

Home Economics

Fashion and Textile Technology

Resource Management

[HIGHER]



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SECTION 1**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**

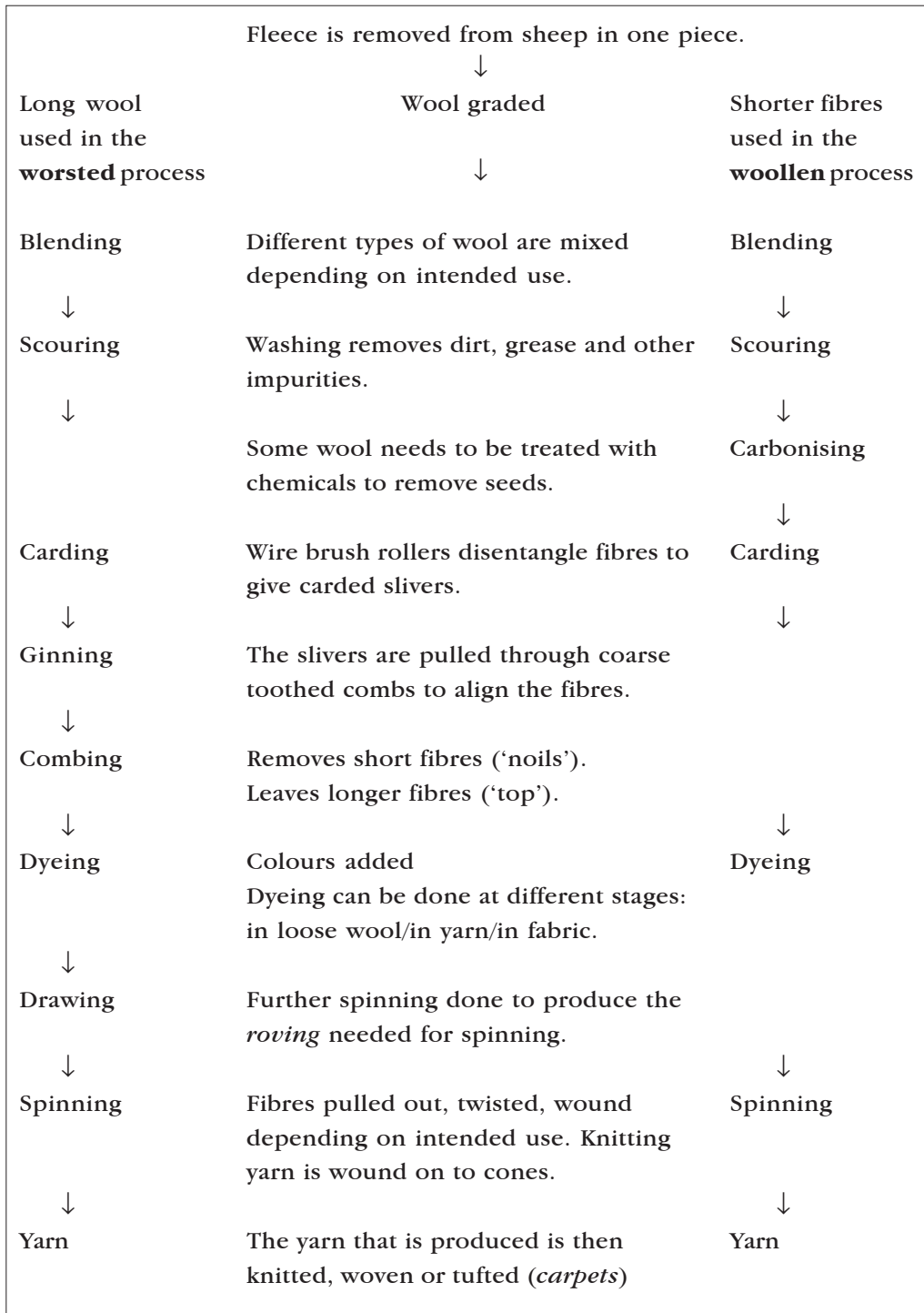
Wool fibres come from the fleece of sheep.

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

The process



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 superfine 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

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.

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

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.

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.	

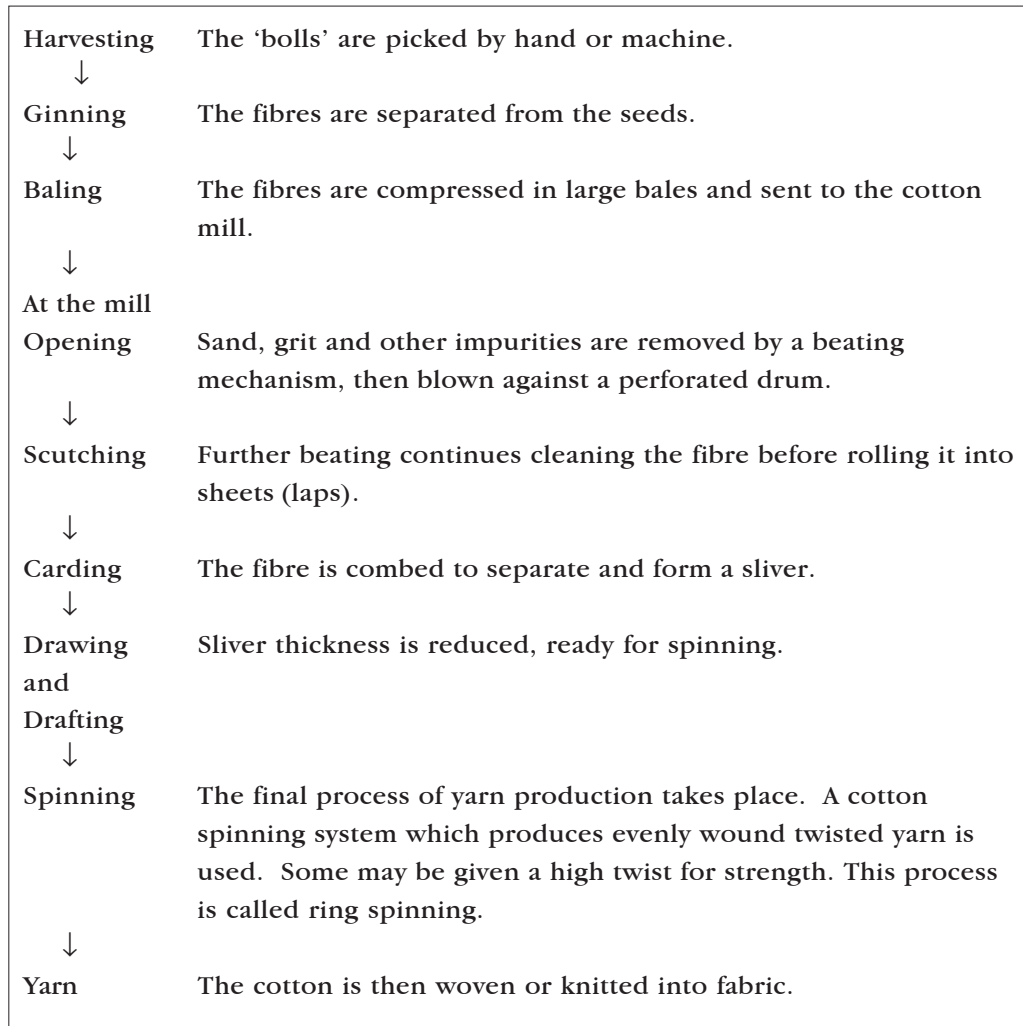
Examples of fabric made from linen are:

Canvas Coir Damask Jute Sisal

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



Examples of fabric made from cotton are:

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

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.	

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.

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.

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

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.

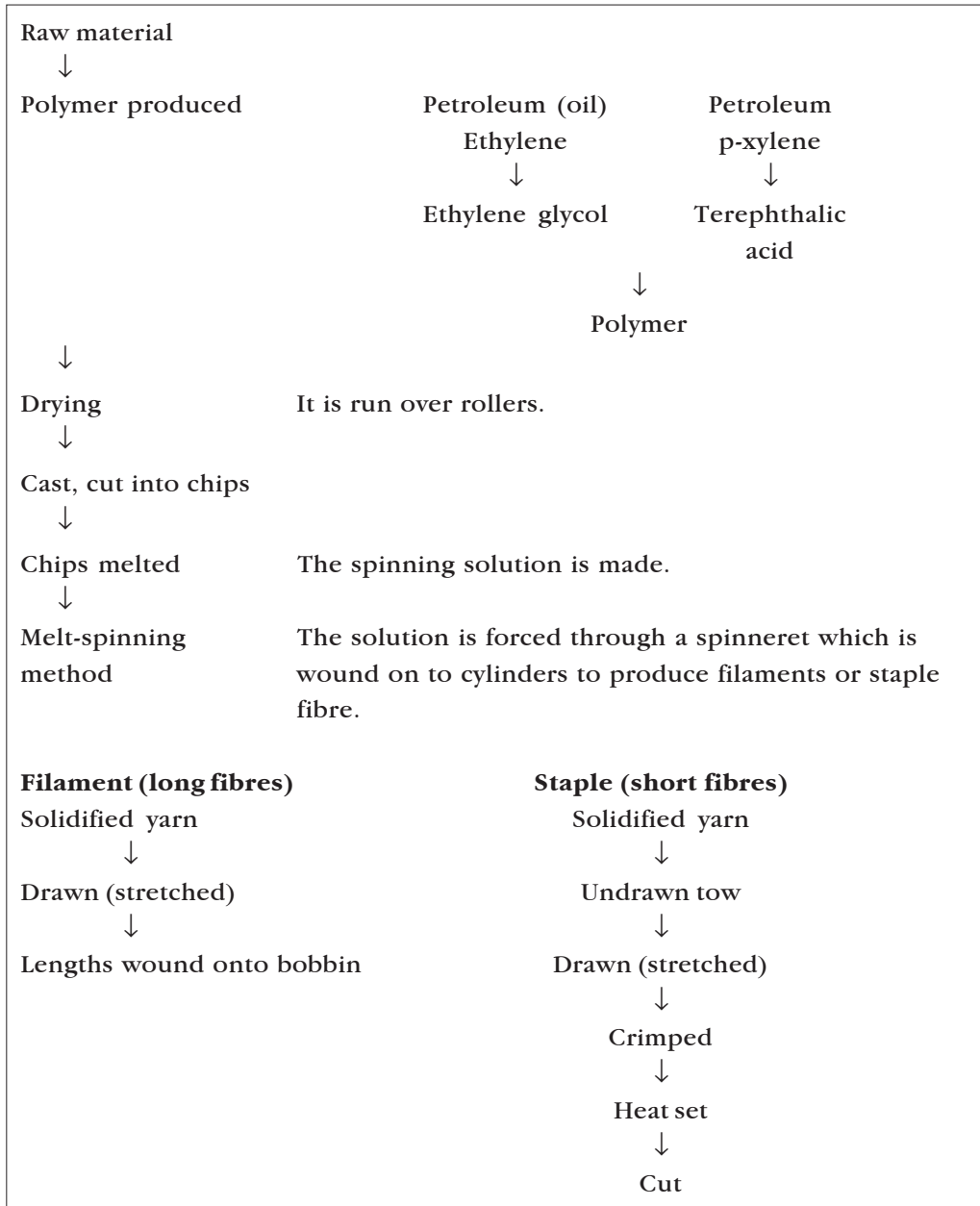
The process

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.

Polyester

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

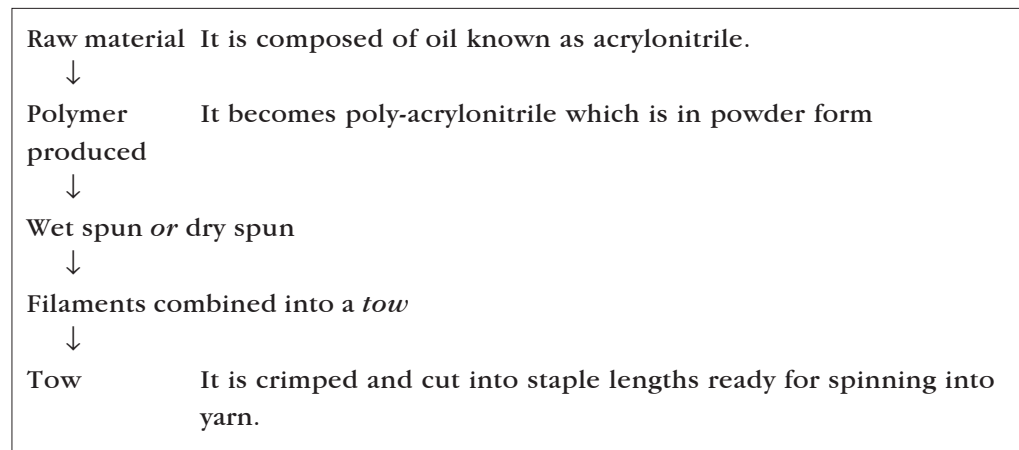
The process



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



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.

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.

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.

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.

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.

Fibre properties

	Absorbency	Crease resistance	Warmth	Durability	Ease of care	Elasticity	Flame resistance	Insulation	Resistance to mildew	Strength
Wool	****	*****	*****	**	*	****	****	*****	*	*
Silk	****	**	****	**	*	**	**	***	*	***
Linen	*****	*	***	*****	***	*	*	**	*	***
Cotton	****	*	**	****	***	*	*	*	*	***
Viscose	****	***	**	*	**	*	*	**	**	**
Acetate	***	**	*	*	**	**	*	*	**	*
Triacetate	**	**	*	*	**	**	*	*	**	*
Lyocell	****	***	**	***	***	**	*	**	**	****
Polyamide	*	*****	*	****	****	**	***	*	*****	****
Polyester	*	****	**	****	****	***	**	**	****	****
Acrylic	**	****	**	**	***	***	**	****	****	**
Elastane	*	*****	**	****	**	****	*	**	****	**

* = poor

***** = good

SECTION 3

Yarns

Elaboration

- Single, plied, cabled
- Spinning – woollen and worsted systems
- Yarns from mixed and blended fibres
- Textured yarns – slub, flock, chenille, boucle, crepe

Yarn construction

Yarns are made up of fibres:

- Staple fibres are made from short fibres, e.g. cotton, linen, wool or cut synthetic fibres.
- Filament fibres are made from long continuous fibres, e.g. silk and synthetics.
- Monofilament yarns consist of a single continuous filament.
- Multifilament yarns consist of two or more filament fibres which may or may not be twisted together.
- Microfibres are made from very fine synthetic fibres, less than one denier in thickness.

A **single** yarn is made by twisting a group of fibres together.

A **multiple ply** yarn is made by twisting together a number of single plied yarns. For example, three-ply yarn is made by twisting three single yarns together.

A **cabled** yarn is produced by twisting together two or more multi-ply yarns. It is often called a cable twist and results in a much stronger, regular yarn.

Yarns are twisted to hold the fibres together. The more a yarn is twisted, the stronger and thinner it will be. Different textures can be produced by spinning them either tightly, loosely or unevenly.

Spinning – woollen and worsted systems

The difference between the woollen and worsted systems is related to fibre alignment, bulk and twist.

Woollen spinning system

- The yarns are carded two or three times but are not combed as with worsted.
- Yarns go directly from carding to spinning.
- The fibres used are shorter, have more crimp and stronger felting qualities.
- Yarns with a high bulk are produced by not aligning the fibres to any great extent – the fluffiness is due to the fibres running in different directions.
- Woollen yarn is spun less tightly to produce a fabric that has a less regular texture and is not so hardwearing.

Uses: tweed, woollen jumpers, knitted accessories – hats/scarves/gloves

Worsted spinning system

- The worsted system is designed for longer wool fibres.
- The fibres are carded and then combed to remove short fibres, drawn then spun.
- The crimp of the fibres is reduced before spinning to make it easier to make them parallel.
- The yarn produced has a high degree of alignment.
- The yarns are more compact, smoother, more even and stronger in comparison to woollen yarns.
- Worsted wool yarn is spun tightly to produce a fine, hardwearing fabric.

Uses: fine suiting, gabardine

Types of yarn

Mixtures and blends

Fibres are often mixed/blended to produce a fabric that has the combined benefits of two or more fibres while also minimising the negative qualities that any single fibre might have. Fibres are selected and blended in different combinations and percentages so the fabric will retain the best characteristics of each fibre.

- A mixture occurs when two or more plies, each containing a different fibre are twisted/woven together.
- A blend occurs when two or more fibres are blended together before or during the spinning of the yarn.

Advantages of mixtures and blends

Improve quality

- enhance performance – abrasion resistance, durability and crease resistance.
- improve comfort – thermal insulation, moisture absorption.
- improve after-care performance – laundering, drying, ironing, shrinking.
- increase yarn uniformity.

Improve the aesthetic qualities of the fabric

- improve appearance, optical effect, colour, lustre, fancy yarns.
- improve drape/handle.

Increase profitability

- reduce fabric costs.

Textured yarns

Slub yarn

Thick patches are formed at intervals along the yarn. Often a second fine yarn is twisted round the slub yarn to keep it in place. Slub yarns occur by:

- varying the thickness of the filaments, e.g. linen and silk.
- varying the speed at which the sliver is drawn out for synthetic yarn.
- varying the amount of twist.

Flock

A soft fancy yarn containing both short and longer staple fibres of different colours. The finished yarn is uneven with soft tufts protruding. Similar to a slub yarn.

Chenille

Chenille is a special yarn with pile protruding on all sides, produced by weaving a fabric with a tightly twisted strong warp and a manufactured fibre filling. The warps are taped in groups and the fillings are beaten in very closely. After weaving, the fabric is cut lengthwise between each of the groups of warp yarns. Each cutting produces a continuous chenille yarn that is then twisted.

Boucle

Boucle is a rough, curly, knotted fancy yarn made with a strong **core** yarn, a fine **binder** yarn and an **effect** yarn to provide texture. The effect yarn is delivered at a quicker rate than the core and binder yarns, and is twisted with them in the opposite direction.

Crepe

Crepe is a general classification of yarns/fabrics characterised by a broad range of crinkled or grained surface effects. Methods include the use of hard twist yarns, textured yarns, special chemical treatment, special weaves and embossing.

Advantages of textured yarns

- Increased bulk makes the fibre trap more air and therefore improves thermal properties.
- Increased ability to let vapour permeate fabric/allowing moisture to travel through fabric, making it more comfortable.
- Makes fabric softer and therefore more pleasant to wear.
- Makes fabric more elastic/extensible, therefore more comfortable to move in.

Fabric construction

Elaboration

Characteristics of:

- woven
- knitted
- bonded
- felt
- laminated
- coated fabrics

Characteristics of different fabrics

Woven fabrics

- By changing the order in which the weft and warp yarns interlace, different surface textures can be created.
- Woven fabrics drape beautifully.
- They do not stretch well along fabric grains and so stretch/elasticity is reduced.
- They only stretch if cut on the bias/cross of the fabric, stretch is limited.
- They tend not to be good insulators as it is not possible to trap much air within the fibres.
- Close-woven fabrics tend to be more durable.
- Closely woven fabrics can assist in the prevention of cold air penetration and so improve warmth/comfort.
- Closely woven fabrics have good dimensional stability.
- They may fray easily.

Knitted fabrics

- These provide much more stretch due to loop construction.
- They tend to be more absorbent.
- They tend to crease less easily/shed creases than woven fabrics, due to construction method.
- They may drape beautifully.
- They have a softer, more fluid handle than woven.
- They may run/ladder easily depending on type of knitting.

Knitted fabrics may be **warp** knitted or **weft** knitted. Each has very different properties:

Weft	Warp
Comes undone easily	Difficult to undo
Ladders and runs	Does not ladder or run
Curles when cut	Lies flat when cut
Stretchy	Stretchy but stable
Loses its shape	Keeps its shape well
Has a right and wrong side	Both sides look alike
Similar construction to hand knitting	

Advantages

Weft	Warp
Quick to produce therefore production costs lower	Very fast method of production, therefore costs kept down
Can be made flat or fully fashioned	Good permeability, therefore comfortable to wear/perspiration can evaporate
Good range of fabrics can be produced	Excellent drape
Many types of yarn can be weft knitted	Wide range of fabrics/weights of fabrics can be made
	Does not ladder/unravel/fray

Disadvantages

Weft	Warp
Can unravel/ladder/fray	Only continuous filament yarns can be used
Unstable	Tricot may shrink/stretch

Pile fabrics

Pile fabrics are woven/knitted with an extra set of looped yarns which are either clipped or left as loops to form special textures of fabrics.

Characteristics

- Pile runs in one direction.
- Fabric has a rich, luxurious appearance and feel.
- Fabric appears lighter if pile runs down.
- Fabric appears darker/richer if pile runs up.
- Pile is easily marked/flattened by water/staining.

As the surface of the fabric is raised, extra consideration should be given to layout, cutting, assembly and finishing to avoid disturbing the pile.

Examples

Carpets	Chenille	Corduroy
Fake fur	Fur fabrics	Novelty pile fabrics
Terry towelling	Velour	Velvet
Velveteen		

Fleece fabrics

Fleece fabric is a knitted fabric consisting of a plain, smooth outer surface. The yarn used is known as the face yarn. A thicker, fleecy backing yarn is laid in at the back. The face yarn does not allow the fleecy yarn to show through to the surface of the fabric and so spoil the smooth finished appearance. The backing yarn is often acrylic and is raised or brushed during finishing to produce a fleecy appearance.

Various weights of fleece fabric are available:

Heavy weight – 350 g per square metre.

Normal – 250–300 g per square metre for sweatshirts.

Different fibres can be used:

Cotton is warm, wind resistant and absorbent but expensive.

Polyester/cotton gives a crisper face to the fabric.

Acrylic is the most economical.

Fleece fabrics can be produced on flat-bed knitting machines or more commonly on circular knitting machines. There is a greater demand for these machines which allow garments such as tracksuits, sweatshirts and leisure wear to be made up without side seams.

Characteristics of fleece fabrics

- fleece backing has a fluffy surface and so is soft and comfortable to the skin.
- raised surface thickens fabric, traps more air and makes it warm to wear in cold conditions.
- lightweight fabric and an excellent insulator.
- absorbent, therefore comfortable to wear.
- elastomeric fibres are incorporated into fleece fabrics to produce a stretch fleece which gives improved stretch and recovery.
- elastomeric fibres make fleece fabric very suitable for sportswear, leisurewear and one-size accessories, e.g. hats, gloves.
- durable and hardwearing, so able to withstand exertions of active sports.
- fleece fabrics provide garments which are functional and fashionable, especially in the sportswear and leisure ranges.
- the face of the fabric is suitable for dyeing, printing and embroidery, thus making items bright and attractive to wear/easy to customise for schools and clubs.
- fabric is easy care, although fleece readily absorbs water, and therefore is more time consuming to dry.

Non-woven fabrics

These are fabrics made by methods that do not involve traditional weaving or knitting. The process of yarn production is missed out. Webs of fibre are produced from unwanted fibres that are too short for the spinning process. They can also be called **batts**. The web of fibres is bonded together either mechanically or chemically, depending on the fibre used and the fabric's end use.

Methods of bonding – mechanical

Needle bonding

- A thick web of fibres is penetrated by a mass of hot, barbed needles. There may be 3,000 needles in a block.
- The fibres become tangled and flatter as the needles withdraw from the web to give a compact, thinner web which holds together well.

Uses – underfelt, wadding, and thermal insulation.

Stitch bonding

- The web of fibres is passed through a warp knitting machine, and the web is penetrated by special pointed needles.
- Each needle hooks on to a nylon sewing thread and as the thread is withdrawn a chain of tricot stitches is formed.

Uses – curtain fabrics, upholstery fabrics and dress fabrics.

Felt

- Felting is one of the oldest methods of making fabric.
- Traditionally non-woven wool fabric was known as felt but today synthetic fibres can also be used to produce a similar fabric.
- The fibres are layered until a web like structure is produced of the desired thickness, width and length.
- The fibres of wool 'felt' together when subjected to moisture, heat and pressure. The interlocking scales of each fibre move and lock with each other causing shrinkage and a matted appearance. The resultant fabric is 'felt'.
- Felt can be strengthened by stitching or by gluing with adhesive.

Methods of bonding – chemical***Bonding with adhesive***

- Webs of fibres are saturated, sprayed or scattered with a powder adhesive.
- Heat is applied to solidify the mass of fibres.
- The fabric may be stronger in one direction or have strength in all directions depending on the arrangement of the fibres.

Uses – J-cloths, vilene interfacing and disposable clothing.

Heat bonding

- Webs of thermoplastic fibres are subjected to heat.
- The fibres soften and stick together.

Uses – short-life rainwear and industrial.

Characteristics of non-woven fabrics

As they are not made from yarns they do not have an ordered structure or arrangement. They therefore have quite different properties.

- can be produced quickly and cheaply therefore not costly to use/replace.

- absorbent, therefore comfortable to wear/useful for mopping up liquids/fluids.
- good crease recovery.
- can be washed/dry cleaned so easy to care for.
- will hold shape, therefore wear well.
- do not lint/shed fibres, so can be used where this is important, e.g. medical situations.
- dense structure and insulating properties allow them to be used as linings and interlinings.
- can give a quality finish to garment.
- do not fray/run/ladder.
- non-allergenic so safe to have against the skin.
- not-durable and so have more limited use, e.g. disposable.
- are not very strong as the fibres are not twisted together, therefore they can easily rub or pull apart.
- if pulled/strained, shape does not recover and they may fall apart.
- do not stretch due to construction process.
- stiff and do not drape well so are difficult to apply to certain styles of garment/limited in use.
- poor handling qualities so may be difficult to sew/press/shape.

Laminated/bonded fabrics

Lamination is the process of combining two or more layers of fabric by an intermediate layer of a polymer adhering to both.

Laminate fabric – an intermediate layer is sufficiently thick and substantial to form a significant part of the sandwich.

Bonded fabric – an intermediate layer merely act as an adhesive to join the two fabrics together.

Coated fabrics

- Coating is a process of applying a layer or layers of a polymer film to the surface of a fabric.
- The fabric is coated on one or both sides with a continuous polymeric layer.
- The layers are bonded together by the addition of an adhesive or by the adhesive properties of one or more of the layers.
- There are many porous and non-porous coatings on the market, offering varying degrees of 'breathability'.
- Surface coated fabrics are more prone to damage as the treatments are exposed.

Types of coating

- Traditional coating layers are made from resin and silicon.
- Linseed oil and wax are traditional coating materials for heavy cotton that can be reapplied.
- Rubber and PVC are waterproof but not breathable.
- Reflective coatings can be made from microscopic glass beads, up to 50,000 per square inch.

Uses of coated and laminated fabrics

Examples include tents, tarpaulins, outdoor garments, protective garments, tablecloths, airbags, medical garments and dressings, imitation leather, and stabilising for an unstable fabric such as a knit or lace.

Coated and laminated fabrics provide excellent waterproofing, but they inhibit the passage of water vapour, therefore condensation builds up inside the garment making the wearer feel uncomfortable. New technology has allowed them to become more breathable by using either microporous or hydrophilic treatments. This has also given them improved handle, softness, and drape, allowing them to be used more widely in the fashion industry.



Technological developments in fabrics

Elaboration

- Breathable membranes
- Microfibres
- Stretch fibres/fabrics
- Performance/Smart fabrics

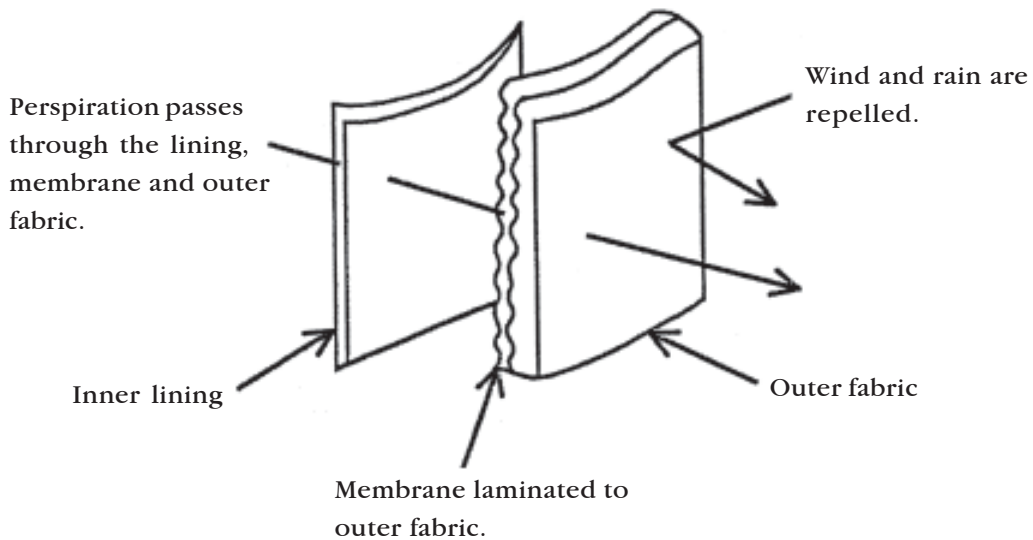
Breathable membranes

Previously, weatherproof textiles formed an impenetrable barrier in both directions (from the outside → in and from the inside → out) and therefore became sticky and uncomfortable to wear. However, since the 1980s manufacturers have been able to create textiles that can be both weatherproof and yet allow the need for perspiration to escape. This prevents a build-up of moisture inside the clothing and a feeling of discomfort.

Breathable – a breathable fabric allows internal moisture (sweat) to escape through the fabric, allowing the skin to ‘breathe’ and remain comfortable. Air can pass in both directions, but moisture/water vapour will only pass outwards, as with our skin.

Membrane – is a thin pliable sheet that can be made of various materials. It can be sandwiched between two fabric layers, or applied to the reverse of a fabric. Membranes are usually used to add weatherproofing or temperature-control functions by acting as an impenetrable barrier to the elements.

Breathable membranes are 'breathable' layers of a textile that act as an impenetrable layer to the elements to provide breathability.



The first manufacturer to produce a breathable membrane fabric was W L Gore who made 'Goretex'. This fabric was made of a porous fluorocarbon membrane bonded on to a finely woven fabric. This membrane had a large number of very fine holes in it which were much smaller than a water molecule but larger than a water-vapour molecule. Thus the fabric had good water resistance. The small holes allowed perspiration from the body to pass through the fabric.

There are now many more manufacturers and brand names that produce breathable membranes, such as 'Windstopper', 'Sympatex' and 'Polartec'.

New developments

New developments include making breathable membranes:

- lighter in weight, for packable performance travel garments that weigh less than a can of coke and fit into your pocket.
- incorporate stretch. Stretch 'Goretex' which provides 30% more fabric extension to weather performance clothing.
- combine with the natural characteristics and appearance of wool, for example, 'Windstopper' Woolshell.

Uses of breathable membranes

Breathable membranes have a wide range of uses. The balance between performance and appearance can be chosen to suit a particular requirement.

- leisure wear – anoraks, cagoules, over-trousers, headwear, accessories, suits.
- sports – high-performance wear for mountaineering, climbing, sailing, ski-wear, cycling, golf.
- workwear – survival suits for air crews, offshore oil and fishing industries, and military clothing.
- medical – medical staff gowns/protective clothing, dressings, seat covers.

Value to consumer

- allows perspiration from the body to pass through fabric, making it comfortable to wear.
- build-up of moisture inside clothing reduced, making it comfortable to wear.
- condensation prevented from forming on inside of the weatherproof layers.
- weatherproof fabric, making it suitable for outdoor use/wet climates/high-performance wear.
- hardwearing fabric, therefore will last a long time.
- lightweight/ non-bulky fabric, making it comfortable to wear.
- lightweight/non-bulky fabric, making it easy to carry.
- has a wide range of uses, making it ideally suitable for many garments/occasions/weather conditions.
- can be expensive and outwith budget.
- manufacturers may offer an extended guarantee for more expensive items.

Microfibres

- Microfibre is defined as a fibre of less than 1 denier (a unit of weight) per filament. A human hair is more than 100 times the size of some microfibres.
- More recently microfibres of 0.3 denier have been produced.
- Microfibres are very fine extrusions of a synthetic polymer.
- Polyester, polyamide and acrylic can all be produced as microfibres.

Initially, microfibres were developed to imitate the feel and appearance of silk. Silk is the finest filament found in nature, 1 denier. Now manufacturers have been able to create a filament finer than silk and softer to touch.

Synthetic fibres have become increasingly appealing as a result of recent research into microfibres. The technology combines a high number of very fine fibres into one yarn.

- There can be as many as 40,000 fibres per square centimetre.
- The high density of warp and weft fibres create minute air traps which insulate the wearer from low temperatures and wind penetration.
- Microfibres alone only create a showerproof fabric, not waterproof, particularly at the seams where the fibres bend.
- Microfibres allow water vapour from the body to escape outwards, therefore keeping the wearer comfortable.
- When woven into a fabric, the textile has a refined, peach-like touch, resembling silk.
- Qualities such as excellent draping, breathability, strength and lightness have taken modern synthetic textiles from everyday basics to highly sophisticated fashion, active sportswear and lingerie fabric, and they are used by many top designers and brands.
- Common trade names include 'Tactel' by Du Pont, 'Tencel' by Courtauld and Microfine.
- A variety of finishing techniques can be applied. For example, sanforising, sueding and sanding to produce differing textures.
- Microfibres are becoming more competitively priced and hard wearing as the range of applications increases.

Uses of microfibres

- lingerie and hosiery.
- shirts, trousers, skirts, jackets and coats.
- ski-wear and other active sportswear because of its high abrasion resistance.
- sleeping bags and tents.
- operating gowns, medical dressings.
- towels.

Value of microfibres to consumer

- very soft feel, therefore comfortable.
- highly absorbent.
- lightweight.
- strong and abrasion resistant due to closeness of weave.
- do not stain easily, therefore good appearance lasts for longer.
- easy to care for, therefore frequent laundering possible.
- dye well into bright colours.
- colours do not fade, therefore good appearance lasts for longer
- dust and lint free, making them suitable for medical use and glass cleaning.
- hydrophobic nature of surface protects medical staff from splashes/spills/body fluids.
- hydrophobic nature of surface gives protection against wind, rain and cold.
- specialised coatings can be applied to provide further protection.
- blend well with other synthetic and natural fibres to produce a fabric that has the combined benefits of both fibres.

Stretch fibres/fabrics

The first stretch fibres were produced by Du Pont in 1959 when they patented 'Lycra'. Lycra was originally developed as a substitute for rubber fibres, which were hot and heavy. Stretch fibres were so different from other fibres that a new classification was made – **elastomeric fibres/elastane** (or spandex in America).

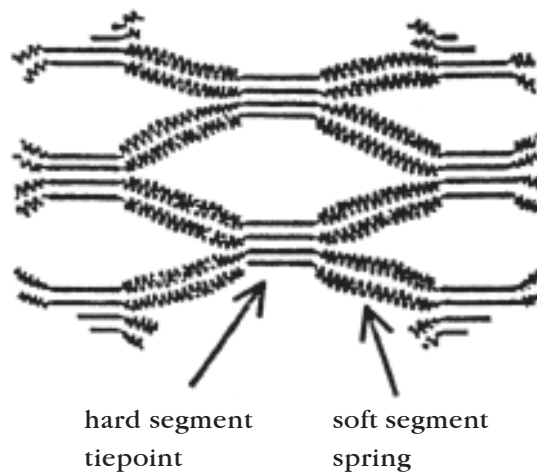
Elastane

In comparison to rubber, elastane:

- is much stronger and more durable.
- has a very high capacity for extension – can be stretched four to seven times its original length without breaking.
- has two to three times more restraining power with one-third less weight.
- instantly returns/recovers to its original length after extension.
- is resistant to repeated laundering at low temperatures, sun, salt water and the effects of sun-tan oils and perspiration.

Fibre structure

Elastane fibres are made of segmented polyurethane. Soft, springy segments are held together by hard segments. This structure gives the fibre its in-built capacity to stretch and recover. When the fibres are relaxed, the soft segments are coiled. Stretching the fibre straightens the coil. When released from extension, the fibres recoil forcefully. Elastane fibres come in a range of different colours and thicknesses or yarn counts.



Elastane is always combined/covered with other fabrics:

- to ensure that the appearance and feel of a fabric is not affected by the elastane.
- to stabilise the elastane. Elastomeric fibres can be unstable during certain processes in weaving and knitting due to their high elasticity. Elastane is stabilised so that it adopts the characteristics and properties of the original fibre.

Covering elastane

- *single- and double-covered elastane* – stretched elastane is wrapped in either a single or double strand of non-elastic yarn.
- *core spinning* – a non-elastic fibre is spun around stretched elastane.
- *interlacing* – a non-elastic multi-filament yarn is fed through an air jet together with stretched elastane. The jet causes the yarns to intermingle, partially covering the elastane.

The comfort of a garment, its closeness of fit and appearance are influenced by the extent to which a fabric will stretch and recover from

extension. The stretch and recovery of woven and knitted fabrics made from conventional yarns are limited, but by the inclusion of an elastane fibre a range of fabrics offering different degrees of stretch and recovery is possible.

Whatever the blend, a fabric containing elastane retains much of the natural appearance and feel of the original fibre but benefits by becoming more fluid, drapeable and adding comfort stretch.

The direction and amount of stretch depends on the percentage of elastane and the construction of the fabric:

- *ease* – to a sharply tailored garment (around 2%).
- *comfort stretch to conform to body contours* – for figure-hugging garments, swimwear and leisure clothing (around 14%).
- *high-performance stretch* – for garments required to control shape, for example foundation wear, bras and leotards (up to 40%).
- *narrow fabrics* – covered elastomeric fibres can run along the length of narrow fabrics, for example as straps to provide support and ease of movement.

Value of stretch fibres to consumer

- lightweight – having good ‘holding’ power/cling to body.
- comfortable to wear due to improved fit through stretch and recovery.
- comfortable as they allow for ease of movement.
- sportswear is aerodynamically designed in smooth finished stretch materials.
- swimwear clings to the body and can weigh less than 200g which eliminates drag.
- hardwearing having a long life.
- good shape retention, eliminates fabric puckering/buckling.
- good crease resistance.
- able to be laundered easily and requires little or no ironing.
- resistant to repeated laundering at low temperatures, retaining good shape.
- accept dyes readily and provide a good base for colour and print.
- elastomeric fibres have a range of uses other than for clothing – around legs of disposable nappies, bandages and car/bus upholstery.
- it is used in furnishing fabrics to create non-sag upholstery.

Performance/smart fabrics

Smart materials respond to differences in temperature and light and change in some way. They are called 'smart' because they sense conditions in their environment and respond. Smart materials appear to think and have some memory.

Thermochromic fabrics

Textiles using specific types of dyes are able to alter their colour in response to particular temperature conditions. A 3°–6°C change is normally required to activate the dye, but it can be designed to change at other temperatures.

The fabric is first dyed with a base shade, for example blue, then over-dyed in a top colour, for example red, making the resulting colour purple. The purple colour reacts to heat, allowing the blue to show through. The top colour, red, is a 'soup' containing a micro-encapsulated **leucodye** which works together with the chemicals that react to temperature change.

The effect will last for 5–10 washes, progressively fading. It will also fade with strong light. The treatment is suitable for fabrics that will accept pigment dyes, but it is mainly used on 100% cotton or cotton mix fabrics.

Uses of thermochromic fabrics

- novelty garments, for example fun T-shirts and children's garments.
- oven gloves.
- firefighters' clothing – under extreme temperature changes fabric turns white and reflects heat away from body.
- medical use – when thermochromatic pigments are applied to wound dressings, they will change colour in accordance with the amount of heat generated, thus indicating when the dressing requires to be changed.

UV-reactive fabrics

Ultra-violet (UV) reactive fabrics use **photochromic** dyes that respond to changes in UV light/sunlight. The UV light changes the molecular structure of the photochromic dyes and makes them absorb colour. The dyes undergo a temporary physical change in which the molecules change state. When the UV source is removed, the molecules return to their original state and the dyes lose some of their colour.

(Photochromic dyes absorb light; normal inks use pigments which reflect light.)

Photochromic dyes are best put onto light backgrounds to maximise the colour change. UV reactive fabrics may also include a sun-protection factor (SPF).

Uses of UV-reactive fabrics

- novelty products.
- club/rave wear.
- can help make adults and children aware when they are exposed to UV light/sunlight.
- can be used as a warning of over-exposure to sunlight.
- military camouflage – to create clothing that automatically changes colour according to the environment and background, to avoid the need for camouflage or change of clothing.
- fabric that reveals woven text/design on the application of UV light.
- photochromic embroidery thread.

Glow-in-the-dark fabrics

Phosphorescent textiles glow in the dark by transforming invisible forms of energy into visible light. Dyes can be impregnated with phosphorescence which traps and stores energy, usually from a light source. This is given off as a glow after the wearer moves away from the light. The pigment can be recharged many times.

Glow-in-the-dark dyes are non-toxic, non-hazardous and non-radioactive and can be applied to most synthetic fibres. The pigment can be used as a surface coating, printed onto a textile or incorporated into a synthetic yarn for weaving.

Uses of glow-in-the-dark fabrics

- children's novelty clothing.
- club/rave wear.
- threads and yarns – used for weaving into denim jeans which will glow in the dark for a novelty effect.
- interior fabrics which glow when the lights are dimmed.
- high-visibility safety garments and trimmings where there is a restricted power supply, for example oil rigs and rural areas.
- luminous fishing nets.

Outlast

The warmth or thermal performance of a textile is traditionally created by trapping air between the fibres and yarns. New technology has led to the creation of **phase-changing materials** (PCM), originally developed by NASA for space crews, and these not only help the body to cope with extreme temperature changes but also prevent overheating.

Outlast is a phase-changing material that is paraffin-wax based. The wax is enclosed in tiny microcapsules, which can be applied:

- as a finish on the surface of a fabric or fibre
- incorporated into the fibre
- embedded into the foam material.

The paraffin will change from a solid to liquid at warm temperatures, absorbing the body's heat and keeping it cool. If the temperature falls again, the wax will solidify and give heat back to the body.

Energy is absorbed when the wax changes from a solid → liquid.

Energy is released when the wax changes from a liquid → solid.

Uses of outlast

The fabric is best used where there is a constant interchange of temperature – cooling down and warming up.

- Active sportswear.
- Protective survival clothing.
- Walking gear.
- Sleeping bags.
- Accessories – gloves, helmets.
- Footwear.

Stomatex

Stomatex is a **bio-mimetic** smart textile – it mimics nature. Bio-mimetics is the science of understanding how nature can respond automatically to external stimulation. Scientists are trying to replicate these responses in fabrics. Bio-mimetic textiles based on this principle are currently being developed for military and sports use.

Bio-mimetic textiles are based on layers of fabric, where only the top surface layer reacts to change. Stomatex is made of three different layers:

- neoprene core layer which is a thermal insulator
- knitted nylon fabric which lines the core layer on both sides.

Stomatex fabric takes inspiration from the way that a stomata on the surface of a leaf breathes and regulates temperature through a process known as transpiration. The fabric mimics nature to keep the wearer dry and comfortable during exercise.

Stomatex has small domes in the surface of the fabric which have tiny holes that allow moisture and heat to move away from the body.

Properties of stomatex

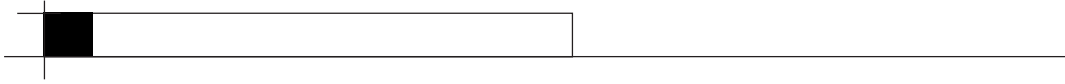
- Thin and flexible.
- Provides good thermal insulation without bulk.
- High-tensile strength.
- High elasticity.
- High compression resistance.
- Responds to the needs of the individual as the fabric balances temperature and sweat removal.
- In water, stomatex keeps nearly all of its insulation properties.

Uses of stomatex

- Diving suits.
- Survival garments.
- Active sportswear.
- Protective wear.
- Medical textiles.
- Workwear.

Liquid crystal

- Liquid-crystal fabrics change colour throughout the spectrum.
- Cholesteric liquid-crystal mixtures are viscous, hydrophobic liquids.
- Not usually used for textiles, as gelatine dissolves.
- Cannot be subjected to water or ironing.



SECTION 6**Line, proportion and texture****Elaboration**

- Visual effects of different lines, proportions and textures.

Line

Good design shows a good use of line, creating a pleasing effect in balance and proportion. Line creates a visual impression of the way in which the body is seen. It can make it appear longer or shorter, wider or narrower. It can be used to flatter, emphasise, detract from or diminish certain areas of the body.

- Line relates closely to silhouette. The silhouette of the human body is cylindrical and the limbs repeat this. However, fashions change the silhouette of the body.
- The silhouette establishes a 'look' and creates or dates a fashion.
- The shoulder width, neckline shape, size of waistline, height of hemline and overall shape give you a silhouette/fashion.
- The positioning of seams is only style.
- Surface decoration and fastenings are only trimmings.

In general:

- *vertical lines* lengthen, slim and add height.
- *horizontal lines* broaden, add width and diminish height.

However, these effects are only true in some cases.

Repetition of a line accentuates it. For example, a series of stripes on a dress.

- The wider the vertical lines the more broadening the effect.
- The narrower the vertical lines the more lengthening the effect.
- The wider the horizontal lines the more broadening the effect.
- The narrower the horizontal lines the more lengthening the effect.

Diagonal/oblique lines are asymmetrical and add interest.

- The more the diagonal line is to the horizontal the more broadening the effect.
- The more the diagonal line is to the vertical the more lengthening the effect.

Whether a line is straight or curved can also influence the overall effect.

- Straight lines tend to lengthen.
- Curved lines tend to broaden.

Proportion

Proportion should have *balance*, *rhythm* and *emphasis*. All other features of a design could be correct but the design will not be aesthetically pleasing to the eye unless the proportions are correct.

Garments, fastenings, decoration and accessories should be scaled to a person's size, to be in proportion.

- *Colour* needs to be balanced in order to be effective. Balance main colour (for large areas) with contrast (for smaller areas) and add neutrals to calm and complete.
- *Line* needs to be balanced to avoid appearing 'top heavy' or 'bottom heavy'. The effect of line can be lost if the style is too detailed.
- *Pattern* is the repetition of a unit of design. It should be appropriate to the shape and size of the design. The size of pattern units needs to balance so that the total effect is pleasing when they become part of the whole. Pattern size should also relate to the body size for which the clothing is intended. For example, large patterns would be inappropriate for small children.
- *Texture* may look out of proportion. Heavy, bulky fabrics used excessively alongside light, crisp fabrics do not look right – for example, tweed cushions on a chintz sofa. If the texture does not match the function, for example cotton shirting used for a coat, the texture may look out of proportion.

Texture

Texture describes the appearance and feel of a fabric.

- Sheen depends on the amount of light that a fabric reflects. Satin is so smooth it reflects light and gives the effect of increasing size. Velvet with its deep pile absorbs light and gives the effect of reducing size. Other fabrics range between these two extremes.
- Heavy, rough textured fabrics such as tweed and fur fabric add bulk and should be used with care to avoid the effect of increasing size and weight.
- Quilted/padded fabrics soften angular contours.
- Light, crisp-textured fabrics stand away from the body and can disguise shape.
- Smooth, lightweight fabrics do not add to bulk and can be used freely.
- Transparent fabrics appear light and weightless. Interesting effects can be achieved by layering them with other fabrics.

Colour

Elaboration

- Colour terms
- Colour wheel
- Colour schemes
- Psychological effects of colour
- Optical effects of colour

Colour is created by sunlight. Without sunlight there would be no colour. Sunlight is a form of energy transmitted in different wavelengths. Some of these wavelengths are invisible to the human eye and some are visible. The visible ones appear as different colours and are referred to as the colour spectrum. There are seven colours in the spectrum – red, orange, yellow, green, blue, indigo and violet. They can be seen as a rainbow.

Objects ‘absorb’ most of the colours contained in daylight. The colours that are not absorbed are ‘reflected’. The individual frequencies radiated by these reflected colours are received by our eyes. When they are transmitted to our brain and compared with knowledge accumulated from childhood, they are decoded and identified as being a particular colour. There are, however, more than seven rainbow colours and the human eye can detect thousands of different ones.

In nature, pigments can be obtained from plant, animal and mineral sources to create colour. Today, chemicals are used to dye fibre, yarn and fabric, and colour possibilities are infinite.

Colour terms

Primary colours: the three primary colours are **yellow, red and blue**. They cannot be produced by mixing other colours together.

Secondary colours: the three secondary colours are **orange, green and violet**. These are made by mixing equal quantities of two primary colours together.

red + yellow = orange

blue + red = violet

yellow + blue = green

Tertiary colours: these are created by mixing a primary and a secondary colour together.

Colour wheel

The colour wheel is made up of twelve colours: primary, secondary and tertiary. Other terms used with regard to colour are as follows:

Hue: what scientists call colours

Value: the lightness or darkness of a colour

Tone: the addition of a complementary colour to add shade/darkness

Shade: when black is added to a colour to darken it

Tint: when white is added to a colour to lighten it

Intensity: the degree of brilliance or brightness of a colour

Grey: when opposites on the colour wheel are mixed

Black: when all the light in the spectrum is absorbed

White: when all the light in the spectrum is reflected

Colour schemes

Colour schemes play an important part in how people live and operate, whether at home, work or leisure. Colour creates different moods and can reflect the personality of the wearer.

The main colour schemes are:

Monochromatic

Different intensities of one colour are used, or simply black and white. The effect can be regarded as bold, dull or neutral, depending on the colours used. It creates a neat, orderly feel.

Analogous

Colours that are very close to one another on the colour wheel are used. For example, blue, blue-green and green. The effect created is restful and comfortable.

Complementary

Colours that are directly opposite on the colour wheel are used. For example, red and green, blue and orange, or yellow and violet. Bold, strong and unusual effects are created.

Psychological effects of colour

Colour affects the brain and can create many different effects. It does this by associating colour with a particular feeling:

- warmth from red, yellows and oranges (warm colours)
- a restful feeling from blues and greens (cold colours)
- the effect of advancing, danger, aggression or confidence with red, which is a strong colour
- the effect of receding or calm with blues and greens
- a strong effect with contrasting colours
- a soft effect with pale or pastel colours
- a pureness with white.

Colour and mood

Colour affects the brain and can affect mood. It can also be used to help express feelings. For example:

I hate.....

I love.....

Feeling *blue, blue* with cold

Green with envy

Purple with rage

Seeing *red*

Black as thunder, *black* despair

Colour choice

Factors affecting colour choice are:

- *age* – white is often chosen for babies, bright colours for small children
- *likes/dislikes* – people have strong personal preferences about the colours they feel comfortable with
- *hair/skin colour* – can determine which colours suit best
- *peer group* – people often choose a colour to be seen to be part of a group
- *fashion* – colours vary from season to season
- *occasion* – colours chosen for celebrations may be different/brighter to those normally worn
- *psychological effect* – certain colours can give a psychological boost or depress an individual.
- *existing items* – colours may be chosen to match or contrast with existing items, garments or furnishings
- *religion/culture* – dark colours for Muslim women, bright ribbons for Polish national costumes
- *superstition* – green is unlucky
- *climate/weather* – dark, warm colours in cold weather, bright colours in warm weather.

Optical effects of colour – shape/size

The colour of a garment is noticed first and remembered longest.

Colour needs to be balanced in order to be effective.

- Main colour in large areas.
- Contrast in smaller areas.
- Neutral to balance.

A slimming effect occurs with the use of dark colours. For example blacks, browns and navy.

An area/feature may be emphasised by using warm, strong advancing colours. For example reds, oranges, vibrant yellows and pinks.

A feature may be overlooked by the use of cool, receding colours. For example blues, greens, turquoise.

Addition of colour

Elaboration

- Dyeing: batch dyeing, continuous pad dyeing, semi-continuous dyeing, tie dyeing, batik
- Printing: screen printing, transfer/sublimation printing
- Weaving

Dyeing

Batch dyeing

Involves a batch of fabric and a controlled amount of dye processed in a self-contained dye bath. The dye can be fixed in the bath or separately later. Batch dyeing can be done in three ways:

- *Jigger system*
The fabric is pulled backwards and forwards through the dye bath. This ensures the colour is evenly spread throughout. Suitable for medium- to heavy-weight fabrics.
- *Winch system*
A winch pulls the fabric from one side of the dye bath to the other in a circular movement. Suitable for knitted fabrics and lightweight wovens.
- *Jet-dyeing process*
High-pressure jets move the fabric around the dye bath. Suitable for carpets to create a multi-coloured design.

Continuous pad dyeing

Involves a complete roll of fabric placed onto a pad or dye bath. The fabric is then squeezed between rollers to make the dye penetrate evenly. Used for vast lengths of fabric.

Semi-continuous dyeing

The fabric is dyed then wound onto a take-up roller to remove excess dye. It can then be stored for several hours at a fixed temperature to allow the dye to fix into the fabric. Suitable for long lengths of fabric.

Tie dyeing

Tie dyeing is a resist method of dyeing. Before being placed in a dye bath, the fabric is folded and tied with string, thread or rubber bands. This prevents the dye reaching some parts of the fabric, and restricts the

amount absorbed in others. Patterns are unique and different effects can be achieved by varying the folds and ties. Tie dyeing is an inexpensive craft and a method of giving existing items a new look.

Batik

Batik is also a resist method of dyeing. It is a process in which wax is used to create lines or areas resistant to dye. The fabric is stretched and wax is applied with a brush or special tool. The fabric is then immersed in a cold-water dye bath then dried. The process can be repeated to build up a multicoloured effect. A different effect can be created by allowing the wax to crack. The wax is boiled off after dyeing has taken place.

Printing

Screen printing

Screen printing is similar to stencilling. A design is transferred to a thin sheet of film and cut out. A screen is made by stretching a fine fabric such as silk over a wooden frame. The film is placed on top of the screen with the design facing downwards. Fabric is placed under the frame and the dye is pushed through the screen by a squeegee. The dye penetrates the fabric in the unblocked areas. Each colour requires a separate screen.

Industrial screen printing works on the same principle but the fabric, screens and squeegees are machine operated. Rotary screen printing is a development of flat screen printing and is quicker and more widely used.

Transfer/sublimation printing

A method of transferring designs from rolls of paper to fabrics. The dye is changed from a liquid to a gas or vapour which penetrates the fibre more quickly and easily. The design is pre-printed on paper with disperse dyes that sublime onto the fabric at 400°F (204°C) in a heat-transfer printing machine. The heat causes the dye to change from a solid state on the paper to a vapour, and then back to a solid state on the fabric – this is called **sublimation**. It is best used on polyester and tri-acetate.

Weaving

Spectacular colour effects can be achieved by varying the colours of the warp and weft threads when a fabric is woven. There is no limit to the number of colours that can be used in the warp or weft thread. Interest can also be added by varying the type of 'yarn' used. Threads, yarns, strips/rags of fabric, ribbon, cord, braid, plastic, PVC can all be woven together to create interesting colour effects.

Addition of surface decoration

Elaboration

- Appliqué
- Beadwork
- Embroidery

Appliqué

Appliqué designs are made from pieces of fabric applied on to a background fabric. The pieces can be applied by:

- hand, using embroidery stitches
- machining, using a zig-zag stitch
- using fusible interfacing
- fabric glue.

- The fabrics used for appliqué should be compatible with the base fabric to enable the appliqué to be cleaned successfully and keep its appearance.
- More than one layer of fabric can be used to build up interesting shapes, colours, textures and designs.
- Appliqué can be applied as part of an original design or added to garments/items to give them a new look or effect.
- It can be further enhanced with hand or machine embroidery.
- Appliqué can also be used, like a patch, to strengthen or repair items.

Beadwork

- Beads, rhinestones and sequins can add colour, texture and shine to items/garments often adding a touch of glamour to special occasion or evening wear.
- It can improve or change the appearance of a plain item and create a very different look.
- Beading can be applied to a wide range of textile items. For example garments, accessories and furnishings.
- It is easy to create a personalised or 'one-off' design.
- Beadwork can be machined but is more often done by hand, which is time consuming and therefore expensive.
- It is carried out using a special beading needle. The thread is coated with wax in order to prevent it being cut by the edges of the beads.

- It can be difficult to launder and care for successfully.
- It may be heavy and uncomfortable to wear.
- It can be too sparkly or shiny, so may not appeal to all.

Embroidery

- Fabric can be decorated with different threads and stitches to build up colour, shape and texture.
- Traditionally, embroidery is done by hand, and today only individual, expensive items will be hand embroidered. For example wedding dresses, designer clothing, table linen or bed linen.
- There are many different types of hand embroidery such as blackwork, hardanger, open work and beadwork, and they are considered to be craft techniques.
- Most commercially produced embroidered items are now manufactured by machine, which is quicker and less expensive.
- Many domestic sewing machines perform a range of embroidery stitches.
- Fully computerised CAD/CAM sewing machines are used in industry to develop the embroidery design, scan it, and then create it on the sewing machine.

Embroidery can be used to:

- trim the edges of items and give a finished appearance. For example, around hems, pockets, collars, button band, bed or table linen
- add features such as logos or badges
- add decoration to an item
- personalise items to suit customer needs
- decorate children's clothing
- create a theme on garments or household furnishings
- decorate a range of accessories.



SECTION 7**Reasons for wearing clothes****Elaboration**

- Comfort
- Modesty
- Protection
- Factors that influence choice of clothing

Comfort

- Clothing helps to control and maintain body temperature. When we change environment, the temperature changes and our bodies register the change. Clothes and the layering of clothing help to minimise these changes.
- Clothing helps to keep us dry and comfortable by absorbing sweat and other body fluids.
- Many clothing fabrics are soft to touch, fluffy and warm, or conversely smooth and cool and feel good against the skin.

Modesty

- Clothing protects us from embarrassment.
- Clothing protects us from being indiscreet.
- Clothing avoids us feeling naked by hiding parts of our body we do not wish others to see, whether because of size, shape, colour, disability or deformity.

Protection

- Clothing protects us from the elements: wind, rain, cold, snow and sun.
- Clothing can also protect us from danger such as fire and keep us safe.
- Padded or thick clothing can prevent damage from falls, bumps and bangs.

Factors that influence choice of clothing

Climatic factors

- Individuals need to be protected from the elements: wind, rain, cold, snow and sun.
- Appropriate clothing helps control and maintain body temperature. When individuals change environment, the temperature changes and our bodies register the change. The fibre, fabric, construction and the layering of clothing chosen help to minimise these changes.
- When an individual chooses clothing, he/she tends to adjust what he/she wears to suit different climatic conditions and so suit the environment. For example, T-shirts in summer, fleeces in winter.

Decoration

- Choice of decoration needs to suit the occasion, and this usually dictates the type of garment and overall style.
- Can add a touch of glamour to special occasions; for example, with evening wear.
- Can be used for novelty/fun for children or fancy dress.
- Can be added to clothing and accessories to complete/finish a look.
- Can easily be over-powering if not used selectively.

Fashion

- The groups most influenced by fashion are teenagers and young adults.
- Fashion can be used as an expression of identity.
- Fashion can be used as a status symbol.
- Teenagers like to change their clothing frequently to match fashion changes.
- Latest fashions are up to date and prevent the wearer looking out of date.
- Teenagers often like fads and extreme fashions and will choose to follow them.
- High-fashion items are often more expensive.
- High-fashion items are often only available in large cities or designer shops.
- Fashion items constantly change, so followers of fashion require to change/buy clothing more frequently, and this is expensive.

Identification – job/status

- Workwear and uniforms identify occupations or jobs. For example, a white coat will identify a doctor, a dark business suit will identify an office worker.
- Workwear and uniforms raise public awareness of service/company/school.
- Workwear and uniforms may give an individual a sense of status.
- Individuals will choose clothing to suit or reflect their lifestyle.
- Designer labels are chosen to give a sense of status within groups.

Personal taste

- Each individual has preferences in terms of colour, shape, line, proportion and texture that he/she considers flatter their body shape, size and colouring.
- Personal taste is subjective and only applies to the individual.

Sense of belonging/peer pressure

- Peer-group pressure is often expressed as the need to dress in the same manner as one's peers in order to 'belong' to a particular group identity.
- Individuals may choose clothing to help them blend into a group or to feel anonymous.
- Individuals may like to look different to their peers to achieve a sense of status so may choose clothing that is contrasting to theirs.
- Individuals may be ridiculed if they do not conform to the clothing choices of peer group.
- Individuals may want to conform to group identity.

Sense of individuality

- Individuals may like to look different to their peers to achieve a sense of status, so may choose clothing that is different.
- Individuals may prefer to express personal tastes and disregard current fashion/colours.
- Individuals may not be interested in fashion.
- Individuals may like to look different for effect, or to show off, or to be easily recognised.
- Individuals may personalise uniform or workwear to stand out.
- Fashion may be used as an expression of an individual's identity.

Self-expression

- An individual may dress differently to stand out from the crowd.
- An individual may wish to make a statement about a particular belief. For example, a vegan would not wear animal fibres.
- An indication of status in society. For example, religious status, such as a nun's habit, financial status, such as a designer suit.
- Peer group pressure is the need to dress in the same manner as others in order to 'belong' to a particular group/identity
- Styles adopted by youth sub-cultures generally make a stand against society's values. For example, punk, hippy and goth.

Self-esteem

- Individuals may like to look different to their peers to achieve a sense of status, so may choose clothing that is different.
- Fashion may be used as a status symbol.
- Workwear or uniforms may give an individual a sense of status.
- Individuals may choose smart rather than casual clothes to achieve a sense of self-esteem.

SECTION 8**The range and use of finishes when choosing fabrics****Elaboration**

Physical finishes: brushing/raising, calendering, stone-washing.

Chemical finishes: anti-bacterial, anti-pilling, anti-static, colour fastness, crease-resistance, flame resistance, mercerisation, moth proofing, stain resistance, shrink resistance, water repellency/water proofing.

Physical finishes***Brushing/raising***

A finishing process for woven or knitted fabrics which creates a soft, fluffy surface. Brushes or spiked rollers are used to raise a pile which hides the fabric's weave or knit. Fabrics with a brushed/raised surface are warm because of the increased volume of air trapped.

Calendering

Calendering is a finish designed to smooth the surface of a fabric and make it lustrous. The fabric is passed through a series of rollers. Different effects are achieved by altering the surface of the rollers, the speed of the rollers and changing their temperature.

- A cold roller gives a soft, light finish.
- A hot roller gives a harder, shiny finish.

Stone-washing

This is a method of achieving a particular colour effect on garments, usually blue-dyed cotton denims. Pumice stones are soaked in sodium hypochlorite to produce a localised bleaching effect. The stones are tumbled with a load of dyed garments in a special washing machine without water. Where the stones come into contact with the fabric, abrasion occurs and colour is removed. The garments may then be over-dyed to colour the whitened areas.

Chemical finishes

Anti-bacterial

Anti-bacterial finishes prevent the harmful growth of bacteria, neutralise body odour and minimise skin irritations. 'Purista' is a finish used on cotton. Naturally derived anti-bacterial finishes are useful for those with sensitive skins or allergies, and are mainly used with natural fibres, for example, organic cotton.

Anti-pilling

Pilling is the formation of small balls/tangles of fibre when the surface of a fabric is rubbed. Pilling most often occurs with wool or synthetic fibres and fabrics made of loosely twisted yarns. Solvents or film-forming polymers are applied to the surface of the fabric to help reduce the occurrence of pilling.

Anti-static

Anti-static finishes prevent the build-up of static charge which makes fabric:

- cling to itself
- attract dust and dirt particles
- cause sparks and mild electric shocks.

Chemicals are added to make the fabric more absorbent. As water is a good conductor of electricity, the fibres can get rid of the electric charge. An anti-static finish is permanent, invisible and applied to acetates and synthetics.

Colour fastness

To avoid colours fading or washing out, the dye is fixed with a *mordant*. Mordants are chemicals used in small quantities in the dyebath. The most common mordants are alum, chrome, iron and tin.

Crease resistance

A crease-resistant finish is applied to fabrics made from cellulose that crease easily, for example, cotton, linen and viscose. The fabric is treated with a resin and then dried. After the garment is made up it is baked to 'cure' the resin. The finish makes the fabric crease resistant, therefore reducing the need to iron. It produces a durable 'easy-care' finish for trousers, skirts, shirts and blouses.

Flame resistance

This finish is added to make fabrics less flammable. All fabrics burn, but the rate at which they burn differs. This finish is applied to the yarn/fabric after all other finishing processes have been completed. The yarn/fabric is saturated with chemicals which prevent it catching fire if placed near a spark or flame. It is essential for furnishings, children's nightwear and protective clothing. Flame-resistant finishes:

- may make fabric stiff
- may be damaged if not washed according to instructions
- if damaged, will make fabric a fire hazard.

Mercerisation

Mercerisation is applied to cotton fibres, yarn or fabric before dyeing to make it more lustrous. The cotton is stretched tightly and soaked in a concentrated solution of sodium hydroxide. This causes the fibres to swell up and straighten out. The cotton becomes softer, stronger and more absorbent; so it is able to absorb dyes more readily. It is a permanent finish.

Moth proofing

The fibres susceptible to attack from moths are the protein fibres – wool, hair and silk. They are attacked by the larvae of the clothes moth and carpet beetle. Mothproofing chemicals are added to the dye bath. The chemicals change the flavour of the fibres so that the larvae no longer like the taste and do not eat them. It is a permanent, invisible finish applied to furnishings, carpets and clothes.

Stain resistance

There are now many new stain-resistant applications:

- Stain-resistant finishes and treatments, for example 'Teflon', prevent water- and oil-based stains from penetrating the fibres and allow dry soiling to be brushed off easily.
- Stain-repelling agents provide an invisible barrier, causing liquid spills to bead and roll off the surface.
- Release technology prevents the fibres from holding stains, so that they wash away readily.
- Hydrophilic or water-loving components draw the detergent and water into the fibre during laundering, allowing the stains to be released.
- Nano-technology can be used to make fibres hydrophobic, and thus repel water and water-based stains.

Such finishes keep a garment looking smart and reduce the time spent laundering. They are particularly important for work wear, uniforms, upholstery fabrics and automotive fabrics.

Shrink resistance

A shrink-resistant finish is applied to:

- *Cotton and viscose* – synthetic resins are applied which reduce yarn and fabric shrinkage during laundering. Important for trousers, curtains and loose covers.
- *Wool* – wool fabrics are prone to shrinkage, due to felting of the fibres. This occurs when wool is subjected to heat and friction. To prevent felting, wool can be treated with:
 - chlorine, which eats away the tips of the scales on the fibre which interlock with each other.
 - a thin coating of synthetic resin which fills up the spaces between the scales.

Wool items that are labelled ‘machine washable’ or ‘superwash’ have undergone this finish.

A shrink-resistant finish is permanent and invisible and can be applied at any stage from carding to finishing.

Water repellency/water proofing

Water repellency is the ability of a fabric to resist wetting.

Water proofing is the ability of a fabric to prevent penetration by water.

Methods of applying these finishes have advanced over the last few years and there are now a number of different ways they can be achieved, depending on the desired performance and end use:

- coating with rubber, plastic, linseed oil, PVC and wax
- nano-technology – silicon-based chemicals are placed onto the fabric, and these wrap around the individual fibres
- non-porous or hydrophilic finishes
- laminating with microporous polymer films.

SECTION 9**Production****Elaboration**

- Job production
- Batch production
- Continual-flow production

Types of production systems**Job production (one-off production)**

- this is used when a one-off item is to be made.
- the product is made from start to finish by one person or a very small team, all of whom are highly skilled.
- the time taken will depend on the design of the garment and the techniques used to create it. For example, a hand-beaded dress will take considerably longer than a chiffon-layered dress.
- garments made by job production are unique, of high quality and require a great deal of a worker's time to complete, therefore they are likely to be expensive.

Examples of items made in this way are:

- theatre costumes for a particular character
- designer garments from a fashion house
- wedding dresses.

Batch production

- suitable for relatively small numbers of identical or similar products.
- products made in specific quantities.
- produced by a team of workers.
- team of workers can make products in less time than one person.
- the team share tasks and equipment and may become skilled at one or more of the operations involved; however, work may become repetitive and boring.
- allows for flexibility when orders change or market demand changes.
- cheaper than job production, because production costs are lower.

Examples of items made in this way are:

All-in-one protective overalls – made in batches of different colours, sizes, patterns, design detail (e.g. number of pockets), collar shapes, cuffs/no cuffs, fastenings (e.g. zip/buttons).

or small batches of different items, for example T-shirts, trousers, tops, sweatshirts, joggers.

Continual-flow production

- suitable for large quantities of the same product.
- workers are semi-skilled/unskilled and work on a production line.
- each worker does one part of the manufacturing process before passing the product on to the next person. This enables them to make identical products very quickly (e.g. one pair of jeans every 10 minutes).
- working on a production line can be very monotonous.
- usually requires high investment to buy computerised machinery.
- machinery often runs 24 hours a day – 7 days a week.
- if there is a breakdown on one part of the assembly line the whole line grinds to a halt.

Items have a lower unit cost due to:

- materials bought in bulk (economies of scale).
- use of semi-skilled or unskilled labour.
- initial cost of machinery being spread over a long period and offset by the high number of items produced.

Examples of items made in this way are jeans, socks, basic T-shirts, underwear, tights, disposable cloths, plain weave cotton.

Stages of production

Elaboration

Design, selecting raw materials, identifying component parts of a garment/item to plan the manufacturing process, lay planning, cutting, assembly, finishing, pressing, audit and quality control

Design

When a problem or opportunity has been identified in the market it is then presented as a **design brief**. A design brief is a short written statement of intent. For example,

‘Design and make a sportswear garment using the property of elasticity.’

Each aspect of the brief must be researched in detail; this is called **market research**. The aim of market research is to gather as much information about the problem/opportunity as possible. For example,

- current trends/fashions
- future trends/fashions
- information about similar/current products
- gaps in the market
- consumer opinion
- expert/professional opinion
- information about resources. For example, fabric properties.

This information is collected and analysed. The conclusions drawn lead to an exact set of details required. This is called a **specification**.

Specifications lay down a set of standards for the product which must be maintained. The specification may be divided into four areas:

- fabric
- product
- manufacturing
- garment.

The design brief and specification provide the information required to begin designing. Designers must present more than one idea in order to consider as many solutions as possible to be able to present a

'collection'. Brainstorming will allow all ideas and thoughts to be considered.

Designing starts with drawings, sketches and pictures. These are used to:

- generate ideas
- develop and improve designs
- present ideas to others
- evaluate designs.

The **design concept** is formulated and may be created by:

- mood boards/presentation drawings, showing greater detail and possible colours, patterns, textures and fabrics. Swatches of fabric, trimmings, yarns and colour are attached to the board to help visualise the finished product.
- computer-aided design (CAD), used to make alterations fast and simple.
- working drawings, using CAD, showing exact details of fabric, resources, components, sizes, and manufacturing techniques to be used.
- a toile, which is the garment made up cheaply from calico to determine drape, line, fit and overall effect/appearance.

The design concept is checked carefully and testing is carried out to:

- find the best fabric, texture, colour and finish/decoration.
- check fabric properties which can be simulated on the computer.

Computer images can be displayed in 3D, showing how the fabric will handle and drape. Information for manufacturing can also be provided (for example, construction and finishing details). The information gained from these tests is used to alter/adapt the product.

Selecting raw materials

Fabric is selected according to its compatibility with the product's function. The fabric's properties/characteristics must suit the product's end use. A fabric list is produced to inform the manufacturer what types and how much of each fabric is required. Consideration must be given to:

- fibre content
- fabric quantity

- fabric quality
- fabric width
- fabric weight
- density of weave/knit
- structure of weave/knit
- possible shrinkage
- colour options
- special finishes
- possible surface decoration
- trimmings
- cost.

Identifying component parts of a garment/item to plan the manufacturing process

- Garments are made from a number of two-dimensional (flat) shapes which when joined together create a three-dimensional (shaped) structure. These shapes are called **blocks**.
- When making a garment, pattern cutters will start with blocks. These are basic garment shapes, constructed to fit an average figure. There is a standard block for each size of a particular garment.
- Blocks are usually made from stiff card or thin sheets of metal.
- The pattern cutter will draw the standard block onto paper and adapt it to create the style and detail required by the designer. The altered shapes then become the pattern pieces for that garment. This is termed **pattern drafting**.
- Garments are made up of several different pattern pieces. Each pattern piece represents a separate piece of fabric used to make up the garment. The number, size and shape of the pieces are determined by the design of the garment. (For example, if a garment is panelled, more pattern pieces will be required to make up 'one' piece.)
- Once all garment pattern pieces have been identified they are collectively called the **master pattern**.
- **Grading** is the stepped increase/decrease of a master pattern piece to create larger or smaller sizes. This provides a range of sizes for the target group or market.

Lay planning

A lay plan is the sorting and arrangement of all individual pattern pieces onto fabric. The aim of lay planning is to position the pieces, which are irregular in shape, in such a way that they fit together as closely and efficiently as possible to minimise waste. The lay plan must also take account of any directional properties of fabrics, such as pile, stripes, checks or florals.

Lay plans can be produced in two ways:

Manually

- the pattern pieces are moved around by hand on the fabric to achieve the most economical fit.
- the lay plan is traced onto paper, which is used as a **marker planner**.

By computer

- the dimensions of the fabric and number and size of pattern pieces are entered into the programme.
- the length of fabric and pattern pieces are displayed on the screen and the pattern technologist 'walks' the pattern pieces around the fabric until the most economical lay is achieved. This may be achieved automatically, depending on the software used.
- the finished lay plan is saved and can be retrieved when necessary.

Cutting

The garment pieces are cut from the fabric, using the **cutting marker** as the outline. Firstly, the fabric is spread out in specific lengths. In industry, many layers are cut at one time, and each layer of fabric is called a '**ply**'. The cutting marker is laid on the top layer of fabric as a visual guide to cutting.

Cutting may be performed in two stages:

- rough cutting to separate individual pieces
- final cutting to accurately cut out each piece

Different methods of cutting are used, depending on the number of fabric layers, fabric thickness/bulk and fabric type:

- Hand shears are normally used for one/two plies of fabric or garments made by the job-production system.

- Straight knives have a vertical blade, similar to a saw. They are used for both coarse and precise cutting.
- Band knives have an endless steel blade which moves vertically through layers of fabric for precise cutting.
- Circular cutters are used to divide a lay into sections. They can only cut in straight lines or gradual curves.
- Die cutters are mainly used for leather, laminates or coated fabrics. They cut like a pastry cutter stamping out the fabric shape.
- Computer-controlled cutting machines are fully automated, and cut fabric using vertical knives. Mainly used in larger factories, as they are expensive to install.
- Laser beams, high-energy plasma (ionised gas) and high-pressure water jets can be used. Mainly used in larger factories, due to cost.

Assembly

The next step in manufacture is construction, when the pieces of fabric are joined together. Industrial machines vary considerably depending on the type of stitch possible, number of tasks they can do in one operation and the position of the bed plate.

Types of industrial machines:

- flat-bed machine
- raised-bed machine
- post-bed machine
- cylinder-bed machine
- side-bed machine.

Overlockers produce a professional finish and can join, trim and neaten a seam in one operation. They are particularly useful when joining stretch fabrics, as the stitch used allows the seam to stretch with the fabric.

Finishing

Finishing can be done by hand, which is expensive, or by machine. It is usually carried out by skilled workers, as the finish of a garment often determines its quality.

Finishing may include:

- addition of surface decoration – top stitching, embroidery, logos, beads/sequins.

- addition of fastenings – buttons and buttonholes/press studs/hooks/rivets.
- chemical finishes applied to the completed garment. For example, 'Teflon' water-repellency finish.

Pressing

- Pressing is setting the garment into a desired shape by the application of heat and pressure.
- Steam, compressed air and suction may all be used to assist the process.
- It is carried out both during construction and after construction on the finished garment.
- Steam helps set fabrics, such as wool, by relaxing the fibres which prevent later shrinkage.

Industry uses three general pressing operations:

- **Underpressing** is used during manufacture to press open seams and prepare them for the next stage of construction.
- **Moulding** gives a three-dimensional shape without darting. Sections of a garment are pressed over a buck (shaped surface).
- **Top pressing** is the final stage on the fully made garment.

Auditing and quality control

Auditing is the formal inspection of products for quality control.

Quality control

Quality control is a set of tests and inspections applied at specific points during the production process. A system of quality control involves inspecting samples of components at specific stages of manufacture.

This is achieved by:

- identifying potential problems which may occur.
- identifying stages of manufacture where potential problems may occur.
- identifying procedures which would eliminate/reduce the problem.
- identifying individual components where potential problems may occur.
- deciding where control points need to be.

- implementing controls.
- monitoring the system.
- taking action if necessary.
- evaluating.

The use of automated testing machines and electronic gathering and analysing of data has led to higher standards of quality and less wastage.

Quality assurance

Quality assurance is the overall approach to ensure high standards of quality throughout. It shifts the emphasis from final product testing to the control of resources and processes.

It includes:

- the way in which the production system is managed to make certain that a product meets the required specification.
- inspection.
- the development and monitoring of standards.
- implementation of different procedures if necessary.
- evaluation.

The manufacturer gives the consumer a guarantee (assurance) that the product:

- has reached a certain standard and that quality has been monitored throughout.
- meets advertising and labelling claims.
- meets legal requirements.

Quality assurance is a working practice/ethos and a number of 'codes of practice' have been drawn up. These include:

- the way a company trains its staff.
- the way a company ensures that its products and services are correct.
- how the company handles mistakes and prevents them happening in the future.
- how the company strives to improve.

Use of CAD/CAM/CIM in design and manufacture

Elaboration

Designing, pattern manufacture, lay planning, cutting, garment-handling systems.

Computer-aided design – CAD

Designers are making increased use of computer software packages when developing their designs and patterns. The use of this software enables designers to:

- draw accurately.
- simulate fabrics, stitches, texture and prints and manipulate them in size and proportion.
- visualise the product in three dimensions.
- rotate designs to see them from different angles.
- make changes and modification easily and quickly.
- digitalise the design which can then be saved or reproduced on the image of a garment.
- test the design/component parts before proceeding to the next stage.

CAD can also be used as a presentation tool. CAD images may be used to produce storyboards and be used for marketing, advertising and merchandising.

Advantages of CAD

- improves quality of presentation.
- maximises creativity.
- increases productivity.
- allows for quick and easy changes/modifications.
- reduces sample costs.
- reduces development time.

Computer-aided manufacture – CAM

CAM is a term used to describe the process of manufacture controlled by computer. Computer packages for manufacturing ensure accurate, duplicated finished products which meet the specification. CAM can be used to:

- spread fabric, ready to be cut.

- work out the most economical lay plan.
- produce a cutting marker.
- cut fabric.
- control garment-handling systems.
- provide technical specifications, size charts and construction details.
- programme knitting and sewing machines to produce a range of stitches and control the movement of small pattern pieces during stitching.
- control ordering and stock.

Advantages of CAM

- ensures accuracy throughout manufacture.
- allows a single person to control many operations at one time.
- reduces human error.
- reduces labour costs.
- reduces development time.
- increases productivity.
- speeds up response time.

Computer-integrated manufacture – CIM

- Computer-integrated manufacture is the passing of information in a computer-readable format from one factory area to another/one country to another.
- CIM links all the different areas of garment production together in one system, under the control of one computer.
- It is a totally automated production process, with every aspect controlled by computer.
- It is used to simplify production, reduce duplication and speed up response time.

Technological developments in manufacturing equipment for textiles

Elaboration

- Robotics
- Cutting equipment
- Sewing machines
- Pressing equipment

Robotics

- Rolls of fabric can be very heavy. Advanced robotic material-handling systems are used by manufacturers to reduce/speed up the movement of fabrics around a factory.
- Robotic sewing machines are still in their infancy. Fabrics can be fluid, soft and have little structure, and therefore are very difficult to control by robotic equipment.

Cutting equipment

- Computer-aided cutter plotter useful for making stencils.
- Computer-controlled cutting machines are fully automated and cut fabric using vertical knives. Mainly used in larger factories as they are expensive to install.
- Laser beams, high-energy plasma (ionised gas) and high-pressure water jets can be used. Mainly used in larger factories due to cost.

Sewing machines

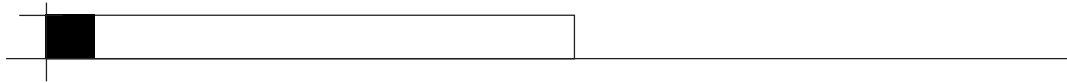
Profile sewing machines use a template and jig to control the fabric during stitching. They allow for accurate and repeatable production of components such as, pockets and collars. The fabric is attached to the jig and when the machine is started it follows the template (profile).

Computer numerically controlled (CNC) sewing machines are controlled via a computer by one of two methods:

- Learning mode – the machinist takes the machine manually through each step in the cycle, the information is then stored as a programme.
- Off-line programming – the sewing pattern is digitised from a computer-aided design package and then processed via a keyboard.

Pressing equipment

- Flat/moulding press. Pressing is done between a buck, which remains stationary, and a moveable head. The head is lowered onto the garment which is placed onto the buck. It is then steamed from above and below.
- The steam dolly. The final garment is placed over a body form which is inflated for several minutes using steam and air.
- Tunnel finisher – is used to press garments such as shirts. They are placed on hangers and passed into a room to be steamed and dried.



SECTION 10**The principles of design****Elaboration**

- Function
- Aesthetics
- Safety and hygiene
- Quality
- Durability

Function

The function of a fabric can be equated with a fabric's performance. How a fabric performs will depend upon its properties. Fabric properties that affect performance include:

warmth	insulation	coolness	absorbency
comfort	flame resistance	durability	strength
ease of care	shape retention	stretch	stain resistance
crease resistance	water resistance	breathability	

Fabric properties will in turn depend upon:

- fibre content.
- mixture/blend of fibres.
- processes used during manufacture. For example, bulking of fibres, such as acrylic.
- method of construction. For example, knitted fabric, as opposed to woven to add stretch.
- mechanical/chemical finishes.
- coatings and laminates. For example, water proofing.
- membrane layers. For example, breathability and weatherproofing.
- new technology providing protective, well-being, signalling or smart/interactive functions.

The term 'fitness for purpose' means that a product must do what it is intended to do. If an aerobics garment's function is to keep the wearer cool and dry, it must do so, otherwise it is not fit for the purpose for which it was intended. Fitness for purpose is essential for good design.

Manufacturers must design products which conform to legislation in the Sale of Goods Act 1994.

Aesthetics

Aesthetics is the ability to see beauty and harmony in good design. It is based upon the principles of design – line, colour, texture and proportion. Good design that is aesthetically pleasing has balance, rhythm and emphasis, where the principles of design all work in harmony. Aesthetics is influenced by personal taste and judgement, but also by war, travel, art, education, social change, fashion and the media.

Aesthetic elements

These are features which make a product more appealing. In textiles, that may include:

- cut of garment.
- fashion.
- appropriateness of colour, line, texture and proportion.
- added value, for example, surface decoration – beading, embroidery, quilting.
- features – what the eye is drawn to. For example, logos, design detail.
- detail, for example, top stitching, tucks, piping.
- good-quality accessories.
- coordinated look.
- packaging, which is in keeping with the product.

Safety and hygiene

Safety and hygiene are important factors when choosing fabrics for the following:

- ***Upholstered furnishings***

These should meet an agreed flammability standard and must be labelled as such, because of the danger of fire.

- ***Nightwear***

Children's nightwear and dressing gowns must by law be made from low-flammable fabrics. Adults' nightwear does not have to have low flammability, but if it does not it must carry a warning label.

- ***Children's toys***

The lion mark ensures toys are mechanically and physically safe and fire resistant. The CE symbol means that toys have passed mechanical, physical, flammability and electrical tests. The long pile of many soft toys makes them unsuitable for children under 3 months.

- ***Safety wear***

High-visibility garments for those working outdoors. For example, oil-rig workers, crossing patrol and emergency services.
Fire retardant for firemen. Waterproof for divers.

- ***Medical textiles***

Dressings and protective clothing are made of disposable fabrics to avoid cross-infection which may occur from re-use; therefore they are more hygienic.

Swabs are produced from lint-free fibres, which allow wounds to heal faster.

Quality

The quality of a textile product can be determined by the following factors:

- fitness for purpose.
- performance.
- price and value for money.
- fabric free of snags, pulled threads and flaws.
- cut – more expensive garments may have a better cut, which improves the hang, fit and drape of the garment. For example, it will not twist. A good cut will also ensure patterns are matched at seam lines.
- fit – the garment will hang well and enhance the wearer.
- finish of seams, top stitching and surface decoration.
- securing of fastenings/trimmings.
- care and cleaning instructions.

Durability

Good-quality textile products should last a long time. In clothing, the durability of a fabric depends to some extent on the frequency of use. For example, special-occasion wear will last much longer than children's clothing.

Various factors can affect the durability of a fabric:

Strength

- resistance to physical forces of abrasion, rubbing, stretching and pulling, causing thin patches, pilling and tears.
- resistance to chemicals, such as detergents, bleaches, perspiration and anti-perspirants, which gradually weaken fabrics.
- resistance to ultra-violet light, which attacks and breaks down the molecules, causing thin patches and holes.

Linen has the greatest strength followed by polyamide → polyester → silk → cotton → wool → viscose → acetate.

Colour fastness

When a fabric becomes moist, the dye will run if it is not fast. This causes the colour to 'run' onto other fabrics. Good-quality fabrics will contain dyes that are fast and withstand:

- rubbing at points of friction.
- perspiration absorption in clothing and bed linen.
- use of anti-perspirants.
- UV light on curtains and blinds.
- chlorinated water on swimwear.
- becoming wet and stop colour running onto other garments/another part of garment that is a different colour.
- washing at temperatures suited to fabric and garment.

Dimensional stability

This means the fabric does not shrink or stretch further than it is meant to. *Fabric shrinkage* may mean the garment becomes too small or misshapen. *Fabric stretch* may mean the garment will lose shape/ become baggy.

Some fabrics have greater dimensional stability than others because of their structure or fibre content.

- woven and non-woven fabrics have greater stability, as they do not have the additional stretch of knitted fabrics.
- loosely woven or knitted fabrics may stretch/go out of shape, because the yarns slip against each other.
- stretch fabrics may lose their ability to recover.
- warp knits are more stable than weft knits, due to their loop construction.
- thermoplastic fibres can be stabilised by heat setting.
- cotton fabrics can be pre-shrunk.
- wool fibres can be given a shrink-resistant finish to withstand normal washing.

Finishes

Some fabric finishes are permanent, while some are affected by laundering and wear and tear.

Permanent finishes	Finishes that may be damaged easily
Anti-static	Flame resistance
Mercerisation	Crease resistance
Moth-proofing	Stain resistance
Shrink resistance	Waterproof coatings

If a textile garment is of good quality and durability it should:

- last a long time.
- give good value for money.
- remain the correct size and shape.
- maintain a good appearance.
- give good performance.

Design constraints

Elaboration

- Cost
- Size
- Waste

Cost

The cost of a garment depends on the type of garment to be produced and its complexity, including such considerations as:

- number of pattern pieces and component parts, for example, trimmings.
- number of straightforward operations.
- number of complex operations.
- fixed costs – manufacturer's overheads – rent, machinery, tools.
- variable costs – materials, energy, labour, maintenance.
- profit margin.
- VAT costs.

The total cost of the above gives the **wholesale price**, which is the price paid by the retailer.

The selling or **retail price** paid by the customer is the price charged by the retailer. Retailers add on overheads and a profit margin which can be anything from 10% to 100%.

The profit made is called the **gross margin**.

Size

Mass-produced clothing sold in high street shops is produced in standard sizes as they must be suitable for a wide range of people. Standard sizes are produced by the British Standards Institute (BSI) who regularly monitor changes in people's measurements by carrying out surveys. The standard sizes are used to produce standard-sized blocks from which patterns for mass-produced garments are made.

In contrast, blocks made for individual clients, bespoke tailoring and haute couture are produced using exact body measurements. Patterns are further adjusted to suit the individual's requirements.

Waste

Waste can be defined as any cost that does not produce value to its customers. There are two different types of waste.

Firstly, there is waste of valuable resources, such as fabrics, trimmings and any other garment components. Waste of these resources can be minimised by:

- obtaining fibres from renewable resources.
- computerised lay planning to keep fabric wastage to a minimum.
- good-quality control systems and management.
- efficient stock control.

Secondly, there is chemical waste produced as a by-product of the textile industry.

- most textile industries produce large amounts of waste that cannot be re-used or absorbed by the environment without harm.
- manufacturers are now considering ways in which waste can be kept to a minimum by using non-toxic chemicals and re-using and recycling them.
- environmentally friendly textiles, such as 'lyocell', have now become increasingly important.



SECTION 11**Product development strategy****Elaboration**

- Concept generation, concept screening, prototype production, product testing, information and advertising materials designed for packaging, first production run, marketing plan, launch.
- Investigation of existing items/items by disassembly
- Use of a toile
- Use of a mood board

Step 1: Concept generation

This is the ‘think’ stage where ideas are generated. A designer or design team will look at various sources of inspiration. These may include:

- fashion shows across the world
- fabric fairs held in various world cities
- fashion trend forecasts
- fashion publications
- current garments of a similar shape and style
- other manufacturers
- fabrics and colours of other cultures
- inspiration from nature, such as animals, plants and buildings
- media
- music.

A mood board outlining fabrics, silhouettes, colours, patterns and a theme for coordinating different garments/items will be created.

A range of garments/items (without detailed specifications) will be developed, either in manual sketch form or by using computer-aided design (CAD).

Step 2: Concept screening

- all information gathered by the design team on new/existing styles is discussed.
- positive comments about new/existing products may influence new product ideas.
- negative comments about new/existing products may steer the design team away from including them in a new collection.
- the first batch of sketches will be pared down to form a commercially viable collection.
- testing will be carried out to find the most appropriate fabric/design/style.
- the sketches forming the basic collection will be developed further.

Step 3: Prototype production

- a prototype is a 3D model, made of an inexpensive fabric such as calico, sometimes called a *toile*.
- the production of a prototype garment/product is one way of further developing a two-dimensional designer's sketch.
- as a more realistic model, it can be shown to others in the design team.
- it enables testing to be carried out to avoid costly mistakes before full production.
- it may test – the pattern, fit, specification and drape.

See the section on use of a toile on page 98.

Step 4: Product testing

Testing is essential to ensure the success of a product in the marketplace. There are several different types of test:

- Discrimination tests, which are objective.
- Preference tests, which are subjective.
- Wearer trials.

The choice of test is important since different tests yield different information – it depends on what the manufacturer is trying to find out about the product.

- product performance is measured against the original sample and variations are noted.

- any adverse results are discussed and solutions explored.
- alterations/modifications required are incorporated into the revised specification and new samples made up.
- the process is repeated until the finished sample is considered 'fit for the purpose'.

See the section on sensory testing on page 103.

Step 5: Information and advertising materials designed for packaging

Packaging is an important marketing tool as well as having the function of protecting the product. It can be used in the following ways:

- determining the target audience to enable the manufacturer to tailor the product, information and packaging to suit the needs of the target group.
- advertising and marketing databases contain information about where the target group live, and a variety of socio-demographic variables such as occupation, income, home ownership, size of family, etc.
- this information can be used to produce an **advertising map**, highlighting where potential customers are likely to be located.
- the advertising message, combined with packaging, is a powerful force when launching a new product – it may influence its success or failure.
- packaging not only influences consumer choice, but can identify the product and may help advertise it.
- acts as an identity for the manufacturer, and therefore advertises manufacturer as well as product. May encourage brand loyalty.
- may use easily recognisable colours/logos to attract consumer.
- should reinforce the image portrayed in advertisements.
- must provide accurate information under the Trade Descriptions Act/ Sale and Supply of Goods Act.
- must protect the product in good condition.
- can be environmentally friendly, and therefore appeal to 'green' consumers.
- must be cost-effective.
- often has added value or snob appeal. For example, a Harrods carrier bag.
- appropriate for medical products to ensure they remain sterile.

Step 6: First production run

The production run is carried out per specification. Processes and operations are tested and monitored closely throughout for potential problems. Quality control is monitored at every stage.

fabrics, trimmings and notions are ordered per specification



production pattern is made from basic block



pattern is graded by computer



layplan is created by computer



fabric is spread manually or automatically to required number of plies



fabric is cut



components are stitched using the most appropriate machinery and tools



garment is pressed at various stages of production



garment is finished by hand/machine



completed garments are inspected and compared with specification



garments are packaged



production cycle is repeated according to success of first production run and number of orders received

Step 7: Marketing plan

The supplier (manufacturer) and retailer must liaise closely to satisfy changing consumer needs and to provide merchandise which the consumer will want to buy.

Factor	Importance to the final success of the product
1. Product and how it will be packaged	<ul style="list-style-type: none"> • Packaging will be designed, labelled and costed to suit the product developed and to encourage sales • Type of packaging must be suitable for the product and to ensure the product will be protected from damage and tampering • Packaging will be designed to appeal to the target group (visual image/recyclable/easy to open or use) to encourage purchase • Packaging may be available in various sizes/ multi packs to suit consumers' needs • Legal labelling designed to meet requirements of the law
2. Price	<ul style="list-style-type: none"> • Initial price of product will be decided by the potential market or target group • Product could be marketed initially at a low cost to attract interest and the price increased at a later date (introductory price) • Product could be marketed at mid/high cost to denote quality to attract a particular target group
3. Place to be sold	<ul style="list-style-type: none"> • Decide where to sell the product, e.g. supermarket or up-market shop, etc. to ensure high profile during launch • Product may be sold in particular branches of a shop to see how well it sells/who it appeals to, before launching it throughout stores nation wide • Shops have to decide where the product will be situated to attract most attention/customers
4. Promotion of the product	<p>How to promote the product to ensure maximum sales. This could include the following methods of promotion:</p> <ul style="list-style-type: none"> • Special offers and money-off coupons might be given to customers to encourage people to try the product. Good for customers on a budget as people feel they are getting a bargain. <p style="text-align: right;"><i>cont'd on page 96</i></p>

- **Free gift.** This will encourage consumers to purchase products.
- **Television adverts.** This is an effective method as a large number of people watch television
Adverts are timed during the day to suit certain target groups, for example children's television on a Saturday morning for this target market. Adverts with a jingle or which have a famous personality appeal to the public
- **On-pack coupons** may be on initial packs to encourage a second pack to be bought
- **Adverts/coupons** may be offered in **supermarkets' own magazines** to promote the product
- **Charity sponsorship**, e.g. cancer appeals – a percentage of the profit will go to charity
- **Point-of-sale display.** Customers often have to queue at point of sale/checkouts so may be tempted by attractive displays
- **Posters** if colourful may have a huge visual impact, e.g. if a celebrity is modelling the garment and the poster attracts attention then this technique could be effective. However, if the poster is unimaginative or displayed in an area where it will have little visual impact it will not be effective
- **Leaflets/fact sheets** will only be effective if attractively presented and do not contain too much text
- **Interactive website.** An interactive website would be available to only those consumers who had access to a computer and therefore may not be so effective. Up-to-date information will be given which allows the consumer to make an informed choice. Special discounts and offers may be promoted which encourage consumers to purchase.

Due to costs involved in developing the website, this is an expensive way for consumers to market their low-value products

Step 8: Launch

Methods of launching a product may include:

- fashion show
- trade show or exhibition
- photoshoot with model or celebrity
- television show or news report
- magazine or newspaper advertisement feature
- promotional in-store leaflet, mailshot or catalogue
- store window display
- posters or billboards.

The method used to launch a product will depend upon the product's:

- appeal to the target group
- uniqueness
- link to a personality/celebrity
- designer
- budget
- projected sales figures and profit

and the appropriateness of the launch method to the target group.

Disassembly

Taking apart a finished textile product is a good way to discover more about its make-up. This is called disassembly (or deconstruction) and designers often do this to evaluate existing products.

The first section to be disassembled/removed tends to be the last piece that was added during construction. Disassembly reverses the order of construction.

Advantages to the manufacturer

- to analyse and evaluate existing products of competitors.
- to discover how the product has been constructed and what fabrics and components have been used.
- to evaluate existing products in order to improve performance or production processes.
- to discover different construction techniques.
- to gain knowledge and understanding of design features.
- to produce a specification for a new product.
- to correct faults that may have occurred during production.
- to ensure quality standards are being upheld.
- used as a check against the specification.
- to consider ways in which the product may be re-used or recycled to help protect the environment.

Disadvantages to the manufacturer

- expensive.
- destroys the product.
- undesirable if the product is unique/valuable.

Disassembly is also used by trading standards officers to ensure that manufacturers are meeting legal requirements and advertising claims.

Use of a toile

A toile is a trial garment made up of calico or other inexpensive fabric/ recycled fabric/paper. In industry, fabric toiles are widely used to make up prototype garments quickly and inexpensively. Fabric toiles are preferable as they are more realistic.

Reasons for making up a toile:

- to test the pattern and ensure it matches the designer's illustration.
- to ensure the pattern meets the specification.

- adjustments can be made easily and the pattern altered before the master pattern is made and production begins.
- reduces the risk of making a costly error.
- to discover how the garment fits and shapes the body – to check proportions, dimensions and cut.
- to discover how the garment hangs and drapes.
- to make decisions about placement of decoration or trimmings.
- to test specific parts of a garment, for example adjustable straps.
- to make decisions concerning construction methods.
- to make decisions concerning tolerance levels required.
- as part of the quality-control process.

Use of a mood board

A mood board is a visual description of a designer's thoughts about what he/she wants to achieve in a product. Designers use mood boards because they are an excellent method for assembling a range of visual research material as:

- a source of inspiration.
- a visual display to show ideas.
- sources of ideas presented in an easily understandable way.
- allowing designers to collate different elements of the design/theme before proceeding further.
- helping to define the market that the product is designed for.
- allowing the designer the opportunity to make changes before work is developed.
- saving time and money if ideas are not what is required

Mood boards may include:

- a caption explaining the design theme.
- computer images, photographs, magazine cuttings of target group/lifestyle.
- images to suggest the theme.
- fabric swatches, yarn samples, possible trimmings.
- colour swatches of paper/textile.
- texture and pattern samples.
- key words.
- designer logo.
- the season the collection is aimed at.



SECTION 12**Market research****Elaboration**

- Reasons why manufacturers use market research.
- Benefits of market research to manufacturer/retailer
- Types of market research:
 - Direct and indirect
 - Qualitative and quantitative

Market research may be carried out by a manufacturer

- Before the development of a new product.
- Throughout the development of a new product.
- After the launch of a new product.
- For existing product evaluation – if the product has been available for some time and sales have dropped.

Manufacturers use market research to find out:

- What consumers want to buy/to gain consumers' opinions – if there is a need for a certain product and will it be marketable and sell, e.g.
 - whether it is cheap or expensive.
 - how exclusive/available it will be.
 - for a special group, e.g. emergency services, sportspersons, or disabled consumers.
- If there is a gap in the market – this helps ascertain if there is a need for a product or service.
- About the competition from other manufacturers.
- The market trends – which clothing fashions are popular at a particular time.

Market research for product evaluation will look at aspects of the product. The public may be asked to judge or comment on sensory properties, such as:

- appearance
- texture
- colour.

Other aspects of product evaluation may be concerned with gaining public opinion on:

- acceptability of price, i.e. will the consumer pay a certain price for the product? (We all like value for money.)
- packaging – what shape and size of packaging will the consumer prefer for the product.

The benefits of market research to manufacturers and retailers are that it:

- helps textile businesses plan how they will promote and advertise a product.
- helps the textile industries find out if a new product is a good idea before they spend too much money on product development.
- should ensure that the development of the product is profitable. Manufacturers will not make a loss and retailers will have a good turnover of goods.
- keeps track of market trends, i.e. what the consumer wants, what meets their needs and how much they are willing to spend. Manufacturers will then be able to provide a product which will sell well and profit margins will increase.
- identifies competition from other manufacturers.

There are different types of market research:

Direct and indirect

- **direct research** is obtained from the public using the telephone, personal and group interviews, testing sessions, questionnaires.
- **indirect research** is gathered where existing information is used, including reports such as *Social Trends* (HMSO publication), computer databases, CD-ROMs, collecting sales information.

Qualitative and quantitative

- **quantitative** – is obtained using large numbers of people by questionnaires and interviews.
- **qualitative** – is obtained by asking small groups of people for their opinions on products. A group usually is made up of ten people or less who are then asked about their likes and dislikes for certain products and how to make the product more appealing.

SECTION 13**Sensory testing****Elaboration**

- Reasons for manufacturers carrying out sensory testing.
- Sensory tests:
 - Preference test – rating test/ranking test
 - Discrimination test – profiling test
- Wearer trials
- Conducting sensory tests to analyse the attributes of a garment/item

Reasons for manufacturers carrying out sensory testing

Manufacturers rely on sensory testing for a number of reasons:

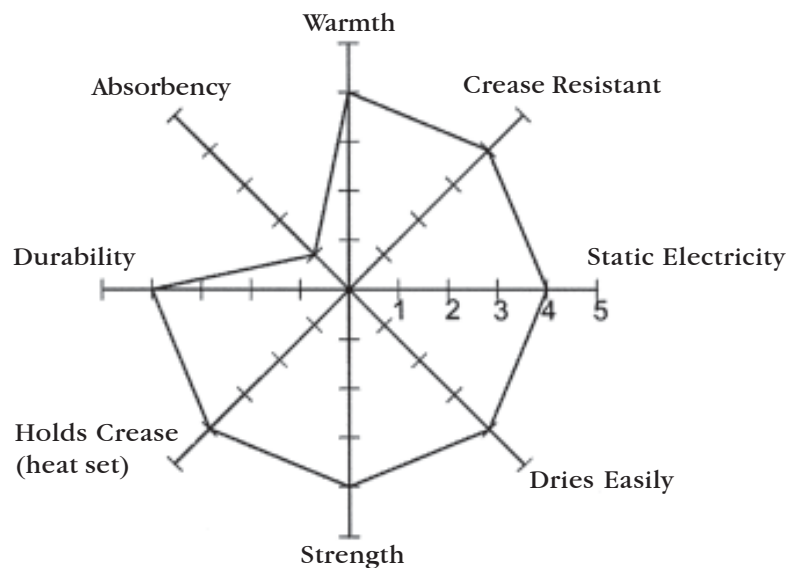
- when developing a new product, to decide its acceptability to consumers.
- to compare a product against those of a competitor, to discover if it is the sensory qualities that affect sales figures or if it is other factors, such as image, advertising or packaging.
- as a part of quality control, to ensure a consistent standard across different batches of product and to compare against original specification.
- to monitor prototypes, checking that the specification or improvements are being met.
- to assess the life of a garment/item by testing products after specific lengths of time to discover how quality and durability have been affected.
- to discover if modifications made to existing products (such as changes in style/detail/decoration) noticeably affect sales.
- to investigate why one product is more popular than another.

Sensory tests

Discrimination tests compare samples to determine whether or not there is a difference in a particular characteristic of the product. Discrimination tests are objective and the tester should not allow his personal likes and dislikes to influence his response. Different kinds of tests include:

- **Paired-comparison test**
Testers are asked to compare two samples for a specific characteristic. For example, colour or texture.
- **Duo-trio test**
The tester is given three samples, one of which is a control. The tester is asked which of the other two samples differ from the control.
- **Triangle test**
Testers are presented with three samples; two are the same and they are asked to identify the odd one out.
- **Profiling test/star diagrams**
This test provides a detailed descriptive evaluation of the product. Each line of the star is marked on a scale of 1 to 5 (1 = least, 5 = most) and each line is labelled with a descriptor. The star can have as many or as few lines as required; it depends on how many descriptions/ characteristics of the product the manufacturer wishes to measure. Profiling tests are useful for discovering the strengths or weaknesses of particular characteristics or properties of garments/items.

A star profile for work trousers is illustrated below:



Star profiling has advantages:

- it provides a clear analysis to allow the manufacturer to make decisions.
- the product need not be destroyed to obtain results.
- the manufacturer can consider the product in a measured way to allow for cost-effective decisions.

The disadvantages of star profiling are:

- the profile may not provide enough accurate detailed information.
- it may be too time-consuming a method to use to be cost-effective.
- it is not scientific enough for certain high-performance/smart fabrics.

Preference tests

These supply information about likes and dislikes. They are not intended to evaluate specific characteristics such as colour or texture. Preference tests are subjective and the response is directed by the personal feelings of the tester.

- **Rating test**

Products are scored on a 5- or 9-point scale according to the degree of acceptability to the tester.

- **Ranking**

Testers are asked to rank in order of preference a range of similar garments/items. For example, 1 = like best, 5 = like least.

Wearer trials

Wearer trials benefit manufacturers by allowing them to:

- check conditions of wear, number of washes and method of washing over a period of time or the number of days worn.
- conditions of wear factors include:
 - general appearance
 - dimensional stability
 - secureness of stitching and fastenings
 - colour fastness
 - strength and durability in relation to abrasion and stress.
- measure original sample (control) against the trial product and note variations to amend specification.
- discuss adverse effects which may occur during trial and find solutions to modify or adapt the product to benefit the consumer.

- make modifications/alterations and re-trial the product, in order to achieve a better product – fit for the purpose.
- produce garments which will suit the figure, size or image of the target market.

Conducting sensory tests

- All products should be tested under controlled conditions to minimise variables.
- Lighting should be white BSI throughout as differences can cause colour variations.
- Temperature should be controlled, dependent upon type of garment to be trialled – cool, for garments worn in cold weather, warm, for garments used in hot weather.
- Background should be plain white or grey to avoid colour clashes.
- The samples should be identical in all characteristics except the one being tested.
- The number of products tested in one session will depend on
 - the complexity/size of product
 - the number of characteristics to be tested
 - the method of evaluation
 - the time available.
- The samples should be coded and presented in the same way.
- The coding should not give the tester any hint of the identity of the sample.
- As little information as possible should be given to the tester since this may influence the results.
- To prevent forgetting the response for a sample, test sheets should be completed after each sample.
- The choice of test is important and depends on the object of the exercise, since different tests yield different information.

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