Breathable weatherproof fabrics have done more in recent years to keep those who do extreme outdoor sports comfortably warm and dry than any other technical development that one could mention. They're only as good, however, as the layers of clothing worn beneath them allow them to be. We look at the latest developments in inner and middle layer clothing technology: some follow traditional thinking, one may be pointing the way to single garments with multi-layer properties.

Moisture control



British yachtsman Conrad Humphreys alone at sea for up to 100 days, currently racing in the Vendee Globe. He's wearing at least two layers under his OC Racer suit!

Jon Nash - Marinepics/O6T

There's little argument that for mountaineers, fell walkers, sailors and others who do outdoor sports that expose them to extremes of weather for any length of time, breathable clothing is the key to staying warm, dry and comfortable. But the message that manufacturers are still striving to get across to all but the most aware customers is that it doesn't matter how efficient weatherproof outerwear is in conducting perspiration to the atmosphere, it will only work properly as part of a multi-layer clothing system with inner and middle layer apparel made of materials that will combine to create what is effectively a benign microclimate around the wearer.

Particularly for inner layer garments, synthetic fabrics – usually polyester and/or polypropylene – are these days generally considered to be better than natural ones. Synthetic-fibre under-garments aren't designed to provide much in the way of insulation, but that's not their job. Their main function is to 'wick' moisture away from the body and keep the skin dry. Being hydrophobic, these synthetic materials don't retain moisture but transfer it quickly away from the body.

By contrast, a cotton tee-shirt will soak up sweat and retain it regardless of the breathability of the clothing layers above it, making the wearer clammy and uncomfortable, and ultimately cold since cotton, once wet, has no thermal insulation. Indeed, wet clothing against the skin will draw heat away from the body 25 times faster than dry.

Some natural fabrics still have value for inner-layer clothing applications. Silk, for example, is useful because it is slow to soak up water and will absorb up to 30 per cent of its dry weight of water before starting to feel wet. And it is also a good insulator owing to its low weight to volume ratio.

Synthetic fabrics also most commonly used in the manufacture of mid-layer garments, although here too natural fibres, most notably wool, still have a place. Wool, after all, has been known for probably millennia as an insulator that remains effective even when it is wet. In fact, it even gives off heat by attracting and absorbing air molecules through a natural process known as sorption. And, like silk, wool has wicking properties and can feel dry even when it's damp as its fibres are hydrophobic. That's why softer wools such as merino remain popular among outdoor sports people for items such as socks. In an ironic reversal of technology transfer, coarse wool from sheep breeds that can't be sold for clothing manufacture is now being used to insulate buildings, the economic and ecological arguments being that wool-based insulation material is said to be far more energy efficient to produce than the standard glass fibre alternatives and are totally recyclable.

Mid-layer garments

For garments designed as mid-layers in hi-tech outdoor clothing systems, where the requirement is for insulation with moisture wicking, it's synthetics that predominate, however. While both wool and synthetics have these properties, the latter generally outperform the natural product because they absorb less moisture and dry faster, are durable, lighter and less bulky.

Possibly the world's best-known brand of synthetic fabrics for layered outdoor sports clothing systems is Polartec. This name, owned by US company Malden Mills, based in Lawrence, Massachusetts, is found in more premium brand outdoor sports clothing than any other world wide, but has also migrated into the workwear market where it's used in protective clothing worn by, for example, police, ambulance and fire services. There are now more than 200 Polartec fabrics that keep runners dry, arctic explorers warm, and construction workers protected from exposure to wind and weather.

The latest fabric for base layers from the group is Polartec Power Dry. This is a bi-component knitted polyester fabric that uses different sizes of yarn on either side. It's claimed not only to wick sweat away from the skin faster than single-component fabrics, but it also provides a high degree of protection from ultra-violet rays when strenuous activity and blazing hot sun compel the wearer to strip down to basics.

'Touch points' on the fabric's inner surface draw off the sweat and transfer it to the outer surface where it spreads for easy evaporation. Capillaries in the yarn on the inside are large relative to those on the outside so that they take up sweat quickly, while the finer capillaries in the outer layer of the fabric disperse it to many times original surface area for maximum evaporation.

The inner surface is designed for maximum softness and comfort, while the fabric's UVPF (Ultra-Violet Protection Factor) 15 protection in most styles is rated as good to excellent. A new version of Polartec Power Dry called Silkweight was introduced last year by North Face as part of its Tekware range of under garments and is claimed by the sportswear company to give a luxuriously silky feeling against the skin.

For mid- and also outer-wear applications, Polartec last year introduced its Power Shield fabrics. Proclaimed to be "the next generation of technical outerwear" these introduce the 'soft shell' single garments that can replace the usual mid-layer fleece and waterproof breathable outer shell system in all but the more extreme weather conditions.



Gill's 2005 range includes reversible Windward mid-layer garments.

Gill

These new fabrics have a smooth, tightly woven face that Polartec claims gives abrasion resistance that is equal to, or even better than, the best shells, but without the stiffness that in 'traditional' outer garments can restrict movement. A polyester velour back traps air to give a high warmth-to-weight ratio in Polartec's new Air Control Technology (ACT) that enables the fabric to block a claimed 98 per cent of wind penetration.

The remaining two per cent is allowed to circulate within the fabric, which greatly enhances moisture vapour transmission, which, says Polartec, is twice as fast as with many breathable shells.

Power Shield fabrics

Power Shield fabrics are finished with a durable water repellent (DWR) to shed rain and snow, and have built-in abrasion resistance. All versions contain elastane or mechanical stretch for freedom of movement.

While all versions of this fabric can be used as an outer layer, thinner versions are equally suited for use as mid-layer clothing. Manchester, UK, sports clothing company Sprayway is one of several manufacturers that has taken Power Shield into its ranges. It's new Litespeed jacket is thin enough to fit comfortably under rugged outer shell jackets, hugs the body, and is also sufficiently rain repellent to be worn externally in light precipitation.

Also a recent addition to the Sprayway range is the Zone 2 jacket, which uses Polartec Thermal Pro high loft, a water-repellent and quick-drying breathable fabric that's particularly suitable as a mid-layer in clothing systems for particularly harsh outdoor conditions. This polyester fabric has a low-pile velour finish that is far plusher than other fleece fabrics and gives it reduced bulk. The Zone 2 jacket is part of Sprayway's Mountain Peak collection.

If mountaineering provides the ultimate test of the moisture control properties of layered clothing systems at altitude, then sailing must present their toughest challenge at sea level. It's not surprising, therefore, that marine clothing companies are at the forefront of layered protective clothing development, just as are their counterparts in the mountaineering market.

Nottinghamshire manufacturer Gill has one of the fullest ranges of breathable yachting gear for applications that range from round-the-world ocean racing via coastal cruising to round-the-buoys dinghy sprints. The demands of these different types of sailing have led to the development of purpose-specific clothing systems. While protection from the roughest seas and weather make protection, durability and insulation priorities for off-shore racing yachtsmen and women, for gentler coastal cruising comfort and warmth are higher priorities. And for often athletic inshore racing, the demands are for freedom of movement, moisture management, low bulk and close fit.

Gill, unlike most of its competitors, sources many of its fabrics from non-branded manufacturers in the interests of keeping its prices to end customers competitive. To give its customers a clear idea of the performance characteristics and suitable applications for its garments Gill has devised its own 'Dot System' graphics. Within this, its base- and mid-layers are grouped under its i37 body temperature regulating system – the 37 being a reference to the optimal 37°C core body temperature which it is designed to maintain in order to keep the wearer comfortable and performing at maximum efficiency.

The i's have it

The i37 system goes in four stages from i2 (Lite and Tec) to i5. Here, i2 Lite is an ultra-wicking base designed to give superior moisture transfer for aerobic



Sprayway's Lightspeed jacket, which launches this spring, uses a new version of Polartec Power Shield that is exceptionally light. Although it's designed to keep out all but torrential rain, it can be worn as a mid-layer garment.

Sprayway

sailing where low bulk is important. The Tec version, in a break with Gill's non-branded fabrics policy, uses two-way-stretch Polartec Power Dry fabric for its increased warmth and moisture management in cold weather and high-endurance sailing.

i3 are microfleece mid-layers for on- and off-shore activity for most seasons and climates around the world, and can also be worn as base layers under technical waterproofs. i4 are fleece mid layers made from middleweight double velour polyester fleece that gives low moisture absorption. i5 garments are performance mid layers that are also waterproof.

It's in this last i5 category that Gill launched two new products in November 2004 – Crosswind and Upwind.

Broadly targeted, the Crosswind mid-layer system is aimed at the inshore racing, cruising and offshore sailing groups. A jacket and salopettes are offered in this mid-layer-cum-outer shell garment range that combines a fully waterproof fabric with taped seams with a quick-drying fleece lining. The waterproof shell of Tactel ripstop nylon has a hydrophilic breathable PU coating on the inside and a durable water-repellent treatment on the outside. The fleece lining is 100 per cent polyester.

The new Windward range, comprising a jacket, smock and vest, also has shelled and fleece sides. The breathable microfibre-shelled side provides wind and, in showery rain, water resistance, but the garments are also reversible so that, if desired, they can be worn with the fleece out.

UK company Musto, another leading international player in the yachting apparel market, also owes much of its commercial prominence these days to its development of breathable clothing systems. It's latest contribution to comfort and dryness next to the skin is its Technical Ts, launched to the trade last November at the world's leading marine trade show, the Marine Equipment Trade Exhibition (METS) in Amsterdam. These tee shirts are made from a 55% polyester /45% nylon fibre blend fabric that's exclusive to Musto and, according to the company, 'promise the ultimate in breathability as a base layer for your clothing system, ensuring that perspiration is instantly wicked away from the skin and transferred through to the outer layer'.

This 150 gm fabric has a fine pique texture on the outside, but a smooth, silk-like lock knit finish inside. At the same time it blocks the sun's potentially harmful ultra-violet rays and, for hygiene, is treated with an anti-microbial finish. In common with much of Musto's technical clothing, these new Technical Ts have been race tested. Musto has strong associations with the world's top yacht racing events, including the Volvo Ocean Race, for which it is the official clothing supplier, and the America's Cup, where the company kitted out more teams than any other marine clothing producer. As well as raising the Musto profile in the yachting market, such involvement provides a useful test bed for its product development. With the new Technical Ts, it's the 2004/2005 Vendée Globe single-handed challenge that has provided a fair measure of technical testing, with skippers Mike Golding (Ecover) and Nick Moloney (Skandia), who were heading for the Southern Ocean as this report went to press, acting as guineapigs. According to Moloney, "These are fantastic tops – quick drying with high comfort levels. To save weight you take the minimum amount of gear, but these were on the 'must have' list for this journey."

All in one

Where one sees Musto and, indeed, Gill in close association with high-profile yacht racing, there one also expects to find another UK marine clothing brand, Henri-Lloyd. This Manchester based company, which developed technical clothing for the BMW Oracle America's Cup challenger, has gone further than many in the multi-layer sports clothing business by coming out with a single garment that appears to do most things that would normally be done by three, and across a wide range of climatic conditions.

The NEO N2S is made from Windstopper N2S fabric that combines three layers – for wicking, insulation, wind blocking and water resistance – in one. Its inner layer is smooth and soft enough to enable it to be worn next to the skin and is based on a 'push-pull' construction whereby one fibre pulls moisture away from the skin while a second pushes it towards an outer breathable membrane. Acting effectively like a non-return valve, the fabric quickly passes moisture to the outside while preventing it from returning. According to Henri-Lloyd, the system improves moisture management dramatically, with the skin staying dry at all times.

As its name suggests, the Neo Top also looks very new and futuristic compared with most other moisture control tops. The outer finish of the fabric has a layered effect, with a black, almost fishnet-like layer laid on top of a white background. The cut of the garment enhances this modern appearance, being anatomically shaped and close fitting.

Could it be that Henri-Lloyd, with this three layers-in-one jacket that breathes, controls moisture, insulates, blocks wind and water ingress and flexes with movement of the wearer has signposted the way ahead for future outdoor clothing development?



Henri-Lloyd's Neo Top made from N2S Windstopper fabric wicks moisture away from the body and delivers it into atmosphere while providing insulation and wind, rain and spray protection.

Henri-Lloyd