Future Woolscapes - Competitor Trends

in

2029

Prepared for

Land & Water Australia

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Prepared by: PCI Fibres
Worth Corner
Turners Hill Road
Crawley
West Sussex
RH10 7SL

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1. INTRODUCTION

This briefing provides a glimpse into the evolution of fibre dynamics and volumetrics over the next two and a half decades. The perspective is that of PCI Fibres (PCI - Petrochemical Consultants International). While the focus of PCI Fibres' activities is the man-made fibre world, the interplay between man-made and natural fibres is key to the analysis of textile activity. Relative fibre prices, regional fibre availability, economic development and industrial and trade policies, lifestyles, consumer / cultural fibre preferences, fibre performance, fibre and textile engineering, environmental constraints and fibre / brand marketing; these are just some of the factors that shape supply and demand for all fibres and influence choice between fibres from the textile processor to the end-consumer.

The motivation for the briefing is to understand the impact that foreseeable developments in man-made fibres and cotton will have on wool and its role in the textile market.

Section 2 sets out the quantitative framework: production and consumption forecasts by fibre and by region. This section also provides a view of polyester fibre prices out to 2029.

Section 3 sets out the factors that have been key to the increasing dominance of polyester (staple and filament) in textile fibre markets and discusses the likelihood of even greater share gains.

Section 4 analysis recent fibre developments in synthetic fibres and asks whether any of these is a potential competitor to polyester and wool.

Section 5 looks at recent developments in textile machinery and at the role of genetically modified organisms in the supply of natural and man-made fibres.

Section 6 reviews trends in textile product re-cycling.

Section 7 addresses consumer trends in both the developed and developing world and discusses how they will shape demand for specific fibres, particularly wool.

Section 8 concludes the briefing with a discussion of the future for wool in the textile market over the next two and a half decades given the challenges identified in the previous sections.

2. TEXTILE FIBRE VOLUMETRICS AND PRICES

In the 1700s wool and linen dominated textile fibre use with over 90% of the market. Other vegetable fibres, silk and a small volume of animal hair made up the remainder of the market. Silk was the only filament fibre amongst a whole range of staple fibres. Fibre characteristics were set and specific to a particular fibre type. Any changes to a desired end-product could only be developed from fabric stage onwards resulting in a very slow and limited evolution of the textile market.

By the 1800s wool and linen's dominance was being eroded by cotton which had achieved a 30% share of the global textile market compared with around 60% for wool and linen. Silk remained the only filament fibre. Cotton's gain in market share was due to its versatility in use and processing, ease of processing and relatively low fibre production and processing costs. As important was the relatively high speed with which production could respond to changes in demand – one growing season. This is in contrast with delays of two years or more for other fibres, with silk in some cases taking up to ten years before new production became fully established. Still, there was little opportunity for fibre development and textile market evolution remained slow and to all intents and purposes limited to changes in fashion.

In the early 1900s wool and linen's share of the market had declined to around 30%, cotton's had increased to nearly 60% and the development of man-made fibres into a commercial activity had just started. Even at this stage, silk remained the 'only' commercial filament fibre although man-made fibres are originally extruded as filament and then chopped into staple. The lack of a textile filament culture in much of the Western World was to shape the original development path of man-made fibres through the staple route.

It would also take some time before man-made fibres became viable commercially. For an industry used to handling relatively stable 'fibres' as the raw material, handling a light and heat sensitive molten polymer posed significant difficulties. In addition, many of the initial man-made fibre discoveries and developments occurred in the petrochemical, not textile, industry. The different cultures in these two industries and the lack of a shared middle ground delayed their introduction of man-made fibres, particularly synthetics, into the mainstream textile market.

Despite the initial drawbacks and high fibre costs, the intrinsic versatility of man-made fibres, at both polymer and fibre level, and high processing speeds achievable, enabled them to gain around 25% of the textile market by the 1950s, a higher share than wool and linen combined. Cotton however dominated the market at this time with a share of over 60%. Silk's share and the share of other fibres of vegetable and animal origin had declined considerably. There were two key issues at this juncture:

- The realisation that man-made fibres, especially synthetics, were highly amenable to fibre development activities that resulted in changes to certain fibre characteristics. This led to greater access to traditional textile markets and attempts to enter and/or develop new markets.

- The emergence of man-made filament in textile markets. This was not just a cost cutting option. It afforded greater access to silk-like aesthetics in traditional textile markets and opened the door to increasing developments at both polymer and fibre level. The latter again creating opportunities in non-traditional textile markets.

Even though man-made fibres (polyester in this case) remained more expensive than cotton through to the late 1960s volumes of both man-made staple and filament increased rapidly (again polyester). Rapidly rising populations and incomes drove a large part of the volume increases in all fibres. For man-made fibres it was their ability to penetrate all sectors of traditional textile markets and their entry into new industrial uses that drove growth over and above that of the natural fibres. In traditional markets, filament yarn and filament fabrics turned exclusive, luxury and unique performance textiles into affordable, fashionable commodities: linings, stockings, sports gear (e.g. parachute fabric, waterproof outerwear and fibrefill) and home textiles (carpets and rugs, curtains, net curtains, blankets and fibrefill for mattresses and duvets, sheeting and upholstery) and in their substitution for leather articles in apparel, footwear and suitcases/bags. Still within the textile market, but in less traditional areas, man-made fibres started to displaced natural fibres and to increase the total market size. This they did in ropes and nets, in filters and in the hygiene area. Fibre engineering and greater product performance, particularly durability, were key factors in these gains..

Economies of scale in polyester fibre production, abundant man-made fibre raw materials, the shift in production to Asia and surplus capacity all combined in the latter half of the 20th century, bringing about a sharp drop in man-made fibre prices, particularly for commodity type polyester (both the staple for the cotton spinning system and filament).

Improvements in fibre and end-product performance (in terms of comfort and fashion), competitive pricing, widespread availability, stable supply, large product range and ease of fibre and textile processing led to the rapid adoption of man-made fibres in this period, particularly in the fast developing Asian countries.

By 2000 the global fibre market reached nearly 53 million tons:

- Cotton’s share was down to around 37%, wool’s share was under 3% and man-made fibres had a 61% share. In fact, polyester fibre production (filament and staple) was equal to cotton production in 2000.

- Man-made filament production had a 28% share of the global fibre market.

- Between 20% and 25% of total fibre production in 2000 was for industrial applications. However only 5% was exclusively industrial fibre meeting strict performance standards – such as nylon or polyester tyre cord yarn and yaarn for architectural applications such as extensive fabric roofing. The remainder was fibre whose use could have been directed at either textile or industrial applications. In some cases, defining an application as textile or industrial is difficult. An example is fibre used in automotive applications. Nylon, rayon or polyester used for tyre cord and polyester or wool used in specific filters is clearly industrial. However, fibre used in upholstery, carpeting, soundproofing, lining and fibrefill may be described as either industrial or textile. For the purpose of this analysis, these fibres are described as textile.

- Filament spun-bonded fabrics are also included in the 5% industrial fibres. These are a class of textiles that to all intents and purposes bypass the ‘fibre’ stage; instead the polymer is extruded directly onto webbing forming a fabric on cooling. Fabric performance is dependent on polymer characteristics, spinneret cross-section and fabric finishing. Originally almost exclusively for industrial applications such as geotextiles and linings, improvements in performance have seen filament spun-bonded enter the textile market, competing at this stage with (staple) nonwoven fabrics. Spun-bonded fabrics have a speed and processing cost advantage over (staple) nonwoven fabrics in that the former is produced directly from polymer while the latter undergoes several processing stages between polymer and fabric: filament extrusion, cut into staple, non-woven fabric formation.

Moving foreword to 2029 man-made fibres should continue to gain share of the global fibre market, reaching 74% while cotton's share drops to 24%. These gains are driven almost exclusively by gains in polyester (staple and filament). Polyester's share of the global fibre market reaches 57% in 2029. A conservative estimate of man-made fibre filament's share in 2029 is 42%. Wool's share of the global fibre market drops to 1%.

Section 3 discusses in detail the factors behind polyester's continuing dominance of the fibre market.

Below is a brief review of production, mill and final consumption by fibre and region to 2029. Detailed tables are shown in the appendix.

2.1 Fibre Production

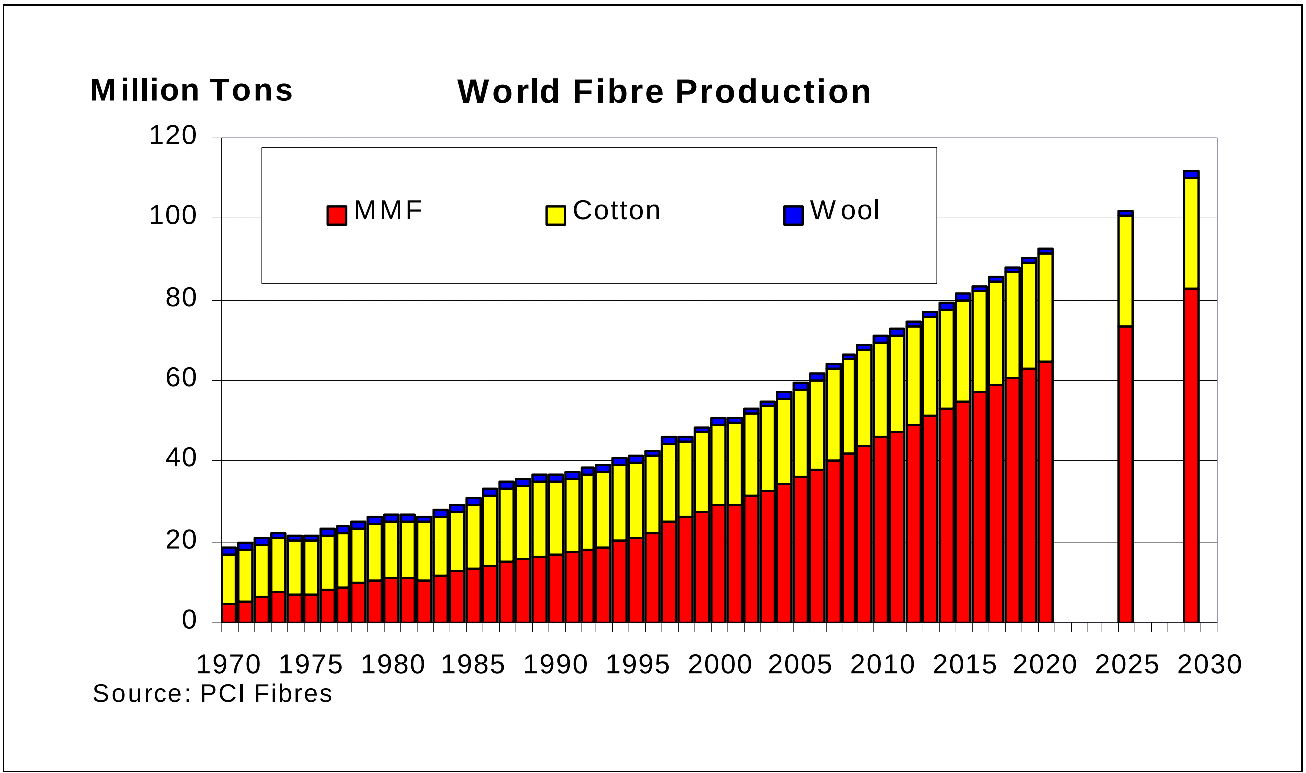
The charts opposite illustrate PCI Fibre's production forecasts to 2029 by major fibre group and by individual fibre. Total fibre production almost doubles between 2003 and 2029, rising from 57 million tons to 107 million tons.

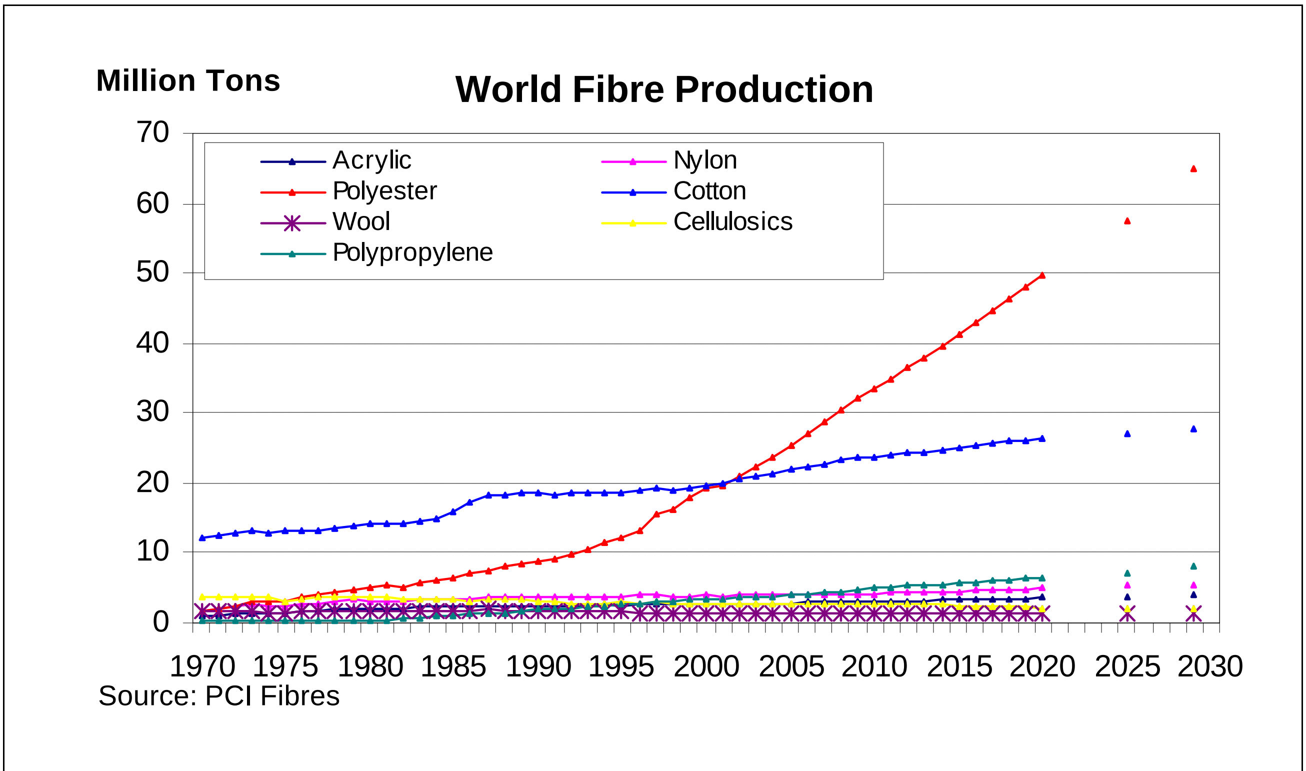
Growth is driven by man-made fibres, particularly **polyester,** which increases by 193% in this period with polyester staple up 144% and polyester filament up 229%.

Polypropylene also increases rapidly, 116%, but from a much smaller volume base than polyester. The attraction of polypropylene is its low cost (lower even than polyester) but to date it has major drawbacks as a textile fibre in particular low heat resistance and very low performance attributes in terms of comfort and abrasion resistance. There is substantial development activity taking place in polypropylene and the outlook is positive for this market in a small number of textile end-uses and mainly at the bottom end of the market. Its low cost initially suggests far larger volumes could be achievable given that population growth is highest in low income countries, but it is unlikely that product development will overcome all the comfort related drawbacks by 2029. Tighter flammability standards in the developed world as we move foreword will also limit its use in the home textile sector.

Acrylic also shows growth, of 46%, again from much smaller volumes than polyester. The high cost of acrylic relative to polyester is one limiting factor. A second limiting factor is that fibre development is taking place much more rapidly in polyester than in acrylic and some of this fibre development is aimed at allowing polyester to mimic both the aesthetics and performance characteristics of other fibres. The net result is that polyester will continue to encroach into acrylic's markets particularly at the volume end of the market. However, growth for acrylic will come from the expanding middle classes in developing countries who will be willing to pay the premium for that little extra performance that acrylic can provide over polyester.

In **Nylon** it is a similar story although perhaps the nylon numbers are a little optimistic on the textile side now that KoSa has taken over Invista. Nylon is an expensive fibre to produce. Raw materials are not abundant and there is strong competition from the plastics industry for these raw materials. Processing and handling the polymer is expensive. Where polyester can mimic nylon's aesthetic and performance characteristics, polyester will always win. In addition, nylon is losing a major market – the hosiery market, which appears to be in terminal decline. Part of nylon's presence in the textile market to date has been the result of large and successful development and marketing efforts by Invista (formerly DuPont). Invista has now been taken over by KoSa. Kosa does not have a strong record in terms of innovation and marketing and is already cutting back on Invista's development activities.


Million Tons
World Fibre Production
120
100
80
60
40
20
0
MMF
Cotton
Wool
1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030
Source: PCI Fibres


Million Tons
World Fibre Production
70
60
50
40
30
20
10
0
Acrylic
Nylon
Polyester
Cotton
Wool
Cellulosics
Polypropylene
1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030
Source: PCI Fibres

Nylon's major growth area is the industrial area, where performance is key to meeting set industry standards. In carpets nylon's growth is limited in developed countries mainly by slow population growth, environmental issues and an ongoing trend to hard flooring. Growth is more likely in developing countries although almost exclusively in the contract and hospitality businesses. These are not small numbers … the development of office space and middle to upper market tourism in China and India will demand a substantial volume of floor covering.

Cellulosic volumes continue on a downward trend. There are two distinct markets for cellulosics. In textiles cellulosics have the advantage of moisture absorption over polyester and until recently, of having more of a natural fibre aesthetic. However, cellulosics are expensive to produce, particularly where environmentally friendly processes are used (and these will be increasingly required). Where polyester can mimic cellulosics, these will find themselves relegated to increasingly niche, upper middle and upper markets. Textured polyester filament and polyester microfibre are challenging cellulosics in almost all their textile end-uses both through fibre and fabric innovation. Cellulosics are also unlikely to hold on to volumes in the hygiene business. Although polyester does not have moisture absorbing properties, microfibre fabric technology to trap moisture is already in use and will soon be available in the mass market in both developed and developing countries.

Cotton is projected to rise by 37% to 27.6 million tons, up 7.5 million tons compared with production in 2003. These numbers may appear optimistic given land use constraints, not least the issue of water availability and food vs. fibre choice in China and India, currently the largest and 3rd largest cotton producing countries. The only scenario where these cotton volumes are achievable is one where GM (genetically modified) cotton remains a viable agricultural proposition. This however is not guaranteed and any restrictions to the use and development of new GM cotton varieties will see projected cotton volumes come down substantially to the benefit of polyester.

There are strong cultural and comfort grounds for projecting these increases in cotton volumes. A large proportion of polyester staple is still blended with cotton, for price, aesthetic and comfort reasons and this is still likely to be the case in 2029 even with ongoing developments in polyester to improve comfort and mimic natural fibre aesthetics. In many regions, particularly Africa, India and South America cotton is widely available but man-made fibres are less so. This is changing slowly but again, it is unlikely that man-made fibre will be as widely available as cotton even in 2029. This view is subject to some debate however particularly in India where investment in man-made fibre is taking off. In China for example, where textile consumption was almost exclusively cotton based as recently as 20 years, textile consumption is now more than 50% man-made fibre based.

US apparel is highly cotton based, and while this influence is particularly strong in Latin America it has a global reach. This influence is in large part key to sustaining global cotton volumes.

Wool volumes show some growth (22%) from the very low level reached in 2003 (1.2 million tons). This rather conservative projection is based not only on the relatively high price of wool but also on polyester's gains in wool's traditional markets.

From a **regional** perspective, the migration of man-made fibre production from Western and Eastern Europe, Japan, South Korea, Taiwan and the USA to China and India in particular continues at an accelerating rate. By 2029, China's share of acrylic production is projected at 42%, for polyester this share is projected at 57% and for nylon, 30%. China and India are projected to increase their hold on world textile and apparel production. Having fibre close to hand reduces transport costs. The economies of scale at fibre production that can be reached when the textile pipeline is vertically integrated reduce costs even further.

For example, in China a polyester company, Sanfangxiang, placed an order for one polyester staple plant producing 0.6 million tons per year by end 2005 while in India, Reliance will be producing 1.5 million tons of polyester staple and filament. Companies like Reliance and Shanghai Petrochemical of China are integrated from oil refineries to making up, wholesaling and retailing.

China slowly shifts from a large net importer of man-made fibre to a small net exporter.

2.2 Mill Consumption

Shifts in mill consumption of man-made fibres are not as extreme as those in production. This is because the USA, Western Europe, South Korea and Taiwan will retain textile activity where it relates to high value added, performance end-uses. This reduces the scope for sustaining mill consumption in the apparel sector except in areas where performance to technical standards and/or value adding is key. Examples include active wear for extreme conditions, flame retardant fabrics, fabrics for medical applications, automotive fabrics and those for use in other forms of transport. Rim countries with tariff preferences will sustain mill consumption for middle/upper market fashion apparel. China, South Asia, Pakistan and India show the largest gains in mill consumption, not only to meet demand from rising domestic incomes and population, but also for export. Projected increases in transport cost show up in lower than anticipated export growth.

There are also projections of large increases in mill consumption of man-made fibre in the Middle East (Iran, Iraq, Syria, Egypt in particular and to some extent Saudi Arabia). These projections are based on current initiatives in these countries to expand textile production. While success has been patchy to date, significant new investment is being considered as part of a larger job creation strategy.

In this analysis we project changes in China's share of mill consumption as follows:

Fibre	2003	2029
Wool	28%	41%
Cotton	28%	27%
Cellulosics	29%	31%
Polypropylene	20%	31%
Acrylic	39%	46%
Polyester	41%	53%
Nylon	17%	30%

2.3 Final Demand

In terms of final demand, total fibre consumption is projected to rise from 9 kg per capita in 2003 to 14 kg per capita in 2029. Over this period:

- Consumption of man-made fibre rises from 5.6 to 10.5 kg per capita.
- Cotton consumption barely increases, from 3.3 to 3.4 kg per capita.
- Per capita wool consumption declines from 0.21 to 0.18 kg per capita.

All regions show increases in fibre consumption at end-product stage. At one extreme is North America, which is projected to consume 45 kg per capita in 2029 up from 36 kg per capita in 2003. At the other extreme is Africa/Middle East, where per capita consumption rises from 3.1 kg to 5.0 kg.

Per capita fibre consumption is projected to increase very rapidly in China, driven by income growth and the government's policy to accelerate the shift from rural to urban population. Per capita wool consumption is projected to remain at around 0.3 kg with wool in menswear particularly strong – the result of increasing affluence and Western style office jobs.

Elsewhere per capita wool consumption tends to decline with man-made fibre, especially products from polyester microfibre taking a higher share of wool's traditional markets.

2.4 Fibre Prices

Cotton and acrylic prices have exceeded polyester staple prices by between 20% and 30% (with some exceptions) in the past twenty years (see appendix). Moving forward cotton prices are projected to increase to around 50% to 75% higher than polyester prices.

The appendix also provides projections to 2029 for commodity type polyester staple and filament. The outlook is for increases over the near term and then prices falling off to below current levels. While oil prices do play a role in polyester fibre prices, other factors, such as capacity at intermediates (PTA and MEG) and excess fibre production capacity are also key drivers price.

Sometimes oil prices are given too great a weight in the analysis of fibre prices. Fibre production is a marginal activity in terms of oil, and could even be described as derived from by-products of the oil and gas industry. Fibre prices are affected both directly by oil and gas prices and indirectly by competition between the many products derived from this industry. To illustrate this, take a barrel of US oil. This splits into different industries as follows:

Gasoline	19.4%
Fuel oil	9.7%
Jet fuel	4.3%
Coke	2.0%
Heavy oils	1.9%
Liquid gas	1.9%
Still gas	1.8%
Asphalt	1.4%
Petrochemicals	**1.1%** (of which fibres are a small part)
Lubricants	0.5%
Kerosene	0.2%
Other	0.4%

Within the man-made fibres, the price hierarchy is as follows:

Lowest Cost:	Polypropylene
	Polyester
	Acrylic
Highest Cost:	Nylon, cellulosics

Fine denier is more costly than heavy denier.
Microdenier is more costly than regular deniers.
Specialities demand a premium – high tenacity, sewing thread, flame retardant, bright, black, etc.

In summary, the cost advantages that man-made fibres, particularly polyester, have had over natural fibres in the last 30 years are expected to continue and even increase. In polyester, economies of scale, continuous polymerisation processes (where the polymer is fed straight through to the spinnerets) and increasing processing efficiency lead to lower processing costs. Advances such as filament spun-bonded fabrics also bring down the price of man-made fibre products. Ever higher speeds and automation at spinning and weaving also reduce costs. In contrast, cotton and wool fibre prices are projected to increase slowly with competition for land-use a key factor. In cotton, reduction or elimination of production subsidies and more realistic water prices (for irrigated cotton) will also lead to price increases. In addition, processing costs are unlikely to decline as rapidly as those for man-made fibres:

- It is difficult to foresee the elimination of the many steps between raw fibre (on the plant or animal) and spinning and weaving.
- A higher share of cotton and wool is traded as raw material compared with man-made fibre.
- While processing speeds are likely to rise as fibre quality in cotton and wool improves, the inherent biological and environmental variability of the fibre is a constraint.

3. POLYESTER'S DOMINANCE

Polyester is the dominant mainstream fibre and its dominance is projected to increase by 2029. Its share of global fibre production was 39% in 2003 and is projected at 57% in 2029. In 2003 filament's share of the polyester market was 58% and staple was 42%. In 2029 filament's share of the polyester market is projected at 65% and staple's at 35%.

Polyester holds around 73% of the global filament market, about 25% of the spun market and 33% of the nonwoven market.

Factors behind this dominance centre around three factors:

Price point: There is little or no price point competition from other fibres. It has a competitive raw material, has the most competitive conversion to polymer and yarn and is the most competitive in its end-use economics.

Versatility: Is undergoing continuous polymer, fibre and end-use development, has the highest variety of fibre products, technology is constantly developing. The enormous size of the polyester market ensures that the economies of scale for R&D in process, product and machinery technology are present. Recent product offers by Nan Ya of Taiwan include:

- Self-extension filament yarn with a dry feel, bulky, soft hand with a touch similar to wool for suits, trousers and dresses.
- Differential cross-section textured yarn with a dry touch, good drape, and a light, cotton feel for knitting and weaving, sportswear and casualwear.

Critical Mass of Production: Has the largest equipment population, raw material is available at market driven prices, there are few entry/exit barriers, has large scale efficiencies, production technology is standard or equivalent between players.

Expanding on some of these points:

- An inexpensive fibre –
    - Widely available and inexpensive raw materials.
    - Widely available polymer and spinning technology.
    - 'Easy' chemistry.
    - 'Easy' fibre and textile processing.

- Versatility – Highly adaptable textile properties (either changing the polymer or the fibre cross section or in texturing the filament) that make this the best fit fibre for most applications. New technologies that enable polymer blending provide even greater versatility.

- Polyester provides almost unlimited denier per filament versatility. From 1.8 micron (0.05 denier per filament) conjugate bicomponent fibre right through to 64 micron (40 denier) monofilament and larger.

- Polyester also provides a wide range of filament shape and combination filament shapes within a yarn to provide desired characteristics – modified cross section yarns, differentially shrinkable combined yarns, thick/thin yarns, multi-layered composite yarns. This enables polyester to adapt quickly and inexpensively to changes in the market.

- Equipment flexibility means capacity installed in a particular denier is no longer an important issue.

- Cationic dyeable, high pressure dyeing and the development of 'micro' dyeing and finishing.

- At consumer level - good wash, wear and durability.

- Ease of recycling – both of process waste and of PET bottles.

- Easily blended with other fibres – some examples:
    - Polyester/rayon: hygroscopic with strength, crease resistance, cool, natural appearance.
    - Polyester/wool: cost reduction, less dry cleaning shrinkage, sheds wrinkles.
    - Polyester/cotton, cationic polyester wool: combination colour effects.
    - Microfilament polyester/cotton: increase uniformity.
    - High wicking Polyester/cotton: increase product functionality.

- The development of microfibre has enabled the polyester industry to responded rapidly to changes in consumer demand: from fashion to function within an all-embracing drive for cost efficiency.

Given that polyester is the most economic chain to a textile yarn / fabric and that it can switch easily from basic to fashion to function there is no other mainstream fibre in the horizon at present that can compete with it. Of the recent fibre developments, none as yet has shown a combination of properties that improves on polyester and so far none look like achieving the critical size necessary to obtain polyester's economies of scale in processing, technology and fibre and product development (see section 4).

What would be required of a fibre to rival polyester? A truly breathable synthetic that is as cheap as polyester.

- At least as hygroscopic as cotton.
- The strength, resilience, durability and dyeability of polyester.
- Continuous polimerization like polyester.
- Raw material chain economics like polyester.

3.1 Microfibre / Microdenier

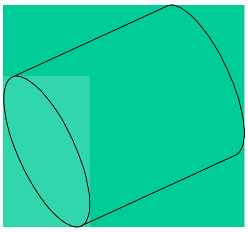
Generally polyester filaments (although also in polyester staple or nylon filament) that are 1 denier or less. The finer the filament the softer the fabric but also the more difficult the processing.

The development of microfibre opened a whole new market for polyester, enabling it to enter niches such as upholstery, leather substitutes, upper market fashion, performance sportswear, and most important of all, achieve comfort through moisture management. The latter opened up the performance activewear market.

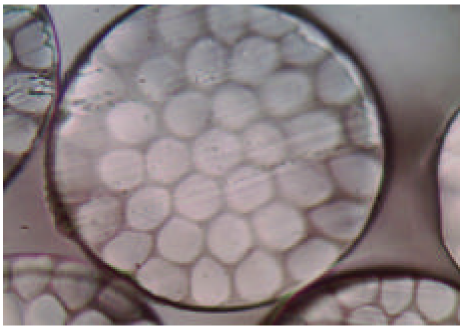
Microfibre has added a whole range of aesthetics and touch to polyester. Texturing of the filament and/or fabric finish imparts a rayon, cotton, wool, leather, and peachskin touch.

Technology developments and commercialisation began in Japan, migrated to South Korea and Taiwan and have now reached China. In China technology has caught up with much of that in South Korea and Taiwan and 'islands in the sea' filament yarn is now being produced.

Islands in the Sea Filament Yarn

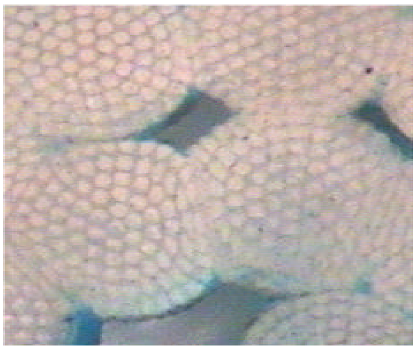


As Spun in Extrusion Process



Islands in the Sea Filament Yarn

Super-fine fibers - “islands-in-the-sea” to produce artificial leather

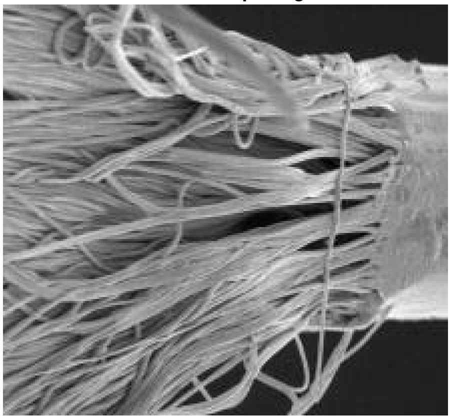


37 - 91 “islands” of 0.6 denier per filament

Creates a leather-like feeling

Used in POÄNG, TYLÖSAND etc

After treatment to split filaments, each filament typically splits to 37 individual filaments. This view is splitting into 600.



Yarn is processed prior to splitting which is done chemically in fabric form.

Islands in the Sea' microfilament yarn is technology used for the finest microfibre that would be difficult to weave in microfilament form. The filaments, as small as 0.05 denier per filament are extruded in bundles held within a (different) polymer matrix that will dissolve at fabric finishing stage. This is the 'next' stage in polyester fibre development and is still at an early stage in terms of product development, marketing and price.

Examples of microfibre yarns from Nan Ya (Taiwan) include:

- Mechanical Split Microfibre Textured Yarn, 0.2 denier per filament, providing a combination of nylon and polyester microfilaments. For casual wear, raincoats, suits.
- Sea Island Microfibre – Differential Shrinkage Textured Yarn, 0.06 denier per filament, a modified PET matrix, for casual wear, raincoats, skirts and suits.

Where to next? Already has already been some success with nanotechnology, where each filament consists of 57 layers of nylon and polyester. This opens the door to relatively inexpensive microencapsulation processes. The technology is polyester technology from Japan. Again, we see polyester taking the lead in a brand new if somewhat tangential fibre area.

4. New Fibre Developments – Synthetics

The textile market is a crowded place for fibres, both mainstream and specialist. With developments in polyester filling almost any niche that opens up, the market is even more crowded. An example is spandex – this has its own niche but is now under attack from mainstream fibres (particularly polyester) with built in stretch.

Almost on a daily basis the textile trade press carries stories of new fibre developments. The stories change over time to reflect changes in consumer preferences and government policies. In the last few years the stories have had a strong environmental theme – spider silk, fibre from soybean, fibre from corn, etc. In the vast majority of cases these stories are at a very early stage of development, possibly still at laboratory stage. Very few have advanced to commercial stage.

Of key importance is that some of the more developed 'new' fibres are a variant of polyester - in their favour is that they can be processed with existing polyester technology.

Over the near to medium term future – say 10 to 15 years, it is difficult to see totally new fibre developments taking place, as compared with developments at the margin of current mainstream fibres. The vast majority of fibre developments in the last 50 years took place in large Western or Japanese textile or petrochemical companies. Turing this time, margins for fibre producers were high enough to sustain considerable research and development activities, pilot plants, marketing and years of losses in order to establish a market.

Capacity expansions in Asia since the early 1990s and the recent migration of Western and Japanese fibre producers mainly to China have led to a sharp reduction in margins and a whole new dynamic in the fibre industry. To date, large Chinese and Indian man-made fibre companies have been more interested in achieving high volumes and reducing costs than in blue sky research and development. In addition, the large fibre producers in these two countries are usually subsidiaries of larger companies that operate in such diverse sectors of the economy as petrochemicals, electronics, transport, real estate, etc.

An example is Reliance of India, one of the largest polyester producers in the world. The Reliance group is a businesses encompassing petroleum through to textiles. Until recently Reliance's polyester offer was very much in commodity products. In order to upgrade its offer, Reliance chose to purchase Trevira, a German polyester company with a focus on specialities and with its own state of the art research and development facility.

Those companies left in Western Europe and Japan are also looking to reduce costs and are scaling down research and development and marketing activities, concentrating on innovation at the margin of proven products. Existing fibre companies in these two regions are not necessarily flush with resources and would find it difficult to justify the large investment required to establish a new fibre.

It remains to be seen whether the relatively new textile industry in China, India and South Asia is prepared to take up the lead in fibre innovation.

Below is a brief list of recent fibre developments that are near or at the commercial stage.

PLA -

Ingeo - the corn fibre from Cargill Dow's polylactic acid (PLA). Known since 1932 but only recently recognised by the US Federal Trade Commission as a generic fibre. PLA is a synthetic fibre manufactured from polylactic acid or poly lactate derived from naturally occurring sugars, such as those in corn or sugar beet. The polymer is now beyond pilot plant stage and although the original goal was a 50/50 split between packaging films and textile fibre, problems with both the fibre and the fibre marketing have meant that packaging film has taken the lion share of polymer.

The original concept was based around environmental responsibility: a polymer based on fully renewable resources (corn starch) and end-products that are fully degradable. The processing technology is polyester's. The fibre is hypoallergenic and is marketed as such in fibrefill and home textiles. On the face of it a winning concept. However, on the fibre side progress has stalled. There are dyeability and low melt point problems (end-products melt with ironing) that need to be overcome for Ingeo to succeed in apparel and home textile markets. Establishing a textile chain that takes the product from fibre to consumer while maintaining the brand and concept identity remains difficult.

The polymer is derived from starch from GM corn. Not a well known or publicised fact that could derail marketing campaigns in Western Europe.

That PLA is manufactured from an agricultural crop rather than from agricultural waste makes this an expensive product (in fibre terms more expensive than nylon). With performance and aesthetic characteristics falling below those of competitors in similar price points (nylon, Tencel and Lyocell) its ability to challenge mainstream fibres is limited. At present only an estimated 5-10,000 tons of fibre was produced in 2003. Activity has been down scaled in 2004 until performance problems have been addressed and a new marketing and commercial strategy is put in place.

PTT

A type of polyester - 1.3 propandiol - used for both staple and filament. Examples include Shell's Corterra and DuPont's Sorona (a 'natural' polyester based on corn starch). Not new propositions but given a push recently by these two major petrochemical companies.

Neither is as yet aiming at polyester. They are currently priced at or above nylon although Shell claims that they can bring polymer prices below nylon's and cut capital investment compared to a cyclohexane based nylon plant. The problem for both Corterra and Sorona has been the handling of the polymer through the traditional textile pipeline and optimising textile processes to reduce costs. Understandably, many textile processors are loath to adjust machinery to process small volumes when it is already set up for optimal processing of large volumes of mainstream fibres.

Shell's Corterra claims to combine the best properties of nylon and polyester and is aiming at nylon's carpet market, with some success. Shell has introduced Corterra through very few partners and via a very targeted marketing program. Shell was set to open a 95,000 ton per year polymer plant in 2004s but whether it can fully utilize this capacity and expand the program to apparel textiles remains to be seen.

DuPont's Sorona is at an earlier stage of development offering sampling from a few (but well known) partners and is not yet fully commercial. However, some was originally branded as Lycra - one of Sorona's properties is a 15% stretch. Volumes are still very small with polymer only around 12,000 tons. Whether DuPont's branding and marketing muscle will be enough to push Sorona through the textile pipeline remains to be seen. By divesting its other fibre activities through Invista (which was recently purchased by KoSa), DuPont may well have lost key resources, contacts, and branding and marketing know how in the textile chain.

PBT

Another polyester using a DMT/Butaneidol mix. This has been available as filament for around 15 years and is currently branded as Nylstar's EliTe or Trevira's ESP. Has remained a minor player in the market due to yarn processing difficulties which require low speeds particularly for finer yarns. Other negatives include a harsh handle, a limited shelf life and stretch and recovery properties that deteriorate rapidly with constant use. However, it has carved a small niche for itself in European activewear and underwear since it is easy to dye at low temperatures, provides both bulk and stretch and is easier to process through the textile chain than elastomeric yarns.

This brief review of relatively recent fibre introductions that have made it to commercial stage suggests that there is no **breakthrough** as such since these fibres are polyesters and to some extent imitate nylon. Volumes remain small, smaller even than elastomeric yarns, which are themselves a niche. What emerges however, is that these new fibres rather than seeking to challenge polyester, will seek to challenge other traditional fibres in niche areas where premia are to be found: nylon and elastomerics in activewear and underwear and cellulosics and possibly wool in outerwear.

Polypropylene

Its low cost production and processing provides plenty of potential in any number of textile end-uses but until the problems of harsh touch, low melt-point and dyeability are addressed its applications in apparel and home textiles will remain limited. At present progress on these problems is slow.

Nylon

If low cost raw material could be sourced this would definitely compete with polyester in the vast majority of apparel and home textile end-uses: better performance, function, touch and moisture retention.

Lyocell

A relatively recent introduction to the cellulosics family, claiming a non-polluting process. Excellent fibre performance in both apparel and home textiles but at a price that is higher than nylon. Lyocell is rapidly replacing other cellulosics and some wool products in apparel and carving a niche for itself in upper middle and upper markets. However, the high price point and the lack of an exclusive or unique marketing story are likely to limit its growth.

In summary, there is no new fibre development that could rival polyester in the near to medium term. However, there are a number new fibres from the polyester family that could threaten higher priced fibres in specific apparel applications. In our view these fibres, should they be successfully marketed through the textile pipeline, would pose some threat to wool.

Of greater significance in our view is the threat to wool from polyester microfibre once prices start falling in Asia. Their chameleon like ability to take on almost any fibre characteristic enables them to compete in most apparel and home textile end-use, particularly in regions where there is little bias against synthetics.

5. IMPACT OF MACHINERY DEVELOPMENTS AND GM TECHNOLOGY ON FIBRE COMPETITIVENESS

Trends in Machinery Development

There are three major trends in textile machinery development (beyond polymerization and extrusion).

Greater processing speeds at spinning and weaving. In pure polyester staple for example, Murata Vortex Spinning can reach speeds of 400 metres / minute and 300 metres / minute for polyester rich cotton blends. This compares with ring spinning speeds of up to 25 metres per minute.

With spun yarn processing reaching these speeds and filament coming directly off the spinnerets, textile processors are calling for looms that produce an equivalent performance. Fibre performance is crucial to withstand the speed and abrasion of these operations.

This type of machinery enhances the competitiveness of man-made fibres, particularly polyester. In a sense this should not surprise. The dominance of polyester in the textile market would ensure that the majority of machinery development is focused on this fibre.

Greater flexibility. It is the versatility of polyester that has led this development. Despite the very large size of new polyester investment, demand is not for massive runs of one type of commodity fibre. The trend is therefore to enable both fibre manufacturers and textile processors to handle different deniers, tenacities, etc without extensive downtimes, waste or switching machinery. In so doing more products are processed as ‘commodities’ rather than expensive specialties.

Increasing automation in garment making. Less handling leads to lower waste, fewer seconds and a faster turnaround between design and finished product. Over time, particularly for basic commodity products, cost savings can add up significantly. There is increasing interest in this area as labour issues threaten to become another type of trade barrier. This type of automation is more likely to benefit man-made fibres that can withstand the heavy handling and are less hygroscopic, but of course much will depend on fabric construction and environmental controls.

All three current trends in machinery manufacture tend to enhance the competitiveness of man-made fibres, which have the strength to process at high speeds. Over time this has become a self-reinforcing loop. The larger the volume of polyester for example, the more likely machinery manufacturers are to devote research and development resources to this sector. This is unlikely to change over the next two and a half decades. If anything we are looking at increasing automation and direct processing from polymer to garment making up in one location, with efficiency and waste reduction gains at each step. Such processes may be ideal when one single plant is generating over half a million tons of fibre.

GM Technology

To date GM technology in fibres has been applied mainly to cotton. Current and projected cotton production volumes would not be possible without breakthroughs in pest resistance. Production costs are also lower through the reduction in herbicide and pesticide applications.

GM cotton is widespread. In China, the largest cotton producer, over 50% of cotton production is in pest resistant GM varieties. China has seen very rapid adoption of GM varieties, from none to the current share in just 6 years. In the USA, the second largest cotton producer, nearly 75% of production is in GM varieties - pest resistant varieties, herbicide resistant varieties and varieties that combine both genes. In India commercial GM cotton was introduced two years ago and is still in its infancy. A number of other countries either have commercial GM cotton programs or are at the testing stage and in other countries there is a full moratorium on GM crops. It should be noted however that given the benefits to growers, GM cotton is grown even in countries where it is banned.

The US and China have large research programs into GM cotton varieties. Drought and salt resistance is one of the key aims of the Chinese program although current reports suggest that this is still some 5-10 years off. In the US the focus is more on plant health and fibre quality. There are also programs addressing coloured varieties but to date these have been mainly normal breeding programs in order to command an 'organic' premium.

At present there appears to be no significant backlash in developed countries against GM cotton products and projected volumes are predicated on this situation continuing. GM is however a double edged sword. Should drought and salt resistant varieties reach commercial stage cotton production would rise significantly and costs and prices would drop. On the other hand, should consumers reject GM cotton it is very likely that volumes will fall back to 15 million tons or less over the next two and a half decades.

GM technology at or near commercial stage is not restricted to cotton. As discussed in section 4, new polyesters are based on starch from GM corn.

6. FIBRE AND TEXTILE RE-ENGINEERING AND RECYCLING

There are many potential drivers for textile and apparel recycling:

In theory, recycling of synthetics should be relatively easy entailing a melt back to polymer and some purification. However, while virgin fibre costs remain as low as they are today, pricing is unlikely to drive recycling of apparel and home textiles. This is particularly the case when the cost of recycling fibre, particularly for apparel and home textiles is so high. Of course there have been attempts at apparel and textile recycling, for example programs aimed at reducing landfill via carpet recycling. These programs have not had much success given the costs: of transport to recycling facility, of separating the various carpet components, of waste disposal of certain components and of recycling the fibre component into shoddy or polymer.

It is also questionable whether legislation will drive apparel and home textile recycling when less than 1% of oil is used in fibres and there are more significant contributors to landfill. There are also major issues in apparel and home textile recycling with reference to contamination. The textile industry in terms of new product is already among the highest producers of toxic waste and largest consumers of water. Why add to this problem with recycling?

There is of course some recycling in the polyester industry, but this is the recycling of PET bottles into fibre. PET bottles have legislated standards of purity so there are fewer issues with contamination than say with recycling apparel. Colour is also an issue in recycling but not in this case since the vast majority of PET bottles are transparent. Even so, the quality of fibre recycled from PET bottles is low and does not generally meet standards for spinning fibre. Most of this recycled fibre is used in fiberfill.

The textile industry is currently under scrutiny for the safety of the many additives and finishes used to enhance performance, function, aesthetics. This is the case for all fibres. It is highly unlikely that legislation would complicate the issue by adding recycling.

In our view apparel and home textile recycling back to fibre is unlikely to be a major issue in the next two and a half decades. Environmental concerns however will impose an increasingly heavy burden on the fibre and textile industry, not just in developed countries. Issues of importance include:

- Use and disposal of toxic materials including carcinogens, dyes and bleach.
- Reduction in water and power use.
- Minimizing packaging and increasing the use of reusable / recycled packaging.
- Engineering products such that consumers can use phosphate-free, biodegradable soaps and cleaning agents.

While these will apply to all fibres in our view compliance costs are likely to be higher for natural fibres, reducing their competitiveness compared with synthetics.

7. CONSUMER DEMAND TRENDS - THEIR INFLUENCE ON FIBRE PREFERENCES

'Lifestyle' is the buzzword generally used when discussing consumer demand trends. Of course changing lifestyles lead to changes in consumer demand and over the next two and a half decades affluent lifestyles are likely to demand ever increasing comfort and versatility from the textile industry.

Comfort from apparel takes on a key role when projections point to:

- An obesity epidemic not just in developed but also in developing countries.
- Aging populations.

Consumer choice here would focus on stretch, moisture management that is critical to maintaining skin health, and technical fabrics. Consumer demand however is for product, and at most for fabric, rather than for fibre. Therefore the challenge for fibre producer is to develop a textile pipeline that meets consumer requirements and where garment engineering is as important as fibre engineering. Man-made fibres would appear to have advantages in all these areas with the exception of moisture management. Even this, however can be addressed to a large extent with fabric and garment engineering..

Versatility in terms of both fashion and function. Increasingly image is seen as defining who a person is. That image can change rapidly. Fashion must therefore respond to these changes, offering individuality within the comfort of belonging to a group. Versatility is also required in terms of function since modern life entails and enables continuous changes in environment.

Again man-made fibres, particularly polyester, appear to have advantages over natural fibres. From polymer engineering to fibre diameter and cross section to high spinning and weaving speeds the polyester industry can produce fibres for almost any aesthetic, touch and function required at relatively little cost to processing efficiencies.

Over the next two and a half decades the majority of growth in affluent populations will occur in Asia. This is a key factor in understanding why polyester is increasingly dominant and fashionable. Asian populations do not have the fibre prejudices against synthetics that exist in Europe and North America. Therefore, the result of differential population and income growth is a shift from a cotton/wool/dull/staple fibre culture towards a filament/lustre/polyester culture. Asian consumer demand for clothing is likely to remain based on brands (versatility in terms of fashion and image), appearance and fit (importance of stretch and crease resistance) and comfort (hot climates take on an increasing importance).

Again, man-made fibres, especially polyester, would appear to have some advantages over natural fibres.

8. CONCLUSIONS: WOOL'S COMPETITIVENESS IN 2029

The purpose of this briefing is to set out PCI Fibres' view of the market for textile fibres over the next two and a half decades. Key points that emerge relative to wool are mainly threats to its competitiveness:

- From an increasingly versatile but low cost polyester fibre.
- From new fibres seeking a foothold in niche enduses at the upper end of the market.
- From trends in textile machinery that address the man-made fibre industry's requirements.
- From consumer trends that appear to require an integrated textile pipeline delivering choice, comfort and function.
- From shifts away from a consumer culture that favours natural fibres to one that is not prejudiced against man-made fibres.

In comparison with the past, wool is therefore facing increasing competition and a loss of competitiveness at least compared with polyester. Whether wool can defend some of its traditional markets and expand into new products and populations will depend very much on the wool industry delivering innovation rapidly through an integrated pipeline.

It will also require greater focus on achieving successful product innovation than in the past. With current small volumes the loss / closure of a few key processors at any point in the textile pipeline is likely to have a significant impact on the rest of the industry. This is in contrast with polyester where huge volumes and extensive product ranges allow more of a scatter gun approach to innovation. The failure of a few businesses is unlikely to compromise the industry as a whole.

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Worth Corner
Turners Hill Road
Crawley
West Sussex
RH10 7SL, England
Tel: +44 1293 884024
Fax: +44 1293 885177
E-mail: fibres@thepcigroup.com
Website: www.thepcigroup.com/fibres