PRODUCT DEVELOPMENTS IN MANMADE FIBRES: IS COTTON ABLE TO COMPETE?

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PCI Fibres, a Wood Mackenzie business

ABSTRACT

In the last 25 years global demand for fibres has increased more rapidly than population. Population rose by 37% to 7.3 billion people while fibres grew by 124% to 88 million tonnes. While population is an obvious driver of fibre demand there have been other reasons for the high growth of fibre volumes. These include rising incomes, more affordable fibre, textiles and apparel products as well as changing attitudes to traditional textile products – used increasingly as disposable fashion.

Equally as important has been:

- The development of fibres to meet aesthetic and performance challenges in traditional textile products (such as intrinsic chemical properties, cross-section, diameter, texturing and bonding).
- Product and process innovation in both traditional and non-traditional textile product areas where the use of fibres has facilitated market growth. These include woven and non-woven products in markets as diverse as medical, hygiene, transport, construction and agricultural.

Manmade fibres contributed 90% of the growth in fibre consumption in the last 25 years with volumes rising from 19 million tonnes in 1990 to 63 million tonnes in 2015. Consumption of cotton increased from 19 million tons to 24 million tons in this period.

This presentation explores key fibre and product developments behind the extraordinary volume growth in manmade fibres as well as future challenges and opportunities.
Product developments in MMF: is cotton able to compete?

33rd International Cotton Conference Bremen
March 16 2016
Agenda

- Textile fibre volumes:
  - Fibre shares over the last 25 years, today, and a view of the next 15 years. Cotton’s share slides as polyester grows towards 60% of fibre consumption.
  - Cotton still dominant in the staple fibre market, but under pressure from polyester filament and viscose staple.
- As population grows, will cotton keep up with additional fibre demand?
- The challenge of polyester filament to all staple fibres.
- The growth of textile applications: MMF in apparel, home textiles and industrial products.
- Sustainability: a challenge for MMF.
Polyester continues to dominate textile fibre consumption

World – Fibre Mill Consumption

Million tonnes


Polyester F+S  Cotton  Cellulosic F+S  Nylon F+S  Polypropylene F+S  Acrylic  Wool

Trusted commercial intelligence
www.woodmac.com
The vast majority of MMF production growth has been in China
Excess capacity at polyester filament and staple 2015

Filament
- Capacity: 45 million tonnes
- Production: 30 million tonnes

Staple
- Capacity: 25 million tonnes
- Production: 15 million tonnes
Asia cotton and polyester staple prices
Cotton losing share and volume to MMF in women’s dresses

Annual US Imports of Women's or Girls' Dresses, Not Knitted '000 DOZ

- Mainly cotton
- Mainly synthetic
- Mainly artificial
- Other
- Total (RHS)

Source: GTIS/PCI Wood Mackenzie
8 Trusted commercial intelligence
www.woodmac.com
Incremental growth in fibre textile mill consumption and population

Wool
Cotton
MMF
Population (RHS)

Million tonnes

1985-2000
2000-2015
2015-2030

0
5
10
15
20
25
30
35
40

-5
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

Billion people

www.woodmac.com
Final demand for MMF now exceeds that for cotton in all regions

Final Demand by Region, Total Volumes - 2015

- Million Tonnes

- Regions: N America, L America, W Europe, E Europe, Turkey, AME, Australasia, South Asia, India, China/HK, South Korea, Taiwan, Japan

- Colours: Wool (light blue), Cotton (green), MMF (dark blue)
Is there potential for higher cotton demand in China?

Final Demand by Region, kg per Capita - 2015

The diagram shows the final demand by region in kg per capita for 2015. The regions include N America, L America, W Europe, E Europe, Turkey, AME, Australasia, South Asia, India, China/HK, South Korea, Taiwan, Japan, and World. The bars represent the demand for Wool, Cotton, and MMF. The data is sourced from trusted commercial intelligence by Wood Mackenzie.
End-use mix - % share global all-fibres demand 1990-2025

Global all-fibres demand by end-use share (%)

<table>
<thead>
<tr>
<th>% share</th>
<th>1990</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparel</td>
<td>69.4%</td>
<td>53.4%</td>
</tr>
<tr>
<td>Industrial</td>
<td>14.9%</td>
<td>26.1%</td>
</tr>
<tr>
<td>Household</td>
<td>15.7%</td>
<td>20.5%</td>
</tr>
</tbody>
</table>
MMF filament growing faster than staple fibres

World – Fibre Mill Consumption

Million tonnes


Cotton
Polyester S
Cellulosic S
Acrylic S
Nylon S
MMF filament

Trusted commercial intelligence
www.woodmac.com
Polyester staple fibre – macro end-use applications

Global PSF macro end-use shares

- Spinning
- Nonwovens
- Filling

% spinning share (RHS)

Million mt


% spinning share

0 10 20 30 40 50 60 70 80 90
<table>
<thead>
<tr>
<th>Market segment</th>
<th>% share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hygiene / wipes</td>
<td>15%</td>
</tr>
<tr>
<td>Fillings / waddings</td>
<td>27%</td>
</tr>
<tr>
<td>Technical</td>
<td>2%</td>
</tr>
<tr>
<td>Carpets</td>
<td>4%</td>
</tr>
<tr>
<td>Home furnishings</td>
<td>16%</td>
</tr>
<tr>
<td>Auto</td>
<td>2%</td>
</tr>
<tr>
<td>Activewear</td>
<td>3%</td>
</tr>
<tr>
<td>Apparel</td>
<td>33%</td>
</tr>
</tbody>
</table>

**Volume total ktes** 15868
## End-use definitions – Apparel Textile Product Format

<table>
<thead>
<tr>
<th></th>
<th>Knitting</th>
<th>Weaving</th>
<th>Nonwovens</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intimate apparel</strong></td>
<td>Textile filament PE, PA, viscose, cotton, wool</td>
<td>Textile filament Spun yarns (minority) PE, PA, viscose, cotton</td>
<td>Staple nonwovens PE, viscose, minor PP</td>
<td>Textile filament Spun yarns (minority) PE, PA, viscose</td>
</tr>
<tr>
<td><strong>Swimwear</strong></td>
<td>Textile filament PE, PA, cotton</td>
<td>Textile filament Spun yarns (minority) PE, PA, cotton</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sportswear</strong></td>
<td>Textile filament Spun yarns PE, PA, cotton, wool, viscose, ACR</td>
<td>Textile filament Spun yarns PE, PA, viscose, cotton</td>
<td>Staple nonwovens Membranes PE / others</td>
<td>Textile filament Spun yarns (minority) PE, PA, viscose, cotton</td>
</tr>
<tr>
<td><strong>Hosiery</strong></td>
<td>Textile filament Spun yarns PA, PE, cotton, ACR, wool</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Outerwear</strong></td>
<td>Textile filament Spun yarns PE, PA, viscose, cotton, ACR</td>
<td>Textile filament Spun yarns Minor IF yarns PE, PA, viscose, cotton, ACR, wool</td>
<td>Staple nonwovens Spunbond nonwovens PA, PE</td>
<td>Textile filament Spun yarns PE, PA, viscose, cotton, ACR</td>
</tr>
<tr>
<td><strong>Career apparel / uniforms</strong></td>
<td>Textile filament Spun yarns PE, PA, viscose, cotton, ACR</td>
<td>Textile filament Spun yarns Minor IF yarns PE, PA, viscose, cotton, ACR, wool</td>
<td>Staple nonwovens Spunbond nonwovens PA, PE, PP, viscose</td>
<td>Textile filament Spun yarns PE, PA, viscose, cotton, ACR</td>
</tr>
<tr>
<td><strong>Ethnic costumes</strong></td>
<td>Textile filament Spun yarns PE, PA, cotton</td>
<td>Textile filament Spun yarns PE, PA, viscose, cotton</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Diapers and personal hygiene</strong></td>
<td>Textile filament Spun yarns PE, PA, cotton</td>
<td></td>
<td>Staple nonwovens Spunbonded nonwovens PE, PP, viscose</td>
<td></td>
</tr>
</tbody>
</table>

*PE=polyester, PA=polyamide, PP=polypropylene, ACR=acrylic. Viscose includes other cellulosic variants.*
### End-use definitions – Household Textile Product Format

<table>
<thead>
<tr>
<th></th>
<th>Knitting</th>
<th>Weaving</th>
<th>Nonwovens</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Curtains / upholstery</strong></td>
<td>Textile filament</td>
<td>Textile filament</td>
<td>Staple nonwovens</td>
<td>Textile filament</td>
</tr>
<tr>
<td></td>
<td>Spun yarns</td>
<td>Spun yarns</td>
<td>Spunbond nonwovens</td>
<td>Spun yarns</td>
</tr>
<tr>
<td></td>
<td>PE, PA, viscose, cotton, ACR</td>
<td>PE, PA, viscose, cotton, ACR</td>
<td>PE, PP, PA, viscose</td>
<td>PE, PA, viscose, cotton</td>
</tr>
<tr>
<td><strong>Carpets / floorcoverings</strong></td>
<td>Filament yarns</td>
<td>Staple nonwovens</td>
<td>BCF filament</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spun yarns</td>
<td>Spunbond nonwovens</td>
<td>Spun yarns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE, PP, cotton, ACR, wool</td>
<td>PE, PP, PA</td>
<td>PE, PP, wool</td>
<td></td>
</tr>
<tr>
<td><strong>Linen</strong></td>
<td>Textile filament</td>
<td>Textile filament</td>
<td>Staple nonwovens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spun yarns</td>
<td>Spun yarns</td>
<td>Spunbond nonwovens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE, viscose, cotton</td>
<td>PE, PA, viscose, cotton</td>
<td>PE, PP, viscose</td>
<td></td>
</tr>
<tr>
<td><strong>Towels</strong></td>
<td>Textile filament</td>
<td>Spun yarns</td>
<td>Staple nonwovens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spun yarns</td>
<td>PE, viscose, cotton</td>
<td>PE, PP, viscose</td>
<td></td>
</tr>
<tr>
<td><strong>Wipes/cleaning</strong></td>
<td></td>
<td></td>
<td>Staple nonwovens</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Spunbonded</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PE, PP, viscose</td>
<td></td>
</tr>
<tr>
<td><strong>All other</strong></td>
<td>Textile filament</td>
<td>Textile filament</td>
<td>Staple nonwovens</td>
<td>Textile filament</td>
</tr>
<tr>
<td></td>
<td>Spun yarns</td>
<td>Spun yarns</td>
<td>Spunbond nonwovens</td>
<td>Spun yarns</td>
</tr>
<tr>
<td></td>
<td>PE, PP, cotton, ACR</td>
<td>PE, PP, cotton, ACR</td>
<td>PE, PP, viscose</td>
<td>PE, PA, viscose, cotton</td>
</tr>
</tbody>
</table>

*PE=polyester, PA=polyamide, PP=polypropylene, ACR=acrylic. Viscose includes other cellulosic variants*
## End-use definitions – Industrial Textile Product Format

<table>
<thead>
<tr>
<th>End-use</th>
<th>Knitting</th>
<th>Weaving</th>
<th>Nonwovens</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive textiles</td>
<td>Textile filament&lt;br&gt;Spun yarns (minor) PE, PA</td>
<td>Textile filament&lt;br&gt;Spun yarns (minor) PE, PA</td>
<td>Staple nonwovens&lt;br&gt;PE, PA, PP</td>
<td>Industrial filament&lt;br&gt;PE, PA</td>
</tr>
<tr>
<td>Light denier industrial</td>
<td></td>
<td>Industrial filament&lt;br&gt;PE, PA</td>
<td></td>
<td>Industrial filament&lt;br&gt;PE, PA</td>
</tr>
<tr>
<td>Heavy denier industrial</td>
<td>Weft insertion / warp knit&lt;br&gt;PE</td>
<td>Industrial filament&lt;br&gt;PE, PA, rayon</td>
<td></td>
<td>Industrial filament&lt;br&gt;PE, PA, rayon</td>
</tr>
<tr>
<td>Airbags</td>
<td></td>
<td>Industrial filament&lt;br&gt;PE, PA</td>
<td>Staple nonwovens&lt;br&gt;Spunbond nonwovens&lt;br&gt;PE, PP</td>
<td></td>
</tr>
<tr>
<td>Geotextiles</td>
<td></td>
<td>Industrial filament&lt;br&gt;PE, PP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filtration</td>
<td>Textile filament&lt;br&gt;Industiral filament&lt;br&gt;PE, PA, high performance yarns</td>
<td></td>
<td>Staple nonwovens&lt;br&gt;Spunbond nonwovens&lt;br&gt;PE, PA, PP, high performance</td>
<td></td>
</tr>
<tr>
<td>Composites / Concrete / Reinforcement</td>
<td></td>
<td></td>
<td></td>
<td>Staple, filament&lt;br&gt;PP, glass fibre, steel etc.</td>
</tr>
<tr>
<td>Paper reinforcement</td>
<td></td>
<td></td>
<td></td>
<td>Staple&lt;br&gt;PP</td>
</tr>
<tr>
<td>All other</td>
<td>Textile filament&lt;br&gt;Industrial filament&lt;br&gt;Spun yarns (minor) PE, PP, cotton, ACR</td>
<td>Textile filament&lt;br&gt;Industrial filament&lt;br&gt;Spun yarns (minor) PE, PP, cotton, ACR</td>
<td>Staple nonwovens&lt;br&gt;Spunbond nonwovens&lt;br&gt;PE, PP, PA, rayon</td>
<td>Textile filament&lt;br&gt;Industrial filament&lt;br&gt;Spun yarns (minor) PE, PP, rayon, ACR</td>
</tr>
</tbody>
</table>

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Polyester filament functionalities

Yarn functionality can be modified by various methods:

- filament/fibre thickness
- bright/dullness level
- filament/fibre cross section shape
- dye-uptake levels
- shrinkage
- stretch/recovery
- strength/tenacity
- bulk

- touch/softness, brushability, drape
- appearance (lustre, shine, matt)
- appearance & functionality
- standard dye, deep dye
Adjusting fibre cross-section is the first step to differentiated product

Very broadly speaking, cross sections are used as follows:

- Trilobal, octolobal, tape, diabolo (ie different solid shapes) alter the lustre (and to a lesser degree handle) of the fabric.

- A channelled surface (eg Coolmax, Gcool) is generally about moisture transportation, wicking, etc.

- Hollow cross sections are used to regulate thermal properties (often to store heat).

- Certain cross sections are used in bicomponent yarns to alter the differential shrinkage of the two polymer components and so achieve properties like stretch, different colour values, etc.
Challenge: marine litter. Plastic waste to the oceans, persistent macro particles as well as micro and nano particles.

Macro plastics in fishing nets with catch.

Source: ECOALF
One solution: recycling

Bale of PET bottles ready for recycling

Source: ECOALF
Polyester filament / staple in rPET

Share of polyester variants in rPET

- Total PET: 85.6% Virgin, 14.4% rPET
- PTF: 95.8% Virgin, 4.2% rPET
- PSF: 63.1% Virgin, 36.9% rPET

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Polyester in apparel - rPET

20 denier recycled polyester
Source: http://www.eddiebauer.com/

Source: http://www.nike.com/
MMF end-product examples addressing product innovation and sustainability

- Bio-raw materials for MMF.
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