of records:</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of information:</td>
<td>Information to be collected includes participants contact details, signed letters of consent and questionnaire responses.</td>
</tr>
</tbody>
</table>

(b) For what period of time will the information be retained? How will the information be disposed of at the end of this period?

Information will be retained for 5 years after the research is undertaken at which time the material will be shredded, or deleted.

(c) Describe the security arrangements for storage of the information. Where will the information be stored? Who will have access to the information?

All information will be held in a locked cabinet in the researcher's office.

How will the privacy of individuals be respected in any publication arising from this project?

(e) Will the project data be transferred to a person/organisation either interstate or overseas?

(If you are a researcher sending data to, for example, another researcher or institution in another state then you will need to tick 'yes'. Normally, a research student transferring data to their supervisor is not subject to these principles, whether or not the transfer is across state or national borders.)

☐ Yes ☒ No

If yes, give details of how this will be carried out in accordance with relevant Privacy Principles (e.g. HPP 9, VIPP 9 or NPP 9).

(f) Does the project involve the adoption of unique identifiers assigned to individuals by other agencies or organisations?

☐ Yes ☒ No

If yes, give details of how this will be carried out in accordance with relevant Privacy Principles (e.g. HPP 7, VIPP 7 or NPP 7).

6 Adverse Events

Are procedures in place to manage, monitor and report adverse and/or unforeseen events relating to the collection, use or disclosure of information?

☒ Yes ☐ No

Give details.

As explained previously, the risk to participants is minimal as their participation is voluntary and is based on their professional experience. Data will be held in accordance with University policy, stored in a locked cabinet in my office. No material will be published or otherwise reported that identifies participants, unless they agree otherwise. Adverse events are unlikely; however, should any such event arise I would seek advice from the Director of Design and Social Context Portfolio.

7 Other Ethical Issues

Discuss any other ethical issues relevant to the collection, use or disclosure of information proposed in this project. Explain how these issues have been addressed.
Section G: Other issues

NB: If a question is not relevant write ‘Not applicable’ underneath it.

1. Do you propose to pay participants? If so, how much and for what purpose?
   No payments will be made.

2. Where will the project be conducted?
   Project will be conducted in the participant’s workplace and through the Centre for Applied Social Research at RMIT University with participants who live in Victoria.

   Where the research project involves enrolled students or members of University staff, or any other participants for whom the other institution does not take responsibility, approval must be obtained from the RMIT Ethics sub-committee before proceeding.

   In some cases another participating institution may insist on their consent forms, plain language statements and letterhead being used. This is acceptable as long as a duly constituted Human Research Ethics Committee of the relevant participating institution has approved them.

3. Is this project being submitted to another human research ethics committee, or has it been previously submitted to a human research ethics committee?
   No
Appendix 3

Ethics approval

Human Research Ethics Sub-Committee

Phone: 9925 2974
Fax: 9663 2891
Email: andrew.hyde@rmit.edu.au

7th October 2008

Ms Diane Klein
46 York Avenue
EAST IVANHOE 3079

Dear Ms Klein,

Re: Human Research Ethics Application – Register Number HREC A-108-07/08

The Design and Social Context Human Research Ethics Sub-Committee, at its meeting on 2nd October 2008, considered your amended ethics application entitled “Natural fabric selection in clothing to enhance physiological and psychological wellbeing”.

I am pleased to advise that your application has been approved as Risk Level 1 classification by the committee. This approval will be reported to the University Human Research Ethics Committee for noting.

This now completes the Ethics procedures. Your ethics approval expires in February 2010.

Please note that all research data should be stored on University Network systems. These systems provide high levels of manageable security and data integrity, can provide secure remote access, are backed on a regular basis and can provide Disaster Recover processes should a large scale incident occur. The use of portable devices such as CDs and memory sticks is valid for archiving, data transport where necessary and some works in progress. The authoritative copy of all current data should reside on appropriate network systems; and the Principal Investigator is responsible for the retention and storage of the original data pertaining to the project for a minimum period of five years.

You are reminded that an Annual /Final report is mandatory and should be forwarded to the Portfolio Ethics Subcommittee Secretary by mid-December 2008. This report is available from: URL: http://www.rmit.edu.au/rd/hrec_apply

Should you have any queries regarding your application please seek advice from the Chair of the sub-committee Prof Joseph Siracusa on (03) 9925 3188, joseph.siracusa@rmit.edu.au or contact Cheryl de Leon on (03) 9925 2974 or email cheryl.deleon@rmit.edu.au

I wish you well in your research.

Yours sincerely

ANDREW HYDE
For. CHERYL C DE LEON
Secretary, DSC Human Research Ethics Sub-Committee

cc: Ms Sue Thomas, School of Architecture and Design
Appendix 4

Plain language statement

7th January 2010

Dear

My name is Diana Klein and I want to thank you for considering your involvement in a research project currently being undertaken by me at RMIT University within the School of Architecture and Design. The Master of Design by thesis explores the connection between fabric and well being and the title of the research is ‘Intimate Habitat’. I would like to take this opportunity to provide you with some information about the project.

The way a fabric feels next to the skin impact upon our senses, it may also have an impact on our well being. Proposed, is that the information gained from investigating these concepts will contribute to international discourse on the relationship between fabric and wellness, giving a concrete base from which informed design decisions can be made. The information gained from the research will give designers in all areas involving textile fabrics a concrete base from which informed decisions can be made.

You are invited to partake in a series of trials which will run over a period of four separate working days. As part of the research there will be a garment trials and a survey conducted. The project will involve a survey and questionnaire involving around twenty people. I am recruiting participants for the survey.

- You will be required to wear a number of T-shirts for eight hour durations and to fill out short accompanying questionnaires.
- The T-shirts are made from conventional fibres and fabrics so it is not anticipated there will be any adverse effects, however, should you experience any irritation or discomfort contact your doctor.
- Participation is voluntary and you are free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.
- Your written consent will be sought before the trials begin and a copy of the consent form is included for your information.

My supervisors are Sue Thomas, (99252784, Email: sue.thomas@rmit.edu.au.) lecturer, in Fashion at the RMIT School of Architecture and Design and Dr. Chun Li, (99257635, Email: Chun.guang.li@rmit.edu.au ) Associate Professor in the school of Health Sciences at the RMIT Portfolio of Science, Engineering and Technology. For further information contact me on 99252781 Email: diana.klein@rmit.edu.au or my senior supervisor

Yours sincerely,

Diana Klein

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. Details of the complaints procedure are available at: http://www.rmit.edu.au/rd/hrec_complaint
Appendix 5

Prescribed consent form

RMIT HUMAN RESEARCH ETHICS COMMITTEE

Prescribed Consent Form for Persons Participating In Research Projects Involving Interviews, Questionnaires, Focus Groups or Disclosure of Personal Information

PORTFOLIO OF
SCHOOL/CENTRE OF
Design and social context
Architecture and design

Name of participant: 
Project Title: Intimate habitat

Name(s) of investigators: (1) Diana Klein Phone: 99252781
(2) 

1. I have received a statement explaining the questionnaire involved in this project.
2. I consent to participate in the above project, the particulars of which - including details of the questionnaires - have been explained to me.
3. I authorise the investigator or his or her assistant to administer a questionnaire.
4. I give my permission to be photographed ☐ Yes ☐ No
5. I give my permission for my name or identity to be used ☐ Yes ☐ No
6. I acknowledge that:
   a) Having read the Plain Language Statement, I agree to the general purpose, methods and demands of the study.
   b) I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.
   c) The project is for the purpose of research and/or teaching. It may not be of direct benefit to me. The privacy of the information I provide will be safeguarded. The privacy of the personal information I provide will be safeguarded and only disclosed where I have consented to the disclosure or as required by law. If I participate in a focus group I understand that whilst all participants will be asked to keep the conversation confidential, the researcher cannot guarantee that other participants will do this.
   d) The security of the research data is assured during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided to Diana Klein. Any information which may be used to identify me will not be used unless I have given my permission (see point 5).

Participant's Consent

Name: 
Date: 

(Participant)

Name: 
Date: 

(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. Details of the complaints procedure are available at: http://www.rmit.edu.au/rd/hrec_complaints.
Is it possible that the fibres we come into contact with on a daily basis protect us, or are they creating a hostile environment?

A study at RMIT School of Architecture and Design aims to recruit about 15-20 women aged 18 – 35 years to take part in a wear trial. Ideal volunteers would be those who work in an administrative role and who would be willing to wear a T shirt for an eight hour work day. At the end of each wear day, volunteers are required complete a questionnaire designed to capture personal responses to the wear experience.

To volunteer for the clothing fibre study call Diana Klein on 99252781 or email diana.klein@rmit.edu.au
Appendix 7
Schedule for the wear days of trial

INSTRUCTIONS FOR THE (8 HOUR) WEARING DAY’S

T shirt to be ‘donned’ ½ an hour after arriving at work. This is to allow time for the body to calm down.
T shirt must not be removed during the course of the 8 hours
Underwear needs to be minimal.

T shirt must not be worn outside air conditioned environments. Pack a lunch.

SCHEDULE

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Appendix 8

Questionnaire survey

See following page
22. Does wearing the t-shirt make your body feel cool?

23. Does wearing the t-shirt make your body feel sweaty or clammy?

24. Do you consider the t-shirt would be comfortable to wear over an extended period? (e.g. more than 8 hours)

25. Did the t-shirt feel cold when it first made contact with your body?

26. Do you feel more energised when wearing the t-shirt?

27. Did the t-shirt warm up during the wear trial?

28. Did you feel more anxious than usual when wearing the t-shirt?

Please respond to the following statements:

29. I was relieved to take off the t-shirt.

30. I felt less able to concentrate at work wearing this t-shirt.

31. I felt anxious for most of the day.

32. The t-shirt feels soft and gave me a wrapped & nurtured feeling.

33. I took off the t-shirt for several hours during the day.

34. Today was an extremely busy day.

35. I felt the day was very stressful.

36. I had a very successful day.

Please rate the following according to their importance in your choice of a perfect t-shirt:

37. It has to feel soft against my skin.

38. It has to absorb perspiration from my body.

39. It has to drape well on my body.

40. It is important that I will feel good when wearing the t-shirt.

41. It is important that the t-shirt is roomy.

Were you in any pain requiring the administration of analgesics?

ON COMPLETION OF THE TRIALS, PLEASE PUT THE GARMENTS IN THE ORDER IN WHICH YOU PREFER THEM STARTING WITH 1 FOR YOUR FIRST CHOICE THROUGH TO 4 FOR YOUR LEAST PREFERRED.
Preliminary Instructions

1. These questionnaires are an important part of a pilot study being run to test the comfort of fabrics in common use. The questions are designed to collect information about how the wearing of certain fabrics affects your quality of life from your own point of view.

2. Complete the questionnaire using a ballpoint pen. Press firmly and neatly when writing to ensure copies are clear and legible.

3. Please take the time to read and answer each question carefully. Some questions may look like others, but each one is different.

4. Please answer every question by circling the number that best describes your answer. Please give the best answer you can.

5. There are no right or wrong answers. If you are unsure about how to answer a question, please give the best answer you can.

6. Your answers are confidential. The study co-ordinator will check for completeness only and not share your answers with other staff.

Glossary

Cover - Refers to a fabric’s transparent or opaque nature.
Clammy - Describes the moisture ‘build-up’ between a fabric and the skin’s surface.
Cling - When a fabric ’grips’ the skin surface and prevents the free movement of air around the body.
Drag - When a fabric restricts body movement.
Itch - Sensation which encourages the wearer to scratch.
Prickly - Sensation of mild stabbing.
Riding Up - Unwanted movement of fabric, not returning to original position.
Return - Ability of a texture to go back to, or maintain it’s original dimensions.

Example

1 2 3 4 5 6 7
NOT AT ALL A LITTLE A LOT YES NO

The following set of questions invite you to explore, describe and represent your experiences whilst wearing an assortment of t-shirts. Please read the categories carefully.

In the event of any problems, please contact Diana Klein on (03) 9925 2781 or DIANA.KLEIN@RMIT.EDU.AU

Please do not wash the garment after wearing.

Preliminary Questions

1. Do you work in a temperature controlled environment? YES NO
2. Do you know the temperature? YES NO
   If so, what is the temperature? ____________________________
3. Is your work mostly sedentary? YES NO
4. Did you walk to work? YES NO
   If so, how long was the walk? ____________________________
5. Did you cycle to work? YES NO
   If so, how long was the ride? ____________________________
6. Do you rely on artificial lighting to do your work? YES NO
7. Is the floor surface in your work environment covered in a synthetic fibre? YES NO
8. Are the fibre compositions in any of the clothing you are wearing under the t-shirt predominantly natural in origin? (e.g. cotton, silk) YES NO
9. Are these fibres predominantly synthetic in origin? (e.g. polyester, nylon) YES NO
10. In your understanding of your body and in your opinion, were the trials carried out when you were feeling your best? YES NO
11. Do you usually wear fitted clothing? YES NO
12. Do you usually wear a t-shirt? YES NO
13. During the trial period, how ‘aware’ were you of the t-shirt as you worked? ____________________________
14. Do you consider the t-shirt to be a heavier t-shirt than you would normally wear to work? ____________________________
15. Do you consider the t-shirt gives you enough modesty? (protection) ____________________________
16. Do you consider the t-shirt prevents your body’s natural ability to modulate temperature? ____________________________
17. Does the t-shirt feel smooth against your skin? YES NO
18. Does the t-shirt prickle? YES NO
19. Does the t-shirt itch? YES NO
20. Does the t-shirt create unwanted cling? YES NO
21. Does the t-shirt feel slippery? YES NO
Appendix 9

Data Collection

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Appendix 10

Statistical Data Analysis

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Appendix 11.

Analysis of data (in three stages).

Stage 1. Collating of data.

The three comfort determinants for fabric performance.

T shirt fibre compositions numbered as:

- Cotton 1
- Wool 2
- Polyester 3
- Viscose 4

COMFORT
SENSORIAL (12)

13. During the trial period, how 'aware' were you of the t-shirt as you worked?

**MOST** Polyester - Wool - Cotton - Viscose  **LEAST**
Biggest differences: 1 v 2 3 v 4 1 v 3 2 v 4
i.e. Cotton and wool; polyester and viscose; cotton and polyester; wool and viscose

15. Do you consider the t-shirt gives you enough modesty? (protection)

**MOST** Cotton - Wool - Polyester - Viscose  **LEAST**
Biggest differences: 1 v 4
i.e. cotton & viscose

17. Does the t-shirt feel smooth against your skin?

**MOST** Viscose - Cotton - Polyester - Wool  **LEAST**
Biggest differences: 3 v 4 2 v 4 1 v 4
i.e. polyester & viscose; wool & viscose; cotton & viscose

18. Does the t-shirt prickle?

**MOST** Wool - Polyester - Cotton - Viscose  **LEAST**
Biggest differences: 1 v 2 3 v 4 2 v 4
i.e. cotton & wool; polyester & viscose; wool & viscose

19. Does the t-shirt itch?

**MOST** Wool - Polyester - Cotton - Viscose  **LEAST**
Biggest differences: 1 v 2 2 v 4
i.e. cotton & wool; wool & viscose;

21. Does the t-shirt feel slippery

**MOST** Polyester - Viscose - Wool - Cotton  **LEAST**
Biggest differences: 2 v 3 1 v 3 2 v 4 1 v 4
i.e. wool & polyester; cotton & polyester; wool & viscose; cotton & viscose
24. Do you consider the t-shirt would be **comfortable to wear over an extended period**? (e.g. more than 8 hours)

**MOST**  
Viscose - Cotton - Wool - Polyester  
**LEAST**

Biggest differences:  
3 v 4  
1 v 3  
2 v 4  
i.e. polyester & viscose; cotton & polyester; wool & viscose

26. Do you feel more **energised** when wearing the t-shirt?

**MOST**  
Viscose - Cotton - Wool - Polyester  
**LEAST**

Biggest differences:  
3 v 4  
i.e. cotton & polyester;

28. Did you feel more **anxious** than usual when wearing the t-shirt?

**MOST**  
Polyester - Wool - Cotton - Viscose  
**LEAST**

Biggest differences:  
3 v 4  
1 v 3  
i.e. polyester & viscose; cotton & polyester;

29. I was **relieved** to take off the t-shirt.

**MOST**  
Polyester - Wool - Cotton - Viscose  
**LEAST**

Biggest differences:  
1 v 2  
2 v 3  
3 v 4  
i.e. cotton & wool; wool & polyester; polyester & viscose

30. I felt better able to **concentrate** at work.

**MOST**  
Polyester - Wool - Cotton - Viscose  
**LEAST**

Biggest differences:  
3 v 4  
i.e. polyester & viscose;

31. I felt **anxious for most of the day**. [No marked differences here]

**MOST**  
**LEAST**

32. The t-shirt feels soft and gave me a **wrapped & nurtured** feeling.

**MOST**  
Viscose - Cotton - Wool - Polyester  
**LEAST**

Biggest differences:  
2 v 3  
1 v 3  
2 v 4  
i.e. wool & polyester; cotton & polyester; wool & viscose

**MECHANICAL (2)**

14. Do you consider the t-shirt to be a **heavy garment** to wear?

**MOST**  
Cotton - Polyester - Wool - Viscose  
**LEAST**

Biggest differences:  
2 v 4  
3 v 4  
1 v 3  
1 v 4  
i.e. wool & viscose; polyester & viscose; cotton & polyester; cotton & viscose

20. Does the t-shirt create **unwanted cling**?
MOST Polyester - Viscose - Cotton - Wool LEAST
Biggest differences: 2 v 3 3 v 4 2 v 4
i.e. wool & polyester; polyester & viscose; wool & viscose

THERMAL (5)

16. Do you consider the t-shirt prevents your body’s natural ability to modulate temperature?
MOST Polyester - Cotton - Wool - Viscose LEAST
Biggest differences: 3 v 4? 1 v 4?
i.e. polyester & viscose; cotton & viscose

22. Does wearing the t-shirt make your body feel cool?
MOST Viscose - Polyester - Cotton - Wool LEAST
[No marked differences here]

23. Does wearing the t-shirt make your body feel sweaty or clammy?
MOST Polyester - Cotton - Wool - Viscose LEAST
Biggest differences: 2 v 3 3 v 4
i.e. wool & polyester; polyester & viscose;

25. Did the t-shirt feel cold when it first made contact with your body?
MOST Polyester - Viscose - Wool - Cotton LEAST
Biggest differences: 1 v 3
i.e. wool & viscose; polyester & viscose; cotton & polyester; cotton & viscose

27. Did the t-shirt warm up during the wear trial?
MOST Wool - Cotton - Polyester - Viscose LEAST
[No marked differences here]

Although aware of the following, in hindsight I needed to investigate different language to facilitate questions that went closer the mark. The questions need to be crafted to reflect more closely exactly what I want to prove.

Twenty questions (from a surveyed 41) closely address the three comfort measures of textile performance. They were in the context of the sensorial, the mechanical and the thermal expressions of comfort.

Only the remarkable differences were considered worthy of analysis. Questions 32 – 41 responses showed no marked differences recorded across the volunteers.
The volunteer responses to some of the questions I expected to fill these criteria (see 33 – 36, 40) were unremarkable in their differences therefore not useful at the point of analysis.

33. I took off the t-shirt for several hours during the day.
34. Today was an extremely busy day.
35. I felt the day was very stressful.
36. I had a very successful day
37. It has to feel soft against my skin
38. It has to absorb perspiration from my body
39. It has to drape well on my body
40. It is important that I will feel good when wearing the t-shirt
41. It is important that the t-shirt is roomy.
Stage 2. Collating of data.

The four T-shirts were rated out of 4 according to the various properties (1 is most and 4 is least).

**SENSORIAL COMFORT**

**COTTON**

Comfort awareness – 3 and no difference when compared to viscose

Modesty – 1 and no difference when compared to wool

Smooth – 2 and no difference when compared to polyester and wool

Prickle – 3 and no difference when compared to polyester and viscose

Itch - 3 and no difference when compared to polyester and viscose

Slippery - 4 and no difference when compared to wool

Extended wear - 2 and no difference when compared to wool and viscose

Energised - 2 and no difference when compared to wool and viscose

Anxious - 3 and no difference when compared to wool and viscose

Relieved - 3 and no difference when compared to polyester and viscose

Concentration - 3 and no difference when compared to wool, polyester, viscose

Nurtured - 2 and no difference when compared to wool and viscose

**WOOL**

Comfort awareness – 2 and no difference when compared to wool and polyester

Modesty – 2 and no difference when compared to cotton and polyester

Smooth – 4 and no difference when compared to cotton and polyester

Prickle – 1 and no difference when compared to polyester

Itch - 1 and no difference when compared to polyester

Slippery - 3 and no difference when compared to cotton and polyester

Extended wear - 3 and no difference when compared to cotton and polyester

Energised - 3 and no difference when compared to polyester and viscose

Anxious - 2 and no difference when compared to cotton, polyester and viscose

Relieved - 2 and no difference when compared to viscose

Concentration - 2 and no difference when compared to cotton, polyester, viscose

Nurtured - 3 and no difference when compared to cotton
POLYESTER

Comfort awareness – 1 and no difference when compared to wool
Modesty – 3 and no difference when compared to viscose and wool
Smooth – 3 and no difference when compared to wool
Prickle – 2 and no difference when compared to wool and cotton
Itch - 2 and no difference when compared to wool, cotton and viscose
Slippery - 1 and no difference when compared to viscose
Extended wear - 4 and no difference when compared to wool
Energised - 4 and no difference when compared to wool
Anxious - 1 and no difference when compared to wool
Relieved - 1 and no difference when compared to and cotton
Concentration - 1 and no difference when compared to wool, cotton
Nurtured - 4 and no difference when compared to viscose

VISCOSE

Comfort awareness – 4 and no difference when compared to cotton
Modesty – 4 and no difference when compared to polyester
Smooth – 1 and no differences
Prickle – 4 and no difference when compared to cotton
Itch - 4 and no difference when compared to polyester and cotton
Slippery - 2 and no difference when compared to polyester
Extended wear - 1 and no difference when compared to cotton
Energised - 1 and no difference when compared to cotton
Anxious - 4 and no difference when compared to wool and cotton
Relieved - 4 and no difference when compared to wool and cotton
Concentration - 4 and no difference when compared to wool, cotton
Nurtured - 1 and no difference when compared to polyester and cotton

MECHANICAL COMFORT
### COTTON
- **Weight**: 1 and no difference when compared to polyester and viscose
- **Cling**: 3 and no real differences

### WOOL
- **Weight**: 3 and no difference when compared to viscose
- **Cling**: 4 and no difference when compared to polyester and viscose

### POLYESTER
- **Weight**: 2 and no difference when compared to viscose and cotton
- **Cling**: 1 and no difference when compared to wool and viscose

### VISCOSE
- **Weight**: 4 and no difference when compared to wool, polyester and cotton
- **Cling**: 2 and no difference when compared to polyester and wool

### THERMAL COMFORT

#### COTTON
- **Temperature modulation**: 2 and no difference when compared to viscose
- **Cool**: 3 and no real differences when compared to other fibres
- **Clammy**: 2 and no real differences when compared to other fibres
- **Cold sensation**: 4 and no difference when compared to polyester
- **Warm up**: 2 and no real differences when compared to other fibres

#### WOOL
- **Temperature modulation**: 3 and no real differences when compared to other fibres
<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Cool</td>
<td>4 and no real differences when compared to other fibres</td>
</tr>
<tr>
<td>Clammy</td>
<td>3 and no difference when compared to polyester</td>
</tr>
<tr>
<td>Cold sensation</td>
<td>3 and no real differences when compared to other fibres</td>
</tr>
<tr>
<td>Warm up</td>
<td>1 and no real differences when compared to other fibres</td>
</tr>
</tbody>
</table>

**POLYESTER**

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature modulation</td>
<td>1 and no difference when compared to viscose ?</td>
</tr>
<tr>
<td>Cool</td>
<td>2 and no real differences when compared to other fibres</td>
</tr>
<tr>
<td>Clammy</td>
<td>1 and no difference when compared to wool and viscose</td>
</tr>
<tr>
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</tbody>
</table>

**VISCOSE**

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</thead>
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<td>2 no real differences when compared to other fibres</td>
</tr>
<tr>
<td>Warm up</td>
<td>4 no real differences when compared to other fibres.</td>
</tr>
</tbody>
</table>
Stage 3. Reflections on the data.

Before the writing could commence, some reflection was needed on the data generated by the trials. The following documents the process.

| COTTON | 1 |
| WOOL   | 2 |
| POLYESTER | 3 |
| VISCOSE | 4 |

A Leichardt Scale was employed to capture the responses from 1-7. In this case 1 represented little to no response and 7 represented a significant response.

Method:
It was important to firstly find where the differences in responses were between the groups. It was at the point of biggest differences that I needed to concentrate my writing findings. When the difference was significant, it meant there was likelihood of a real difference between the T-shirts.

The questions were grouped according to whether they referred to Sensorial, Mechanical or Thermal comfort. This grouping took into account both the physiological and psychological aspects of comfort. Look for trends.

Look into the groups with differences and summarise the result of each T-shirt (eg for question 13 below, the cotton and Viscose shirts had a significantly lower score than Wool and Polyester groups (No difference between cotton and viscose. No difference between polyester and wool)

What did that mean? Was this in line with the research hypothesis?

COMFORT
SENSORIAL (12)

The discussions were imbedded into the writing chapters on wellbeing and comfort.

13. During the trial period, how ‘aware’ were you of the t-shirt as you worked?
Awareness can be interpreted in different ways but for the purpose of this research relating to well-being it is understood that a comfortable body is one in which there is no experience of discomfort, in this case the state achieved when the individual is so unaware of the fabric being worn on a particular day that they cannot remember the T-shirt on the following day.

FINDINGS:

| MOST aware | Polyester | Wool | Cotton | Viscose |
| LEAST aware | Polyester | Viscose |

The significant differences in responses were between:
1. Cotton and Wool
2. Polyester and Viscose
3. Cotton and Polyester and
4. Wool and Viscose.

[No difference between cotton and viscose. No difference between polyester and wool].

The volunteers experienced the most awareness of polyester and the least awareness of viscose. The results are in keeping with the background reading on fibre structures if hard and soft ‘hand’ are determinants of awareness because polyester fibre is derived from petroleum (synthetic chemical
composition) which creates a hard fibre and viscose, a low density cellulose (chemical composition) fibre has the softest hand of the trial fibres.

Polyester is the most hydrophobic of the trial fibres (lowest vapour transmission / absorbency) and in the office environment it would become more dry and prone to collecting static electricity. Conversely viscose is the most hydrophilic (highest absorbency of the fibre’s tested) able to absorb vapour from the body making it less prone to electrical charge build up.

1. **Cotton and Wool**
   Chemical compositions are different: cellulose compared to protein
   Therefore the comfort properties will be very different i.e. density, electrical conductivity, elasticity, absorption and thermal retention.
   Other properties that will be different include aesthetics e.g. appearance retention; durability; chemical resistance, and environmental resistance.

   **Cotton** has a crisp hand creating a more rigid silhouette in the trial t-shirt despite the numerous washes undertaken prior to wearing.

   The volunteer responses to **wool** will vary but all would be aware of its unique texture (hand) resulting from its scaled and crimped morphology.

2. **Polyester and Viscose**
   Chemical compositions are different: synthetic (polyester) compared to cellulose (viscose).
   Therefore the comfort properties will be different.
   Polyester is derived from petroleum product creating a hard fibre.
   Viscose is derived from cellulose (chemical composition) and has the softest hand of the trial fibres.
   in particular electrical conductivity and absorption.

   There will be similarities with aesthetic properties e.g. drape, texture and lustre.

3. **Cotton and Polyester**
   Chemical compositions are different (cellulose compared to synthetic); therefore the comfort properties will be very different in particular **absorbency** and **electrical conductivity**. The awareness of a lack of absorbency can be experienced over an eight hour trial period.

   The fibres that are particularly dry, that is they have little moisture available to disperse the charges (typical of synthetic fibre compositions due to their chemical composition and fibre morphology’s) contribute to an individual’s store of electricity in their body (the ‘load’). The evidence of any built up electrical charges are hidden and therefore may not become apparent. Add to this the fact individuals carry different amounts of electricity in their bodies and some are more aware of the effects upon their well-being.

   Both fibres create fabric with diversely different **drape** which would have been a primary reason for differences in perception and therefore awareness. Cotton creates a crisp silhouette due to its staple twisted ribbon morphology whereas polyester with its smooth filament structure will lie closer to the body.

4. **Wool and Viscose.**
   Different chemical compositions: protein cf. cellulose.
   Comfort properties will be very different in particular thermal retention and absorption
   They share some properties considerate of comfort i.e. highly absorbent, flexible, have high elongation, low dimensional stability
   Viscose moves with the body.

   [No difference between wool and polyester. These two fibres are from different chemical groups and therefore have different properties for example, wool’s texture or hand compared to polyester and the differences in their hygroscopic nature. If this is the case it will be born out in the questions relating specifically to these properties. Meanwhile the reason for the lack of differences can be explained when one takes into account the wide range of individual perceptions
   No difference between cotton and viscose…. the chemical composition of these two fibres…both being cellulose means they have similar properties relating to comfort i.e. density, electrical conductivity, elasticity, absorption and thermal retention (among others that may not be relevant to this research). However the ‘hand’ of cotton and viscose are disparate so volunteer responses were unexpected].

15. Do you consider the t-shirt gives you enough **modesty? (protection)**
For the purpose of this research relating to well-being it is understood that modesty means low to no exposure of the body or any garments worn under the t-shirt.

**MOST**  
Cotton - Wool - Polyester - Viscose  
**LEAST**

Biggest differences: cotton & viscose

1. **Cotton & viscose**
   Volunteers experienced cotton to be the fibre that provided them with the most modesty and viscose the least. Difference would be due to the inherent density and drape of the two knit fabrics used in the trials. Cotton has high cover and a sharp silhouette whereas viscose has low cover and an almost 'liquid' drape, running close to body contours.

   [No difference between cotton and wool.

   Although affording different degrees of 'cover' against a light source, the fabrics were both dense enough to provide sufficient modesty.

   No difference between wool and polyester.

   Wool and polyester shared similar properties of 'cover' and are also the two fabric's that are most similar in offering 'protection':

   No difference between Polyester and viscose.

   These fibres exhibit similar 'cover' unless in front of a light source. The polyester fabric is quite noticeably different to the viscose fabric due to the air holes in the construction which allows the light to penetrate. The viscose T-shirt drapes closer to the body which possibly is perceived as affording less modesty. Despite this however the volunteers felt that the polyester offered them more modesty.

   Cotton and polyester due to their different silhouettes (polyester runs closer to the body than cotton) may have been perceived as not offer the same 'protection' simply because the cotton fabric would drape from the shoulders and polyester would rest against the body’s contours.

   Wool offers more modesty than viscose because of the difference in drape (modesty is not afforded in front of a light source) but the difference is not sufficient for discussion as the fabric’s are the most alike out of all the trial T-shirts in relation to this property.

17. Does the t-shirt feel **smooth** against your skin?

**MOST**  
Viscose - Cotton - Polyester - Wool  
**LEAST**

Biggest differences: polyester & viscose; wool & viscose; cotton & viscose

Viscose is the smoothest against the skin and wool is the least smooth. The viscose fibre has no remarkable morphological features being a long, smooth filament structure and wool has scales and a crimped staple structure.

Cotton was perceived as the next smoothest despite its staple, convoluted fibre morphology. This result may be due to polyester's synthetic chemical composition which creates a hard but smooth fibre.

The marked (biggest) differences in responses were between:

1. **Polyester and Viscose**
2. **Wool and Viscose.**
3. **Cotton and Viscose.**

   [No difference between cotton and wool; wool and polyester; cotton and polyester].

1. **Polyester and Viscose** are both filament fibres (lie close to the skin) therefore not in line with the research readings. The 'smooth' perception for viscose would be partly to do with the irregular polyester knit construction. At the time of sourcing fabric it was not possible to purchase a100% polyester due to its poor lack of absorption reputation hence a sport version was substituted which had tuck stitches creating ventilation holes to allow the transmission of vapour from an exercising body. The T-shirt would have been perceived as less smooth because of this construction detail.
2. Wool and Viscose.
This difference can be explained due to the different fibre morphology’s and yarn structures. (Wool has overlapping scales and a crimped staple whereas viscose is a continuous and smooth filament structure). The staple fibres are twisted together to create a continuous yarn whereas the filament fibres are bundled and less bulky in nature.

3. Cotton and Viscose.
Cotton is a staple fibre therefore has protruding ends which contributes to the less smooth nature of the fabric (although the t-shirt uses good quality cotton with long fibres therefore less possible ‘fuzz’). The cotton t-shirt has higher ‘cover’ than the viscose t-shirt with a higher thread count.

[No difference between cotton and wool. Both cotton and wool are natural fibres so feel soft initially in the hand, lacking any underlying harshness; however this outcome does not conform to the readings on these fibres.

No difference between wool and polyester. Also is surprising when considering their different morphology’s.
The same applies to cotton and polyester].

18. Does the t-shirt prickle?

MOST Wool - Polyester - Cotton - Viscose LEAST
Biggest differences: cotton & wool; polyester & viscose; wool & viscose

The volunteers experienced the most ‘prickle’ from the wool fibre and the least from the viscose. (Noticeably, the mean volunteer response to wool prickle was high) The results are in keeping with the background reading on wool and the ‘prickle factor’.

Why would polyester ‘prickle’ cf. cotton and viscose?
- May be due to the chemical composition creating a hard fibre? (synthetic polyester cf. cellulose cotton and viscose)
- All the t-shirts were washed – times which would soften the cotton and viscose but make no difference to polyester.

The marked (biggest) differences in responses were between:
1. Cotton and wool
2. Polyester and Viscose
3. Wool and Viscose.

[No differences between wool and polyester; cotton and polyester; cotton and viscose]

1. Cotton and wool
Cotton (twisted ribbon morphology) vs. wool fibre (fibre diameter, crimp and scales). The crimp and overlapping scales in the wool fibre morphology mean that wool is a fibre that has the potential to create discomfort. Dependent upon the diameter of each wool fibre this irritation can be unbearable for the wearer.

2. Polyester and Viscose
May be due to the chemical composition (synthetic) and associated hard hand of polyester compared to the soft hand of the viscose (cellulose).

3. Wool and Viscose.
Wool fibre (scales, staple structure vs. viscose filament)

[No differences between wool and polyester This is not in keeping with the literature but confirms the possibility that polyester is a fibre that creates some skin discomfort possibly scratchy as opposed to prickly? Cotton and polyester displaying little difference means that cotton is also abrasive in some way? The volunteer understanding of the term ‘prickle’ may require clarification.

Cotton and viscose being similar is understandable. They are both derived from the same chemical group and therefore share many properties. Add to this, the viscose is the softest fibre of all those used in the trials].
19. Does the t-shirt itch?
MOST Wool - Polyester - Cotton - Viscose LEAST
Biggest differences: cotton & wool; wool & viscose;

Findings are expected to be similar to question 18 (prickle) given that language used to describe some sensations may be an issue. (prickle and itch may equate to the same sensation for some of the volunteers).

As expected however unlike question 18 where Polyester and viscose were markedly different, polyester and viscose are not sufficiently different in terms of itch to warrant discussion.

The marked (biggest) differences in responses were between:

1. Cotton and wool
   In this case, wool would be the itchy (as expected) largely due to the ‘prickle factor’.

2. Wool and Viscose.
   Also as expected

   [No differences between wool and polyester?
   Polyester and viscose; in keeping with expectations from reading; cotton and polyester; ditto
   cotton and viscose; ditto].

21. Does the t-shirt feel slippery?
MOST Polyester - Viscose - Wool - Cotton LEAST
Biggest differences: wool & polyester; cotton & polyester; wool & viscose; cotton and viscose

The volunteers felt that polyester was the most slippery and cotton was the least.

The marked (biggest) differences in responses were between:
1. Cotton and polyester
2. Wool and Viscose.
3. Cotton and viscose

[No differences between cotton and wool; polyester and viscose];

1. Cotton and polyester
Given the chemical composition (cellulose vs. synthetic) and yarn structure differences (staple vs. filament) this response is understandable. Both wool and cotton have ‘grip’ i.e. resistance to surface sliding.

2. Wool and Viscose.
Wool is more ‘grippy’ which is in keeping with its crimped and scaled staple structure and viscose is filament (smooth) therefore slides over the skin.

3. Cotton and viscose
Although both cellulose, cotton is a staple fibre (short and spun which creates more grip)

[No differences between cotton and wool as both are natural staple therefore ‘grippy’ fibres
No differences between Polyester and viscose both being filament structures they would be equally slippery].
24. Do you consider the t-shirt would be **comfortable to wear over an extended period**? (e.g. more than 8 hours)

**MOST** Viscose - Cotton - Wool - Polyester **LEAST**

The viscose t-shirt was considered the most comfortable to wear over an extended period and polyester the least.

The marked (biggest) differences in responses were between:
1. Polyester and Viscose
2. Cotton and polyester
3. Wool and Viscose.

*No differences between cotton and wool; wool and polyester; the 'prickle factor' of wool; cotton and viscose; the slippery nature of viscose*

---

26. Do you feel more **energised** when wearing the t-shirt?

**MOST** Viscose - Cotton - Wool - Polyester **LEAST**

Biggest differences: cotton & polyester

The volunteers responded that wearing the viscose t-shirt made them feel more energised and polyester made them feel less energised.

The marked (biggest) differences in responses were between:
1. Cotton and polyester

*No differences between cotton and wool; wool and polyester; wool and viscose and cotton and viscose.*

*The few differences indicate that volunteers were unaware of an energy sensation.*

---

28. Did you feel more **anxious than usual** when wearing the t-shirt?

**MOST** Polyester - Wool - Cotton - Viscose **LEAST**

The marked (biggest) differences in responses were between:
1. Polyester and Viscose
2. Cotton and polyester

*There were no differences between cotton and wool; wool and polyester; wool and viscose; cotton and viscose.*

---

29. I was **relieved** to take off the t-shirt.

**MOST** Polyester - Wool - Cotton - Viscose **LEAST**

The marked (biggest) differences in responses were between:
1. Cotton and wool
2. Wool and polyester.
3. Polyester and Viscose

*There were no differences between cotton and polyester; wool and viscose; cotton and viscose.*
30. I felt better able to **concentrate** at work.

**MOST** Polyester - Wool - Cotton - Viscose  **LEAST**

The marked (biggest) differences in responses were between:
1. Polyester and Viscose

[There were no marked differences between cotton and wool; wool and polyester; cotton and polyester; wool and viscose and cotton and viscose]. This is the same outcome as question 19 which tallies up with the itch factor of 19 and the concentration factor of 30.

31. I felt **anxious** for most of the day.

[No marked differences here]

32. The t-shirt feels **soft** and gave me a **wrapped & nurtured** feeling.

**MOST** Viscose - Cotton - Wool - Polyester  **LEAST**

The marked (biggest) differences in responses were between:
2. Cotton and polyester
3. Wool and Viscose.

[No differences between cotton and wool; polyester and viscose; cotton and viscose]
14. Do you consider the t-shirt to be a heavy garment to wear?

**MOST**  Cotton - Polyester - Wool - Viscose  **LEAST**

The marked (biggest) differences were between:
1. Wool & viscose
2. Cotton & polyester
3. Cotton & viscose

[No differences between]

20. Does the t-shirt create unwanted cling?

**MOST**  Polyester - Viscose - Cotton - Wool  **LEAST**

Biggest differences:  2 v 3  3 v 4  2 v 4  

i.e.  polyester & viscose; wool & viscose

[No differences between: cotton and wool; cotton and polyester]

16. Do you consider the t-shirt prevents your body’s natural ability to modulate temperature?

**MOST**  Polyester - Cotton - Wool - Viscose  **LEAST**

Biggest differences:  polyester & viscose; cotton & viscose

[No differences between cotton and wool; wool and polyester; cotton and polyester; wool and viscose]

22. Does wearing the t-shirt make your body feel cool?

**MOST**  Viscose - Polyester - Cotton - Wool  **LEAST**

[No marked differences here]

23. Does wearing the t-shirt make your body feel sweaty or clammy?

**MOST**  Polyester - Cotton - Wool - Viscose  **LEAST**

Biggest differences:  ; polyester & viscose;

[No differences between: cotton and wool; cotton and polyester; wool and viscose; cotton and viscose]
25. Did the t-shirt feel cold when it first made contact with your body?

MOST Polyester - Viscose - Wool - Cotton

LEAST

Biggest differences: cotton & polyester;

[ No differences between: wool and cotton; cotton and polyester; polyester and viscose; wool and viscose; cotton and viscose]

27. Did the t-shirt warm up during the wear trial?

MOST Wool - Cotton - Polyester - Viscose

LEAST

[No marked differences here]

On concluding the analysis of findings the INVERTED questions have been the most troublesome to analyse. Hence, any future trials would benefit from re-wording the questions, to make the process more straightforward.
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