Home Economics

Fashion and Textile Technology

Resource Management

[HIGHER]

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Sources of natural and man-made fibres

Elaboration

- Natural fibres:
  - Animal: wool, silk, hair
  - Plant: linen, cotton
- Regenerated fibres: viscose, acetate, triacetate, lyocell
- Synthetic fibres: polyamide/nylon, polyester, acrylic, elastane

Natural fibres – animal

Wool

Wool fibres come from the fleece of sheep.

All fibres are made up of a group of molecules called **polymers**. The polymer of a wool fibre is made up of protein and produces a short fibre known as a **staple fibre**.

There are two basic methods of processing wool into yarn:

- Worsted process
- Woollen process

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The process

	Fleece is removed from sheep in one piece.	
	↓	
Long wool used in the **worsted** process	Wool graded	Shorter fibres used in the **woollen** process
	↓	
Blending	Different types of wool are mixed depending on intended use.	Blending
↓		↓
Scouring	Washing removes dirt, grease and other impurities.	Scouring
↓		↓
	Some wool needs to be treated with chemicals to remove seeds.	Carbonising
		↓
Carding	Wire brush rollers disentangle fibres to give carded slivers.	Carding
↓		↓
Ginning	The slivers are pulled through coarse toothed combs to align the fibres.	
↓		
Combing	Removes short fibres ('noils'). Leaves longer fibres ('top').	
↓		↓
Dyeing	Colours added Dyeing can be done at different stages: in loose wool/in yarn/in fabric.	Dyeing
↓		
Drawing	Further spinning done to produce the *roving* needed for spinning.	
↓		↓
Spinning	Fibres pulled out, twisted, wound depending on intended use. Knitting yarn is wound on to cones.	Spinning
↓		↓
Yarn	The yarn that is produced is then knitted, woven or tufted (*carpets*)	Yarn

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Wool products and processes

Cool wool
A lighter-weight wool product that makes the garment more comfortable for the consumer in warmer conditions. Garment retains smart appearance due to the natural properties of wool enhanced by the 'cool wool' process.

Lightweight lambswool
A lighter-weight wool product that makes the garment more comfortable for the consumer in warmer conditions.

Merino extrafine wool
For products that comprise wool of 19.5 microns or less.

Natural stretch
Pure new wool fabrics that meet minimum stretch and recovery requirements.

Non-woven wool
New developments with non-woven wool aim to reduce fabric production costs to a one-step process. The resultant fabric does not fray and is suitable for high-tech production methods, such as laser cutting and welding. High-pressure water jets create a layer of fabric which is ideal for linings that are windproof, soft and comfortable. They have also been used in experimental prototype fashion garments.

Pure merino wool
For products that comprise wool of 22 microns or less.

Sportswool pro
A wool-rich blend of merino wool and polyester developed for active sportswear. It has a knitted double jersey construction with a wool inner layer and a polyester outer layer. The wool absorbs moisture which is wicked away by the polyester. Therefore moisture vapour is transported away from the skin during strenuous activity.

Super-wash wool
Super-wash wool is more resistant to felting/shrinkage. Shrink-resistant finish allows the consumer to machine wash product, making care of wool easier.

Total easy care
Products meeting this criterion must be both machine washable and able to be tumble dried without loss of shape, appearance, colour or

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shrinkage. Product retains all natural properties of wool: soft handle, resilience, breathability and insulation.

Flame-resistant finish
Used on upholstery to make products safer for consumer. Also used for industrial/military clothing as it makes products non-flammable/difficult to ignite.

Stain-resistant finish
Stain-resistant finish offers a degree of water repellency.

Silk

Silk is made by the caterpillar (larvae) of the silk moth. The basic fibre substance of silk is **fibroin** with a structure of long chains of protein molecules which form a continuous filament. Silk production is known as **sericulture.**

The process

The caterpillar spins a cocoon from two liquids **fibroin** (protein) and **sericin** (gum). It secretes them through a hole called a spinneret. This liquid sets into silk fibre which the caterpillar winds round itself.

↓

Cocoon is harvested before the caterpillar becomes a moth (approx. 10 days).

↓

Cocoon is subjected to dry or wet heat which kills the insect inside.

↓

Cocoon is placed in a bath to remove gum.

↓

Filament ends are found and wound onto a reel. A single filament is too fine, therefore a number of cocoons are wound together, which results in raw silk or 'grege' silk.

↓

Reels are made up of a bundle of continuous filament around 1,000 metres long.

↓

Several bundles are twisted together into a 'throwing' process which increases strength.

↓

Spinning will determine the fabric's end use.

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Examples of fabric made from silk are:

Brocade	Chiffon	Crepe	Crepe de chine
Damask	Duchesse	Dupion	Georgette
Organza	Satin	Taffeta	Velvet

Hair

- Luxurious hair fibres that have the qualities of wool are obtained from animals living in cold climates throughout the world.
- All hair fibres are based on the protein **keratin**, but their characteristics differ as a result of the climate variation in which they live and breed.
- Luxury hair fibres can be combined with many other fibres – natural or synthetic depending on the requirements.
- The high price of such fabrics limits their use in many areas other than in expensive garments or luxury interiors.

Fabrics made from 100% pure luxury hair are:

- good thermal insulators
- naturally crease resistant
- soft and have a luxurious handle
- dirt repellent
- do not build up static electricity
- naturally fire resistant

Angora

Angora rabbit hair is obtained from angora rabbits. It is very fine, soft, fluffy and slippery and requires special processing in order to spin it into yarn. The fur consists of a soft undercoat (about 2 cm long) and coarser guard hairs (about 7 cm long) which give angora its characteristic spiky appearance. Angora is white, extremely lightweight and warm.

Camel

Camel hair is collected as it falls off the animal so it is never shorn. As a result the hair is very expensive. The hair is in great demand for its warmth and lightness. Because of difficulty in bleaching the fibre, it is used undyed, in its natural colour – which varies from light tan to brown/black.

Cashgora

Cashgora comes from New Zealand and is obtained by crossing wild cashmere goats with white angora goats. The white fibre and quantity of

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soft down per animal is good. The yarn produced has the lustre of mohair and the soft handle of cashmere.

Cashmere

Cashmere is taken from the cashmere goat which is raised in the Kashmir region of India and Pakistan, as well as Mongolia and China. The goats have a very fine, soft, downy undercoat which is about 9 cm long. The resultant hair is strong, soft, light and shiny.

Llama

The alpaca and guanaco llamas are bred for their hair and shorn every two years. The hair is soft and reddish brown/brown in colour.

Mohair

Angora mohair is a long white lustrous hair which comes from the angora goat, originating in Turkey. It is now also raised in Texas and South Africa – the world centres for mohair. The hairs are fine and possess remarkable strength and elasticity. Mohair is 35% warmer than wool and 10% stronger.

Vicuna

Vicuna is the smallest species of the South American camel family. The fibre is about 5 cm long and the finest of all animal fibres. It ranges in colour between golden chestnut and fawn. Vicuna is strong, resilient, lustrous and very soft. Most of the wool still comes from wild animals that must be killed to obtain the hair, therefore supplies are limited. It requires forty camels to make one coat.

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Natural fibres – plant

Linen

This is made from the cellulosic fibres of the flax plant.

The process

Pulling	The plant is harvested whole to obtain the full length of the fibre.
↓	
Roughing out removes seeds and unwanted material.	
↓	
Retting	removes the fibres from the plant by breaking down the pectin which is a gum-like substance. (a) The plants are left lying in a field for the dew to wet them. (b) They are then steeped in warm water tanks.
↓	
Rippling	removes seed capsules.
↓	
Scutching	separates the fibre from the rest of the flax straw. This is done by large turbines which roll, beat and break the straw. The process leaves the flax fibres flexible.
↓	
Hackling	The fibres are combed to produce long line fibres known as 'line flax'. Short fibres removed are known as hackle tow.
↓	
Spinning	The method used is wet spinning which gives fine regular yarn. It is used for high-quality household textiles and clothing.
Hackle tow is spun to give a heavier yarn. It is used for tea towels, canvas and furnishing fabrics.	

Examples of fabric made from linen are:

Canvas Coir Damask Jute Sisal

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Cotton

Cotton grows on bushes which flower. The seed produced forms pods called '**bolls**' which burst open when ripe. The boll is made up of a fluffy mass of creamy white fibres that are cotton.

The process

Harvesting	The 'bolls' are picked by hand or machine.
↓	
Ginning	The fibres are separated from the seeds.
↓	
Baling	The fibres are compressed in large bales and sent to the cotton mill.
↓	
At the mill	
Opening	Sand, grit and other impurities are removed by a beating mechanism, then blown against a perforated drum.
↓	
Scutching	Further beating continues cleaning the fibre before rolling it into sheets (laps).
↓	
Carding	The fibre is combed to separate and form a sliver.
↓	
Drawing and Drafting	Sliver thickness is reduced, ready for spinning.
↓	
Spinning	The final process of yarn production takes place. A cotton spinning system which produces evenly wound twisted yarn is used. Some may be given a high twist for strength. This process is called ring spinning.
↓	
Yarn	The cotton is then woven or knitted into fabric.

Examples of fabric made from cotton are:

Calico	Cambric	Chintz	Corduroy	Damask
Denim	Drill	Flannelette	Gabardine	Muslin
Oxford	Poplin	Sheeting	Terry Towelling	Velvet

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Regenerated fibres

These fibres are made from **cellulose** that comes from natural sources, e.g. wood pulp. The cellulose is extracted by chemicals. Regenerated fibres are classified according to the system used to convert the cellulose into a solution that can be spun.

Viscose

The process

Raw material	This comes from trees (eucalyptus, pine, beech). The bark is removed, chipped and impurities are removed.
↓	
Cellulose	It is purified, bleached and pressed into solid sheets.
↓	
Cellulose sheets	They are dissolved in a caustic soda solution (**sodium hydroxide**).
↓	
Soda cellulose	The excess liquid is pressed off, shredded and left to age. This process reduces the length of the cellulose molecules and they dissolve more easily.
↓	
Carbon disulphide added	This changes cellulose into soluble form (xanthation).
↓	
Cellulose fluid	It is dissolved in dilute sodium hydroxide to produce spinning fluid, which is a treacle-like liquid.
↓	
Wet spinning Spinning fluid	It is filtered and extruded into a spinning bath. It is then washed to remove process chemicals when the filaments solidify.
↓	
Solidified filaments	
↓	
Filament yarn	It is wound onto spools or cut into lengths to make staple (short) fibres. The fibres are washed and dried.

Filament yarn makes lustrous fabrics, crepe fabrics and lining fabrics.

Staple yarn is used mainly in blends.

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Acetate

Acetate is a combination of cellulose and acetic acid which is made by a similar process to viscose. However, unlike viscose, acetate can be dry spun when dissolved in acetone.

The process

Raw material	Wood pulp is the raw material used.
↓	
Cellulose	It is steeped in a solution of acetic acid (acetylation), acetic anhydride and sulphuric acid, which results in the production of cellulose triacetate.
↓	
Ripening	The triacetate becomes acetate after the process is complete.
↓	
Drying	The sediment is dried and turns into a white flaky powder. When the powder is mixed with acetone, the solution is ready for spinning.
↓	
Filtration of spinning solution	The solution is filtered to remove undissolved flakes.
↓	
Spinning	It is forced through a spinneret into a current of warm air which solidifies the filaments.
↓	
Filaments	They are twisted together into continuous filament yarn. The yarn is cut into staple lengths for fabric manufacture.

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Triacetate

This fibre is a development of acetate.

The process

Raw material	It is derived from wood pulp.
↓	
Cellulose	It is treated with acetate, acetate anhydride and a catalyst (acetylation).
↓	
Cellulose triacetate	A viscous solution results when water is added.
↓	
Drying	The remaining sediment produces dried triacetate flakes.
↓	
Spinning fluid	Triacetate flakes are mixed with methylene chloride.
↓	
Spinning	The solution is forced through a spinneret into a current of warm air which solidifies the filament.
↓	
Filament	The filaments are twisted together to form a continuous filament which is then cut into staple lengths for fabric manufacture.

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Lyocell

- Lyocell is the generic name for solvent-spun cellulose. It was first produced in the early 1990s by Courtaulds under the brand name of 'Tencel'.
- It is environmentally friendly as it is produced from renewable wood pulp of trees specifically grown for the production of lyocell. The wood pulp is processed by a 'closed-loop' spinning technique in which the (non-toxic) solvent is recycled, reducing environmental effluents.
- Lyocell has a special feel/soft handle but also has excellent strength, drape and absorbency.
- Lyocell is much more durable and stronger than viscose.

The process

Raw material	Wood pulp is dissolved using solar power, carbon dioxide and water.
↓	
Cellulose	The substance called cellulose results.
↓	
Spin	The solution is forced through a spinneret to produce a solidified filament.
↓	
Wash	The solvent produced after washing (water wash) is recycled. It is used again at the dissolving stage of the process.
↓	
Dry	Warm air is used for drying.
↓	
Crimp/cut	Staple fibres are produced after cutting.

Uses of lyocell

workwear tents hygiene wipes teabags

breathable fabrics to produce swabs and dressings for medical use

dresses skirts blouses shirts trousers jackets

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Synthetic fibres

All synthetic fibres are made by processes that are similar but which use different chemicals. Coal or oil is the raw material used.

Simple chemicals are joined together to form polymers in a process known as **polymerisation.**

Polyamide/nylon

This was the first fibre to be made entirely from chemicals and coal. There are two methods of producing polyamide:

- Two compounds react to form a polyamide polymer, called **nylon 6.6**
- One compound links with itself and is called **nylon 6**

Today polyamide is made from oil rather than coal.

The process

Raw material	Chemicals are used as well as oxygen, nitrogen and hydrogen (air and water).
↓	
Chemicals	It is heated to make a hot syrupy liquid which is called Polyamide.
↓	
Polymer	The solution is poured over revolving rollers and cold water is sprayed on. As it cools it forms into a solid white strip (polymer).
↓	
Polymer chips	The strip is cut and heated to form spinning liquid.
↓	
Filaments	The liquid is wound onto cylinders.
↓	
Cold drawing process	The yarn is stretched to four times its original length.
↓	
Tow	A number of filaments are stretched, crimped and cut into staple lengths for spinning.

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Polyester

This is a versatile fibre which is synthesised from oil. It has a wide range of uses.

The process

Raw material
↓
Polymer produced — Petroleum (oil) → Ethylene → ↓ → Ethylene glycol; Petroleum → p-xylene → ↓ → Terephthalic acid; ↓ → Polymer
↓
Drying — It is run over rollers.
↓
Cast, cut into chips
↓
Chips melted — The spinning solution is made.
↓
Melt-spinning method — The solution is forced through a spinneret which is wound on to cylinders to produce filaments or staple fibre.

Filament (long fibres)
Solidified yarn
↓
Drawn (stretched)
↓
Lengths wound onto bobbin

Staple (short fibres)
Solidified yarn
↓
Undrawn tow
↓
Drawn (stretched)
↓
Crimped
↓
Heat set
↓
Cut

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Acrylic

This is made from simple chemicals derived from oil. The polymer can either be wet spun or dry spun. The 'feel' or handle is similar to that of wool.

The process

Raw material	It is composed of oil known as acrylonitrile.
↓	
Polymer produced	It becomes poly-acrylonitrile which is in powder form
↓	
Wet spun *or* dry spun	
↓	
Filaments combined into a *tow*	
↓	
Tow	It is crimped and cut into staple lengths ready for spinning into yarn.

Elastane

This is made from segmented polyurethane. It has the capacity to stretch and recover and is used mostly in a blend with other fibres.

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Spinning

Regenerated and synthetic fibres can be produced by three different methods of spinning:

Wet spinning – for viscose and acrylic

Polymer solution	The balance of chemicals depends on the fibre being made.
↓	
Coagulation bath	A metered pump feeds the correct amount of solution into the bath. The solution neutralises the solvent and coagulates the filaments.
↓	
Forced through spinneret	The filament is solidified.
↓	
Filament	The filament is then drawn and wound.

Dry spinning – for acetate and acrylic

Polymer solution	The balance of the solution depends on the fibre being made.
↓	
Spinneret	A metered pump feeds the correct amount through the spinneret.
↓	
Warm air	The filament is solidified.
↓	
Filament	The filament is then drawn and wound.

Melt spinning – for polyamide/nylon and polyester

Molten polymer	
↓	
Spinneret	A metered pump feeds the correct amount through a spinneret.
↓	
Cold air	The process cools the melt and solidifies the filament.
↓	
Filament	It is drawn and wound. Colour may be added at this stage.

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SECTION 2

Properties of fabrics and fibres

Elaboration
Absorbency, crease resistance, durability, ease of care, elasticity, flammability, insulation, resistance to mildew, stain resistance, strength, warmth.

Absorbency

- This means the fibre can readily soak up/absorb water/moisture.
- The fibres are termed **hydrophilic**, water loving. For example, cotton and viscose.
- In contrast, some fibres are naturally water repellent.
- These fibres are termed **hydrophobic**, water hating. For example, polyester, nylon and acrylic.
- Polyester is so hydrophobic that it attracts and absorbs fats, oils and greases. It is termed **olephilic**, oil loving. This can make it difficult to remove grease stains.

Crease resistance

This means the fabric:

- sheds creases easily
- keeps good appearance
- requires little ironing/tumble drying.

Crease resistance may be added by a chemical finish.

Durability

- This means the fabric does not wear out easily.
- It is resistant to abrasion, rubbing and friction.
- Chemicals in detergents and anti-perspirants may reduce durability.
- Ultra-violet light may break it down.

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Ease of care

This means the fabric can be easily laundered without damage. The fabric:

- allows soiling to be removed easily
- is not damaged by detergents
- does not lose colour when washed
- does not lose shape when washed
- does not shrink when washed
- dries easily/quickly
- can be tumble dried
- requires little ironing
- does not require special care/dry cleaning.

Elasticity

This is the ability a fabric has to stretch. The fabric:

- has the ability to recover to its original shape and size
- easily sheds creases and crushing
- gives added comfort in wear
- is resilient and recovers well after stretch.

Flammability

- This is the degree to which a fabric will catch fire or burn.
- Non-flammability may also be achieved by a special chemical finish.

Resistance to mildew

Mildew is a whitish fungi that appears on fabrics. It grows on vegetable and animal fibres, for example cotton, linen, silk and wool. Synthetic fibres are naturally more resistant to mildew.

- Warm, moist atmospheres and the presence of staining and soap all promote the growth of mildew.
- A mildew-resistant finish can be applied to susceptible fibres.

Strength

- This is the degree to which a fabric will resist strain.
- A strong fabric will not tear easily and will have a high **tenacity** value.

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Stain resistance

- Fibres which are hydrophobic will resist water-based stains.
- Stain-resistant chemical finishes can be applied which contain silicones/synthetic resins.
- Stain-resistant finishes are mainly applied to clothing that cannot be washed/must be dry cleaned. For example, upholstery fabrics and carpets.

Warmth/thermal insulation

- Fibres trap air, preventing passage of heat away from body.
- Construction of knitted fabric, laminates and membranes lend themselves to trapping air and preventing passage of heat away from the body.

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