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# Advances in wool technology

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Edited by  
N. A. G. Johnson and I. M. Russell



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## Preface

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In 2007, the Australian wool industry celebrated the 200th anniversary of the beginning of the Australian wool trade, supplying merino-based raw wool and wool products to the global textile industry. A photographic competition held as part of the anniversary celebrations was won by a stark and iconic image of an ancient wool press in a 100-year-old darkened wool shed. The image described 'A relic that epitomises the resilience of the Australian Wool Industry. Scarred, but still solid and stoic, it is a timeless reminder of the tough people, and tough times behind a proud and resilient industry' (Merino 200, 2007).

That image looks back nostalgically to a time when wool was a major textile fibre, but those times have long gone. This book looks forward optimistically, reviewing how recent advances in science and technology will help the wool industry meet the challenges and opportunities it faces in its 202nd year.

The reality is that wool is now a minority fibre, with only a 1.9% share of a global fibre market. It does, however, retain a greater market share in some significant areas such as apparel and interiors and a few industrial niches. Wool's market share began to decline from the 1950s, to some extent in absolute tonnages, but more importantly in percentage terms as the total textile market increased in size through global population growth and as textile consumption per head increased, especially in developed countries.

Synthetic fibres were created and enhanced through scientific and technological breakthroughs which show no sign of abating. They were cheap to produce and began to dominate the market and to outstrip even cotton production. In the 1960s the holy grail of the synthetic fibre industry was to develop a fibre that could mimic the comfort, appearance and moisture-retention properties of the natural fibres. That research effort was doomed to

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Merino 200 (2007), 'Iconic image announced winner of 'Australian Wool to the World' Photographic Competition', <http://www.merino200.com/lo/index.html>, accessed 14 May 2008.

fail, largely because wool is a highly complex biological material that has challenged scientists over many decades, and has proved impossible to replicate.

However, the synthetic fibres continued to innovate and to develop fibres with their own unique and distinctive properties, both physical and chemical, that now claim their own performance advantages. A cursory examination of the active sporting and outdoor clothing markets will quickly identify the multitude of properties that have been engineered into the synthetic fibres as a result of this intensive research and development.

Wool has not stood still throughout that same period. Research into the complex structure of wool was intense and the knowledge gained has been at the forefront of our understanding of complex biomaterials. Its complexity also offers opportunity as we understand it better, and there are new scientific tools and techniques to explore and modify it to create new features and levels of performance. Wool remains a unique and almost magical fibre, with its ability to absorb a high level of moisture but with a simultaneous ability to provide protection against showers, with resilient mechanical properties and with natural odour resistance. With the fundamental knowledge of the structure and chemistry of wool that we now possess, wool fabrics can be engineered to be either warm or cool and to function superbly in extreme sporting situations or in the most elegant of formal occasions.

This book highlights the breadth of sciences that have been applied in recent years to create advances in wool across the full spectrum, from genetics of wool production, to processing, to finishing, and to its use as a source of proteins for a range of novel applications.

Unfortunately, as wool has declined in importance, the global research effort backing its further development has also declined. This will limit the scope for the future advances in wool that will be needed if this wonderful fibre is to continue to compete with the inevitable advances in alternative materials, and not be further relegated to the status of a rare novelty fibre. Marketing will remain important, but it will only take the fibre so far. Consumers are constantly seeking improved performance and exciting new innovations that only research and development can provide.

On the other hand, a great opportunity on wool's horizon is the growing consumer interest in natural and sustainable materials. This aspect will require further research effort if wool is to fully exploit this opportunity, and not fall foul of the counter-claims that wool production is unsustainable, that some animal husbandry aspects are unethical and that its processing uses unfriendly chemicals. Significantly the wool industry has begun to recognise the need to be proactive in this area and the theme of the most recent IWTO Congress, notably in Beijing, was 'Wool – The Environmentally Friendly Fibre'. IWTO President Günther Beier 're-emphasised the importance of capitalising on the ecological aspects of the wool fibre and its inherent properties as a textile fibre, which can bring wool back onto the retail floor prominently'.

Many commentators and indeed many in the wool industry feel that wool is currently at a crossroad; however, the Editors strongly believe that the challenges ahead can be addressed by continued focused research, and some progress is reported in the following pages.

Part I of this book deals with advances in wool fibre and fabric production. Rogers and Bawden identify opportunities that might be provided to grow wool fibres with tailored properties through advances in genetic modification by targeting the skin follicle, the 'engineering room' where the fibre is produced. The opportunities are great but the wool fibre has evolved to its current optimised state over millions of years. As a result, progress is slow and difficult.

One of the great challenges for wool is that it is a natural fibre with great inherent variability. Sommerville describes developments in presale objective wool testing and in modelling that allow consignments of wool to be prepared which will have predictable properties and processing characteristics at top and yarn stages. These variability issues are not faced by the synthetic fibres, and the growth of objective wool testing has greatly improved reproducibility and has significantly reduced early stage costs.

Russell describes the development of credible and workable definitions of eco-wool and organic wool by the wool industry and notes the increasing importance of European consumers and European legislation in establishing good environmental practice through textile supply chains. An important development is the increasing availability in the marketplace of eco-wool tops and yarns available for spinners, weavers and knitters to purchase; these products significantly shorten the supply chain for the late stage product manufacturers and the availability of eco-wool garments is expected to increase rapidly.

**Chapter 4** by Prins and **Chapter 5** by Gupta describe the latest developments in wool spinning, weaving and knitting. These are areas of intense innovation by researchers, machinery manufacturers and processors. Wool benefits by adapting generic advances made principally for use with other fibres. This is where costs can be reduced, but more importantly, this is where the new and attractive wool fabrics are generated that will excite the consumers of the future.

Finn and Wood examine the possibilities for wool to bypass the traditional methods of fabric formation via yarns and to be processed directly into fabrics and other products through the various non-woven routes that have had such an impact on synthetic fibre consumption. The authors identify the problems and the opportunities encountered for wool in these products. Many developments in this area are being driven by the cost savings available and this is important for wool; however, the products are unique and may fill potential market niches, not just in technical applications but in certain apparel opportunities.

To complete Part I, new developments in the areas of finishing and coloration are reviewed by Shen and Lewis. While these areas also stimulate innovation in aesthetics and performance to entice the consumer, many of the recent developments in these areas are driven by environmental problems of the past and the present. Many of these problem areas, such as chlorine for shrink resistance, heavy metals in dyes and insect-resist agents are unique to wool. It is essential that wool can continue to be converted into garments that meet all of the performance and environmental needs of the modern consumer, and still meet the essential aesthetic needs of drape, appearance retention, handle and deep subtle colours that are unique to wool.

Part II of this book examines possibilities for new wool products and applications. Wool has long been thought of as an autumn/winter fibre, prevented from entering lightweight spring/summer markets because it has been considered in its traditional role as a warm, heavy fabric, unavailable in light pastel shades. Developments in spinning, in the weaving of singles yarn and the 'CoolWool' innovations have countered the first misconception; however, the fact remains that wool is less white than cotton and the synthetics. Millington describes research aimed at producing stable white wool fabrics. Progress has been made in understanding the fundamental reasons for wool's yellowing behaviour, but importantly, this understanding has allowed the technical development of stable white wool blend fabrics.

The 21st century has seen very rapid growth in the field of nanotechnology and most researchers consider that the area is still in its infancy. Denning reviews the field and examines current applications and possible future applications of the technology to wool. There are several nanotechnology treatments applied to cotton that have not yet been used on wool and there are many opportunities on the near horizon.

An important step in changing the perception of wool from its old-fashioned and traditional role was the development of 'Sportwool', a wool blend fabric that took full advantage of wool's unique moisture buffering capacity to produce a very high-performance fabric for elite sports. Holcombe describes the requirements of moisture management fabrics and examines wool's position in this high-profile and rapidly developing area.

Wool has many unique properties as a textile fibre; however, there are occasions when it can be blended with other fibres with specific and complementary properties to further improve the performance of the blend. Miao reviews the objectives of blending of wool with other fibres and the techniques for obtaining optimum performance for the different blend yarns and fabrics.

The field of intelligent garments is expanding rapidly, but again, the area is still in its infancy. These technologies can add the ability to 'sense-and-respond' to the most basic textile materials, posing a threat to wool's superior position that has been gained through its natural ability to respond to changing