Textile design: principles, advances and applications

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Chapter 2 Weave
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Abstract

This chapter considers woven fabrics, their formation, properties and applications. It explains the principles of weaving, details the basic constructions, and common weaving terminology in use. Design approaches to woven fabric design are detailed, along with the role that technology plays to create and communicate ideas. Advances in woven fabric construction, design and weaves relationship to other processes are other key topics covered.

Key Words

Weave design and manufacture; sustainability and weave as a traditional craft; computer aided design and the global textile market; fabric performance and advances in woven technology.

Contents

2.1 Introduction

Designers of woven fabrics are challenged with bringing together creative flair and technological know how to create fabrics that not only excite, but perform for a given market and end-use. This chapter outlines the basic weave structures, categories, design considerations, and opportunities available in this long established sector of the textile industry. The marriage of technology with weaving and the push to achieve cutting edge design and performance, whether in isolation of through combination with other disciplines are also covered.

2.1.1 The origins of weaving

For centuries weaving was carried out by hand in the home on a cottage industry basis, where the two processes of spinning and weaving were carried out side by side in the home. There is evidence of cloth being woven can be traced as far back as 7000 to 8000 BC in Mesopotamia and Turkey, but the exact date is difficult to pin point due to the perishable nature of textile goods.

As civilisation developed figures in royalty and the church began to indicate their stature through the use of intricately woven ornate fabrics.

In the cottage weaving industry, men and women took on the different roles of weaving and spinning, to produce a final cloth on hand operated looms, which was then sold onto a cloth merchant. Evidence of this cottage industry can still be seen in the weaver's cottages of West Yorkshire, where mullioned windows span the full width of the house allowing sufficient light into what was the loom chamber on the upper floor.

2.1.2 Industrial Revolution

By the 1700's imports of cheaper textiles from the Far East and India started to replace those produced in the UK, which drove the domestic weaving production of cloth to find a way to increase its productivity. The move from the domestic and cottage industry based route in the 18th century was made possible by a number of key inventions that mechanised some of the processes involved in producing cloth. The invention of the flying shuttle in 1733 by John Kay, required faster spinning methods to be developed, resulting in the creation of the Spinning Jenny (James Hargreaves in 1766) and Arkwright's Water Frame and Spinning Mule in 1779. Steam power to drive looms was harnessed in the 1780's, and production moved to the Mills that grew up near the coalfields of Lancashire and Yorkshire, a period which marked the end of the cottage industry and the start of the Industrial Revolution. These northern mills were some of the first factories in the world, and they saw a movement of people away from agricultural work into the factory system, driven by the rise in the cotton and wool trades.

The mechanisation of spinning and weaving improved the quality of the thread available and enabled 100% cotton fabrics to be produced. The Spinning Mule led to even finer stronger yarns and hence a lighter weight, finer cloth suitable for printing. Production speeds were increased through the use of steam power, which formed the basis for the cotton mills of the 1800's.

2.1.3 Mass production

The 19th and 20th centuries were a period that saw the creation of many new synthetic fibres and a whole new range of cloth types. Combining cotton with

man-made fibres was found to increase productivity in weaving by 30-40% due to the strength of these yarns, which resulted in fewer breakages, and enabled looms to run at faster speeds. The development of mixed blend and synthetic fabrics satisfied the growing consumer desire for garments that were easy to wash and care for. New dyestuffs and processes to manufacture these fibre types more effectively were developed for woven fabrics types such as polyester and nylon.

Weaving today is almost entirely automated, with the exception of specialist companies, or craft weavers. Production rates, efficiency and quick turn-around times are the key drivers of an industry that has to meet the demands of the 'fast-fashion' environment of the 21st century. Manufacturing is a global business for most companies, with factories moving further east to countries such as China and India, to seek lower labour and production costs, thus enabling them to remain competitive in a the cost driven apparel and furnishings markets.

Development of new woven fabric types is intrinsically linked to developments in new fibre and fabric finishes, especially in the field of performance fabrics. Traditional techniques for fabric production are being built upon gradually with advances being made in the areas such as that of 3 dimensional weaving.

Long established weaving processes like those found in the carpet industry are refreshed with the addition of new solutions of adding colour and pattern through the use of digital printing.

2.2 Weave processes.

Weave covers a broad spectrum of fabrics in use within the apparel, furnishings, transportation and performance textiles sectors. Woven fabrics can be split into two categories, flat-woven and pile woven; which have a surface effect created by loops or tufts of yarn that stand proud of the body of the cloth.

Woven fabrics are made by interlacing two sets of threads at right angles to one another. The vertical threads are known as the warp (or ends) and the threads inserted horizontally are called the weft (or picks). By lifting the warp threads in different combinations, the threads are interlaced to form a vast range of cloth types suitable for many end uses.

The loom is a weaving device that typically holds a set of vertical threads (warp) parallel to one another and through the use of a harness or shafts groups of warp yarns can be lifted in different combinations before the insertion of the weft yarn. Initially the weft insertion was done by hand, and later by shuttle allowing a bobbin of yarn to be inserted across the width of the cloth at a higher speed.

2.2.1 Loom Types

Weaving looms can be characterised according to the type of mechanism used to insert the weft, and the type of mechanism used to lift the warp ends in order to produce different patterns.

Weft insertion can be carried out using a shuttle, (the flying shuttle, was invented in 1773 by John Kay) where the weft yarn is wound onto a bobbin,

inserted into a shuttle and then inserted back and forth across the loom. The number of shuttle boxes limits the number and combinations of weft colours inserted and these looms have been superseded by faster looms and more efficient shuttle-less loom types. These looms can run at much faster speeds, so maximising production of man-made fibre types.

A rapier loom passes the yarn from one side of the loom to the other through the use of a rigid rod or flexible ribbon and may have one or two arms that meet an exchange the yarn in the middle.

Air jet looms use a jet of air to pass the weft across the width of the loom, and are usually used in the production of griege (un-finished) fabric. They have a high production rate making them suitable in the production of finely sett fabrics.

Water jet looms can operate at high speeds but are only suitable with filament yarns in the production of synthetic fabrics.

2.2.2 Flat woven

The two types of mechanism that control the lifting pattern of the warp threads and therefore the complexity of the weave pattern produced are, dobby and jacquard.

Dobby fabrics are woven on a loom with a dobby patterning mechanism. Designs produced on this type of loom, have small pattern repeats created by the warp yarns being lifted in regular sequences by a series of shafts through which the warp ends are threaded. Fabrics produced in this way include; worsted suiting fabrics, and shirting fabrics such as, poplin, flannelette and oxford.

Jacquard looms are used in the production of fabrics that are more highly patterned and these looms are capable of designs with large repeats. The jacquard loom was first invented in the 1801 by Joseph Marie Jacquard, and were fully mechanised by the 1830's. A jacquard mechanism or harness is positioned above the loom and each individual thread in the fabric is drawn through the hooks. The harness may be strung using a differing numbers of hooks and varying widths and configurations, to give pattern repeat widths from few centimetres up to the full width of the loom. Fabric types produced on these looms include furnishing fabrics, some outerwear fabrics, and cloth for transportation such as; damask, tapestry, coating fabric and aircraft seating.

Treadle looms are also still in use, but these are used primarily by the hand weaver, who operates a series of pedals connected to each shaft to form a pattern in a similar fashion to a dobby mechanism

2.2.3 Pile woven

Pile woven fabrics are produced in a number of ways, and they are commonly seen in end uses that include both carpets and towels. Loops formed in the cloth may be cut as in the case of velvets, or uncut as in terry towelling.

Patterning in pile cloths can also be controlled by a simple dobby mechanism to create plain or semi-plain effects, or more complex patterns can be formed through the use of a jacquard mechanism, for example moquette used on public transportation.

2.3 Overview of end uses

The staple cloth for thousands of years, woven fabrics is used for a broad spectrum of end uses, from the decorative to the functional. Fabrics may be produced to meet an aesthetic need, as in the case of apparel fabrics, and interior fabrics, or they may be at the other extreme and perform a specific function or have an industrial use.

Woven fabrics are used in apparel for lingerie, ladieswear, outerwear, suiting, shirting and sportswear. For interiors, curtains, soft furnishings, upholstery, carpets and bedding all use woven fabrics. Other more specialist end-uses include; geo-textiles, composites, architectural solutions, airbags, transportation, and medical textiles.

2.4 Key issues affecting the designer

Weavers have a rich and varied past to draw from and the continual strive to innovate and create new surface qualities and fabric blends has created new combinations of fibres and weaves in the realm of woven fabrics. The success of the weave designer requires an ability to be able to translate ideas not only visually, but in a textural three-dimensional form whilst working to the confines of the intended loom type.

The creative process for the design of woven fabrics can take on many forms, and is often dependant on the context of the designer and the end use of their fabrics. The inspiration for weave designs can start in the same way as that for any other fabric type, but the translation of an idea may not always be so literal due to the specific nature of a woven fabric. Colour, texture, and handle

are more likely to be interpreted into the final cloth, except in jacquard fabrics where the image of a design can be represented in the fabric.

Weave design is traditionally carried out using point-paper (a series of marks on a grid) that correspond to the ends to be lifted in the loom. Historically the designer's experience and yarn knowledge enabled them to visualise the intended appearance of their designs, designs that they were then able to check on the loom on site. Jacquard designs were painted by hand, weave structures assigned to each colour and then pattern cards were cut. We may view these processes as rather long and laborious, but the thinking time available, their knowledge base and the ease with which they could check the designs ensured a high rate of success.

2.4.1 Blurring of technologies

The boundaries between the long established fabric categories are being blurred, as technologies are no longer restricted by their perennial function as the co-existence of craft and technology move forward. Fabrics developed for performance sportswear can be seen in streetwear, and couture borrows ideas from technical and protective clothing.

New developments in yarns and finishes, print and coatings are frequently drivers in the progression of woven fabric design, and cutting edge designers will consider these in combination rather than in isolation. The work of Nuno Corporation in Japan is a good example of this approach to design; an approach that has resulted in ground breaking textiles. Recent work from Nuno has included pleated weaves using Kibiso silk (the silk from the outside

of the cocoon) whose crunchy and stiff properties are the antithesis of most silks.

2.4.2 Niche versus mass market

As large scale textile manufacture in the west has contracted and moved overseas, the detailed knowledge of structures and traditional skills base has slowly been lost with it. There is a growing prevalence of niche and specialised textile producers left in the UK, with a focus on high end, selected markets or on value added, high performance products. The High Street retailers are still an important employer of textile design graduates and many of their suppliers retain a design and development team in the UK supported by overseas manufacturing. Weave as a craft skill continues in its importance, especially in the current climate, where sustainability, and hand-made products are both valued and desirable.

The apparel industry is one where it is a benefit to have a good solid background in textiles. University's and colleges are continually refreshing the content of their textile courses, in order to provide their graduates with the design and technology skills to succeed in these fast paced and demanding textile and retail industries.

2.4.3 Craft weaving and the Designer Maker

Craft weaving has the luxury to evolve organically, through experimentation on loom with different types of yarns and structures. The intuitive response to the handle and properties of a yarn are the starting point for many textile artists, and practice leads to a thorough understanding of structure and fabric

properties. Craft practitioners are more often than not, engaged in the pursuit of their own practice, and their design output is less restricted by the demands of mass production. Traditional craftspeople have some involvement with all aspects of the design and making of a textile, whereas a designer-maker may subcontract aspects of their production to mills or finishers, after the creation of an original piece.

Textiles is now more complex than the original craft disciplines that it originally grew from, but these skills are still an essential foundation for the hybrid fabrics created to meet the desires of a more demanding customer.

2.4.3.1 Case study Margo Selby

Margo Selby was educated at Chelsea College of Art, and the Royal College of Art and launched her first collection in 2003 with the help of the crafts council. Margo's double cloth fabrics are richly coloured and have a wonderful three-dimensional surface quality formed by the lustrous un-stitched areas of her weaves. Her branded goods for interiors and fashion are sold through galleries and museums as well as through her own shop in central London. An important development between her craft and manufacturing was formed when she took part in the 'Eureka project' through Design Nation in 2008. This project to make design more accessible, resulted in a collaboration with habitat to produce an exclusive range of products that are now sold in store and online

Margo has reached the point where her work crosses the

boundary between craft and mass-production with a fabric collection aimed at fashion accessories and more recently interiors.

Fig 2.0 Double cloth woven fabric, Margo Selby

There are other crafts people that use the capabilities of the manufacturing environment to develop their work in new ways; such as Ismini Samanidou.

2.4.3.2 Case study Ismini Samandiou

Ismini Samandiou is a textile artist and designer who works with the medium of woven cloth. She is not only fascinated by the construction methods of woven fabrics and but also by the way textiles can exist within an architectural space. Her most recent work has been woven on a computerised jacquard

loom at Oriole Mill, in North Carolina, USA, a machine capable of full width pattern repeats. The resulting site specific architectural installations have a clear narrative, as could be seen in her work 'Time line' for the Jerwood Contemporary Makers, 2009 exhibition. This piece measuring 3 metres high x 16 metres long, took inspiration from the history of the Jerwood Space site and used explored the current capabilities of state-of-the-art jacquard patterning technology.

2.4.4 Commercial textile designer

Weave designers in industry require a different approach to design creation and development, even though their education may have been identical to that of the craft weaver. Tight deadlines, cost and productivity demands, coupled with performance requirements all have to be taken into account, and this necessitates a more considered approach to the design process. Re-invention of classic fabrics, a trawl through the archives, or interpretations of trend predictions are the most likely routes to a design collection for an industry-based designer; requiring a decisive focused approach.

2.4.4.1 Case Study Ulf Mortiz

'a true industrial textile designer able to cope with the limitations of commerce and production, encountering there his challenge and source of limitless energy.' Lidewij Edelkoort comments about Ulf Mortiz.

At the leading edge of the market, each year Ulf Moritz creates a visionary range of textiles for Sacho Hesslein, creators of high quality furnishing fabrics.

He is able to bring together handcrafted with technology and leads the way in using new materials and fibres at the same time re-inventing traditional techniques. Ulf pushes the boundaries of weaving through his technological knowledge of textile processes.

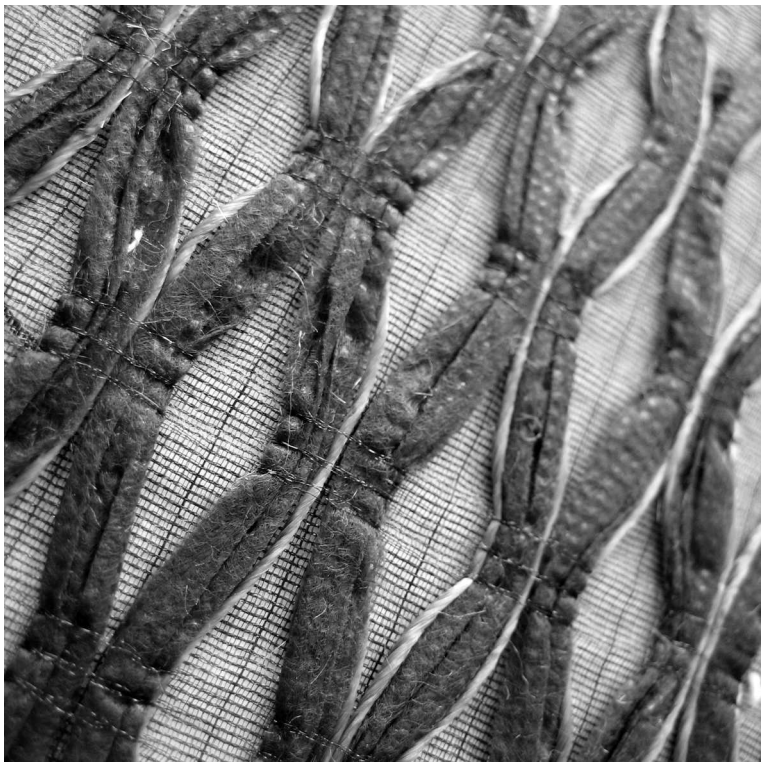

Fig 2.1 Ulf Moritz fabric for Sahco Hesslein

2.4.4.2 Case Study Kathy Schicker

A graduate of the MA Textiles Futures course at Central Saint Martins, Kathy Schicker fuses craft skills with new technology to produce smart textiles for interior environments. Part of a collective of textile designers called Puff & Flock, 'risk-taking to expand new boundaries' is their mantra. Kathy's textiles explore the integration of smart fibres into high-end woven jacquard fabrics and she is also interested in designing for educational and medical end uses. Her light emitting textiles use sunlight to activate the fibres, charging them up so that they glow in the dark, revealing previously unseen patterns within her

weaves. Kathy is a member of the TFRC (Textiles Futures Research and Consultation) at the university of the Arts in London.

2.5 Synopsis of different weave processes

This next section of the chapter will explain the basic principles and terminology used in weaving. The most commonly used weave structures and their applications will be detailed, giving an introduction to woven fabric types and their uses.

2.5.1 The principles of weaving

Woven fabrics are formed by the interlacing of two sets of threads, arranged at right angles to one another and interwoven to form the cloth. The threads running parallel to one another running down the length of the loom are called the warp or individually each thread is known as an end. The warp is kept under a constant tension and therefore must be strong enough to withstand the pressures exerted by the loom and the abrasion of weaving. Warp yarns are generally finer and have a higher twist than the yarns that form the weft, as the warp yarns need to be stronger to cope with the stresses and tension they are put under during weaving. Weft yarns or picks interlace with the warp across the width of the fabric, or horizontally in a pattern determined by the lifting of the warp ends.

2.5.1.1 Lifting plan or peg-plan

A lifting plan or peg-plan is the instruction to either lift or lower the shafts on a loom. Lifting plans are represented by a pattern of dark squares or marks on a graph paper; this point paper and the number of shafts that they represent in a loom are usually repeats of 4. The instruction to lift or lower shafts are controlled by different mechanisms on power-looms, but were traditionally controlled by pegs in wooden boards called lags, that controlled the dobby mechanism. The word peg-plan originates from this method of controlling the shafts and is still used now, even on looms that are electronically controlled.

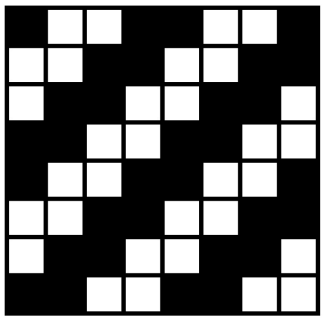

Fig 2.2 Peg plan for 2/2 twill

The patterning on jacquard looms was originally controlled by the punching of jacquard cards, a method which has now been superseded by CAD/CAM systems to lift ends in the harness.

2.5.1.2 Draft

The sequence that these ends are drawn through the shafts determines whether the pattern is simple (all-over effect) or more complex, using a series of different weave structures in combination with one another. The order in which these ends are passed through the heddles in the shafts in a loom is

termed the draft. A straight draft represents threads that have been inserted in sequential shafts (there are usually up to 16 shafts used, but there may be as many as 24) working from the front to the back. A straight draft will weave a lifting plan exactly as it is represented on the point paper.

A pointed draft, as the name suggests, is formed by threading the ends in sequence through sequential shafts, then mirroring this pattern; working in reverse, back to the front of the loom.

Herringbone drafts when combined with a 2/2 twill will form what is termed ‘a clean cut’ in the warp lifts at the point in which the draft reverses back down the shaft order. This type of draft and resulting weave structure is common in jacketing and suiting fabrics.

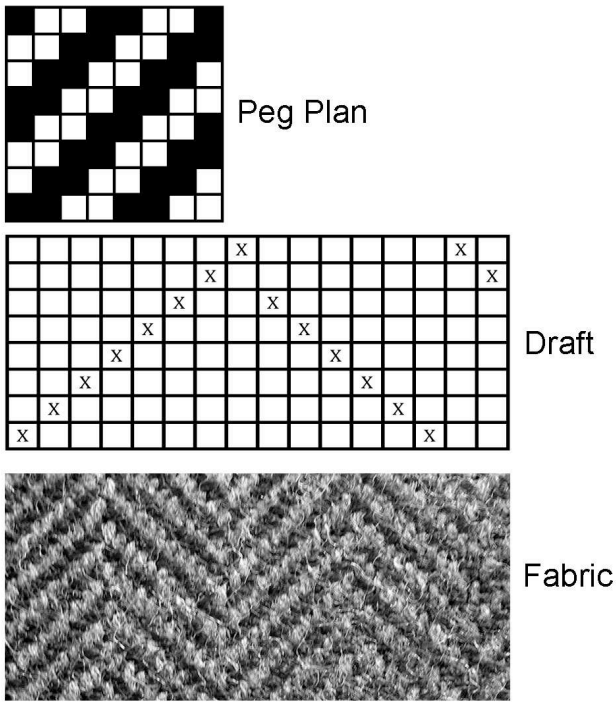

Fig 2.3 Herringbone draft on a 2/2 twill

Other common draft types include; skipped draft, satin draft, and curved drafts.

2.5.1.3 Sett

The sett of a fabric (the number of threads per cm or inch) is determined by the combination of the yarn count (diameter) and the weave structure to be woven. Ashenhurst's 'setting theory' which uses factors related to the dimension of different fibre types, is one method that is used to determine the sett of a proposed fabric based on the weight of a measured length of the chosen yarn. Square sett fabrics have the same number of threads per cm in both the warp and the weft direction. The density of a weave is a critical factor in the end appearance, drape and handle of the final fabric; looser fabrics can be woven with the intention that they have room collapse or shrink in subsequent finishing processes.

Once the sett of the warp has been determined and the warp made to the length required, the ends are drawn through the shafts in the order already determined in the draft, before finally being 'sleyed' (threaded through) the reed. The reed is a metal comb that is the same width as the fabric to be produced that keeping the ends aligned and evenly spaced during weaving. Each space within the reed is called a dent, and ends are drawn through these in groups, of 2 or more, and this number combined with the dents per centimetre determines the sett or ends per cm in the loom-state fabric.

Generally speaking there are more warp threads per centimetre than weft threads; but although this does increase the loom set up time, it most importantly increases the rate of production

2.5.2 Weave structures

There is generally understood to be four basic weave constructions; plain weave, twill, satin and sateen (as described below). Countless other

variations of these structures are in everyday use and further documentation on these can be found in the work of William Watson (Advanced Textile Design) and Doris Goerner (Woven Structure and Design. Single Cloth Constructions)

2.5.2.1 Plain Weave

This is one of the elementary weave constructions, and although the simple is used more frequently than any other. In plain weave the warp threads lift alternately allowing the weft yarn to interlace with every other end and form a tight cloth, with a firm structure, suitable for a range of end uses. The resulting cloth can be very flat, making this type of weave suitable for printing, pleating and smocking.

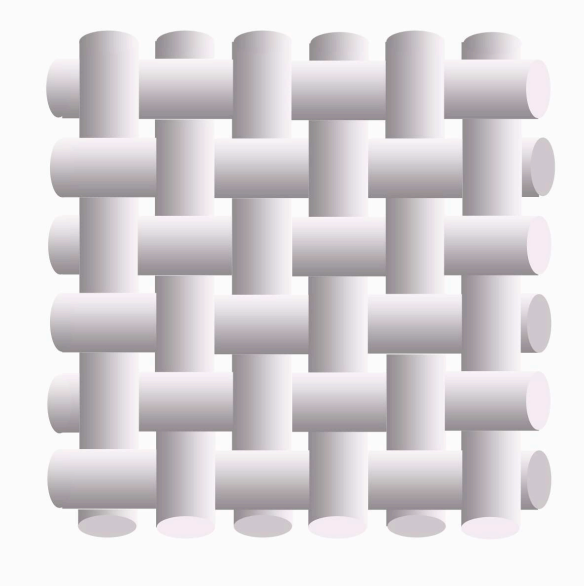

Fig 2.4 Plain Weave

Fabric types that usually use plain weave structures include; voiles, chiffon, canvas, and calico.

Voile - Semi-sheer, lightweight fabric made with fine, fairly highly twisted yarns and originally made from cotton, but other fibres are used

Canvas - Strong, firm, relatively heavy and rigid, generally plain-woven cloth traditionally made from cotton, linen, hemp or jute.

Calico - cotton fabrics that are heavier than muslin. These are usually left unbleached and still contain starch giving them a stiffer handle, and are made in a variety of weights, often used for making toiles.

2.5.2.2 Twill Weave

Characterised by diagonal lines on the face of the cloth, the weft yarns in twill fabric's float over at least 2 warp threads before they go back under. Twills can be regular; where the twill runs at 45˚ or irregular/steep where the angle of the twill is greater than 45˚. Twill lines usually run from the bottom left to top right; a right-handed twill or less often from right to left, a left-handed twill. Twill fabrics are strong and durable, and have a natural stretch in the bias, making them suitable for both furnishings and fashion. Twill fabric types include; denim, drill, chino, tweed and twill derivatives such as *herringbone*.

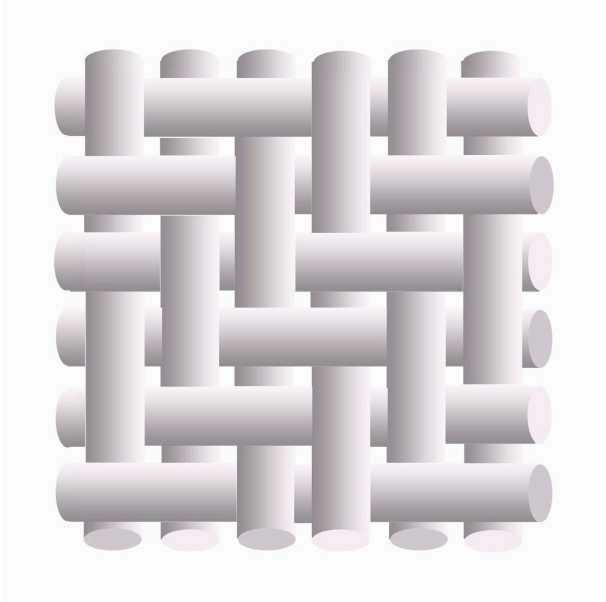

Fig 2.5 2/2 twill weave

Denim – is a warp-faced twill, usually made from yarn dyed cotton warp and ecru weft. Strong, stiff and durable this fabric started life as workwear, before becoming the fashion staple that it is today.

Tweed – traditionally made from wool and usually of a medium to heavy weight. They were originally handmade on the banks of the river tweed, but most are now produced on power looms with the exception of Harris Tweed. Tweeds may also feature other structures such as hopsacks and herringbone twills

Herringbone twill – an even sided twill that when reversed produces a characteristic vertical break or cut in the fabric. Suiting fabrics are one area that uses this construction

2.5.2.3 Satin Weave

The appearance of this fabric type is smooth, non-directional, and characteristically lustrous due to the tightly packed warp floats on the face. Interlacing points are set out in a regular, yet all-over manner in order to avoid any twill lines or stripes being visible with the back of the fabric looking significantly different to the face. Traditionally satin fabrics were made of silk, but now they are produced in a variety of fibres, for linings, sheets, dress fabrics and upholstery. High lustre filament yarns sett at a high-end count, are common and make best use of the longer warp floats in this structure, resulting in strong durable and smooth fabrics. Some satin varieties include; double-faced satin, bridal satin, ciré satin and antique satin.

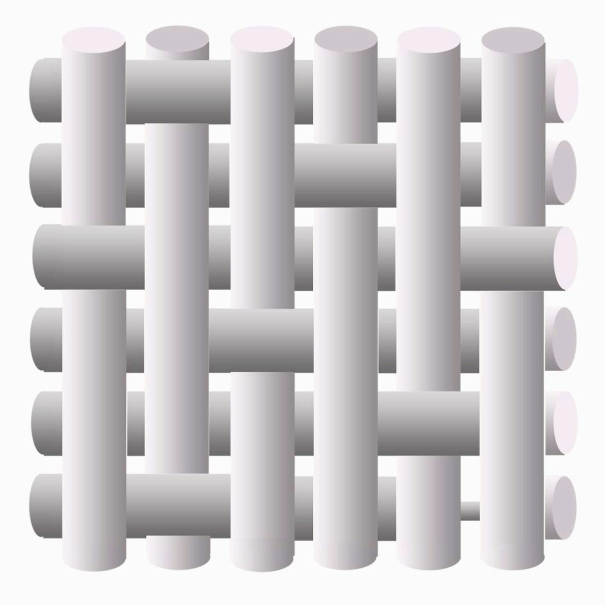

Fig 2.6 Satin Weave

Double-faced satin – is woven with 2 faces of the fabric created using 2 warps and one weft layer. The additional weight of the fabric makes this more expensive, but both sides are equally lustrous and two different colours may also be used.

Bridal Satin – a heavy weight satin used for wedding gowns, with a smooth lustrous surface effect.

Ciré Satin – this satin is finished to produce a cire effect; an effect that is stiff and a very high lustre particularly suited to give the fabric a metallic appearance.

Antique Satin – has a smooth but dull appearance on the face and surface slubs on the technical back of the fabric. The technical back is often used as the decorative side, for curtains and furnishing fabrics.

2.5.2.4 Sateen

This weave structure is weft faced, so the floats in the weft direction are much longer than those in the weft direction. Binding points in sateen's are

infrequent and arranged in a all-over manner to create fabrics that do not show diagonal lines. The smallest number of ends that a sateen can be designed over is 5. These fabrics tend to have a higher number of picks than ends, which combined with a thicker cotton yarn produces a soft, lustrous fabric.

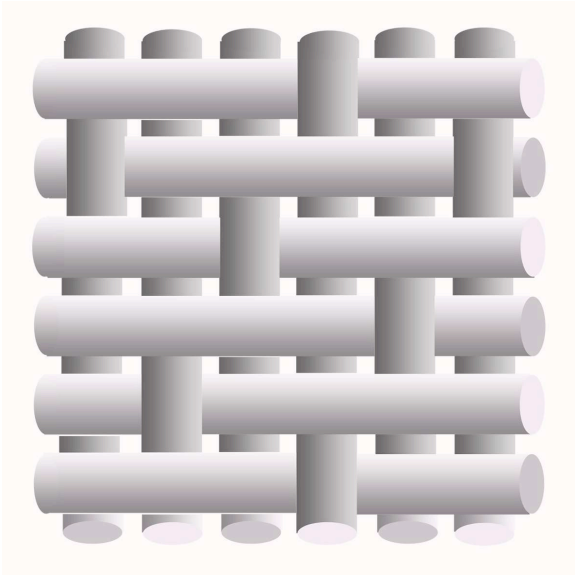

Fig 2.7 Sateen Weave

Satin and sateen weaves are used in combination in many jacquard fabrics, such as Damask fabrics for curtains, upholstery and napkins.

2.5.2.5 Double cloth

The elementary weave structures described above are all classed as single cloth structures, which relates to the way in which the warp and weft threads are interchanged, and the resulting cloth appearance. There are many other structures in use that are used to form a cloth that reveals multiple warp or weft colours, or which are used to have double faced patterns, appearance or contrasting textures on one face.

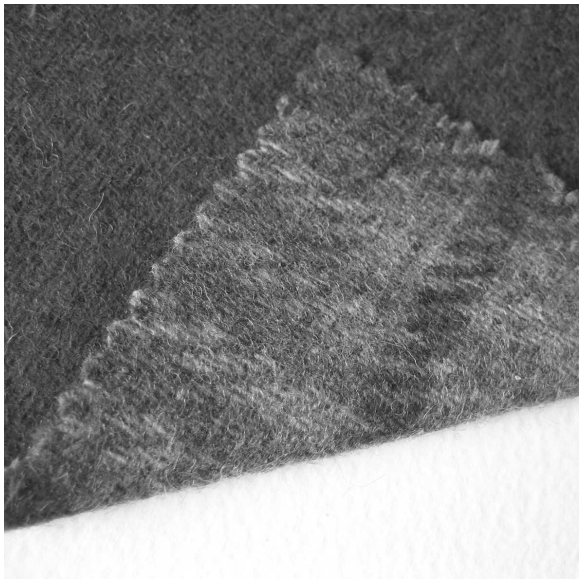

Fig 2.8 Double Cloth Fabric

The most common of the multiple layer weave structures is double cloth, and as the name suggests, this weave forms two distinct faces in the finished fabric, that are interlinked through the use of stitching points between the warp and weft. The requirement of more than one set of yarn in the warp and weft makes these fabrics more expensive to produce, as they are heavier and slower to weave, due to double or treble the number of picks being inserted to produce one pick on the face.

Double cloth fabrics include Matelassé (a figured fabric with three or four sets of yarns), Cloque (with four sets of yarns that simulates quilting stiches), blankets and other interior fabrics.

2.5.2.6 Jacquard weaving

Jacquard designs are usually a combination of smaller scale weaves applied onto a larger scale repeating design that has been produced on a CAD/CAM system such as; Scotweave, Pointcarré, EAT or Ned Graphics.

Jacquard looms are fitted with a jacquard patterning device or harness that enables individual ends to be lifted in complex patterns to form larger and

usually colourful designs. Fabrics produced by this method can be of any fibre type, and are generally in greater use in the interiors sector where their higher price can be afforded. The usually high sett fabrics with multiple colours and many layers make them too costly for most areas of the apparel industry.

Jacquard designs can be geometric, organic, large scale, or form a all-over repeat, and the design is made up of a combination of dobby weaves applied to chosen areas of the fabric.

Fig 2.9 Jacquard fabric

2.5.2.7 Other fabric types

Pile fabrics fall into two main categories that are; cut pile and loop pile.

Cut pile where the threads created in between the cloth layers or on the face of the fabric, are cut (usually on the loom). These fabrics will be cropped to the desired height during finishing.

Loop ‘pile’ fabrics can be produced in the same manner as cut pile but the loops are left in place. The loops can help durability or absorbency in the case of towels.

Velvets can be produced through the use of an additional set of warp yarns that produce loops over a wire inserted at regular intervals; these wires include a cutting blade that shears the loop as the blade is withdrawn. The ground warp forms a tight, plain weave to hold the pile threads in place.
The other common method of velvet production is to use a double cloth (two layer) construction, where the two cloths are woven face-to-face. In these looms the pile yarn weaves up and down between the two layers of ground fabric, and this interlinked construction is then cut whilst still on the loom, in the same method as some carpet production.

Velveteen is similar to velvet, but an additional weft yarn forms the pile rather than warp yarn. The fabric needs to be cut in finishing to produce the pile which is generally speaking the pile is shorter than that of velvet.

Moquette fabrics are still used as seating fabrics in the bus, train and tram sectors, where its weight and durability are needed. These fabrics are produced in a similar way to velvet, and may be composed off cut pile, uncut pile or a combination of both; usually produced in worsted, mohair or nylon.

Terry Towelling is an example of an uncut pile fabric, whose softer, looser sett loops to provide maximum absorbency, are usually are woven in cotton, for towels.

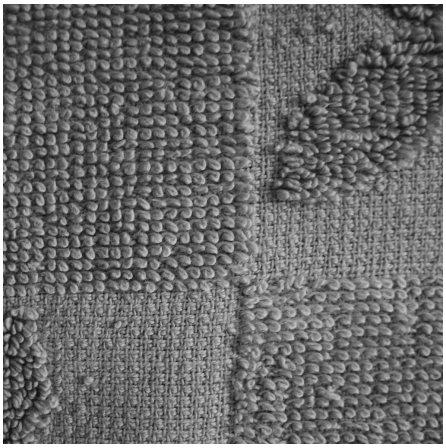

Fig 2.10 Terry Towelling

Woven Carpets are split into two categories named after the towns of Axminster and Wilton, and these types are both more hardwearing constructions than other tufted or nonwoven carpet types. Three warps make up the structure of Wilton, which is again produced using wires to form loops in the ground, which may be cut or left uncut. 'Gripper' Axminster woven carpets are produced using a different method, where the coloured cut tufts of yarn are pre-arranged in a sequence to form a finished pattern, inserted by the grippers.

2.6 Computer technologies

CAD packages are an essential part of the design process for weave designers, acting not only as a tool to create ideas, but also as an essential link to the loom (especially in the case of Jacquard weaving). The creative process no longer demands that the designer sit in front of a loom and work through various weave connotations in isolation. An industry-based designer

will work alongside specialists from a background of science and quality control, whilst considering parameters set by the sales and marketing team.

The current range of weave software packages, allow the designer to visualise a design without ever having to weave one pick. Yarns can be simulated; construction details entered, and weaves edited for long floats or bad joins. Not only can this reduce costly mistakes, by enabling the designer to visualise the design before committing to an actual fabric, it can also replace some of the early stages of sample trials. Printouts can be generated to show to a customer at the early stage of design development; in colours matched to their standards.

This ability to view a weave design, both in a 2D and 3D format and to immediately see the impact of a change to a draft or peg plan on the cloth, has made it possible for the less skilled weaver to work with confidence in the textile industry. CAD systems are an excellent tool in the teaching of weave students, at all levels of higher education, giving the them chance to experiment and make mistakes, before setting up a loom.

CAD software from companies such as Scotweave, Pointcarre, Ned Graphics and EAT are all capable of generating realistic simulations of both dobby and jacquard fabrics; which can be then transferred to a chosen loom for immediate weaving. This ability to create and control a loom through CAD has helped facilitate the development of overseas manufacturing, whilst at the same time keeping the design development control in the UK. Designs are easily sent electronically to the weaving facility, enabling quick turnaround and ease of editing a design as necessary. Fabrics can be simulated and mapped

onto realistically generated garments, bodies or other three dimensional forms giving a good indication of how a given fabric will look in-situ.

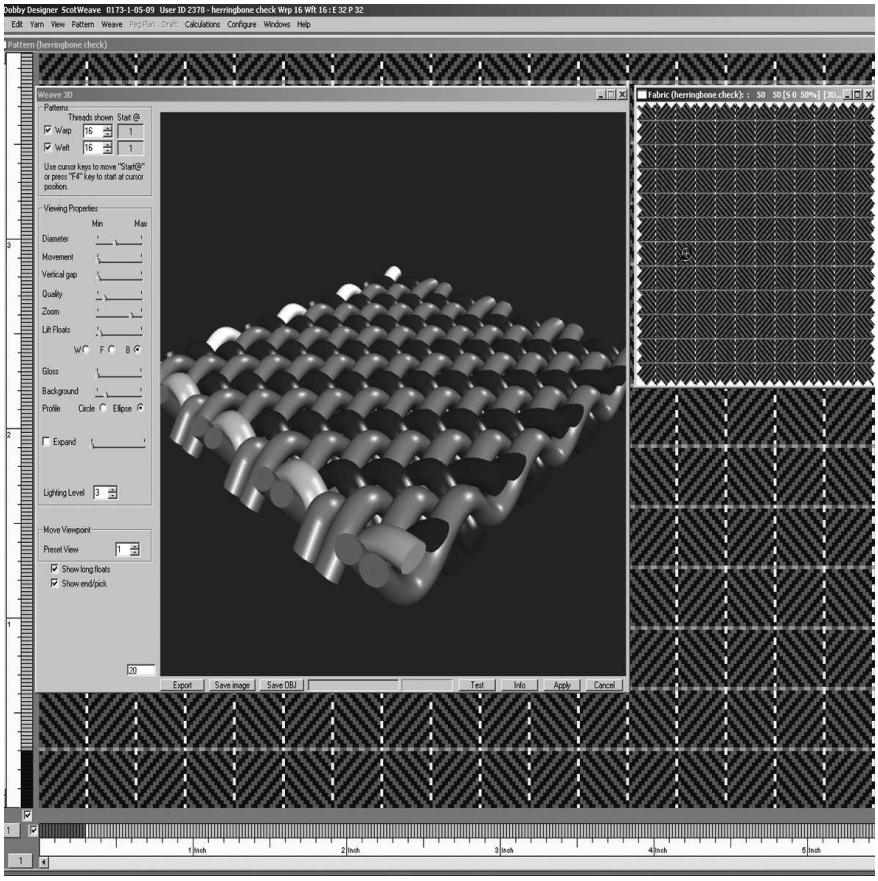

Figure 2.11 Fabric simulation Scotweave

Simulation of woven fabrics may not however always executed by a specialist weave designer. High street retailers frequently use less technical forms of weave simulation software to mock up designs as ideas of direction for their suppliers. Lectra Product Lifestyle Management systems include dobby weave design based on a library of weaves and yarns, which can be used in combination to mock-up fabric designs. This type of software does not rely on specialist knowledge of weave structures or how they are formed, but does give the designer a visual tool to communicate their ideas with.

Current CAD packages cannot entirely replace the physical weaving of a cloth, as they are cannot easily simulate the physics of weaving; the effect of yarn twist for example, or the dimensional changes between one weave structure and another. Spider weaves whose distorted threads are a result of using a combination of long warp threads surrounded by tight plain weave, are one example of this.

Scotweave have recently developed new software to meet the needs of the more technical weaving industries such as the, automotive, aerospace and medical industries. Real-world yarn information, including fibre types and cross-sections of the weave architecture can show multi-layer fabrics, interlacing of yarn, and calculations of tensions expected when woven.

2.7 Practical design applications

The design and production of woven fabrics and the design of a garment or interior furnishing are not as closely linked as they are in knitting, where you are more likely to design the garment alongside the initial sample. Woven fabrics are designed as a length and then the garment is produced from it. Fabric producers for both apparel and furnishing, design ranges each season, from which their customers select fabrics for the next season's collection. These fabric ranges are sold by the supplier's, at fabric fairs such as Première Vision (fashion) and Heimtextil (interiors). Some modifications to the colour or design may be requested by brands at the high end of the market, as they aim to stamp their own identity on their read-to-wear collections. Haute couture garments use some of the highest quality unique fabrics available.

Performance fabrics for end uses including those for Automotive and Aircraft are developed exclusively or each client, but designs often start life as part of collection based on trend predictions.

2.7.1 Apparel

The apparel market can be divided into five main sectors: Supermarket, high street, independent designers, ready-to-wear and haute couture. Most woven fabric types are used in all market levels, with some minor differences in weight, colour fastness, or yarn content. The type of garment that the fabric is designed for, and its perceived value may sometimes be the only point of difference between how a given cloth is differentiated.

Cheaper fabrics are used by the supermarkets, whose bulk buying power also enables them buy some better quality fabrics at a lower price. The high street retailers vary in that some will demand high wearing easy to launder fabrics, and others are looking for a lower quality fabric for fast fashion purposes. Ready-to-wear as already mentioned look to use more unusual fabrics with some point of difference. This may be in the use of fancy yarns, more expensive constructions or exclusive fibres.

The main categories for apparel woven fabrics are:

Outerwear – coating fabrics, including tweeds, cavalry twills, in polyester, wool, worsted, and microfibres

- shirting, linens and cotton viscose and polyester
- dress weights, chiffons, silks,
- support fabrics and trimmings

2.7.1.1 Case Study Harris Tweed

Independent designers may source woven fabrics with some heritage cache, such as Harris Tweed a cloth that has been handwoven by the islanders of Lewis, Harris, Uist and Barra in their homes, using pure virgin wool that has been dyed and spun in the Outer Hebrides.

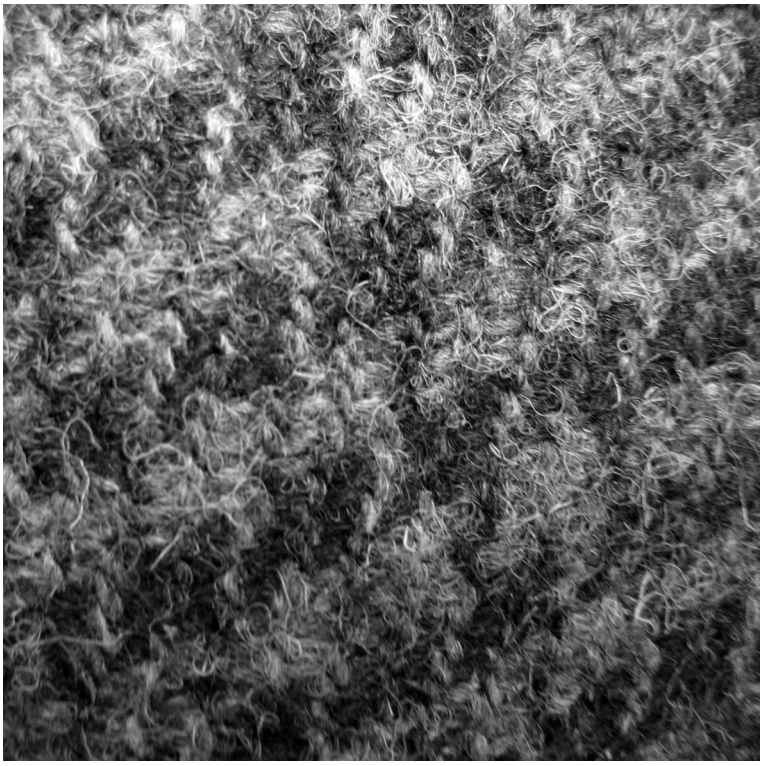

Fig 2.12 Harris Tweed

A plan in 2008 by Yorkshireman ,Brian Haggas to revive and rationalise the Harris Tweed industry, by reducing the complexity and number of colour-ways & patterns woven backfired. The true appeal of this traditional fabric lies in the wonderful and varied colours produced using the locally dyed yarns, whose colours are influenced by the landscape of the Outer Hebrides.

Scottish designer Deryck Walker featured Harris Tweed fabrics in his 2009 collection and Italian powerhouse Gucci has recently placed an order for the fabric.

The profile of this struggling industry was recently boosted by the wearing of jackets made from their cloth on television (Doctor Who) helping to raise the profile of this traditional cloth, and hopefully attracting a younger customer at the same time.

2.7.2 Interiors

The interior textile market can be segmented into two main categories. These are the areas of contract furnishings; for hotels, offices, and other public buildings or home furnishings, for interiors in the home. Woven textiles in this area are used for the bedroom, bathroom, dining room, window treatments, upholstery and flooring.

Interior woven fabrics are required to perform to a level suitable to last the lifetime of the product, be suitable for its end use, and include any requirements for aftercare in order to maintain appearance. The performance requirements of the proposed fabric are dictated by standards set out by the customer, and are usually more stringent for contract furnishings than those for say a cushion in the domestic home furnishings market. Designers in this field need to consider weave construction and float length (the number of ends/picks that a given yarn floats over in the peg plan) in order to meet abrasion requirements. They also need to consider colour-fastness of the yarns so that they do not fade or transfer dye, flammability and the suitability of the fabric for laundering or dry cleaning.

High end manufacturers are represented in locations such as the Design Centre at Chelsea Harbour in London; an invaluable resource for the independent interior designer where all the top companies are represented. These interior fabric producers are long established, and yet many are at the cutting edge of the latest trends and innovations in this market. Companies like Sahco Hesslein, Osborne and Little, Zimmer + Rohde, Romo and Colefax and Fowler are all represented; and sell primarily through interior design companies. These fabric companies cater for both the high-end domestic market and the more demanding contract furnishings sector, where innovation needs to be underpinned by high performance standards.

Trend forecasts drive the direction for colour, pattern, texture and finish in interior woven textiles, as they do in the apparel market. Historically a slower moving industry than that of apparel, the introduction of lower pricing, more demanding consumers and fashion retailers branching out into interiors have created a more ‘throw-away, quick change’ approach to buying in this market.

Mid level manufacturers, although not well known to the buying public, work closely to supply fabrics to the high street retailers with targeted ranges of bedding, towelling and curtain qualities. Concepts and ideas are presented to these customers and then further developed to fit the brief for colour, design and fabric performance.

Main fabric categories are:

Bedding - sheets, duvets, pillows in cotton, polyester and some silk

Curtains - using dobby structures including hopsacks and satin and jacquard weaves such as damask and tapestry.

Furnishings – upholstery, soft-furnishings and cushions

2.7.2.1 Case study Herbert Parkinson

Herbert Parkinson design and weave John Lewis "own brand" furnishing fabrics and manufacture ready-made and custom-made curtains, and other soft furnishings. They also produce a wide range of fabrics for other customers outside the John Lewis Partnership, but this company is the one remaining fabric production unit owned by the partnership

Herbert Parkinson designs range from heavy tapestries to fine cottons and from dobby woven plains to fine figured jacquard designs. The yarn types used for these fabrics are typical of those used extensively in the home furnishings market and include; cottons, cotton/linen mixes, cotton/viscose mixes, linens, acrylics/modacrylics, chenille and polyester.

2.7.3 Performance fabrics

Woven fabrics are used in many of the industries where high performance, quality and durability are essential qualities. Some of the products within this category may also have an aesthetic importance attached to them, which includes transportation seating fabrics for the automotive and aircraft and the outdoor/sports apparel sectors. The final look or appearance is however a

secondary consideration in the fields of medical textiles, geo-textiles, narrow-fabrics and those used in canopies and supporting structures.

Fibre type in combination with the weave construction, high specification colouration and finishing treatments are all key factors in the performance of products in this sector. In sportswear higher value, smart textiles using the latest developments in new fibres, and finishes are replacing the traditional cotton fabrics, as consumers demand a better product. Rigorous and frequent testing is required in both the development and manufacturing stages of technical and performance fabrics, to ensure fit-for-purpose, and consumer confidence.

2.7.3.1 Case study Airbags International

Air Bags International is a company that have developed a patented weaving process to produce a one-piece woven air bag, reducing the need for cut-and-sew processes. Their latest development has been to create a ‘smart’ airbag, which inflates relative to the size of the occupant at the point of impact. The force of the occupant during impact triggers specially engineered (sacrificial) seams within the weave design, break and increase the volume of the bag to be inflated.

2.8 Future Trends

The ability to innovate re-invent and add value, are as important now as they ever have been in the long established weaving industry. As mentioned previously, the weaving industry in the United Kingdom has become

increasingly focused in niche areas of the business where fabric production is for a high end product and or the more discerning customer. Performance textile weavers invest a lot of capital in the research and development of new products that keep them at the cutting edge and open up potential new areas of business. The key themes of smart textiles, nanotechnology, and sustainability and three-dimensional weaving are at the forefront of technical innovation in weave.

2.8.1 Sustainable choice

The future strategy for many high-end European mills is to pursue a sustainable or eco route in the development of their products and the production of their cloth. The high-quality textile producers are aware that their customer base has socio-environmental concerns about the provenance of their garments they buy. Valuing craftsmanship and tradition are as important as the eco credentials of the yarns and processes involved in the make up of these luxury items. The weaver and the tailor are master craftsmen, valued by brands such as Holland & Sherry, who promote the use of cloth from Yorkshire and Scotland, fabrics that are produced to a high quality in a time honoured way.

Wool is a sustainable and natural product, which produces far lower carbon emissions during production than man-made fibres. The benefits of wool and cloth made from it are currently the focus of a new promotional campaign to boost the use this fibre in the middle and value retail markets. This Wool Project aims to raise awareness of the natural benefits of the fibre, and this is

echoed in the resurgence of woollen cloth being used by cutting edge fashion labels.

2.8.1.1 Case study Dashing Tweeds

This trend towards responsible lifestyle choices and the desire to keep traditional crafts alive can be seen in the Dashing Tweeds brand, co-founded by Guy Hills and RCA trained weaver Kirsty McDougal. They develop their own range of woven designs that are then produced using, worsted yarns sourced in North Yorkshire and woven by Lochcarron of Scotland. Their innovative and often humorous approach to design, has seen the creation of some traditional tweeds with a twist. Reflective yarns woven into a ground of tweed check inspired by the wet pavements and yellow lines of London's roads are used in coats for cyclists and bike riders; a welcome alternative to a reflective yellow jacket.

2.8.1.2 Case Study Cradle to Cradle and Lantal

'Ultimately, we want ecologically intelligent design to become so integral to product development and economic systems, that it becomes known simply as good design' William McDonough quotes of the Cradle-to-Cradle thinking that he has developed in conjunction with German chemist Michael Braungart. The C2C 'cradle-to-cradle design is an ecologically intelligent approach to architecture and industry that creates materials, buildings and patterns of settlement that are wholly healthful and restorative…Materials designed as biological nutrients provide nourishment for nature after use; technical

nutrients circulate through industrial systems in closed-loop cycles of production' William McDonough & Michael Braungart 2003.

Lantal a world leader in transportation textiles with its Climatex® LifeguardFR™ fabrics was nominated as a finalist of the Crystal Cabin Award 2010 in the category Greener Cabin. Lantal achieved the Cradle-to Cradle Gold certificate with these woven fabrics, which are fully biodegradable. The fibres and finishing components used in the production of, Climatex® LifeguardFR™ have no toxicological or ecotoxicological effects, so after a long service life, the seat covers can be returned to biological cycles.

Lantal have also made great strides to reduce the weight of its fabrics used in the aviation industry, through innovation in yarn and fabric construction and more recently with its pneumatic comfort system. This system uses inflatable chambers placed in layer between the seat fabric and seat frame to increase passenger comfort, whilst at the same time reducing the weight of the seat and importantly adding to a reduction in fuel consumption.

This sustainable approach to design is the key to the survival of fabric producers from all areas of the industry, be it for apparel, interior or technical end uses. Key players in the transportation sectors, such as the car manufacturers, and the airlines, are now tasked with taking ownership for the disposal or re-cycling of their products, a responsibility which therefore also falls to the Tier 1's and their suppliers.

2.8.2 Three Dimensional Weaving

The very nature of woven fabrics is three dimensional despite the two dimensions of the traditional warp and weft. The interlacing of the ends and picks, combined with differing float length, yarn types and specialist looms can combine to create cloths with a third dimension; a dimension that is still being explored.

Current examples of 3D weaving technology can be seen in the field of medical science for woven vascular vents, prosthetic applications and artificial arteries. Air-frame and self supporting structures also use circular (polar weaves) and demonstrate amazing strength; whilst carbon fibre and tri-axial structures are important components in the aerospace industry.

2.9 Summary

This chapter has the detailed the main types of woven structures, and their construction. It has considered their characteristics, formation, and application and how the textile designer applies these to different markets. It has also considered the challenges and future opportunities for the design and development of woven textiles.

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List of Figures