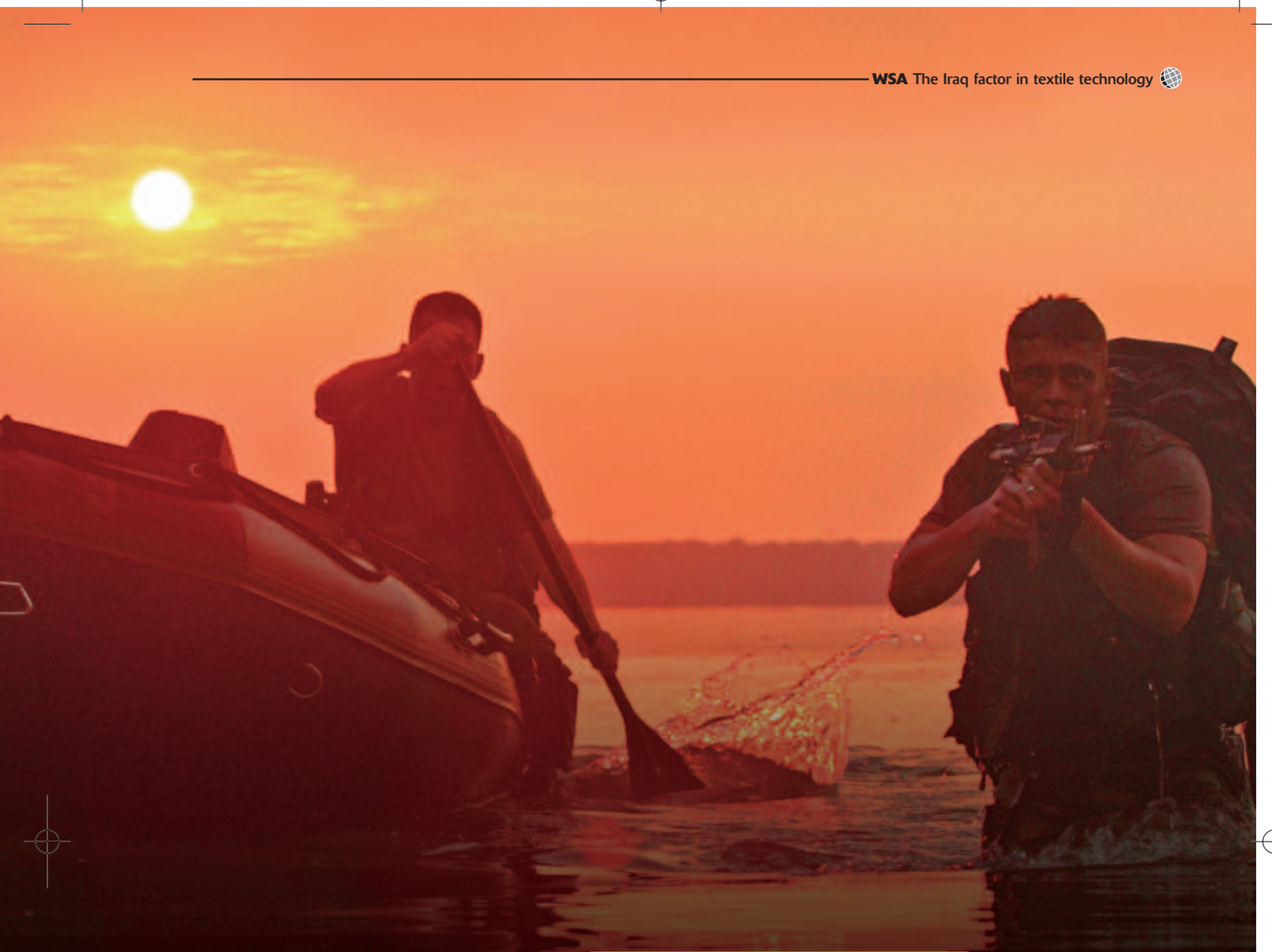
Warfare is often a testing ground for new technology as R&D experts continually seek solutions for new battlefield situations. The war in Iraq is no exception, especially when it comes to the apparel worn by the military. More than three years on, the Iraq conflict is providing fabric and apparel specialists with a long list of dilemmas and problems to solve and some of these technologies are now active in the consumer field as well as on the battle field.

The Iraq factor in textile technology

One area that has garnered considerable attention in Iraq is the horrific damage caused by Improvised Explosive Devices (IED). Early in 2006, the forward commander of the US Marine Corps Expeditionary Force in Iraq banned the wearing of polyester and nylon under shirts for personnel conducting activities outside the corps' bases, as these types of clothing melt when ignited and have caused horrific wounds. Subsequently, an initiative began to develop anti-drip and anti-melt T-shirts and other garments. From the onset of the war in Iraq, the Marine Corps has developed various new technologies and apparel to cope with the specific conditions involved. The clothing has advanced from standard cotton materials to include functions such as moisture wicking and antimicrobial properties. The next evolution of apparel development includes the prevention of melting and burning due to flames and exposure to high temperatures, which can be caused by IEDs.

In a joint effort, the US army and Marine Corps have now embarked on an endeavour to advance this initiative for apparel to become self-extinguishing. The search for new solutions to meet the demands of the battlefield is ongoing. Advancements that have already been made include improvements in durability, lighter weight, and improved moisture wicking and fire resistance properties, which have evolved as a result of the feedback and requirements received from soldiers.

One example of a new innovation for the marines is the Combat Desert Jacket (CDJ). The CDJ was specifically designed for the mountainous desert terrain in Iraq, Afghanistan and similar environments. It is a lightweight, wind resistant, water repellent jacket intended to provide multi-season environmental protection in desert environments. It also has a minimal impact on the combat load carried by soldiers, but will provide protection against wind, blowing sand and light rain/snow. It has been designed to be compatible with the Marine Corp. Combat Utility Uniform (MCCUU), fleece pullover and lightweight cold weather underwear and is lightly insulated with a neck gaiter/headover that is rolled and stowed in the collar. The jacket has pockets on the chest, lower front sides and sleeves, which



end in a monkey paw configuration that provides additional hand protection and insulation. It will be produced in the desert printed fabrics that also feature moisture management and breathable characteristics.

The marines are currently looking towards designing a fire resistant uniform which will be a part of the Flame Resistant Organizational Gear (FROG) programme. The current focus of the FROG programme is to procure clothing that will provide protection against flames, heat and flashes of 800°F (427°C) to the face, neck, upper torso and extremities. The programme is currently at the research and development phase, which involves purchasing a limited number of various fabrics and designs for balaclavas, gloves and long-sleeved T-shirts which are being trialled. In the upcoming fiscal year, research and development will be conducted on the MCCUU that will offer similar protection.

"The Marine Corps is committed to providing the best possible protective equipment to the war fighter in combat. One of our missions is to field, sustain and assess clothing and equipment while anticipating the needs and maintaining contact with the operating forces in order to

Polartec manufacturer Malden Mills has extensive links with the US military. Its fabrics are widely used by the Marines and Navy for their thermal and weather protection properties.

Malden Mills

enhance the performance, capability, survivability, mobility and sustainability for marines," says Dan Fitzgerald, infantry combat equipment programme manager for Marine Corps Systems Command.

Home grown technology

Recent increased demand for new textiles and apparel from the military has created a welcome boost for the US textile industry. The Berry Amendment, passed by the US Congress several years ago, requires that the US Department of Defense only purchases products judged to be essential to military readiness from sources that can supply goods with 100% US content that are manufactured using only US labour. These products include clothing and other textile items, specialty steel and food.

One of the many US companies working with the military is Noble Fibers, a subsidiary of Noble Biomaterials. Noble's signature product is X-Static, a silver fibre incorporated into a wide variety of consumer performance garments to add antimicrobial properties. Noble is currently working on a variety of projects with several companies in order to develop new products for the military.

"Flame resistant, or FR clothing, seems to be the biggest area of concern today," says Shawn Connor, director of military sales. "The military is trying to determine the most effective level of protection within its cost parameters. IEDs give off some pretty severe flashes when they explode." He adds that the military is doing everything in its power to avoid severe burns and although 90% of burns affect the hands and face, protection cannot be limited to those areas alone. As a result the FR effort is now a major undertaking, ranging from base layer garments through to full battle uniforms.

Connor adds, "With one of our licensed partners, we're working on a technology that when a shirt 'sees' a flame, it will extinguish itself and will also bring into play all the technical qualities from a standard T-shirt such as antimicrobial, moisture wicking and anti-static properties." The new technology is testing well so far and Connor believes it has a good chance of becoming standard issue. The next step will be to work on other garments from gloves to the uniform itself.

Other Noble initiatives that have shown promise are in the footwear area. "Just because you have an antimicrobial sock, it doesn't make it a complete system. If you put a sock into the moist environment of a combat boot and tie it tight, you've got a whole environment for bacteria to grow. We're now looking at the lining and insole of a shoe with products to regulate temperature and fight moisture. Soldiers are in their boots 18 hours a day. Imagine how nice it would be if they take their boots off and they don't smell," comments Connor. But soldiers are not the only people who could benefit from this technology.

Military intelligence hits the High Street

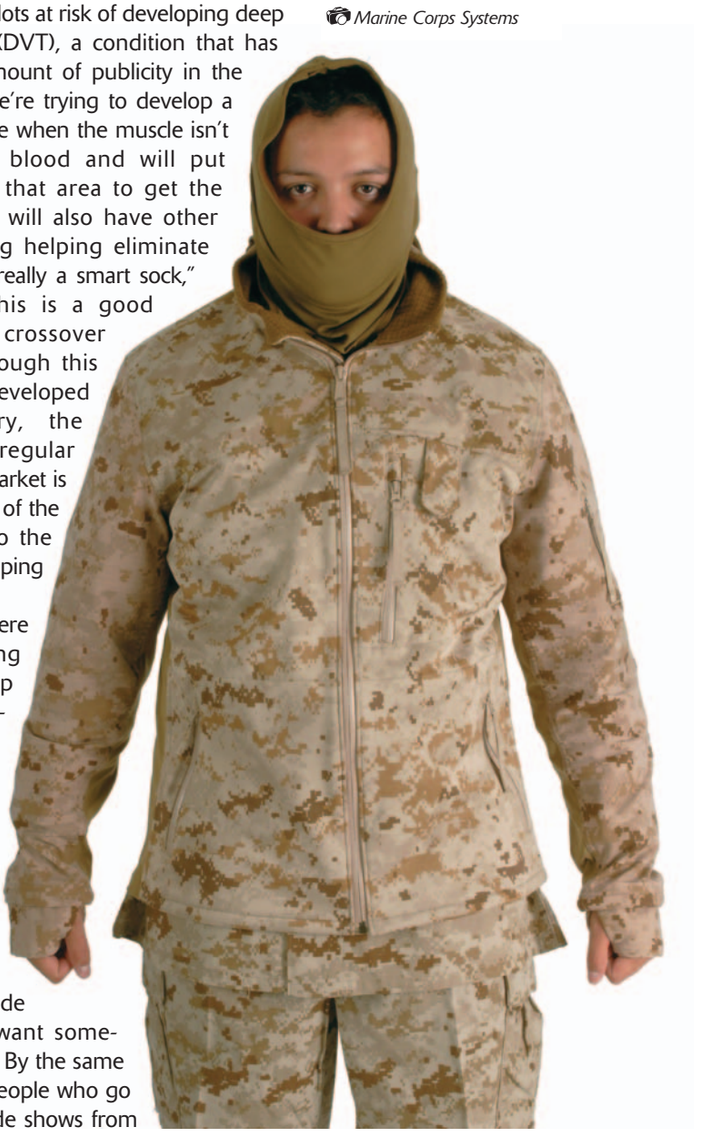
Military sales are one of the fastest growing areas of X-Static's business and although Connor is swift to point out that breaking into the military market is far from easy, he adds, "Once a company makes the grade, it can be a long-term venture. Our brand is becoming more and more recognised. The military knows the brand now. It's similar to the early days of Gore-Tex." This exposure in the military field also offers benefits in the wider consumer market.

Noble also specialises in products for medical applications, and a new sock designed for the air force fits in this category. The high-tech sock is aimed at pilots on long flight missions, which can sometimes last up to 40 hours. The length of time puts the pilots at risk of developing deep vein thrombosis (DVT), a condition that has received a fair amount of publicity in the last few years. "We're trying to develop a sock that will sense when the muscle isn't getting enough blood and will put compression on that area to get the blood flowing. It will also have other benefits including helping eliminate athlete's foot. It's really a smart sock," says Connor. This is a good example of crossover technology. Although this sock has been developed for the military, the potential in the regular consumer retail market is evident as a result of the attention given to the dangers of developing DVT when flying.

Connor says there is an interesting relationship between consumer and military apparel markets and both sectors keep tabs on what's new in the other. "A lot of times the military will look at commercial grade vendors if they want something off the shelf. By the same token, there are people who go to the military trade shows from

The Marine Corp. Combat Desert jacket was specifically designed to deal with the mountainous desert terrain in Iraq and Afghanistan.

Marine Corps Systems



the consumer industry. There's an even exchange of technologies back and forth. From an apparel standpoint, there's no difference between the needs of an Olympic sprinter and a lieutenant colonel in the army trying to perform in a hostile environment."

Polartec manufacturer Malden Mills has also benefited from its links with the military. It has a strong relationship with the military, whose contracts have helped the Massachusetts firm recover from a period of bankruptcy. Polartec fabrics are used extensively by all branches of the US military and, by the end of this year, the US government will have bought more than $15 million worth of Polartec garments. This sum includes $1.1 million for a third year of research and development of electronic textiles for the Army's Combat Casualty Care programme, which provides remote physiological monitoring of soldiers in combat.

Polartec also has three other product lines that are widely used by the military. The Army Extended Cold Weather Clothing System (ECWCS) uses a range of Polartec fabrics for cold weather operations. The next-to-skin, thermal and weather protection fabrics allow the ECWCS system to provide comfort, enhance mobility and reduce the weight and bulk of the garments. Polartec fabrics are also used in the Marine Corps Mountain Cold Weather Clothing and Equipment programme to provide warmth, antimicrobial properties and wind-and water-resistant characteristics. The Navy Air Warfare Center's Multi-Climate Protection System, which uses thermal layering protection and shell garments, integrates Malden, DuPont and Peckham Vocational Industries technologies to provide garments that meet the vigorous standards of protection demanded.

Employing the right tactics

Scott Jones founded Beyond Fleece in 1996 to create high-end, customised cold weather clothing. He says the ability of customers to design their 'perfect' jacket or pair of trousers separates his company from competitors as the customer is offered a choice of colour, various performance options and fit.

Jones says the US Navy Seals discovered his company through an article written in a backcountry skiing magazine and in 2001 Jones' company began design and production work with the Seals on their Level 5 soft shell jacket, which proved highly successful. This collaboration began a relationship with the US military that continues today.

Specialising in quick response production allowed Beyond Fleece to supply ten custom-made jackets made of Schoeller Textile's WD400 fabric at short notice for skiing in the worst possible conditions in Vermont. That programme is now in its fourth year and was the beginning of a new company division, Beyond Tactical. "We branched out from there and the military folks continue to come to us and we co-design new products," says Jones. "They will say, 'this jacket has this, but not everything we want.' We can get a prototype out to them the next day."

Milliken & Co. is one of the world's largest, most diverse textile companies and it has deployed an array of its operating divisions to work on military applications.

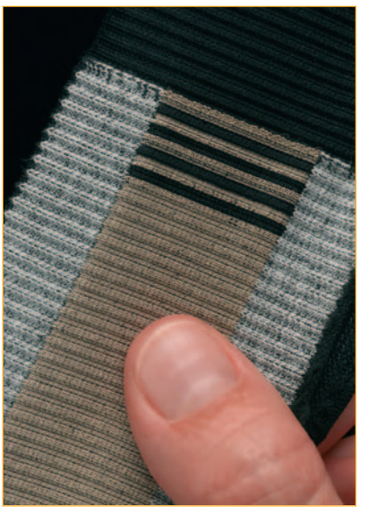
"A good understanding of the needs of the modern military is critical," says Benjie Reynolds, general manager of Military Performance and Specialty Products for Milliken. "It's very important the military has the absolute best products available so they can function properly.

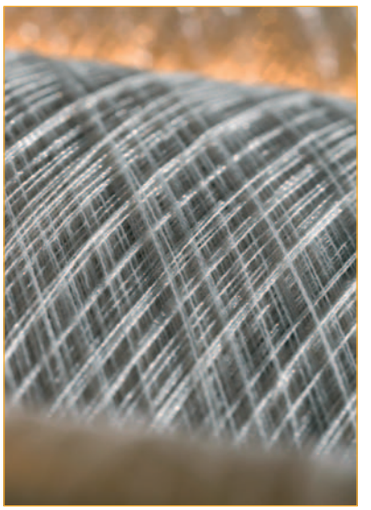
From an innovation standpoint, Milliken is working very hard with military test facilities to develop products that will give our military the edge." Reynolds says that Milliken is currently working on products that include the use of antimicrobials to help the overall medical welfare of soldiers who are required to wear garments for extended periods. The company is also working with other performance characteristics such as stretch, comfort and lighter weight fabrics. "We're working diligently to come up with finishes, chemistries and new fibres and fabrics that lend themselves to giving a garment a multitude of performance characteristics," states Reynolds. This has led to the development of lighter weight fabrics which will be a big benefit to soldiers who usually tote 120-150 pounds (54–68kg) with a full pack in combat arenas. "What we have seen in Iraq with IEDs is that mobility is extremely important, but protection from shrapnel and from bullets, as well as flame-resistant characteristics, is also extremely important," concludes Reynolds.

Electronics enter the field

The combination of textiles and electronics also offers many potential uses for the military and several companies, including Malden, are working in this area. Another is UK-based Eleksen, which produces a touch-sensitive textile used to create interface products using fabric interfaces. "As a non-mechanical, lightweight and low power interface technology, ElekTex offers designers of military products a unique way of addressing the needs of the military," says John Collins, Eleksen's vice president, Marketing and Business Development. The interfaces are embedded in uniforms or accessories such as communications packs which allow product designers to develop products with fabric interfaces which are said to offer higher durability than traditional switching hardware.

The programmable nature of the ElekTex smart fabric also allows a single touchpad to become a single interface to the multiple products carried by a soldier. Integrated as either a simple button touchpad or a sophisticated array of buttons and scroll controls, which can be rolled up and stowed away, Collins says the ElekTex solution solves many of the problems that mobile fighting forces face due to equipment size, weight and operational complexity. He adds that because the interfaces are non-mechanical they are protected from the invasive problems that can affect mechanical interfaces in extreme environments. These include desert environments where sand is a constant obstacle to operational safety and efficiency, or freezing environments where moisture can form ice crystals that impede performance.





Textronics, Inc. (left) has developed textile electrodes which incorporate heart rate monitoring technology into the knit of the fabric itself. The technology could enable military units to monitor the physical condition of soldiers in combat.

Textro-yarns (right) combine conductive silver-coated nylon with Lycra fibre into a single yarn that can maintain its electronic functionality through all the normal textile processing steps and still give the look and feel of normal textiles when woven or knitted.

Marine Corps Systems

Using ElekTex control textiles in uniforms allows the military to store communications gear more easily in a pack or inside a garment. With no hard surfaces or heavy materials the touchpad, when embedded in a uniform, is undetectable by a soldier. Furthermore, its low power requirements mean that it won't draw on the critical battery power that is required for core communications and reconnaissance tasks. It can be embedded into garments, bags and packs and can use any fabric surface to create an interactive element.

Another company working on potential military applications in the electronic textiles area is Textronics, a spinout of DuPont. If that name rings a bell, perhaps it should—it developed the Numetrex heart-sensing sports bra that was unveiled last year.

"Textronics has developed the core technology and materials to apply electronic textiles to a variety of military uses, such as shielding fabrics, textile antennae, heating systems and physiological monitoring garments," says Stacey Burr, CEO. "The technical development process will vary from product to product, as we work with each military client to apply our technology to their specific needs." Burr adds, "While military applications for electronic textiles are significant, an even greater business opportunity will be the modification of military products for everyday consumer use. Adapting military technology for consumer applications is much more challenging because it requires more fashionable solutions and tighter price points, and must appeal to a wider demographic." As Burr emphasises, the necessity to produce new technologies to save lives on the battlefield has led to a great deal of R&D and investment in new technologies and functionality which have, in turn, led to new innovative apparel appearing on the shelves of retail outlets.

If only R&D didn't require the spur of conflict…