

Hyperhidrosis—the technical term for excessive foot perspiration—may not be a particularly pleasant subject, but is one that needs to be addressed... and has been, extensively. The old saying of 'where there's muck there's brass' could be aptly linked to the idea 'where there's sweat there's innovation' — and a profit to be turned. The problem of sweaty feet has provided the basis for a plethora of material developments in socks and footwear.

Hyperhidrosis — the science of sweaty feet

The foot, especially the plantar surface (sole of the foot), is richly endowed with sweat glands and ducts—about 120,000, give or take a few, in an average pair of feet. Sweat ducts connect sweat glands to the tiny pores in the skin's surface. On warm, humid days, inside a pair of shoes actively engaged in sport, an average pair of adult feet will produce more than half a litre of perspiration.

As the temperature rises inside a pair of shoes, the pores open up to give off perspiration and cool the body. The sweat glands and pores also help to expel body waste in the form of heat and this 'breathing' function is especially important for the foot, which is usually enclosed inside shoes for two-thirds of each day. Sweating is the body's most effective system of cooling down and the thermo-physiological properties of both the materials and construction in footwear and socks have a considerable influence on the foot's ability to 'breathe' properly and allow it to cool, thus contributing to foot and shoe comfort. Furthermore, whilst shoes and socks have



Adidas' ClimaCool footwear scavenges slow moving air surrounding a shoe during exercise, and conducts it through air channels to cool the foot.



to allow the foot to cool down, they also have to deal with the by-product of this cooling system, i.e. perspiration, as a cool foot is still not a comfortable foot if it is wet with sweat.

Finding the comfort zone

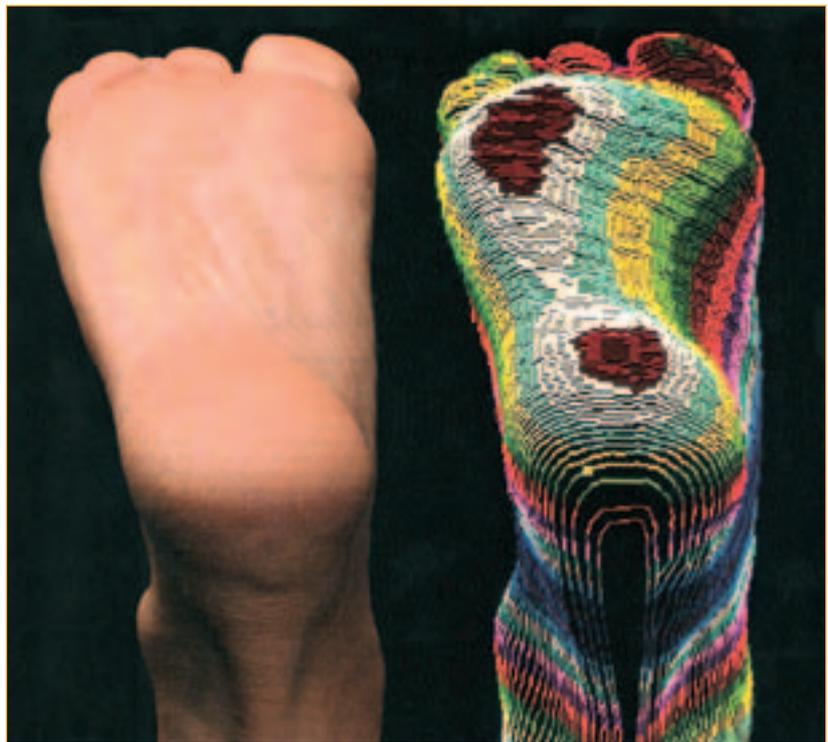
Comfort is a personal, subjective assessment. The definition of comfort has evolved to embrace such features as cushioning, compression set resistance, resiliency, shock absorption, and dryness. This expanded view of what comfort really means can be broadly categorised as: (a) mechanical comfort and (b) sensory comfort and it is the latter that we will explore further in this article.

The two critical components of sensory comfort are controlling temperature and moisture in the shoe environment. Humidity or moisture typically builds up due to perspiration on the plantar and dorsal areas of the foot. This perspiration is a mixture of water and water vapour, and the aim of any moisture management material, whether in socks or in footwear, is to proactively absorb the liquid moisture and transport the vapour away from the foot to keep it dry. One critical aspect of good moisture management, which is sometimes overlooked, is the ability of the material to then release the absorbed moisture and water vapour when the hose and shoe is not being worn.

The term 'moisture management' is defined as the ability of water vapour permeable materials to absorb a significant amount of moisture (sweat) at an optimum rate, combined with the ability to dry or expel that moisture in a short period of time. There are a number of 'hydrophilic' materials which absorb large amounts of moisture (greater than 1,000% by weight). However, the intrinsic hydrophilic properties of such materials prevent them from releasing that moisture, which may lead to discomfort, microbial growth and odour. Other materials are essentially 'hydrophobic' but have the ability to store moisture between the fibres, which shortens drying time when the foot is no longer in the shoe.

The fibre story spins a yarn

In order to improve on the wicking properties of natural fibres several companies have developed synthetic fibres that have drastically improved moisture management in sport hose. Pioneering sport sock manufacturer Thorlo has promoted the exclusive use of acrylic fibres over many years, but Thorlo still uses Merino wool in its alpine winter socks. Wellman has also been instrumental in promoting the use of performance hollow-spun fibres including ComFortrel XP, Sensura and Spunnaire. These fibres, developed from a patented co-polymer,



The plantar surface of the foot.

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allow yarns to be atmospherically dyed for greater colour fastness, fit, shape retention, abrasion resistance and moisture management.

Not to be overlooked, Unifi, the US-based textured yarn producer, touts several yarn innovations aimed at various athletic sock markets. These products include Sorbek, for moisture management and A.M.Y. for antimicrobial and odour control.

Supematural socks

Socks, and their constantly evolving material content, are obviously a vital factor in the temperature/humidity environment of the foot. Natural fibres used in hose such as silk, cotton, wool, and even linen, still play an important role despite being largely superseded by synthetic fibres. Socks containing Merino wool offer softness and warmth, even when wet. Silk has always been famous for its lightness and thinness of yarn, which is still very much prized today. Cotton has been recognised as an extremely absorbent fibre for many years, but natural cotton does not release moisture well, hence feet remain wet and cold. In response to this, Cotton Incorporated recently developed technology that adds the moisture management properties found in synthetic and blended materials to an all-cotton fabric. Combined with natural cotton through a 'finishing technique' this technology moves moisture away from the body, resulting in lower absorbency, quicker drying and reduced cling, while maintaining cotton's natural wicking capabilities.

SmartWool fibres are made up of 90% keratin, a highly resilient protein that is naturally bacteria resistant. Each fibre has a protective coating of

cuticle cells that help to repel water as a liquid, but allow water to move through the fibre as vapour. US sock innovator Wigwam combines an olefin liner and outer wool sock knit together as a one piece fabric, allowing the wearer the benefits of both without the bunching and friction caused by two separate socks.

Science over nature

Despite these efforts to improve on nature and the role that still exists for certain natural fibres, many leading sport-specific sock manufacturers currently prefer to use 100% synthetic or a blend of synthetic yarns offering high performance fibres. Acrylics and polypropylene fibres, which are also amongst the lightest, both offer excellent thermoregulation and moisture management properties. Ciba's Ultraphil chemical fabric treatment helps to transport water vapour away from the body, making the wearer feel comfortable and cooler and helps to avoid post-exercise cold, wet feet. Italy's Borio Fiore produces two polypropylene-based yarns for use in sock manufacture. Its Isofil is said to be 160 times less absorbent than cotton and eight times less than polyester. With its low thermal conductivity, it reduces the dissipation of body heat therefore regulating body temperature. Combined with the moisture management properties of the yarn, it allows the feet to remain warm without overheating. Optimer's Dri-Release fabric is a mixture of natural and synthetic fibres with the natural blend absorbing moisture, wicking it away from the skin, whilst the synthetic fibres repel moisture, forcing it through the sock to the exterior where it can evaporate. Tests show that Dri-Release dries four times faster than cotton and it integrates well with new designs and materials such as the recently introduced Hilly sock, as featured in the July/August issue of WSA.

The effects of footwear

It is not only socks that have an affect on the foot climate — shoes, and their linings, are also vital to comfort. Sport has traditionally been the testing ground for new materials and design improvements when it comes to the foot's relationship with its ergonomic environment. What could be more stressful on the skin of the foot or cause the temperature inside a shoe to reach 'blister pitch' than hours spent hiking or a close five-set tennis match?

Perhaps the simplest and most effective method of ventilating a closed shoe is by means of perforations in the upper, but the introduction of perforated soles came as somewhat of a surprise. Most shoe designers would never have envisioned the concept, innovation, or success of the Geox brand of footwear. Perforated



Geox has a breathable yet waterproof sole.



ventilation holes in the soles of shoes are hard to visualise, but thanks to breathable waterproof membranes, such as Gore-Tex, it has been possible to introduce air through the sole of the shoe without the feet getting wet.

In cold weather, inside a closed shoe OutDry membrane's hydrophilic properties guarantee moisture absorption, reducing overheating, in-shoe humidity and preventing sweat saturation. When outside temperatures rise, any excess sweat and vapour is pushed out through a gap between the inside and outside of the footwear, thus ensuring a 'comfortable interior thermal environment'. Another footwear issue is waterproofing. As DriLex puts it, "Sucking sweat in a waterproof lining system is a thankless job, but somebody's got to do it". DriLex's shoe lining system, with its underlayer of 100% Hydrofil nylon from Honeywell and polymer membrane with moisture vapour transfer is one solution to keeping the foot dry from outside and removing moisture from the inside.

Many categories of athletic shoes uppers are now made completely of open nylon mesh, which is a more obvious system of keeping the foot cool. Adidas' ClimaCool materials system of all-round mesh aeration has become a major selling feature for the brand. Technologies such as Cambrelle in footwear and CoolMax in socks also help to wick sweat away from the skin and quickly evaporate vapour through perforated or hollow-spun fibres.

Hyperhidrosis may still be a condition of the human body, but advances in material technology means consumers no longer have to 'sweat the small stuff' when it comes to improved comfort. 