

Moving smart fabrics to market

With trends to turn electronics into fashion statements gaining momentum, smart textiles are finally finding consumers ready-to-wear.

By Dr. Patricia Wilson

The last decade has seen a sea change in the integration of technology in our lives. The ability to pack ever more computational power and features into a smaller package has made personal electronics part of our everyday life. Cell phones now bring the Web, e-mail, music and even video to us anywhere, a far cry from the bulky bag phones introduced only a decade ago.

As everything that we carry has a size-to-utility value proposition, the smaller package now allows us to integrate a larger number of such devices into our daily travels. Once a unit becomes part of our required set of instruments, fashion and personalization takes over and aesthetics and form become ever more important to individuals. A quick survey of fashion and shelter magazines illustrates that the latest electronic devices have made the leap from *Popular Mechanics* to *Vogue*.

Paralleling the miniaturization and personalization of devices is the coming of age of generations who are more technically literate and use technology as part of their social fabric. Their acceptance of new modes of communication and information-sharing is instantaneous. This provides us with both a willing young market for smart textile products and one that will be more adept at interfacing with unusual forms for devices. This generation has grown up with light-up shoes, personalized cell phone rings, instant messaging, glow sticks, and electronic candy. For them, information should be instantaneous and everywhere, and drawing attention to themselves using personal displays of sound and light is socially acceptable.

The emphasis on hip design, fashion, and wearability of our portable electronics is a testament to how we have become dependent on them. This leads naturally to an integration of device and the soft goods that surround us as we strive to make them unobtrusive and personalized. These consumer trends, combined with the economic pressures from the globalization

The Cardio Shirt from NuMetrex gives active men an alternative to the bulky, conventional chest straps that accompany heart rate monitors.

of the textile trade, have made manufacturers open to possibilities in textiles that were once only the realm of science fiction. Dubbed smart fabrics or e-textiles, these textiles are or are part of electronic components that allow the product to sense heat, transmit data, or light.

Mobile and hands-free

A rapidly growing area of smart textiles is backpacks and outerwear. It seems that every pack or jacket now requires more than just pockets to accommodate our devices. Backpacks have been turning more and more digital as they offer bags with iPod™ remotes built into the straps, speakers built into the backpacks and packs with Bluetooth capabilities, to synch the devices carried safely within. Jansport of San Leandro, Calif., has an entire digital line of packs that include Livewire™ technology in the strap to allow control of music players. Companies such as SOFTswitch Ltd., Roeclift, U.K. and Eleksen, Bucks, U.K. are providing textile buttons and textile ribbon wiring that are part of the pack structure. John Collins, vice president of marketing and business development for Eleksen notes, "We have seen an explosion of interest in our technology at recent shows from a wide range of product manufacturers." Not content with providing the interface for clothing, they have recently launched a set of rollable and soft keyboards for mobile devices such as Blackberries and Palm Pilots.

Getting the information in and out is one application, but yet another is powering those mobile devices. With a large surface area, our outerwear and carry-alls are perfect places to generate power on the go. While plastic solar cells and solar cell fibers are under development, rugged solar cells are being integrated into backpacks and messenger bags by companies like Voltaic Systems Inc., New York, N.Y. Designed to charge your small electronics on the go, you never have to run out of power on your cellphone again. Not just marketed to the geek-set, companies like Tumi, South Plainfield, N.J., are introducing chic versions with equally high-end prices.

Marrying electronics and fabrics

Often lumped together as smart fabrics, textile systems that incorporate electronics and e-textiles are not one and the same. The difference lies in which medium carries the electrons. The way textiles and electronics can be combined can be broken down into three categories.

- At the most basic level, the textile is used as the outer packaging of an electronic device. Examples of this would include the Hoodio™ radio jacket by Wild Planet Toys Inc. and GapKids, both of San Francisco, Calif. In this product, the entire radio system is taken out of its tabletop box and distributed around the jacket, using the textile as a soft packaging. Other than the mechanical stability that the textile provides, there is no other contribution to the function to the radio by the jacket fabric.

- Marketed at \$69, the Hoodio jacket helps to familiarize the consumer to smart textiles. Products can push electronic component manufacturers to make more textile-compatible pieces, a necessary piece of the puzzle to accelerate growth of



The GlowSkin principle applied to mainstream clothing; even the detail incorporates the safety feature's glowing material.



On the glow: The GlowSkin system features thin, flexible, durable film strips that are applied as easily as stickers.

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Eleksen

A 100-percent fabric keyboard gives the wearer access to a laptop computer and is so compact it can be rolled up and put in a pocket.

the smart textile industry. Products that converge “soft” and “hard” or passive and active, respectively, will lead the way to acceptance of more functional textiles.

- A second level of integration is where the fabric is part of the circuit. This type of integration will predominate in the market in the long run and provide the largest market share for textile companies. In this type of integration, the electronics is divided up between the soft and hard in such a way that each is used for its strengths. For silicon chips, it's computational power in a small package. For textiles, it may be softness, flexibility, and durability under the environmental conditions the product endures. Currently there isn't a good way to generate power or display information using fibers, so conventional components must be used.

Examples of this type of integration are becoming numerous; to mention just a few: the Lawrence, Mass.-based Malden Mills Industries Inc.'s Heat™ blanket; the NuMetrex™ heart-sensing sports bra by Textronics of Wilmington, Del.; and the line of iPod compatible jackets and backpacks by Burton Snowboards, Burlington, Vt. Each of these products uses a conductive textile as a sensor, resistor or power and data transmission cable as part of the electronic device.

The market appears ready for these e-textile products. Fast off its successful introduction of the NuMetrix sports bra for women, Textronics is launching a new product aimed at men. The NuMetrex Cardio Shirt was designed to give men an alternative to the cumbersome chest straps which usually accompany heart rate monitors. Chest straps tend to slip, chafe and loosen during workouts; the NuMetrex Cardio Shirt eliminates this problem by integrating the conductive textile electrodes right into the fabric of the shirt. “As soon as we launched the bra, men began asking when a similar performance product would be available for them, so we immediately started work on the prototype for the shirt,” says Meg Burich, marketing director of Textronics.

- The third level of integration, and the most challenging of all, is the complete use of textiles to form the device. Solar cell fibers, battery yarns and transistor fibers are just some of the innovations required and under development.

Flexible electronics: coming of age

The last decade has seen a surge of R&D in the area of “plastic electronics.” Polymer LEDs and plastic transistors are just two of the hot areas of research. Developers are keen to capitalize on their flexibility and ruggedness over their glass and silicon cousins. Since textile

electronics have limitations in display output and computational density, these developments will have a significant impact on the type of products that can be made with smart textiles.

GlowSkin™ is one such spin-off of the plastic electronics industry that is making fast inroads as part of fabric systems. Based upon electroluminescent polymers, Safe Lites LLC, Eden Prairie, Minn., produces thin, flexible and amazingly durable films that can be applied to fabrics like a sticker. “The applications for our GlowSkin products center around increasing visibility” points out Tony Morse, vice-president of marketing at Safe Lites. That application might be safety, product signage enhancement or even novelty clothing.

The first applications of Safe Lites' GlowSkin technology was in apparel for the public safety professional. True to the promise of smart textiles, GlowSkin is much more than slapping a light bulb on a vest. “It took several years to develop the technology so it would surpass ANSI requirements for washability of public safety gear. You can remove the battery and send the entire garment through the washing machine without worrying about damaging the function of the system,” explains Morse. Able to be seen clearly for more than 1,000 feet in all weather conditions, recent integration of the base technology in the Blauer Manufacturing Co., Boston, Mass., line of safety products promises a greater availability of the technology to public safety professionals.

Safe Lites and other producers of EL technology have crossed over into the general consumer sector by offering products aimed at those who want to be seen while out walking in the evening. The COOL BLUE™ line of children's jackets and backpacks offered by Lands End of Dodgeville, Wis., is one such foray into the mass-market that is making waves on the playground as well.

Not limited to clothing, the ability to apply a thin, flexible EL “sticker” to fabrics opens up the ability to selectively light up signage for billboards or awnings to attract attention to the specific portions of the message. Morse also expects there will be future potential for accent lighting of the architectural space because of the technologies' ability to flex and be made in numerous colors.

Getting to market

While the number of smart textile or e-textile products appearing is increasing rapidly, there are still many barriers to hurdle if you have a viable product idea. Getting to market with an e-textile product requires not only developing the technology and manufacturing techniques but also understanding issues that face the different segments of the value chain.

The lack of strong e-textile system integrators in the value chain is forcing most textile companies or brands interested in the smart textiles market

Hot pants

When some textile insiders say that the smart fabric market is heating up, they mean it literally. Bulky wired heating systems have been available for motorcyclists and hunting enthusiasts for a while. But with a comfort factor that is low, they haven't penetrated the casual clothing market. This lucrative comfort market is sure to take off soon. Brookstone Inc., Merrimack, N.H., recently introduced a pair of cargo pants with heated carbon fabric panels in the seat and pockets to help Dad endure those late-season football games. Marketed at \$150, they are attractively priced for the weekend warrior.

to wear more hats than they had previously. The development of the industry is not yet at the point where yard goods of cable components or circuits can be sold to garment makers blindly. In most situations, companies will need to design the finished e-textile product themselves and teach the brands how to integrate the device into their products. Bringing on the right expertise in electrical systems and manufacture has been one of the largest challenges for interested companies.

The lack of component standards has also resulted in a long lead-time for product developments, as a tool kit of interchangeable parts doesn't yet exist. Some manufacturers have found that while their technology might be just one component of the circuit, they have to provide the turnkey solution from the wiring to the battery pack and controllers to get their textile unit accepted by the brand manufacturer.

Adding even more complexity, most systems are a hybrid between off-the-shelf electrical parts and textiles. Therefore three areas constantly limit designs: power, packaging, and connections. The size and capacity of the power component, most usually a battery, often drive the application and its form factor. Packaging of the electrical components against mechanical wear and flexure and environmental ingress of dirt and water is important. Textile products are

more flexible and durable to rough handling and wet conditions than electrical components (just try to send a conventional wire harness through the washing machine). Breaking of connections and water-induced shorts are common when adding electronics into the textile environment. Proper sealing and stress relieving of components and connections is a big task for product development.

Even with these hurdles, the interest from brands in smart fabric and e-textile developments is steamrolling, making the area a hot topic. Smart textiles have already made the leap from specialty products, such as those for medical and safety, to the aisles at the Gap and Target or the pages of a Lands End catalog. It

Consumer trends and the globalization of the textile trade have made manufacturers open to possibilities in smart fabrics that were once only in the realm of science fiction.

won't be long before you may find a smart fabric or e-textile in your closet, and your shop, too. **R**