Continuing Professional Development

A-level Textiles

Maximising student performance in the AS and A2 written papers (Units 1 and 3)

Fibres and Fabrics

develop:

advance; amplify; elaborate; enlarge; evolve; grow; improve; learn; perfect; progress; train; unfold...
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Fibres and Fabrics

A sound basic knowledge of fibres and fabrics is essential for success in the Unit 1 examination and to prepare for A2 work. Students need to understand how the properties of the fibres and the method of fabric construction make fabrics appropriate for intended use.

Fibres

Fibres are the basic building blocks of fabrics. Fibres must be twisted (spun) together to make a yarn before they can be made into a fabric.

Fibres → Yarns → Fabrics

Fibres are either man-made or natural in source. Natural fibres can come from animal, plant or mineral sources.

The following tables show the classification of fibres in common use, including some brand names of fibres belonging to the fibre group.

<table>
<thead>
<tr>
<th>Fibres from natural sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural plant/vegetable (cellulosic)</td>
</tr>
<tr>
<td>Cotton (seed)</td>
</tr>
<tr>
<td>Linen (bast)</td>
</tr>
<tr>
<td>Ramie (bast)</td>
</tr>
<tr>
<td>Jute (bast)</td>
</tr>
<tr>
<td>Hemp (bast)</td>
</tr>
<tr>
<td>Pineapple (leaf)</td>
</tr>
<tr>
<td>Banana (leaf)</td>
</tr>
<tr>
<td>Bamboo (bast)</td>
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</table>

As technologists strive to find more sustainable alternatives to the established fibres such as cotton, other sources of natural fibres are beginning to be used to make textile products, eg bamboo, pineapple and peat fibres.
### Man-made fibres

<table>
<thead>
<tr>
<th>Regenerated (Natural polymers)</th>
<th>Man – made</th>
<th>Inorganic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>viscose</strong></td>
<td><strong>polyesters</strong></td>
<td><strong>Glass fibres</strong></td>
</tr>
<tr>
<td><strong>modal</strong></td>
<td><strong>Trevira®</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Lyocell®</strong></td>
<td><strong>Polartec®</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Tencel®</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>acetate</strong></td>
<td><strong>polyamides</strong></td>
<td><strong>Carbon fibres</strong></td>
</tr>
<tr>
<td><strong>triacetate</strong></td>
<td><strong>eg nylon</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Aramid fibres</strong></td>
<td><strong>Tactel®</strong></td>
<td></td>
</tr>
<tr>
<td><strong>eg Kevlar®, Nomex®, Zylon®, Cordura®</strong></td>
<td><strong>Supplex®</strong></td>
<td></td>
</tr>
<tr>
<td><strong>cupro</strong></td>
<td><strong>elastomeric fibres</strong></td>
<td><strong>Metallic fibres</strong></td>
</tr>
<tr>
<td><strong>eg Lycra®</strong></td>
<td><strong>Spandex</strong></td>
<td><strong>(aluminium, copper gold, silver, steel, titanium)</strong></td>
</tr>
<tr>
<td><strong>alginate</strong></td>
<td><strong>polyacrylic</strong></td>
<td></td>
</tr>
<tr>
<td><strong>acrylic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>rubber</strong></td>
<td><strong>chlorofibres</strong></td>
<td><strong>Ceramic fibres</strong></td>
</tr>
<tr>
<td><strong>eg polyvinyl chloride (PVC)</strong></td>
<td><strong>Rhovyl</strong></td>
<td><strong>eg used for anti-bacterial properties, thermal regulation, UV protection</strong></td>
</tr>
<tr>
<td><strong>polyolefinenes</strong></td>
<td><strong>eg polypropylene</strong></td>
<td></td>
</tr>
<tr>
<td><strong>polyethylene (eg Tyvek)</strong></td>
<td></td>
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A fibre can be short, called a **staple fibre**, or a very long continuous length, called a **filament fibre**. All natural fibres, except silk, are staple fibres. All manufactured fibres are filament fibres.

**Fibres** have different **properties** according to where they come from. **Cellulose fibres** (cotton, linen) tend to be strong and good at absorbing moisture; this means they can take a long time to dry. They can be washed and ironed at high temperatures. Unfortunately they crease badly and shrink, but they can be given a special finish to overcome this. They are also easy to set alight so can be dangerous.

**Wool** is soft and warm because it has a natural crimp – like curly human hair. Wool does not crease easily and is naturally water-repellent. It is also very good at absorbing moisture and can absorb up to 30% of its weight in water without feeling wet. Wool does not set alight easily and when it does, it puts itself out.
Wool's bad points are that it shrinks badly – known as felting. This makes it a problem to wash but it can be given a special finish to prevent shrinking. Because it is so very absorbent it takes a long time to dry, especially as most wools will shrink if put in the tumble dryer.

Silk is lightweight, very smooth and has lustre. It is a very strong fibre but becomes weak when wet, so it needs careful washing. It is warm and absorbent so it feels nice next to the skin. Although it has natural elasticity, it can crease very badly, and is very expensive.

Manufactured fibres have different properties according to their source. Standard viscose is derived from cellulose and has some similar properties to cotton. It is very absorbent but not a very strong fibre, especially when wet. It can also shrink and crease very badly. Most viscose fabrics are given special finishes to reduce shrinking and creasing. Viscose has a silky feel to it. Many new viscose-type fibres are being manufactured, eg Tencel, which are stronger and do not crease and shrink.

Synthetic fibres, such as polyester and nylon, are very strong, good at resisting abrasion, and lightweight. Most synthetic fibres are not good at absorbing moisture so they dry quickly – this is not the same as being waterproof! Synthetic fibres do not shrink and do not crease much during normal use. Because they are thermoplastic, they will become soft when hot, so should not be washed at high temperatures; otherwise they will become badly creased during the washing and spinning process. These creases are not easy to remove as the fabrics melt under a very hot iron with disastrous consequences! Synthetic fibres do not set alight easily but will melt and drip – this molten fibre is very hot and can cause serious burns.
Internal fibre structures

In order to fully understand fibre properties, it is necessary to look at internal fibre structures. This can be done in a relatively simple way.

All matter is composed of atoms which join together to form molecules. Molecules can link together to form long chains – **polymers**.

All textile fibres are made from long-chain molecules, but the combination of atoms in the molecules will vary for the different fibre types.

If the chains of molecules inside the fibre are tightly packed, and lie parallel to each other and to the length of the fibre, they are said to be **highly oriented**.

In a less oriented fibre, the molecular chains are less tightly packed together and lie at various angles to the longitudinal fibre axis.

All fibres have areas of high orientation, called **crystalline regions**, and areas of low orientation, called **amorphous regions**. Crystalline and amorphous regions occur randomly throughout the fibre and not in any particular order. Each chain of molecules will be a part of a number of crystalline and amorphous regions and this helps hold the fibre together.

The diagram below represents a simplified and exaggerated view of the internal structure of a fibre.

**Fibre properties** are related to the internal fibre structure.

1. **Strength:**
   If the chains of molecules in a fibre are highly oriented and the fibre is put under tension, all the molecules share the load, so the fibre is strong.
If the molecules are less oriented, some of them will 'straighten out' in the direction of the fibre length when tension is applied, so the fibre will be less strong but able to extend more before it breaks. Cellulosic fibres have many crystalline and amorphous regions, linen having more crystalline regions than cotton, which accounts for its being stronger than cotton.

Regenerated cellulose fibres such as viscose have many amorphous regions so they tend to be weak, although it is possible, using modern production methods, to manipulate or engineer the internal structure to produce viscose with better strength.

A synthetic fibre starts off as a liquid spinning solution which is forced through a spinneret. When the filaments leave the spinneret they are still in a liquid state and are completely amorphous. The fibre ‘sets’ or dries from the outside to the centre. As it is setting the fibre is stretched and this causes the chains of molecules to become oriented and lie parallel to the fibre axis. This process is called **drawing** and gives synthetic fibres their superior strength.

The diagram below is a simplified representation of the stages a drawn synthetic fibre passes through.

![Diagram showing the stages of a drawn synthetic fibre](image)

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### 2 Ability to absorb moisture:

It is difficult for water molecules to penetrate between the tightly packed fibre molecules in crystalline regions. Amorphous regions are more easily penetrated by water because of the larger spaces between the molecules. Natural fibres and viscose types are very absorbent because they have more amorphous regions. Synthetic fibres are more oriented so the water has few places to go. This is the reason why they do not absorb moisture well.

‘Dry’ fibres like synthetics also develop static charges.
3 **Extensibility and elastic (crease) recovery:**

Extensibility is the measure of how much a fibre will stretch or extend before it breaks. The chains of molecules inside a fibre are joined sideways to each other at intervals along their length. These cross-links stop the chains of molecules from sliding past each other and are important in understanding extensibility in fibres. The strength of the cross-links varies in different fibre types, and this strength is partly responsible for a fibre’s ability to return to its original length after being stretched.

Fibres with lots of crystalline regions, eg linen, tend to be stiff and inflexible. This is because the chains of molecules do not have spaces where molecules are less tightly packed to move in to. If these fibres are subjected to excessive stretching and bending the cross-links between the chains of molecules will break, causing irreparable damage and weakness where the breaks have occurred. This causes wrinkling and creasing of fabrics due to the weakened structure of the fibres.

If a fibre has a mix of crystalline and amorphous regions the chains of molecules can move when the fibre is stretched or bent. This ability to flex gives the fibres a softer handle. If the chains of molecules within these fibres are held together with only weak cross-links, they will be easily broken when stretched or bent and this will cause wrinkling and creasing of fabrics made from them.

An elastic fibre is one whose chains of molecules can recover from strain after the applied load is removed and return to its original length after stretching.

The table below shows the strengths and extensibilities of fibres.

Strength is measured in grammes per tex, and extensibility at 65% relative humidity at a temperature of 20ºC.

![Graph showing strength and extensibility of various fibres](chart.png)

*Source: ‘Technology of Textile Properties’*

From studying the chart it can be seen that cotton is strong but not very extensible, wool has moderate strength but is very extensible, nylon is strong and very extensible.
Fibre cross-section formation

The cross sectional shape of a fibre can have an impact on the properties of that fibre. All fibres have their own naturally formed cross section, but it is possible to change –or engineer - the cross sectional shape of man-made fibres in order to build-in specific properties.

The shape and formation of the fibre length can also affect the properties of the fibre.

Cotton

An immature cotton fibre has a round cross-section which is where the plant nutrients pass along the fibre as it is growing. When it is picked, the fibre dries out and collapses into a flattened bean-like cross section. It also twists along its length so that it looks like a twisted and flattened ribbon.

The smooth surface prevents air from being trapped between the fibres, making cotton a poor insulator so cool to wear. The flat twisted form does not reflect light well so cotton does not have a lustre.

Source: ‘Textiles Technology to GCSE’

Linen

Linen has a many-sided cross section and a long, regular length to the fibres. This regular surface is able to reflect light quite well which gives linen its slight lustre.

The cross markings across the fibre length are called nodes and these give linen its slubbed appearance.

Source: ‘Textiles Technology to GCSE’
Silk

The silk worm spins 2 triangular shaped filaments, one from each side of its mouth. These 2 filaments are held together with sericin which is a natural gum produced by the silk worm. This triangular cross section gives silk its lustre and softness.

Source: ‘Textiles Technology to GCSE’

Wool

The wool fibre is similar to human hair. The surface of the fibre is covered by overlapping scales. The outer surface of the wool is covered with natural grease called lanolin, and this makes the wool fibre water repellent.

Source: ‘Textiles Technology to GCSE’

The scale on the wool fibre can lock together when the fibre is in the presence of heat, moisture and friction. This will make the wool shrink and the property is used when making felt from wool fibres. It also explains why wool can be difficult to care for, and why it needs gentle hand washing or dry cleaning.

Source: ‘Textiles Technology to GCSE’

Wool fibres also have a natural crimp and when many fibres are spun together, the crimp, and the scales, will cause them to stand away from each other and trap air. This is what gives wool its ability to insulate.

Source: ‘Textiles Technology to GCSE’
Viscose
Longitudinal view of viscose fibre.

Viscose filaments are manufactured fibres. The spinning process for viscose fibre involves coagulating, or setting, the liquid fibres in a bath of chemicals. The fibres set at an irregular rate which makes tiny grooves, or striations, along the length of the filaments.

Source: ‘Textile Science’

Cross section of viscose fibre

These striations give the fibre an irregular cross section.

Viscose has a relatively smooth surface which is able to reflect light. As this can be an unwanted property, a de-lustering chemical is often added to the spinning solution to reduce this ability to reflect light.

Source: ‘Textile Science’

The shape of the cross section of a fibre affects its lustre and handle. The shape of the cross section of manufactured fibres can be changed by using spinnerets with different cross sections.
Synthetic fibres

Synthetic fibres are produced as continuous filament and look like glass rods. This very smooth surface enables them to reflect a lot of light. Because they are so smooth they do not trap air and are therefore poor insulators.

Source: ‘Textile Science’

The cross section of nylon and polyester is circular.

Source: ‘Textile Science’

The cross section of nylon can be modified to a tri-lobal shape. This means that the fibre surface will have less contact with skin when worn, so that it becomes more comfortable.

Source: ‘Textile Science’
Inorganic fibres

Inorganic fibres come from glass, metal, ceramics and carbon. Inorganic fibres, both metal and non metal ones, are more resistant, more rigid, have an higher melting point and are more heat resistant than traditional fibres. They are also totally non-flammable. Their textile importance is limited but developing, but they are widely used as reinforcement in composite materials. Ceramic and carbon fibres are important in the production of nano-fibres.

Ceramic fibres are noted for their high temperature resistance as they can withstand temperatures of more than 1000 °C. They are also extremely lightweight, have low thermal conductivity and chemical stability - they can resist attack from most corrosive chemicals. They are widely used in thermal insulation industry.

Ceramic molecules can be incorporated into synthetic fibres, either by coating them with ceramic particles or by encapsulating them within the fibre. The inclusion of ceramic molecules in a synthetic fibre can give the fabric UV protection properties, eg Esmo and Sunfit fabrics. Ceramic molecules can also make fabrics which are able to regulate body temperature, eg Thermolite, a lightweight fibre with a hollow core.

Carbon fibres (graphite fibres) are extremely thin and composed mostly of carbon atoms. The carbon atoms are bonded together in microscopic crystals which make the fibre very strong for its size. Several thousand carbon fibers are twisted together to form a yarn, which may be used by itself or woven into a fabric. Carbon fibre is very strong but lightweight and these properties make it very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports. However, it is relatively expensive when compared to similar materials such as fibreglass or plastic.

Carbon fibres are used in the production of electro-conductive fibres used to make intelligent fabrics or wearable computers. Because the fibres are flame retardant they are used to make some specialised fabrics such as those used for aeroplane interiors.

Glass fibre (fibreglass) is made of extremely fine fibres of glass. It is used as a strengthening agent, eg glass reinforced plastic. Fibreglass is commonly used as an insulation material and to produce flame retardant fabrics for specialised applications.

Metallic fibres are made from metal, plastic-coated metal or metal-coated plastic. Gold and silver have been used as yarns for fabric decoration since ancient times. Today, aluminium yarns have replaced gold and silver and metallic filaments are coated with transparent plastic film to prevent tarnishing. Lurex is a common plasticised metal yarn.

Titanium is a metal which is able to memorise a shape and is used, for example, in intelligent clothing. Silver coated fibres provide protection against bacteria, electric shock, can aid moisture management and provide thermal protection.
Yarns

All fibres, whether they are staple or filament, must be made into yarns before they can be woven or knitted into a fabric. Yarns are essentially long, continuous strands made up of fibres twisted together.

Continuous filament yarns are made by lightly twisting filament fibres together. Staple yarns are made from short staple fibres; these have to be carded, or combed, so that they all lie in the same direction, before being twisted together to form a yarn. Filament fibres can be chopped up into short staple fibres; this means that they will need to be twisted together to make a yarn. If a filament fibre is to be blended with a staple fibre, the long filaments need to be cut into staple before being spun into yarn.

Filament yarns are smooth but staple yarns are hairy. Hairy yarns are good at trapping air between the fibres – this means that they are good insulators and will make fabrics which are warm. Smooth yarns are not so good at trapping air and so make fabrics which are not good at insulating. The hairy yarns can also trap moisture between the fibres.

Most modern fabrics contain more than one fibre. This is because there is no such thing as a perfect fibre so manufacturers include different fibres in a blend. Blending is achieved by spinning two or more fibres together to make a yarn. In order to make a successful blend, the fibres must be of the same length so that they can be mixed together before they are spun into a yarn. Continuous filament yarns can be twisted together to make a multi-filament yarn, eg polyester and nylon.

The main reasons for blending fibres are:
- To help reduce the cost of the fabric
- To give different effects in the texture and handle of the fabric
- To allow for novelty effects when the fabric is dyed
- To make a fabric with specific qualities for a particular end use
- To make the fabric stronger
- To make a fabric easier to care for
- To enable fabrics to be more crease resistant
- To allow fabrics to be heat set.

Popular blends include:

Polyester and cotton blends are commonly used to make a wide variety of fabrics. Different percentages of cotton and polyester are included according to what the fabric is to be used for. The polyester helps cancel out the shrinking, creasing and slow-drying of cotton. The cotton makes the fabric better at absorbing moisture and makes the fabric feel nicer next to the skin.

But, polyester/cotton blends are very dangerous when they set alight. This is because the cotton burns easily and holds the polyester in place. As the polyester gets hot it starts to melt and drip. The fabric burns very fiercely at high temperatures and gives off a lot of black smoke.
Elastomeric fibres like **Lycra** are blended with many other fibres. The Lycra gives the fabric some stretch – the higher the percentage of Lycra, the more the fabric will stretch. Only **very small amounts** of Lycra are needed to give a lot of stretch – Lycra is never used on its own to make a fabric because of its high stretch. Elastomeric fibres are combined with other fibres by **core-spinning**, wrapping or interlacing. The Lycra also makes the fabric more crease-resistant. Fabrics containing Lycra should not be washed and ironed at high temperatures as this can damage the Lycra.

**Viscose fibres** are used in many blends. They help make the fabric more absorbent and soft to handle. As viscose is cheap to manufacture, it can help reduce the price of the fabric.

**Wool** is often blended with **nylon** for products such as socks, trousers, jackets and coats. The wool makes the fabric soft and warm, and makes it a bit more luxurious. The nylon gives improved strength and resistance to abrasion, makes the fabric lighter in weight, and helps prevent the wool from shrinking when it is washed. The inclusion of nylon will also reduce the overall cost of the fabric.

Some other fibre blends include:

- viscose and nylon
- polyester, wool and Lycra
- cotton and Lycra
- linen and polyester
- silk and polyester
- silk and cotton
- acrylic and polyester.
Giving yarns some texture

Yarns, are generally smooth, especially those made from synthetic filament fibres. They lack texture and are poor insulators.

Yarns can be given texture to make them more interesting, and/or to help them hold more air so that they will be better insulators. The fine tubes created in and between textured yarns help them to carry water, or become more able to wick moisture.

Source: ‘Textiles Technology to GCSE’

The characteristics of continuous filament fibres can be changed by introducing crimps, crinkles, snarls and snarls into the filaments. Many of the methods used to give texture to yarns depend on the thermoplastic nature of the fibres which allow the filaments to be heat set onto the new shape.

The most important methods of texturing yarns are shown below.

**False Twist**

A false twist yarn is made by twisting the yarn tightly, heat setting it, then untwisting it. The yarn will then have lots of crinkles and snarls.

**Bulked continuous filament (BCF)**

A jet of hot fluid pushes thermoplastic yarns against a cold surface. This causes the filaments to cool into a saw-tooth edge shape.

**Air-jet texturing**

A jet of compressed air is directed at the continuous filament yarn. This causes the individual filaments to become tangled and create small loops along their length. This method can be used with any continuous filament yarn as it does not depend on the thermoplasticity of the fibres.

Source: ‘Technology of Textile Properties’
Fancy yarns

Fancy yarns give texture and interesting effects to fabrics. They have irregularities and other effects added to the length of the yarn, and can be made from any fibre in either continuous filament or staple form. The most common form is to have three different parts to the yarn: the fancy effect thread is twisted round a base thread. A tie thread is then used to hold the two together. The threads are often of different thicknesses in order to create the special effect. Some of the most common fancy yarns are shown below.

Slub yarn

This is usually made spinning thicker and thinner sections of yarn at irregular intervals.

This yarn gives a fabric a similar texture and appearance to linen or wild silk.

Bouclé or loop yarn

These yarns have looped projections and are used to make bouclé fabrics which have a textured bumpy feel.

Chenille yarn

This has fibres projecting from all round a central core of threads, produced by weaving an open net-type fabric which is cut afterwards. Chenille fabrics are soft and bulky.

Source: ‘Technology of Textile Properties’

Metal yarns

Most metal effect yarns are made by sandwiching sheets of aluminium foil between sheets of clear plastic film. The laminate is then cut up into a flat, ribbon-like yarn. It is possible to use other metals such as gold and silver to make yarns, but these are very expensive and rarely used.
Corespun yarns

These are made by twisting a sheath of fibres round a core made from a different fibre. The most common type of yarn made using this method is one which has an elastomeric fibre as the core, and synthetic or natural fibres as the sheath.

The stretched elastane fibre is covered by a sheath of non-elastic fibres. These may be natural or synthetic fibres, or a blend.

Source: ‘Textiles Technology’

Folded and cabled yarns

Different types of yarn are manufactured for different end uses. Standard single yarns spun from staple or continuous filament fibres are easy to make and therefore fairly inexpensive to manufacture. But these single yarns are not of an even thickness along their entire length, and this leads to weak spots.

If a yarn is to be used for a better quality fabric, two single yarns are twisted together to make a folded yarn. This helps to even out the thick and thin places.

Folded yarns are also more lustrous than single yarns.

Source: ‘Technology of Textile Properties’

Sewing threads need to be of an even thickness with no weak places, so folded or cabled yarns are used to make them.

A cabled yarn is made by twisting two folded yarns together. These yarns are not used much for clothing fabrics, but are more likely to be used for industrial applications such as conveyor belts.
The effect of twist

The twist in spun yarns holds the fibres together and gives strength to the yarn. The more the yarn is twisted, the tighter and stronger it becomes. If there is too much twist put into a yarn, it will cause the yarn to twist back on itself and this will make it untwist and snarl. This is how the crinkly yarns used for crepe fabrics are made.

If the fabric is to be brushed then a yarn with a low twist is needed. This allows the fibres to be teased apart easily to form the raised nap.

Twist can be put into yarns in one of two directions – S or Z.

When an S twist yarn is folded with a Z twist yarn, the yarn is said to be balanced and is less likely to untwist or snarl.

Yarn sizes

Yarns and fibres have a wide range of thicknesses (diameters) and it is important to select a yarn of the correct thickness for a specific purpose.

The thickness of a fibre or yarn is not a good way to measure its size as it can vary along its length. Instead, the size of a fibre or yarn is given as tex or denier.

Tex and denier are worked out by weighing a specific length of the filament fibre or yarn. The thicker the filament or yarn, the higher the number of the tex or denier, eg, 60 denier tights are thicker than 15 denier tights.
Making Fabrics

Woven and knitted fabrics are made from yarns spun from fibres.

**Woven fabrics** are produced by interlacing two sets of threads at right angles to each other. The **warp** threads are fixed in the loom and run the length of the fabric. The **weft** threads run across the fabric from selvedge to selvedge. There are **three main types** of weave: plain, twill and satin. Other weaves are variations on one of these types.

**Plain weave** is the simplest weave.

The main features of plain weave are:

- It is the **simplest** and therefore the **cheapest** weave to produce.
- It has a **plain surface** and makes a good background for **printing**.
- It has the maximum number of interlacing points and thus produces **firm, strong fabrics** which look the **same on both sides**, eg calico, lawn, poplin, chiffon, taffeta, organdie, flannel.
- A variety of **decorative effects** can be produced by using dyed yarns, eg gingham, madras, chambray. Fancy yarns can also introduce interest to the fabric.

**Twill weaves** produce **diagonal lines** on the cloth.

The main features of twill weaves are:

- It is the **hardest wearing** weave.
- It is **more complicated** to produce thus **more expensive**.
- Fabrics have a definite **right and wrong side**.
- Because of their **uneven surface** twill weaves **show dirt less** than other fabrics.
- It makes a **firmer** fabric which is **more likely to fray** because there are fewer interlacing points.
- There are **more variations** possible with twill weaves, eg denim, gabardine, drill, herringbone twills, cavalry twill, dog’s-tooth check.
Satin weave fabrics have a smooth and lustrous appearance.

The main features of satin and sateen weaves are:

- The weft yarns are almost completely hidden by the warp yarns which 'float' over them in satin weaves eg satin.  
- Because the threads do not interlace very often, satin weaves fray easily.  
- Satin weave fabrics have a right and wrong side.  
- The shiniest satins are made from filament yarns.  
- The floats snag easily so satins are not very hardwearing.  
- There are not many variations possible.  
- Fabrics made from satin and sateen weaves include duchesse satin, satin-back crepe, heavy bridal satins, lighter weight satins for linings and lingerie.

Pile weaves have tufts or loops of yarns which stand up from the body of the fabric. They are classed as three yarn system woven fabrics.

1 Warp pile weaves have cut loops, eg velvet. One method of producing velvet is to weave 2 cloths face to face with the third (pile) warp alternating between the 2 fabrics. The pile warp is specially woven in to form the pile. A knife moves back and forth at the front of the loom and cuts the pile warp as the fabric moves forward as it is woven. This produces 2 separate pieces of velvet at the same time.

Source: ‘Technology of Textile Properties’
2  **Weft pile weaves** have cut loops produced after weaving, eg **velveteen, corduroy and needlecord**.

**Velveteen**

![Velveteen diagram]

Velveteen has a short pile produced by cutting the third (pile) weft after weaving.

*Source: ‘Technology of Textile Properties’*

**Corduroy and needlecord**

![Corduroy and needlecord diagram]

Corduroy is a ribbed cut weft pile. The pile runs parallel to the selvedge. The cords can vary in width to give jumbo cord (very wide) or needlecord (very fine).

*Source: ‘Technology of Textile Properties’*

3  **Uncut loop pile weaves, eg terry**

![Uncut loop pile diagram]

The pile warp remains slack and loops above and below the fabric to form the pile.

Towelling fabrics are produced using this weave.

*Source: ‘Technology of Textile Properties’*

**Jacquard** is another type of weave which produces **complicated patterns**, often designed and controlled by computer programmes.

**Special effect Fabrics**

Eg seersucker, crepes, bouclés.

Colour woven fabrics, eg stripes, checks, shot effects

These effects can be achieved in a number of different ways.
**Knitted fabrics** consist of yarns looped together in a variety of ways. The two main types of looping are **weft knit** and **warp knit**. Other fabrics are variations on one of these types.

**Weft knit** is the simplest type; it can be produced by hand, on a domestic knitting machine or industrially. It is made up when one yarn travels the width of the fabric, in the same way that a weft thread goes across from selvedge to selvedge in a woven fabric. Each successive row of loops is drawn through the previous row of loops in the fabric.

The **horizontal row** of loops is called a **course**.

Each **vertical row** of loops is called a **wale**.

**Single jersey fabric**

![Diagram of single jersey fabric]

The main features of weft knit are:

- It has a **lot of stretch** and is easily distorted, especially when washed
- It **drapes softly** and easily takes the shape of the figure
- Fabrics **do not crease** easily
- Fabrics **trap air** and are good insulators in still air. But moving air is able to get through the gaps in the fabric thus making it cool to wear in these conditions
- It **ladders easily** if snagged
- There is a distinct back and front (face) of the fabric.

**Variations** of weft knit include single jerseys (stockinette), double jerseys (interlock), rib knits, sliver knits (pile type fabrics), Jacquard knits (complex patterns with different coloured yarns).

Weft knitting can produce tubular fabrics.

**Polyester fleece** is a weft knitted fabric which has an extra yarn knitted into it. The fabric is brushed on both sides to give a soft dense nap which is able to trap air. This makes it a good insulator.
Warp knit is a more complicated structure using many separate yarns which are interlaced sideways. The loops are formed along the length of the fabric in the same way that the warp thread runs parallel to the selvedge of a woven fabric. The **horizontal row** of loops is called a **course**. Each **vertical row** of loops is called a **wale**.

In more complicated warp knits, the needles travel sideways for two or more wales before making a new loop.

The main features of warp knit are:

- It is **less stretchy** than weft knit and thus produces a firmer fabric
- Fabrics **do not ladder** and cannot be unravelled ‘row by row’
- There is greater scope for the production of a **variety of fabrics**
- It is **faster than weft knitting** and the cheapest method of fabric production using yarns.

**Variations** of warp knit include tricots, locknit fabrics, knitted velour, Raschel knits, knitted lace fabrics.
Fully fashioned knitted garments.

The garment parts are weft knitted to the exact shape and size required.

This method means that the fabric does not need to be cut to shape and reduces waste.

Fully fashioning is used in the manufacture of high quality garments.

Partly fashioned.

The garment parts are shaped at one end only, so some fabric is wasted.

Piece goods

The fabric is knitted in long lengths in the form of a tube. The fabric can stay in a tubular form, or may be cut open. The garment pieces are cut out and sewn together in the usual way. This method produces more waste.

Source: 'Clothing Technology'
Non-woven fabrics are made directly from fibres which have not been spun into a yarn. They include felts and bonded fabrics.

Felt made from wool fibres uses the natural felting ability of wool to cause the fibres to matt together using heat, mechanical action and moisture. Wool felt is expensive.

Needlefelts are made from synthetic fibres such as acrylic, nylon and acetate. These are matted together by mechanical action when barbed needles entangle the fibres to produce a dense felted fabric.

Diagram to show the principle of needle felting

*Source: ‘Textiles at the Cutting Edge’*

Bonded fabrics are made from webs of fibres which are held together in various ways:

- adhesive bonding
- solvent bonding which uses a solvent to soften and fuse the fibres together at the points where they touch
- thermal bonding which utilises the thermoplastic properties of some or all of the fibres, to fuse all the fibres together using heat and pressure
- stitching with thread (stitch bonding).
The main features of non-woven construction are:

- Cheap to manufacture as fabrics are made straight from fibres
- Because there is no ‘grain’ they are cheaper to use
- They do not fray when cut
- They are not as strong as woven or knitted fabrics
- They do not drape as well as woven or knitted fabrics.

**Typical uses** for bonded fabrics include disposable products, interfacings, filters, insulation and liners.

**New developments in non-woven fabrics**

There are many new developments involving non-woven fabrics as they can be given special characteristics and finishes appropriate to the intended end-use.

For example, flame retardant non-woven fabrics used for disposable head rest covers on public transport, the use of carbon fibres for fabrics for military and filtration uses, non-woven fabrics used for insulation and decoration of car interiors, Tyvek used in buildings, fabrics impregnated with beneficial chemicals such as those used in bandages and wound dressings.

These new fabrics are usually stronger and can be washed. Because they do not fray, they are easily cut using lasers.
**Fabric Finishes**

Fabrics need to be fit for their intended use. Many fibres used to make fabrics have disadvantages. It is possible to cancel out some of these disadvantages by applying a fabric finish. An applied finish always costs money, so a manufacturer will need to think about how important it is to put a special finish on to a fabric depending on what it is to be used for. Some common fabric finishes are:

- shrink resistant; use on cotton and woollen fabrics
- crease resistant/non-iron finish used on cotton, linen and viscose fabrics
- flame retardant used on cotton, linen and viscose fabrics, and those intended for children's nightwear or furnishings in public buildings
- water-repellent used on fabrics for outdoor wear
- stain repellent, eg Teflon
  (NB most water repellent finishes also make a fabric repellent to water borne stains.)
- mercerisation of cotton fabrics to add strength and give a lustre. It also means that the cotton will be better at absorbing dyes.

The process involves treating the fibres with caustic soda. This changes the cotton fibre from the ribbon-like twisted form to a more circular cross-section.

- heat setting, using synthetic fibres, makes fabric crease and shrink resistant
- a brushed finish produces a nap and traps air, eg on cotton fabrics, and makes a fabric softer, warmer to wear but more flammable
- calendaring which produces a lustre, eg on cotton fabrics
- antibacterial finish, eg on socks, which deodorises fabric
- printing and laminating processes which produce colour effects, eg a light sensitive finish which changes colour as light intensity increases

**Laminated and coated fabrics**

A laminated fabric is made up of two or more layers. The layers are held together with an adhesive or thermoplastic fibres which are heat set to fix the layers together. Typical laminated fabrics include Gore-Tex and Sympatex, lace fabrics backed by a woven fabric to give them stability.

A coated fabric has a layer of polymer film to the surface of the base fabric. Typical fabrics include PVC coated cottons, and imitation leather fabrics.
Comfort issues related to fabrics

A number of issues are related to the comfort of fabrics when in contact with skin.

**Warmth:** In order to keep the body warm, a fabric must be able to insulate. This usually means that it can trap air, in the fibres, yarns or the way in which the fabric is constructed. Trapped air is an insulator as it does not conduct heat; the more air that is trapped, the warmer the fabric.

**Windproof:** Closely woven fabrics have a high resistance to air penetration. Fabrics with large air spaces, eg loosely woven and knitted fabrics, will not be windproof.

**Humidity:** In conditions when the body is perspiring a great deal, it is important that moisture can be removed from the skin. This is usually effected by wearing fabrics which can either absorb the sweat, or wick it away from the body. Fabrics with large air spaces allow moisture to evaporate from the body. Modern synthetic fibres can be engineered to allow them to wick moisture away, eg CoolMax®.

**Scratchiness:** Some fabrics can irritate skin, eg wool. Generally, smooth fabrics are less irritating than hairy ones.

**Fabric cling:** A build up of static electricity in fabrics can cause discomfort by causing them to cling to the body.
Modern Fibres and Fabrics

Textile fibres and fabrics are constantly being updated and new ones developed. New fibres can be engineered to have properties needed for specific uses. There are many new laminating and finishing processes which give fabrics special qualities. Below are a few examples of new developments – there are many more.

**Microfibres** are an important new development. These are extremely fine synthetic fibres, mainly polyester and polyamide. Microfibres are very lightweight, soft and drape well, and are used for a variety of clothing products. They are often blended with natural fibres to give high performance fabrics for outdoor and sports use. Tactel is a polyamide microfibre, eg Tactel Aquator, Tactel Diabolo.

Tencel is a modern type of regenerated fibre engineered from cellulose. This group of fibres is classed as lyocells. Tencel can be used on its own or blended with other fibres and is bio-degradable.

**Non woven fabrics** are being made from a wide variety of fibres, and can produce interesting fabrics using the heat-setting (thermoplastic) properties of synthetic fibres. Tyvek is a modern non-woven fabric.

**Laminated fabrics** such as Gore-Tex® and Sympatex® are membrane systems which prevent water and wind from penetrating whilst allowing perspiration to escape. They are used for outdoor clothing, particularly for extreme conditions.

**Micro-encapsulated fabrics**

![Micro-encapsulation within a fibre](image)

Various health and cosmetic chemicals can be incorporated into the hollow centres of microfibres. The chemicals are released slowly and absorbed through the skin of the wearer. The chemicals break down slowly, so the effects last for a long time. This technique is also used to include ceramic molecules in a fibre. The micro-encapsulated microfibres are covered with other fibres in a similar way to producing a core-spun yarn.

*Source: ‘Textiles Technology to GCSE’*

**Smart Fabrics**

Smart or intelligent fabrics are able to react to their environment and change their properties as they are needed. They are able to sense and react to conditions around them, eg light, heat, power. Smart fabrics include those which can warn users of changes, such as loss of heat or presence of pollutants, and fabrics which incorporate electronic components, such as music systems. Many of these fabrics are used in health and safety or sportswear applications.
Textiles and the environment

The manufacture, use and disposal of textile materials and products can have serious consequences for the environment in the following ways:

- fibre sources; growing cotton uses fertilisers and pesticides which can pollute the atmosphere and waterways, synthetic fibres are made from petrochemicals which come from non-renewable sources.
- changes to the landscape because of intensive farming and deforestation, eg when growing cotton crops and producing wood for regenerated fibres.
- manufacturing and finishing processes use chemicals such as those found in dyestuffs, and their effluent can be damaging. Water and energy are also necessary for these processes.
- waste is produced when fabrics are made into products, and this may end up in landfill sites.
- the manufacture of components may use plastics and metals as well as energy.
- packaging of products can be wasteful of paper, card, plastics, printing inks, and the energy used to produce and transport the packaging.
- caring for textile products requires the use of detergents, dry cleaning fluids, energy and water.
- transportation of raw materials and finished goods produces CO2 emissions from transport systems, these contribute to global warming and damage to infrastructures.
- disposal of discarded textile products is often to landfill sites. Fabrics and components can take many years to decompose with the consequent methane production, and leeching of heavy metals from components such as zips.

There are many ways in which textiles can be made ‘greener’ and reduce their carbon footprint. These include:

- recycling of fabrics and the production of new fabrics from recycled materials can reduce waste.
- development of new fibres, such as Tencel, which come from sustainable sources and use ‘clean technology’ in their manufacture. Ingeo, a new fibre to replace polyester, is made from plant starches and is fully bio-degradable.
- using fewer dyes or develop fibres which grow ‘coloured’. Microfibres and dark colours use enormous amounts of dye and water to achieve the desired colour.
- assessing a product’s life cycle and considering its impact on the environment from ‘cradle to grave’.
- reducing the amount of packaging; ensure it is bio-degradable and recyclable.
- using detergents which are effective at lower temperatures (30ºC), and washing machines which are energy efficient and use less water. Only wash clothes when they are dirty and dry them outside when possible.
- considering using energy produced from renewable resources.
- using more environmentally friendly forms of transport and consider manufacture of materials and products nearer to the places they will be sold.
- reducing the need to discard perfectly serviceable products just because fashion has changed by having fewer changes in fashion.
Some recommended sources of information

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R D Franks bookshop at 5 Winsley Street, London W1W 8HG ([www.rdfranks.co.uk](http://www.rdfranks.co.uk)) is a treasure trove of textiles books and magazines.

There are also numerous websites which can be accessed via a good search engine such as Google.

The market is constantly changing and it is important to be aware of new developments.