Extreme design

Extreme fashion future: communication clothing

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Abstract

Communicative clothing is emerging as the next generation of intelligent clothing, with communication being achieved between clothing and the wearer or between clothing and the external environment or people. In both cases, 'communicative' clothing refers to any clothing or textile accessory that receives or emits information out of the structure that composes it. The market for these textiles is foreseen in many some area applications among Professionals (the need for 'free hands' functions, safety, data exchanges); Health care (monitoring, training, remote diagnosis); Everyday life (telephony, wellness); Sports (training, performance measurement); or Leisure (aesthetic personalization, network games) etc. Large volume production and application in products of everyday use is however still a dream for the manufacturers. One of the main roadblocks to successful adoption of these technologies by fashion designers and retailers is that the designers have not had access to ready materials with which to experiment and develop commercially successful products. Communication clothing for example is a result of integration of a number of different technical elements like Control interfaces, sensors, data processing devices, output devices, energy sources and connectors. It will be reasonable to expect that if these technologies/elements are known and available as standard tools & accessories, which can be used by fashion design students/ designers to add value to any garment ensemble, their application & volume in fashion will grow. This paper reviews the status of various elements of communicative technologies with potential applicability to fashion in terms of their availability, limitations and challenges. List of commercially available products, manufacturers is provided. A point of view for future strategy is presented.

Keywords:
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Extreme fashion

In spring 2005, Cooper Hewitt Museum presented an exhibition devoted to the subject of textiles designed for ultimate performance in extreme conditions called 'Extreme Textiles: Designing for High Performance'. The exhibition, presented over 150 extreme textile applications exploring the recent advancements in technical textiles and reference to historical examples of textile structures and techniques – such as weaving, knitting, braiding and embroidery – that continue to be used in the most pioneering textiles today. The term 'Extreme Fashion' would therefore probably describe a class of fashion that has embedded active functions in addition to the traditional properties of fashion. These novel functions or properties are obtained by utilizing special textiles or electronic devices, or a combination of the two. Thus, a blouse that changes color under the effect of heat could be regarded as extreme fashion, as well as a sports bra that records the heart rate of an athlete while he/she is exercising.

Communication clothing

Although all clothing communicates intrinsically by virtue of its appearance, communication clothing can be perceived either as that generation of extreme fashion where the communication is that of information coded and transmitted by means of electronic components in clothing. Communication can indeed be achieved between clothing and the person who wears it, or between clothing and the external environment and other people. In both cases, 'communicative' clothing refers to any clothing or textile accessory that receives or emits information out of the structure that composes it. First examples of such clothing is those where integration of portable telephones, media players and miniature PCs have been achieved. Many more applications are being studied and many are yet to be imagined.

It is also significant to know that the evolution of these smart and interactive technologies is taking place at the same time when fashion trends are predicting a more individualistic approach in times to come. Most of these technologies are ideally suited for customisation and individualization. It will be reasonable to expect that if these technologies are developed as standard components and accessories, which can be used to add value to any garment ensemble, their application volume in fashion, will grow.

In this paper, it is proposed to review the various elements of typical communication clothing in terms of building blocks available for integration, commercially available products and their manufacturers so that the review acts as a ready reckoner for potential users.

Potential targets and applications

Everyone wears clothing, and most people are concerned with the appearance of communication apparel. However, the needs will be different within any given group of people. Most significant areas of application that have emerged in recent past are:

- Professionals (the need for 'free hands' functions, safety, data exchanges);
- Health care (monitoring, training, remote diagnosis);
- Everyday life (telephony, wellness);
- Sports (training, performance measurement);
- Leisure (aesthetic personalization, network games).

Many applications have been reported in recent years. Nike introduced an iPod in shoes for their jogging consumers. Adidas introduced a shoe with electronic damping adjustable to ground surface, as also its 'fusion project' with integrated sensors for heart rate and step frequency. Numetrex integrated electrodes in their sports bra measure and transmit wirelessly the pulse watch. O'Neill' s snowboard jacket allows to operate a cell-phone hands-free via Bluetooth. Numerous companies offer apparel with integrated MP3 and iPod remote control – sometimes with additional Bluetooth functionality. Apart from jackets by Burton, O'Neill, Spyder and Norrona, one can also find iPod gloves from O'Neill and Marmot, and pants from Levi's and Lodenfrey. Music and communication has also been integrated into rucksacks and bags, for example from Simpak, O'Neill and JanSport. The Oakley Company offers MP3 integration with its Thumb 1 and Thumb 2 eyewear and Bluetooth headset integration with Razrwire. Motorola and Oakley are showcasing '0 ROKR" vision as a fusion of sunglasses and Bluetooth stereo headphones. The sunglasses are equipped with a Bluetooth receiver that is Stereo Music Profile enabled. Uranium is providing jeans and shirts with integrated LED panels that show a customer's message to everybody. The new technologies are also finding their way into the field of work wear and protective clothing like Philips 'Know Where Jacket' with integrated GPS (from Interactive Wear).

While the market for these textiles has been gaining momentum in many such niche area applications, large volume production and application in products of everyday use is still a dream for the manufacturers. It is hoped that fashion designers and retailers will begin to adopt these technologies in near future. Limited commercialisation attempts by some brands (Uranium and Levis jeans, Rosner, Hugo Boss) and some retailers (Wal-Mart, Marks & Spencer) have taken place.

Technologies and components

A communication clothing application combines intelligent micro system with both electronic and textile components, power supply and interfaces for textile integration. It consists of several technological building blocks, which are quickly analyzed, in next few paragraphs.

Sensors and actuators

Sensors are used for input and control as well as for determining environmental and body parameters. Since clothing accompanies every body movement, and is sometimes in direct physical contact with the person, it also serves as an ideal medium for translating and interpreting human activity by means of sensors. Textile control elements, working as pressure sensors are a typical application here. Clothing could be used to detect different actions, in particular the recognition of gestures, in order to facilitate certain commands that are intuitive, as with the automatic release of a phone call when one moves the collar of clothing to the ear. Moreover, when these sensors are associated with computing and with the control unit, they may allow the recognition of situation and context for a better interpretation of reality. Actuators are virtually the opposite of sensors: they translate signals into actions and can produce heat, light or sound.

Sensor-actuator networks, in which distributed sensors and actuators are linked, organise themselves into networks and perform a task cooperatively, sometimes working with standard communications technologies (like Bluetooth or Zigbee) for the PAN (Personal Area Networking). Sensor networks when applied in medical engineering will have the sensors and embedded systems worn on the body as a closed network, in what will be called a BAN (Body Area Network), in which communication can also take place by wireless means.

User interfaces

Many applications would require a display or reproduction of information produced by communicating systems integrated into clothing. Traditional interfaces such as displays, LCDs, screens or speakers have to satisfy the same ergonomics and rigidity criteria as those for other components. Solutions containing micro-screens in glass or using technologies, including flexible supports, have begun to appear. In addition, the proximity of clothing and textile accessories to the natural human senses opens new possibilities for the transmission of information. Visual and auditory ways of collecting information (such as screens and speakers), which are today largely developed in a form that do not require direct contact with the user, could soon be joined by tactile and olfactory methods. The T-shirt with a collar that translates environments by diffusing a combination of perfumes is about to leave the realm of science fiction.

Data processing

Integrated microcomputer facilitates a wide variety of functions such as music playback, communication via Bluetooth with a mobile telephone, readout of sensors, and the control of actuators. These are called ‘embedded systems’ and are ubiquitous – whether in cars, mobile telephones or washing machines; 90% of all microcomputers are 'embedded'. The material supports in terms of memory, computation and data processing (RAM, hard disks and processors) will certainly not evolve much in the short term unless they do so in the direction of miniaturization. A few systems can already be integrated into clothing today, they remain however fragile and require partly rigid protection in order to be integrated into communication apparel. However, their integration has become entirely possible, as seen in the incorporation of a micro PC into the loop of a belt. With increasing miniaturisation, it will be possible to realise simple systems in the form and size of a button or emblem. More complex systems are usually connected to the textile through a docking station, or are constructed to be flat and flexible with the aid of flexible substrates. Researchers are currently working on textile substrates for the assembly of electronics and on printed circuits based on polymer semiconductors; these promise to be the flexible and washable construction elements of the future. It is also possible to imagine that only a small quantity of information is processed locally in communicative clothing, and that higher-powered remote servers handle

more complex functions and more significant memory capacities. This difference between local and mass treatment involves the development of specific algorithms, as is the case for intelligent vehicles.

Connectors

Connection problems are another major issue in state-of-the-art communicative clothing. The individual elements are mostly mounted at distributed points within the item of apparel and must be securely and reliably connected with one another. The connection technology is the key to textile integration and is actually the essence of wearable electronics since it is how information and energy will be transferred among the various components of the electronic system with optimal efficiency. The connection implements the power supply and data exchange between the individual components. Both textile character and high reliability are important. The connection is subject to considerable stress: both mechanical stresses produced by the washing machine and chemical stresses from cleaning agents and body perspiration. The look and feel of a textile is also important because the introduction of the additional functions to the item of apparel should be achieved in a way that is imperceptible to the user.

In recent years, great advances have been made in the development of textile cable materials. Today, for individual connections, as well as crimped connections and solder joints, sewing techniques are also being researched and implemented in prototypes. In a textile setting, both methods are handicrafts for which good quality control is essential. Plug connections have the advantage that connections can be cleanly established and terminated again by the end user. A plug is, however, always a non-textile element that is detectable in a garment, and hence stands out. A better alternative is the classical snap-fastener, specially when only a few lines are required. The connection is durable and can be used inconspicuously directly in the textile. Hence Interactive Wear uses snap-fasteners to attach earphones and microphones into the collar. Light emitting units can be similarly integrated into snap-fasteners.

As an alternative, diverse techniques of wireless transmission exist; for example, infrared or radio waves using various standards (IEEE 802.11, Bluetooth, etc.). If these modes of transmission are to free communicative clothing from the need for physical connections, several

additional constraints must be taken into account. For example, the energy consumption necessary to their operation may be important. Moreover, when it is a question of simple information transport (such as an open or closed contact or something similar) or of energy transport, wired connections become indispensable. The wireless connections mainly have to be used to connect the user to the external environment.

In addition, energy distribution to the disparate electronic interfaces is also an issue. While a single source allows better energy management, each electronic interface could have its own computation and storage capacities, which would allow resources to be allocated and weight to be distributed. It is also important to examine the problem of control and the centralization of information restitution. In fact, to be able to manage all of the functions of a complex communicating device, it is necessary to centralize outgoing controls and incoming information on a single interface. This means that the accessing of emails or a direction on a cartographic site, for example, must be done on a single screen.

Energy

Interactive apparel requires power and, since some components are very power-hungry, the power supply is frequently a critical component. Autonomy in energy is still a main handicap of the majority of mobile electronic devices. Depending on the application, the challenge lies in achieving as long a period of autonomous operation as possible or else a high energy density. The longer the running time and the easier the charging, the better it is.

In the case of communication apparel the choice is either on energy sources – and storage – or else on power generation systems. Storage batteries offer the best autonomy, which however must be weighed against their weight and volume. Though battery technologies have evolved in recent past (e.g. Lithium-Polymer) but they unfortunately, continues to be the heaviest part of a portable device.

The dream is of a wearable electronics application, which generates the power itself in the way that automatic watches do. Researchers have investigated this field for years. One interesting alternative seems to be the use of renewable energy sources. Solar energy and wind are relatively poorly adapted to clothing because they require large surface areas to be truly effective. It is expected that organic solar cells will lead to much

more cost-effective solutions in this area within the next few years. On the other hand, many studies have been carried out on local power generation from motion or temperature, referred to as energy harvesting. Human body as it is generates in its 'stand by operation' about 100 watts of waste heat. Normal activity results in about 400 watts of power dissipation, and top athletes can emit as much as several kilowatts. Is it not possible to use this energy? In 2002, the semiconductor company Infineon Technologies introduced energy extraction from temperature differences, using a thermo-generator. Using this method it is just about possible to power a watch but it is insufficient for energy intensive applications such as heating or even cooling. The harvesting of mechanical energy at the soles of the feet or from breathing or arm movements has been investigated and the basic techniques ascertained – fundamental work has been carried out at MIT to this end. In the next two to three years, micro fuel cells should also have found their way onto the market. In comparison to lithium-ion batteries, they can be recharged in an instant with replacement tanks and have a higher energy density. But in practice it is not currently possible to dispense with the good old conventional or rechargeable battery. Whether standard cells (A, AA, AAA) or lithium-ion rechargeable as used in mobile telephony, the technology is proven and reliable.

Roadblocks to commercialization

There are some roadblocks to successful commercialisation of communication technologies in fashion on a global/volume basis. One of them is that the current wearable technology research is driven by the computer science/electrical engineering disciplines and not by textile and fashion technologists.

While it is true that the concept crosses boundaries between many disciplines ranging from fashion design, textile technology, human biology, electronics, multimedia, interaction design and marketing, in most cases however the designers and developers seem to have followed a reverse design process by finding a problem which fits a pre-existing solution rather than the other way round.

Take for example the range of clothing that has been introduced with music/telephony or computing connectivity. There is a disparity in product cost, expected lifespan, and situational appropriateness between garments and complex electronic technologies. New fashion is

designed/developed every season, and expected to be worn anywhere from a few months to a few years. Portable technologies takes years of development and new models are also expected to last a few years. Consumers will not pay for a new device every time they purchase a new garment. Further, garments are end-use specific i.e. eveningwear, party wear, sports wear; whereas portable devices are more versatile in their usage. For example, If an MP3 player is permanently integrated into a garment, then that specific garment must be worn any time the user wishes to make use of the device. Either the garment must become as versatile as the device, or the device must become inexpensive enough to be fitted in all garments. One can infect raise the question, why should a device be garment-integrated? Wouldn't the device function better as a portable device?

Secondly, many body-centric clothing issues such as weight, movement and mobility, thermal management, and moisture management that are crucial to the comfort and functionality of a wearable device are not given sufficient attention. Some issues, which can be raised, for example are: Bulk/weight/stiffness: Most electronic components, no matter how small in size, will be rigid, stiff and solid as against the surfaces of the human body, as are most available power sources.

Thermal and Moisture Management

Clothing comfort is closely related to the transport or conservation of heat and moisture throughout the garment system. All computing and electronic components will produce heat, some more than others. Besides the discomfort to the wearer, the heat can be damaging to the microprocessors and other complex chips, which must be kept, cooled in order to prevent malfunction of their fine circuitry. In cooler environments, the user's body itself can absorb excess heat. However, in warmer environments both the user's body heat and the device's heat must be removed or diffused. Further, All electronic circuitry is constructed on a base on non-conducting substrate so as to prevent any short-circuit. The body, however, continually produces moisture, which may pose a threat to the device itself by way of a short circuit or corrosion of interconnections.

Flexibility/Durability

While flexible circuit boards are also available, flexibility is at the cost of durability and any aggressive flexion or torsion will weaken electrical

connections and could cause components to be ripped free of the circuit board. Weak points are usually the pin connections and solder joints.

It is quite clear therefore that this 'new' clothing design discipline while embracing creativity and aesthetic awareness also has an extreme requirement for technical understanding and innovation. The interdisciplinary components involved are still relatively isolated from each other, and it will require a deeper understanding of usability and the importance of the interface between emerging technologies and the needs of the 'customer' for successful commercialization to take place.

More importantly, because of the high investments being incurred by certain companies or research teams, these technologies are being offered as a proprietary package. Companies are offering ‘solutions’ rather than ‘building blocks’ or ‘components’ of these varied technologies. As such traditional designers, product developers or even fashion design students do not have access to standard, ready materials with which to experiment and develop products.

Recommendations

Communication clothing or other wearable electronics represents an emerging ‘new’ discipline which presents designers with new influencing variables that currently lie outside their scope of their experience. There is a need for a ‘protocol’ to be prepared for integration of electronics into clothing in a way that it is seen as a ‘new tool’ by apparel designers (as CAD was a few decades ago) thereby integrating this technology into their design process. A lead will have to be taken by IFFTI, as the ‘only global body representing fashion technology’ to set up a group for this purpose.

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