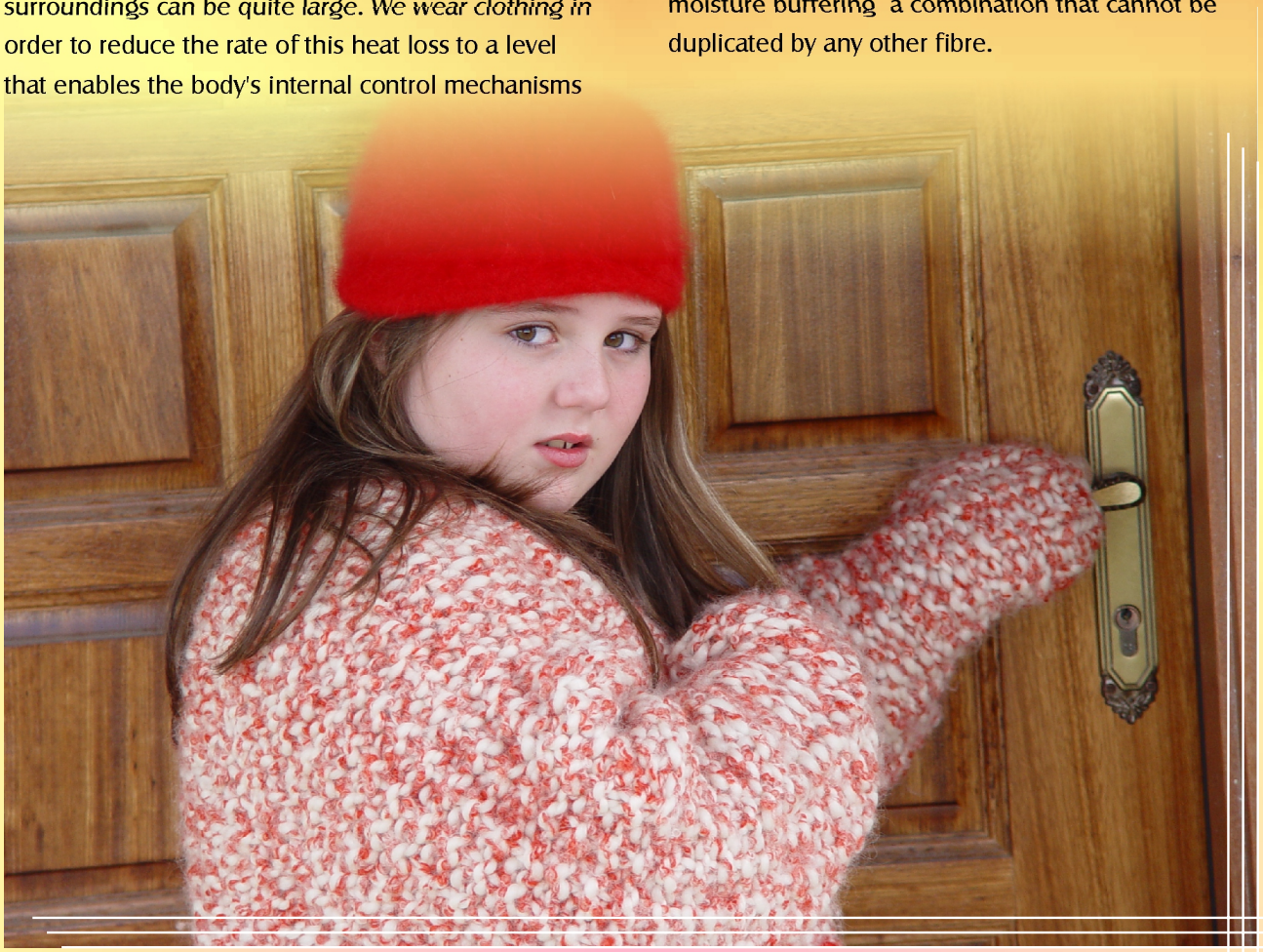
Wool and Warmth

Probably the first thing that springs to mind when the word wool is mentioned is warmth. There are several good reasons for this. In the early days of textile processing, spinning and weaving equipment were far less sophisticated than they are today.

Wool's high crimp meant that it could be most easily spun into soft, hairy yarns to make the thick, insulating fabrics that dominated the clothing market at a time before central heating became universal.

The physical property of textiles responsible for warmth is thermal insulation. Heat flows through textiles at a rate determined by the difference in temperature between the two faces of the textile and the thermal insulation of the textile itself. The human body must maintain a central or core temperature within a quite narrow band around 35°C in order to sustain life. In cold conditions the difference in temperature between the body and the surroundings can be quite large. We wear clothing in order to reduce the rate of this heat loss to a level that enables the body's internal control mechanisms to maintain a safe core temperature, putting on and taking off garments as necessary.

Textiles consist largely of air, a much better insulator than fibres, so in the absence of substantial air movement thermal insulation is largely a function of fabric thickness. Two layers of any given textile insulate twice as well as one, three insulate three times as well and so on. Wool's long-standing reputation for warmth can be attributed to its high natural bulk and elasticity which together give wool knitwear and doonas excellent insulating characteristics in a package that is light in weight, feels soft against the skin and has outstanding moisture buffering a combination that cannot be duplicated by any other fibre.



Some synthetic fibres are extruded with a hollow core or cores, claimed to increase the amount of air trapped within the textile. They are generally used for insulating materials where the proportion of fibre relative to the total volume is typically below 1% - often much lower. Even if the core makes up 50% of the cross-section of the fibre the amount of immobilised air within the fibre is trivial relative to the volume of air within the structure so the insulation of these materials is not significantly different from that of conventional fibres.

There is another aspect to wool's warmth that is quite unique amongst insulating materials and very relevant to winter wear. Wool garments actively generate heat when taken from warm indoor environments into the cold and wet of an outdoor winter. The effect is most noticeable in the first five or ten minutes after stepping outside, but lasts for several hours. This behaviour can be attributed to a large and rapid re-adjustment of moisture vapour content within the wool fibre when taken from warm dry indoor air to the cold moist air outdoors. The heat energy released is not readily obvious to a wearer due to the fact that it causes a steady rise in temperature of the whole garment rather than the rapid change near the skin needed to stimulate skin temperature sensors. However it actively reduces the thermal shock on the body during the transition from indoors to outdoors.

Phase change materials are increasingly being combined with textiles in order to provide a form of thermal buffering against cold. These are typically paraffin waxes with melting points close to the temperature of the body that release latent heat of fusion when they solidify to give a level of protection against cold when moving outdoors or when the temperature falls. The wax is are encapsulated in acrylic spheres that are applied to the textile as a coating or co-extruded with some synthetic polymers. It is worth bearing in mind that the thermal energy available from this transition is less that one tenth of that released by wool as it changes its moisture content from totally dry to saturation. Wool is a powerful natural buffer!