

A cut above

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From solar-powered bikinis that charge your iPod, to wearable games and his'n'hers LED jackets, visitors to the recent Siggraph show in San Diego were given a glimpse of an exciting future where clothes are much more than something we wear to keep warm.

But despite almost a decade of hype, stoked by a hectic events calendar offering regular previews of the wardrobe of the future, real-world applications of smart clothing are remarkably thin on the ground. In commercial terms, the business has not amounted to much more than MP3 controls in jackets.

Finally though, reality is beginning to catch up with the vision, and a range of new applications and technologies suggest intelligent garments that are comfortable, washable, and useful may be heading for our clothes hangers soon. The emergence of these new technologies has been given added impetus by claims that in the face of low-cost competition from India and the far east, smart clothing is the beleaguered European textile industry's best hope of survival.

One of the most exciting areas for smart textiles is in healthcare, where the marriage of fabric and electronics is leading to the development of wearable, non-invasive systems for monitoring patients' conditions.

A chief innovator in this area — Italian firm [Smartex](#) — last year launched a shirt able to monitor the electrical activity of the heart. Developed under an EU research Wearable Health Care System (Wealthy) project, it is woven from electrodes made of stainless steel wires twisted around a viscose yarn. It sounds uncomfortable but, according to Smartex, because the wires are so fine, the material feels like cotton or polyester. It can also be cleaned in a washing machine.

Dr Rita Paradiso, Smartex research director, said the company is now poised to take the technology a step closer to commercialisation with a follow-on project called Healthwear, in which three hospitals will evaluate and test the performance of 50 garments.

Similar technology has been developed by US firm [Textronics](#), which has developed a fabric-based system for monitoring heart rates and measuring respiration. The material is based on the company's so-called Textra-Yarns; comfortable, washable, elastic, conductive composite yarns that can be knitted and weaved into clothing. Earlier this year the company launched an exercise vest for men under its NuMetrex brand.

Meanwhile, Smartex is taking part in the €3.1m (£2.1m) EU-funded Biotex project, which hopes to increase further the potential of wearable monitoring systems through the development of smart fabrics capable of analysing bodily fluids.

Talking to The Engineer in June, project co-ordinator Jean Luprano, of Swiss R&D firm [CSEM](#), explained that through integrating optical, electrochemical and electronic sensors, the Biotex consortium hopes to develop textiles that can monitor bodily fluids such as blood, urine and sweat.

Paradiso said Smartex's role in the project is to tackle the problems of integrating biochemical sensors with textiles and handling liquid collection. Luprano said that as well as being used for remote monitoring of vitals signs, such a system could also be used to improve early illness detection and the identification of metabolic disorders.

While Biotex gathers pace, Smartex is just one of a number of Italian firms dipping its toes in the smart fabrics industry. With its strong tradition of engineering excellence and historical links with the international fashion industry, Italy seems to provide a fertile climate for smart fabric development.

The burgeoning relationship between the textile business and the world of high technology is neatly exemplified by the activities of [Grado Zero Espace](#); a hi-tech spin-off from Italian clothing manufacturer Karada Italia that specialises in the transfer of materials from the space industry into high-performance clothing.



Textronics has developed the conductive composite Textro-Yarn (above right) and the Smartex shirt (above left) that can monitor the electrical activity of the heart

The firm was behind the development of the McLaren F1 suit, which uses a cooling system borrowed from space suits. It also came up with the absolute zero jacket for Hugo Boss, a super-insulating garment lined with aerogel — a material originally developed to insulate Mars probes.

Most recently, through ESA's Safe and Cool project, the company developed the Hydrojacket. Designed to protect firemen and steelworkers from life-threatening heat, the jacket is claimed to draw on technology used in space suits to reflect 97 per cent of radiated heat.

According to Giulia Bimbi, one of the company's engineers, a range of even more exciting projects are now under way, including an effort to integrate carbon nanotubes into fabrics. Although she is tightlipped about this initiative, Bimbi said the fantastic mechanical properties of nanotubes, their low weight, ease of manufacture and electrical conductivity make them attractive for advanced clothing applications.

However, despite the ever-expanding range of potential applications, the consumer electronics industry is still the main driving force in the commercial rise of smart

fabrics. Gratifyingly, alongside Italy, the other hotbed of innovation in this area is the UK.

The technology developed by one UK firm, Yorkshire's [Peratech](#), was at the heart of the world's first iPod ski jacket, developed in 2003. Marketed under the name Soft-Switch, it exploits a scientific phenomenon known as quantum tunnelling to make textiles sensitive to external inputs such as heat and touch.

The company's so-called quantum tunnelling composites are essentially metal-filled polymers that are transformed from a virtually perfect insulator to metal-like conductor when deformed through twisting, stretching or compression. This enables the material to be used in a number of switching and sensing applications.

Another UK firm excited by the possibilities of wearable technology is Cardiff's [G24 Innovations](#), which has spotted an intriguing gap in the smart fabrics market. It is scaling up production of an innovative, flexible, solar-cell system that it claims could be incorporated into clothing as a wearable, renewable power source for charging a range of other smart fabrics. The technology is poised to appear on a new range of hi-tech tents, where it can be used to generate a charge for mobile phones, iPods and other mobile devices.

Unlike thick silicon-based solar cells, the so called dye-sensitised solar-cell technology, licensed from US solar expert [Konarka](#), is based on an organic dye that absorbs light and generates electricity.

Paul Norrish, G24I's worldwide sales director, said a particularly attractive feature of the technology is its sensitivity to more of the visible light spectrum than conventional solar cells. This means it is able to work indoors and, according to Norrish, has led manufacturers of domestic smoke alarms to look at using the material to develop a battery-free smoke alarm.

Perhaps the most well known UK developer of Smart Textiles is [Eleksen](#). Based at Buckinghamshire's Pinewood Studios, the company began designing the the grotesque puppets for 1980s TV satire Spitting Image. It now produces a wearable fabric sensing system which, from numerous items of ski-wear to Marks & Spencer's recently-launched iPod suit, is at the heart of some of the most prominent commercial applications of smart clothing.

Made entirely from a proprietary fabric and containing no moving parts, the company's Elektex technology consists of three layers: a top and bottom layer of conductive material and a middle layer that conducts electricity when pressure is applied to it. When the fabric is pressed, current flows through the middle layer and by measuring the change in voltage resistance it is possible to figure out where and how hard the fabric has been pressed.

Mark Barrett, Eleksen's chief technology officer, agreed that the incredible rise of the iPod has been good for business. 'It bootstrapped the whole success of the concept — we've been able to focus on one generic device which is supported widely enough that gives people the motivation to use the product — it's been a hugely important catalyst in where we are today.'

Now, fuelled by the success of its iPod applications, the company is beginning to stretch its wings and is rolling out a new product which, while still underpinned by the core Elektex technology, will allow a range of different types of devices to be used. 'We're looking at much more of a plug-and-play scenario,' said Barrett.

Further into the future, while the relationship with consumer electronics is expected to continue to grow, the company is excited about the opportunities for its technology in the healthcare sector. Barret thinks the market may even eventually outstrip consumer electronics: 'I think we're looking at a five-year timescale before that but I think the market is much bigger,' he said.

Barrett is excited by the strong signs of growth in an industry which, according to market researcher VDC, will be worth \$642m (£318m) by next year.

Sharon Baurley, an expert in wearable technology from London's Central St Martins College of Art & Design, agrees there is plenty to get excited about. She also thinks there is a lot riding on the success of the smart fabrics industry.

Baurley, who organises the smart materials network and sits on the DTI's SmartMat committee, claimed that for western textile manufacturers smart fabrics represent one of the few paths to survival: 'The industry is gravitating towards hi-tech textiles and clothing because mainstream textile production has gone to China and India so the European, Japanese and US producers can't compete on price — it's going to save their industry.'

Baurley warned that while a busy calendar of dedicated events and a flurry of specialist newsletters give smart fabrics the appearance of an industry that is going places fast, things are unlikely to happen as quickly as some predict. 'It's a painful transition for a lot of textile companies in Europe; they invested a lot over the years in standard textile production and now have to change over to something that's high-specification — so there are a number of factors in the equation that make development very slow.'

Also, the all-important dialogue between the textiles industry and the hi-tech world cannot happen overnight. 'To develop the materials into a product you have a number of different types of expertise that you need in that cocktail and there isn't a history of communication between those different sectors,' said Baurley. 'The textiles industry is one of the oldest industries in the world and has a very traditional way of thinking. It moves quite slowly.'

But the nature of the textiles business is not the only thing holding the industry back. And Baurley claimed the technology industry also has plenty of work to do.

She said: 'What we need is a new generation of textile fibres that are multi-functional and more intelligent. But it's a bit of a chicken and egg thing: you need to know where the drivers are going to come from in order to insight development and if the materials don't really do the job then the products aren't going to develop and they won't turn the consumer on.'

According to Baurley the other big hurdle is consumer acceptance: 'We carry mobile phones and various gadgets but putting technology on the body is another matter and it's going to require quite a mind leap in terms of culture for the consumer.'

This, she said, is where the fashion industry comes in, and where events such as Siggraph — however divorced from reality they may be — are important.

'As more and more concepts come into the public domain they sow the seed and people start to get used to the idea of wearing technology,' said Baurley.

To this end, much of her time is spent working alongside the likes of HP labs, BT and Philips and analysing the ways in which young people engage with wearable technology prototypes. Again, this is unfamiliar territory for the textiles industry. 'They usually bring the user in at the end of the development process whereas now we need to bring them in at the beginning.'

Pointing to the phenomenal success of text messaging, Baurley suggested it is the perhaps unexpected ways in which young people latch on to the technology that will ultimately drive the business forward.

'Service providers never expected texting to take off in the way that it did. It was because of the kids that appropriated it that it became so big and that's what will happen with wearable technology,' she said.

Despite the numerous hurdles, there is no doubt there are plenty of reasons to get excited about smart fabrics.

And while the wearable technology revolution may be a little further off than its most ardent fans proclaim, there seems little doubt that in the not-so-distant future 'smart clothing' will mean a whole lot more than a nice suit and a tie.

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