Fabricating the Body: Textiles and human health in historical perspective.
Pasold Research Fund Conference supported by the Wellcome Trust University of Exeter.

Sustainable Fashion Textiles Design: Value Adding through Technological Enhancement

Co-Authors: Dr Joan Farrer RCA (University of Brighton UK) and Angela Finn (Queensland University of Technology Australia)

Introduction

A key concern in the fields of fashion and textiles design is the emergence of 'fast fashion,' best explained as "buy it Friday, wear it Saturday and throw it away on Sunday" (O'Loughlin, 2007)[i]. In this contemporary retail atmosphere of "pile it high: sell it cheap" and "quick to market", even designer goods have achieved a throwaway status. This modern culture of consumerism is the antithesis of sustainability and is providing a significant problem, in terms of sustainable practice, for designers and producers in the disciplines (de Blas, 2010)[ii]. Design researchers in textiles and fashion have begun to explore what is a key question in the 21st century in order to create a vision and reason for their disciplines: Can products be designed to have added value to the consumer and hence contribute to a more sustainable industry?

This paper provides an overview of some of the design and technological developments from the textiles industry, endorsing a model where designers and technicians use their transferrable skills for wellbeing rather than desire. The opportunities offered by research in the area of smart textiles for improved health and wellbeing are discussed in relation to three different research projects. The aim is to explore how fashion textiles design research can contribute to practical solutions for key problems faced by researchers in the fields of health, wellbeing and prevention of serious illness. The authors propose that collaboration between fashion and textiles designers and more traditional scientific researchers in the field of medical research, including health and wellbeing, could also lead to more sustainable practices for designers and consumers.

Background

Textiles are one of the oldest and most important disciplines known to man. The word 'textiles' comes from the Latin *textillis* – meaning woven.

Many phrases in the English language have come from this ancient industry, where cloth remnants have been found from 36,000BP (before present) and fashion and textiles meanings are subliminally embedded into our culture. Phrases like 'after a fashion' meaning to follow a style or behaviour, 'fabric of society', 'folded into', 'text' from textile, 'tailor-made', customized, a 'thread of conversation', the list of 'material' is substantial[iii].

Textiles have protected us from the elements and have clothed us for modesty. Fabrics have protected our human skins from damage since we stopped wearing fur and leather as clothing. The use of bandages in Europe has been well documented since the fifteenth and sixteenth centuries, but has been written about since Egyptian times where fabrics have been used for medical applications including bandages, woven in flax to wrap the mummified bodies of royalty (Refer Figure 1). However, except for the inclusion of natural products such as flax, or honey used to aid healing, these textile applications remained 'dumb.'

Figure 1: Egyptian Mummy displayed at The British Museum[iv]

It was with the advent of synthetic fibres and textile engineering, at the end of the nineteenth century, smart applications began to be seen. Today contemporary fabrics are used to carry medicine, restrict and control pressure on limbs or are even combined internally in the body to create improvements. Examples of emerging developments in smart textiles, for applications in the medical sector, include shape memory alloy and fully fashioned knitted textile polyamides for surgical applications such ostomy procedures.

Smart Materials

Smart materials in the form of responsive and adaptive fibres and fabrics combined with electro active devices, and ICT are increasingly shaping many aspects of society, which have been embraced by the leisure industry and interactive consumer, however these products are ever more visible in healthcare. Combinations of biocompatible delivery devices with bio sensing elements can create, analyse, sense and actuate early warning and monitoring systems which can be linked to data logging and patient records via intelligent networks. Patient sympathetic, 'smart' fashion/textiles applications based on interdisciplinary expertise utilising textiles design and technology is an emerging R+D field.

Contemporary 'smart' textiles have various functions which include sensing, actuating, powering/ generating/ storing, communicating, data processing and connecting. However, traditional or 'dumb' textiles also have the power to sense: for example the cellulose structure of cotton enables it to be comfortable on the skin. Wool actuates when changes in the environment are felt using a wicking technology to pull moisture away from the skin to keep it dry. Flax will react to absorb moisture four times more successfully than cotton and act as an antibacterial agent. Powering is found in early man made fabrics which conduct static electricity. Communicating happens in dumb cloth through the power of touch. Data processing is created by visual stimuli. Connecting occurs between people through emotion and desire of display through clothing.

One of their newest areas in textile development is the area of smart and interactive textiles. This is vanguard research where computer technology and electrical interactivity are combined with fashion and textiles for potential wellbeing outcomes which are not yet realised as the concept of interdisciplinarity is still in its infancy. However, the field is developing at a rapid rate and has the potential to affect many fields including medical applications. Schwartz et al (2010, p101)[v] said

> '*the convergence of textiles and electronics can be exemplarily pointed out for their development of smart material, which is capable of accomplishing a wide spectrum of functions found in rigid and inflexible electronics today. Smart textiles could serve as a means to increase the*

well-being of society and they might lead to important savings on the health budget.'

Fibres and textiles are allowing micro-electronics to be integrated into garments for personal customization and wellbeing. The first evidence of electronics being integrated into fabric was in 1921[vi], which was an electric blanket developed for sanatorium patients with tuberculosis. This was a simple resistive heating coil sandwiched between two fabrics and was developed so that patients could sit outside in the fresh air and remain warm. Today sophisticated electronic textiles allow a community of users to interact seamlessly with their environment via mechanism such as multimedia combined with WiFi technology, Radio Frequency Identification [RFID] and micro computers creating smart products which are sensitive to people's needs.

Wearable electronics have in fact been 'portable electronics' rather than wearable and have used bolt on technology such as electrical components which run off large heavy batteries strapped to the body. The challenge now is to achieve discreet wearable electronics which act ubiquitously within the fabric and perform invisibly. Now that power sources are becoming more sophisticated, for instance solar batteries are reducing in size, the technology is able to become incorporated and wearable. Early workers in this area focused on miniaturisation and computing technologies but engineers in the electronics field were not aware of the dynamics of fabric or garment design and performance, motion and desire. Since researchers from these fields have been working collaboratively with design experts they have been able to form tacit understandings of emotional design - which brings to the product the importance of function in combination with form, and desire linked to practical solutions. Early developers in this field, such as *Philips UK Electronics*, *Soft Switch.org* partnerships and *Design for Life* at Brunel University use experimental embroidered conductive thread, felted fabric, knitted and woven cloths containing elementary pressure sensors.

This is a key function of wearable technology. Textiles which allow conductivity, audio, data and power to be moved around a garment have mindboggling applications as yet undiscovered. The wearer no longer needs to be connected to a permanent power supply or attached to electrical cables. This is particularly useful in medical applications. But getting power into and out of and fabric, without breaking the circuit, is a challenge. Conductivity can be activated using a variety of substrates such as wire, conductive layers such as foam padding or using a fabric with a metal coated surface. Fabrics which are treated or blended with conductive materials such as nickel, carbon, steel, or silver can create pathways to carry electronic information in the fabrics and clothing.

Another technology uses printing with conductive inks which can be screened directly on to the fabric to be used as switches or pressure pads for the activation of printed circuits such as the headline grabbing, telephone control panel on a sleeve. Several companies are developing solutions for medical monitoring where a patient or users such as Emergency First Responders, can communicate with a doctor or manager to monitor a person's heart rate, respiratory rate, rhythm and temperature. These vital signs monitoring systems can include global positioning systems (GPS) to establish an individual's location such as in a fire or on a battlefield. One such example is Zephyr Technologies Ltd in New Zealand.

Solar power is one good way of generating energy through fibres woven into fabric and activated by sunlight. These solar fabrics are less sophisticated and productive than crystalline solar cells which are now becoming miniaturised and flexible and are therefore much more applicable as electrical generators for the body. Another power generating method is the human battery which allows heat generated by the wearer to be gathered to supply power which has an unlimited life span. Energy produced by motion is also under development and was first pioneered in the area of wrist watches with kinetic movements. The possible applications for integrated electrical communication are enormous particularly in the fields of entertainment, toys and fashion which are where these 'blue sky' applications are often adapted first. However, it is in the field of wellbeing, physical disability, the ageing population and the medical sector where the real smart textiles applications are still to be developed.

The main stumbling block to this development is the idea of transdisciplinarity where numerous fields must work together autonomously to produce one invention. Massachusetts Institute of Technology (MIT), a leading research and development university in the USA, has made large investments in the field of smart and interactive textiles. They have developed research projects using electrical and conductive fibres. For instance, these fibres are connected to sensors which can transmit data about the speed or direction of a bullet as it strikes the wearer. The sensor can then transmit this data to a medical unit who can deliver care quickly and effectively using this data on the patient in the battlefield. Another smart application in the field is optical camouflage where data can be collected and then linked to fibre optic technology. A background image can be projected onto a body and the garment becomes transparent as it blends into the surroundings. For the purposes of defence, new liquid crystal electro-chromic technologies electrically alter molecules to detect a soldier's background environment and change colour and pattern in the fabric accordingly, negating their need in future for different uniforms.

It was Philips Ltd. in 1995 who first coined the phrase *wearable electronics*[vii]. Phillips created a unique team of textile designers, electronic engineers, garment designers and computing experts to work on blue sky applications for clients such as Nike and Levi Strauss PLC. Here the technology was 'clunky' and 'bolt on'. Today the use of RFID technology commonly known as 'tagging' is widely used and sophisticated. Tags can be implanted into nanno polymers to track and trace people around the globe. In a modern hospital textiles appear in many applications, for implants to replace tendons, tissue engineering for burns reconstruction, in hygiene and health care products such as bedding, and protective covers. Protection in bandages for wounds and operating room gowns or as packaging for surgical implements and last, but not least, for clinician's uniforms.

Medical textiles are divided into three types '*which are those external to the body, those intended to be transplanted into the body, or those strictly concerned with the Healthcare and hygiene'*. [viii] Medical clothing and textiles includes fabrics designed to protect from the transfer of micro organisms through to specific engineering and performance fabric that are resistant to liquid yet have good moisture and vapour permeability, to allow patient comfort to be maintained. Internal uses of textiles include grafts and implants (Ramakrishna 2001)[ix]. Textiles with multi component layers are used in a dialysis treatment and can be 'tuned' for use as artificial blood vessels. Embroidery techniques are used for implants that have been tested for shoulder or neck disk repair. Dyer 2010[x] in his PhD practice, has developed shape memory alloy in woven textiles through the integration of wire-form, nickel titanium [Ni/Ti], which could be applicable for arterial stents which expand to a pre programmed body temperature.

New fabrics developed for abdominal fissures, aneurysms and ruptures use design engineering in woven or warp knitted fabric with directional stretch to mimic muscle performance. These internal textiles are sometimes made from bioresorbable fibres where tissue can bond with the textile and are treated with bio compatible film that can be implanted to aid their regeneration of body damage or are used in the controlled release of a drug. Other textile applications in medicine include a novel dressing that can provide sustained release of anti microbial compounds over a pre determined period, such as to treat burns, that can accelerate the growth of new skin while preventing bacterial entry. Mast Carbon® have developed an ultra filter made from non woven and woven material which is devised to provide improved filtration for liquids or gas molecules through engineered carbon fibre design with specific sized holes and permeability which can be ‘tuned’ to let certain size molecules through that can be used for face masks, and wound dressings.

An opportunity for fashion and textiles to contribute to improved health outcomes is seen in the prevention of serious skin cancer and melanoma. Sun protection factors (SPF) were first established in Australia and New Zealand however melanoma is increasing despite the millions of dollars that are being spent on SPF creams each year. In adolescence and young adulthood, between the age of 15 and 24, our bodies are exposed to 80 percent of the total harmful radiation that we will encounter during our lifespan. This is an age group where the fashion is to wear cotton T-Shirts and shorts suited to an outdoorsy antipodeans’ lifestyle, and for teenage boys going without a shirt is a particular issue. Textiles have intelligent protective systems where the fabric can protect against skin cancer or premature ageing of the skin which are key concerns in this part of the world where protection from harmful UVB rays and ultraviolet radiation, which cause acute sunburn, is in development. In general, the darker the colour of the fabric the higher the sun protection factor rating. In sunscreens UPFs absorb UV rays, rather than blocking them, and increase the fabrics UVP rating - polyester and certain polyamide are particularly good at absorbing dangerous rays. The inclusion of ceramic molecules into a synthetic fibre or surface coatings can deflect harmful rays. This type of system can withstand wash and wear processes and remain effective. Tighter and denser weaves give increased protection whereas standard cotton stretch weaves allow harmful rays through the cloth when the cloth is extended.

Signalling textiles can play a part in early warning systems where thermo-chromic dies are important. Chromic inks are intelligent materials capable of responding to their environment. They can be made as semi conductor materials, from liquid crystal compounds, which can respond to room temperature by changing colour. These can change colour depending on a number of different predetermined temperatures. Also into this category are reflective textiles, for photonic fabrics where a single fibre can be tuned to reflect light at different wavelengths to create a kind of optical bar code which could be woven into fabric to identify the wearer. These fibres could also be designed to reflect thermal radiation over various ranges. Signalling textiles could include electroluminescence where by phosphate powder is encased in a flat polyester film. An electric current excites the phosphor molecules to emit a gentle light in a consistent and uniform fashion. Electroluminescence was first developed in 1936 and has been used in watch faces for example. Another signalling textile is fibre optics which will transmit information about colour, light or even pattern through the fibre.

Conclusion

Fashion Textiles Design has much to answer for in contributing to the problems of unsustainable practices in design, production and waste on a global scale. However, designers within this field also have great potential to use their extensive skills to contribute to practical real world solutions. This presentation and paper will discuss a series of developments in the areas of smart and intelligent textiles which provide enormous opportunity for fashion textiles design practitioners to exploit the concept of value adding through technological garment and textiles applications and enhancement for health and wellbeing and in doing so contribute to a more sustainable future fashion/textiles design industry.

References

[i] O'Loughlin, S. (2007). Is Uniqlo Unique Enough To Crash Fast Fashion Party? [Article]. *Brandweek, 48*(6), 15-15.

[ii] de Blas, A. (2010). Making the shift: from consumerism to sustainability. *Ecos* (153), 10-12.

[iii] Farrer, J., (2011)'Remediation: Discussing fashion textiles sustainability'. In Gwilt, A., Rissanen, T., (Eds) Shaping sustainable fashion. London. Earthscan. pp 19-33.

[iv] Image: Retrieved from http://www.flickr.com/photos/francescaturchi83/4197243168

[v] Schwartz, A., Van Langenhove, L., Guermonprez, P., Deguillemont, D. (2010) 'A roadmap on smart textiles'. The Textile Institute. Cambridge. Taylor & Francis. 42, (No2).

[vi] Bellis, M. http://inventors.about.com/od/estartinventions/a/ElectricBlanket.htm

[vii] Hibbert, R. (2006) 'Textile Innovation'. London. Line Publishing. p106.

[viii] Slater, K. (2003). *Environmental impact of textiles*. Cambridge. Woodhead Publishing. p.194

[ix] Ramakrishna, S. (2001) 'Textile scaffolds in tissue engineering', in Tao, X. (Ed), Smart Fibres, Fabrics and Clothing. Cambridge. Woodhead.

[x] Dyer, P. (2011). Dynamic control of active textiles: The integration of Shape Memory Alloys and the manipulation of woven structures. PhD Thesis, University of Brighton.