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**The role of the Fashion
Designer with regard
the emergence of
Smart textiles and
Wearable technology.**

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INTRODUCTION

Forward

The need to clothe one's body is an innate response to protecting our bodies from environmental conditions. Clothing has evolved to reveal a person's personality as well as their emotional state, indicated by the colours they wear and the way one holds themselves in their attire.

'Clothing is our own house'. Society evolves, lives and feels within clothing. We treasure different moments in our lives and remember what we were wearing when we experienced that special moment. Clothing can impress or discourage a person. It can influence judgement and it can reveal desire and creativity presenting a much larger area to scrutinise compared to that of any other expressible part of the body. (Flugel, 30, p15)

Clothing in the western world - elaborate leathers, laser cut denim and intricate embroidered dresses are seemingly extravagant appendages compared to that of people in other cultures - entered into our existence, as social beings. Clothing earned a social status when it became a form of expression, another mode for which people could display or disguise their emotions.

Psychologists have deduced three main areas as to why one wears clothing; that is for purposes of decoration, modesty and protection. (Flugel, p16, 30). All three purposes propose very different fundamental importance among people in society but today, in the 21st century, it is evident that there is another purpose for clothing, and that is for prevention. If a garment was capable of indicating to the wearer - through the use of colour reacting dyes - that there was CO₂ in a house they inhabited, this garment could prevent an unnecessary death. Similarly, for the purpose of protection for professionals who work in hazardous conditions, wearable technology could also

prevent injury or loss of a life. Wearing a garment that responds to its surroundings would be invaluable in the area of professional security. Other areas of prevention medicine and prevention in terms of professional security shall be divulged later in the thesis.

The introduction of wearable technology or smart textiles will bring about a form of protection that surpasses any average textile protection of the 21st century seen so far. This advancement in technology and science can be translated into the fibres of clothing, which in turn, means that a simple jacket can perform as a protecting layer for professional motorcyclists or in a construction industry where hazardous conditions are a threat to all. A simple structure common to all is that of a jacket, this structure could be modified to protect a body from harm; such is the case of the LQ Jacket of Grado Zero Espace. More detail regarding the science behind the LQ jacket will be illustrated in chapter three.



Fig 1 – LQ Jacket, Grado Zero Espace

This thesis aims to provide an insight into the future(s) of smart textiles and wearable technology and how the evolution of dress has evolved to furnish the population with scientifically advanced or technology based clothing. John Carl Flugel provides a theoretical foundation behind the psychology of clothing and how one dresses in chapter one. George Howard Darwin who initiated the theory of the evolution of dress

also plays an important role in the theoretical foundation of this thesis. Chapter one will also demonstrate how the evolution of dress is correlated with the evolution of animals based on the theories of Flugel, and Darwin.

Chapter two will furnish the reader with a brief history of the emergence of smart textiles and what has been possible to date with advancements in technology.

Following on from the theoretical grounding from Flugel in chapter one, this thesis will broach the subject of nature as the original designer and how biomimicry has brought about many integral innovations that are evidentially used throughout the world of design. A source of inspiration for design is from the structures employed by nature, which is formally known as biomimicry.

Chapter three will attempt to articulate the diversity in the fashion industry today, in terms of technology integration and the evolution of the fashion designer working within a multidisciplinary workplace. It will also divulge how an intelligent garment is considered intelligent and discuss the components that make an intelligent garment differ from smart textiles.

This chapter will also furnish the reader with two very different projects, the first the LQ jacket, an example of a smart garment courtesy of Grado Zero Espace and the second is an example of how Jalila Essadi, an artist who collaborated with scientists to create bulletproof skin, encountered difficulties in communication and experimentation. (Appendix C)

Our ever-innovating world requires one to alter their perception of the world, perception of people and the perception of technology and our environment. It requires one to adapt quickly as animals adapt to survive. A similar principle is

applied to the industry of fashion. Adapt or die. A once acrid and bleak saying has become a mantra of many fast paced industries, such as the fashion industry and particular business sectors. What the final chapter in this thesis intends to demonstrate is that, due to nature in which technology and science has integrated with fashion, healthcare and professional security, a new customer has become apparent. Therefore a particular approach to design must be applied to the design process. Chapter four intends to articulate both the benefits and the disadvantages of intelligent responsive garments while also deducing the emergence of a novel role for fashion designers.

Research Methodology

To continue this investigation into the evolution of the fashion designer and the environment it will be necessary to adopt a method of research that will look into published literature, articles, journals, and company websites. However, due to the nature of the subject matter, there is a lack of information on the role of the fashion designer throughout the last ten years. Initial research will involve corresponding with various professionals via email who have participated in projects that have involved the development of wearable technology. All primary information received through correspondence can be seen in the appendices. All information gathered provided this thesis with the fuel to propose a novel role for the fashion designer in support of the evolution of animals and man.

Literature Review

The 'Psychology of Dress' written by J.C. Flugel in 1930 was hugely influential in the development and foundation of this thesis. Flugel's writings brought about an inquiry into the first theorist regarding the psychology of dress, which was George Howard Darwin, the son of Charles Darwin. With regard to design in society and the

role of the fashion designer in the evolution of technology and clothing, Tom Inns book 'Designing for the 21st century: interdisciplinary questions and insights' 2007 was useful when approaching novel design roles in the 21st century, however as a whole, Inns writing was too complex with regard to design strategies rather than design roles thus arose the need for primary information from designers working within the industry of smart textiles and wearable technology.

This thesis aims to highlight a new niche for fashion designers within the industry of wearable technologies and smart textiles. Supported by a theoretical foundation regarding the evolution of clothing, a designer is obliged to adapt to the environment as dress have evolved to suit the society it bears custom to.

CHAPTER 1

This chapter provides a theoretical grounding for an investigation into the psychology of clothing and more specifically the future(s) of fashion and the integration of computers in the fashion industry. The chapter will broach the subject of the psychology of dress and social theories behind what we wear and thus build a psychological foundation of reasoning for the reader regarding why one chooses to dress in a particular style. Various theories regarding dress from JC Flugel, to Wilfred Mark Webb to the original theorist on dress George Darwin have been considered throughout this thesis, thus the intention of this chapter is to furnish the reader with an interpretation of the evolution of dress. It will also look briefly at how intelligent clothing today was influenced the father of computer science Alan M. Turing.

‘It is the indirect expression of an individual through his garments, that tells us, for instance, that the person whom we ‘see’ approaching is one whom we know’. (Flugel, 30, p15)

According to J.C. Flugel’s ‘The Psychology of dress’, it is only when the reader views clothing with an analytical eye that they (the reader/clothed person) come to understand how clothing has evolved to be a social form of expression. As an alternative to words, Flugel believes that clothing is an indirect expression of human feelings and emotions. In his book, Flugel states that man, being a social being has imparted his personality onto that of his clothes. Clothes are an extension of how we feel or how we want to feel on a day-to-day basis. For example, a person who is in a position of power in the workplace wants to emulate their power through their dress; hence the suit is an example of how a professional can feel powerful in their title. Such appendages that were long ago simply a necessity for warmth now encompass many different connotations, interpretations and ideologies in today’s society. For

many, the fashion industry is a disposable industry due to multiple chain companies such as Pennys, H&M and Forever21. Though there is some truth in the belief that these companies solely promote disposable clothing, these companies have also provided every person from every society to acquire the latest fashion at an affordable price. The fashion industry, fast moving as it is, represents one of the major economic players on a global scale. Consequently, an expression of one's personality is not compromised due to lack of money. (Inns, 07, p299)

This section will explore some of the contradictions within Flugel's theory on the evolution of dress. To compare the evolution of clothes to the evolution of living forms is quite a philosophical and profound statement proposed by George Darwin in Flugel's 'The Psychology of Dress'. (Flugel, 30, p168) George Howard Darwin was the first man to distinguish a connection between the evolution of clothing and animals, and in 1872 in Macmillan's magazine, London, Darwin materialised his findings. He likened the living evolutionary changes between animals and their environments to that of clothing. He believed that such as the way people have given names to different species of cats and dogs, reptiles and mammals, humans have also given names to that of different types of clothing that cover different areas of the body depending on size, shape, colour and texture. (Flugel, 30, pg168)

Flugel also mentions in his book that it is possible to compare a whole type of garment with a species of animal, with this idea we might regard coats as one species and trousers as another, shirts as a third species and shoes as a fourth and so on. Likewise in the animal kingdom, lions are one species, elephants another. In both cases each individual member, be that clothing or animals, bears some resemblance to its immediate forefathers and in turn, hands down varying characteristics to its

descendants. For example, a shawl would be the forefather of dress and a descendant of a dress would be that of a cape and to further the evolution then, would evolve a jacket. Just as biology has taught us that one species may gradually develop from another species, there can be no doubt that one type of garment may have evolved from remote ancestors of quite a different type. (Webb, 12)

Along with Flugel, Wilfred Mark Webb believed that the evolution of dress was not dissimilar to the evolution of living things. Evidence of the evolution of man can be seen in our skeletons, where a particular vestigial bone referred to as the tailbone supports Charles Darwin's theory of the evolution of living things. However, today it has no particular use in the human structure, rather it is a record of our evolution as a species. Equivalently, evidence of the evolution of garments can be seen in vestigial ornamentation that once served a purpose in a particular garment. Firstly a contrasting stripe on men's evening trousers can be seen to hide a line of buttons on a soldier's uniform as the trousers were very usually too tight to pull on, therefore buttons were fitted to each side of the leg. The line of contrasting fabric was used to make a feature of concealing the buttons. Today the stripe is a mere display of decoration on dress pants. (Flugel, 30) This is an example of the natural changes that occur in fashion. Similarly, minute changes such as a strip that once served a purpose on soldier's trousers can be compared to natural evolutionary change in animals. An appendage that once had a function soon becomes a vestigial organ or a form of ornamentation. This is evidence of evolution is seen in dress and in animals.

'Clothes proper are of later origin, and, as we have already mentioned, would only be adopted for protective purposes after man had lost the greater part of his hairy covering'. (Webb, 12, pg10)

In the past our ancestors, the original humans, had no need for clothing. The bodies of the earliest man and woman were covered in a thick hair in order to keep warm in the cold and keep them cool in the sun. As time progressed it is believed by Webb and Darwin that man began to procreate with women with less hair, thus leaving behind a man with a great 'hairy covering'. (Webb, 12, p10) A reminder of this once 'hairy covering' is evident on every living being. Similar to the natural selection that occurred with the earliest man to produce a less hairy descendant, various types of clothing were also naturally selected. The survival of the most aesthetically pleasing creature/garment can be applied to the theory of evolution. Clothes have unrelentlessly evolved since its origin and over the centuries, fashion designers have adapted simultaneously. Each century records various modes of innovation with regard to dress and as time moves on, sometimes-vestigial remains can be seen on coats and dresses from the previous century as a reminder of its origin.

Modesty Vs Desire

Unfortunately, clothes being appendages that project the wearer's emotional and psychological state encompass conflicting feelings that Flugel believed to be the reason behind human attachment to clothing. Flugel believed that modesty was directly correlated with desire. Modesty being that which is not wishing to attract any unnecessary or unwanted attention from others. Desire being that which is a feeling of longing for or wishing for something that if obtained would bring satisfaction and/or enjoyment. Flugel speaks of modest clothes fighting the urge of desire, but in turn the act of modesty 'rekindles' feelings of desire. He supposes that through the disappearance of modesty, it will find its end, thus bringing desire to an end.

The Naked Society

Flugel had many controversial theories; the first mentioned above - modesty and desire - are completely correlated with each other. The second was a theory regarding a naked society. Flugel was content in believing that clothing would soon become obsolete and if a society rid themselves of clothing then desire and modesty would become a part of history such as clothing would. He wrote that until modesty can be abolished, clothing would always exist. Modesty embodied a combination of phallic and moral symbolism. It also brought about the need for clothing and for this reason, Flugel condemned modesty for 'distorting the appearance both of our bodies and minds', (Flugel, 30, p192)

'Indeed if,... we content ourselves with the simple equation of the immoral with the genitally sexual, these experiments show pretty conclusively that nakedness is a potent method of reducing immortality.' (Flugel, 30, p192)

Without the concern for being modest or worry of experiencing desire, Flugel believed the mind was free to embrace other thoughts thus extending the lives of many in society. From the investigation into Flugel's 'The Psychology of dress', this section has deduced that desire and modesty are two characteristics of human beings that breed within the mind; they are not a part of clothing. The feelings can be expressed through dress but the initial growth of desire/modesty begins in the human mind. The combination of clothing and the human mind can result in an elaborate expression of oneself however it is through the application of psychology to that of clothing where the fashion designer can truly begin to understand the task of designing for a specific need. The following chapter will deduce the application of technology to that of clothing and the development of such applications.

CHAPTER 2

This chapter proposes to illustrate how clothes have evolved over the centuries and how societies will have to accept technology-based clothing in the future. The average clothing that one is accustomed to wearing will emerge smarter and more efficient and adaptable to the environment of the 21st century. Due to the technologically fuelled society that exists today, designers must learn to adapt to the technological environment. Similarly, the way animals have evolved to suit the environment they inhabit; fashion designers will have to evolve to suit the 21st century.

Biomimicry is an example of designers and scientists adapting to the environment and borrowing from nature by taking aspects of nature's design - plant and animal survival - from nature to enhance our clothing. This chapter is an investigation as to how clothes can act as a foundation to house sensor technology, to improve clothing and make dress more adaptable to our current environment. That is, jackets that can keep our body temperature at a comfortable height in cold conditions and lower when in the body becomes over heated.

Alan Turing is considered the father of computer science. His 1950 paper on 'Intelligent Machinery' mentions artificial intelligence and machine development long before the first computer was materialised. He mentions that in order for an appliance to become intelligent, it must be trained. Similarly the way a child is taught to be as intelligent as it can be, so is a computer. 'If the untrained infant's mind is to become an intelligent one, it must acquire both discipline and initiative.' (Turing, 50)

Sixty-one years later, in 2011 there is an abundance of artificial intelligent machines and software that stemmed from Turing's 1950 paper; iPods, iPads, smart phones and now smart houses that can anticipate the user's every need. Essentially, an intelligent form is capable of learning, reasoning, problem solving, perception, and

language- understanding. (Copeland, 2002) Therefore, one can say that particular appliances nowadays, are intelligent forms, but as a nation, can our civil society extend this artificial intelligence to clothing and be accepting of it as an evolutionary advance? This question shall be further articulated in chapter 4.

In 1958 further research began to develop technology to protect the human body from the elements in outer space. The idea that textiles could protect humans, not only from the cold or the sun, sparked enormous innovations in textile technology which brought about fibrous material five times stronger than steel called Kevlar.

Technology developed in research centres such as DuPont (who developed Kevlar) NASA and the European Space Association (ESA) are being utilised by inventive companies such as Phillips, CSEM and Grado Zero Espace to construct intelligent garments to aid people in professional workplaces. After exhausting all forms of ornamentation on the high street and in luxury brands, technology sought to bring new innovating advancements to clothing and fashion. Thus began the integration of everyday coveted technology with everyday clothing. iPods were integrated with jacket sleeves for easy control and speakers harmonised in the collars made listening to music while exercising more efficient, making earphones obsolete – theory of evolution and natural selection.

The first space suit is an example of one of the first intelligent garments. Innovations that are discovered through research and ‘training’ in organizations such as NASA are used to improve life for the U.S. and British army soldiers to protect them in harsh and threatening conditions. Stemmed from institutions such as NASA, these technological innovations have become useful in medicine, the U.S. and British army and professionals. Some medical intelligent garments have the amazing potential to

improve people's lives that suffer from a chronic disease. Other intelligent garments could save the lives of people who work in hazardous environments through the use of colour-enhanced dyes. Colour enhanced dyes are a combination of colour transfer dye and a chemical reactant which is applied to clothing in the form of a print similar to printed garments seen in commercial retailers. The coloured dye on a garment is chemically manipulated to react to certain toxins, radiation or detrimental gases such as CO₂. When detected by the dye in the image, the print will automatically change colour to indicate to the wearer there is a hazardous gas in the environment. This chemically enhanced dye is an example of textiles used to prevent ailments or death. More importantly for governments and economies alike, it will save money in healthcare in the future as these intelligent textiles could prevent accidents. (Quinn, 2010)

Smart Textiles

Smart textiles can be described as textiles that are able to sense, to react and adapt to their environment. The area of smart textiles that initially sparked a discussion for this thesis was that of monitory medicine. Many people across the world in Georgia Tech University in America, CSEM in Italy and Philips in Britain, to name a few are constantly developing smart textiles. However, from a fashion design point of view, can scientists design an effective garment for human use?

This thesis required primary information from professionals involved in the development of intelligent garments thus, correspondence with Franklin Hadley of Institute of Soldier Nanotechnologies at MIT was essential in the research regarding the evolution of the fashion designer. Hadley stated that Army partners such as Natick Soldier Research considered much of the work involving fit, sizing etc. however, there were no qualified designers. (Hadley, 2011, Appendix F)

Through copious correspondence with many professionals in the area of wearable technology and smart textiles, the investigation into this industry deduced that there is an evident need for fashion designers where innovative garments are being produced for a specific need. The skill that fashion designers can contribute to that of a multidisciplinary team for production of intelligent medical garments can make the transition from unintelligent garments to intelligent garments more accessible and more comfortable. (Van Langenhove, 07)

Intelligent garments are textiles with integrated technology; they are also garments that are no longer objects of fiction. Many scientists have imagined a garment that monitors the wearer's health and many teams have realised their research in the form of a prototype that works efficiently and that can in theory, be applied to professional use. For instance, a man named Sundaresan Jayaraman, in conjunction with Georgia Tech University developed a 'smart shirt'. The 'smart shirt', initially designed for soldiers in combat, has an integrated wearable motherboard, which means it is able to monitor vital signs of a soldier and detect a bullet so as medics in the field of battle could receive information on the soldier's medical status. Another use for this shirt is for monitoring post-operative patients for when they leave the hospital. (Mattila, 06)



Fig.2 'The SmartShirt', Sundaresan Jayaraman, Georgia Tech University

CSEM is the Swiss Centre for Electronics and Micro-technology. It was one of the companies involved in the development of the MyHeart project. MyHeart is based on prevention medicine for people who suffer from cardio vascular disease (CVD). Cardiovascular disease is one of the leading causes of deaths in the Western world today. In Europe alone more than 20% of people suffer from this chronic disease. (Luprano, CSEM) This project was developed with the intention of establishing a monitory from of medicine. Through monitoring a patient over a prolonged period of time, vital signs would be recorded at all times, day and night. This form of medical application could enable the first signs of a stroke to be detected before harm could be done to the body. A blood clot could be detected before blood flow could be restricted to the heart causing a heart attack. Data collected through the monitoring of the patient would be sent via Bluetooth or through a mobile network in real time to medical professionals to examine. The MyHeart vest or an adaptation of the vest could enable doctors to diagnose a patient faster and more efficiently. Philips adapted these new technologies to develop more commercial monitory products for sportswear.

Through a process of investigation into intelligent textiles and why they are needed the research behind this thesis made evident, that the most simplistic everyday physiological actions could have a dramatic effect on various systems in the body; therefore, an analytical insight into the changes in body systems permits even greater understanding of disease prognosis and thus influencing potential disease therapy for the better. Monitory medicine can save someone's life, or prevent his or her health from deteriorating further.

With regard to medical innovations and wearable technology, 'Intelligent Textiles and Clothing' written by H.R. Mattila, supports the idea of continuous monitoring by

saying that brief periods of clinical monitoring limits the potential of information gathered. Continuous monitoring of even the most insignificant moments of a patient's day can help with disease therapy and understanding disease progression. Failing to measure normal periods of activity, rest and sleep, can have a morbid effect on one's health. (Mattila, 06) However, how can one achieve continuous monitoring?

Role of Design within Smart textiles

This thesis is not specifically concerned with smart textiles in terms of technology development; rather it is interested with the design of monitory garments and the possible niche that is created for a fashion designer in this market. In order to obtain continuous monitoring, the wearer must be psychologically comfortable in wearing an intelligent garment as well as physiologically comfortable. The research behind this thesis can support the idea of continuity in monitoring, which can be achieved to a customer satisfactory level with the aid of a fashion designer. As mentioned in chapter one, dress is an expression of one's personality, and if such products impede on one's lifestyle then the display of a, for example flamboyant style expressed through dress would become redundant.

In relation to that of Flugel's theories behind dress - the application of technology to that of everyday garments to create intelligent garments - modesty and desire must be able to be expressed through the wearing of such an intelligent garment.

Understanding clothing and how people express themselves through dress is the foundations of design development within intelligent textiles or any production of clothing; otherwise similar to the body's natural reaction to bacteria, we reject the unnatural, however beneficial it may be. (Flugel, 30)

With regard the area of medicine, treatment tends to work more effectively when the patient is accepting of the drug or in this case the garment. The imposition of a bulky intelligent garment could compromise a patient's prognosis or a professional worker's safety and health and others around him/her.

From an investigation into smart textiles and wearable technology, this thesis can present to the reader a new and exciting niche that has been created for future fashion designer in the intelligent textile market. Designers have been given the opportunity to design for the customers need, to enhance someone's life and not inhibit their day-to-day routine in terms of expression of personality. Technology today has sparked the evolution of clothing. Jackets have emerged aesthetically similar to that of its ancestors throughout the decades, however, the technology-influenced environment that society inhabits has encapsulated textiles and computing to create an artificial intelligence housed in clothing. This artificial intelligence can vary from integrated iPod speakers in a collar to epidermal drug distribution to monitory medicine.

Biomimicry

Innovation begins at a point of observation; this applies to scientists, engineers, and fashion designers. Plants and animals environmental adaptations have been an enormous research area for many innovators to borrow ideas from. This is known as biomimicry. According to Tom Inns, author of 'Designing for the 21st century', 2007, the growing field of biomimetics is concerned with identifying particular design solutions in nature, and converting them into usable artefacts – essentially stealing ideas from nature. The thistle for instance brought about the invention of Velcro after a man named George de Mestral noticed that the seeds of the thistle that clung to his

trousers were a series of miniscule hooks. From here the application of Velcro was developed to become a popular fastening in dress today. (Inns, 06)

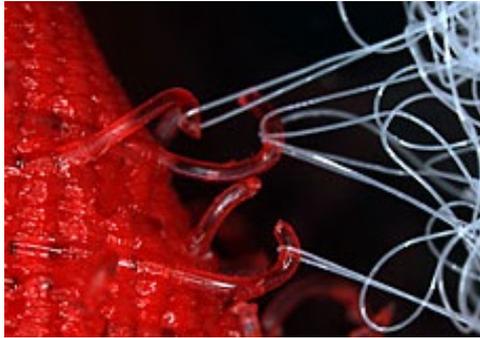


Fig 3. Velcro hooks on a textile developed from biomimetics



Fig 4. Water repelled on a lotus leaf

The lotus leaf was another plant that gave rise to surface treatment to create waterproof clothing. The lotus plant survives in a muddy environment and yet, its flower is never tainted by the pond water. Its waxy surface was investigated and was emulated on the surface of textiles to create a waterproof garment. (Barthlott, 97, p667-677) These technological advancements when applied to clothing further the evolution of dress.

Clothing will constantly adapt to its environment but the implementation of such adaption needs to be tactical and discreet with regard to shape, scale, colour and lifestyle suitability. Similarly in the wild if scientists want to monitor an animal such as a tiger, the device must not inhibit them in any way, for instance, if a collar is used as the chosen device and the surface does not mimic the animals coat it could effect hunting it's prey. (Townsend, 08) The collar introduced to an animal in the wild can be correlated with that of people in their environment thus clothing should not inhibit a person's day-to-day routine, clothing must enhance it.

Smart technology

The last ten years has seen significant change in technology and the environment it is present in. Fashion designers noticing this change will observe a possible need for more pockets, bigger pockets, protective clothing, adaptable clothing etc. However, the integration of technology with textiles creates enormous possibilities for dress. The combination of technology and fashion will in turn establish a multidisciplinary workforce where engineers, fashion designers and scientists will work together in order to adapt to their environment. Be that of heat sensors that display a range of colours in a garment or a garment that protects a fire fighter from the threat of flames and smoke inhalation, fashion is evolving to suit the needs of the people of this century and to aid them in their professional or domestic lives. The development and innovation in technology could not only transform the consumers market but it could alter the economy for the better.

‘New technologies also provide something besides increased life span and lower infant mortality rates. They provide NOVELTY. They provide an outlet for human creativity and way for humans to participate in society, which is argued to be important for human happiness’, (Orth, 2012, Appendix H)

The need for a fashion designer to be a prominent role in the development of intelligent or smart garments is evident in Orth’s statement regarding the customer and the customer’s needs and desires.

Wearable technology and smart textiles could transform the existing environment just as mobile phones laptops and iPods have transformed a generation of people. With a foundation in the evolution of clothing and the basic needs of design, a fashion designer could create a comfortable, modern but wearable garment that could prevent dehydration could prevent disease progression in a patient or prevent ligament

damage in an athlete but more importantly as mentioned above, create an outlet for customer happiness. Fashion has not just become more adaptable; it has been given intelligence that could change or enhance someone's life for the better.

CHAPTER 3

In this chapter, this thesis proposes to illustrate how a fashion designer, or be that any designer can adapt to a new environment. Provided, will be an investigation into how the society that Flugel relates to in his book *The Psychology of Dress*, is not vastly different to the society of 2011/2012. The chapter will also broach the subject regarding how fashion design can be applied to professional security, healthcare, domestic life, and sports. This chapter will also discuss what is required of an intelligent garment or smart textile when a garment is christened with such a title. In a world teaming with technology and innovations, a designer needs to be adaptable and animalistic in an approach to design, and how smart textiles have really changed the way designers innovate today?

A multidisciplinary workforce is required when attempting to design, construct and test an intelligent garment. The process is vastly different from that of commercial designing. A hybrid methodology is applied to the design process of monitory garments, from user needs to potential research and testing for near market prototypes. This thesis will investigate the challenges that a designer would have to face in a multidisciplinary workforce from communication boundaries to language boundaries. This chapter will furnish the reader with a composition of elements that, in the opinion of this thesis, can make an intelligent garment marketable and covetable, for patients, professionals and for athletes.

Fashioning intelligence

The need for a fashion designer in this area is not to regenerate past forms of ornamentation in order to discreetly hide evidence of sensors, rather, to develop a

comfortable fitting garment yet modern enough that will not impede on the wearers expression of personality through dress.

“This will render clothing more responsive to our needs for protection, care and well-being in addition to its aesthetic qualities, and will change our relationship with what we wear in the near future.” (Inns, 07, 306)

The book *Smart Textiles for Medicine and Healthcare* written by H.R. Matilla describes intelligent garments as textiles that are able to sense, to react and adapt to their environment. Similarly humans have adapted in the same way to the environment by altering their clothing accordingly. Now the environment demands that designers adapt accordingly. Essentially designers are enhancing clothing so as the clothing can act and think for itself and giving a fresh new character to the clothes. (Webb, 12, pg316)

‘We can only see a short distance ahead, but we can see plenty there that needs to be done.’ (Turing, 50) Alan Turing could see what is actually possible today as early as his first paper on computation in 1936. He described today’s modern computer in that 1936 paper. Turing is still an inspiring man today. If we could perceive the world as Turing once did, anything could be possible. However, today, people are more cautious approaching computers, particularly people from Turing’s generation. Computers have infiltrated our world today. There is an abundance of technology, readily available and affordable such as iPods, iPads, smartphones. Computers in a compact form have become a part of everyday culture due to the size, aesthetics, design and novelty. This application of design and customer consideration seen in everyday computer based gadgets must now be applied to intelligent garments with the aid of a fashion designer. (Appendix H, 5/1/12)

‘Clothes are our own house.’(Flugel, 30, p15) They are a common material to us all. We know how to use them and we know what to expect when we go looking for some. As Flugel mentions in his book, clothes have evolved as animals have, however if we look back at the earliest jackets, dresses, or trousers you will notice that like animals over centuries they are changed gradually but always maintaining the same basic structure. Now in 2011, intelligent garments are adaptations of a basic structure. From a Frankensteinian point of view scientists have given life to garments.

Before breathing new life into clothing, a designer must consider all factors and requirements of the design. In healthcare, security or be that professional sportswear, a fashion designer has a new customer that has specific everyday needs therefore; technical, functional, physiological, social, cultural and aesthetic components must be considered in depth so as not to impinge on the design of clothing or the wearer’s lifestyle. The garment is intended to be attractive, comfortable and fit for purpose similarly to that of normal clothing but rather more intelligent. In this case the function of the garment is to monitor vital signs of the patient, therefore the garment must be fitting close to the skin in order to detect and change in heart rate, temperature or skin pH. (McCann, J, Bryson, D. 2009)

The design process is one of in-depth analysis. A designer must choose a particular direction for design research, he/she must examine the market that they wish to design into and finally they must study their customer. The designer is seeking to develop a product that fits comfortably, attractive, that is discreet (possible undergarments), affordable, low maintenance, mendable, washable, easily and efficiently produced, and most importantly, it will function in harmony with our daily lives.

In order for a garment to bear the full title of intelligent garment it must have an actuator and a sensor and possibly a processing unit, which drives the actuator on the basis of the signals from the sensor. (Van Langenhove, 07)

An actuator is quite simply, a mechanical device that converts energy into actions. A sensor on the other hand detects the presence or absence of something. The hybrid methodology mentioned above is a combination of elements that need to be considered at all times when designing intelligent garments. An example of intelligent technology would be the MyHeart vest or the smart shirt in Fig.2 as there is evidence of hardware and software.

Smart garments are quite different to that of intelligent garments. Intelligent garments have a computer (brain) and it is programmed to sense and react to its environment. A smart garment on the other hand is more chemical rather than computational. Smart textiles would be textiles that have endured a treatment of chemicals or a state change at a molecular level, thus enabling them to react to the environment like plants and animals do. Applying a treatment that replicates the surface of the lotus leaf onto fabric is like giving a garment a hidden power. A change in the environment enables smart textiles to sense and react to the conditions. Any detection of moisture and the surface of treated fabric will become impermeable to any liquid substance.

The following case study should illustrate how smart garments react to their environment.

LQ Jacket – an example of a smart garment



Fig 5. LQ Jacket, Grado Zero Espace

One smart garment that is a particular example of design innovation using smart textiles is that of Grado Zero Espace's 'LQ jacket'. In an interview with one of the co-founders of Grado Zero Espace, Syuzi Pakhchyan from fashioningtech.com, discovered that the company is comprised of ten technologists, designers, chemists, textile experts, electronics engineers, computer engineers, mechanical engineers, and optical engineers. (Pakhchyan, 2011)

The LQ jacket is a motorcycle jacket, which becomes hard on impact. Giada Dammacco a co founder of the company describes this d3o technology used in the jacket as specifically engineered with intelligent molecules that flow with you as you move but upon impact, lock together to absorb impact energy. This is an example of a smart garment reacting to the environment around it in order to absorb any impact. This technology could also be adapted for sportswear protection for rugby players and for professionals in the construction industry. (Pakhchyan, 2011)

The responsive jacket contains other innovative solutions, as it is made of ultra-thin leather with a liquid shell, which is a protective treatment, which allows a marked increase in leather properties, such as flexibility, elasticity and a resistance to abrasion, UV rays and to saline environments. The d3o technology is already available the commercial market in the form of furnishings, yachting, accessories and luxury leather goods. . (Pakhchyan, 2011)

Intelligent Technology in Sport

An example of wearable technology is seen in the application of sensors made from piezoelectric materials in sportswear apparel. Smart Nanotextiles: A review of materials and application co-written by Dr. Shirley Coyle of DCU, mentions that the piezoresistive sensors can be utilised to detect posture, improve movement performance and reduce injuries. (Coyle, 2007) Strain and possible ligament damage can be detected through the stretching and stress applied of the fabric used. The movement of the fabric can also assess physiological movements that impose strain on a certain area of the body such as fallen arches in the feet, which in turn leads to strain in the knee. Garments with integrated technology such as ICPs and conductor loaded rubbers with strain sensing capabilities offer continuous monitoring of the body movements and vital signs. Coyle discusses further how this technology can also be used to improve athlete's performance in relation to how they move by providing real time feedback about limb orientation. (Coyle, 07)

Bulletproof skin – an example of industry limitations

Through correspondence with Jalila Essaidi, this thesis could consider various problems that could arise when working in an interdisciplinary field. For instance, when it comes to working within interdisciplinary fields experimentation becomes a

thing of the past. The process of design development takes on a more calculated approach according to Essaidi who is an artist who instigated a collaboration with scientists at Forensic Genomics Consortium to develop a bullet proof skin or possible new skin for burn victims. The concept of the artwork was based on spidersilk from goats; however, the final piece was made from spider silk from silkworms. The silk was then collected and woven in a specific pattern in order to promote skin cell growth and still remain strong enough to catch a bullet to ensure the skin would be bullet proof. After it was fused with two different layers of different skin cells, epidermis and dermis. Jalila describes the process as slow and calculated with some communication problems due to scientific jargon however, the end result could create a new form of protection for soldiers or if adapted into a jumpsuit skin, an alternative version of Flugel's naked society could exist. (Essaidi, 2011, Appendix C)

CHAPTER 4

The subject of the psychology of dress and that of the future and/or futures of clothing has led the reader to chapter four. This chapter will exhibit a final theory that Flugel highlights in his book *The Psychology of dress*. It will also examine the possibility of Flugel's theory being correct and how it is evident in civil society today. The chapter will broach the subject of one's relationship with their body and try to justify the development of intelligent and smart textiles for the benefit of fashion designers and for the customer – be that a professional or a home owner. Also to be examined will be that of the emergence of a new novel role for the fashion designer, which is evidence that like that of the adaptations of clothing to that of their environment, designers are required to adapt and change also.

Reconciliation

Flugel deduced from his research that clothes should provide the maximum of satisfaction in accordance with the full recognition of reality. He believed that clothing was a mere episode in the evolution of man, therefore contradicting Darwin's theory of the evolution of dress and the evolution of animals being conversely parallel. Flugel mentions that humans do not need clothing, only for protection. 'We consistently allow ourselves an undistorted recognition of our bodies', (Flugel, 30, p234). What Flugel intended to communicate here was that the preconceptions that people have about beauty and the perfect body is distorting the relationship that humans should have with their bodies. (Flugel, 30) Flugel believed that the very existence of clothing relies on the purposes of modesty and protection as mentioned before in chapter 1, thus providing a way to rid people of modest thoughts; if a person could reconcile their relationship with their body then clothing would therefore cease to satisfy a need and would thus fall into the category of useless or conventional

extravagances. The result of embracing a nudist society and ridding the nation of all clothing 'except in so far as they might still be required for purposes of our protection', (Flugel, 30, p194) this change would mean a new orientation, the formulation of new principles and a fresh discussion of the whole field of clothing in the light of these new principles. Modesty would take on a new form and desire would also evolve to take a new form with regard to the naked body. In the removal of clothing, human needs become more basic. It would also cause a society to re-evaluate the psychological values of the desire for beauty, modesty and protection. Flugel was whole-heartedly convinced that the expulsion of clothing would create more relaxed society and also from an academic deduction a more environmentally efficient nation. Not only would time and energy be saved on not clothing the body, but the skin as a natural fabric, can be cleaned when dirty and dried when wet.

A new form of dress

'Thus aesthetic taste, as it develops, tends to become reconciled and more to the natural human form and seeks to set off and reveal its beauties rather than to hide its deficiencies, or to substitute other beauties of a kind that are foreign to anatomy.' (Flugel, 30, p235)

'Beauties of a kind that are foreign to anatomy' (Flugel, 30, p235), are, when applied to society and clothing today, that of technology integrated with clothing. Technology is a substitute for previous beauties with regard to clothing. What is evident today and different from Flugel's period, is technology, however one can apply technology to Flugel's theories similar to that above and aesthetic taste and beauties are comprehensible as technology. One could refer to technology as a new form of dress. The changing environment and the increase in educated people and their need for

revolution and change brought about an influx in the development of technology demonstrated most evidently during the industrial evolution. Technology has flooded the world we inhabit today, as people are constantly curious, constantly being educated and there is a desire to better every part of our lives, hence the introduction of intelligent and smart textiles. The constant evolution of man and animals thus indicates – according to Flugel – that clothing will constantly evolve as well. Rather than becoming a nude society, technology has infiltrated our clothing and our everyday lives thus remedying the possibility of discarding clothes. Clothing has evolved, just as human's have, to become more intelligent and adaptable.

This section of the thesis intends to prove that clothing will cease to evolve structurally. Due to the intelligent nature of new textiles, and their ability to adapt to changing climates to suit temperatures, pH levels, oxygen levels etc, means that humans will be safe in knowing they are being aided (if in need) by their clothing. Intelligent garments are already aiding professionals as mentioned before in chapter 2, fire fighters can be safeguarded by innovations in the form of the hydro jacket, construction workers, rugby players and motorcycle drivers can be protected by the LQ Jacket and patients with cardio vascular heart disease can be screened by a MyHeart vest. Intelligent and smart textiles could protect many professionals in the majority of areas of the economy. Therefore why would there be any need to rid a society of such intelligence if it can improve our nation and protect people from harm.

A socio-technical approach to design

This thesis broached the subject of smart textiles and wearable technology and thus, as a result of much investigation, there arises a conflict here in chapter four with regard the future or futures of intelligent and responsive garments. The aim of this

chapter is to examine and exhibit a new niche for fashion designers after due consideration of information in the previous chapters. Due to the evolution of technology, smart and intelligent garments have been introduced to the 21st century consumer. According to Tom Inns who wrote the book designing for the 21st century, the purpose of using technology is orientated towards social change and social justice. H.R. Mattila describes interdisciplinary as an ambiguous term applying to both the idea of unity and a more limited integration of existing disciplinary concepts and theories. In order to broach more complex questions, a team of diverse professionals is needed to gain insight into all fields, to address broad issues, to explore disciplinary and professional relations and to solve problems beyond the scope of any one discipline and to achieve a unity of knowledge. (Mattila, 06)

Likened to the introduction of mobile phones, smart garments and intelligent garments will, in time, become a necessity and be endorsed by the consumer for practical use. Thus, in order for these innovative garments to be marketable and coveted by the consumer, a fashion designer must approach the design process with the help of other professionals such as chemists, engineers, product designers, each professional bringing some aspect of their field to the collective design process as mentioned above by H.R. Mattila. In the application of intelligent and smart technology in garments there is no doubt that there is a need for fashion designer skills in the production of a successful prototype or even mass production. (Inns, 06)

‘Nature is the ultimate designer. Every species, every individual, can be seen as the result of an implicit design process,’ (Inns, 07, p192) and as a group within nature, designers, scientists, engineers are various components collaborating to create an environment to house innovative products that could preserve life for a little longer.

A socio-technical process relates to that of an organisational approach to design, which involves the interaction and collaboration of various people from vastly different professions who intend to achieve a similar outcome. A socio-technical process could also be applied to that of human behaviour if complex structures were that of an intelligent garment or machine.

‘Perhaps the most significant, overarching insight is that, in using technology to effect social change, design must be understood as a profoundly socio-technical process’

Introducing smart or intelligent textiles into a social environment must be done with great precision and calculated care. (Inns, 06)

Novel Roles

Inns, describes the emergence of new design roles as novel or emergent roles. (Inns, 07) He suggests that products such as intelligent garments must be designed under a strong socio-technical view of design as mentioned above, which draws attention to the social and organisational arrangements in which technology is designed and used. Consumers today are seeking out products that are well designed, will endure everyday use and withstand particular environmental conditions. Such expectations from the consumer today demand great attention and dedication to the production of any technology based product.

Looking to clothing as a business, due to the global scale of the industry and the fact that fashion is one of the few remaining craft based industries in the world, not only is the consumer considered in the design process but the market and environment is considered also. What Inns proposes in his book is a new approach to design development and what the core of this thesis is trying to broach. The new niche for fashion designers, which is created with the production of intelligent garments, gives

rise to a novel role for professional people who are looking to innovate on a national scale. The role of the novel fashion designer in this intelligent industry would be to be aware of particular social aspects of technology use, how people take off and put on clothing for instance. The way people use technology even clothing can be linked to wider social concerns which is the responsibility of a novel fashion designer.

However, the very nature of technology usage in a social setting may also make the social dimensions of design and usage rather more obvious. (Inns, 06, 108)

Smart clothing and wearable technology is a transition point according to D. Bryson at the University of Derby. (Bryson, McCann, 09) With regard to healthcare, designs in the past were considered wishful thinking and were not feasible due to the lack of technology, nevertheless as the years progressed and technology advanced, designs of the past became an aspect of the future, but have yet to become reality in terms of being introduced to a consumer market. The novel designer needs to be clear of his/her target market for the technology and its levels of user acceptability, always taking into account that there are many varying types of users from young to old and varying levels of technical ability. Problems can also arise where a user has particularly large or small hands, also, people suffering from arthritis can experience limitations in dexterity where technology is used. Pin pointing who the user is, is critical to understanding the market as many patients may have carer's therefore the carer will then be the final recipient of the technology. Bryson illustrates how healthcare technology cannot be fashion led, rather they must be user led as mentioned above. From a thorough investigation into the industry of intelligent garments and smart textiles this thesis proves that wearable technology can be fashion orientated however not fashion led. In order for a garment to be psychologically accepted by a customer, this thesis believes that comfortable clothing is not the only

aspect to consider when accommodating a customer. The structure of the garment needs to be basic however; decoration in the form of colour or embroidery is limitless. Correspondence with Maggie Orth from International Fashion Machine Inc wrote that the designer needs to provide novelty and creativity for the customer. (Orth, 2011, Appendix H) Thus the need for technology based clothing to be somewhat fashion led. All factors must be considered and every experiment must be calculated. Continuity is a key factor when designing for healthcare. The design must be universal and it must be modern and non trend based as due to the amount of money that would be invested if successful, the technology must be available and used successfully for ten to fifteen years after production. (Bryson, McCann, 09)

Implications of wearable technologies

The development and production of intelligent and smart textiles have been promoted throughout this thesis, however, the implications of such artificial intelligence have not been considered until now. To gain an unbiased perspective of the new area of technology to which professionals (fashion designers, doctors, chemists, scientists) and consumers will benefit from, this thesis has considered the effects such innovation could have on a civil society and the continuity and evolution of man. Intelligent and/or smart garments have the potential to open the door for many exciting applications in sportswear, hospital care and in professional security. It could lead to a novel role for fashion designers and growth in the textile industry however; these innovations encompass social and cultural factors to consider also.

Alex Petland at the MIT Media lab foresees medical garments that diagnose and administer medication without the wearer ever noticing. (Quinn, 02)

Implications could occur in natural production of reaction hormones. The wearing of these garments for commercial or professional use could have a drastic effect on hormones involved in producing fear, stress and worry. It is evident that face-to-face interaction reduces levels of hormones produced when a person is worried or frightened and increases levels of trust, bonding, and attention and pleasure hormones. (Xiaoming, 05) Nevertheless, the rapidly growing volume of research into smart fabrics and wearable technology, accessories and interiors will enable a new exciting niche for fashion designers and many innovators alike. The integration of technology and fabric will render clothing more responsive to our needs for protection, well-being and care, in addition to its aesthetic qualities. From the research and investigation into the progression of intelligent garments, this thesis can deduce from its findings that in the future, there will be clothing available that will adapt to one's body shape so if a person ever loses weight or gains weight there will be no need for additional expenditure for bigger/smaller fitting clothing. The integration with technology and clothing will change our relationship with what we wear in the near future.

CONCLUSION

The thesis aimed to highlight a new niche that is evidently emerging for fashion designers in a new advanced market. This market has been developed and advanced to a point where the collaboration between designers and scientists could bring about incredible innovations that could alter a person's life, prolong life, prevent harm and possibly death. With the help of Flugel and Darwin the thesis has grounded the investigation into the futures of fashion and technology with the history and evolution of dress.

Referring back to the beginning of the thesis, the psychology behind how one dresses was described to the reader to create a foundation on which to build an argument for intelligent garments. Flugel believed that dress could alter one's impression of another. A piece of our psyche was projected through what we wore on our bodies. The colours one wore, the fit, the textures amalgamated together created a keyhole into how one was feeling.

The correlation between the species that is animals and the human race was at first apt and profound but upon contemplation and analysis, pieces began to connect and form an evolutionary line. The next phase of evolution is that of technology based clothing and smart textiles. This developmental phase is a descendant of the space suit and has sparked worldwide innovation as well as creating a new niche for fashion designers.

Not only has clothing evolved in style, shape, texture and colour, fashion designers have evolved as well. Charles Darwin's theory of evolution stated that animals were naturally selected based on the stronger or faster animal in order to create a powerful species; now in the 21st century, particular clothing structures has been naturally selected for use in technology integration. Technology has conversely evolved and paved a path for fashion designers to adapt to a new apparent customer.

There were three main reasons to cloth oneself, which were deduced in J.C. Flugel's 'The Psychology of Dress', - protection, modesty and desire, the reasoning behind the way we will dress in the future will evolve as well. The nature in which we wear clothing is different today. Fortunately Flugel's prediction of a naked society was not to be, as the feelings of desire and modesty are expressions that the human mind is not willing to forget. However, a new form of dress is maturing. Evidently, through this thesis the reader has been able to recognise how apparent technology is in the 21st century and what innovations are already in motion. Consequently, the reasoning as to why we will wear intelligent technology based garments or smart textiles have emerged; protection being the paramount reason and curiosity and convenience being the subsidiaries of the first.

Protection is the main reason for wearing innovative garments as it can be separated into three distinct areas of use, healthcare, professional security and sport. Healthcare can benefit from wearable technology as monitory vests can be designed for particular user based needs such as patients suffering from heart problems. Patients who are initially admitted to the emergency room can also benefit from monitory garments as the technology and constant monitoring could speed up the process that is diagnosis, which in turn inspires prognosis, saving money for the patient and time for hospital staff. Professional security is quite similar to healthcare in its application, as seen in chapter two with the SmartShirt by Sundaresan Jayaraman. However the difference being, soldiers would be monitored in case a soldier incurs an injury on a mission away from army base. Information regarding the extent of the injury can be assessed in real time while in pursuit of the injured soldier thus evaluating the situation more quickly and saving more lives. Construction workers and firemen can also fall under the heading of professional security. Intelligent technology could protect a fireman from the flames of a building through

the use of an advanced chemical layer in the uniform called Aerogel. Construction workers could make use of an adaptation of the LQ jacket to prevent any heavy machinery or threatening materials breaking bones.

Finally in sport the smart molecules used in the LQ jacket could also protect a rugby player from an inhibiting impact to vulnerable areas of the body. Additionally, using a Bluetooth connection linked to the fibres in a chest plate with LQ molecules, an injury could be measured by recording the stretch in elastine fibres endured as a result of a hit once in a smart undershirt. Smart textiles or wearable technology could also be applied to any type of sportswear garment and due to the tight fitting nature; measurements of vital signs would be quite accurately.

The final two reasons for wearing smart textiles or wearable technology is for convenience and curiosity. Beginning with the later, curiosity, and the unknown can spur an interest in many people, which in turn will lead consumers to purchase an intelligent garment in order to silence their eagerness for knowledge.

Convenience is the final reason for a customer to acquire an intelligent garment. If a consumer knows of a product that could make their life a little easier – easier being a baby grow that records the temperature, breath rate and heart rate of a newborn therefore putting a new parents mind at ease- then a purchase will ensue. Protection however will always be the main reason for clothing the body.

Biomimetics has played an enormous role in the development of smart textiles and will continue to influence the world of design. Nature is the ultimate designer. Every animal, every plant, every species can be seen as part of an implicit design process. (Inns, 06) The role of the fashion designer in this innovative world of technology is to adapt to nature, to employ nature as an inspiration and to be appreciative of what nature has gifted the world with, therefore environmental efficient design must be

incorporated into every design idea and process, not only for the environment but for the benefit of the consumer also.

The main reasoning for this thesis was to distinguish a difference between that of a fashion designer and that of scientists and engineers. Every profession has a niche market but today the lines of professional practice areas are becoming more blurred. As mentioned before the most important aspect of this thesis was to highlight a new innovative niche for fashion designers. Fashion designers can view structures in a novel way, different to that of scientists and engineers. They understand the psychological and physiological reason for clothing the body and from this understanding can convey their knowledge to be applied to a future intelligent garment. They understand how various fabrics feel on the skin and how they will stretch or drape or disintegrate when washed. A fashion designer can examine a garment and immediately know if the shape will inhibit movement or restrict one's day-to-day life, whereas scientists understand the scientific basis of the garment and if the prototype will perform as it should.

In conclusion, a new role for the fashion designer has been brought to light through the application of Flugel's theory of evolution and through the evolution of dress and the introduction of intelligent textiles.

Appendices

APPENDIX A:

Correspondence with Auli Sipilä of Phillips: 26/10/11

Dear Dara,

I got your e-mail from Philips, from the colleagues with whom I have worked in European HeartCycle project. I'm sorry that I have been so slow to answer, but the last two weeks have been very hectic. I'm working in the Finnish company Clothing+, which has been already several years as a link between electronics and textile companies and specialized in comfort body monitoring, especially heart rate monitoring.

In HeartCycle project, we are producing small lots of carrier shirts and monitoring vests. I could imagine that there is a need for e.g. designer specialized in designing for elderly patients. In this project, products are clothes so e.g. pattern making and sizing is a big challenge as we would like to have a product that fits to as big audience as possible and people tend to have so different bodies. In addition, we need a good skin contact for the sensors so the solution needs to be something else than just a big size.

Kind regards,

Auli

Dara Fallen Bailey

APPENDIX B

Correspondence with Jean Luprano of CSEM

3/10/11

Dear Roisin

In the case of the project we are working in, the garments are designed and prepared by the companies involved with us in the projects. We specify together the requirements for the sensors and they make suitable design and construction to meet them. I suggest you contact garment makers who are involved in such smart textile projects. I have no project with MIT, but I guess it is the same for them (at least I would do so): they certainly have a designer in their team. In the case of the projects I am involved in you may try to contact companies such as Sofilta in France or Smartex in Italy.

I hope you will find an area of interest in the field of your research.

Best regards,

Jean

APPENDIX C

Correspondence with Jalila Essaidi, co creator of Bulletproof Skin: 25 September 2011

Hi Roisin,

The concept of the artwork was based on spidersilk from goats, the final piece was made from spidersilk from silkworms. This due to the fact that Randy Lewis was moving his goats at the time of realization of the project.

The spidersilk I used was really thin and couldn't be used on European looms. So first it had to be twined to get it the right thickness for the looms to handle it, it also had to go on different cones since European looms can't handle US cones. This was a really specialized process and I couldn't find anyone who could do this in Europe.

Eventually I found help for this in Asia.

Once the spidersilk was capable to be used on the loom it is the default process like with normal silk. We had to weave it in a special pattern in order to make it support skin cell growth and still remain strong enough to catch a bullet.

The final textile looked pretty much like your average bandage, only a really strong spidersilk one. The solid surface you see is only after it fused with the two different layers of different skin cells (epidermis and dermis).

I submitted this idea for the Designers and Artists for Genomics awards, which provided me with the finances and teamed me up with the Forensic Genomics Consortium Netherlands in order to realize the project.

I still had to contact pretty much the entire Benelux to find the right partners for all the different obstacles that I faced, ranging from skin growth to weaving and shooting at it while recording it with a high speed camera.

Working as an artist among scientists can sometimes be pretty frustrating. It all moves so slow and every move is calculated. Scientist tend to follow their 'protocols' and are good at what they do in their specialized field but once you cross boundaries with other disciplines they get afraid ;). There is not much room for experimentation or following your gut feeling. I was lucky to find the right partners though, who were really open for the idea.

And yes of-course there were difficulties with communications, mostly due to jargon. But those got resolved pretty fast.

I hope I answered you're questions, if you still got some questions feel free to e-mail me.

Good luck with your thesis, once finished if possible could you mail me a copy in PDF because I'm curious now.

Kind regards,

Jalila

APPENDIX D

Correspondence with Mauro Tallini in relation to F1 Suit

7/9/11

Dear Roisin, here some news I hope can help you for what you're looking for.

The idea was to make the mechanics (McLaren in this case) in the condition to work as better as possible even during races where the temperature outside could be really warm.

I knew there was a heating system made by cables stitching on the lining of the aeronautical jackets and pants. Was a kind of workmanship invented during the second World War for the U.S. Army airplane pilots because there was no heating system in those airplanes. So my idea was very like say "like Colombo's Egg"; if they can (the system) "can keep the body warm, why can't keep even cold?" the problem was first of all to find a miniaturized cooling system, the second how to stretch the cable we need, because for the warm system the cables were made by copper, so whenever you stretch you never cause damage to the system. In our case, we were using cables where inside have to pass cooled liquid, so the stitching story was quite complicated. At the end we used stitching machines from the sails production. Regarding the miniaturized refrigeration system we thought by using Frigidaire and all was ok. The fabric choice was easy because you can do this system where you like, also in a jersey t-shirt. I send you also some of my sketches remembering you that are covered by "rights" so if you need to make some publication you'll need my permission.

Good luck and all the best, Mauro Taliani.

APPENDIX E

Correspondence with Monty Reed creator of the LifeSuit

17/8/11

Roisin, I look forward to speaking with you further on this subject of future textiles. I will write a blog page that should answer your questions.

<http://theyshallwalk.org/blog/> It may take a few weeks to get it posted so I will give you most of it here.

I have a vision for something even greater than what you are already aware of. The future textile will actually be part living tissue. I call it "biosynthetic muscle fibers" and they are grown in a dish from living muscle tissue and combined with synthetics. We are still a few years off but the technology is sound. To read more about the muscle tissue you can research "replacement bladder implants". At the University of Washington and other locations researchers can grow you a new bladder in 8 weeks, surgically install it and you can use your new bladder completely about 8 weeks after the surgery.

Backing off to current day, we have the LIFESUIT robotic exoskeleton that is transitioning towards the future textiles.

The older prototypes use aluminum, steel, plastic and velcro to support the person wearing it. The LIFESUIT robotic exoskeleton allows paralyzed people to walk, exercise and even dance a little. Soon it will be available in India at the CMC

hospital in Vellore, after that the world.

The current version of the LIFESUIT robotic exoskeleton is for therapy and will be installed at the Christian Medical College in Vellore, Tamil Nadu, India very soon.

There paralyzed people will go three times a week to exercise. Many of them will learn to walk again. The therapy model is adjustable and comes in three basic sizes.

It is meant to be shared by 25-50 people depending on the amount of time a LIFESUIT site is open for clients to come and use it.

The next version that is under development is for use in the home and at work. The LIFESUIT is made so that paralyzed people, even complete quadriplegics, will have their life back. This LIFESUIT will be custom fitted to each user. In fact a fun fact from the city of Burien in Washington state in the USA has to do with an application to occupy a site near the Seattle Tacoma (SEA TAC) International Airport. One of the 'allowable' uses for the zone was for a Taylor Shop. Since each of the LIFESUITs would be Taylor fit, we qualified and the city council unanimously approved the application. We ended up not occupying the site, we are very thankful to the city for approving the application.

Q:Who oversees the making of such a garment?

A: Monty K Reed (myself) and a team of experts from different fields.

Q:Is there a person who has a degree similar to my own in fashion design who looks after aspects of construction such as; the positioning of certain seams, decides on a particular stitch, position of padding, electronics and one final but critical aspect, i.e. comfort?

A: At this point we do not have any on staff. Most of the design comes from my original plans and those are all based on dreams and visions I have had over the last few decades. Experts have helped me to make the visions become reality. We work together to take the fiction out of science fiction.

Q:Essentially is there a designer who is part of the team involved with the making of the LIFESUIT?

A:No Fashion Design degree holder.

We would welcome input from textile engineers and fashion designers.

I learned to make clothes as a child and that has helped a lot. My father taught me to build just about anything.

Let me know if you have any other questions.

Warm regards

Monty

APPENDIX F

Correspondence with Franklin E.W. Hadley of the Institute for Soldier

Nanotechnologies, MIT

1/8/11

Hi Roisin,

The ISN emphasis, at least currently, is on the materials and systems necessary to make protective suits for Soldiers, other military personnel, and first responders.

There is, as of yet, no fully formed prototype suit of the sort you reference, as many of the incorporated technologies are still in their initial stages of development.

While certainly there are concerns of design, fit, and so forth, to be aware of, they will ultimately be addressed by those who are putting the garments together. Much of that work will be done by Army partners, such as the Natick Soldier Research, Development, and Engineering Center, which is responsible to the design, development, and testing of much of a Soldier's equipment; and by industry partners, such as WL Gore & Associates.

Best,

Franklin Hadley

APPENDIX G

Initial correspondence with Dr. Shirley Coyle of DCU & CLARITY

25/5/11

Hi Roisin,

It's becoming a really big area with lots of applications so I can understand that it's hard to pick an area to focus on.

Integration into textiles is difficult, the commercial things that are out there are generally conventional electronics packaged nicely to fit into the clothes. Then there's vests that use metallic threads to create electrodes to pick up heart rate. not sure of the status of bullet proof vests, I'm sure the US army have developed something but we won't hear about it for years!

useful books...

<http://www.thamesandhudsonusa.com/new/fall05/551245.htm>

(in DCU library)

http://www.amazon.com/Fashionable-Technology-Intersection-Fashion-Science/dp/321179591X/ref=ntt_at_ep_dpt_1

http://www.amazon.com/Fashioning-Future-Suzanne-Preez-Warren/dp/0500285853/ref=sr_1_1?ie=UTF8&s=books&qid=1306358048&sr=1-1

http://www.textileinstitutebooks.com/Merchant2/merchant.mv?Screen=PROD&Store_Code=TI&Product_Code=WP-9781845690274&Category_Code=WP

Wearable ehealth systems for personalised health management : state of the art and future challenges / [edited by] Andreas Lymberis, Danilo de Rossi. (in DCU library)

some of these are in DCU library, (I ordered them!) you could get an inter library loan or else get an ALCID card to enter the library.

Hope you find these useful, Do you need to make a prototype garment or anything as part of the project?

regards,

Shirley

APPENDIX H

Correspondence with Maggie Orth, founder and Chief Executive Officer of International Fashion Machine Inc.

5/01/12

Do you work in a interdisciplinary team of technologists, designers (yourself) and possibly chemists?

My company, International Fashion Machines, IFM, is in the process of shutting down. I currently have no employees.

I have worked with technologists and scientist in the past. They have been employees at my company, at professors at universities who I collaborated with on research, and also during art projects. I have employed mostly electrical and mechanical engineers, MBA's and designers. I have worked with a range scientists on research grants- such as electrical engineers and material scientists, but not chemists.

I have not employed or worked with chemists. After I left MIT Media Lab, my company focused on technology design and commercialization, which did not require research at the fundamental level of chemistry- or perhaps what might be more relevant to e-textiles, material science.

My company has always been small- no more than 5 employees. Because the work I do is inter-disciplinarian and vertically integrated- ie, I have to do all aspects of product development and manufacturing, it has always been a challenge to have the resources I need to do it all. That means picking the most important people for the work I am doing. Low level research was not something I could do.

Do you believe that designers need to adapt to the age of technology that we are currently living in?

Yes. This is an imperative. Currently few design schools have a tradition of research based or scientific thinking. Gaining a scientific or researched based perspective is important for young designers for two reasons.

1) Designers are going to be working with technology. Technology demands a more rigorous approach to problem solving and design. Designers need to understand their medium (technology), and they cannot do so without some technical knowledge. Steve Jobs was a great designer, not just because he made things user-friendly, prettier and more designy. He was a great designer because he understood what technology could do, and CHANGED ENTIRE INDUSTRIES to do it. A great example of is the “Pro Cap” touch screens in the iphone. Before the iphone was introduced in 2007, the pro cap touch screen it was just an esoteric piece of technology. But Steve Jobs knew he could make it work. Apple made it more robust than most conventional touch screens and convinced a Taiwanese business man to build a 100 million dollar factory to meet his supply needs. If Jobs had listened to technologists and business people those touch screens would not exist. The iphone as we know it would not exist. Now Pro Cap sensing is taking over the industry. So designers need to understand technology and industry to make their complex dreams a reality- otherwise they are at the mercy of technologists.

Designers also need to be able to TALK to technology people- which is imperative. They need to present their ideas in language that technologists can understand. That is why we have the field of HCI. Designers started researching their design choices to

justify to technologists why they needed things to be a certain way. Otherwise the programmers just said no.

2) Humanity is at the edge of environmental crisis. Designers are making the products that are defiling our planet. Currently, design schools are trying to introduce the language of sustainability. But the results are poor, because these schools have no tradition of research. Most don't even have math classes. This means that very few design schools and programs can teach true sustainable design.

I will qualify this by saying that the poor education in math and science extends beyond art school and starts in grade school and high school where many are taught that creative kids don't need math and science. Nothing could be less true. Right now we need to be encouraging everyone to study math as science for as long as possible.

Art and design schools need to think about how to bring knowledge of research, science and technology into their programs. This is critical for them to remain relevant. While I am a great believer in aesthetics, design and beauty, I also know that today, these cannot be all designers learn.

And finally do you believe that there are and disadvantages to society's connection and dependency on technology, or the futures of technology?

WOW. This is a big question. This is economics and evolutionary biology- but it is something I am thinking about – so here goes. My answer will not be a research paper. I am not going to give you foot notes. But here is my opinion based on research and reading.

Technology does good. No doubt about it. Think vaccines. But new technologies also create waste. And when new technologies displace old ones, they create waste. This is leading to environmental crisis. Not just climate change but an environment laden with toxins, wastes and garbage.

Many new technologies do not improve human well-being. We don't need EVERY technological advance. Did we need flashing LED Christmas lights? We don't need a new form of video player. But it can be more complex than that. Did we need a cell phone? The US had the infra-structure in place for land-lines. When cell phones came along that became valueless. Of course, cell phones enabled people in countries without this infrastructure to have a phone. Thus one countries useless new technology may create important advances for another country.

New technologies also provide something besides increased life span and lower infant mortality rates. They provide NOVELTY. They provide an outlet for human creativity and way for humans to participate in society, which is argued to be important for human happiness. It is my belief that human beings cannot stop innovating- creating and experiencing new things and technologies. This ability and drive to create new things is what has made us so successful as species. It is also what may very well be our downfall.

Now it would be great if there was some way we could tell what technology to invent. What technology would do good? What helps? And what is just a gizmo- a worthless piece of technological junk. Like an light plastic drinking cup. Right now we have only one way to make judgments about what technology is useful. It is called the

market, and it is pretty crappy. But what the market guarantees freedom. People are free to create things. They are free to make useless things, and wonderfully helpful things. And because we cannot know the future, we really can't say what will be useless and what will do good. What seems like just a crazy pie in the sky idea might someday lead to the form of computation!

This is the reason that I think we need to redirect human creativity toward the environment and ethical problems. We need to invent new forms of economic models (beyond growth), new forms of energy, new ways to clean up, and new ways to manufacture things that reduce waste. We need new ways to eliminate uncertainty and error, so we are not just making mistakes all the time that have to be cleaned up later.

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