

**White Paper on
Smart Textiles
- market overview**

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Introduction

This white paper takes a market orientated approach, since this is of primary interest to companies considering venturing into the smart textiles market and this approach is rarely seen in the material available.

Our target audience is companies in the traditional textile and electronics industries, who are looking for an overview of current trends.

Definitions

Smart Textiles:

- Textiles with the capability to react to different kinds of physical stimuli, for example temperature, pressure etc.

Wearable Technology:

- Any electronic device that is small enough to be worn or carried on the body.

Interactive Textiles:

- Wearable technology which is sewn into clothing and operated or controlled by an integrated control panel/operation button.

Market overview

Smart or Interactive Textiles is a new market segment resulting from the miniaturisation of electronics and the fall in price of components and manufacturing costs for both electronics and textiles. A simultaneous trend in the clothing industry toward manufacture of specific products for dedicated uses i.e. for running, skiing, golf and extreme sports has created a niche where smart and interactive textiles enable new functions and features that can enhance a garment's performance and its wearer's experience.

Market drivers

Low cost fibre and textile manufacturing in Asia and India has caused significant cut backs in production in Western Europe and has pressed traditional textile companies to look to new technologies to add value in the design phase of a production. Such new technologies are immature and often promoted by start-up companies that are spin-offs from professional research. With limited funding to commercialise their products, the result is that some of the most exciting technologies have not yet been exploited to the full.

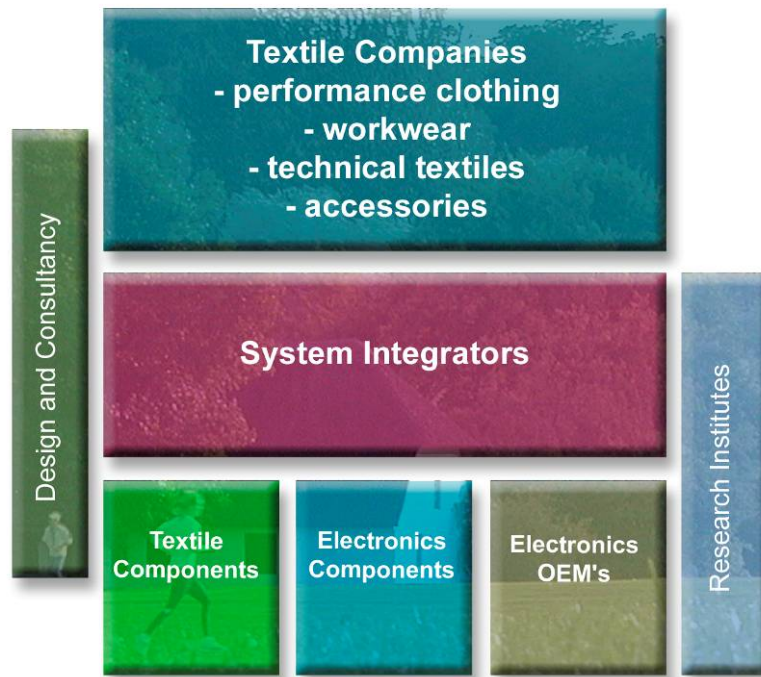
During the past two decades much research has been carried out by research organisations funded by government agencies and industry members alike. The EU has also funded a series of projects in development of smart and interactive textiles through the FP 6 programme. This continues in the 7th framework programme which is designed in part to facilitate a restructuring of the European textile industry by strengthening research institutions and commercial developments made by textile companies working in the smart textile field.

The EU's technology transfer programmes are designed to ensure widespread dissemination of technologies and standards throughout Europe for the benefit of the industry as a whole. Without common standards for interconnects etc. new technologies risk being throttled in their infancy if they are not compatible with the technology that makes the initial breakthrough.

While a great deal of research has resulted in patents etc. commercial applications have yet to make a widespread breakthrough. Lack of a "killer application" means that demand for basis technologies has been limited so far and that implemented technologies have not yet benefited from economies of scale.

The most successful applications so far have therefore been based upon incremental changes to high end products focusing on performance (addition of one or two new features) coupled together with a smart design that makes them attractive to consumers; examples include O'Neills snowboarding jacket with MP3 player and the Nike-Apple sports kit with a pedometer in the shoe that communicates with an iPod nano to record its wearers run.

Marketstructure



Market Structure and stakeholders

While smart textile applications have made a limited commercial impact so far, with relatively small volumes of commercial products launched primarily in the high performance apparel sector predictions for growth of the smart textile market as a whole are huge. According to the Venture Development Corporation the market for electrically enabled smart fabrics and interactive textile technologies was worth US\$340.0 million in 2005. By 2008 it is expected to be worth US\$642.1 million, representing a compound annual growth rate of 28.3%. While some predictions do not agree on the total value of the market, they are all agreed that the market for smart textiles is one of the most dynamic and fast growing sectors and offers huge potential for companies willing to take the plunge.

Not surprisingly, most of the smart textile consumer products launched so far have been introduced onto the luxury end of the performance clothing market where development costs can be more readily absorbed by higher prices. Companies dominating this segment are those who already have a significant market share such as Nike, Adidas and O'Neill. Products launched in this sector show a clear trend toward strong design features coupled with simple to operate functions that are highly relevant to the garments wearer in the particular use situation. A good example of this is the Nike plus running shoe. Cooperation with IT giant Apple has resulted in a simple user friendly web interface that enables runners to motivate themselves and each other by uploading data recorded by the sensor in the shoe and transferring it to a standard iPod nano. The system is stylish, simple to operate and enables runners to track their performance and set new targets to be reached.

Major actors in the performance clothing segment

- Adidas, Nike
- O'Neill, Burton, North Face, Rosner

Some of the ideas launched in the performance clothing segment are also applicable in healthcare monitoring. Several projects have received EU funding to develop wearable sensing and data transmission systems that monitor the wearer's vital signs; MyHeart: <http://www.hitech-projects.com/euprojects/myheart/> Proetex: <http://www.proetex.org> Biotex: <http://www.biotex-eu.com/> Context: <http://www.context-project.org/> OFSETH: <http://www.ofseth.org/>

Breakthroughs in this market segment have however been limited because of difficulties in developing effective sensors that do not require conductive gel etc. in order to retain electrical contact. In addition, where garments are to be used for monitoring of health and medical conditions it is critically important that the technology functions reliably and without irritating the wearer's skin etc. This segment is one of those predicted to grow most based on the needs of an aging population and increasing focus on health and well-being.

Monitoring health and vital signs, commercial products in 2007

- VivoMetrics (Lifeshirt)
- Adidas, Numetrex

A group of stakeholders which is also predicted explosive growth is that for smart fabrics; textiles that respond to external stimuli such as temperature etc. End user applications are numerous and highly diverse which makes evaluation of market potential difficult. Few standard products are currently commercially available.

Smart Fabrics

- Outlast Technologies (thermal storage release)
- Toray Industries Inc (polyester and nylon shape memory fabrics)

Also known as enabling components, a handful of companies have already succeeded in establishing themselves as commercial suppliers of textile based pressure sensors and switches etc. It is expected that the current leaders in this field will set the standard for interconnects etc. for the industry as a whole.

Textile Components

- Eleksen, Peratech Ltd,
- Fibretronic
- Textronics

Textiles are an entirely new market for electronics and chip manufacturers. Several well established manufacturers have already participated in EU projects. Continued close cooperation is essential for development of a series of standard interconnection and encapsulation techniques.

Electronics Components Manufacturers

- Philips
- Infineon
- Motorola
- CSR

Electronics OEM's

- Philips
- Nokia
- Motorola

Most textile companies are not used to managing extensive R&D projects. A strategic decision to launch a smart textile product can therefore be something of a challenge. However, a number of companies exist who can undertake development of smart textile products for the commercial market. System Integrators are typically smaller companies with specialist expertise, they have competencies in electronics and industrial design, encapsulation of electronics and integration with textile structures. The number of system integrators is expected to grow rapidly over the next decade.

System Integrators

- Interactive Wear, Ohmatex, Fibretronix
- Clothing+
- Polar

Research institutes have played a broad role in smart textile development; working primarily with development of basis technologies and system integration. The leading institutes working with smart textiles are listed below.

Research Institutes

- NCSU – North Carolina State University College of Textiles
- Wearable computing Lab, Swiss Federal Institute of Technology -ETH Zürich
- Centexbel
- TITV (Textilforschungsinstitut Thüringen-Vogtland)
- ENSAIT – Ecole Nationale Supérieure des Arts et Industries Textiles
- SmartWearLab – Tampere University of Technology

A number of textile colleges concentrate on issues connected to design of smart textiles.

Design and Consultancy

- Central St. Martins College of Art and Design
- The Swedish School of Textiles, Borås

Application segmentation

Clothes with integrated electronics and textiles with innovative properties are already available in stores - and the new products are catching on with consumers. Micro-electronics and nanotechnology are opening up a world of opportunities for the electronics and textile industries.

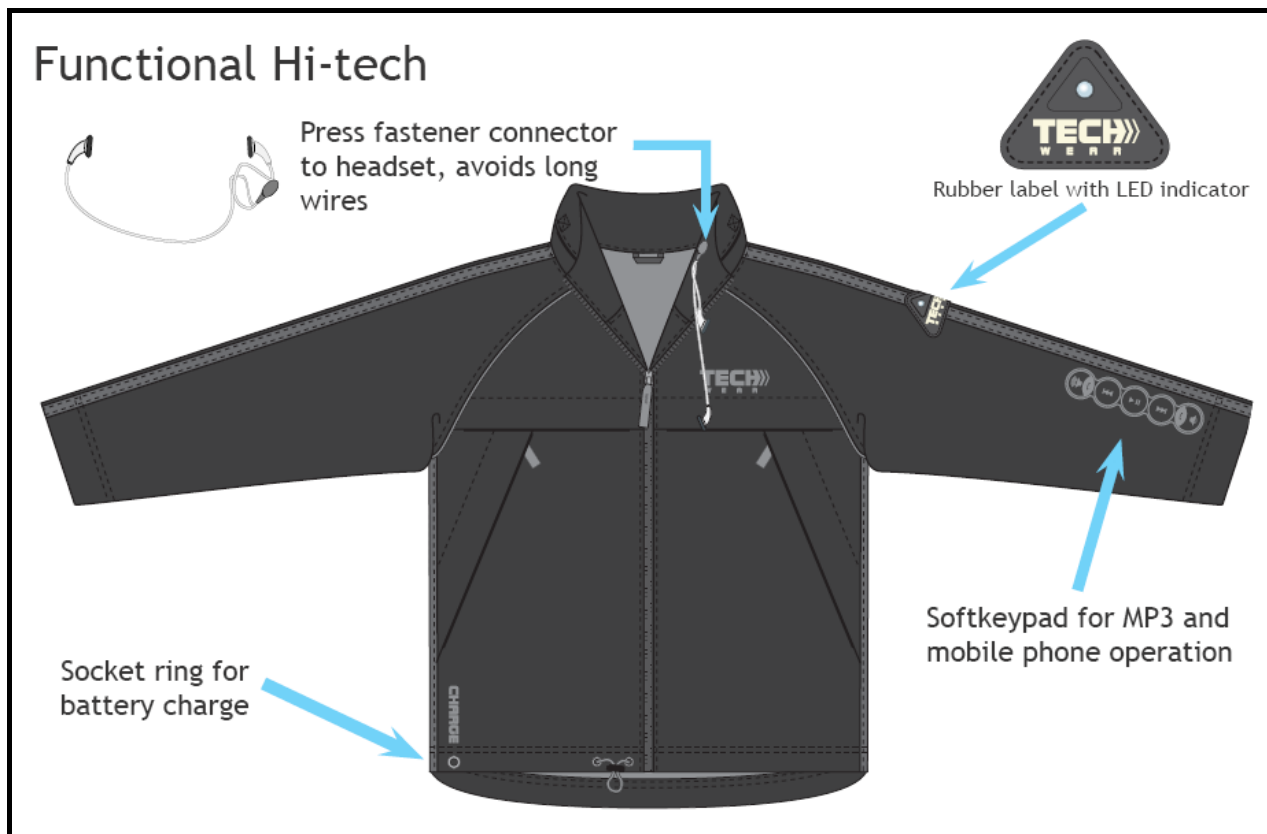
From the commercial applications seen so far the following application segments are identifiable:

- Clothing where electronics are used as a design feature – sports, leisure and fashion wear.
- Work wear where electronics are integrated to provide communications and safety features.
- Accessories (bags, shoes and the like) and home furnishings where a highly diverse range of applications using nano materials and embedded electronics are already appearing.
- Undergarments worn in close contact with the skin, designed for monitoring health and welfare
- New markets are opening up for textiles in architecture, transport and industry. Applications here typically exploit textile properties of extreme strength and flexibility; textile moulds for concrete building elements etc.

Sports, leisure and fashion wear

Garments, for extreme sports such as snowboarding and skiing, with integrated MP3 players and a bluetooth connection to mobile phones have been commercially available for the past 3-4 years. While both Rosner and O’Neill continue to market these items, and even expand their range of related smart textile products, sales have not yet reached large volumes. Nike withdrew their comm jacket from the market before sales really began to take off.

So far smart garmets have been primarily directed at the performance clothing market and solutions have been similar to that illustrated below.



A soft textile pressure sensitive keypad is sewn into the garment sleeve and connected to an earpiece or headset by textile wiring running between the fabric layers of the jacket. The battery, headset and MP3 player are removed for laundering. This product makes use of the keypad and LED indicator as a design feature that differentiates this jacket from standard garments. While the product is expected to have arrived to stay, current products are aimed at younger, tech smart consumers and prices will have to fall considerably before such products are expected to make their entrance onto the wider fashion and leisure wear markets.

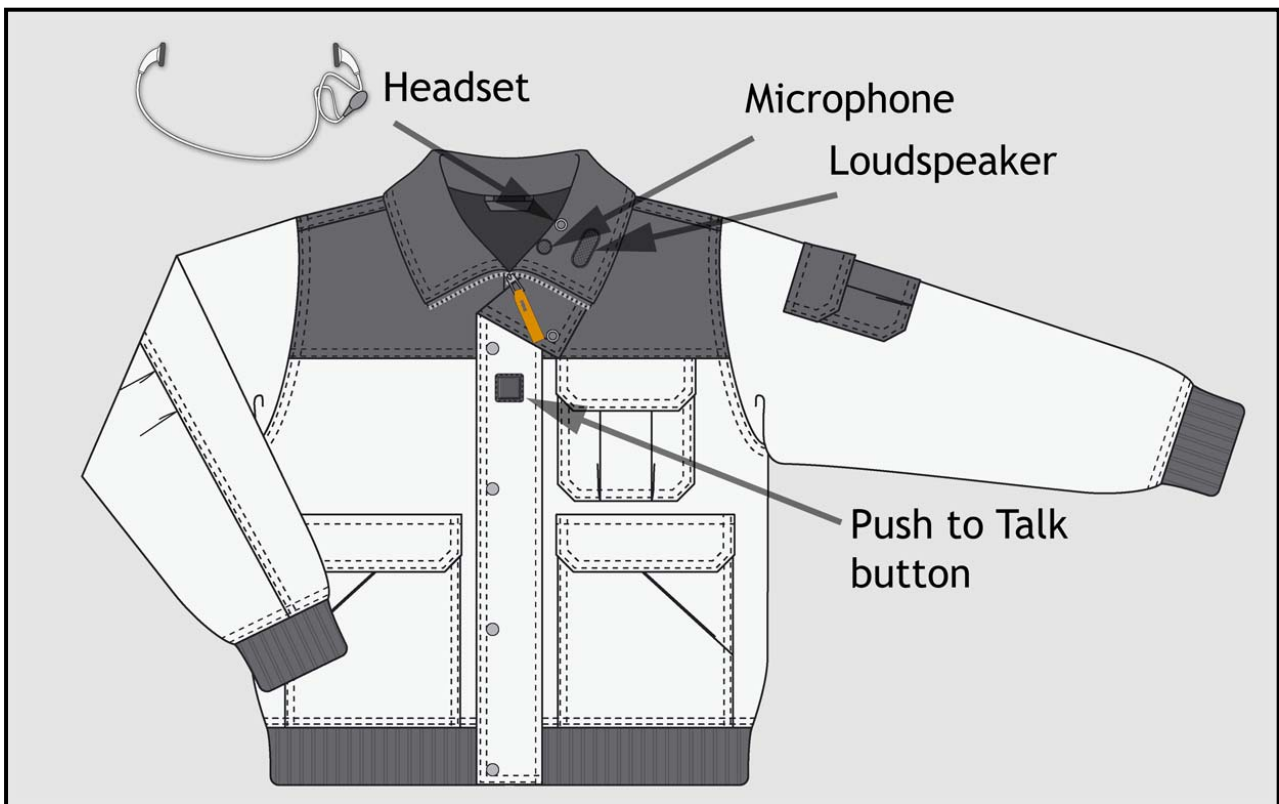
The number of products now available means that new launches have limited “news” value and no longer gain marketing attention automatically.

It is interesting to note that performance garment manufacturers have subsequently also begun to launch varying accessories that provide a “soft interface” to otherwise standard consumer electronics; ski gloves from O’Neill that allow wearers to operate their MP3 player without taking it out of their pocket and Nike who expect to launch a soft rubber watch that can be used to operate an iPod directly.

Few applications have been launched onto the fashion market, although this segment is widely predicted to become a major market in the future. Research at the French textile institute, ENSAIT for example led to launch of a range of denim products with textile displays and integrated programmable electronics. The success of the product is unknown.

Work wear with safety, communication features

The work wear and professional uniform segment is expected to be a major market for smart textiles. As illustrated below, applications are envisaged that enable hands-free communication for a number of professional users including police officers, technical personal, construction workers and many others. The only application of this kind designed for the work wear market so far was the Nike comm jacket and rescue harness which were designed to provide for mountain rescue services with easy to use radio communications. It was withdrawn from the market before it became a sales success.



The comm. jacket was later introduced as a performance jacket for skiers where it enabled communication between skiers via walkie-talkie radio.

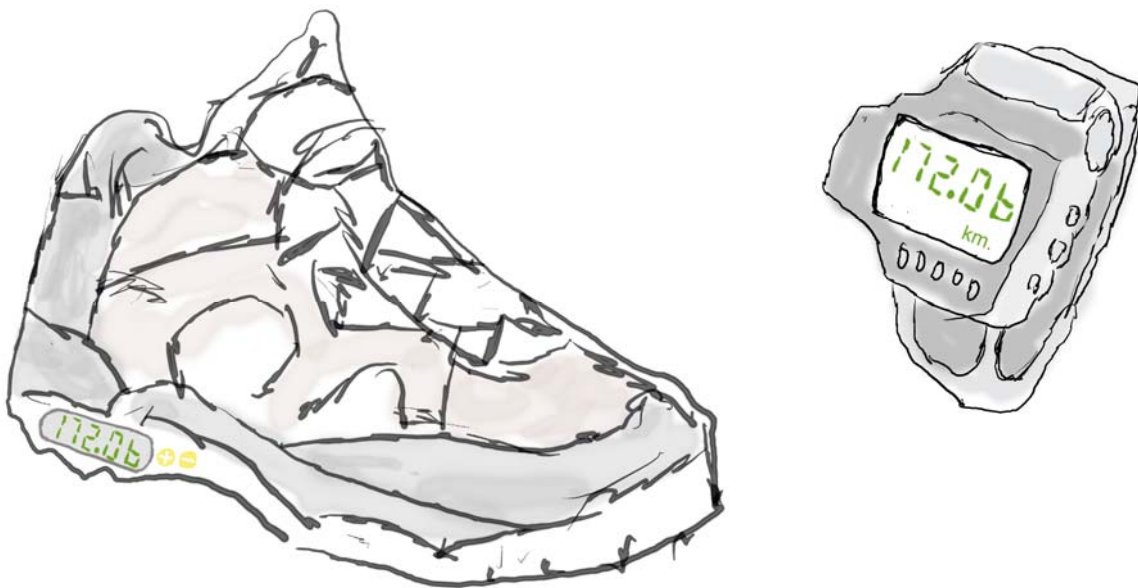
In 2007 Viking Life-Saving Equipment presented a prototype fire-fighters jacket with integrated electronic thermal sensors at the FDIC trade fair in Indianapolis, USA. This is a good example of the second type of application in this segment where proven thermal sensor technology was integrated into the jacket using textile cabling and silicone encapsulation to provide fire-fighters with an alerting system that warns of critical increases in temperature. It is to be expected that new safety features based on integration of electronics and new material types will to be regularly introduced to the work wear market in the future.

Accessories and special applications

Sports giant Adidas was one of the first companies to launch a series of commercial products (2004) combining micro-electronics and textile materials. The intelligent shoe Adidas_1 was originally designed as a running shoe that senses the terrain and adjusts cushioning in the shoes heel within split seconds, to absorb shock. The shoe has been further developed for the basketball market where it is currently marketed.

Probably the most common applications in this segment are bags with integrated controls, speakers or headsets to an MP3 player or iPod. A number of manufacturers have launched products of this type including G-Tech, O'Neill, Simpak etc.

What is interesting is that these kinds of bags are no longer just designed for the performance sports market but are also designed for the fashion market where smart designs combined with electronic features have predominantly aimed at attracting the young market. More recently however, sales outlets such as the British department store, Marks & Spencer have also begun to market just such a bag for a wider more popular market. This could well indicate a shift in the maturity of the market with wider consumer acceptance of this type of integrated technologies and may be the starting signal for an explosion in similar types of products and accessories for the broader market.



Monitoring and healthcare

Several commercial technologies are already available for monitoring various physiological functions. Of these, most are aimed at the performance market and designed primarily for use in monitoring the efficiency of an athletes training. Typically they monitor heart rate and are used to log and plan athletic training. Textile sensors are knitted into a t-shirt / undergarment and are worn in direct contact with the skin. A detachable wireless transmitter sends sensor data to an external receiver that records and displays heart rate, exercise period etc.

A number of systems in this category are commercially available and prices have begun to fall so that systems are no longer significantly more expensive than standard performance sports wear.

Sensors that can monitor pulse (heart rate) can also be used to measure other parameters. Vivometrics Lifeshirt can not only be used to measure sporting performance, but is the first of these systems to have launched a commercial product aimed at monitoring a whole series of parameters in order to determine the wellbeing of particularly vulnerable target groups such as medical patients and fire-fighters. Embedded sensors collect pulmonary, cardiac, posture and activity signals and additional peripheral devices can be used to measure parameters such as blood pressure, blood oxygen saturation, EEG/EOG, periodic leg movement and temperature.

This system is highly complex and requires calibration to the individual wearer. It is also necessary to use conductive gel to ensure good electrical contact with the skin. However, the system has been on the market for a period of time and has now obtained FDA (the American Food and Drug Administration agency) and EMEA (European Medicines Agency) approval. Many of the EU funded projects under the FP6 programme have concentrated on this type of solution which market is predicted an exponential growth due to an aging population and increased western focus on personal wellbeing.

New markets for textiles

Chemical engineering developments in recent years have led to development of textile fibres with properties such as extreme strength, lightness in weight and where fibres can change their shape dependant upon temperature or other external stimuli. These features are just beginning to be exploited in entirely new sectors, where textiles have not traditionally been standard materials.

Applications are widely predicted to be highly diverse, covering segments from EMI shielding in automotive, planes and the like to use as moulding forms for architectural components and to reinforce and strengthen concrete building elements.