Exciting new spinning technologies

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The journey between sheep's back and garment is often long and tortuous. In this slide the very lightweight sheer property of the garment the model is wearing highlights markets that are very difficult for wool to penetrate. If wool is to gain a presence in this market – for light and softer products – it is important that we integrate our approach to engineering the product from fibre selection through manufacturing processes to the final garment. The nature of the traditional wool industry, which has a horizontal structure, often works against this. Vertical operations, like many in China and India, however, can provide opportunities to access the needs and wants of new markets and work back down the demand chain to provide the solutions.

Critical issues

So when we develop new and different products, what are the needs we have to consider? The following are perhaps the most critical issues:

1. We have to be innovative in our approach to solving the issues and develop new concepts and ideas to generate excitement in the consumer market.
2. Whenever we produce a new product we have to generate a change in our processes, so the better we understand our processes the more opportunities we have to generate different products of a reliable and repeatable quality.
3. We have to ensure our new ideas are given the fullest opportunity to be adopted in the customer market.
4. New and different products can be created by approaching individual aspects of our production chain, or we can make exciting products through the various combinations of the factors that contribute to that chain.

New and different products can be created by developments in the following areas:

Fibre

The properties of diameter, fibre crimp and to a lesser extent fibre length are the important fibre properties that contribute to the final end product

Blends

Blends are a popular way of developing innovative products with improved performance and/or aesthetic appeal. It has to be remembered that approximately two-thirds of wool fibres end up in blends, so this is an important aspect of innovation in wool textile manufacture.

Physical and chemical modification

Softness, shrink resistance and changes in tactile properties (for example Optim) can be brought together to develop new and exciting products.

Yarn formation differences

Point of difference attributable to the yarn manufacturing system is an interesting and recent development in wool textiles.

Adoption of non-conventional methods

This is leveraging innovative ideas from other industries; for example, vortex spinning, micro fibres and splittable fibres.

Versatility in finishing

There are many different ways to approach the development of an end product and understanding the mechanisms of various finishing routines can lead to different handle of the final fabric. There is an exciting yet untapped potential for wool fabrics. An example is light, natural, easy-care products to be discussed in another session.

Fabric geometry and design

Young designers need to be attracted to the excitement that wool can generate.

Fibre crimp is one of the unexplored properties of wool. Fibre diameter is well known in terms of its contribution to final product, but fibre crimp can significantly affect all the factors listed in the accompanying diagrams. Technologists need to know and understand the individual contributions and how they affect the final product.

Similarly, fibre length has an effect in manufacture and final product but to a lesser extent than fibre diameter and crimp. Nevertheless, its contribution needs to be fully understood, particularly with the move to softer and lighter fabrics.

It's interesting to turn now to the subject of spinning and yarn formation and how that can impact on the final product.

In discussing this topic it is important to understand that the ring spun yarn becomes the reference or benchmark against which we judge the development of other spinning systems. We need to look at the development of new spinning systems in the light of how we can generate not just cost savings but new products for wool. In this regard the tactile and appearance properties of the final product are critical. Traditionally, the wool industry, particularly in Western Europe, has been conservative, which meant that new spinning systems and their potential for wool have not been fully exploited. It is better in approaching these new spinning systems to seek the opportunities and point out differences that can be valuable in not only traditional, but non-traditional outlets for wool.

In looking at the yarns that come from these new spinning systems there are a number of critical aspects that have to be considered. The uniformity of the yarn is critical, particularly optical appearance. It should be remembered that a suit contains approximately 1.6 kilograms or about 50 kilometres of yarn and that yarn needs to be regular centimetre-to-centimetre for those 50 kilometres. The fault rate must also be very low.

The description of the processes that are involved act as a reminder to where the cost elements are in conversion of wool top to fabric.

A diagram of the conventional spinning system, which is the reference for wool, and one needs to consider some of the aspects of:

- single-strand feed
- small packages
- numbers of fibres in the cross-section
- low delivery
- high rotational speeds limited by large masses.

Limits to the production rate in ring spinning mean a large number of spindles have to be used in manufacture to gain a reasonable return on investment.

The relative coarse aspect of wool means that the finest counts that can be spun, and in turn the lightest fabric weights that can be generated is a major limiting factor.

The price of the raw material for wool means that the cost per kilogram is generally reasonably high. Conversion costs also are higher for wool because of the protracted processing that wool undergoes compared with its competitors. This means that at yarn and fabric, wool is often three to five times more expensive than its competitors.

Obviously, anything that can be done to reduce either the cost of the raw material and/or the cost of manufacture will be eagerly adopted by the industry.

These cost restrictions mean that it is difficult for wool to compete against its competitor fibres, which use lower cost raw materials and lower cost conversion systems.

New manufacturing systems have been attempted for wool, but with varied manufacturing success. One system that has been used is self-twist, which uses alternative twist insertion to allow very high delivery speeds of up to 350 metres per minute. Unfortunately, the twist variation means that optically the fabrics in some critical end uses, such as fine quality men's suits, is less than acceptable. This has meant that the self-twist concept has found little application in wool processing. The good news is that a re-invention of this process is opening up new opportunities for wool.

The concept was innovative not only for its high speed and innovative approach to yarn manufacture, but it challenged the very concepts of yarn and fabric formation. The result was a series of ongoing inventions all generated from the original self-twist concepts. Some are:

- Sirospun
- Solospun
- splicing technologies.

The self-twist concept when applied to ring spinning, developed a system called Sirospun. This is a two-strand system containing the physical properties required for weaving, but uniquely at the time, is generated in one step. This means that costs are reduced substantially because of the lower number of conversion processes, and Sirospun yarns are typically 30% less than conventional produced yarns. This yarn had some limitations because of optical variation but was the basis of a cool wool tropical suit program, which created a new global concept in wool in the 90s. This success highlights the power of such technical innovation.

Solospun is another exciting technique. Here, a weavable singles yarn is developed on a spinning frame. This means a weavable, lighter weight strand than conventional two-fold yarns is produced in one step. So the breakthrough is into lighter fabrics but also at lower cost. This is all accomplished with a relatively low cost of the attachment needed to generate the Solospun.

Adoption has been lower than expected probably because of a lack of understanding of the critical nature of the system, particularly in developing countries.

Another development in ring spinning for both short staple and long staple is air condensed spinning. This technology is now five or six years old and has had limited penetration in both markets. The yarns are very smooth and lean with reduced hairs and pilling and have had some rejection because of the lack of texture in the final product. With an increased understanding of fibre properties and yarn and fabric engineering, there should be considerably more opportunity to exploit these yarns in certain parts of the market; for example, sports programs.

Another limitation to compact spinning is the relatively high cost because of the additional attachments. In turn, this has demanded that the yarns find a premium market.

The Murata Vortex spinning system is an innovative technique based on Vortex spinning technology, which was invented in the 1950s. This system generates a yarn directly from sliver, at very high linear speeds to 450 meters per minute. This means the yarn is **very low cost.**

This process has been developed for cotton, which has a fibre length range of 20–40 mm, compared with wool, which has an average fibre length of 60–70 mm.

The formation system means that there is a variation in the cross-section of the yarn in which fibres are formed. The core of the yarn consists of fibres that are very parallel, whereas, in the outer sheath, the fibres are much more entangled. It is the outer sheath that develops the yarn integrity. AWI and CSIRO projects have developed ways in which wool can be processed on these systems but only in blends with cotton or synthetic fibres, not with pure wool alone. This system has now been adopted by some commercial spinners in South East Asia.

Speed of production is related directly to the cost of the yarn and this diagram shows the very high speeds and, therefore, accompanying reduced costs. Yarns from high speed systems have found application in upholstery, hosiery, corporate wear, cotton–wool fibre blends, baby wear and golf shirts. These are cost sensitive markets for wool.

Winspin produces a four-ply long-staple yarn from roving with speeds up to 250 metres per minute. The principle of manufacture is that of self-twist oscillating rollers developed by CSIRO for the Repco ST machine. The machine is fully automated, only roving bobbins or sliver cans having to be replaced manually. The delivered package then requires two-for-one twisting.

The spinning parameters are fixed with a traverse of 80 mm for two-fold yarns and 70 mm for four-fold yarns. Amplitude is 110 mm for both situations. The yarns have largely been targeted at knitwear and the claims made include:

- improved quality and appearance
- very resistant to pilling
- very soft handle due to 50% less folding turns
- short material flow time and reduced stocks.

Ring	**Compact**	**Vortex**	**Solospun**	**Winpro**	
Cost	Hi	Hi	Attractive	Reduced	Hi
Robust	Av	Av	Acceptable	Reduced	Av
Flexibility	Good	Reduced	Limited	Different	Limited
Quality	Hi	Hi	Reduced	Questions	Questions
Appearance	Hi	Hi	Reduced	Questions	Questions
Distribution	Hi	Limited	Small	Questions	Small
Market	Reducing	Stagnant	New-Limited	Stagnant	New Limited
Fibre needs	Reference	Ring/Long H	SS	Ring/Long H	Standard