Vest world

Keeping your driver cool can mean the difference between winning and losing a race, but could hi-tech underwear really be the answer? *Racecar* puts Walero's NASA-standard kit to the test

By BRADLEY APPLETON

The scene was set for the first back-to-back Bathurst win in 10 years. In October 2018 on the Mount Panorama circuit the Supercheap Auto Bathurst 1000 was in its closing stages and the Erebus Penrite Racing car driven by David Reynolds and Luke Youlden, which had dominated the weekend and led the majority of the race, was engaged in a head-to-head battle with veteran Craig Lowndes.

Then, suddenly, Reynolds suffered crippling leg cramps. His ability to apply the pedals was severely restricted, and he lost the feeling of his foot being either on the brake or on throttle. His margin over Lowndes shrunk, and he relinquished the lead just a few laps from the final round of pit stops. The stop would be the final nail in Erebus' hopes of back-to-back wins, as Reynolds' leg cramped again, and he lost his ability to depress the clutch pedal whilst the racecar was up on jacks, causing the rear wheels to spin and earning a penalty.

Reynold's physical problems were caused by severe dehydration. Whilst it was later revealed that sleep deprivation and lack of fluid intake were contributing factors, sitting in a hot Holden Commodore for hours over a triple stint, where cockpit temperatures can often rise above 60degC, was found to be the main factor. And there are many other examples of drivers suffering from high cockpit temperatures.

Cool rulings

The conditions that drivers experienced at Le Mans in 2005 led to rule changes being introduced by the ACO. The endurance classic was the first race to make air-conditioning a requirement, as of 2007. In the current WEC regulations, closed cars are fitted with a thermometer, which must be placed level with the driver's helmet, in the middle of the car. If the temperature around the driver exceeds the value defined by the regulations (32degC maximum when the ambient temperature is less than or equal to 25degC, a temperature less than or equal to ambient temperature + 7degC if it is above 25degC); the racecar will be stopped until the temperature drops again.

This is all to do with thermoregulation, a process that allows your body to maintain its core internal temperature, and all thermoregulation mechanisms are designed to return your body to a state of equilibrium. An average human core body temperature is generally between 36.5 to 37degC. There is a small window of flexibility for this temperature to increase, but once you get to the extremes of body temperature just two degrees higher at 39degC, it can seriously affect the body's ability to function. Increased sweating can quickly cause dehydration, leading to a loss of cognitive ability, dizziness, blurred vision, and other symptoms including nausea, muscle cramps and a rapid heartbeat.

This area of sports science has been of particular interest to former senior performance coach at renowned Hintsa Performance, Dean Fouache. He worked closely with ex-WEC LMP2 and current Blancpain GT team Strakka Racing as its head of human performance until August 2018. In Fouache's first season, the team competed in the 2016 Six Hours

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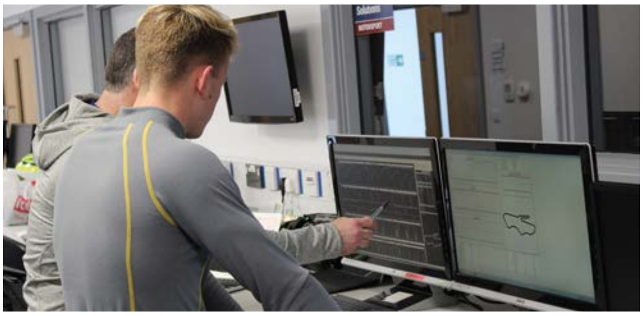
NASA uses this technology in gloves worn by astronauts, to help them cope with the extreme temperature variations experienced in space



Race driver Jack Mitchell, wearing a Walero vest, reviews the results of the test

The study took place at Cranfield Simulation and involved two stints driving around Donington

of Circuit of the Americas in Austin, Texas. Weekend temperatures were consistently above 30degC, with Sunday's race starting at 36degC and a relative humidity of 60 per cent. These challenging conditions prompted Fouache to measure the weight of the drivers before and after their stints. For a particular driver, double Le Mans class winner Jonny Kane, Fouache recorded a 3.3kg drop due to fluid loss over a single one-hour stint in the car – equivalent to five per cent of his overall body weight.

'It was clear that, for racing in such extreme conditions, I had underestimated the physiological and cognitive stress that is put on a driver's body,' Fouache says. 'From then on, I felt it was crucial for me to understand the complexities of thermoregulation and its effects on the body. It's an area of human performance that is vital, especially in endurance racing.'

Space race

Racing underwear supplier Walero is looking to address these issues with a range of underwear base layers using NASA-developed Outlast temperature-regulating technology.

Most established racing underwear manufacturers use Nomex, a heat and flame resistant fibre, combined with traditional wicking fabric. Found in performance clothing such as football shirts and mountaineering jackets, wicking fabrics are made of hi-tech polyester, which absorbs very little water. A specially designed cross-section and a large surface area allows the material to pick up moisture and carry it away from the body. By spreading it out to then evaporate easily on the outside of the fabric, this aims to keep you cooler and dryer than non-wicking clothing.

However, this becomes an issue when the material does not have a source of airflow available to enable evaporation to take place. Walero's Patrick Grant explains: 'Wicking fabrics may feel cool when worn separately, but when worn under a non-breathable fireproof race suit, this restricts the airflow around the body, hindering the mechanism which cools the body through sweat evaporation.'

While wicking fabric is designed to take moisture away from the skin, it does not prevent you sweating in the first place. 'Walero underwear is aimed at being a prevention rather than a cure, and is designed to reduce the amount a person sweats altogether, reducing the dangers of dehydration and the chance of suffering from heat stress or fatigue,' Grant says.

Walero's clothing utilises phase change materials (PCM). A PCM is a substance with a high heat of fusion which, by melting and solidifying at certain temperatures, is capable of storing and releasing large amounts of energy. The technology is comparable to ice in a drink; as it changes from a solid to a liquid, it absorbs heat and cools the drink, keeping the drink at the desired temperature for longer.

Walero's underwear works in the same way, but the clothing is micro-encapsulated to be permanently enclosed and protected in a polymer shell to increase durability. This is incorporated into the fabric of the base layer, which gives Walero's underwear the capacity to absorb, store and release the excess heat from the skin when needed.

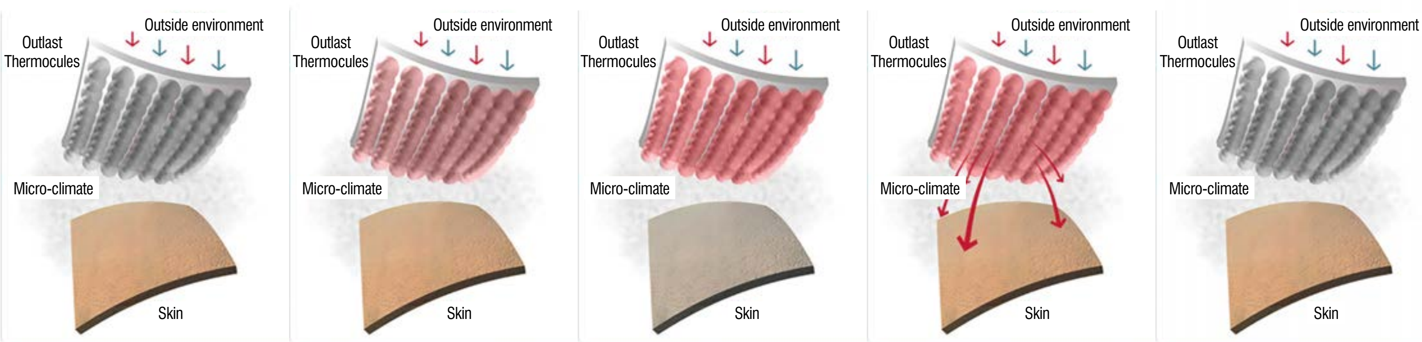
This type of material has been tried and tested across many different industries, including bed linen, socks and office chairs. NASA has even declared it a certified space technology for use in the gloves worn by astronauts, to help them cope with the extreme temperature variations experienced in space.

Test match

Through a chance encounter, Fouache was invited to conduct a controlled experiment to put the theory to the test, comparing driver performance when using a Walero base layer against a standard Nomex base layer. The test was conducted in the fully enclosed and temperature-controlled simulator room at Cranfield Simulation, home to one of the most technically advanced simulators outside F1.

Cranfield's innovative simulator has three different modules of motion technology, operating in 11 degrees of freedom across

How Outlast technology works



1. A driver's skin is exposed to temperature changes that affect the human body's micro-climate
2. When drivers overheat, their bodies naturally release excess heat and sweat to cool the skin
3. Outlast absorbs excess heat and stores it in microcapsules which are called Thermocules
4. When drivers start to cool, their stored heat is then released back into the body
5. The result is a constant comfort zone next to the race driver's skin, Walero claims

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six axes. This includes a rectangular base platform with four linear actuators in each corner to simulate roll, pitch and heave movement, and a long-stroke actuator at the rear to simulate lateral yaw movement.

Additionally, the Proportional Rapid Onset (PRO) system allows the seat to move independently of the chassis, and is used to replicate very minor and high frequency movements in the fore/aft, vertical and lateral axes that cannot be produced by the main suspension platforms. Finally, the Sustained Motion Cueing System (SMCS) is composed of a number of unique pneumatic pressure modules situated around the cockpit seat and harness, which expand and contract to simulate the *g*-forces felt when cornering, braking and accelerating. These cues are progressive and thus proportional to the relevant *g* demand, and are continued until the demand is removed. Any three demands can be combined on to any axis at any one time, so both sustained and vibration cues can act at the same time on one axis or the sum of two different frequencies and amplitude. This is claimed to sustain the sensation of acceleration and deceleration indefinitely, misleading the brain in to believing the body is moving. It was for this reason this simulator was selected for the test, as the motion technology imparts similar sensations onto the body as found in reality, with the aim of exerting similar stresses onto the brain to produce similar levels of perspiration, as seen in a real racecar.

Figure 1: Lap time consistency

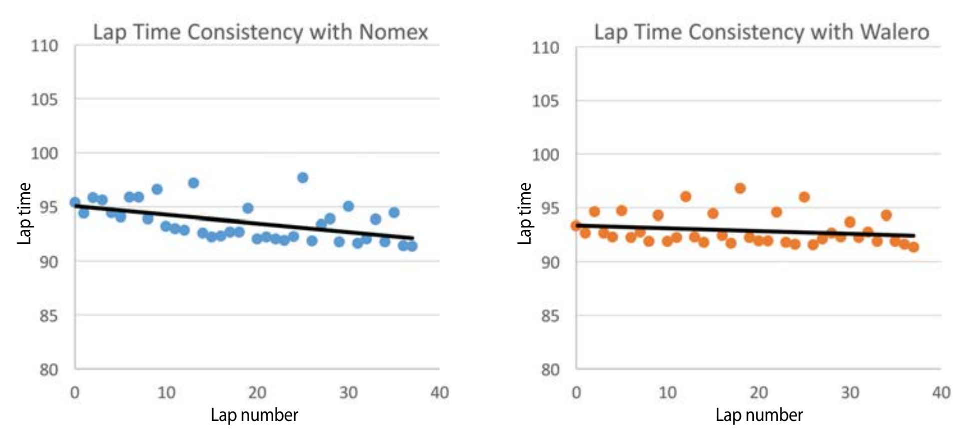
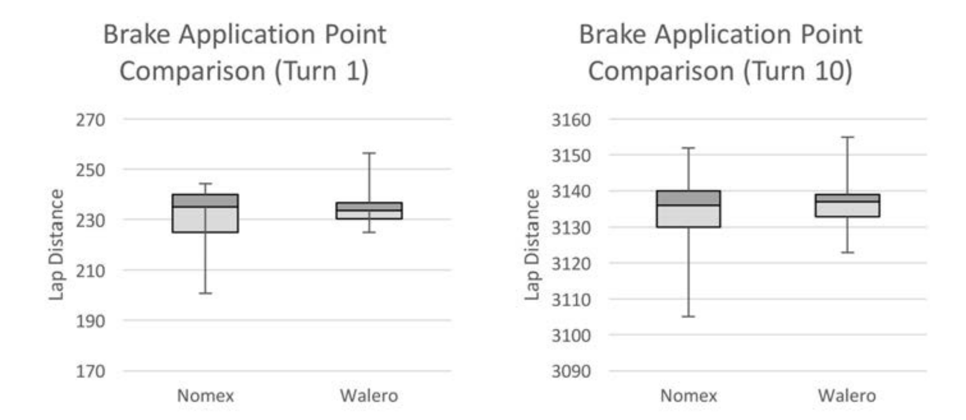


Figure 2: Brake application



The hot seat

Using 2018 British GT4 Champion Jack Mitchell as a test subject, the comparison study involved driving a Ginetta G55 GT4 vehicle model around Donington Park's Grand Prix configuration over a one-hour stint. On the first day Mitchell would wear standard Nomex race underwear, and then Walero underwear on the second. With the simulator room kept at a controlled 32degC, the upper limit for cockpit temperatures as defined by the FIA WEC technical regulations, Mitchell's starting body temperature on both of the test days was measured at 36.9degC.

On day one, wearing the standard Nomex underwear, Mitchell's temperature rose to 37.6degC in just 10 minutes, with a continuous progression to a peak of 38.4degC at the end of the stint. On day two, now wearing Walero, Mitchell experienced a noticeably slower increase in body temperature. He remained at his starting temperate of 36.9degC for the first 10 minutes of the stint, before gradually rising to a peak of 37.5degC at the end.

Additionally, Mitchell's average heart rate over the stint was reduced from 108bpm to 100bpm, and he lost 0.3kg in body weight when using Walero underwear compared to 0.5kg using the Nomex. Fouache found Mitchell sweated around 40 per cent less in the Walero underwear and his average heart rate was eight beats less over the course of the hour.

Best of the vest

Fouache says of the test: 'We decided to measure three key metrics: the driver's body temperature increase, weight loss and average heart rate. Walero's impact on these metrics was extremely impressive. A 0.9 degree difference between the two studies is a huge amount in terms of thermal regulation. Jack's body temperature elevated much more slowly when wearing the Walero base layer than he did in the Nomex, meaning his physiological and cognitive functions have the opportunity to perform optimally for a greater duration.

'If a driver is making better decisions while driving, the likelihood of him making mistakes, missing braking points or the apex of a corner which can cost valuable lap time decreases,' Fouache adds. 'As a by-product, his average lap time then becomes more stable.'

By comparing lap times throughout each stint it can be seen that, although small, there is an improvement in overall consistency, with better average and ultimate lap time using Walero *vs* standard Nomex (**Figure 1**).

This is further highlighted when looking at driver input consistency such as brake application point. This is a good indicator of driver concentration and ability to repeat a lap time consistently throughout the stint. This can be seen in the box plots in **Figure 2**, indicating a similar median value, but noticeably smaller range of brake application when using Walero in comparison to standard Nomex.

It has to be acknowledged that this was a small-scale test, with the use of just the one driver, and that some of the improvement could be down to Mitchell becoming more used to the simulator and car/track model. Nonetheless, this throws up interesting results that could serve as a wake-up call to those who currently ignore this side of race driver conditioning.