Light as a feather, warm as toast

In recent years, quilted outerwear has become very fashionable, with everyone from footballers, to rap stars, to teenagers donning 'puffer jackets'. But, whilst many may choose their jacket based on the latest brand to be 'a la mode', the correct level of insulation can avoid the loss of life for some, such as soldiers at war, rather than a loss of street credibility for your typical teen on the high street.

There is a lot more to insulation than fashion, something that French company PEG clearly understands. It has been producing insulation materials since 1850 for the automotive, anti-trauma, healthcare, and apparel industries. "Soldiers can remain without moving for a long time. They need a lot of comfort, since when you have to act, if you are frozen, nothing happens," comments Marc Blondell, PEG. The company has had great success in the military market as the only license holder in Europe for Invista's Thermolite Micro, having worked with the British, Romanian, and French armies to produce the required level of insulation for soldiers without compromising on comfort or wearability.

Protection without bulk

Thermolite Micro is a microfibre offering down-like softness without bulk. This patented microfibre provides a natural softer feel for comfort and a higher level of insulation compared with other insulation at the same thickness. With a thermal resistance of Rct m^2 K/W of 0.0225, or 3 CLO (when 1 CLO = 0.155 m^2 K/W, according to standard NF EN 31092), there is no doubt that this insulation can keep a soldier warm even in the most hostile of climates. However, warmth is only one aspect of insulation, and there is no point being insulated, if the wearer is not also kept dry. According to PEG, its wadding not only offers high thermal resistance, it also achieves excellent vapour resistance. Thermolite Micro, as a microfibre-based wadding, is said to have a permeability index of approximately 0.70 or more (the closer the value to 1, the broader the comfort range).

LLBean uses 3M's Thinsulate in its performance outerwear.
LLBean

PEG also supplies specialised insulation for sportswear, sailing gear and sleeping bags and uses a variety of lightweight fibres in its wadding to allow optimum insulation in the most lightweight form. After years of research and development, PEG has discovered that to achieve the best performance from wadding, it is crucial to achieve an equal thickness with the finest fibres, to create dense but lightweight fills. High thermal resistance, combined with excellent vapour resistance, offers the wearer the most comfortable, effective garments.

Alongside Thermolite Micro, PEG also holds licenses for Thermolite Plus, a lightweight insulation material for cold weather, made from 80% recycled polyester and Thermolite Extra, a three-hole spiral fibre that is warm and soft with the same bulk as down. The company also uses Lenzing AG's Tencel, a cellulose fibre with a high level of moisture management, to manufacture lightweight, soft and supple fills which meet Oekotex class 1 levels. PEG has its own fabrics under the Trispace brand, following the acquisition of the brand from Rhone Poulenc. This brand offers a range of various qualities of wadding and insulation materials to meet a variety of applications. The Trispace range offers excellent insulation due to its mix of microfibres and fine fibres. It can withstand intensive washes, is lightweight – starting from 25 g/m^2 - and offers long-lasting performance.

But whilst PEG cites equal wadding as the key to success, one UK-based company, Radar, markets its lining based on the fact that it isn't equal across the garment. Radar has developed a new technology in which different insulation materials and thicknesses are placed in different areas of the garment, dependent on the varying thermal importance.

Keeping the balance

Radar's patented technology works on the basis that the body has a wide range of thermo-regulatory requirements that all need the correct level of insulation, dependent on their function. The lining is designed in relation to the body's need for protection against the cold. For example, around the stomach cavity, where the liver, kidneys and spleen are located, Radar's lining offers a high level of insulation as even a slight drop in temperature can stop these organs functioning correctly. This area is insulated with Flectalon – silver-coated strips of polyester – as this not only offers a high level of insulation, it actually reflects body heat back towards the most vulnerable organs. Across the back and halfway down the upper arm the Radar lining incorporates a microfleece as it is lightweight and flexible and provides enough insulation for these areas. There is no extra insulation in the rest of the jacket as this allows excess heat to escape through non-vital thermal areas.

This sounds like a fairly simple concept, but Radar's lining is the result of years of research that has been tested at Leeds University and is now patented. It works on the theory of creating thermo-neutrality. In layman's terms, the lining insulates the cold profile so that no heat is lost when the wearer is cold, and heat is expelled when the wearer is too warm, whilst controlling the level of heat retention or loss to retain a comfortable warmth.

The results of the laboratory tests undertaken at Leeds University concluded that the jacket was as cool as an unlined jacket and as warm as a fully lined jacket. "The best of both worlds," comments Mike Willans from Radar.

Based on heat loss through radiation, the company designed its lining on typical losses through radiation, which are quoted as being between 56% and 70%. By controlling heat loss or retention based on radiation, it maintains the body's natural core temperature of 37.2°C, and rather than transporting moisture away from the skin, as is the case in so many fabrics on the market, Radar's product actually reduces the amount of moisture produced.

"Why should you be sweating when it's cold enough to wear a jacket in the first place?" asks Willans. Others seem to agree, as Radar has already sold over 700 jackets.

The possible military applications for this technology are wide. As soldiers need to keep warm despite enduring long periods of inactivity and then periods of exertion.

3M has also adopted the concept of providing different weights and materials in different zones with its Thinsulate insulation in outerwear which is used by brands such as Polaris, Arctic Cat, The North Face, and Alpina. Introduced 25 years ago, Thinsulate has always been marketed as offering 'warmth without bulk'.

In order to address the issue of different body parts requiring different levels of insulation, such as toes getting colder, and the fact that the core body temperature can change as activity increase or decreases, 3M introduced Thinsulate zone insulation. This enables performance apparel producers to offer a wide range of insulation types and weights in specific areas, offering more where it's needed and less where it isn't.

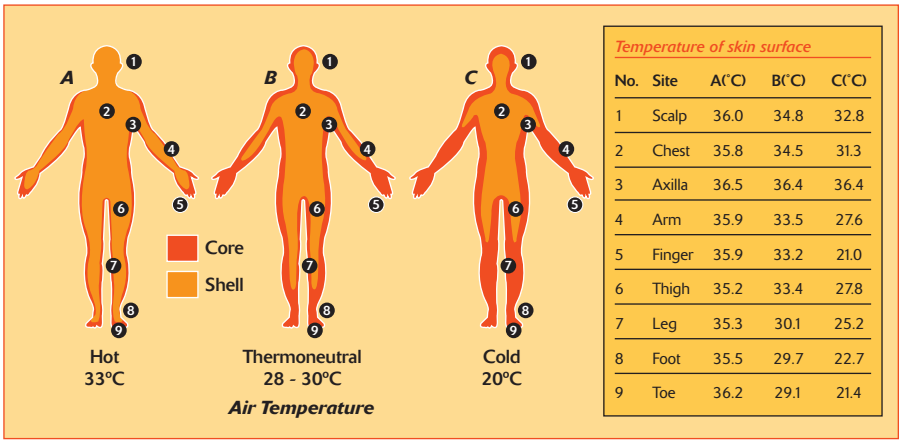
"Winter sport designers are taking outerwear in new directions with hybrids, and Thinsulate zone insulation provides the necessary tools to be creative by performing in extreme conditions, stretching and providing warmth without bulk," says Kim Kocer, 3M's market development manager in personal safety products. Not content with offering the highest level of insulation, 3M has taken its Thinsulate one step further by introducing Thinsulate Flex - a fine blend of olefin fibres and larger staple fibres. This insulation offers not only optimum protection from the cold, but allows the wearer full freedom of

movement due to its stretching properties, which are vital attributes when participating in sports or working in hostile conditions. In fact Thinsulate Flex stretches 40% in all directions and recovers without wrinkling, tearing or compromising its insulation properties.

Thinsulate insulation is used in a variety of military applications, outfitting the soldier from head to toe - including gloves, ponchos, and combat boots. It is also commonly used in their insulated tents.

A leap of faith

But whilst the benefits of wadded insulation have a long history and have advanced almost beyond recognition over the last few decades, the military is also opting for new intelligent materials as a form of insulation. In a recent record attempt for the new Serbian height record without oxygen, of 9,250 metres, in Djerdap, Serbia, eleven men and one woman from a special unit of the Serbian and Romanian army opted for phase change materials (PCMs) to protect them against the extreme conditions. Facing a temperature range of -50°C to +22°C the team opted for the least bulky materials on offer, moving away from any form of wadding and choosing Mille Dragic Production's protective suits with Outlast's Adaptive Comfort material. "Under the combination of Sympatex first layer and the Outlast lining we wore only a cotton T-shirt," says officer Kuzmanovic.



Temperature of skin surface

No.	Site	A(°C)	B(°C)	C(°C)
1	Scalp	36.0	34.8	32.8
2	Chest	35.8	34.5	31.3
3	Axilla	36.5	36.4	36.4
4	Arm	35.9	33.5	27.6
5	Finger	35.9	33.2	21.0
6	Thigh	35.2	33.4	27.8
7	Leg	35.3	30.1	25.2
8	Foot	35.5	29.7	22.7
9	Toe	36.2	29.1	21.4

Radar's technology is based on maintaining thermoneutrality.

Radar

PCMs are able to absorb, store, and release excess body heat, when the body needs it, without the need to trap air as in the case of wadding. This works through microencapsulation, but with a stable shell so that the microcapsules are not ruined, and a paraffin-type substance which are capable of phase change. These, thermocapsules, can be integrated into garments in three ways: in the fibre, as a coating on the textiles, or in foams for helmets or shoes. They work to heat or cool the body as required to maintain a constant, comfortable body temperature. This technology has been incorporated into ballistic vests, protective suits, and uniforms.

So whether consumers opt for wadding or phase change materials it seems that in the current market 'less is definitely more' when it comes to insulation, allowing the wearer a higher level of protection from the cold - whether on the battlefield or on the ski slope. With the huge advances made in materials and fibres over the last few decades, for insulation materials , particularly in the case of Serbia's army, the sky is truly the limit.