Wool Fibre Innovation

OPTIM Technology

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CSIRO Textile and Fibre Technology

Drivers for Wool Fibre Innovation

- Changing consumer and market need
  - Finer, lighter yarns and fabrics
  - Softness and low prickle required
  - Reduced demand for >21 µm wools
  - Product Innovation

- Challenge: How to make wool finer?

Fibre transformation provides major scope for proc
Fibre transformation is the most radical form of inn

- Solution (1): Breed finer wools (5 yea
  breeding for 1µm)
- Solution (2): Drought conditions
- Solution (3): Fibre modification/trans

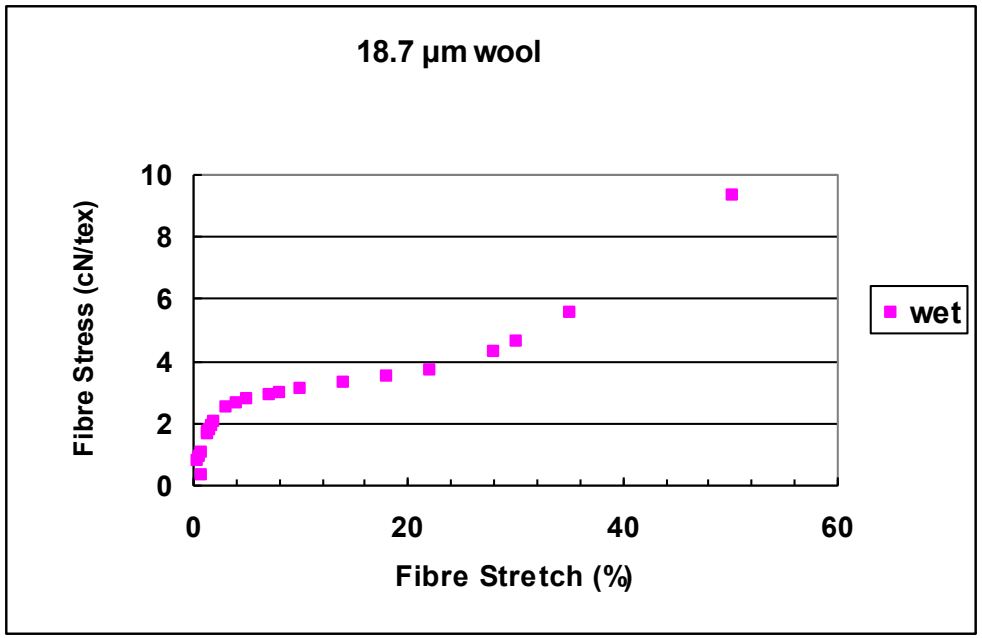
What is Innovation? "Make the strange familiar or
make the familiar strange." C.K. Chesterton

The supportive CSIRO R&D environment in the 1980s

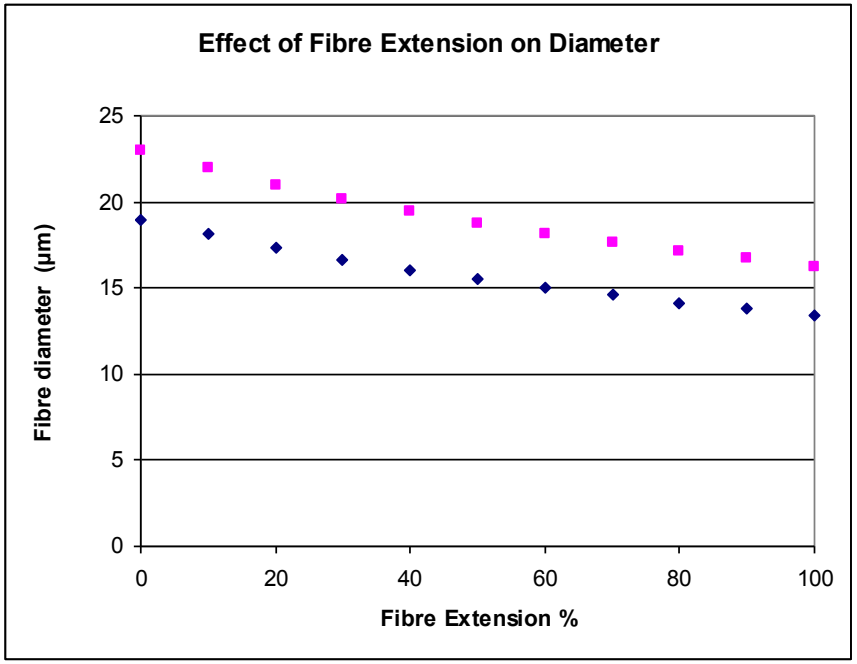
- Radical innovation encouraged
  - 'Fibre modification underpins fundamental innovation.'
- Broad skill base at Geelong:
  - wool physics and chemistry know-how
  - machine design and building skills
  - fibre-to-fabric facilities
  - fibre-to-fabric know-how.
- Strong support from wool R&D funding body.

Wool fibre is extensible

- Data for 18.7 µm wool fibres (3.5 dTex)



Fibre diameter decreases with extension



Wool fibre is extensible

- Extensibility depends on:
  - moisture content of fibre
  - temperature
  - level of broken disulphide bonds (thiols)
    - needs reducing agents.

Wool fibres can be set

- Setting chemistry is well-known.
  - Wool fibres can be set in bending, extension or when twisted
- Two separate setting processes can apply:
  - glass transition temperature (cohesive)
  - thiol-disulphide interchange

Setting of wool

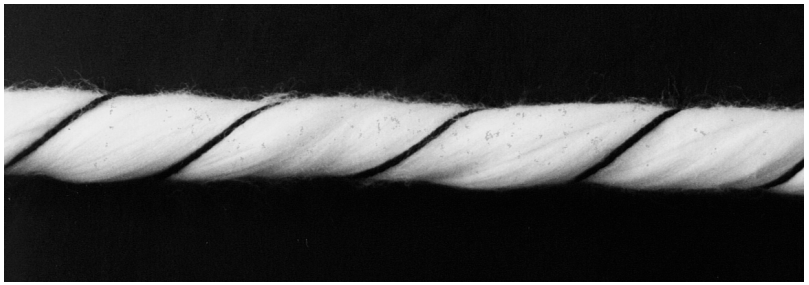
- Glass transition temperature
  - Cohesive (released in cold water)
    - e.g., wrinkles in trousers.
- Thiol-disulphide interchange
  - Temporary (released in hot water at 70°C)
    - stability of a wool fabric surface after pressing using mild steaming conditions (e.g. 87°C)
    - treat a freshly spun yarn in steam at 87°C for several minutes.
  - Permanent (stable to hot water at 95°C)
    - stability of a wool fabric surface after pressure decatising at 110°C
    - bend and hold a fabric in boiling water for one hour
    - extend and hold a fibre in boiling water for one hour

The Challenge

- How to extend and set fibres in practice?
- What were the consequences?
- What were/are the opportunities?

Stretching of fibres

- Too difficult to stretch fibres separately.
- Stretch against twist provides fibre cohesion and control.
- Stretching of slivers using false twist developed.



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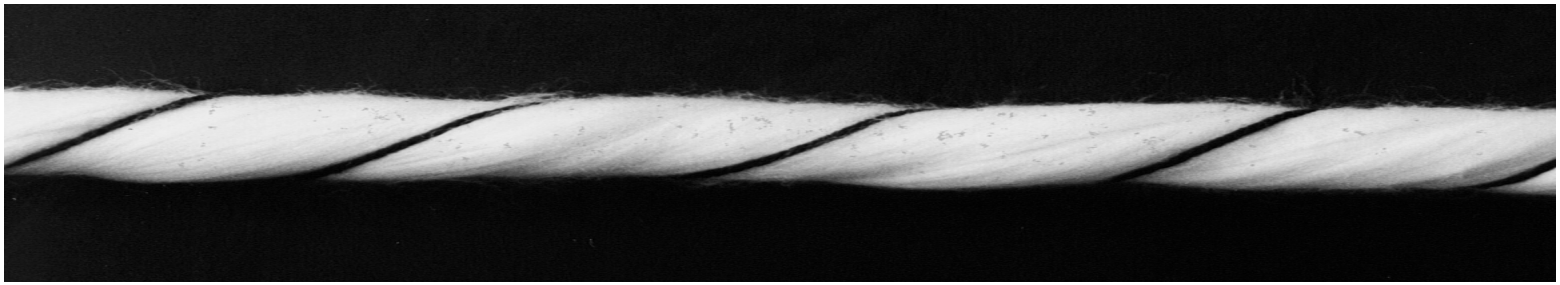
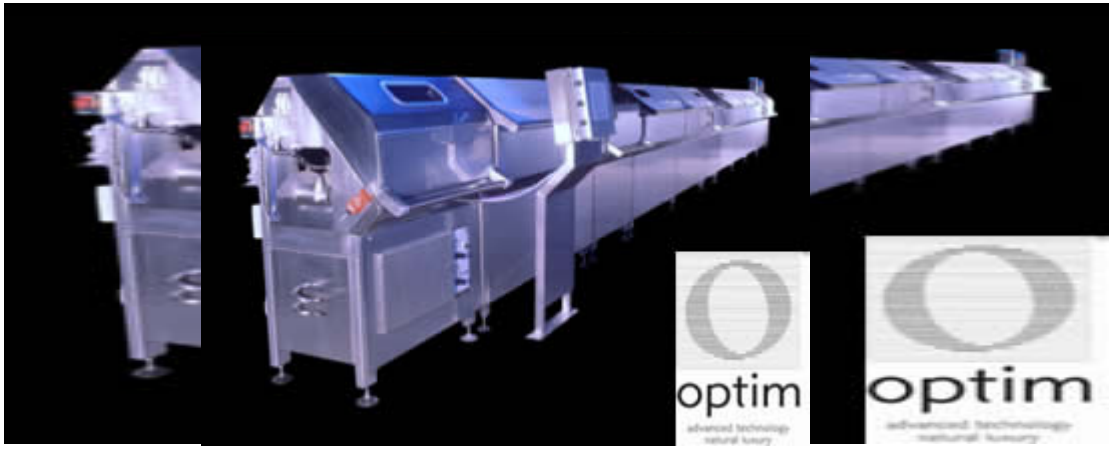


Commercial Optim plant

Woolmark/Andar commercial plant

Productivity: ~ 30-40 kg/hr

6 machines globally (including 5 Andar machines)



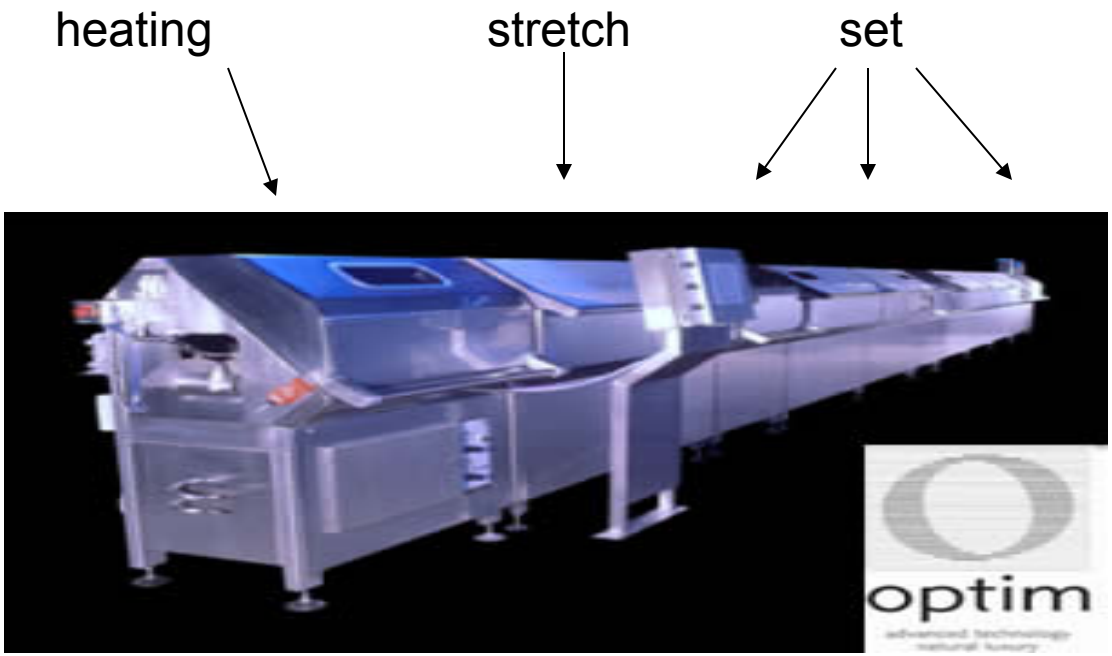
Setting of extended wool fibres

Temporary or permanent set possible.

- Stress relaxation occurs in stretched fibres.
- Reducing agent generates thiols.
- Thiols aid the relaxation process by thiol-disulphide interchange.
- Oxidation step rebuilds disulphides.
- Time and temperature parameters important.

- Choice of conditions produces temporary or permanent set.

Commercial Optim plant



Optim™ fibres

- At present, two fibre types allow product innovation:
  - OPTIM™*fine* – permanent set
  - OPTIM™*max* – temporary set.

The OPTIM™*fine* process

WOOL SLIVER *(e.g., 19 µm)*

TWIST

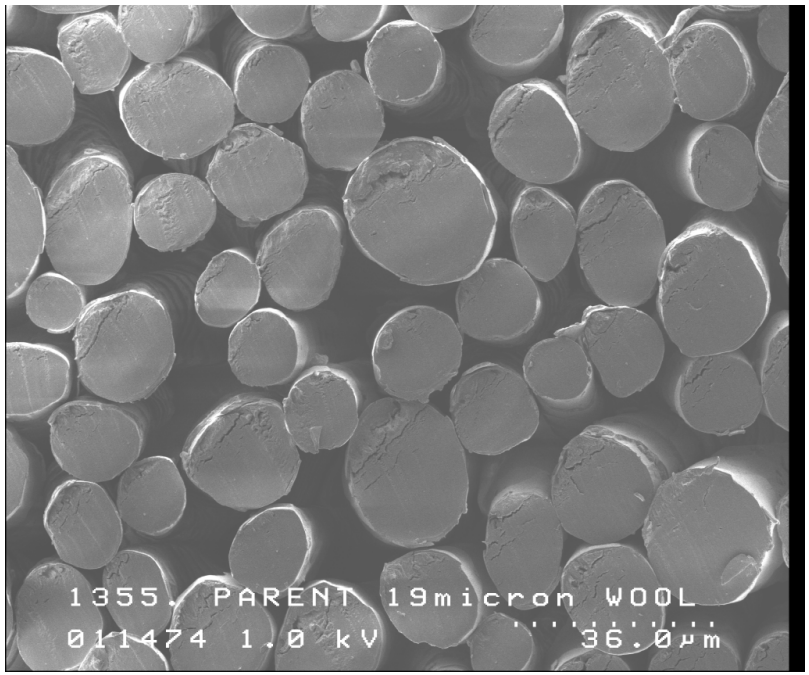
STRETCH

PERMANENTLY SET

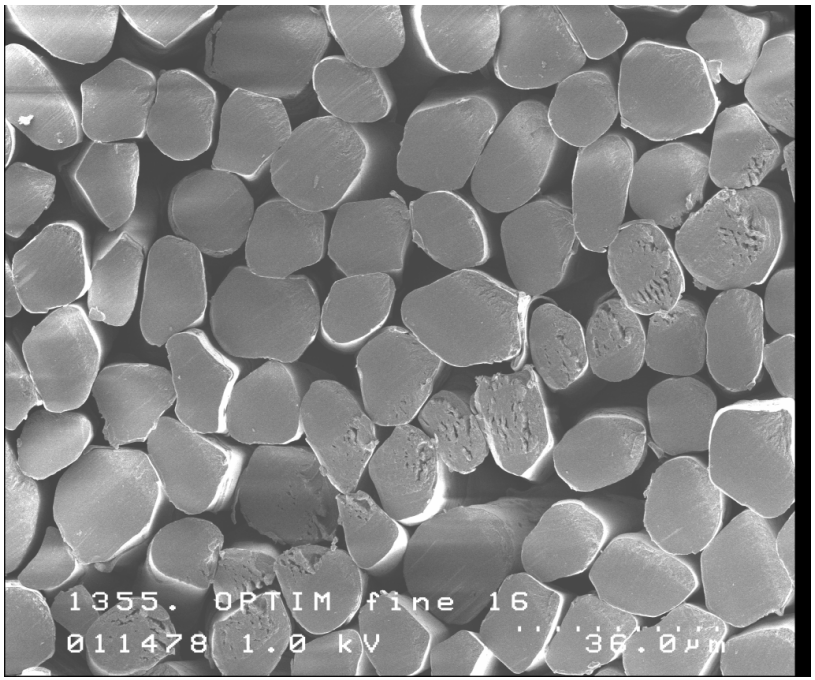
OPTIM™*fine* FIBRE *(e.g., 15.5 µm)*

Cross-sectional shape of OPTIM™*fine*

Parent Wool

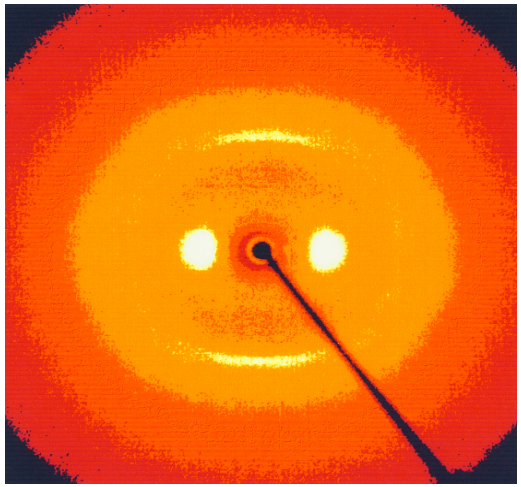


OPTIM™*fine* fibres



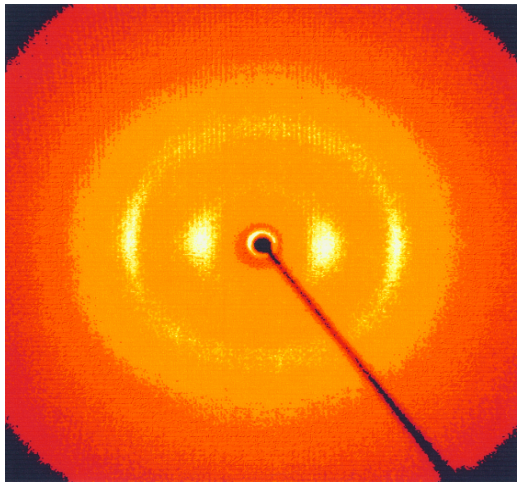
Fibre structure

Wool



Alpha keratin diffraction pattern

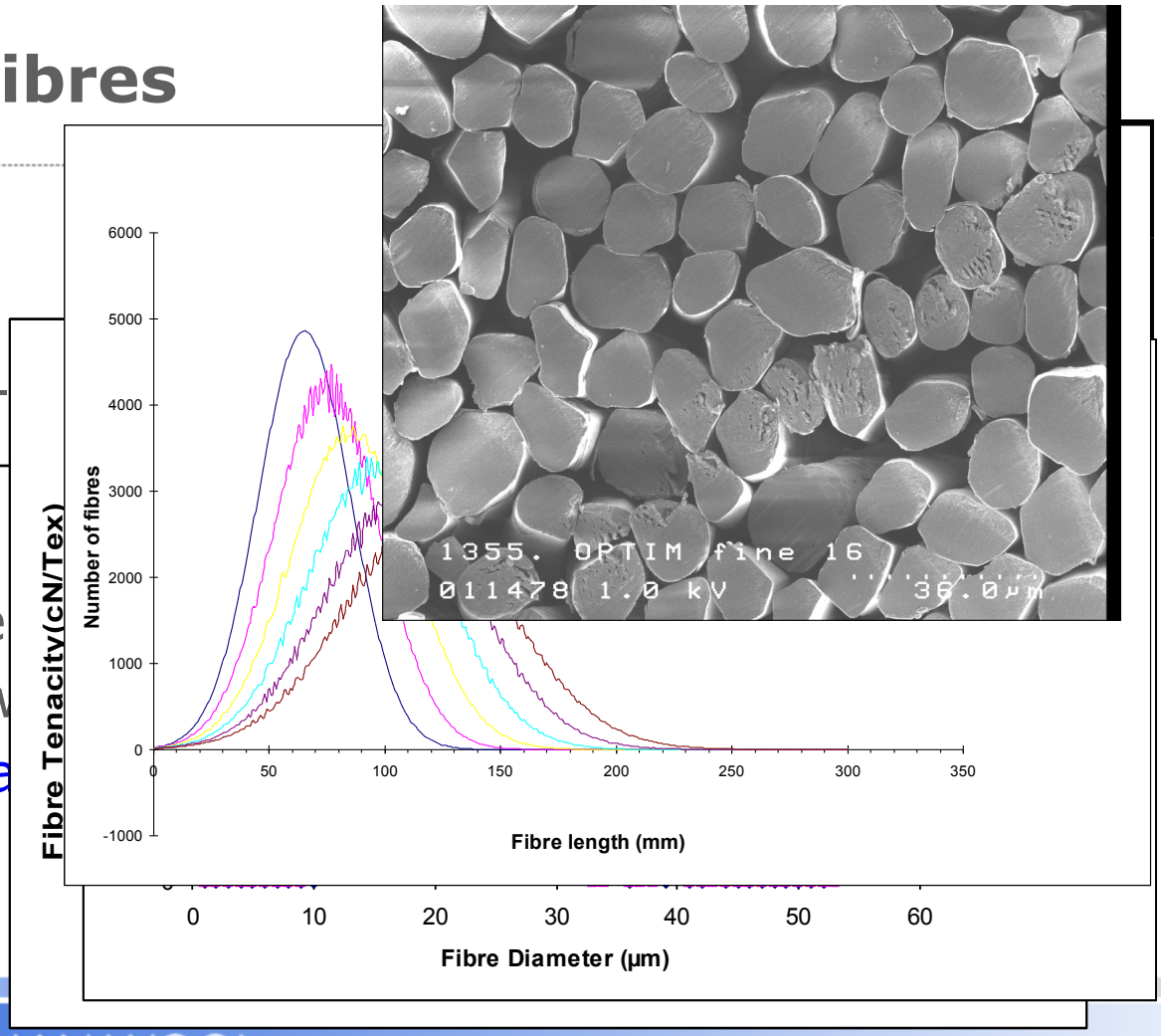
OPTIM™fine



Beta keratin diffraction pattern (silk-like)

Optim™ *Fine* Fibres

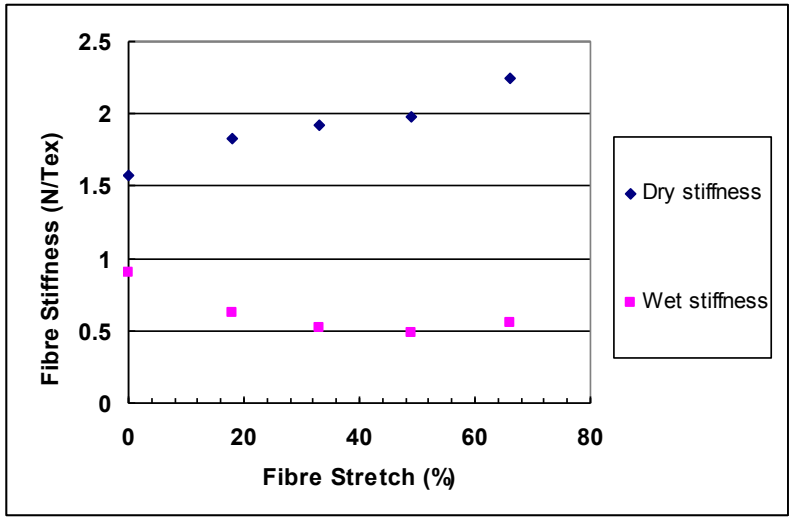
- Benefits
  - Lustrous, silk-
  - Longer
  - Stronger
  - Prickle reduce
  - Applies to all
  - (and all anima



Optim™ fine properties

Disadvantages

- Low wet modulus
  - affects top and package dyeing
  - more care needed in finishing
  - poor wrinkling behaviour



OPTIM™fine fibre properties

	Optim™ ***Fine***	Wool	Viscose	Silk
Linear density (dTex)	2.3	3.7	1.7	1.2
Tenacity (cN/Tex)	14.5	11.5	22-26	39
Extensibility (%)	19	38	20-25	18
Wet modulus (cN/Tex)	51	95-100	40-50	220

The OPTIM™*max* process

WOOL SLIVER

TWIST

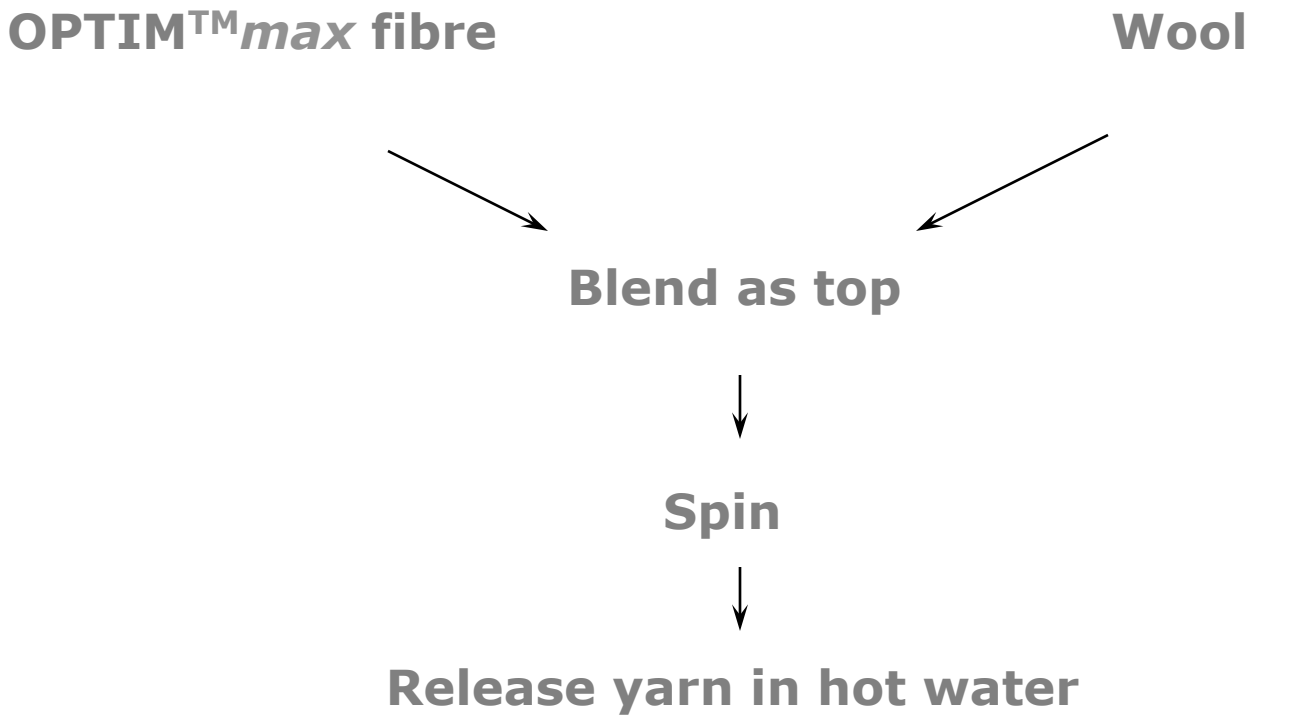
STRETCH

TEMPORARY SET

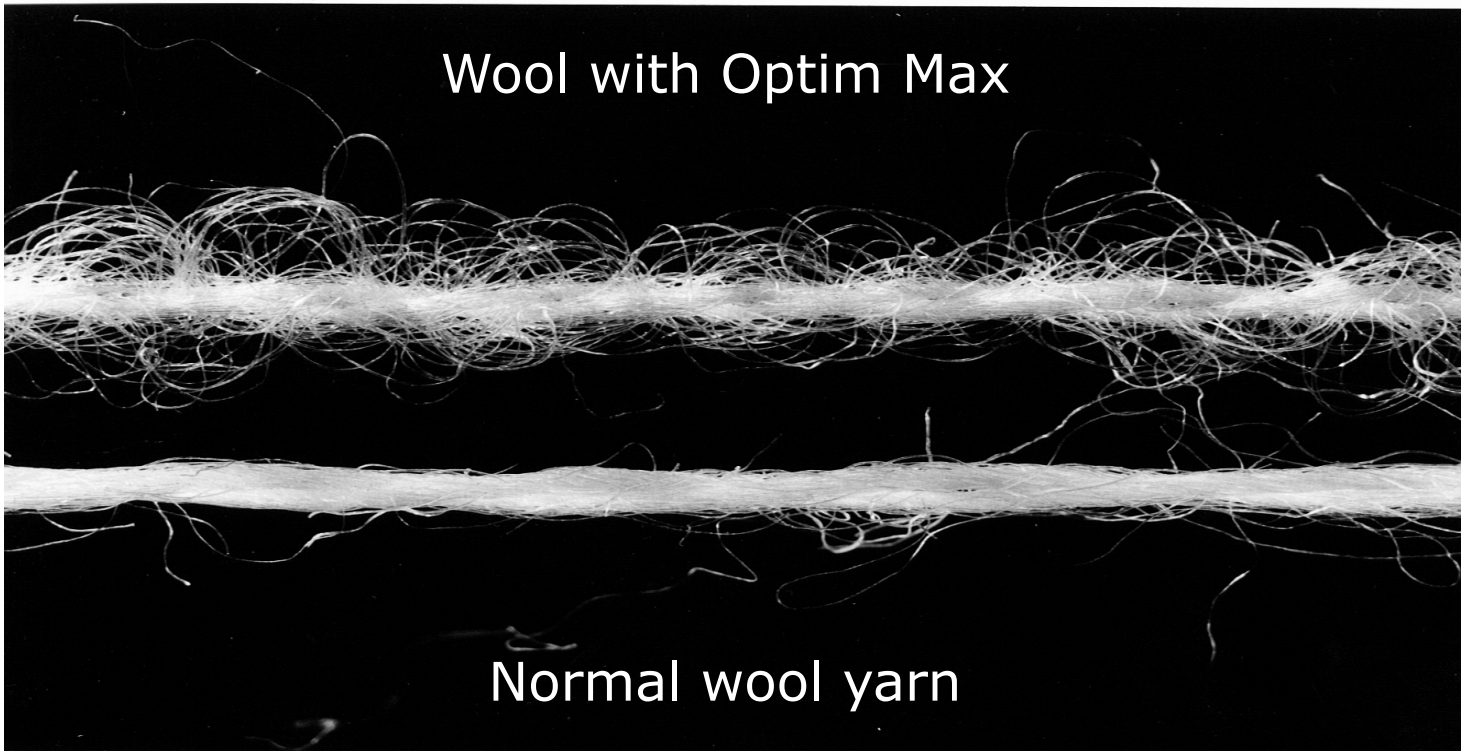
OPTIM™*max* FIBRE

Retractable wool fibre ~ 25%

Bulk generation in yarn



Yarn bulk



Yarn and fabric bulk (wool with Optim™*max)*

	Yarn count (Tex)	Yarn bulk (cm^3/g)	Fabric bulk (cm^3/g)	Fabric weight (g/m^2)
Wool	R75/2	12	3.5	287
Wool with Optim™ ***max***(40%)	R74/2	17	6.3	225
Wool	R478/3/3	6	7.8	
Wool with Optim™ ***max***(40%)	R435/3/3	12	10.5	

Optim™*max* properties

Benefits:

- Retractable
- Generates bulk when blended
- Good for ‘warm without weight’ products
- Basis for further product innovation.

Disadvantages:

- Extra relaxation process required in yarn processing.

Commercial position

- Process patented
- Woolmark was sole licensee for manufacture and sale of Optim machines now part of AWI merger .
- Detailed technology transfer packages provided to Woolmark from CSIRO
  - Fibre to fabric processing advice available
- Optim™ machines are operating in China and Japan.
- Arcana machine operating in Australia.

Further developments of Optim

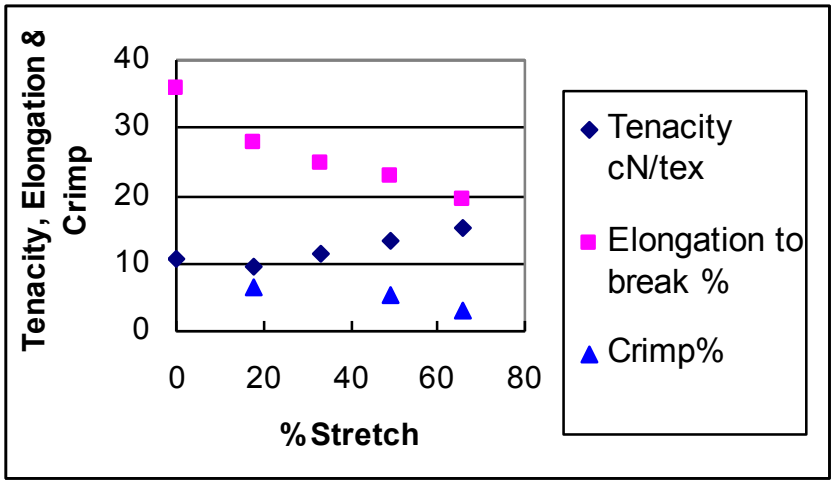
Currently Optim demand is limited by supply, fibre cost and performance issues.

The following will enhance the opportunity for Optim products:

- reduce cost of production
- improve wet fibre and fabric properties
- develop new fibre products

Black box approach to fibre modification

- Modify process to engineer wool fibres for unique product applications.
- Optim example:
  - fibre tenacity
  - elongation to break
  - crimp
  - range of fibre types possible.



Ancient thoughts on problem solving

'By always thinking unto them, I keep the subject constantly before me and wait till the first dawnings open little by little into the full light.'

Sir Isaac Newton (1642-1727)

Final word on innovation

Product innovation is largely a process of problem solving combined with passion and persistence, but, above all, arises from the need to think and rethink about needs, problems and opportunities.

David Phillips, 2007

Next

- Questions
- Visit to Optim™ prototype plant
- Show of Optim™ products