Open to change:
Embracing nature and the fragility of design. An investigation into outdoor seating materials through the practice of leno weaving.

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Abstract

The research documented in this thesis investigates the potential of leno woven fabrics to be developed for outdoor seating use, and to understand the influence that hand-weaving of these fabrics has on the design process for the commercial textile designer. It investigates the potential of hand woven leno fabrics to be aesthetically pleasing and yet meet the physical requirements for a seating material exposed to the external climatic conditions.

Themes of, material change over time and fabrics that blend into the landscape are explored through a series of samples produced on a handloom using a range of manmade and natural fibres. Contemporary weave practitioners, artists, product designers and an analysis of the current uses of leno fabrics has informed and guided the direction of this research.

The hand weaving of doup-controlled leno fabrics employing a mix of monofilament and wool yarns has resulted in the creation a range of dynamic, stable and open net-like structures that could be suspended within a seating frame. It has been demonstrated that this method of fabric production is capable of producing strong yet flexible substrates whose design successfully reflects the beauty in colour and forms found within the landscape.

Reflection on the relationship between the handcraft of weaving, and the decision-making process and knowledge of the textile designer has been recorded. The resulting knowledge of the design process and the insight into the mechanics of leno weaving on a table loom, are to be built into a programme of undergraduate workshop and weave theory lectures.

This research has grown out of an interest in the slow decay of abandoned textiles in the landscape and forms a starting point for the exploration of how climatic conditions might affect the physical and visual appearance of a fabric used outdoors.

Acknowledgments

Thank you to the University of Huddersfield Textile Workshops for the kind loan of a table loom for the duration of this project, and for the provision of a range of yarns used in the initial trials.

I would also like to thank my supervisor, Dr. Pammi Sinha for her patience, understanding and support throughout this process and my partner for his emotional support. My final year weave students in 2013-14 have also provided me with the inspiration and encouragement to focus on my own studies.

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Glossary of Terms

Doup	Loop of twine or specialist heddle through which the twisting ends are threaded in a leno set-up. This threading is in addition to the threading through the standard pattern shaft heddles
Warp beam	The back roller on a loom onto which the warp is wound. This controls the let-off or tension of all the ends, and two beams may be needed in order to allow different rates of let-off in some structures.
Warp	The threads running in the vertical direction in a woven cloth (up and down the fabric)
Weft	The threads running across the woven cloth in a horizontal direction (backwards and forwards across the fabric at a 90^{o} angle to ends)
Shed	The opening created by lifting some ends and leaving others down in the warp, through which the weft yarn (pick) is inserted.
Leno	A form of gauze (net) fabric produced by the crossing over of adjacent warp threads in order to trap the weft yarn.
Monofilament	A yarn extruded in production in one continuous length, which is made up from one filament of fibre. This term is used for synthetic yarn production such as fishing line.
Heddle/Heald	Wire or twine loops suspended in heddle frames (shafts) through which individual ends are threaded. Every end must be threaded through one single heddle. The pattern of threading through the heddles in the shafts is used to create more complex weave patterns.
Pick/s	Weft yarn inserted across the warp.
End/s	Individual threads in the warp direction
OEM	Original Equipment Manufacturer is a term used in the automotive industry when referring to the car manufacturer. i.e. Nissan

Reed — A comb like device through which the individual ends are threaded. The number of ends per dent, (slot) in the reed determine the sett (density) of the cloth. The reed (set in the beater bar) ensures the warp ends remain parallel when beating the fell (upper edge) of the cloth.

Singles Yarn. — A yarn that after twisting (to add strength), has not been doubled with another end of the same yarn, to create a two-ply yarn (usually with more strength). Singles yarns are often weaker, and potentially more twist lively than doubled yarns.

Chapter 1 Introduction to research

Project background and overview

A specific type of knowing comes from the handling materials in the handcrafting of an artefact. Potential new design opportunities can be opened up for the commercial designer by moving out of the studio and back into the workshop environment. A practice-led approach will explore the potential of hand weaving in the crafting of a leno fabric and comparing this to commercial design process whilst in pursuit of a potential product for outdoor seating.

This research project explores the relationship between constructed materials and the landscape. The evolutionary qualities of dynamic and open web-like materials created through the craft of weaving will be investigated and developed through research into traditional woven techniques typical of leno and gauze fabrics. The process of leno weaving on handlooms will be explored, combining experimentation into material and yarn selection, the development of leno weave structures and the off loom manipulation of woven pieces. The development of these woven gauze materials, apparently neglected in current hand weaving practice, will be compared to other textile based developments for open structures used for suspended seat coverings and technical fabrics.

This project has grown out of my professional experience in the textiles industry and my subsequent academic career as a specialist in the design of woven fabrics. Skills specific to the creation of high performance fabrics for the automotive interiors industry were developed over a 15-year period, working as a designer and then later as an advanced designer. My expertise in engineering the design of both woven and knitted fabrics to meet the testing requirements of automotive OEM's (Original Equipment Manufacturer) necessitated skills in blending the aesthetics of design with a knowledge of fibre, yarn, structure and textile finishing. My academic career and specifically the teaching of handloom weaving and weave structures have allowed me the opportunity to revisit the basic building blocks, which underpin the creation of a woven fabric. The chance to slow

down and re-engage with the weaving process where the interpretation of visual stimuli (an image, photograph or drawing) into a piece of cloth was important in the pursuit of a better understanding of the dynamics of a textile fabric and its potential to interact with the outdoor environment.

Jessica Hemmings (2012) refers to the weaver's sensibility, and the way that this guides their approach to the visual and material world, far beyond the construction of the cloth. A weaver needs to have the ability to work in a logical and organized manner, especially when involved in the industrial process of weaving, yet they need to be open to unexpected discoveries and embrace these in their creative development.

Inspiration

My interest in this topic of pursuing textiles for the landscape was sparked in response to the ugly brutality of man-made furniture sited in public spaces of historical and national importance.

Fig 1. Memorial Bench

Fig 2. Stranded Sock

A visit to the extensive grounds of Rufford Abbey Park in Nottinghamshire (2012), where a plague of black plastic benches 'in memoriam' as seen in Figure 1, are lined up one after the other, instigated a reaction. These bulky, blocky, mass-produced versions of the wooden park bench, jarred with the beautiful, timeworn landscape, stonework, gardens and woods. No consideration for the relationship between this historic setting and the seating seemed to have been considered. Not only were the seats large in number, but their form, surface texture, and colour demonstrated little sensitivity to the natural

surroundings. This apparent lack of thought in the selection or perhaps choice of public benches on offer, led to my contemplation of how the creation of a more sympathetically, aesthetically pleasing product could be developed.

Fig 3. Fragments of fishing net

Fig 4. Spiders web Merrydale Clough

A growing interest in the balance between the landscape and man-made products, surface quality and form, was developed through regular engagement with the outdoors, including walks though local woodland, hiking over the Pennine Moors and strolling along the beaches of Wester Ross. "In many or most cases we have got so used to this ornament that we look upon it as if had grown of itself, and note it of no more than mosses and the dry sticks which we light our fires" (Morris 1877). Forgotten and abandoned possessions, a stranded sock on a barbed wire fence (Figure 2), bailing twine to fix a gate, fisherman's nets washed up on the shore (Figure 3), On closer inspection of the surrounding landscape, these discarded items, had a strange and fascinating beauty. Observations around the patina and softening of surfaces brought about through weathering and the subsequent acceptance of these material interlopers in the landscape was seen as an opportunity to research the relationship between materials, erosion and beauty.

Spiders webs captured in the early morning dew (Merrydale, 2012), caught by the sun, revealed suspended random nets cast over the underlying vegetation, and suggested the possibility of creating layered suspended materials as solutions for outdoor furnishings (Figure 4). The open delicate layers seen within these webs, was one of the main catalysts

in the selection of the leno technique of woven design, a mechanism that facilitates the creation of strong, yet open, and transparent cloth. The desire to create an aesthetically pleasing just visible material, which contrasts with that of the highly visible, plastic benches compliments the role that textiles usually assume in uses from clothing to furnishings, medical to landscaping. The invisible discreet nature of textiles, the airy-fairy perception of fabric designers (Barber 2014), and the immense range of creative and decorative possibilities have led to a tendency to overlook the potential of a fabric to redefine and enrich an environment. Discarded, washed-up, stranded and abandoned pieces of fabric, yarn, string and net, brought to my attention a new perspective. How could I create pieces that tread lightly in the landscape and yet enhance our vision and understanding of a site?

Part of the aims of this research may be to raise the awareness of textiles by placing them in an outdoor environment where they are not normally seen. They are generally there by accident, or very industrial in their application or hidden in their function as in the example of geotextiles.

Research into the outdoor seating market, revealed a limited availability of solutions that harmonised with their surrounding landscape. Material selection is inherently designed to be durable and resistant to the ravages of the climate, creating product that should remain 'as good as new' for as long as possible.
Development of gauze-type materials for seating (suspended and supported) has thus far been restricted to the realms of high end contemporary furniture design, and is produced using techniques that include, warp knitting, basket weaving, crochet, and other knotting techniques and employs materials such as plastic cords, bast fibres, plywood, rattan, rope. There is one key example of leno weaving used in the production of the Aeron chair for Herman Miller, but this example is used within the contract furnishings sector (see Chapter 3).

The approach to this research involves myself as a practitioner and designer researching through creative 'action' and 'reflecting in and on action' (Schön, 1983). Artist/designerly forms of inquiry will centre around the observation and reflection of my setting up and

weaving a series of woven fabrics on a handloom, which will include experimenting with a variety of yarns and simple leno structures. My response to the physical creation of these woven pieces, and a reflective commentary on each samples' success (against a set of criteria) will be recorded in a written format. "With regards to epistemological issues, the practitioner is the researcher" (Gray and Malins 2004, p20) Early idea creation and visualizations have been developed through drawing and the manipulation of mixed media, in response to a series of physical journeys taken through specific sites (Yorkshire, Nottinghamshire, Wester Ross), and recorded through the medium of photography and sketching. Gray and Malins cite Robson's (1993) definition of a practitioner-researcher, whose approach to research and inquiry is of relevance to their job, and this description fits my position as a weave tutor and early researcher, with extensive industry experience. Keeping an open mind and being objective and acknowledging the complexity, and unpredictable nature of the real world need to be central to my position as a reflective practitioner.

The quote "We come to know the world theoretically only after we have come to understand it through handling" Bolt (2007, cited in Smith & Dean, 2009, p.6), really resonates with my idea of how important the role of practice is to this research. A specific type of knowing comes about through the engagement with practice as part of the research process, and in this case through the act of weaving trial fabrics on a hand controlled table loom. This primary research enables me as a designer with a background in commercial textile design to explore the potential of an established industrial production method through a craft-like approach and to slow down and engage with the materials themselves. Rather than relying on secondary information gleaned from other makers, textile artists and designers, the role of practice in this research will enable me to gain a new insight into the process of responding to a self-written brief without the time pressures of textiles mass –production.
This practice-led research follows Biggs (2004) "claim that practice is an integral part not only of the communication of outcomes but also of the process of research".

Drawing and photography have been used as part of my personal exercise to seek inspiration from a number of outdoor landscapes, and environments where discarded

materials have been observed. This approach to developing ideas through the medium of the sketchbook allowed me to stimulate ideas through my interpretation of the source material I was focusing upon.

This research has been approached through creative practice and support has been obtained through research into historical publications, contemporary practice, material innovation and the work of academic researchers. Some of the final woven pieces (see Appendix 2, samples from Warps 2 & 3) of this research were exhibited at the Surface Design show in 2014, as part of the Future Materials exhibit on the Huddersfield University Stand.

Aims and Objectives

The aim of this research is to explore the potential of hand weaving leno fabrics to produce fabrics suitable for outdoor use. It will further consider the importance of a hands-on, practice-led approach to design and the value this may have to the commercial textile designer. Furthermore this study will look at exploring potential change and ageing in materials, as they slowly break down and display some visible sign of change or partial decay when exposed to climatic conditions. It should be noted however that where some change in aesthetics or physical properties is desired, a complete decay where the strength and integrity of the structure is compromised is not the end result desired. The objectives of this research are therefore:

Exploring the notion of how to marry the environment with design, through the development of woven textiles

To investigate the practice of leno weaving in order to gain an understanding of its benefits and limitations in the creation of suspended seating materials for outdoor use.

To understand the current practice in the design and manufacture of textile materials which respond to environmental conditions.

Explore the material and woven structure potential of leno weaves through the practice of hand weaving.

To establish how a practice based approach to a the fulfilment of a self-written design brief can lead to new insights into design thinking, material and structure, knowledge and understanding

Criteria for analysis of samples

1. Design potential
    a. As a blend of materials that has the potential to partially change with age demonstrated through a change in visual appearance.
    b. To be utilised in an exterior seating design. Ability to be suspended, and flex / support
2. Sample retains a visual resemblance to the original inspiration material (sources)
3. Dynamic potential of the structure
4. Aesthetic appearance of the finished samples (idea of beauty)

Proposed Method

Two main methods (detailed in Chapter 4) employed in this research are:

1. Literature review to examine the work of other artists and to research leno weaving:
    - Other artists responses to the environment
    - Practitioners using net structures in the landscape
    - Creative responses to abandoned nets
    - Leno weaving techniques
    - Outdoor seating and contemporary design
2. Design and hand craft work through:
    - Inspiration – observations and ideas, recorded through photography, video, drawing, sketchbooks and a blog
    - Concept mapping – through theme boards, and diagrams
    - Sampling – on the loom using a range of materials

- Assessing – outcomes of woven samples, reflection and photography and record of leno technique

Chapter 2 Literature Review

Introduction

This chapter reviews the practice of designers, artists and practitioners and examines their work in relation to the research topic. An analysis of the UK council's response to providing all weather, vandal-resistant benches in public parks and other open spaces will be made and a sample of bench manufacturers considered.

The chapter will then continue by examining current practice in the wider field of landscape art and in particular it will be looking at designers who consider erosion, decay and responsive materials in their work. Open net-like suspended textiles will be examined, the subject of ageing and decay in exterior fibre and fabric pieces, and textile work classed as interventions in the landscape, will be considered to determine their aesthetic value. Research into designers who use open nets and suspended fibres constructions will then be investigated in order to consider their influence on current contemporary and commercial product development. Finally artists and companies that are see the beauty in using discarded nets and synthetic materials to create new product ideas and other artwork.

The plastic bench

Following the authors' visit to Rufford Park (2012) and seeing the outbreak of numerous black plastic memorial benches, it was necessary to investigate the material composition and manufacturing processes involved in these seating solutions, and to try to establish how other people may have reacted to the aesthetics of this type of design. UK councils are adopting a purchasing policy that fulfills their requirements to buy public furniture that meets a reduced budget and uses materials that require minimal maintenance once installed. The solution for many is to buy plastic benches that mimic the wooden ones that they replace (see Figure 1 in Chapter1).

A couple of UK based manufacturing companies' products, investigated through an Internet search, further revealed that these plastic memorial benches are generally formed from recycled material. British Recycled Plastics (Hedben Bridge, West Yorkshire) and Waste 2 Wood (Horncastle, Lincolnshire) proudly promote the 100% recycled plastic content of their benches and include the type of household items are typically blended and extruded into the components for their design. Waste 2 Wood, comment on the indestructible nature of this "one of the best products on the market for the sincerely heavy commercial environment". The quality of this recycled product is promoted for its low maintenance, splinter resistance, resistance to mould and vandals. Available in brown or black, they appear to be targeting the wooden bench market with these rather clunky designs.

Sites of historical interest and outstanding beauty do not seem to be the place for these 'designs', and reaction against the replacement of traditional wooden benches in the Edinburgh Botanical Gardens was recorded in the Edinburgh News (2012) when they quoted arts impresario Mr. Demarco "It is nonsense – lamentable. Visually, the experience of being in the Botanics will be reduced by this," he said. "The fact those benches were wood was completely in harmony with the idea they were located in woodland. Now they're planning to put in man-made stuff …" Perhaps this strong reaction is one felt only by those of an artistic nature, a genre in which I would count myself. Edward Feser, a writer and Philosopher at Pasadena City College (USA), states "In general it takes, I think, careful analysis to explain exactly what it is about artefacts and their natural and cultural contexts that accounts for our judgments about their beauty or ugliness." He also mentions in this article on the metaphysics and aesthetics of plastic and that "the right answers are not necessarily the ones that might at first glance seem obvious. Moreover, plastic, though in another and obvious sense "artificial," is not ugly when new and functional" (Feser, 2014). So the both the context and the age or appearance of the plastic item could determine the reaction that it may get. Using plastic in a natural situation or within the landscape if handled insensitively can cause consternation. Aged wood, metal or stone are seen as being aesthetically appealing, but not plastic, so why not?

Open networks, dynamic structures

Open suspended seating structures employed in contemporary furniture, dynamic and responsive materials in architecture and sculpture have all influenced the direction of this practice-led research.

Textiles that move or change are a key topic in the Jessica Hemmings (2012) book Warp & Weft. She describes the range of stimulants that woven textiles can respond to, whether from the local environment, such as temperature of humidity, the material memory of the cloth, or the mechanical or electrical dynamic of the weave. "Woven structures make use of complex technologies, as well as the most basic inherent material properties, to become mechanically and electrically dynamic" (Hemmings, 2012, p.51)

Philip Beesley's is an example of an architect whose work has been developed in response to an extended dialogue with the textile artist and weaver, Warren Seelig. Beesley creates diagrid networks, where he acts out the same paths as fibres within a coarsely woven textile, arranged on the bias. In creating these networks he searched for a flexible 'live' hand to the fabric, one that could both span and drape. The early development of this concept was realised in collaboration with Warren Seelig as see in Figure 5, in their work Haystack Veil (1997).

Beesleys' work was initially created by hand, but has subsequently moved onto digital production methods with material/polymer restrictions but these restrictions are ones that he in finds tremendously enabling. Philip Beesleys' cloth can be sensitive to the influence of the body and the environment as his works float and move in response to their surroundings, flexing with physical contact, or to movement of the air around them (Hemmings, 2012) The nature of this cloth is one of a very open loosely connected veil or structures and they operate in kinetic patterns, in an active mechanical response – an artificially intelligent and electrically driven mechanism. These networks are described as near-living chemical metabolisms integrated into the environment, with a fluid circulation system operated by depositing delicate layers of material and building up felted skins.

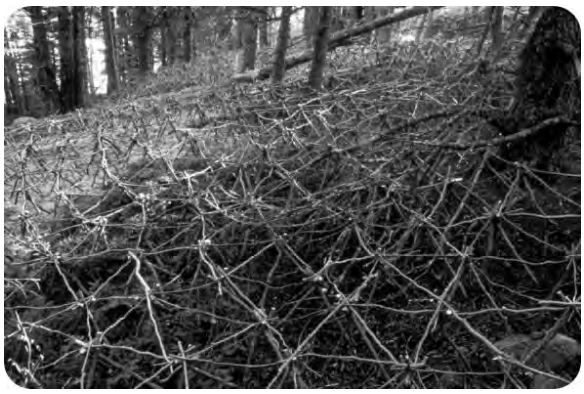

Fig 5. Haystack Veil

Fig 6. Erratics Net

The open nature of these delicate layers in Beesleys' networks, reveal rather than smother the natural surfaces that support them as seen in his sculptural work, Erratics Net in Figure 6. This approach to the landscape is reminiscent of the random spiders web photographed heavily laden with dew, that appear to float over the surface of the low growing shrubs, photographed in Merrydale (Redmore 2012) Figure 7.

Fig 7. Web detail

Fig 8. Transformable Mesh

Hemmings (2012) explains that Beesley will continue this development of diagrid networks, as he hopes that fibres made from chemical reactions can cover the mesh-works and function as self-renewing architectural envelopes that can change and decay with the seasons. "The component mesh-works are deliberately weak + fragile designed to share and shed their forces. Temperature, human occupation and environmental cycles all directly work on the sensitive components and the materials soak up that influence". Beesley (2011), cited by Hemmings, (2012) p.53. As much as Beesleys' work seeks to achieve a balance with nature, submitting itself to the natural cycles and

inevitable decay much in the same vein as the delicate partnership this research rather seeks to pursue a similar aim using the process of weave and the loom itself.

Dena Molnar a graduate of the Masters in Technology at Harvard has a background in the design of high performance textiles for interiors, and worked with Maharam (New York) as head of their High Performance Textiles division. He is also works alongside Janet Echelman (sculptor) to manage her initiative to develop new software for the creation of largescale urban textile sculpture. His research as an academic "addresses the relationships between Textiles, Architecture, and Product Design and how changes in technology can influence the intersection between these industries" (Molnar 2011). His current work explores the methods for modelling, fabricating, and actuating materials and his work in creating a deformable mesh fabric and using leno weaving are of particular interest. Molnar is aiming to develop a fabric that responds to external conditions, such as a change in light, or temperature, and changing physically in its response to these catalysts (Figure 8). His proposal is to use a mesh made from a synthetic fibre, and perhaps a shape memory alloy, one that is capable of changing shape or pattern. Other woven developments by Molnar have explored ideas around the concept of self-sustaining design for simple outdoor seating (In the Air, Textile Series) using monofilament and silk and using the transparent geometry of leno woven fabrics for window treatments.

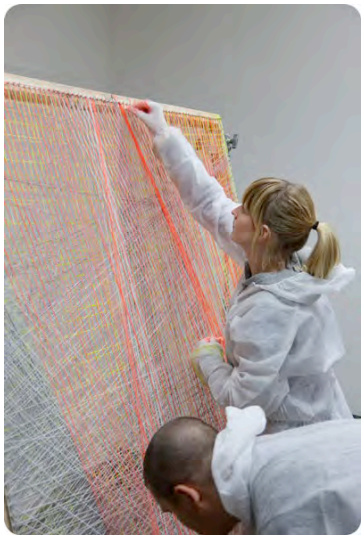

Fig 9. Creation of Moa basket

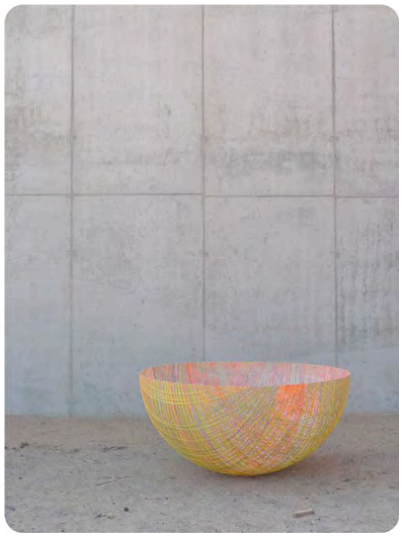

Fig 10. Moa basket

The use of a single thread tensioned across a frame to create a light open, weave-like mesh can be found in the work of recent graduate's, Eva Marguerre and Marcel Besau who have collaborated in the creation of their open basket vessels collection, Moa. These three dimensional vessels are created using a method similar to that seen in 1970's string pictures, where a continuous length of yarn stretched across a pinned frame to form numerous interlacing and crossings of the thread. The resulting elastomeric net created by Besau and Marguerre is subsequently drenched in resin and formed over a mould before the resin is solidified and hardened (Figure 9). The final forms are three dimensional and yet very light in appearance, a look which can be attributed to the open cobweb of fibres used in combination with bright coloured yarns as seen in Figure 10 (2011). Studio Besau Marguerre are excited by their connection between traditional craftsmanship and modern manufacture processes in this their first shared project. Visually their work creates the desired open net effect, but their colours and materials are 100% manmade in both their aesthetic appearance and their chemistry. A much more subtle blend of natural and manmade materials would be a better direction for the interpretation of the inspiration for this research.

Taking imagination seriously

Working on a much larger scale and using knotting techniques to create network structures, the sculptor Janet Echelman has also been inspired to work with a blend of traditional crafts and new production techniques. In her TED talk (2011) 'Taking Imagination Seriously' Echelman inspires the audience with the story of her accidental journey into sculpture when on her Fulbright lectureship to India. Struggling to work out how to create her commissioned artwork (when her paints went missing), she needed to create something with the local materials at hand. On her daily walk along the shoreline she saw the fisherman with their traditional fishing nets, piled up on the beach. In a new and fresh light Echelman saw the potential of this beautiful traditional craft to create volumetric forms without the weight of typical sculpture materials, and worked with fisherman to create a hand-knotted installation. A subsequent trip to Lithuania to study the craft of lace inspired Echelman to push the boundaries of the hand-knotted nets to

create pieces more reminiscent of this hand technique and subsequently went on to meet the challenge of interpreting this onto production machinery.

Fig 11. Janet Echelman in her studio

Fig 12. Tsnami inspired '1.26' Denver, Colorado.

Her first temporary sited piece in Portugal (see Janet in her studio in Figure 11) was her first large-scale three-dimensional net sculpture, and thus she created something that you wouldn't just look at, but something that you could get lost in. The architectural scale of the subsequent pieces led to her solving problems of supporting the weight of this relatively light construction, and then how to model the precise shape and gentle movement of these giant nets. Echelman pushes the craft of knotted nets to new levels, through the creation of new computer modeling software and she has developed new ways to interpret designs for production. In a later work, '1.26' (Figure 12) inspired by the patterns of a Tsunami rolling across the Pacific, sited in Denver, Colarado, Echelman sourced a new fibre for her nets using Honeywell's Spectra® fibre (stronger than steel and 40% stronger than an aramid) was able to reduce the weight of the pieces, and therefore the structural support needed to enable more fluid movement. Spectra® is an ultra-light-molecular-weight polyethylene using a patented gel spinning process (Honeywell, 2014), which has excellent resistance to UV, chemicals and salt water. Echelman's work is suggestive of the same route travelled by this research project, specifically for the value of handcrafts and their reinterpretation into a commercial product, and in her search for the ultimate material to suit her site requirements. Conversely her aim is to produce a

piece that is monumental in scale and resistant to the ravages of the environment, rather than adapting or changing over time, but to create pieces that are still dynamic in their response to the wind.

SHE Design studio in Oslo Norway have taken the concept of a cellular open weave construction in a more robust direction by using fabric rather than a single thread, with the aim to remove the foam from a seat construction and replace it with a textile that provide both comfort and support. Their 'Between' woven textile, combines wool and thermoplastic fibres into a hexagonal configuration in this innovative approach to push conventional materials to their limit. Their Aku room divider as also using 'Between' is more open in its design and claims some acoustic properties too. This design is another example of the way in which different fibre types can be combined to create an open cellular structure

Ageing and decay

What if we wanted to create a substrate that responds to its environment and the climate and celebrates the ageing process? Both fashion and textile designers have considered this in their work and the internationally renowned fashion designer; Hussein Chalayans' graduate project was one that involved the burying and then digging up of fabrics. The collection called 'The Tangent Flows' (1993) featured garments that explored the concepts of change and decay made with fabric he buried with iron filings in a friend's garden for several months. This burial process resulted in a series of heavily rusted, highly textural and decomposed garments, quite in contrast to the minimal design in vogue at the time. The ritualistic process behind its creation became "the beginning of a way of working and a way of telling stories" for Chalayan, cited in Dazed Digital (2013); since then, each of his works have been given their own unique narrative in his push to create new realities through technology and by manipulating hard materials not normally associated with the fashion world, such as wood, metal and mirror.

Hussain Chalayan may have touched on the subject of decay in his early career, but there are other examples of designers and companies who have taken this approach much further. The textile company, Nuno Corporation have also experimented with the properties of rust and the 'dyeing or imprinting' of a fabric with rusted nails and other objects onto a fabric as seen in their Scrapyard fabric (1997) Figures 13 and 14. Other experiments have employed spattering techniques borrowed from automotive plating to fuse particles of nickel, iron and chrome onto a polyester fabric.

Fig 13. Scrapyard Nails

Fig 14. Scrapyard Iron Plates

"Rust and fibre – a release of red: her work 'Scrapyard' most graphically demonstrated the result of changing states effected by organic process" (Millar 2005 p.13). Lesley Millar also describes the rust transfer process as being a metaphor for the relationship of textile to human experience – on of absorbing and retaining trace elements, an imprint; 'the human stain'.

The work of Reiko Sudo and Nuno of Nuno Corporation, is held in high esteem globally, and especially for their use of the latest technologies to push the boundaries of textile design for end uses from fashion through to architecture. Since 1984 their innovative approach combined both a study of traditional techniques in weaving, dyeing, and printing and with new manufacturing technologies from other industries. NUNO means 'functional textile' of the most ordinary kind and yet their work is anything but ordinary.

“Reiko Sudo is unusual in her ability to combine this centuries old approach with a contemporary way of working, one of amalgamating ideas and materials, constructing a collage. She has talent to engage in ‘play’ to allow things to ‘happen’, and finally to take advantage of chance events and an unerring decisiveness.” (Millar, 2005, p.12). This desire to retain old and established skills and traditional craftsmanship echoes the sentiments of designer Patricia Urquiola and her approach to the development of her product design ideas. Reiko Sudo talks about indigenous skilled craftsmen, with a flexible sensitivity, being able to fill the gap between design ideas and the capability to realize these in the manufacturing process. A female sensitivity for design, employed in the creation of rewarding textiles and products is another reoccurring theme seen in the work of Urqiuola (see Chapter 3), Nuno, and also Ayala Serfaty, whose work will be discussed later.

The science of change and decay was taken one step further, in the 2008 collaboration between Carole Colett and the Nobel Prize wining scientist Sir John Sulston, as part of a project conceived by Professor Fisher of the Medical Research Council. Fisher had the vision to recognise that biologists and textile designers could potentially inform and benefit from each other, in research and exploration of new work informed by each other’s practice. The partnership between Colett and Sulstan explored the concept: ‘the design of obsolescence’, essentially informed by Sulstan’s research on Programmable Cell Death (PCD). The use of traditional textile techniques including macramé and crochet was employed in the development of soft furniture and sustainable textiles for garden use. Crochet and macramé were chosen by Colett in an attempt to mimic the cellular development and apoptosis (PCD) seen in Caenorhabditis Elegans, a little nematode that lives in compost heaps, feeding on the microorganisms that decompose our food (McVittie 2008). Of particular interest within this ‘Suicidal Textiles’ collection are the poufs, (Figure 15) created in hand-knotted macramé using a combination of natural (biodegradable) and synthetic (non biodegradable) fibres. Colett (2008) describes the core body of the pouf as constructed in nylon rope with the ability to endure outdoor conditions for a long period of time and the outer layer (of a looser construction) made from a combination of natural fibres (sisal, jute and abaca). This outer layer will compost over a period of years, slowly revealing the inner shape of the pouf made from the more

resistant synthetic fibres. "The slow process of making knots one by one echoed the rhythm of 'life manufacturing. As such the traditional craft of macramé became the catalyst for a biomimicry design model" (Colett 2008). The work for this project not only explores the science of decay in different textiles, but also considers the relevance of slow making of structures using traditional textile techniques.

Fig 15. Suicidal Textiles, pouf

Carole Colett has subsequently explored the relationship between the fields of architecture, materials, science, design, biology and biomimicry with the research network Materiality of Light. Her latest project aims to be the future of sustainable textiles – Biofacture, in which "Colett has re-evaluated the roles that shape-shifting materials, programmable surfaces and technological interfaces can play in every day design" (Material Futures, 2012). Will these visions set out by Colett be a part of our future and if so when? Some shorter term and more attainable approaches to the science of decay are perhaps easier to understand and work with at present.

A decayed aesthetic

Ayala Serfaty's work for her SeeJoSo and Rapa furniture, Figures 16 and 17 created in 2011 has surface textures reminiscent of mould on lichen over a stone surface, and she also uses a very soft muted colour palette. These forms for her furniture are created from large felted pieces that have been molded in one go using a three-dimensional mould with which she sculpts the flat felt surface.

Fig 16. SeejoSo II sofa

Fig 17. SeeJoSo detail

Serfaty is inspired by sculpture and in her SeeJoSo II Sofa she was inspired by the marble surface that she encountered in sculptures by Michelangelo.

Serfaty manages to enhance the worn and muted appearance of her pieces using a process of dying her fibres for her felt using natural dyes. A mix of both wool and silk fibres are employed in varying percentages enabling her to create a varied and random surface to her felted pieces. Serfaty's sofa has an inconsistent profile so one side may be created quite differently to the other on this enables people to sit in different postures over the sofa surface. Her beginning point for the shapes involves the use of sculpture with polyurethane foam over a metal structure giving her the initial form. Then she works out how she is going to cover this, very much in the way in which you might consider using the garment to cover the shape of the body, (Surface Magazine, 2013). She doesn't use cut and sew techniques but makes one full piece of fabric, responding to be natural ability of felt to be formed in multi directional ways due to its nonwoven construction.

This approach where by a single piece of cloth takes the form of the structure behind it is interesting and something that isn't so easily replicated using woven fabric. Woven fabric does not easily stretch in a multi-directional way unless elastomeric yarns and sensitive finishing processes are employed. This furniture range from Serfaty hits all the right cues in terms of its natural, aged-look and soft form, but her other more recent projects have visual similarities with the idea of using open nets. Her work with Aqua Creations, a joint venture with her husband, is now focused on designing innovative lighting, which is influenced by her artistic studies of underwater plants and creatures, translating the laws of nature into the final pieces, (Designboom, 2006).

Fig 18. LcD textile collection

The LcD textile collection by Luc Druez for Fameed Khalique, is a limited edition of 'hijacked' fabrics made from reclaimed technical fibres and shortlisted for the international design product awards in 2013. These beautiful yet distressed fabrics are composed of a diverse range of materials that include: fishing-rod string: (translucent, strong, washable), electrician's copper wire, oxidizable, and in an infinite palette of colours, each one unique, as illustrated in Figure 18. Fameed Khalique offers elite interior designers and architects an unsurpassed resource of unique, innovative and rare artisan materials at a luxury level. His studio has expanded to become a hothouse of textile designers working in new and exciting ways; textiles which shirk the hardwearing feel of many contract interior fabrics. Commenting in Super Yacht magazine (2013) Khalique talks about his frustration with designers, who through sheer lack of time tend to go for the same solutions time and time again. His patronage of designers like Luc Druez, a former designer for Chanel and Be Inthavong, who works with Loatian weaving techniques, is proving to be fruitful in a climate where bespoke, hand crafted textiles are valued over the mass manufacture of commercial fabrics.

Interventions in the landscape

An abandoned or discarded 'man-made' item, a piece of brightly coloured plastic, string, a sock, handkerchief or plastic bottle, are all items perceived to be at odds with the

environment in which they are found. These seemingly insignificant pieces of rubbish, shout out their presence on closer inspection. Does the texture and feel of the surface, shape or patterning, or the material mark out this items as interlopers in the landscape?
In essence all materials are derived from natural resources, but those labelled as man-made or synthetic have had their chemistry altered by man in some way. These changes are ones that nature herself would not waste her energy on.

Many artists have worked closely with the landscape and embraced the changes that natural forces bring upon a material over time and specific examples will be considered here. For Andy Goldsworthy working on the land nourishes his creativity and he is often working against time in very hard climatic conditions. This passion for the landscape and the reward from manipulating of materials grew from his early experiences of playing on the beach at Morecombe as a child.
His work is more concerned with the process rather than the appearances of nature, and his practice involves both the making and the photography of ephemeral works in the landscape. He comments that nature has a veneer of prettiness that conceals a brutality beneath, a brutality that he witnessed first hand during his time working on a farm.

In the creation of his stone enclosures (1996-2007), although he is creating 'permanent' works, he does not have a plan to protect or maintain them for the future, and thus allows nature to take its natural course and gradually alter their appearance, as it does with any other feature in the landscape. Sheep rub themselves against the stones at the entrance to the enclosures, the lanolin in their fleece leaving a shiny patina. Goldsworthy prefers to work in a non-invasive manner, but when he creates a piece for show in a gallery that is not 'site specific', we as observers tend to focus on other aspects of his work, especially the form and sculptural elements. Creating a non-invasive woven piece, a seat in the landscape should embrace Goldsworthy's approach to embracing nature, change and intervention, but should explore other materials.

Richard Long also records and captures the essence of a journey through the landscape. He uses the natural materials around him or makes an impression on the rocks/soil using his own body or the movement of his feet through the environment. His work is not only

located in the landscape, but also made of it (Wallis, 2009). In contrast to Long, Goldsworthy not only works in hard materials but also with other softer materials found in the landscape, like leaves, twigs and sheep wool. A number of textile artists also work with the landscape and use softer, flexible and less permanent materials to form a relationship with the environment.

'Bound' by Philippa Lawrence first conceived for the 'Explorations' exhibition at the National Botanic Garden of Wales' in 2003 was a work linked to her interest in Japanese packaging and their aesthetic regarding wrapping and packaging.
Through binding a tree in cloth she freed the form and could it offer back to the public to see it through fresh eyes. It followed a concern with unearthing qualities in the commonplace that were worthy of note and were mainly over looked. This approach by Lawrence and her desire to highlight hidden qualities, echoes the authors' observations and the beauty found in otherwise abandoned objects. "Bound referred to the process of binding and swathing the trees in cloth, to the time and intention in making the work – and connecting to place and also to boundaries" Lawrence (2003).

Laura Ellen Bacon began making her 'early works upon dry stone walls and evolved to work within trees, riverbanks and hedges, allowing the chosen structure (be it organic or man-made) to become host.' (Bacon, 2013) These large-scale sculptures were initially inspired by nest-like structures, and are randomly woven into organic three-dimensional structures in which Bacon employs the art of basketry in new and exciting ways. Her work uses natural materials whose properties are communicated through her clever manipulation, but she has more recently sited a number of pieces in the urban and built environment that contrast with harder materials and surfaces. She was commissioned to create three works in the Capability Brown-designed grounds of Compton Verney in the summer of 2011 and the three pieces she constructed included work woven from polypropylene ribbon (Figures 19 & 20) as well as her usual willow. 'First Encounter', was created inside a hidden, trunk of a yew tree and 'Web Site' was created as a modern-day folly during Bacons residency at Compton Verney, and was one of a series of nest or den-like spaces she constructed in either natural materials or in the webbing of polypropylene ribbon.

Fig 19. Compton Verney residency

Fig 20. Compton Verney detail

This contrast in material use between the branches and trunks of the trees and the loosely networked synthetic tape is one to be explored in this research through the use of synthetic and natural yarn blends in the creation of woven nets.

Ghost nets

Ghost nets - abandoned, man-made yet beautiful. The other area of influence and inspiration for this work are the abandoned nets, rope and string found amongst the pebbles and sand on the beach. An annual trip to the remote beaches of the Wester Ross region of Scotland, have sparked this particular area of interest.

Abandoned in the sea, fishing nets carry on what's termed 'ghost fishing' as they don't stop fishing, but rather present themselves as hazards to some of the worlds largest mammals, and are reported to be accountable for the death of up to 130,000 dolphins, whales and porpoises (Wilson 2013). There are many initiatives around the globe to try and tackle the issue of ghost nets, both by individual communities and by global companies. There are 22 communities in Australia who are working to combat this problem in a creative way through the creation of artifacts and other products made from the recovered nets. Sue Ryan, Art Coordinator for the Carpentaria Ghost Nets programme, has worked closely with the local indigenous community in running

workshops to create craft and functional items from the nets to raise money for the artists and their communities. Ryan (2010) plans to create a travelling exhibition featuring the works from various communities, collaborative works and works by key artists involved in the project. She hope that the exhibition would highlight the way people interpret the material, and express cultural identities through new art forms in weaving these discarded nets.

Nylon or polyamide monofilament fishing line takes up to 600 years to degrade, and PET bottles only 400 years. Although essentially derived from once living organisms, plastics like these made from petro-chemicals do not biodegrade due to the permanent carbon bonds created to hold the monomers in their polymer chains. Nature itself creates peptide bonds in proteins but various organisms break these down very quickly. The drive for long lasting stable plastic products and yarn's has resulted in an understandable dominance in the use carbon bonded polymers. There has been some movement towards peptide bonds for products with a short shelf life, but for high performance products like fishing nets this is not a suitable solution.

On a more commercial level the Healthy Seas Project has worked with polyamide producer Aquafil and the Dutch manufacturer Star Sock in a drive to regenerate as much abandoned fishing net as possible from the seas around Europe (Wilson 2013). Aquafil have created an industrial system (Econyl) for the production of polyamide 6 from 100% regenerated materials, materials that include recovered fishing nets. In 2012 their cradle-to-cradle process for making Econyl included 30% post consumer waste, which include a percentage of nets and 2014 will see the first commercially produced Star Sock range made specifically from fishing nets.

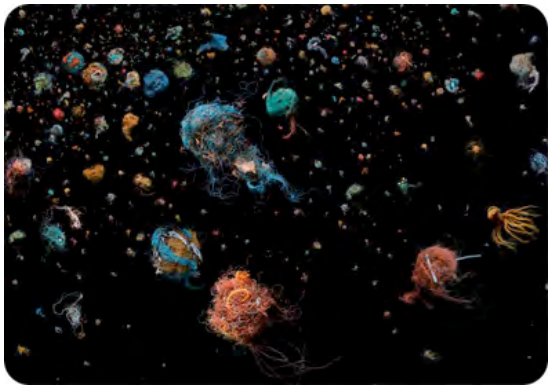

Fig 21. SOUP

Fig 22. Catch as catch can

Mandy Barker response to the issue of Ghost Nets has created enticing photographs, an example of which can be seen in Figure 21, of the tangled masses of strangely beautiful discarded fishing nets in her works, SOUP (2011) and Indefinite (2011). SOUP is a description given to the masses of plastic debris comprising nets, ropes, and other detritus suspended in the sea, she makes particular reference to the mass that exists in an area of The North Pacific Ocean known as the Garbage Patch. Barker (2014) says that her "work aims to engage with and stimulate an emotional response in the viewer by combining a contradiction between initial aesthetic attraction and subsequent message of awareness". Barker has highlighted the slow rate of decay for these manmade plastic materials, in her 'Indefinite' series (2011), through her titles for each piece, which range from: 1 year to indefinite. The beauty Barker sees in this rubbish of the seas is one to be admired and this echoes the objective set to create aesthetically pleasing materials using man-made fibres in this practice based weave research.

Karin Van der Molen is another environmental artist, who is based in the Netherlands and creates artwork in response to local materials and situations. Through the use of scale she encourages people to experience nature in a new way and through the technique of weaving (three dimensional) with both natural and man-made materials and pushes the public to reflect on their surroundings. Of particular interest are her pieces that reference nets and found materials on the seashore. In 'Catch as catch can' (2011) Van der Molen has erected abstract fishing nets suspended in and amongst the trees, playing on the visual metaphor of the net to capture (Figure 22). Earlier development work 'Life line, blue waste ' sited on the coast at Schiermonnikoog, (Netherlands) sees Van de Molen laying out a line of washed up plastics, nets and string in a beautiful blue line.

This chapter has reviewed the work of a range of practitioners, in the fields of sculpture, landscape art, textile art and design, photography and architecture. This seemingly diverse collection of work outlined here has all had some influence on the direction of this practice-led research, whether that is the material used, as a source of inspiration or in their approach to research. Other key aspects of the practitioners work detailed in this

chapter that I plan to use to inform my own research includes, the dynamic response that Dena Molnar is building into his deformable meshes, but my work will look at catalysts like the environmental conditions and weather leading to a visual change in appearance rather than a phototrophic or physical one (as to temperature). The scale and confidence of Janet Echelman's pieces imbues a certain confidence to take textiles into the landscape and highlight their beauty as I would like to do seeing their potential rather than hiding it.

She designs combination of materials that allow rigidity and sound absorption is something that I will translate into fibre combinations where strength and aesthetic beauty/comfort will be provided in the same cloth. The heavy structural appearance of their cellular screen is however too dominant and I wish to pursue a lighter more ethereal fabric - one that blends with the landscape. Bacon and Molen's approaches to working with textiles in the landscape have an attractive beauty which I plan to address through a thoughtful use of materials but their pieces are viewed as temporary responses whereas I want to create a material with a longer life span.

In terms of material erosion and change over time, Colett's suicidal textiles, and Nuno's rusted fabric are a primary influence especially as the changes are planned in such a way as to reveal a new identity for the piece, on that is still attractive and functional, with the changes not being destructive in a way that would lessen the structural integrity of her poof.

Chapter 3 Leno techniques, the alternatives and seating

This chapter will detail the research conducted into a number of methods considered suitable for creating open net-like structures in line with the aim create a fabric that emulates the inspiration identified in Chapter 1, and is guided by the practitioner research in Chapter 2. As a weaver, designer and lecturer in woven design, the opportunity to explore a new technique through handloom weaving is a rare one, in the fast-paced and constantly changing academic environment. An examination of the historical routes of leno weaving (the technique identified as most closely matching the desired parameters for this conceptual seating cloth) plus the current range of commercial options and production techniques for leno fabrics will be investigated. This chapter will also consider contemporary seating design with a specific focus on designers that have employed suspended seating concepts in their work; whether through the use of tensioned fibres, elastomeric nets or through techniques that are derived from the revival of a craft tradition.

Techniques employed in creating open structures

Investigation into potential weave structures for this project has been carried out using current research on weave, but more importantly through knowledge of the writing of two 'masters of the weave structure', William Watson (1912) and Thomas Ashenhurst (1883). Ashenhurst (1883) talks at length in his book 'Design in Textile Fabrics' about the importance of balancing the ornamental with the usefulness of the cloth, and how attention needs to be made to the considering the best structure for an end use. It is perhaps surprising that these texts dating from over a century ago are still relevant today, but despite other more recent weave practitioners (Margo Selby, Anne Dixon etc), addressing some areas of weave knowledge, none have come close to addressing the level of detail and range of structures that Watson and Ashenhurst have covered.

Methods of producing open fabrics.

There are a number of traditional methods of producing nets and intertwined thread structures that could also be considered. Knotting techniques have been developed over a number of centuries and these include fabric types such as, macramé bobbinet lace and crochet.

Macramé

Macramé is typically used for the creation of heavier decorative nets and can be controlled to create intricate patterns. Macramé uses various types of knot tying combinations to secure a length of rope or heavier material.

Lace

Lace and in particular bobbinet lace also uses a twisting mechanism similar to leno but in this case pins set onto a cushion are required to control the openings in the lace structure. A very slow and time-consuming process has meant that bobbinet lace has remained a select handcrafted fabric type. The subsequent machine techniques developed to replicate these traditional laces, were developed on machines that included the leavers lace machine. Leavers lace is now little produced again due to expensive to set up and running costs. This type of lace is now reserved for the very high end products.

Warp knitted lace

Raschel lace produced on a Warp Knitting machine has become the fabric of choice in current mass production. The production of this lace on a warp knitting machine requires a warp thread only which are twisted over each other and intertwined using banks of needles controlled on guide bars. Schiffli embroidery machines were another solution to creating handmade lace type fabrics, but again as with Leavers lace these machines have been phased out. This process required removal of the ground carrier fabric for the embroidered detail and this was carried out using a chemical process that is no longer considered environmentally sustainable.

Twisting threads and particularly in the case of leno weaving is a more efficient and faster production of creating open net type of fabrics on woven machinery. The Raschel lace has become a major competitor to the woven leno fabrics and has subsequently taken over

on the decorative side of decorative net fabric market. Examples of two less decorative fabrics produced on the Raschel warp-knitting machine are illustrated in Figures 23 and 24.

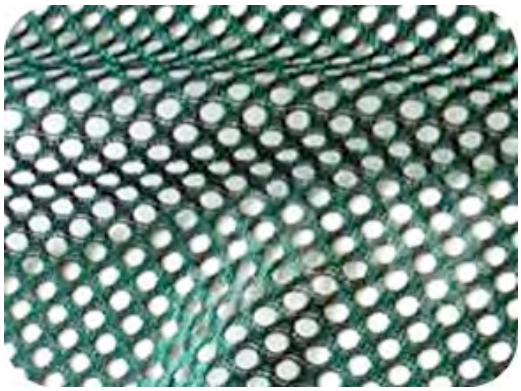

Fig 23. Raschel Lace Mesh

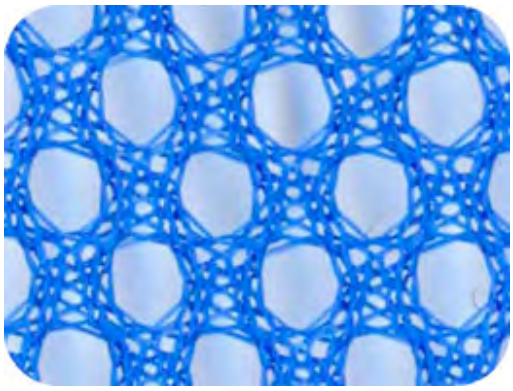

Fig 24. Raschel lace net

Open nets produced through weaving

An open weave structure was identified by the author early in the process, as the ideal vehicle to express the sources of inspiration (fishing nets, webs etc) that catalysed this research. Open in this context can be defined as a weave structure that enables the viewer to glimpse through to another layer through to the surrounding landscape for example. An open net-like structure picks up on the design cues in the wide range of inspiration collected: from the fence, to the knots of twine on a fence post, the fisherman's nets and to the naturally occurring dew-laden cobwebs.

Open net structures in weaving and can be achieved using a variety of methods, which resemble the intertwining and interlacing of clearly defined threads. Distorted weft, mock leno and gauze structures are the most likely to give the appearance of an open net structure. Distorted weft effects enable the weaver to bend specific picks (threads) into angular waves or networks through the use of a combination of plain weave and longer warp and weft floats. The plain weave sections create areas of resistance whereas the long floats in the warp direction shrink in length pulling the weft feature floats out of their horizontal position. This effect although attractive, relies on a fully set ground weave and therefore does not allow any opportunity to create a weave with see through areas.

Mock leno weaves can be defined as weave structures that create the illusion of a leno weave but that do not require any additional mechanisms or device installing on the loom. These structures are used where the mechanism to produce a true leno is not available, and the designer wants to create a fabric that has the visual appearance of a leno fabric. Areas of plain weave and areas of longer floats are again employed in the mock leno structure and placed in regular patterns to create small geometric effects. Unlike true leno weaving, these mock leno structures have threads that always remain parallel to one another in the weaving process, and they never cross-over or twist over each other as in the case of a full leno structure. The mock leno structure does create some small holes within the cloth, and as can be seen in the example Figure 25, but there are still not enough openings created to produce an open net effect.

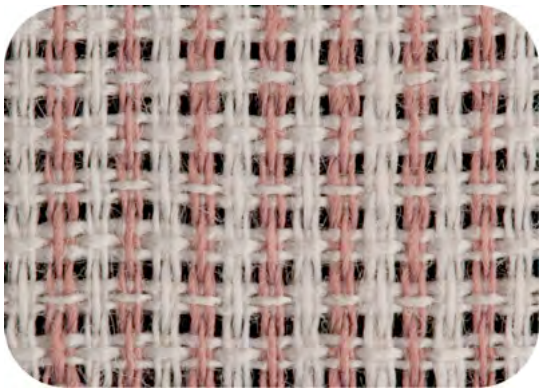

Fig 25. Mock Leno fabric

The analysis and subsequent dismissal of these other structures by the author has led to the selection of leno or gauze techniques to achieve the desired outcome. Leno woven fabrics can be characterized by their open, structurally stable, and lightweight appearance, and properties. Leno constructed fabrics are made from twisting together two warp threads that can be controlled under varying tensions, and one weft thread. This structure produced through the use of specialist heddles allows the creation of truly open fabric structures, which suggest the open net effect that is of interest for this research.

Leno fabric samples in the archive

Investigations into the Huddersfield University archive of historical fabrics revealed a rich resource of decorative leno fabrics dating from the 1930's to 1960's.

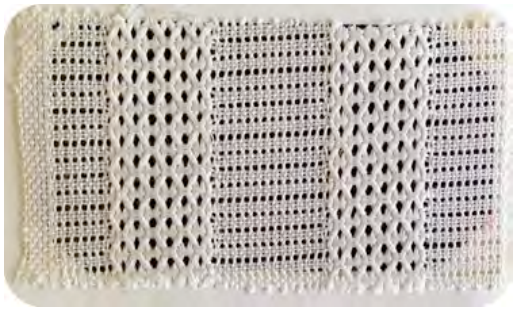

Fig 26. Archive sample 1

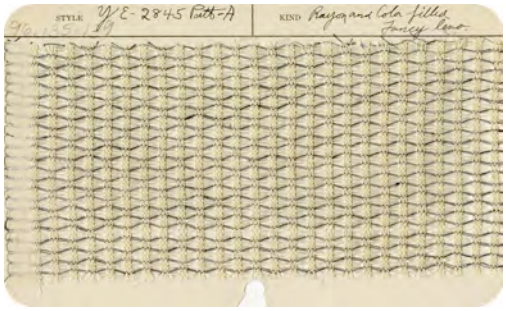

Fig 27. Archive sample 2

These examples of medium to heavy weight examples of leno woven designs are varied in terms of the yarns they employ, the colouration of the textiles and the complexity of the weave structure used. Examples of the type of design produced at this time in the textile industry can be seen in the archive samples in Figures 26, 27, 28, 29 and 30.

Online research revealed some other excellent archives of these historical, and decorative examples of leno, at the university of Philadelphia and

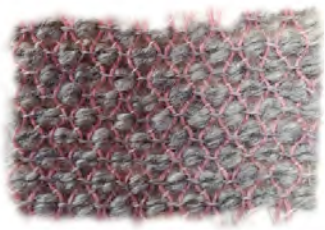

Fig 28. Archive sample 3

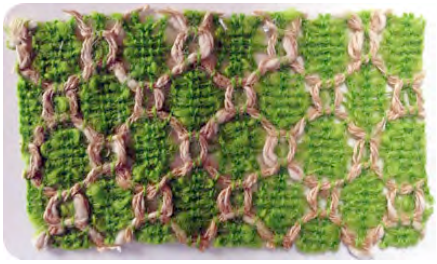

Fig 29. Archive sample 4

Fig 30. Archive sample 5

Little evidence of this type of decorative leno fabric has been found in this research, which could be due to new fabric technologies being used to produce similar cloths, and the market for this 'look' not being there any more.

In Japan the handcraft of tangling threads to create nets and gauze-like fabrics, is a very old and highly respected form of textile production dating back to the Nara Period (710-794). Many methods that fall under this Karamiori category are described by Marshall (2011) as called leno weaves and these range in complexity from 'Sha' with no discernible pattern, to 'Ra' where 'bird nets and open-weave basket structures' are created.

> [Leno weaving] is really the only way to achieve a light, airy weave that won't bruise easily. It allows light and air to pass through the weave freely while maintaining its structure. If a simple in-and-out flat weave were woven very loosely to achieve this same affect, the threads would have a tendency to shift from side to side (bruise) if rubbed, disturbing the beauty of the weave. (Marshall, 2011)

Leno weaving

The leno mechanism enables adjacent warp threads to be twisted together, crossing over them over each other and therefore trapping the interlacing weft yarns, and this twisting motion prevents the fibres from shifting and enables fabrics suitable for high performance applications, industrial uses, agricultural, medical, construction and other substrates. "The crossing of the warp threads gives the fabric a very firm structure, and a fabric woven in the leno principle is considerably stronger than other fabrics containing a similar number of ends and picks per inch" (Shinn and McKenna 1930, p.31)

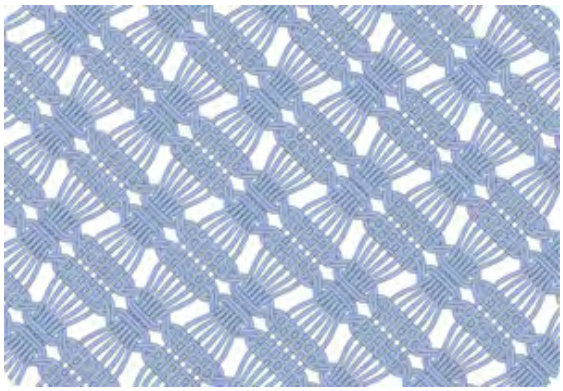

Fig 31. Grenadine stripe fabric

There are various types of leno woven fabrics and these include gauze, which is characterized by its thin, open and translucent appearance. This fabric is generally produced using synthetic yarns, and these have now mostly replaced the traditional silk for fashion end uses. Leno fabrics that use cotton yarn are found commonly used in medical dressings for wounds where the open structure prevents the fabric from sticking. Leno is also used in safety lamps where the gauze is constructed using metallic yarn to

create an open wire Mesh. Grenadine is a dress fabric or a curtain fabric again using the leno method but in this example, an all over mesh or stripe is formed as in Figure 31.

Tulle and net are also part of the leno family and these fine meshes, totally transparent in appearance are typically constructed using synthetic yarns. Nets are produced for a wide variety of fashion fabrics, and other accessories fabrics such as ribbons and veils. Leno fabric is usually made from silk and this category of leno woven construction is characterized by a striped pattern. These patterns are formed through a mix of leno twisted sections and plain weave interspersed between them. A typical horizontally formed leno stripe is used for clothing. (Chen Y 2011). Chen (2011) states that leno fabrics can be summarized as only being used to produce lightweight meshes and transparent structures for fashion and home furnishings.

Mechanisms used in the production of Leno weaving.

Leno weaving can be controlled in a variety of manners. In the case of hands weaving on non-mechanized looms, such as those typical of the craft practitioner there has been experimentation using bead leno, and some use of doup leno weaving. Beads or doups are used to control the crossing threads that are an essential part of the leno weaving structure. In the case of doup leno weaving (see Figure 32), an extra shaft is required to tie the doups to and another set of empty heddles on another shaft is required for these doups to be passed through to control the crossing of the threads.

In the case of power loom weaving a range of insertion methods can be used in the creation of leno weaving and these include the rapier loom projectile loom, and shuttle controlled mechanisms. Here looms are set up with a mixture of leno heald frames and standard heald frames. There again there are two systems in use for controlling the crossing threads. The first system is a twine Leno heald system and this is particularly useful when designing on a jacquard-weaving loom. The second system involves the use of metallic leno healds as illustrated in Figure 33 and 34, and is used extensively on Dobby controlled looms.

Fig 32. Twine doup

Fig 33. Stainless steel doup

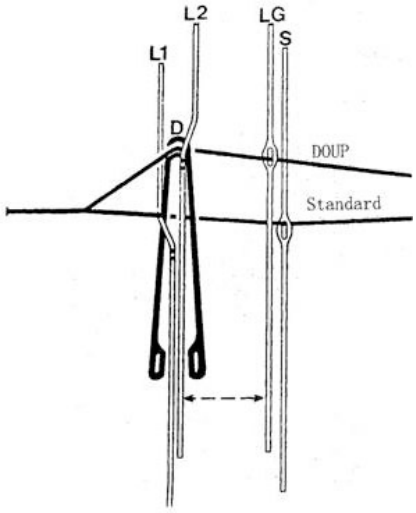

Fig 34. Doup threading in loom

The bottom leno system is more commonly used in industry and the system involves controlling the thread with three types of shed. These are the crossing the shed, the opening shed, and a standard shed. These three sets of sheds can be combined to form a variety of patterns and structures.

Leno Advances

The ability for leno fabrics to create open and yet stable structures has seen the use of this method of weaving develop from the purely aesthetic and fashion oriented fabrics as mentioned previously to the now more common use in performance and medical textiles. Lightweight, deformable and securely interlaced warp and weft gauze fabrics were developed in a very decorative manner at the height of the popularity in the early twentieth century (1930-1950's), but subsequently these fancier more complex designs (see archive examples in Figures 26 to 30) were more economically produced with the development of warp knitting technology. This use of leno weaving to produce the more decorative, complex designs has been mainly replaced by its development into self-supporting substrates, geo-textiles, compression bandages, in aerospace, and for other technical mesh applications. Current applications outside of the popular transparent fashion fabric's are best described as, used for non-aesthetic functional end uses, where

high performance fibres coupled with the structural stability means that the performance of the cloth is more important than the actual appearance. Many new innovations in fibres and structures are being developed in the field of medical applications, according to Chen (2011), and could include tissue-engineered scaffolds, and vascular implants.

Leno weaving on the industrial side has been developed extensively through the creation of new heddle mechanisms to control the crossing of the threads by loom manufacturers such as Lindauer DORNIER GmbH. DORNIER's EasyLeno® 2T technology simplifies leno fabric production, whilst raising productivity and reducing material consumption. Of special interest is the ability for this system to handle more delicate yarns, cope with varying tensions and to create new fabric appearances (Dornier, 2005). The key markets for these new advances are cited by Dornier, as being for drapery, technical and semi-technical fabrics that are in essence plain or semi-plain in appearance. Students from the department of Textile and Clothing Technology University Niederrhein have developed a cord-like fabric using the EasyLeno® 2T system. Kampermann and Wortelkamp (Dornier 2010) used the DORNIER technology to create a mock cord or rib using a combination of chenille and standard yarns across a polyester warp. This LenoCord has the appearance of a true cord but without the costly production process that a traditional cut and brushed cord requires. This project by Dornier (one of the key manufacturers of loom technology) is an example of an attempt to broaden the use of this technical cloth.

Nets, seating and the great outdoors

This section will briefly analyze the current product offerings available for outdoor seating and bench designs, with specific reference to the materials employed. An investigation into the exterior sector, to research the current market and use of leno fabrics for seating will be detailed. Directional design concepts that use suspended fibres/yarns and other net-like materials will also be considered.

Contemporary seating concepts

Commercially available outdoor seating that employs a mesh-like substrates and supporting materials can be found sourced at trade shows such as IMM Cologne and Spoga + Gafa in Germany. The mesh seating products have a tendency to of a minimal and clean design and employ small scale semi-translucent supporting mesh fabrics.

Fig 35. Sun Lounger by Alias

The outdoor Sun Lounge by Alias is typical of this type of product available to the mass market (see Figure 35) whereas the designs of Bertjan Pot push the scale and application of suspended net fabrics.

Fig 36. Tiebreak chair

Fig 37. Carbon chair

Two good examples are his tennis net chair "Tie-Break' (Cologne IMM 2012) see Figure 36 and his Carbon chair (2004) for Mooi in figure 37. A number of other innovative product and furniture designers have played with the concept of suspended cords, meshes and natural rattan weaves.

Fig 38. Detonado chair

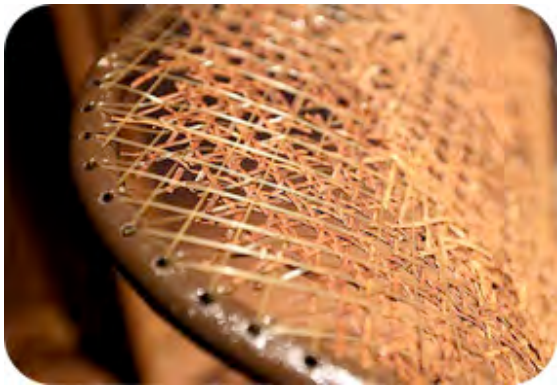

Fig 39. Detail of Detonado chair

The Campana Brothers, Fernando and Humberto created the Detonado chair in 2013, which combines natural wicker fibre with nylon into a woven mesh strung between a metal frame (see Figures 38 and 39). An alternative approach to the desire to create a seat with a supportive textile back, can be seen in the work of Benjamin Hubert in his Membrane chair designed for Classicon (see Figure 40).

Fig 40. Membrane chair

Fig 41. Tropicalia for Moroso

Moving into the realm of the established designer, Patricia Urquiola's work spans product design, architecture and installations such as lighting, and her work has been featured at MOMA in New York. Urquiola's fresh approach to the use materials employed in her furniture design for many Italian contemporary design companies is of particular interest to this study. She has produced a range of seating solutions over the last eight years, many for the outdoor furniture market and has created pieces for companies like B&B Italia and Moroso. In 2008 Urquiola created the Tropicalia chair, Figure 41 for Moroso,

which featured wrapped threads around a tubular frame, a chair where the threads were available in a range of man-made and natural materials. In this design, Urquiola constructed the seat support material in structures that combine solid and void areas, is reminiscent of a multi-axial woven fabric and geodesic forms.

Morozzi (2010) suggests that Urquiola "has changed the whole face of design and influenced general taste". The approach to design that Urquiola adopts is one that blends the best of new material innovation and traditional craftsmanship. Her work combines creative invention with a passion for research into handcrafts and these have included, crochet, hand knitting, embroidery and weaving. "She takes [products] by the hand and ensures they fit into their context" (Morozzi, 2010). Her work has its roots in the world of art and craft despite her position as a designer of innovative product design; she is adept at reinterpreting historical styles and techniques, recreating them into something fresh and contemporary. Morozzi (2010) suggests that Urquiola does not want to generate conflict or to be provocative, she wants to consider the pleasure of using things, and she uses her feminine intuition to form an intimate bond with physical product. The structure of woven cloth and basket weaving have been revived in a number of her designs including the Canasta range for B&B Italia, inspired by Crinoline, and the Flo collection for Driade (Figure 42). This reinvention and modernisation of traditional crafts, through the application of new materials as seen in Urquiolas work, is similarly important in the direction of this research. Urquiolas open approach to such a broad range of design challenges also marks her out as someone to emulate in my design work.

Fig 42. Flo chair for Driade

Fig 43. Mueller chair

Another furniture designer, who works in a similar manner, with creating open seat designs using a single thread tensioned across the back and seat, is the young Austrian Alexander Mueller. Muellers work is "based on traditional weaving techniques reinterpreted with inspiration from Naum Gabos' 'Construction in Space' works and straight line drawings" (Designers Block 2013). Mueller's geometric seating pattern in Figure 43, was created by deconstructing traditional weaving methods in a similar way to those used for Patricia Urquiola's work. He also examines the relation between the frame, the cord and the end user in his aim to bridge the value of handmade crafts with modern manufacturing techniques.

Leno fabrics in seating

The use of leno weaving in combination with technical fibres is demonstrated in the excellent example of the Aeron® chair in Figure 44 developed by Bill Stumpf and Don Chadwick for Herman Miller in 1994. This partnership to create a new generation of office seating, aimed to create a product that was durable, easy to repair, recyclable and easy to disassemble. Bill Stumpf designed this revolutionary chair with a suspended seat structure with himself in mind, as he knew what he wanted in order to be comfortable.

Fig 44. Aeron chair

Fig 45. Pellicle fabric

The Pellicle® fabric (Figure 45) uses leno weaving technology and a composition of 68% elastane and 32% polyester yarns. The aim of this transparent material construction was to permit the free flow of air and moisture, as you would with a lace curtain or other

permeable membrane. Stumpf and Chadwick designed the Aeron® chair to have no straight lines and to be biomorphic and curvilinear, echoing the human form. This new approach to office seating, by Herman Miller (2014) claims to support you in any position you adopted and to be unobtrusive, communicating the inner workings of the chair through the transparent construction.

Herman Miller have taken its open suspension concept further with subsequent office seating products, created in collaboration with the likes of Yves Béhar and other product designers. SAYL® the suspension seating product by Behar "looked at how design can deliver the most with the least". He looked at applying the principle of suspension bridges over water to the design of the chair, and created an open lattice that became a frameless back for the chair, thus taking the open leno look further. It is interesting to note that the later suspended seating developments by Herman Miller moved away from the leno construction and into using an injection moulded elastomer seat back for SAYL®. This change in technique could be in part due to the individual approach that each designer takes to a design challenge, or due to a breakthrough in materials knowledge and application. One weakness of the Pellicle® fabric stems from its yarn composition and the leno woven manufacturing process, one which creates a delicate open mesh, but one that is open to damage from sharp objects and knives. There is no indestructible inner core to the coated yarns used in Pellicle® that can protect it from acts of vandalism. In an office environment the chances of damage to the suspended back of the Aeron® Chair is minimal, but the potential increases significantly in the public outdoor seating arena.

This approach adopted by Herman Miller, to create open and honest design using leno net fabrics, suspended to support and yet not interfere with the surrounding environment, supports my pursuit of using leno fabrics for outdoor seating fabric.

Further research unearthed the work of Susan Lyons a material consultant who has worked alongside Herman Miller in the revival of the Eero Saarinen and Alexander Girard-designed chair, now being sold as the Eames Aluminum Group outdoor seating. This updated version of the original 1958 design, uses a hybrid fabric called Outdoor Weave

that retains the spirit of the original polyester fabric and combines this with the technical capabilities of the Aeron chair's Pellicle suspension fabric. The Outdoor Weave fabric is composed of a sturdy monofilament polypropylene for strength and elasticity, and four multifilament polypropylene yarns to give it a softer look and feel (Herman Miller 2014).

This chapter has analysed the mechanism and structure of leno fabrics and considered other methods of constructing this look of fabric that are available to the textile designer.

Leno fabrics meet the requirements of this research as evidenced in their open netlike appearance, stable construction, and strength. Established and notable contract interior companies such as Herman Miller have already identified Leno constructed fabrics as suitable materials for use in office seating products. Their Pellicle® fabric is durable and provides support without reverting to conventional material/foam combinations typically seen in seating design. In this respect the potential of using leno fabrics in an exterior context as intended in this research has been justified. Potential downsides are the inherently vulnerable nature of fabrics used in public spaces where they are susceptible to vandalism and other damage.

The enduring aesthetic appeal of simple leno net fabrics has been established in the fashion arena, and their technical usefulness identified in the technical textiles market. There does however appear to be a gap in the use of this weaving method in the production of decorative yet functional fabrics for interior or exterior use. The reinvention of traditional craft techniques, which are developed by hand and then adapted for commercial production, (as seen in the work of Patricia Urquiola) mirrors the hands–on weaving process, which will be adopted in this specific research project.

Chapter 4 Methodology

Introduction

In this study the researchers own textile practice and woven creations were used within the framework of practice-led research, as a method to gain first hand experiential knowledge about the subject of the relationship between the loom and materials in the creation of textiles (Niedder & Stokes, 2007). Having expertise as a textile designer, the author was able to employ design thinking and craft skills to work with the material and adopt the role of a "reflective practitioner" (Schön, 1983) to scrutinize and reflect on the making processes and resulting works.

During this research, connections and relationships were formed through reading around the subject, and researching the work of leading practitioners that in turn influenced and supported the making process. Nimkulrat (2012 p4) supports the relationship that “while literature brought about ideas to be experimented in creative practice, creative productions suggested relevant literature to be discussed in relation to the productions”.

Methods for capturing information

Qualitative and exploratory in nature, a Mood Board was used throughout the research process as a visual guide to keep a focus on the aims of the project. Typically used in design studios, Mood Boards visually communicate and target, the aesthetics, style and context of a project (Martin & Hanington, 2012) where images were edited and collaged as a reminder to myself of the aesthetic target I had in mind (see Figure 46). Photographs and design articles were arranged alongside physical artifacts, salvaged rope and string in a three dimensional, and constantly evolving picture of the key ideas influencing the research project.

Fig 46. Mood Board

Using the Internet to carry out a proportion of the secondary research expedited the gathering of initial information, previous research, products, and the work of other makers and designers.

This is an excellent method of research to establish the initial boundaries of a design project and to identify where the gaps might be (Martin & Hanington, 2012), but a selective approach must be taken in sifting through this vast resource to find quality references and information. A blog was created and used through the early stages of this research to capture a more visual reference to the work of practitioners relevant to the intended direction of the project. As someone who would class herself as a visual learner, my ability to easily reference and capture my exploration of the topic in this way was extremely helpful and enabled me to find reoccurring patterns and common threads in a range of textile, product and other material design work.

Methodology overview

The methodology used within this study has elements of Action Research (McIntosh, 2010) where there was an integration of craft of making and the analysis of the relationship between myself the materials used and the woven pieces themselves.

Photographs of the weaving process, technical notes and diaries supported the researcher's "reflection-in-action"(Schön, 1983) in evaluating the work in progress and solving making problems, a process which was then further facilitated through the final stage of writing up the thesis. There was space to reflect on the process throughout, but there was a continued eye on what the original long-term goals were.

Gray and Malins (2004, p21) in their book 'Visualizing Research' say that a "methodology is responsive, driven by the requirements of practice and its creative dynamic. It is essentially qualitative and naturalistic. It acknowledges complexity and real experience – it is 'real world research' and all 'mistakes' are revealed and acknowledged for the sake of methodological transparency". Qualitative rather than quantitative data will be the focus of this research, as qualitative data collection is more open ended and thus flexible and exploratory. "researcher's choose to collect qualitative data, because in the absence of

prior theory, they simply cannot anticipate which constructs can be measured in a closed-ended quantitative manner" (Graebner, Martin & Roundy 2012 p278)

In the field of textiles, in which the author is involved professionally, practitioners tend to consolidate both art and design in their occupation (Niedderer & Townsend, 2010 cited in Nimkulrat 2012). As in many material-designated disciplines, the craft of textiles is understood to be a way of making things by hand, but also as a way of thinking through the hand manipulating a material (Nimkulrat, 2010, p. 64). This understanding follows the notion of craft as "a way of thinking through practices of all kinds" (Adamson, 2007, p. 7) and "a dynamic process of learning and understanding through material experience" (Gray & Burnett, 2009, p. 51 cited in Nimkulrat, 2012). Cross (2011), labels design ability, the multi-faceted cognitive skill as a "designerly way of thinking" and claims that it is a natural form of intelligence.

The practitioners' creative practices are employed as vehicles of theoretical inquiry and subjects for scholarly research, which has often been labeled practice-led or practice-based research (Rust, 2007). Nimkulrats (2012) approach encouraged the inclusion of the researcher's creative practice and concerns the researcher who simultaneously takes the role of an artist or a designer and carries out the creative process and production of artifacts as the target of the reflection. Gray and Malins (2004, p. 30) identify practice-based methodologies in art and design as involving "making art/design/creative work through specific project frameworks or as a body of work exploring the research questions". The emergence of craft in practice-led design research confirms that design has not taken over the making of material objects from craft. Rather, craft making has been included in design research carried out in academia that in return enables practitioners' voices to be heard and the implicit knowledge embedded in the making to be reflected. It is used to exemplify how craft can facilitate a practice-led research process and how research can enhance craft practice.

Joyce Yee in her paper on 'Recent Methodological Innovation Used in Design Doctorates' (2009) considers the methodologies found in design PhDs and the characteristic with which this research aligns itself is perhaps characterized by her 'pick and mix design

approach'. She opines that Frayling's classifications of design research; Research into Practice; Research through Practice; and Research for the purpose of Practice are not mutually exclusive.

Cross (1996) devised a taxonomy based on the focus of the investigation rather than the method. He focuses on the knowledge that resides in people, a process or product. His classifications are Design Epistemology, Design Praxiology and Design Phenomology, which is the study of the form and configuration of an artefact or product. Fallman (2008) however takes a more holistic approach plots the position of design led research activity between the three extremes:

1. Design Practice - like commercial design work, but for a research question
2. Design Exploration - explores a 'what if' question, through a process of designing rather than answering a particular question.
3. Design Studies - similar to traditional academic research.

In Schön's (1998) search for a new 'epistemology of practice' to help explain how practitioners engage with their practice, he describes a kind of knowing-in-practice or a tacit knowledge. According to Schön design proceeds as a reflective conversation with the situation. It is an interactive process, with complex pathways that can produce consequences that are other than those originally intended or rather a reflection in action. There is a tendency for designers to use an unspoken language or understanding between themselves and other designers and Igoe (2010, p9) labels the textile designer as " sociologically swaddled." She goes on to note Anne Louise Bang's (2010) theory that only when [textile designers] come into contact with industry or other fields of design do they start to tacitly understand what distinguishes the textile discipline and when they see their design in context or in use...do they see " the relational emotive and communicative qualities of the textiles they have designed".

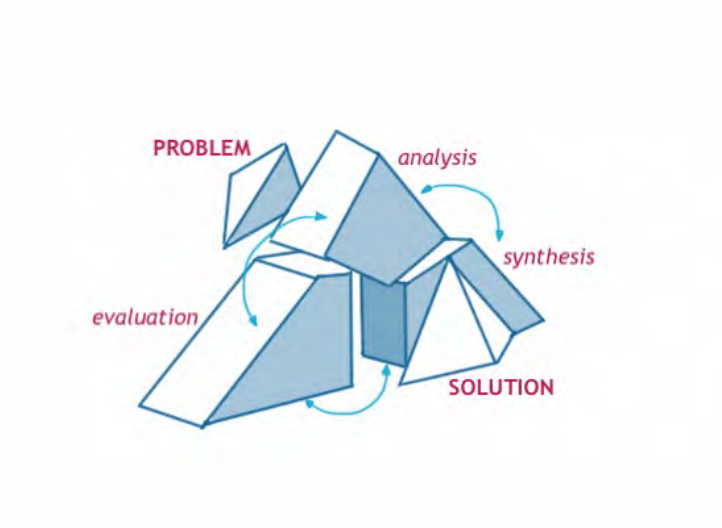

Fig 47. Design process negotiation. (Adapted from Lawsons Map of the Design Process)

Design research or craft practice-led research?

The design process of a technical designer, with a commercial customer focus, as in the case requires that there is both imaginative thought and mechanical calculation, as suggested by Lawson (2005). Mapping the process between problem and solution can be illustrated in a simplified way in Figure 47. Lawson goes on to identify that the activities of analysis, synthesis and evaluation are ongoing and do not seem to have any specific path or progression, reflecting what is in essence a complex mental process. As a professional designer, the brief is to design for someone other than oneself and this mindset is a difficult one to step out of. Is this necessary? This research project, is in its conception an indulgent idea, and is a concept proposes to adopt craft-like approaches to the first stages of creation, and the development of constructed textiles. The proposed 'end product' is however a material that could sit in a public space and may ultimately need to perform to meet exterior furnishings standards?

Visualisation and development of ideas

Lawson (2005) talks at length about how designers differ from craftsmen and how the designer has evolved to move away from the physical process of making a product. This distance from the making process has necessitated a rich and varied approach to the visual communication of a design idea. Whether through drawing or another digital medium instructions on how a concept is to be made and how it will look, are required

for the clarity and accuracy of the process. Beyond this communication function, drawing in design becomes part of the thinking process itself (Lawson 2005) and it allows multiple changes to an idea before actually committing to the final product. This method of working facilitates the rapid rate of response required to demand for new design iterations demanded in the 21st century economy. Conversely there is only so much detail that can be communicated in a 2D or digital format, as the feel and response of materials is much more difficult to understand without handling an actual prototype or a piece of fabric.

Working in a visual way it is essential to both the development of the work, and in the communication of the concept to the viewer. In the case of this research into product that will ultimately be visible to the user, and in fact visible to the public at large. The change of the role of the designer following on from the industrial revolution, when they moved on from the role of craftsman, required the designer to be able to express and communicate their ideas and instructions through the medium of drawing. Lawson (2005) talks about design drawing being part of the thinking process itself or in fact design. Drawing is used in different ways at different stages of the design process from initial ideas through to modifications and finally to maybe expressing the outcome of the product for presentation. In the design context these early explorations of the idea using drawings enable multiple changes or iterations to be considered, before actually committing to the process. Conversely for the craftsman in the vernacular process this is not an option and a slower more considered approach is needed. This slower approach will be adopted in the weaving process for this research, in order to better understand the materials, their function and potential performance.

In this research, drawing, visual studies, and material experimentation have all been utilized as tools to develop the initial concept and to think around the iterations developing on the loom and in my imagination. Sketching or drawing, an ordinary activity involved in most design practice, was used in this research to support the conceptualization of creative productions. These visual expressions have been captured in a both a sketchbook and through photography and they have formed an immersive part of the studio environment that has channeled the direction of this research. Photography

was used to record the process of making, from the loom set-up through to the final samples. A visual and written reference for each piece woven was recorded in the format of a loom ticket, and included details of the warp sett, peg plan, weft order and yarns used finishing process employed.

Fig 48. Photography, drawing and material experimentation

This mix of imagination, reason, technology and art is difficult to integrate and yet necessary in the pursuit of a successful design based research.

Commercial weave designers are typically driven by two sets of influences one is their imaginative thought and the second is the need for an ability to create very accurate mechanical calculations in the process of working out how to produce the fabric envisaged. Typically professional designers designed for other people rather than themselves, and this can create a certain unease when trying to think outside the normal customer briefing. Lawson (2005) says that 'we need to appreciate a historical work in its own right, but also to use it to inform contemporary design'. In the development of woven textiles this blend of the traditional and moving forward as technology and materials develop is an essential part of the designer's role. This role requires that the designer is not only technically competent but it also has a very well developed aesthetic

appreciation. The balance between textiles needing to function and perform and provide aesthetic pleasure is a complex skill and yet we tend to take textiles for granted. Igoe (2010 p.5) "allude to the pleasure giving qualities of textiles, which maybe subtle, tactile or decorative and sensorial". Often textiles are subdued, taken for granted, or not rewarded for their design input - so they have accepted a less active role in pertinent debate around design research.

Methodology for textiles

Textiles in all aspects of life rather fly under the radar and assume a supporting or invisible role in our everyday lives. This perceived position of textiles as 'always there' has resulted in a limited amount of practice-led or practice based research into this area of design. The context for disseminating research in the field [of textiles] is also less developed and Igoe (2010 p.2) posits that the "Paucity of academic writing concerned with the idiosyncrasies of textile design marks it out as taciturn in comparison" to other areas of design research in product, architecture etc.

An explorer of ideas, a designer's awareness is high. They are sensitive to their internal and external environments, are optimists, capable of spotting unexpected openings and new opportunities (Cross 2011). The gap in the market, the light bulb moment, the original idea of this research has been one that has remained at the centre of all the development that subsequently followed the initial idea. Lawson in his book 'How Designers Think', talks about the problem of designers hanging on to their original initial idea at all costs. He suggests that this could potentially impede their progress on a given concept but if the technical obstacles to overcome it are found, it is perceived as a great act of creativity. Another issue that can face the designer is that designers really have little understanding of when to stop designing. In fact when does the design process finish? "Designers simply stop designing, either when they run out of time or when, in their judgment it is not worth pursuing the matter further." Lawson (2005 p.55)

There is a natural tendency as a designer to jump to a quick solution, an ideal or flash of inspiration that occurs at the first instance of the idea, Bruce (1963). The challenge throughout this work has been to remain open minded about what the final result might be and to try and be receptive to building new findings and pieces of knowledge into the

possible end solution. Designers do however need to be willing to embrace unexpected occurrences and be open to possible changes in a brief at end stage within the creative process. In design the final goal imagined, is in a way a constructed fantasy or shimmering prize on the horizon, which we then seek out through exploration and experimentation. As an industry trained designer, working to advanced deadlines (predicting ideas for up to 5 years ahead) there is a skill in predicting what the trends might be for the automotive sector. This skill does not sit in isolation however, as work in the competitive environment of car interior fabric design, requires a capacity to frequently develop ideas very quickly, with little time to carry out research through the mediums of photography, or drawing, context research or hands-on trials. Previously captured influences, imagery and knowledge are drawn upon to offer a quick range of solutions, and to the designer is able to create (fabricate in a way) a back story to support the relevance and suitability of the ideas proposed. Rust, Mottram and Till, (2007 p.13) refer to the expression “The science of Uncertainty” which has been used to describe design by Makela (2005). They go on to recognize the principle that designers deal with problems that may even resist description and these problems may not even have an optimal or predictable solution.

Bryan Lawson makes an observation in 'How do designers think' on a designers' tendency to hang on at all costs to their original idea, and this can in turn impede their progress. Should this initial idea be seen to fruition having overcome a series of technical challenges or obstacles, the outcome is perceived as a great act of creativity.

Textile designers are involved In a complex process where they "have to blend technology - chemistry, fibre physics, knit, weave and spin - and aesthetics - colour, composition, texture and form - to make textiles that meet accustomed requirements" Studd (2002 p.2). Lawson (2005) supports this statement with his view that the student of design must learn to appreciate and develop new technology and cannot remain immersed in traditional crafts. He goes onto stress the importance of appreciating the historical context of work, and to have an appreciation for aesthetics as well as being technologically competent.

In her paper on the textile design process Studd attempts to address the paucity of information available on the textile design process. There is literature available relating to the general design process used in industry, but very little of this has specifically investigated the process undertaken by designers in the diverse field of textile design. Those designers that follow a career working in the Research and Development of textile companies are required not only to have expertise in their subject area, but also to have knowledge of a wider range of innovation in processes, in order to drive innovation. The textile companies that have survived the downturn in British manufacturing have created a strong competitive advantage through their innovation and a move to high quality to high performance products.

Textile designers typically work to a design brief, which may be driven by a customer request or the desire to create a speculative range to show to prospective clients. Studd (2002 p.11) notes that design research includes looking at colours, fabrics and trend forecasts but often "the idea is personal and intuitive".

Studd identifies certain critical stages in the textile design process and the 5 generic phases are suggested as below:

Phase 1 - Planning: sourcing work and planning design brief
Phase 2 - Research and analysis: briefing research collection and analysis of data
Phase 3 - Synthesis: design creation, design solutions and initial sampling
Phase 4 - Selection: collection development, design presentation and purchasing
Phase 5 - Production: sampling, manufacturing through to evaluation.

This generic framework is varied dependent on the specific context and the complexity of design. Studd (citing Bruce and Bessant 2002) surmises, "it is crucial that textile designers understand that there is a need to combine aesthetic considerations with technology, cost and customer needs, along with being commercially oriented “.

In order to prepare and conduct my research a range of activities were required. These activities included, renewal of my work as a studio practitioner, as a field practitioner or

observer, a desk practitioner, and as a member of an academic research community (Igoe, 2010). It was this mix of activities that enabled the consideration of intellectual and practical decisions during my creative practice on the loom and within the studio environment. The mix described above has taken my own practice and research methodologies into new realms where I can indulge myself in a greater range of approaches, due in part to what I would term the indulgence of the handcraft of weaving. The shortcuts to the end product or solution, typically adopted by the commercial designer have been enriched with the reflective practice of discovering and experiencing the weaving process specific in this case to leno fabrics.

Weaving by hand

Working on the loom in a slow and considered manner, enables the practitioner to build a pathway through the creative process in an organized and yet organic way. Each of the warps put onto the loom provides a set of parameters to play with, but these are dictated by the initial decisions made as to which yarns are used, their count, the fibre type and sett. The process of weaving could be compared to the creation of a recipe, where the base ingredients are enhanced, in order to add new flavour combinations to the mix. Seelig (2005) talks about how "with artists working directly in fiber and textile, the hand becomes an articulate sensor" and this hands-on approach to the creation of fabrics is important in allowing the designer (in this case for woven fabrics) to assess how each mix of threads and structure work together. These experiments don't always turn out as predicted and may fail, and yet there are inevitably surprises along the way, that were not expected and move the work on in a new direction.

Philpott (2011 p.103) identifies that "textile substrates, whether knitted, woven or non-woven, achieve their state of being by unifying a multitude of disparate threads or fibres into one continuous surface". She further comments on the way in which these elements are brought together to create an emergent system, one that is unique and is not easily predicted using digital software, 3D visualizations or by building models of the intended outcome. Capturing these elements and bringing them together into new forms and

combinations is a key driver in the design and development process, where new iterations are sought using well established and traditional production methods.

On a trip to Philadelphia College of Textile and Science, Ingrid Bachmann (2005) notices the energy of the textile laboratory, and its "embodiment of the mad scientists laboratory and the spirit of experimentation and curiosity". These labs bring together the best of the old and new, in their mix of vintage jacquard looms, and odd collections of materials, contrasted with state-of-the-art digital technology. This observation sums up beautifully the influences brought together in this research. It could be said that this blend of traditional skills and equipment, which enables the designer to work at a slower more considered pace gives essential insight into the design process and opens up the potential to innovate and create using a blend of new materials, and well known fibres using a more craft like approach to an established technique/process.

> Like all signifying systems, weaving transforms the analog into the digital. The analog of continuous thread becomes a textile, and the textile then replicates a mimesis of the analog; it drapes, it clings, it folds, it moves. The action of this simple craft turns the grid into matter, material that has length as well as width. Pajaczkowska (2005) P 235

Skill in weaving as with other textile processes is attained through the integration of knowledge developed through time spent on the loom which is combined with technical understanding, and the imagination to create new creative outcomes. Philpott (2011 p.122) reflects on her process of creating folded textiles, in "which consciously rationalised technical knowledge informs the preparation of the task, at the moment of making touch guides my actions allowing me to work intuitively to the strengths of the inherent qualities of the material".

Hand versus machine

My industrial experience of designing for automotive fabrics (from 1990-2006) required a minimal amount of hands on contact neither with the actual loom mechanism nor with the interlacing of the threads themselves. Working to a tight set of parameters to meet

the stringent requirements for automotive fabric testing, requires the skills to be able to create woven cloth of a very flat nature, as the texture so often desired in other more decorative weaving process does not meet the requirements. The length of any warp or weft float in the weave (where one thread crosses the other in the cloth) was restricted to no more than 3 to 5 as a guide to give a new design the chance to pass the harsh physical testing for abrasion and snagging,

Creating and designing in this commercial context required a fast turn around (each new set of iterations took at around one week to design) of new ideas and this was facilitated by the use of digital technology. CAD (Computer Aided Design) started to speed up the interface between the designer and the sample unit, and with the use of software like ScotWeave (from 1989 onwards) designers could create suitable ideas rapidly. The CAD interface with the loom is one that enables the designer to envisage the finished product on the screen, but cannot however currently reward the designer with feedback on what the cloth physically looks and feels like. It is a virtual representation of the visual appearance of the cloth. In the early 1990's the design team at Courtaulds Textiles Automotive Products, attempted to create the annual design collection, using CAD rather than weaving them, by using a representation on screen alongside, paper printouts of the designs. This non-fabric collection failed to ignite the sales of this trend collection. Crucially the tactile touch of fabric was missing with its associated nuances of colour and textural differences in the surface of the cloth.

Warren Seelig (2005) in his speech delivered to the Daegu Textile Art Documenta talks about the concept of materiality in which materials have been a driving force behind textiles and other art forms. He suggests that there is a "new materiality as a profound revelation in the context of the ubiquity of the virtual world." His observation that we are being slowly distanced from the physical world with increasing speed, and the materials we experience as users are increasingly synthesized and homogenized, resonates with the drivers behind this research project. Seelig (2005) goes on to recognize the increase in the use of materials that re-sensitize, through exposure to the primal reality of raw material. He also identifies an increasing interest in:

> …haptic intelligence and its role in understanding creative impulse in an age of multiple realities. Rarely is empathy for materials greater than it is in the textile and fiber-related media, where they are felt and experienced beyond their physical presence as is they were animate and alive (Seelig, 2005, p.42-45 paragraph 7)

Jessica Hemmings in her introduction to the work, of a range of contemporary practitioners, notes that:

> The pros and cons of hand and industrial production are apparent throughout [the book], often with designers moving back and forth between the two in an increasing acceptance of the potential for digital tools coupled with the acknowledgement of the vital importance of the weaver's hand (Hemmings, 2012, p. 7).

Getting back in touch with the physicality of weaving is central to this research. It presents an opportunity to engage in some of the complex processes associated with handloom weaving, skills which industry based designers are less familiar with due to the necessary industrialization of the textiles industry.

My move to teaching weave in 2006 and the challenges faced in helping students understand the complexities of the loom was the starting point for my new relationship with the loom itself and specifically the handloom. The physical act of warping up the threads, and dealing with the challenges different fibre types and yarn counts pose are an essential part of the act of weaving. An often slow and laborious process, the loom set-up and then the physical act of weaving is influenced by the nature of the fibres themselves, the pattern they are woven in and the tensions they are held under in the loom. Taming of the loom requires a certain logic and ability to visualize how the mix of structure and yarn combinations can produce certain effects. This knowledge is built slowly with each warp that is made and is very much influenced by the final processes that may be applied to the finished cloth.

The structure of a fabric or it's weave - that is, the fastening of its elements of threads to each other - is as much a determine factor in its function as is the choice of raw material. In fact, the interrelation of the two, the subtle play between them is supporting, impeding, or modifying each other's characteristics, is the essence of weaving (Albers, 1965)

My values of what constitutes 'good design' were formed as a result of a 15-year career in the performance textiles industry with a focus on fabrics for use in car interiors. This approach required a narrow knowledge of weave structures, structures that had historically passed the OEM's (Original Equipment Manufacturer) tests for abrasion, light fastness, snagging etc. There was scope to create visually attractive designs using jacquard loom technology or to mix simple Dobby woven structures with short floats (no longer than 3 ends or picks), but three dimensional structures, designs with longer floats or in fibres other than polyester were not an option. In the automotive interiors sector the designer not only designs but acts as the first point of contact or sales person with the OEM trim stylist. Not only must the fabric be accepted aesthetically by the stylist and marketing but also meet laboratory testing procedures specific to each OEM, and the Tier 1 supplier, (Fung & Hardcastle, 2001).

Aesthetically pleasing design in the context of the automotive industry could be defined as design that must appeal to the masses, fits with the brand values of the car company and in essence is not be too extreme, highly coloured or too directional in that it must not date easily.

Subsequently, further understanding, of a wider range of weave structures and peg plans has resulted from the eight years of undergraduate teaching in textile design. The dynamics of multiple layered cloths has latterly made sense, after years of struggling with the concept of the relationship of the warp and weft threads in double cloths and other more complex weave structures.

Thinking time on the loom

What has made the difference? Physical hands-on weaving on a table loom, where the control of the yarns and structure are manipulated by hand and where the three-dimensional interchange between the warp and weft can be observed and felt in real time. This process of discovery on the loom has been discussed at length in T'ai Smith's (2011) article 'Architectonic: Thought on the Loom'. Smith considers the journey that a number of fibre artists, made in the late 1970's, to revert back, from off loom, to on loom weaving. Constantine and Larsen (1981, cited in Smith 2011, p.269) "describe as following an "architectonic logic," demonstrate an interest in the geometric and three-dimensional possibilities of this woven cloth." These fiber artists had led a revolution to move off the loom and had explored a range of hand-controlled techniques that included hand knotting, primarily seen as a move away from the perceived restrictions of industrial textiles. Not until they had exhausted their curiosity and experimentation with these older techniques did their feel comfortable in returning to the loom to continue the exploration of woven structures that their predecessors such as Anni Albers had been dedicated to. "Indeed in their search for new ways to understand their medium, artists in the late 1970s re-harnessed the logic of the loom without regret" (Smith, 2011 p.270).

This trend for textile art was echoed in the work of traditional artists in Japan also starting in the 1970's. Keiko Kawashima (2005) in her foreword for the publication 2121 dedicated to the work of Reiko Sudo and Nuno, talks about the production of three-dimensional textile-arts by artists who had studied the Japanese traditional techniques. She posits that the work of Reiko Sudo with its balance of traditional skills and new technology is unique, because it draws from weaving and dyeing techniques specific to Japan. Patricia Urquiola (Trendease, 2008) also references the many things that shape her development as a designer including her culture, and history. She follows on to say that, "you accumulate more aspects of yourself than you think, so that when the moment comes and you start [designing] it's actually fairly instinctive" (Trendease, 2008).

The slow pace of the craft hand weaving allows the practitioner a reasonable amount of time to consider the next sample, the next idea, or how they are progressing in pursuit of

their creative goal. The challenge is to try and capture, or record the next iteration in some way before this ‘next idea’ is lost in the mechanical and physical process of weaving Ideas cascade into the mind of the weaver at a faster pace than can be physically woven on this type of loom. The weave practitioner requires a mechanism not only to express their ideas but to capture the next development of the sample they are currently working on. As a designer in an industry context where the process of weaving is carried out remotely in a mill this challenge differs from that of the hand weaver. Although the actual process of weaving the samples is carried out at speed in a industrial setting, the designer is usually located remotely from the manufacturing plant in a design studio and has little opportunity for personal physical contact with the loom itself

The design process can be a rapid generation of initial ideas when the concept is first proposed and this initial iterations need to be visualized in some way. In contrast to the process of producing a piece of work, using a handloom requires a more considered and slower pace of development. The challenge for the handloom weaver is one of thinking through ideas before setting up the actual loom. The amount of time it takes to create the warp and thread up the heddles and then subsequently weave each piece of cloth is a long one that requires days if not weeks. The ability to visualize, in ones mind the final piece of cloth is essential and this skill that takes time to perfect. A student, new to the weaving process has little knowledge of how to predict the outcome of the final fabric, or they are challenged with understanding how they might actually create what they envisaged in the first place. Fortunately CADCAM technology allows the constructed textile designer and specifically the weaver to visualise the fabric before even starting to handle any yarns, or set up the loom. This technology is however still a two dimensional representation of what will ultimately be, a three-dimensional and potentially very textual piece of cloth. The intricacies of the interlacing of the threads, the quality of the yarns, the fibre composition and the physical forces, which act upon the piece, can now be roughly simulated on software such as ScotWeave.

There is however, no replacement for actually seeing and feeling the interaction with the threads on the loom and seeing how the subsequent removal of the warp tension allows the cloth to find it's natural state.

Morozzi cites Claude Levi Strauss in his speech on receiving the Nonino Prize in 1986.

"The purpose of working with your hands is to have a dialogue with the nature of materials being worked. Man and nature collaborate in an exchange based on mutual respect…[man] must do his best to understand [nature] patiently, cautiously trying to get their attention and almost, even seducing them"

Moving forward

This chapter has considered at length a range of opinions on the value of practice-led research, the textile design process and the potential for decisions about design to be made whilst physically weaving on the loom.

A practice-led reflection on the hand weaving of a series of fabrics using the leno weaving process will be recorded both in a written and in a visual format. The value of using visuals to organize research (mood boards), express early ideas (sketches and material experimentation) and record the final outcomes (photography and film) has been established as central to the design process. The importance of a slow hand crafted approach to creating and finding a design solution will be compared to that of a digitally connected commercial designer. Design iterations and the decisions made in this organic design process will be captured in a reflective commentary and accompanying technical 'loom tickets'.

Chapter 5 Weaving and change

This chapter focuses on the process of weaving leno samples, a series of development fabrics that will be produced and then assessed against their potential to meet the criteria setout in Chapter 1. In the first instance trials were carried out on a speculative warp in order to better understand the process of setting up a loom for leno weaving, and to start to understand the effects that differing yarn properties and structure had on the cloth produced. Surface manipulation will be explored through simple changes to the weave structure, and reflection on these first samples will subsequently inform the decisions made in the creation of subsequent warps (2 and 3). Detailed documentation of all samples will be recorded using the weavers tool of the 'loom ticket', enabling accurate detailing of the yarns, sett, warp set-up and lifting plan employed for each iteration.

A continuous process of reflection on the success of the samples produced will be recorded and an analysis of each woven piece recorded and compiled in a table of criteria, referencing the functional and aesthetic ideals being sort for this research. The chapter will also cover the exhibition of the final leno samples, and the photography of the samples in the original location of the 'stranded sock'. The sock itself and its journey of erosion, recorded in parallel to the timescale for this research will also be detailed.

Selection of materials

Yarn choices

Learning to hand weave a leno fabric myself, using a variety of yarns (sourced locally), were the priority in this project. Determining which alternative yarns I should start to source as the project progressed was informed by the success of each fabric on the loom. The samples produced in this research not only explore the differences that twist level can have on a structure, but also how natural and synthetic yarn qualities used in combination with each other can influence the final appearance of the cloth.

As previously mentioned (in Chapter 4) for some weave types, the effect of the structure (of warp lifts) is powerful enough to produce a change in physical and textural qualities, and leno could be described as one such example. These tendencies for the threads to react in a certain manner (dependent on the length of floats and structure combinations) can be further developed through the use of carefully selected yarns with specific characteristics. Much research on the loom has been carried out and recorded over the last century, and a number of well-established weavers have explored how the influence of the twist level in a yarn can affect the finished fabric quality. Twist level can affect even the simplest structures creating crepe effects, pleats and collapse weaves. Ann Richards (2012) makes reference to the work of Lotte Dalgaard, a prominent hand weaver, who has experimented at length in the weaving of fabrics using high-twist yarns. Dalgaard (translated by Ann Richards, 2007) expresses a new found excitement after 40 years of weaving (flat neat controlled fabrics) when she discovered the joys of working with over-spun yarns, and seeing the fresh possibilities that these opened up. Some of the work for this research will use twist lively (over-spun yarns) in order to investigate the potential influence of these highly twisted yarns on the open stable crossings (of warp and weft) that are inherently built into the leno structure. After 15 years designing, flat, tightly constructed weaves for the automotive industry, I am also now experiencing the joy in creating more three-dimensional fabrics.

The influence of fabric construction and finishing

This use of yarns with a 'shape-memory' with an ability to return to their ideal state is aided by the use of weave structures whose design has spaces left to facilitate the physical movement of the cloth upon removal from the constraints of the necessary high tensions in the warp and weft. This type of potential is explored at length in Ann Richards publication on 'Weaving Textiles that Shape Themselves' (2012). One specific example to note, is Philippa Brock's 'Self Assembly' collection (Brock 2008) which uses high-twist yarns that contract and deform the fabric during the post weaving process and wet finishing the fabric. Wet finishing includes a range of processes where the fabric can be washed, fulled, felted, and stentered under tension to set the structure and width of the cloth. A simple use of (in the home) wet finishing techniques will be used in this research

in order to explore the potential of fibres like wool to shrink under the influence of water and heat. This post weaving stage can significantly alter the structure and form of a weave, and not only changes the handle of the cloth, but in more extreme applications (as in the work of Brock) can alter the straight path of the warp and weft yarns. The resulting fabric has the potential to resemble more three-dimensional cloth typically produced using other technology such as a knitting machine.

"The weaving of textiles, especially strong textured ones, can best be thought of as an emergent process, in which these fundamental elements [of fibre types, yarn counts and weave construction] interact to create entirely new properties in finished fabrics" Richards (2012 p 47). The finished fabric results from a subtle mix of the properties of the materials themselves, and the way in which they have been combined. The length of warp and weft floats and the combination of tighter and looser areas of the weave structure all influence the woven fabrics properties and the chances of a specific combination of factors to act in a certain way. With time the weaver builds knowledge of probable outcome when using a planned combination of yarn types and peg plan. This ability to predict the finished look of the cloth, time and time again is essential to the role of the industrial textile designer or weaver, where reproducibility is key. The number of potential combinations of all these factors is however infinite, and rather than seeing this complexity as an obstacle, this potential to innovate and create something new, continues to satisfy textile designers in search of the new.

The loom set-up

Warps using commonly used 100% wool (two-fold) were used for the initial trials, in order to focus on the process of leno weaving, loom set-up and peg plan selection. The challenge of setting up the shafts with the necessary doups (loops attached to the heddle frame, which control the twisting action) the optimum length of these doups, and the influence of the lifting order (peg plan) were of primary concern in the first instance.

The loom was set up with two warp beams, to allow maximum control of the tension on the two sets of threads (twisting and sleeper threads). In a simple leno (gauze) structures the doups control the lateral movement of single or pairs of ends, by pulling then across

the adjacent sleeper end/s when the assigned shaft is lifted see Figure 49. When not selected to lift the twisting ends lie parallel to the other warp ends as they would in any standard woven construction.

Leno fabrics can be composed of a series of twisted picks and standard (plain woven) picks, and these combined with a more complex draft can enable the weaver to create fancy effects. “Other all-over effects may be obtained by using additional doups sets and ground harnesses” (Shinn & McKenna, 1930).

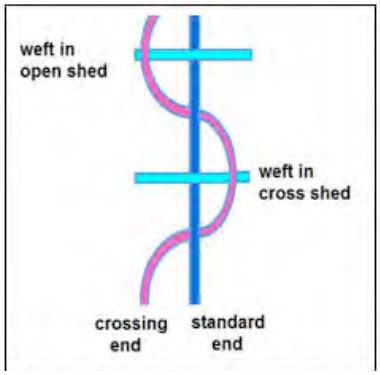

Fig 49. Twisting ends crossing over sleeper ends

Passing alternate threads through left or right-hand doups can also allow the weaver to move the threads in opposing directions. For the purpose of this research, left and right hand bottom threaded doups will be used to create the open gauze effects thought to best represent the open net appearance desired (see Figure 50).

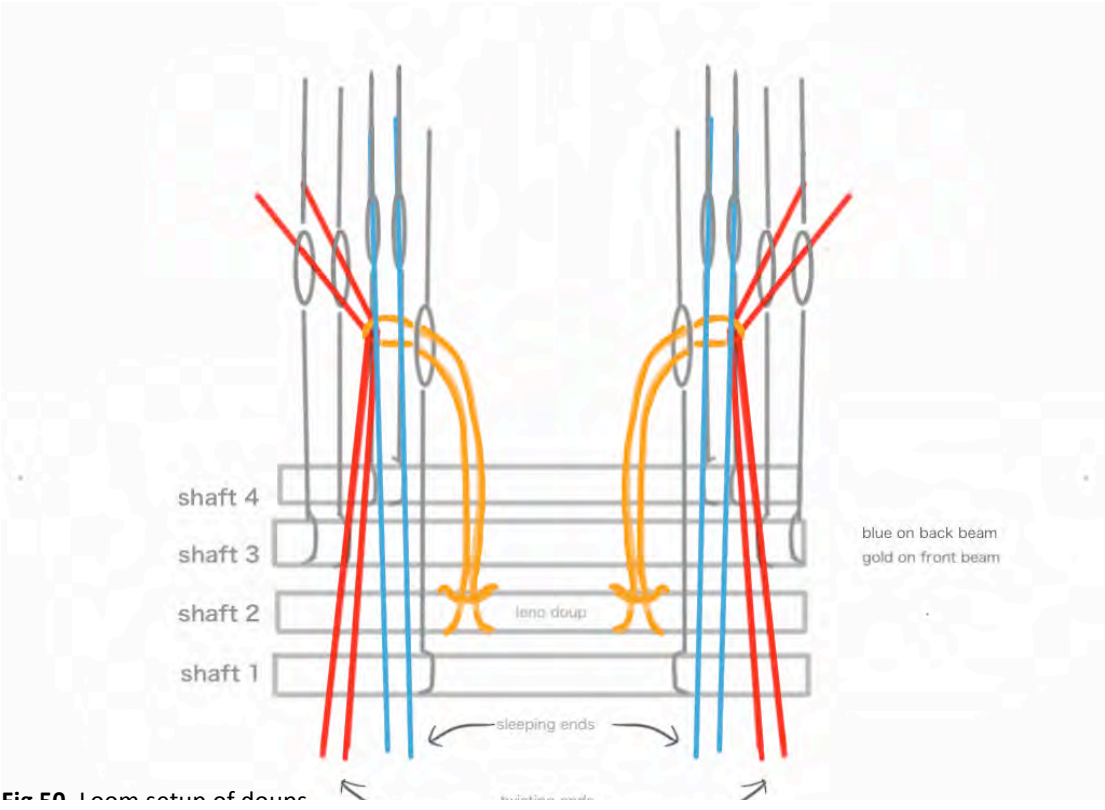

Fig 50. Loom setup of doups

Samples with a mixture of synthetic and natural fibres were also developed in order to mimic the appearance of the initial inspiration (cobwebs, and fishing net) as well as being chosen for their potential to shrink and distort the cloth in both planned and unexpected ways. A series of weft combinations were also produced which played with both the scale and the count of the yarn, in an attempt to replicate the differing thickness of 'threads' recorded in the original source material.

Production method

This research has been produced on a Harris eight shaft table loom. This type of loom is a typical entry-level loom, used by many students and craft enthusiasts, and it is also easy to set-up and operate by hand. Eight shafts are sufficient for the development of simple leno structures, as the production of open gauze fabrics only require small-scale peg plans and a corresponding simple draft. Research located in the work of Shinn and McKenna (1930) and Hall (2012) on leno structures confirmed the requirements needed to set up for weaving a basic leno or gauze fabric. The decision to constrain the patterning to eight shafts creates a workable set of parameters for the creation of variations on leno gauze, where the fibres, and yarn types colour and sett of the loom will be the main variables considered.

Doup Controlled Leno

Doup controlled leno was the preferred method for the control of the crossing ends in the structure. Doup leno produces a more open workable shed (Spaargaren, 2008) than the alternative bead leno option, despite the complexity of setting up a doup leno system. The doups are essentially string loops (see Figure 32 Chapter 3) tied to the loom's shafts that enable the weaver to twist two or more warp threads around each other while weaving. This twist makes it possible to weave open fabrics with a reduced number of ends per inch in the warp and creates fabrics that are stable despite the low sett. Traditionally these doups were made from twine of worsted or ramie fibre (Shinn and Mckenna, 1930) but they were therefore liable to wear away and break easily in

production weaving. Mass manufacturing of leno fabrics moved onto engineered doup heddles with complex mechanisms developed to control the crossing of the thread and the development of these mechanisms continues today. Specialist heddles as illustrated in Chapter 3, Figure 33 are not available for handloom weaving so a system of doups (see Figure 32) formed from redundant jacquard harness cord have been used to control the crossings.

Doup controlled leno fabrics require a minimum of two extra shafts beyond the normal requirement of shafts for the basic peg-plan, with one shaft acting as an anchor for the doup and the second holding empty heddles through which the doup is threaded. This empty heddle is the controlling mechanism for the twisting action of the specific warp threads threaded through the doup. Doups can be tied from the bottom up and this essentially creates a fabric that weaves face down, or from the top up, and hence a face up fabric is produced. When weaving the pattern the shaft to which the doups are tied and the shaft containing the empty heddles will need to lift together in order to pull the warp threads across to form the twist. The weaving of the cloth and the tension in the shed is reduced considerably by having the 'doup shaft' lifted at all times, and this does not affect the pattern in any way.

When as is the case for the following trials the weaver wants to employ yarns of differing count and or quality in the cloth, two warp beams should be used to provide the maximum control on the tension as possible. Working with more unusual yarns such as monofilament (see trials on Warp 3) can be difficult even in a standard cloth due to the slippery nature of the yarn and this not only requires tying tightly onto a beam, but some more manual encouragement of the warp ends to descend after lifting.

Doup control of the twisting mechanism

Using a wool warp sett initially at 16 epi (ends per inch). And a simple pegplan (see loom ticket 1-1a in Appendix 2) enabled the author to develop the basic understanding of how the leno mechanism works.

The natural stretch of the wool warp was very forgiving during the initial trials where the physical lifting of the doup controlled ends was unfamiliar to this automotive weave

designer. The best method and order for raising the doups themselves and displacing the twisting threads and thus the shafts that control these ends became easier as these first samples took shape. Advice on the Weavezine website (2008) suggests that the doup shafts should remain lifted at all times even between picks, but when weaving the three warps in these trials, the act of dropping this shaft and then immediately raising it again helped to create a cleaner shed and separated the slightly hairy wool warp yarns ready for the next lift. This procedure was also carried out in the final, Warp 3 which contained no wool yarns, as here again dropping then raising the doup shaft helped to create the best shed possible. Inherent in the weaving of doup controlled leno on a hand loom is the narrower shed (Figure 51) and this smaller shed was further diminished in the final warp N^{o} 3 where the monofilament yarns inelasticity meant that the threads tended to bag, not wanting to drop back into place very easily. The process of weaving these latter samples was slow at times due to issues with slack ends and uneven tension.

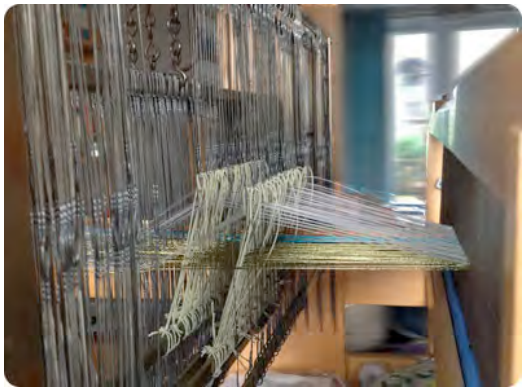

Fig 51. Narrow shed

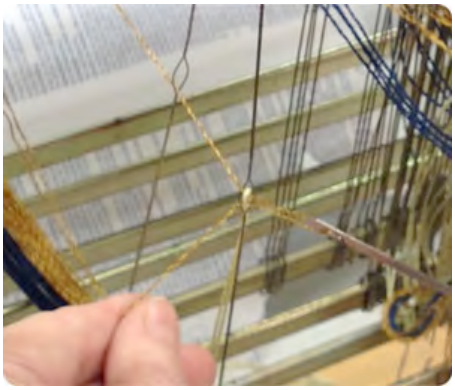

Fig 52. Drawing the doups

Critical to the success of creating a workable shed size was the length of the doup loop threaded through the empty heddle and around the twisting ends. The shorter the doup the greater the sideways movement exerted on the twisting ends, so a template for tying each doup was created to ensure uniform doup lengths where possible. The length of time this extra process of doup making, takes on top of the standard set up time for a warp, requires the practitioner to plan their designs with extra care, so as to ensure the optimum results are achieved from each length woven. This insight became more apparent as the design and weaving process developed and knowledge of the impact of

yarn type, doup length, drafting plan and denting order were reflected upon and recorded.

Weaving results

A fabric is born

The physical process of weaving on a handloom provided a practical understanding and tacit knowledge of leno weaving, which reading around the topic could not allow. “It is through the process of making that the novice eventually acquires an expert knowledge of his trade” Marchand (2001, cited in Stankard 2010. P102). This practical knowledge allowed me to analyse and make judgements upon the technical constraints of leno weaving, and make subsequent decisions on the yarn qualities to use for the warp and weft.

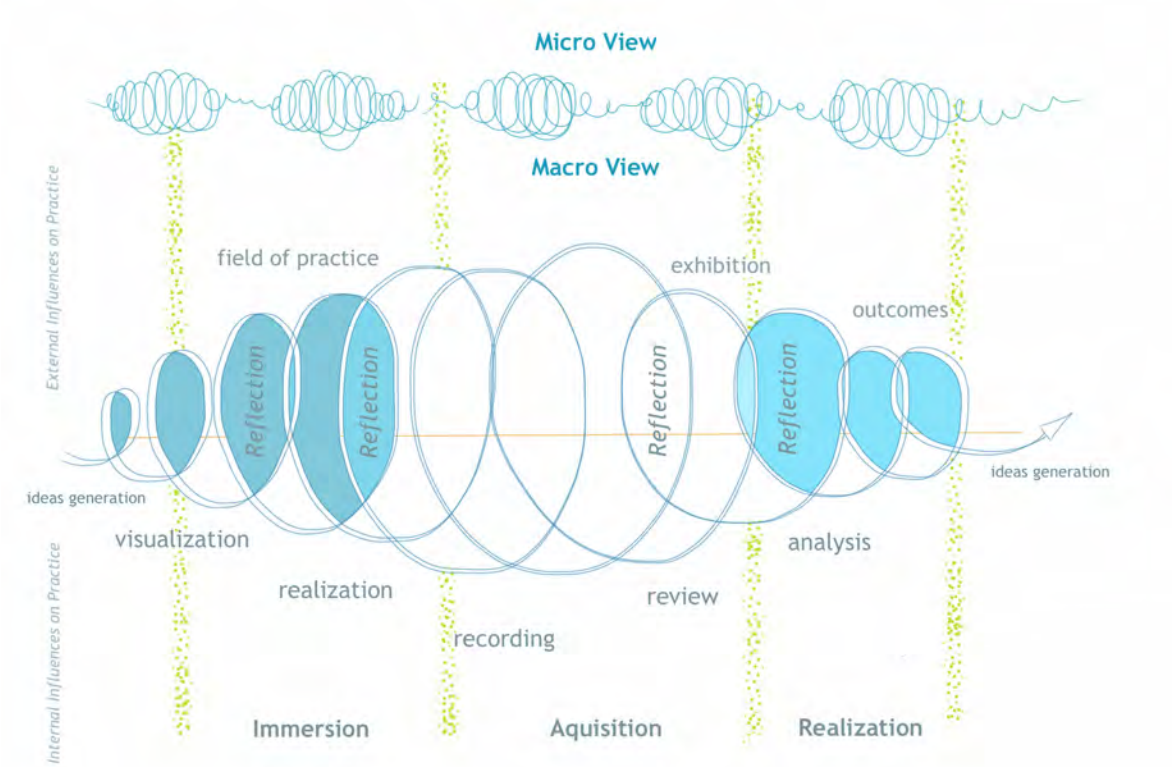

Fig 53. Visual model of the researcher’s creative process (adapted from Gray & Malins, 2004, and Bunnell 1998)

My reflection on the weaving process has been recorded alongside each sample produced (See Appendix 2) forming a sequential commentary on the success of each sample and

the possible direction of the next sample. As a designer and as a maker, these reflective comments are not always recorded in writing at the moment of creation, but are the expressions of the iterative thought process that was being carried out during the physical act of weaving. As a creative and designer it is not always easy to transcribe the detail of the decisions made during the design process and this is echoed by Igoe (2010) quoting Anni Albers (1944), [in that the] "inability to give words to the experience of making and designing is not symptomatic of a lack of intelligence but an indication of an intelligence that expresses itself through other means" an intuition or tacit knowledge. An existing framework for analysis that could be applied to this research can be seen in Figure 53. Gray and Malins (2004) cite Bunnell's (1998) use of this model to understand her own creative process, and this is a framework, which helps me to articulate the process I went through in the journey from the initial woven samples through to the final pieces.

Sample Warp 1

The first warp yielded some surprisingly satisfying results, but only after some initial problems with crossed ends and incorrectly threaded doups were rectified. Samples 1-1a and 2-1a both demonstrated how the simple crossings of warp threads in leno weaving can create stable, soft and stretchy fabrics (see Figure 54). In these two samples the singles wool used in the weft reacted beautifully to finishing with a little hot water and detergent, and created a degree of stretch in the fabric more reminiscent of a knitted structure.

Fig 54. Sample 1-1a

Fig 55. Sample 1-2d with Rubco weft

Other trials (Figure 55) on this wool warp gave some valuable insight into how more technical looking yarns such as Rubco (Nm 2.2 polyurethane coated polyester thread) might create a more open look to the fabric and therefore highlight some of the leno crossing effect. Using two fold wool yarns of high twist, which are inherently strong, produces an open structure to the fabric but a flatter less elastic construction. In the last sample on this warp 1-2e the structure is very lifeless and the yarns have remained held apart as if still in the cloth, which has meant that, the reed marks are still evident in the cloth (Figure 56).

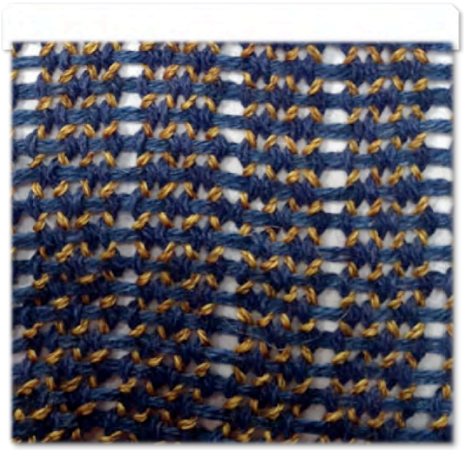

Fig 56. Reed marks evident

The sett of the fabric was increased after the first two samples were woven from 16 epi to 22 epi through some simple changes to the denting in order to create a more compact yet elastic cloth. This first warp gave good insight into the effect of leaving empty dents between some dents (see Appendix 2 Sample 2-2f). The gaps created by the empty dents enable a more open fabric to be woven, but there is an ideal sett, and this was achieved through the trials at the beginning of each warp. The calculations for the first trials were informed by the work of student Charlotte Hall (2012) and the work of Irma Spaargaren (2008) on the Weavezine blog. Unlike the setting of a standard (non leno) cloth the weaver does not need to apply the normal rules of cloth sett calculations by using a system such as devised by Thomas Ashenhurst (1902) or by wrapping the yarn around a ruler a (system used by many hand weavers). For both of the first warps the sett was increased after weaving two or three samples, washing them and then assessing the appearance and handle. These samples were assessed against the criteria set for the

outcomes of the work, which included colour, texture, stretch, and clarity of the leno structure.

It is difficult to quantify the exact parameters required as these first samples are woven, as the assessment is a subjective one, and yet the knowledge to make these decisions has been attained through experience of handing fabrics, designing textiles and guiding students in academia. Intuitive thinking maybe derived from previous experience and learning in situations where appropriate or inappropriate responses were made (Cross 2010, pg10).

Sample Warp 2

The second warp that was set up on the handloom used all wool yarns as in warp one, but with some changes to the colours and qualities. The colour choices in this warp were made in response to yarn wraps (stripes of yarn wrapped around a card) created from colours extracted from artwork created from original photographs of the landscape in and around Slaithwaite and Gairloch . A single accent stripe of a turquoise makes reference to the use of a contrasting colour in the mended fishing nets seen in Gairloch.

This warp was also set up at 16 epi and the initial samples were woven at this more open sett than the subsequent samples, which were once again increased in sett to 22 epi in order to try and achieve a cloth with more body and stretch recovery.

The practice of weaving a few samples at the start of a warp removing these from the loom and putting them through a finishing process is not uncommon amongst the weaving community. In industry there are pre-set parameters for the sett of the cloth and the yarn combinations, already established over years, if not decades? The craft of hand weaving may also slowly build up this type of predictive knowledge (about how a cloth may behave), but due the slower rate of production and new iterations this knowledge bank of tried and tested combinations, is much smaller. In fact the freedom to change and experiment and develop the work in new directions is surely part of the attraction of hand weaving. There is the risk that this freedom can leave creativity

unchallenged, or not pushed to its limits, whereas the tighter constraints of the commercial environment can push a designer to innovate in unexpected ways.

The process of weaving requires the practitioner to develop a relationship with the materials on the loom, whilst aiming for an unarticulated vision, and all the while the influence of new knowledge and research permeates the process. The end point in this journey is a difficult one to pin down, as it is a moveable, constantly updating, and being influenced by not only the process itself but also awareness of new designs influences and the work of other practitioners.

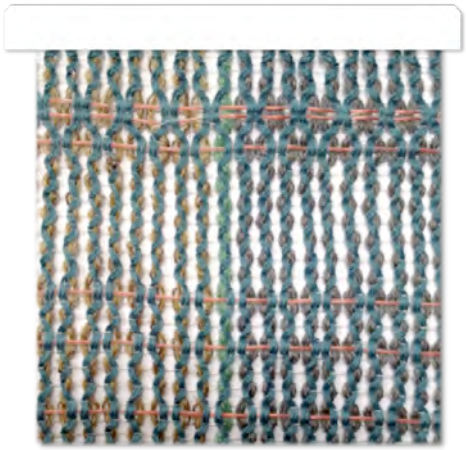

Fig 57. Fine monofilament and Rubco (sample 2-2f)

This second warp became a test bed for a wide variety of yarn combinations, all selected due to their resemblance to some of the inspirational materials gathered in the outdoor environment. The dry raffia and paper yarns brought to mind, blown dried vegetation and bleached eroded ropes. Fine monofilaments and coated Rubco yarns, see Figure 57, echoed the synthetic nature of found materials and man-made interventions in the landscape. The transparent nature of the monofilaments and the sheen of the viscose emulated the early morning dew on a web and the water on an abandoned net. Wool yarns formed a strong basis of the collection due to their potential to shrink, their volume, twist characteristics and at a simple level, they are reminiscent of the sheep's wool caught on a barbed wire fence. The use of wool also introduces the potential for an element of decay to the fabric mix. One of the original intentions of this project was to develop a substrate that may have the potential to change overtime, and to develop

imperfect and organic characteristics; using some natural fibres suit this ambition. In the same way that Carole Colett designed in an element of decay to her 'Suicidal Textiles'; a fabric with the potential for change is being sought in this research.

Early trials in this warp were informed by warp one, but then a broader approach to trying out more extreme combinations developed. In part the confidence to try out these riskier mixes of yarns and leno structures was established during the first warp, when an ability to manipulate the leno mechanism was developed and built upon. The 'craft of weaving' requires hours of practice and requires a certain dexterity of hand and sensitivity for the materials and their potential or limits.

Reflection on Warp 2

The samples from warp 2 can be loosely categorized into fabrics that tried to emulate the source material in their colour and or structural appearance, and then other samples that excited the potential to manipulate the look of the leno structure, but with little consideration of the original inspiration. This approach where riskier random combinations are tried out, can lead to fruitful designs, which are unexpected, and yet the initial selection of method and materials results in samples that still fit the brief. The most innovative of solutions can be achieved through embracing the elements of chance and mistakes that are part of the design process.

The practical application of step-by-step procedural cycles, as models of design such as the one offered by Cross (1994), in Figure 58

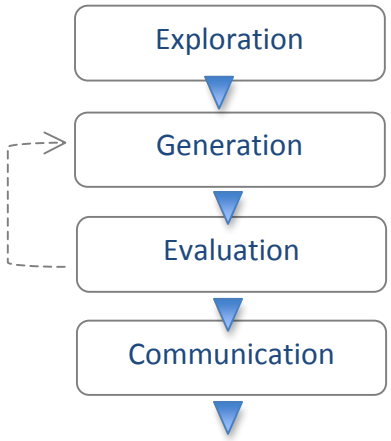

Fig 58. **Model of design process** (1994) adapted from Cross, N

In terms of the original ambitions of this project, the more successful samples from Warp 2 are, 2-2d, 2-2f and 2-2g as evidenced in Figures 59, 57 and 60 respectively. The success of these samples lies in the combination of soft and hard profile yarns, and mixing synthetic and natural fibres with elements of transparency, to reveal the unique qualities of the leno structure

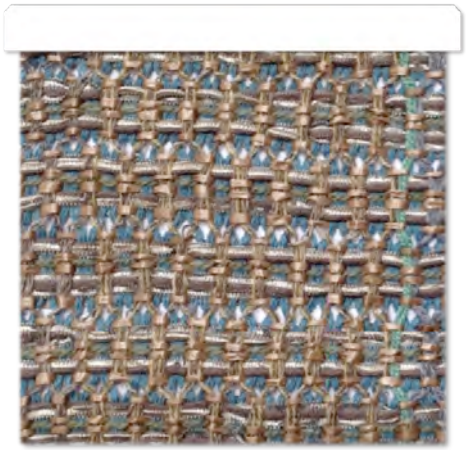

Fig 59 Sample 2-2d

Fig 60. Sample 2-2g

Sample Warp 3

The third and final warp developed for this research was created in response to the success and surprises thrown up by samples produced from the first two warps. The yarns used in the warp of this final collection saw a change in the yarn quality selected, with a monofilament yarn being used on one beam and viscose on the second beam. Reflection on the original desire to create a fabric with both synthetic and natural qualities, combined with the objective to create an aesthetically pleasing collection of weaves, led to this decision. The transparent qualities of the monofilament combined with the bright sheen of the viscose warp, contrast nicely with the softer wools in natural and soft neutral colour's.

This warp demanded more skill from the practitioner in the weaving and set-up and I had to draw on the experience built up in the first two warps, when trying to tame these slippery and less flexible yarns. The monofilament does not knot easily and therefore

requires some less conventional approaches to be adopted in the loom set-up. See Appendix 3. After drawing through the heddles and tying the ends onto the cloth roller, an extra process of securing (fixing with masking tape) the knots in place is required. The other challenge that the weaver faces when working with (non stretch) monofilament yarns, is the lack of elastic recovery which causes problems with uneven tension and bagging of the warp. It is commonly acknowledged that weaving requires a lot of tension to be placed on warp yarns and that strength is the most important quality when selecting yarns, but some flex and recovery is also needed in order to work with the structures, stresses and strains of the weaving process. During weaving the tendency for the fabric to 'neck in' due to the structure and openness of the leno weave, requires a form of temple to be employed to keep the width whilst weaving. A mechanism similar to that encountered in the work of Irma Spaargaren (2008) was created using everyday objects (elastic band and paper clip) see Appendix 3, secured to the loom frame and moved along the cloth as weaving progressed.

Initial samples on this warp used the singles cream wool and the simplest of leno structures, so replicating samples tried out on the two previous warps. This approach gave me the ability to compare the characteristics of this more 'synthetic' warp to the previous wool warps used in warps one and two. The same pattern of investigation was followed for the first few samples, whereby they were woven, removed from the loom and washed. Again this replication of the early steps gave me some insight as to how the mix of yarns and structures reacted to each other, and to ascertain what changes to the set-up, if any, were needed. A minor change to the sett of the cloth was again made to increase the ends per inch and create a narrower more compact fabric.

A range of trials, using a diverse range of yarns were carried out, and decisions made on the loom as to their success against the criteria set. The relationship between the slippery monofilament and some of the weft yarns was markedly different to that on the previous warps but some far more pleasing effects were soon achieved. These were deemed to be more successful especially in the visual sense, with the lustre of the viscose, contrasting with the blurred wools whilst the monofilament produced a more open and transparent look to the fabrics. This transparency and visibility of the open leno

structure called to mind the work of influential practitioners whose work is evidenced in Chapter 2 and more importantly, and started to resemble the original sources of inspiration.

Reflection on Warp 3

Sample 3-2e as illustrated in Figure 61 is the first example on this warp where the balance between the warp and weft yarns is moving towards a more delicate look somewhat reminiscent of the spider's web imagery. The weft yarn in this sample was however too thin to counteract the strength of the stretch imparted by the warp yarns and this sample has subsequently collapsed to a very narrow width on removal from the loom.

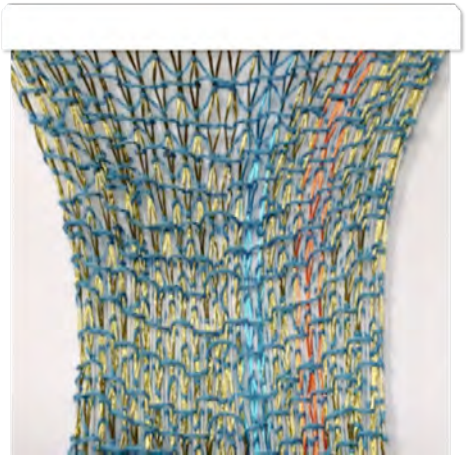

Fig 61. Sample 3-2e

Fig 62. Sample 3-2g

Many of the samples on this warp met the criteria in terms of their appearance but not until sample 3-2g (see Figure 62) does the balance between the warp and weft yarns really start to work. This sample, with the orange chainette yarn in the weft, allows the warp and weft to have an almost equal influence on the structure and the resulting weave makes the most of the weft distortion brought about by the twisting ends creating an over net of threads. The colours in this sample also connect well with the brighter accents of orange witnessed in the beach finds, the mended fishing nets and a rope swing seen in the woods in Merrydale.

Fig 63. Sample 3-2i

Sample 3-2i revisits the simplest of leno structures and using the singles cream wool, re-establishes the regular open network seen in warp 2 illustrated in Figure 63. A little bit of the stretch and flex properties have however been lost, and this was addressed in the final two trials on this warp.

Reaching an end point

The end point for a design project, is perhaps glimpsed early on or imagined by the designer, but time and resources are key factors in deciding on what is the end point.

> In design there is not an already-known goal; the designer creates the goal in creating a solution concept...[Designers] construct a fantasy city or magical treasure of their own. In a sense they are genuine explorers, mapping unknown territories and returning with fascinating finds... Cross 2011, p134

Referencing the objectives and criteria of this research, an end point in this practice led research has revealed itself in samples 3-2j and 3-2k. See Figures 64 and 65. The golden treasure at the end of the rainbow, these two leno woven samples meet all the criteria set out, both in terms of their potential to provide support and flexibility and in evoking the open delicate nets and webs which inspired this research.

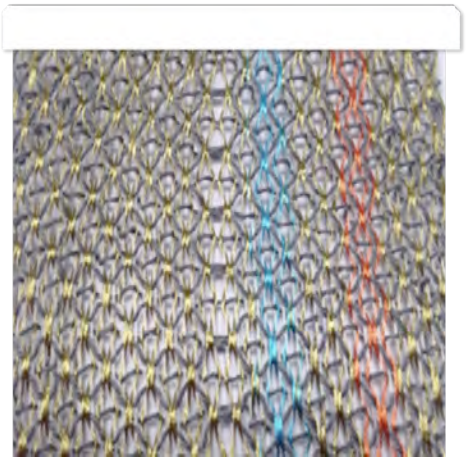

Fig 64. Sample 3-2j

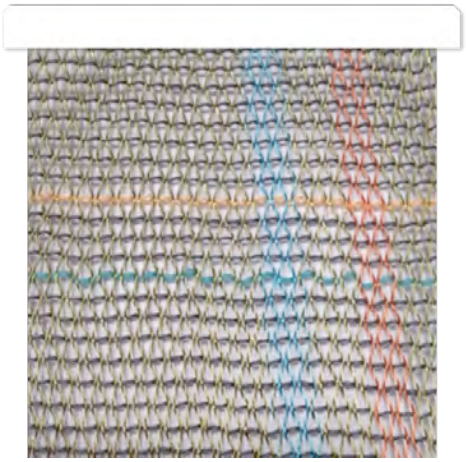

Fig 65. Sample 3-2k

A public viewing

The final two samples woven on Warp 3 were selected for display on the Huddersfield University stand at the Surface Design Show in February 2014 at the Business Design Centre in London (see Figure 66). The two designs were kept as one single piece measuring in at about 1.2 metres with a length of the remaining warp threads left intact at one end. This combination created a certain amount of visual impact, not otherwise possible with the shorter pieces previously woven, and this impact was enhanced with the end threads adding interest through their freedom of movement. This loose bundle of threads was used to great effect later in the year (May 2014) in the final photo shoot taken up on Marsden Moor. A number of other samples were also displayed alongside the final piece as seen in Figure 67.

Fig 66. Final samples

Fig 67. Supporting samples

Some interest in the main hanging samples was received from a young architectural practice that visited the stand; which was rewarding and supports my thoughts for future developments, whether for outdoor furniture or for interiors.

Overview and analysis of all samples

In order to assess the success of the whole sample collection against the criteria set out at the beginning of the research, a table of results was compiled to provide a visual representation of the ranking of each design. This table enables the selection and filtering process carried out concurrently with the data generation (Gray & Malins, 2004, p132) undertaken during the development process to be captured in a transparent format (see Figure 68). Preliminary evaluation and analysis are iterative processes that take place almost subliminally, and therefore require a mechanism to make the results explicit and accessible.

The spectacles, sieves and filters used in the analysis of the data created by the sampling process undertaken in this research are those of my own making and these have been refined throughout the process.

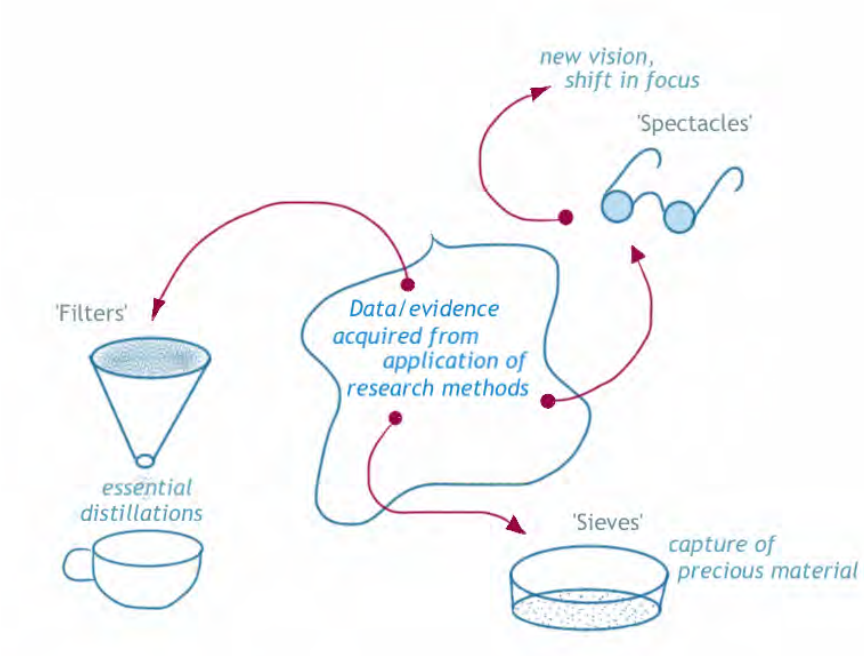

Fig 68. Spectacles and Sieves (from Gray & Malins, 2004)

Sample ref		Composition has potential to partially decay	Flexibility of weave structure/ support potential	Visual resemblance to source material	Aesthetics & appearance – blends into landscape
Warp 1	1a				
	1b				
	1c				
Warp 1	2a				
	2b				
	2c				
	2d				
	2e				
Warp 2	1a				
	1b				
	1c				
Warp 2	2a				
	2b				
	2c				
	2d				
	2e				
	2f				
	2g				
	2h				
	2i				
	2j				
	2k				
Warp 3	1a				
	1b				
Warp 3	2a				
	2b				
	2c				
	2d				
	2e				
	2f				
	2g				
	2h				
	2i				
	2j				
	2k				

Key to colours:

Not acceptable	Red
Some potential	Amber
Meets criteria	Green

Fig 69. Overview of results

When analysing the table of results in Figure 69 it is immediately clear that the route to the samples that were most successful (against the criteria set), was not an entirely linear one. The use of colour in a 'traffic light system' to flag the status of each fabric woven, has produced a clear visual overview of the entire sampling process, in which we can compare the samples in chronological order against the four criteria, relating to their physical, visual, material and dynamic properties. There were some samples in the earlier warps that displayed a certain degree of success when assessed against the set criteria, but the natural scoping process of design and development also produced some fabrics that meet only one or two categories at the early stage. The decisions to jump from one design and material to another, in what appears to be a random manner, is an approach often used by designers in the early stages of a project, to test out a broader range of possibilities.

As the design process develops 'a reflective conversation with the situation' proceeds (Schön, 1983) in what can be considered a very complex situation where unintended outcomes are produced. A scientific and sequential plan to sampling, is not necessarily the most efficient route to the perceived end point, and can be less rewarding to the creative, who wishes to follow their 'gut instinct' throwing apparently random combinations into the mix. In design practice there is also the factor of the "co-evolution' of problem and solution (Cross, 2011, p.123) which is an ongoing interactive exploration of both the problems and the solution during the process of development. The more random and less linear path of success taken from the initial concept through to the final solution is supported by the work of Bryan Lawson referred to in Chapter 4 that posits a more three dimensional approach to design development.

Insight into weaving

It should also be reflected upon, that my journey through this sampling process, was not only about reaching an ideal in terms of appearance of the fabrics, but also a journey through the hand-weaving process and specifically into the mastering of the doup-leno technique.

Challenges in working with less flexible and slippery yarns (monofilament and viscose) during set-up and weaving have been mainly resolved, and this first hand knowledge will be passed onto students in future teaching in the university workshops at Huddersfield.

It has been established that yarns with good stretch characteristics like wool create excellent body (fullness) in the final samples; singles wool being the most successful in bulking-up when hand finishing process using boiling water and detergent. For clarity of design and the desire to create an open-net transparent fabric, the use of monofilament yarns in combination with a natural fibre (wool) provided an excellent result (against the criteria set). The balance of a slippery man-made fibre, with a hairy natural fibre, produced a cloth in which the leno twisting action created stability in the structure and yet the final piece retained the ability to flex and stretch and deform. These qualities suggest the potential for use in a seating application where strength, and flexibility are required when the material is suspended in a frame of a given design.

The dynamic and aesthetic properties of samples 3-3j and 3-3k have been recorded in a series of short films, Final Fabrics 1-3 (Redmore 2014) that can be watched through a link on my blog 'Left out in the rain: abandoned but not forgotten'. Images of the final fabrics situated in the same location as the original 'Sock on fence' in Figures 70 to 74 (Redmore 2014).

Fig 70. Leno on fence 1

Fig 71 Leno in landscape 1

Fig 72 Leno in landscape 2

Fig 73 Leno in landscape 3

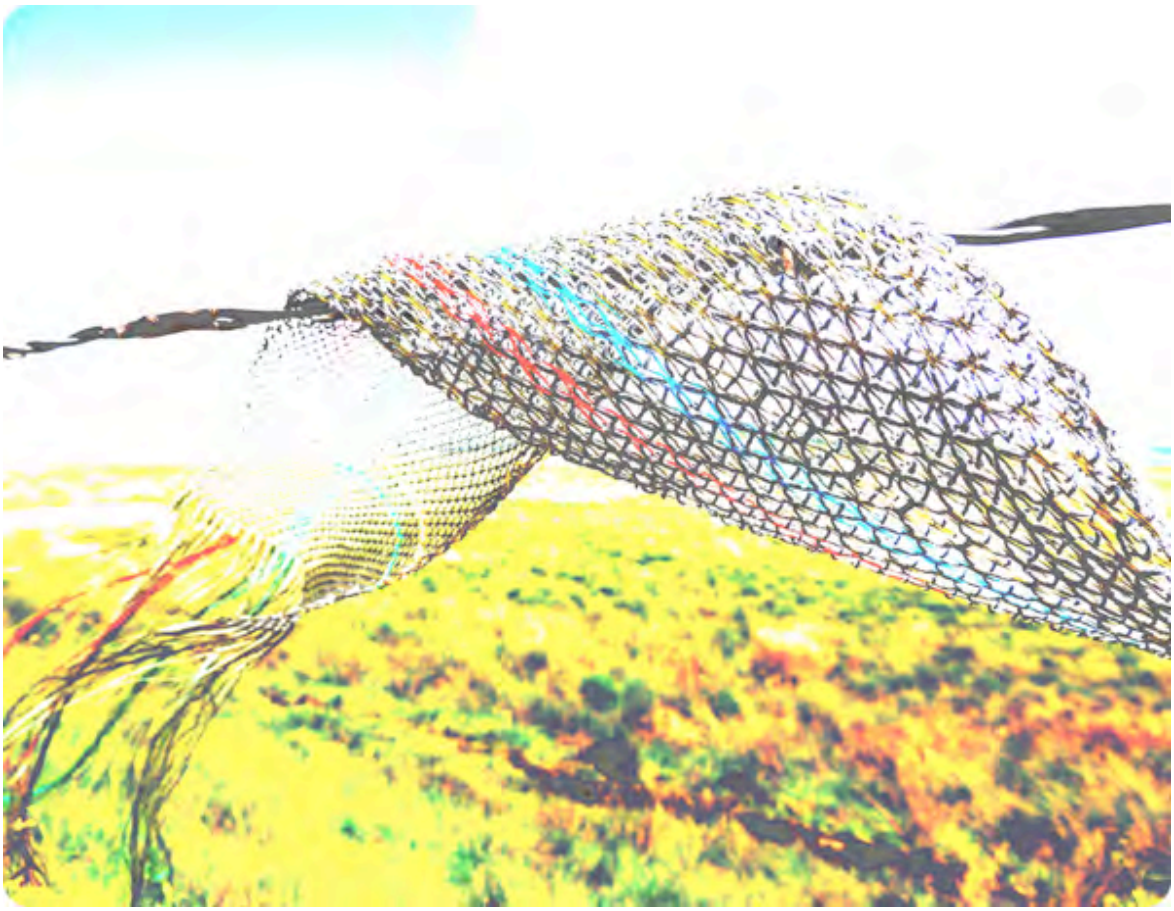

Fig 74. Leno on fence 2

Sock on the fence

Throughout the duration of this research project frequent visits to the original sock, stranded on the fence were made, partly through curiosity but also to note the changes in its physical appearance. This sock has been exposed to two severe winters positioned as it is on the top of the moors above Marsden in West Yorkshire. There is no shelter from the weather in this site (380 metres above sea level) and the prevailing winds and rain that come in from the west are felt in full force. It is pertinent to note that that on every occasion the sock was visited over the two year period there was a strong wind blowing – both in summer and winter. Although not buried in the ground like the early work of McQueen and Nuno (see Chapter 2), or left to slowly decompose in a sheltered garden as in the case of Colet's Suicidal Textiles, this sock has been subjected to a set of climatic conditions which have tested its resilience to sunlight, precipitation, freezing temperatures and wind.

I do not know exactly how long this abandoned sock had been in place before I first noticed in 2012, perhaps a year, but what remains two years later is now very much diminished in size and colour (see Figure 70). This research has not kept a scientific record of the changes seen in this knitted sock, but further investigation in an extended study would look to provide some data around the rate of decay of different fibre types and fabric compositions exposed to external conditions. The last visit in June 2014 revealed new life in the remaining scrap of fabric; a small cocoon made there by an insect and ready to spring into new life. A visual record has been recorded through the timeline in Figure 70, and a series of films taken at three intervals in the life of the sock (Sock on fence 1 - 3), embedded into my blog mentioned previously (Redmore 2014).

Fig 70. Sock on fence timeline

Conclusion

The sampling process described and analysed in this chapter has detailed my experience as a designer and how this previous knowledge has aided my approach to the task I have set myself. It has been established that leno weaving is suited to the production of open net-like fabrics and that these fabrics display the potential to be used in seating when suspended in a frame. The best combination of fibres and leno structures to meet the objectives set out at the beginning of this research uses a combination of monofilament nylon, viscose and two-fold wool. The fabrics produced have an attractive appearance when viewed in the landscape, their transparent quality blending with the natural materials in an aesthetically pleasing manner.

Hand weaving samples as part of the creative design process has enabled me to get back in touch with the craft of weave and has provided me with some quality information as to the best parameters for designing this cloth. Finally the thinking time on the loom afforded by this hands-on approach has provided me with new insights and understanding of the design process that I had used for years in industry.

Chapter 6 Conclusion

This Masters in Research has achieved a number of the aims set out in the initial objectives, especially around the potential of weaving leno fabrics by hand and the associated insight into practice led design thinking that has accompanied this process.

It has been demonstrated that leno weave structures have the potential to create open transparent, stable yet flexible fabrics. The aesthetic and structural appearance of these hand woven leno structures is a good match to the source inspiration of nets and webs, in its ability to create clean open intricate crossings of the warp and weft. Using a mix of monofilament nylon, viscose and wool yarns has resulted in a collection that also references, ropes and nets abandoned on the beach, the shine of dew on a spiders web and trapped textiles and wool on wire. Although this project has not been developed fully into a seating material for an actual outdoor chair the potential of these fabrics to work in the context of the landscape has been explored through research into the work of other practitioners and through in-situ photography on the Pennine Moors.

One of the most important aspects of this practice-led research, has been the journey of this textile designer from that of a commercial designer, to one of a weave practitioner, exploring the limits of construction and material combinations. The slower pace of development has allowed a greater analysis of the design decisions that I normally make in isolation of any making process. Reflection on this approach to design development and the way in which I set about to achieve my aims, has been invaluable in planning my delivery of future teaching in relation to both on loom weaving and commercial design methods.

Valuable insight into the performance limits of specific yarn types employed in the samples produced has revealed some successful workable combinations of fibre types. Using a handloom to create these pieces has been key to this understanding. A number of warps were set up and a series of samples produced in each using a limited selection of man-made and natural yarn qualities. Reflection on the success of each sample was

recorded on a loom ticket alongside technical information on the sett, yarns and peg-plans used in each design produced. A monofilament and viscose warp combined with wool weft give; great stretch and movement in the fabric, create the desired friction to grip a natural yarn like wool, an attractive appearance to the fabric, but one that would blend into the landscape. Observation of the sock stranded on the fence has produced some information on the rate of decay in a textile piece continuously exposed to the weather, but further detailed analysis of the fibres and specific construction used in the fabric is needed to develop useful results.

The value of archival records and historical literature and manuals on weaving leno, have revealed vital knowledge, which has been little documented since the decline of the textile industry. Knowledge in manufacturing and commercial design contexts, if often presumed or remains locked within the mind of soon to retire technical designers. The textile industry is naturally secretive and this competitive environment is such that technical knowledge is rarely shared, restricted to silos of know-how, each the property of a separate company. In contrast the world of the craft weaver is far more open and transparent, knowledge is readily shared through blogs and Internet forums, exhibitions and conferences. The technical scope of the craft weaver is driven by different requirements, as it has a smaller customer base and is practitioners naturally create a more indulgent outcome, working as they are on a smaller scale.

This research has allowed me to develop a greater ability as an industry (commercial designer) to articulate the automatic and intuitive process of design that I follow as a textile designer. Some of this insight into the design process and how this contrasts with that of a craft practitioner has already been built into a collaborative student project delivered in April 2014. Leading a small student team allowed me to encourage them to adopt similar methodologies to myself in their pursuit of their own ‘sock on a fence’.

Research into the work of other practitioners, artists, designers and sculptors supports the possibility that suspended structures can work successfully within an outdoor space at both a large and a small scale. Using leno structures in seating is achievable as evidenced in the interiors market. The interest received at the Surface Design show 2014

in these first samples supports my instinct as a designer to develop a leno fabric with a simple but attractive aesthetic and this trend has been evidenced in the work of Patricia Urquiola and Janet Echelman amongst others.

Further research

Scaling-up the trials already completed and working in collaboration with a product or furniture designer to realise the potential of this cloth for seating could be further developed. It would also be desirable to understand how the knowledge I have built up by weaving on a handloom can be translated successfully into a production fabric; in order to identify what aspects of the design might be lost. Designers such as Urquiola have successfully achieved this marriage of the handmade and mass produced in the most literal of senses through the use of traditional craft techniques adapted for contemporary seating companies.

Investigating the timeframe needed for a mixed fibre fabric to visibly and physically change when exposed to external environment and influence of the climate is a key aspect of the research that I would like to take further. Detailed analysis of fibre properties, combinations of materials and finishing techniques could be carried out in order to predict decay timeframes and visible design changes in the fabric. Research into textile chemistry that would produce slow, attractive and planned changes in a cloth when exposed to external conditions would take this idea to the next step.

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Appendices

Appendix 1.


EMOTIONALLY DURABLE DESIGN
= long lasting relationship with consumer
Aged look = valued
craftsmanship
Rust
Corten steel
Richard Serra
= Navajo Tapestries (Arizona)
Rust creates patterns
Reiko Sudo - nuno
outdoor furniture
public spaces
Outdoor furniture
trade fairs / market
highend = tasteful
B+B italia
Patricia Urquiola
plastic/metal
wood
protective coatings on textiles
Active Silver
Repel water + dirt.
Product Designers working with bacteria
Algae
biofracture
Biological manufacture
microscopic → nano
Tokujin Yoshioka
Biotech gel chairs
textile scaffold.
Textiles
Biolace
Nobel textiles
erosion of top surface to reveal new form
self repair
self Assemble
Articles made from
waste
(Ghostnets)
fishing nets
rags
other biproducts
washed up
abandoned
synthetic brights
vs natural materials
OPPOSITE
interface
Solidwool
SHE design
Ayala Serfaty
Werner Aisslinger
heat moulded
layers create intricate skin
artisan
luxury
Restore a sense of human connectivity
Materials
stranded in landscape
or jarring with surroundings
Rate of decay
Nature absorbs materials back into landscape
ungraceful ageing leads to...
Materials that age
change or adapt
environmental conditions
textile conservation
Archive of textiles ageing issues
Do not beat nature down
Designs described as having stood the test of time have not only been tested by time but shaped by experience over time R Caplan 2006
materials with evolutionary characteristics
Andy Goldsworthy
(natural materials
Brutality of weather + weathering
Respond to external factors
architecture
Philip Beesley
Diagrid Networks
Kinetic response to environment
Eroded Matter - aesthetic ambiguity
Hussein Chalayan
Buried garments
Root bridges of Meghalaya
could design be as fragile as the nature we are trying to protect?

Technical details for woven samples

Warp tickets

- Warp 1
- Warp 1-2
- Warp 2-1
- Warp 2-2
- Warp 3-1
- Warp 3-2

Loom tickets

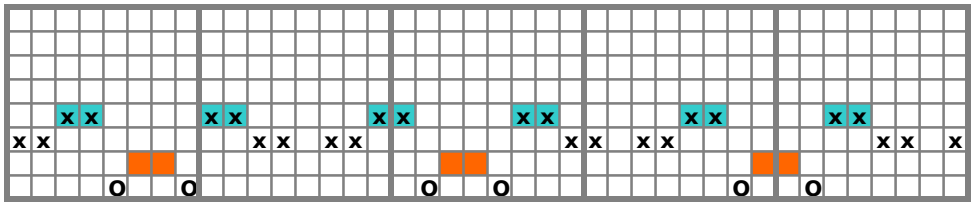
- Design 1-1a
- Design 1-1b
- Design 1-1c
- Design 2-a
- Design 2-b
- Design 2-c
- Design 2-d
- Design 2-e

Design 2-1a
Design 2-1b
Design 2-1c
Design 2-2a
Design 2-2b
Design 2-2c
Design 2-2d
Design 2-2e
Design 2-2f
Design 2-2g
Design 2-2h
Design 2-2i
Design 2-2j
Design 2-2k

Design 3-1a
Design 3-1b
Design 3-2a
Design 3-2b
Design 3-2c
Design 3-2d
Design 3-2e
Design 3-2f
Design 3-2g
Design 3-2h
Design 3-2i
Design 3-2j
Design 3-2k

Loom Ticket Warp 1

Draft



Denting

Reed

8

twisting ends x sleeper thread x doup tied on empty heddle O

Warping Plan

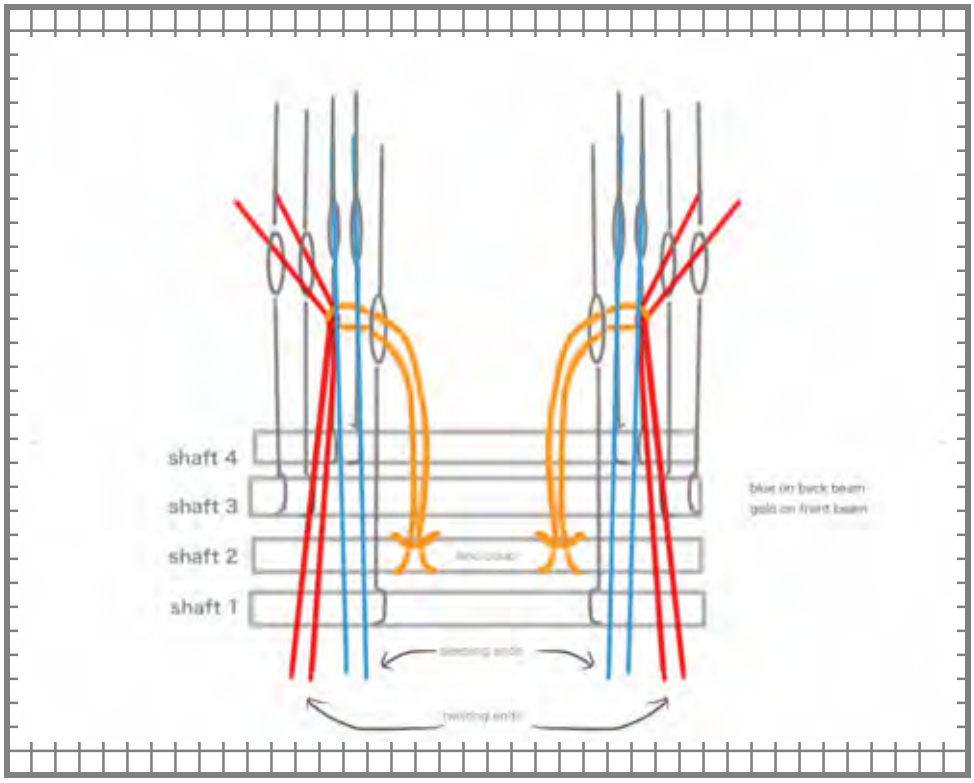
Gold Wool 2/18 wstd	2			
Blue Wool 2/34 YSW		2		

Total ends 116

x 2 9

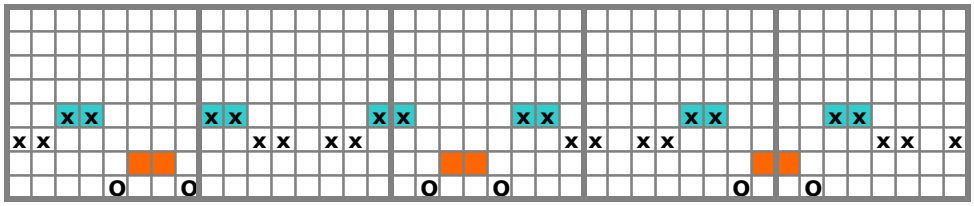
Ends/"	16

Diagram of loom set-up



Loom Ticket Warp 1-2

Draft



Denting

Reed: 8

twisting ends x sleeper thread x doup tied on empty heddle O

Warping Plan

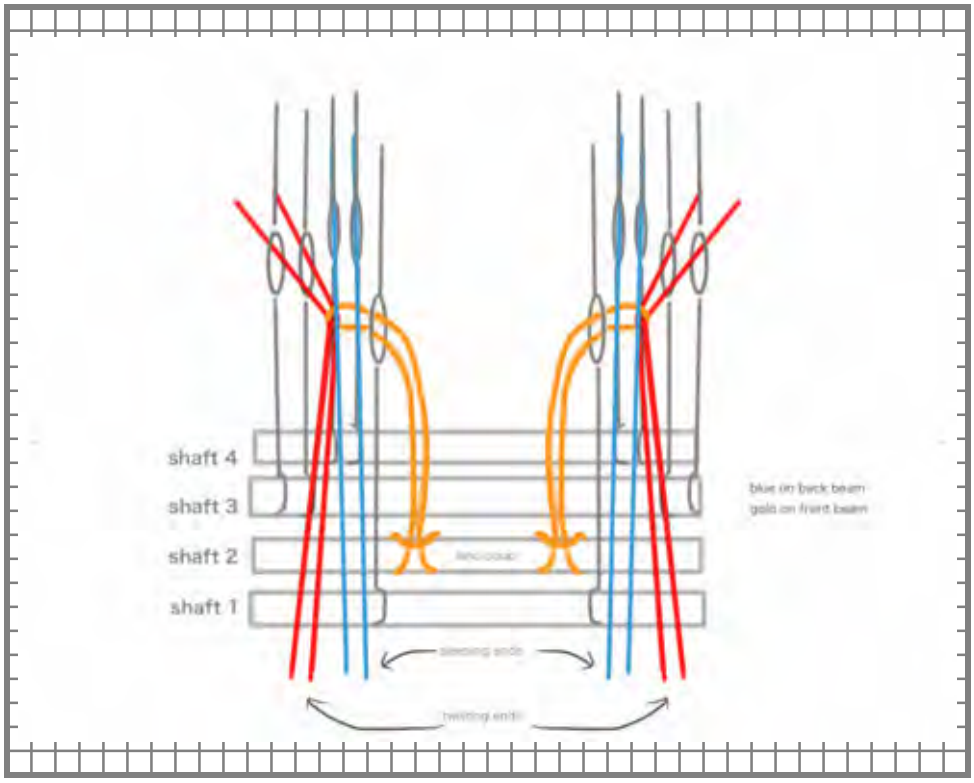
Gold Wool 2/18 wstd	2			
Blue Wool 2/34 YSW		2		

Total ends 116

x 2 9

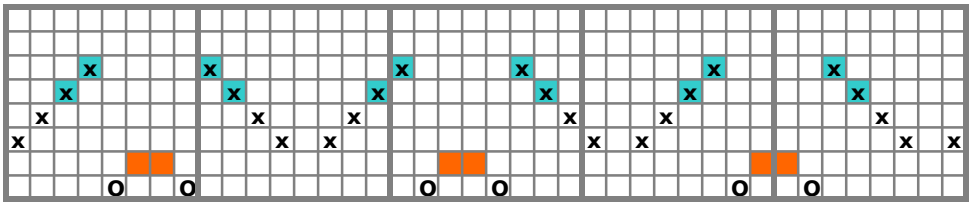
Ends/"	22

Diagram of loom set-up



Loom Ticket Warp 2

Draft



Denting

Reed

8

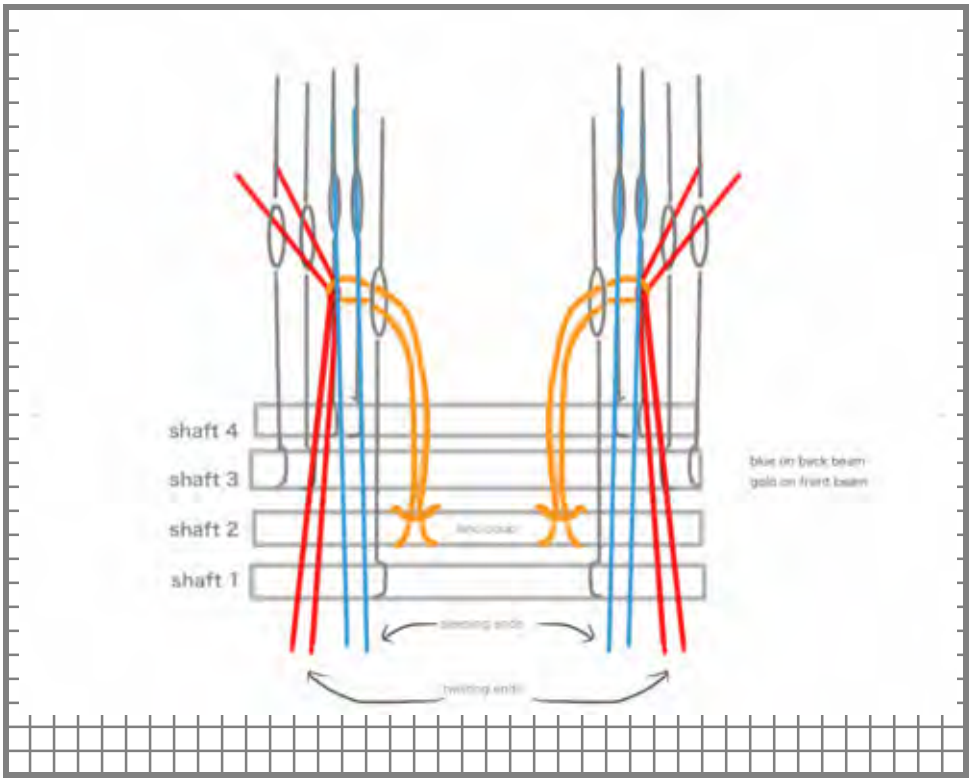
twisting ends x sleeper thread x doup tied on empty heddle O

Warping Plan

Denim Blue 2/12 wstd	2			2		
Green 2/12 wstd					2	
Beige 2/32 YSW		2				
Aqua 103 tex			2			Total ends 186
		x 2 7		x 1 9		

Ends/"	16

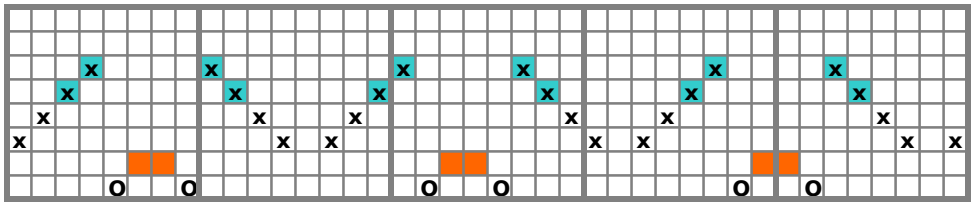
Diagram of loom set-up



An easy

Loom Ticket Warp 2-2

Draft



Denting

Reed

8

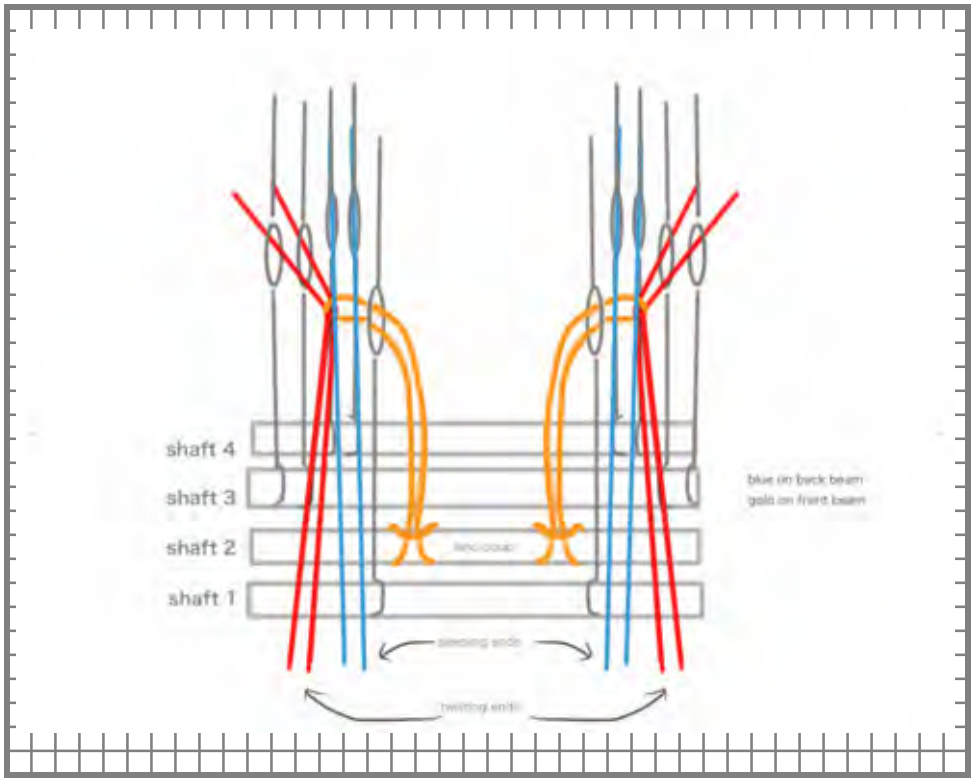
twisting ends x sleeper thread x doup tied on empty heddle O

Warping Plan

Denim Blue 2/12 wstd	2			2		
Green 2/12 wstd					2	
Beige 2/32 YSW		2				
Aqua 103 tex			2			Total ends 186
		x 2 7		x 1 9		

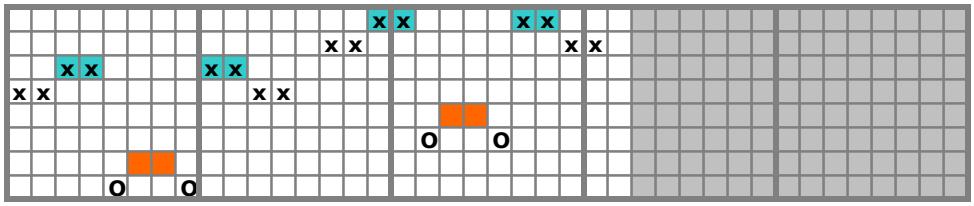
Ends/"	22

Diagram of loom set-up



Loom Ticket Warp 3

Draft



Denting

Reed

8

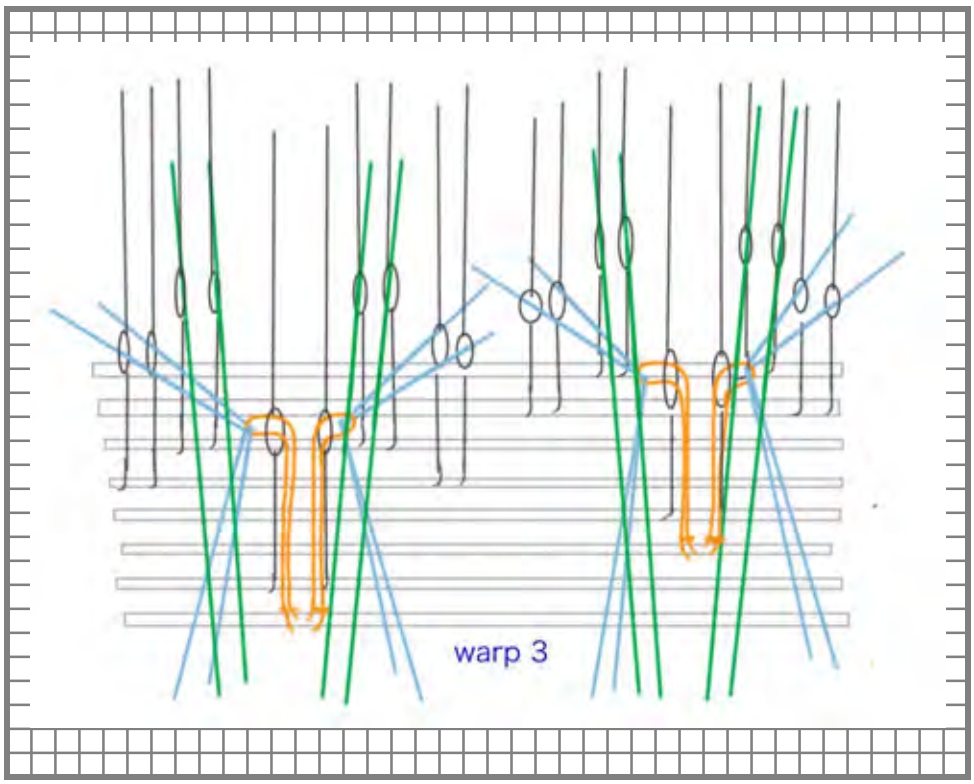
twisting ends x sleeper thread x doup tied on empty heddle O

Warping Plan

Monofilament	2		2		2		2		2	
Sage green viscose 670 dtex		2				2				2
Turquoise Viscose 670 dtex				2						
Orange Viscose 670 dtex								2		
	x 2 9		x 5		x 5		x 4		x 1 0	

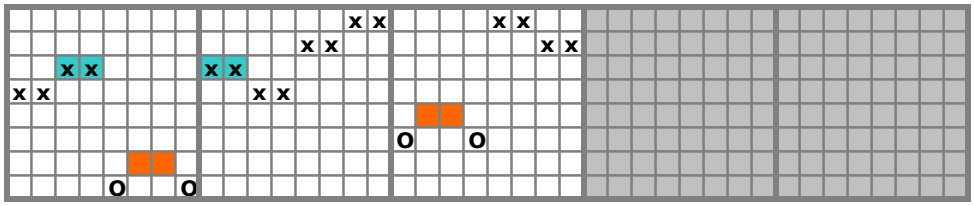
Ends/"	16

Diagram of loom set-up



Loom Ticket Warp 3

Draft



Denting

Reed

8

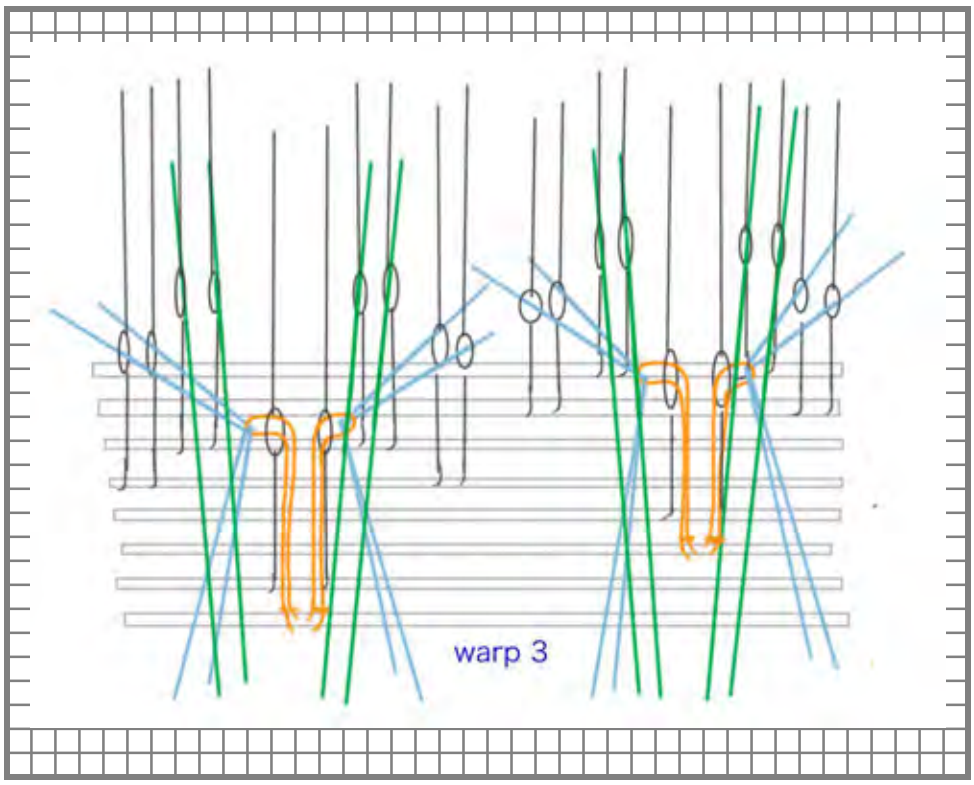
twisting ends x sleeper thread x doup tied on empty heddle O

Warping Plan

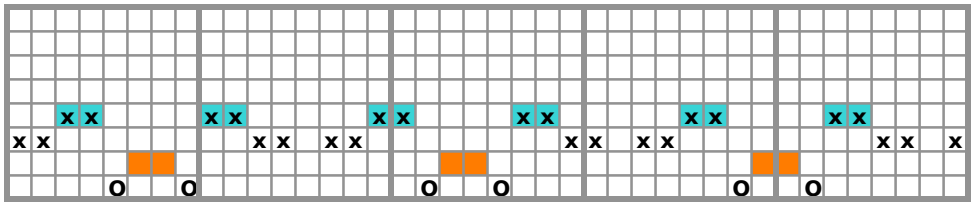
Monofilament	2		2		2		2		2	
Sage green viscose 670 dtex		2				2				2
Turquoise Viscose 670 dtex				2						
Orange Viscose 670 dtex								2		
	x 2 9		x 5		x 5		x 4		x 1 0	

Ends/"	32

Diagram of loom set-up



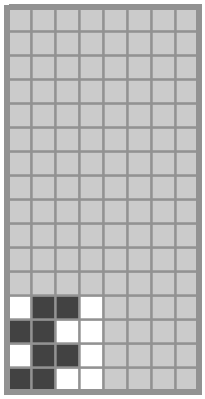
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

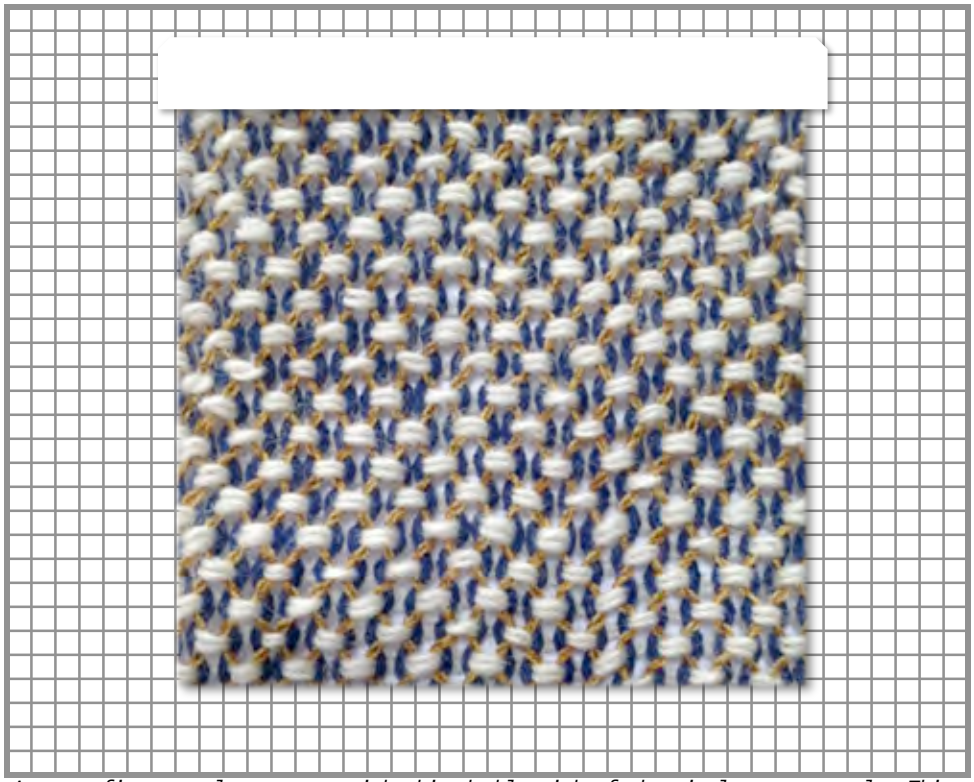
Peg Plan



Wefting plan

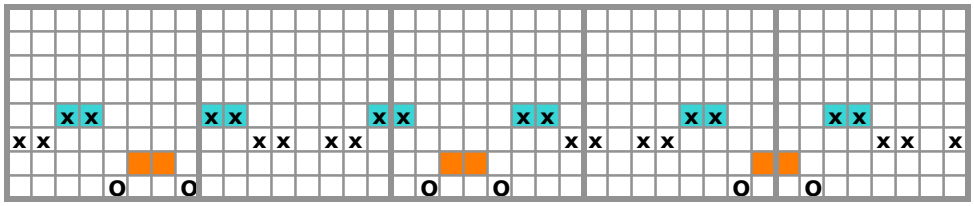
Cream wool 10's YSW	2					

Fabric



An easy first sample to weave with this double pick of the singles cream wool. This sample along with the rest of this warp have all been wet finished using a little detergent and boiling water in a bowl. Agitated for about 1 minute and then rinsed with cold water and dried flat (under no tension). The wool warp and weft in this the simplest of leno structures has produced a wonderfully springy cloth, with a soft touch and alot of elasticity

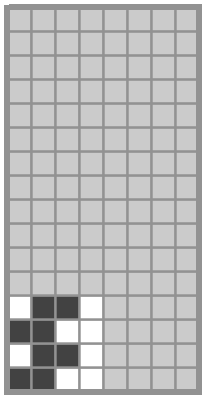
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

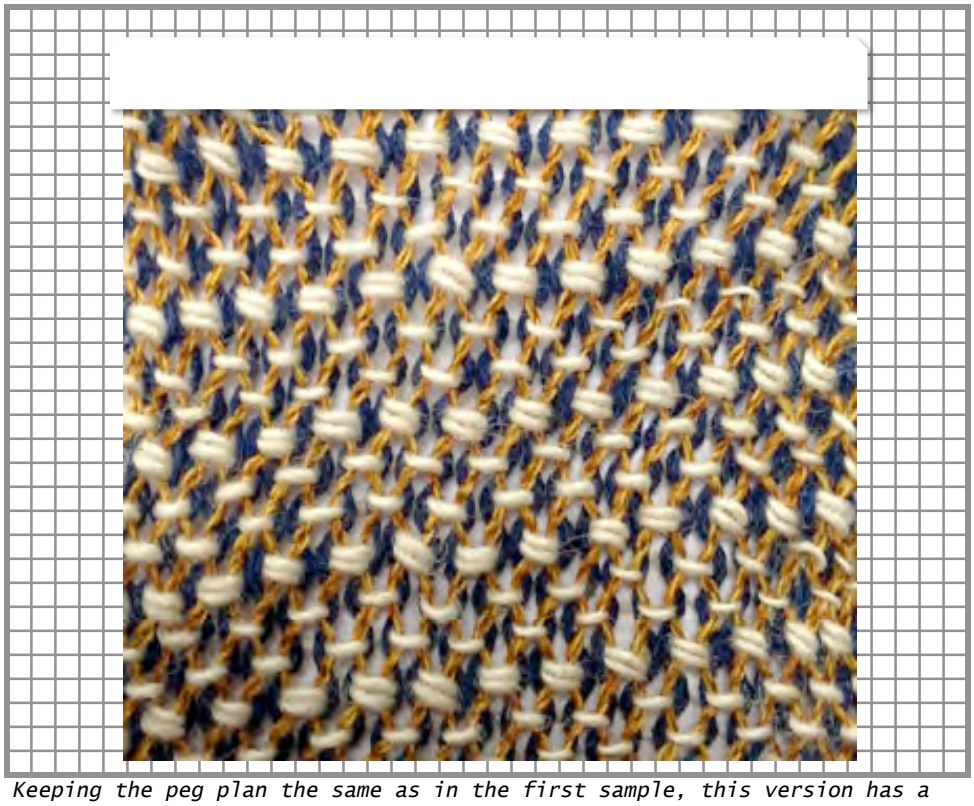
Peg Plan



Wefting plan

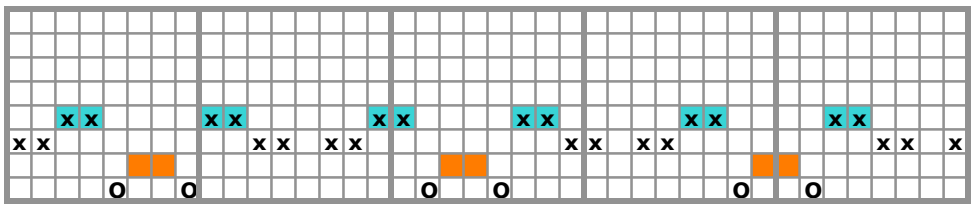
Cream wool doubled	1					
Cream wool 10's YSW		2				

Fabric



Keeping the peg plan the same as in the first sample, this version has a combination of single and double picks of the singles wool. This simple change creates a more complex fabric, but the single picks do not create the same body in the fabric as the previous piece using a double pick throughout.

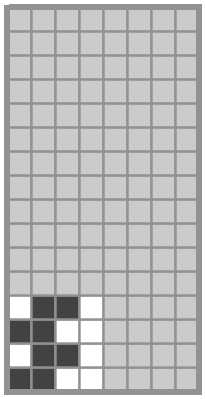
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

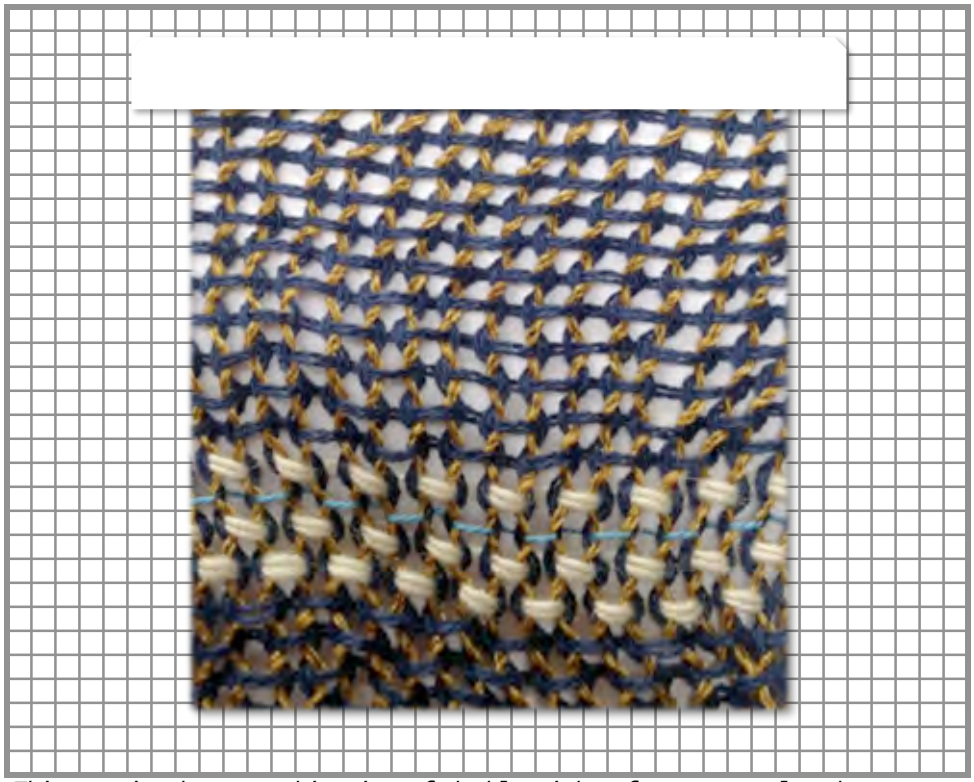
Peg Plan



Wefting plan

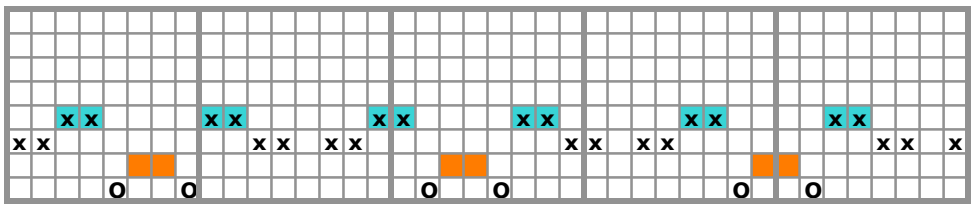
Navy wool doubled17's YSW	4				12	
Cream wool doubled10's YSW		2		1		
Turquoise wool 70 Tex			1			

Fabric



This version has a combination of double picks of a navy wool and a feature stripe in cream and turquoise. The colours work well, but the navy wool does not shrink to give the same body to the fabric as in the case of the singles cream yarn. This could be due to the fact that this yarn is a two-fold yarn or that it has a higher twist level.

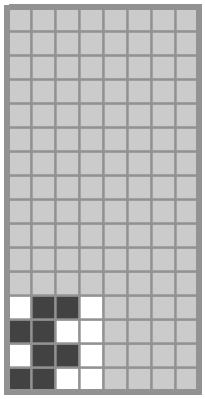
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

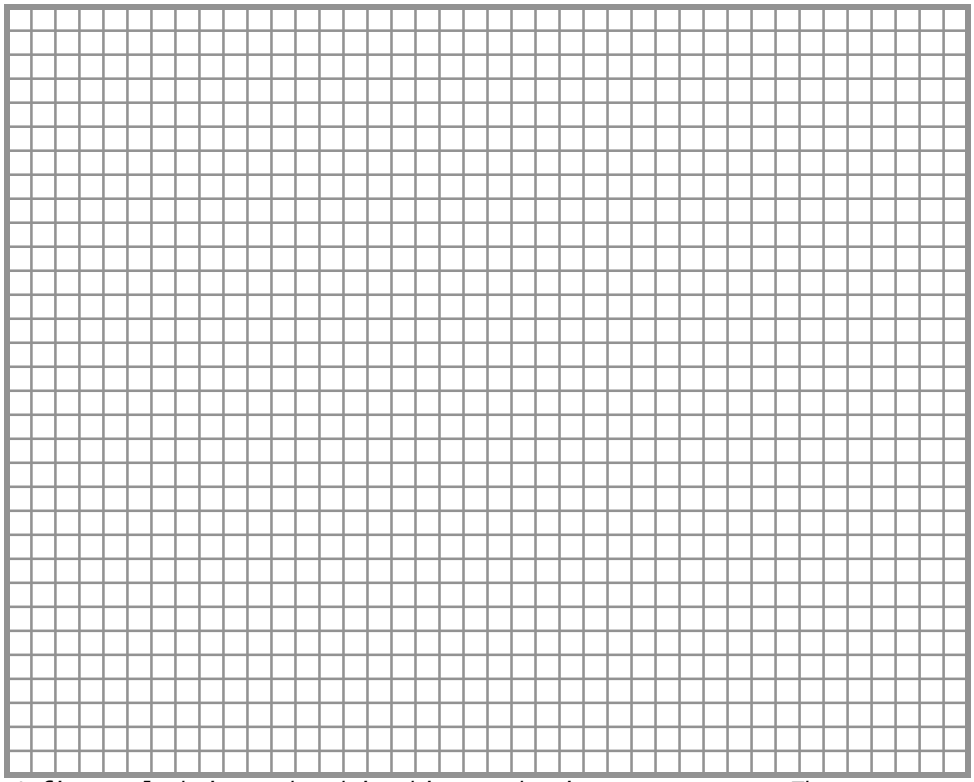
Peg Plan



Wefting plan

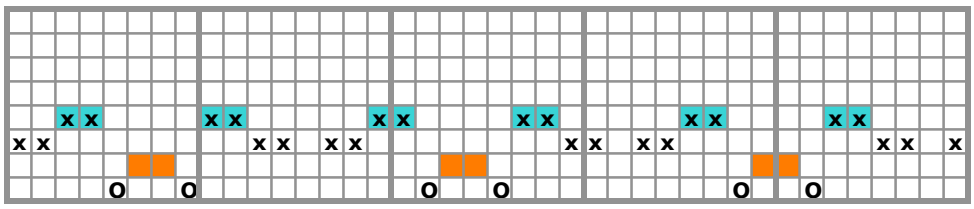
Cream wool doubled 10 YSW	S	O	L	I	D	

Fabric



A firmer cloth is produced in this new denting arrangement. The same double pick of wool is used as was seen in sample 1-1a. The resulting design is attractive and has been lightly wet finished to add some body to the cloth

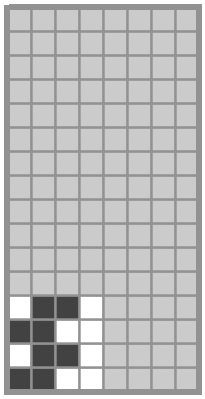
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

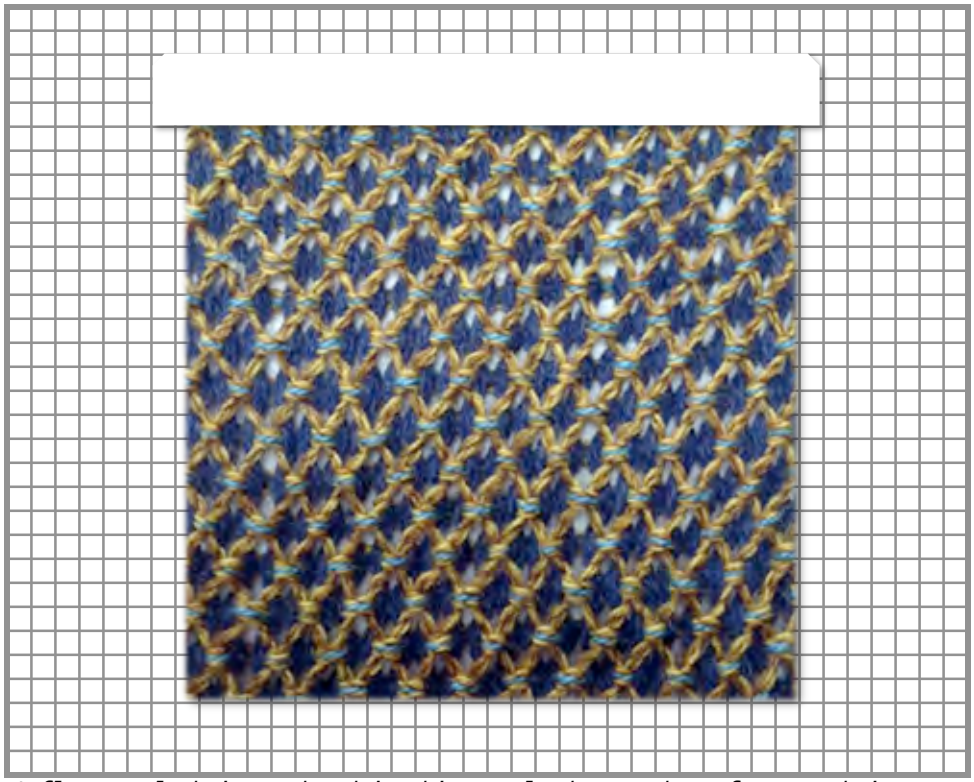
Peg Plan



Wefting plan

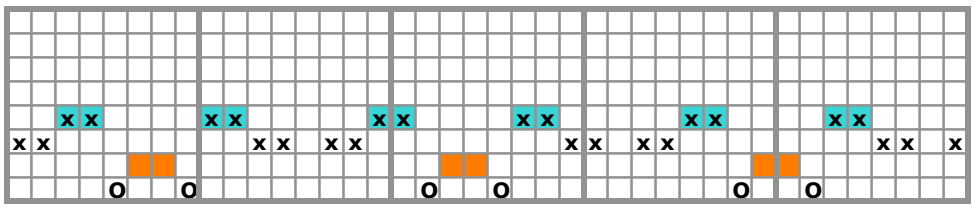
Turquoise wool 70 Tex	1					
Gold wrapped wool 2/18 wstd	1					

Fabric



A flatter cloth is produced in this sample due to the weft yarn choice. The same doubled pick of the 2 wools both have a quite stable and highly twisted structure, so there is little movement and body to this sample. Further yarn combinations need to be tried out at this reduced sett.

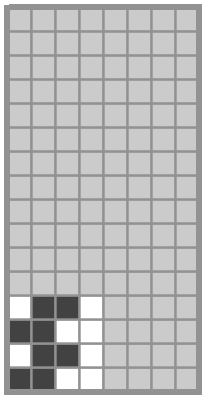
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

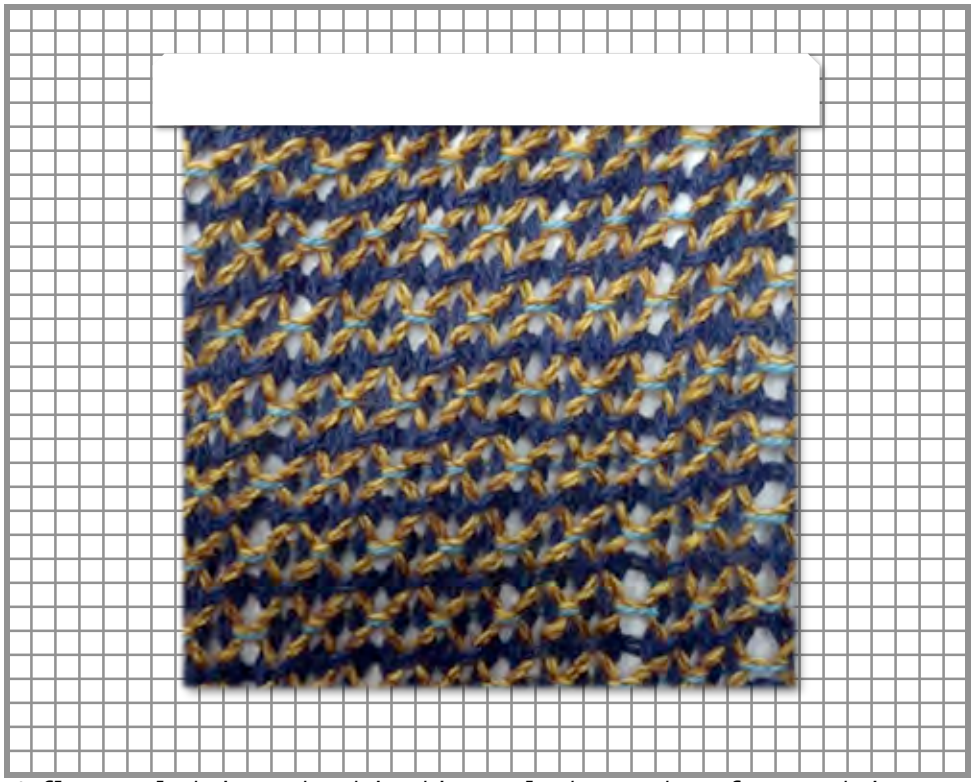
Peg Plan



Wefting plan

Turquoise wool 70 Tex	1					
Gold wrapped wool 2/32 YSW	1					
Mid Blue wool 2/34 YSW		2				

Fabric



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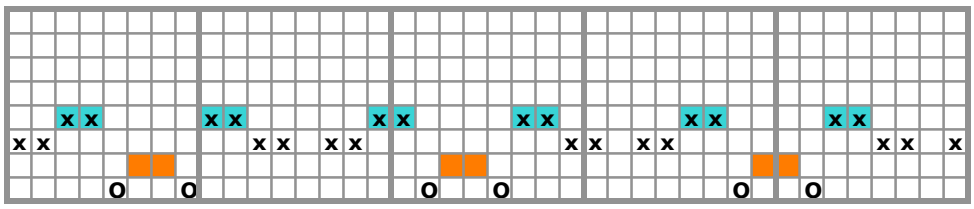
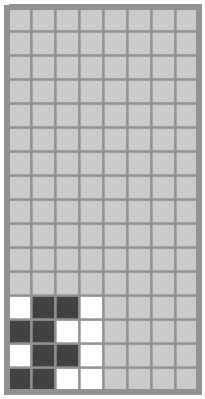
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

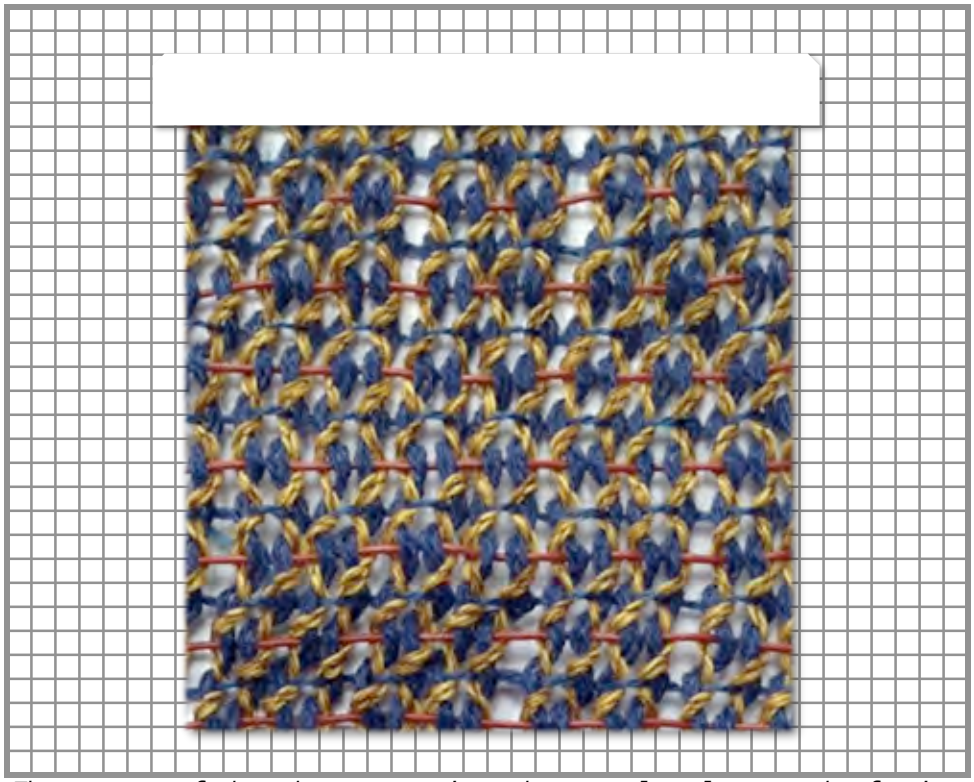
Peg Plan



Wefting plan

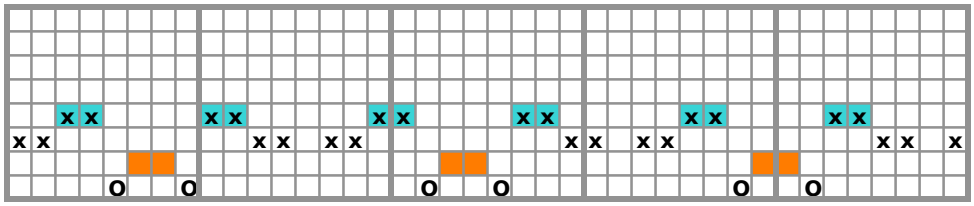
Mid Blue wool 2/34 YSW	1	
Red Rubco 2.5 nm		1

Fabric



The contrast of the rubco yarn against the natural wool warp and wefts in this sample provides a cleaner look to this simple leno structure. The rubco is quite slippery and has a tendency to hold the structure open, but can easily be manipulated to distort the appearance of this fabric.

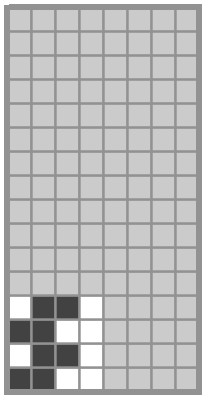
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

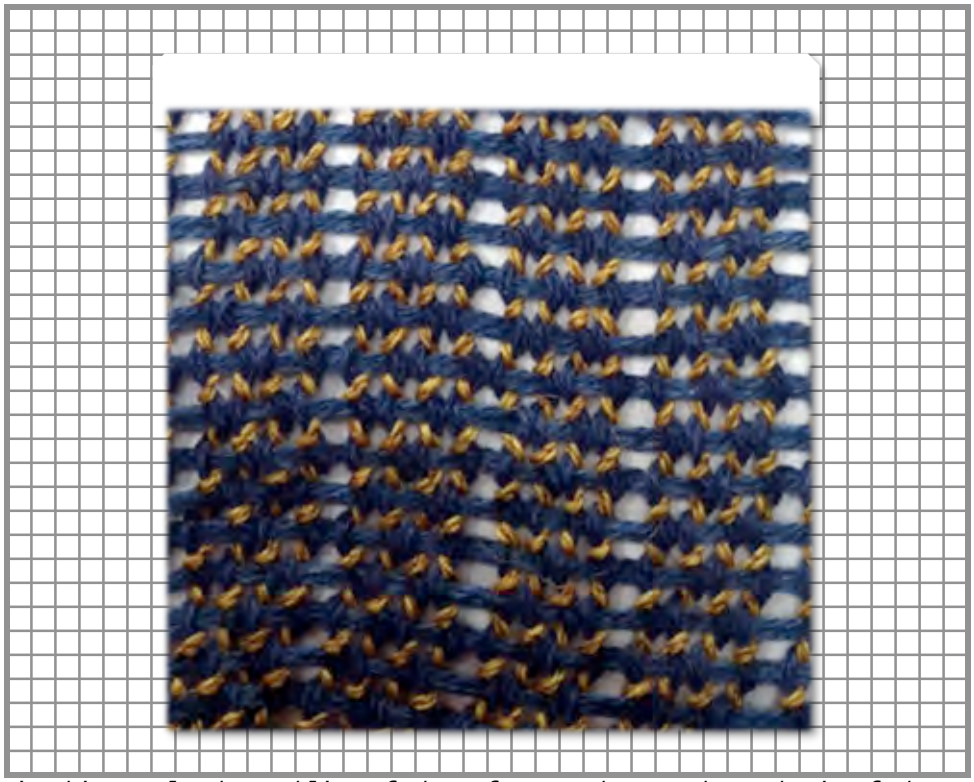
Peg Plan



Wefting plan

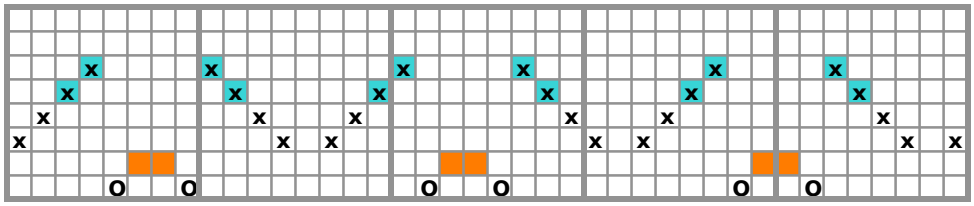
Mid Blue wool 2/34 YSW	3					

Fabric



in this sample the trebling of the weft yarn changes the emphasis of the structure to create a rigid network where the blue dominates. Interestingly in this sample the rigidity of the weft holds the the warp open to such an extent that the empty dent becomes evident in the warp direction. Not of real value to this project due to the inbalance of warp

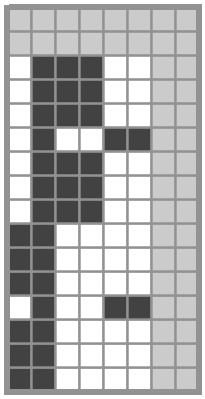
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

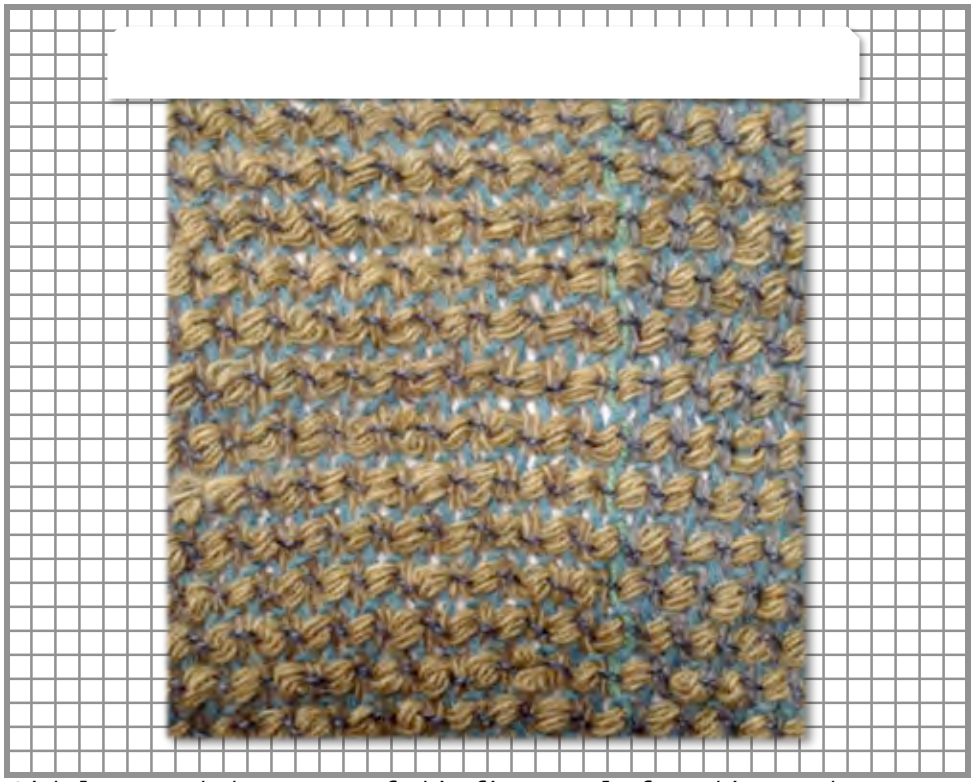
Peg Plan



Wefting plan

Beige wool 16's YSW	3		3			
Navy wool 2/34 YSW		1				

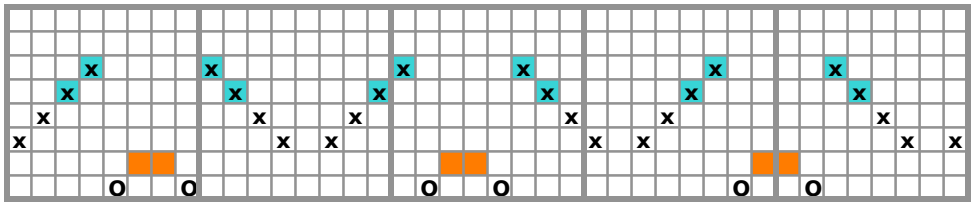
Fabric



Lightly steamed the texture of this first sample from this warp has some of the loftiness and texture seen in the previous samples constructed from 100% wool. This sample has a nice earthy and natural look to it, imparted by the sudbued weft colours and soft form of the weft yarn. This could be of interest should I decide to persue a less open appearance to the

Warp 2 **Design 1b** Wire

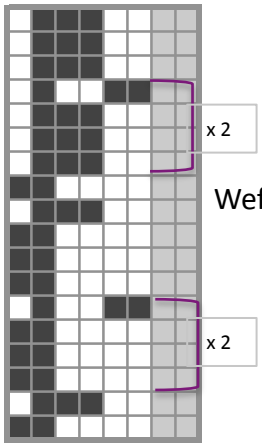
Draft



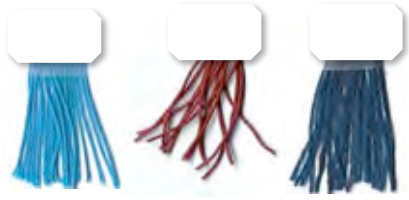
Denting

twisting ends x sleeper thread x doup tied on empty heddle O

Peg Plan

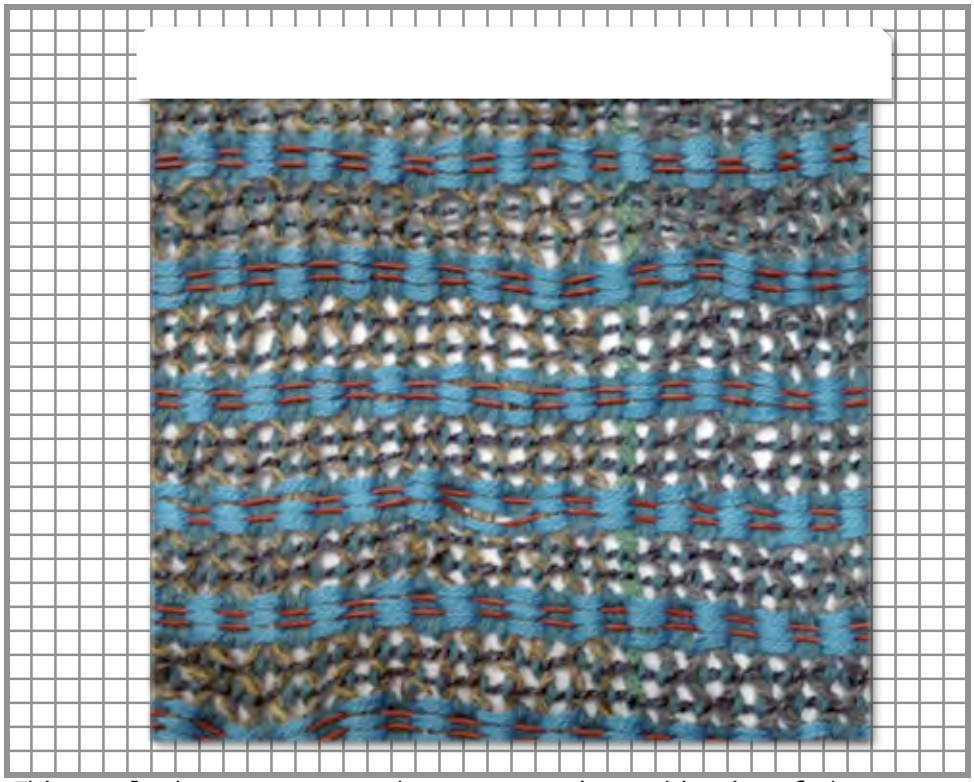


Wefting plan



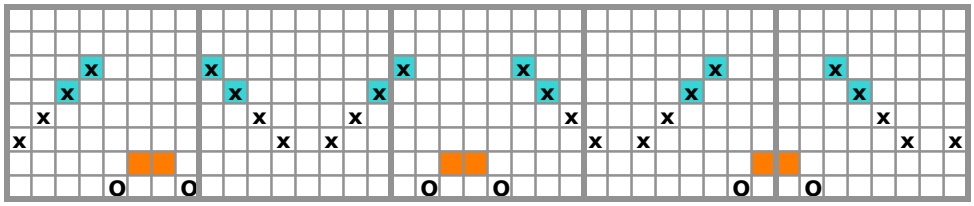
Turquoise wool 70 tex		3		3		3
Red Rubco 2.5nm			1		1	
Navy Wool 2/34 YSW	2					

Fabric



This sample demonstrates a much more attractive combination of the man-made (rubco) and the natural(wool) yarns linking with the fishing net photographs taken in Gairloch. There is an issue with the lack of friction between the rubco yarn and the wool warp - and a similar warp to weft may go someway to solving this issue?

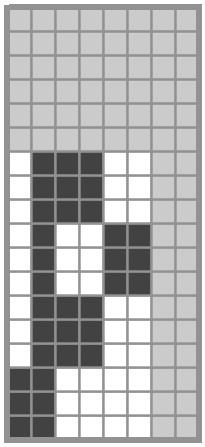
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

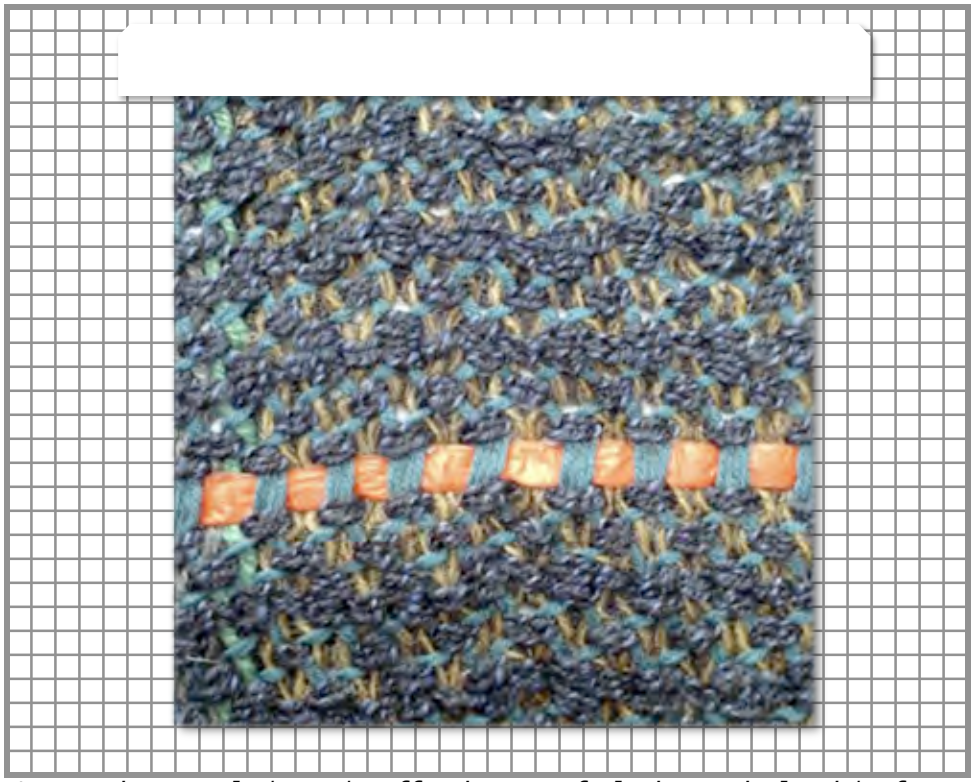
Peg Plan



Wefting plan

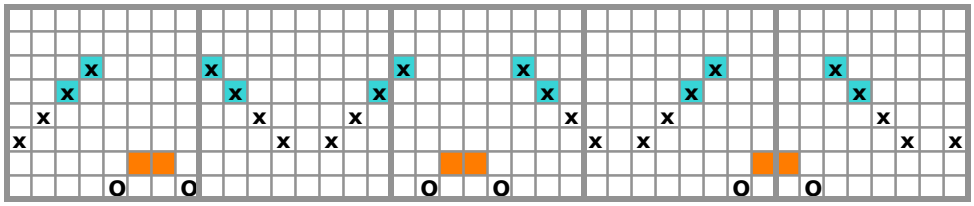
2 tone blue (x3) 2/12 wstd	18		9			
Sainsbury carrier bag		1				

Fabric



An experiment to look at the effectiveness of placing a single pick of a strip of a carrier bag into the weft. This sample was susequently pressed in the heat press (180oC) to melt this piece into the background of the fabric. Due to the use of wool warp yarns the carrier bag has deformed around the warp threads rather than bonding to them.

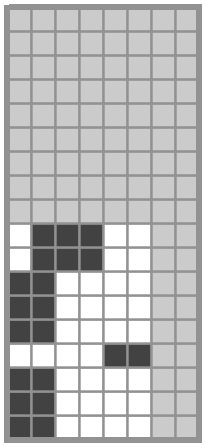
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

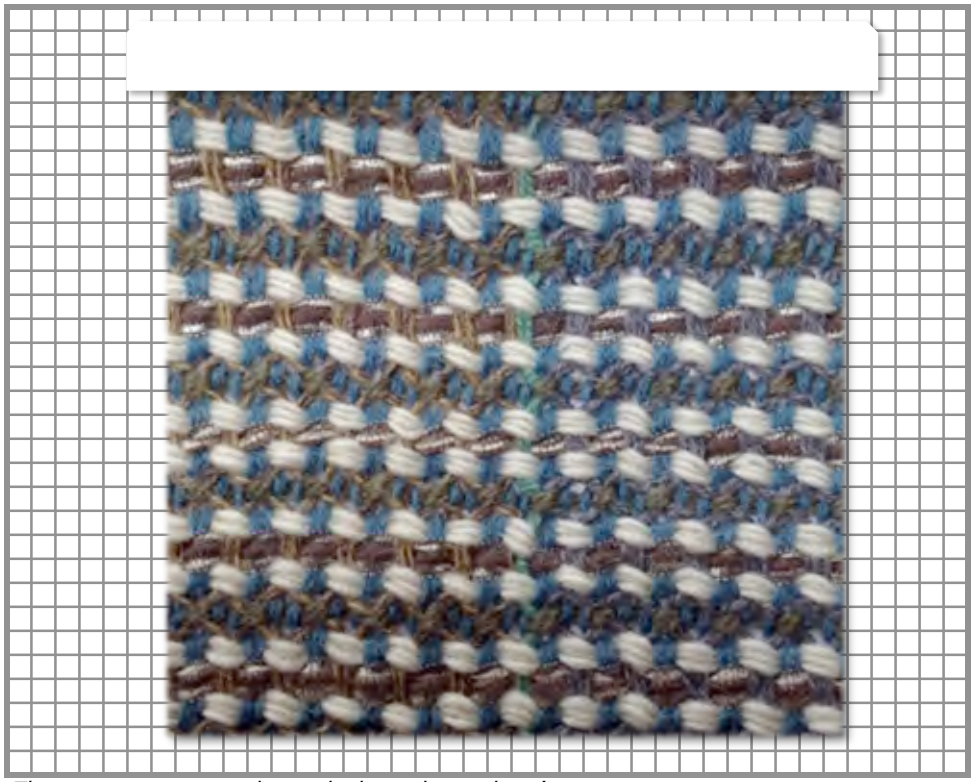
Peg Plan



Wefting plan

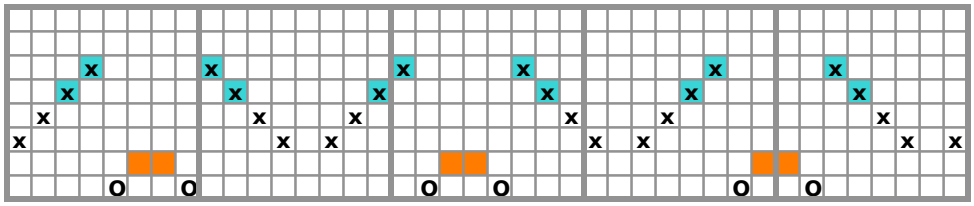
Cream wool 10 YSW	3		3			
Tape yarn 430 tex		1				
Green wool 2/32 YSW				2		

Fabric



The warp sett was changed through re-denting to create a more compact structure. This sample employs a mix of wool and tape yarn in the weft and on finishing the weft has almost disguised the leno twist. The resulting design has pleasing angles to the wool weft as they are deflected by the leno warp yarns.

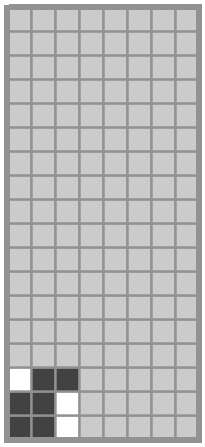
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

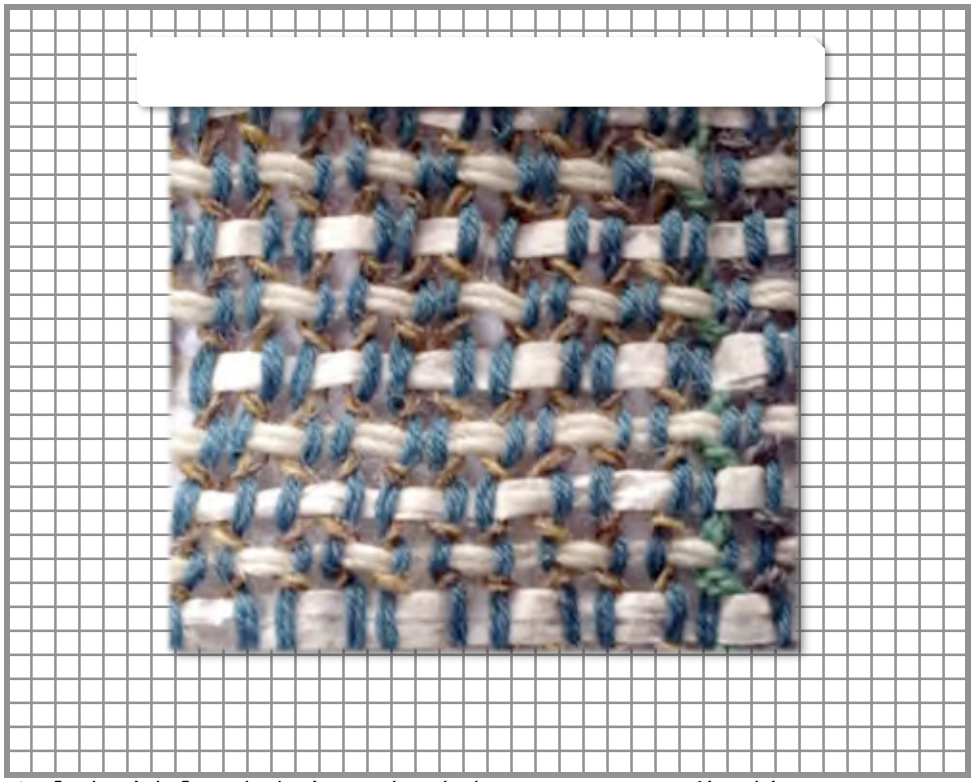
Peg Plan



Wefting plan

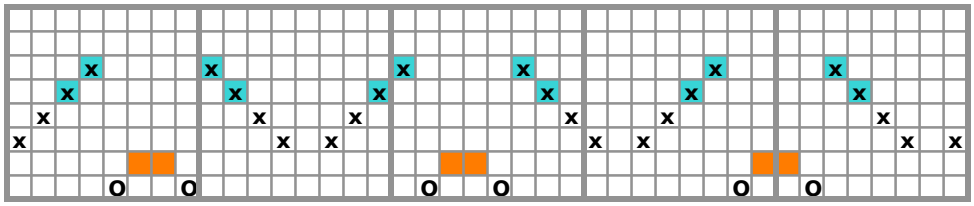
Cream wool 10 YSW	2						
paper yarn		1					

Fabric



A cloth with less body is produced when a paper yarn (in this case a very flat yarn) is introduced into the weft of the cloth. The resulting fabric has less elasticity than sample 2-1a and does not show off the leno structure paticularly well either.

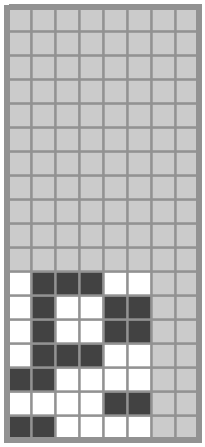
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

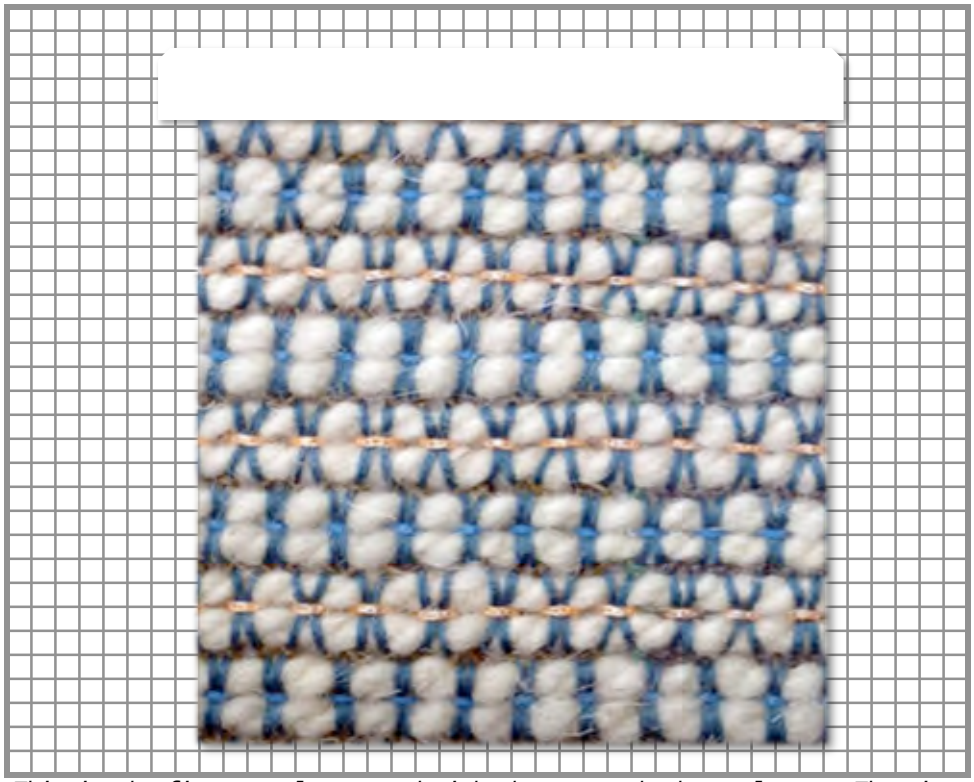
Peg Plan



Wefting plan

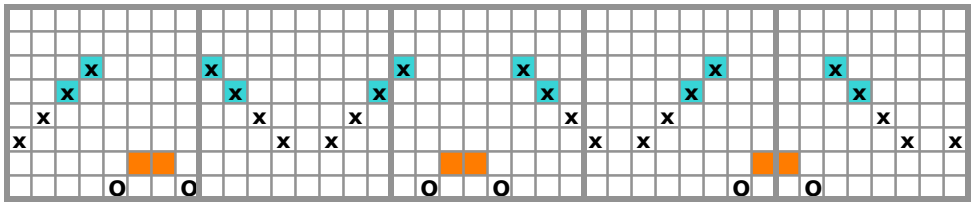
Thick cream wool 2115 tex	1		2		1	
Orange chainette 258 tex		1				
Turquoise wool 70 tex				2		

Fabric



This is the first sample created with the super chunky wool yarn. The mix of the chunky cream wool with accents of the blue and orange seen in the fishing net inspiration is quite striking. Of particular note is the definition of the crossing threads as they are held firmly on the surface by the thicker yarns. This is something to experiment with further.

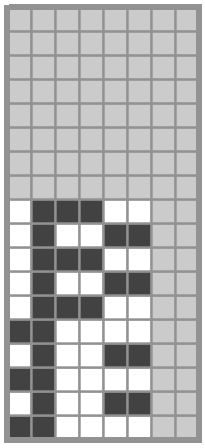
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

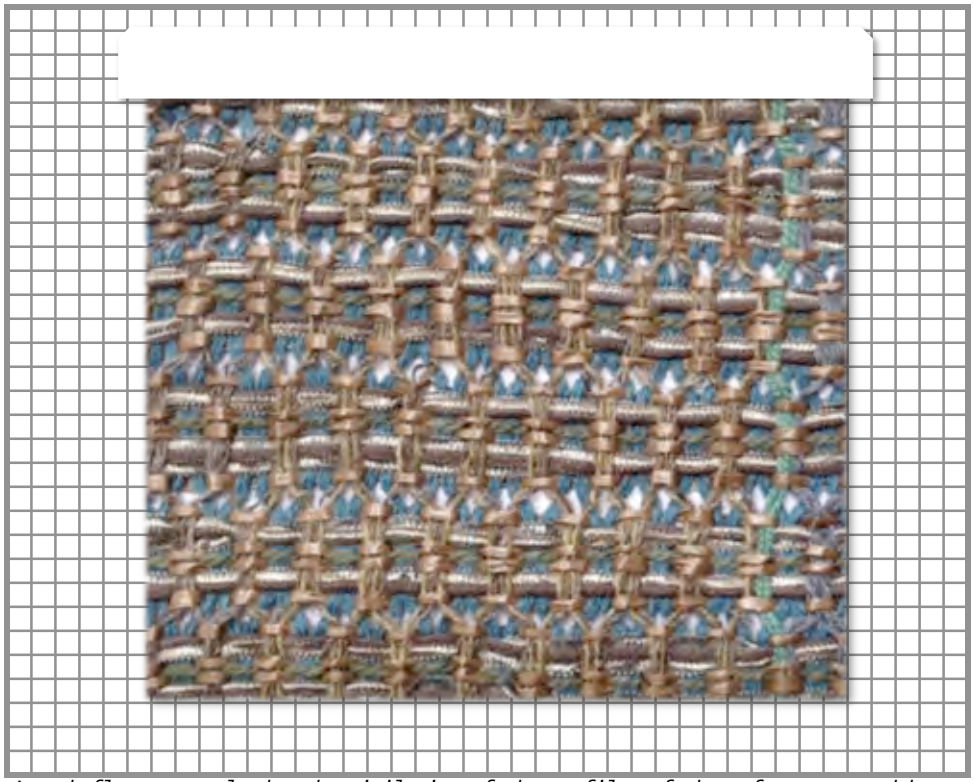
Peg Plan



Wefting plan

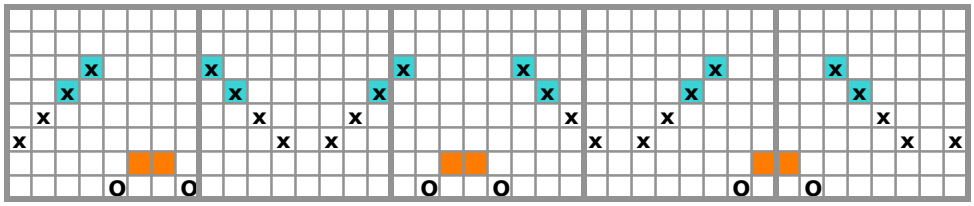
Raffia in copper	1		1		1		1
Tape yarn 430 tex		1				1	
Mid Green wool 2/32 YSW				1			

Fabric



A much flatter sample due the similarity of the profiles of the weft yarns used here. All the wefts with the exception of the wool are flat in nature and the warp yarns are therefore tending to bunch together in 4's helped by the peg plan employed here (which has elements of non crossing plain weave, mixed with the occasional twist of leno). A subtle and attractive colour mix has resulted in this sample.

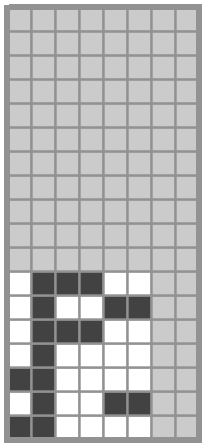
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

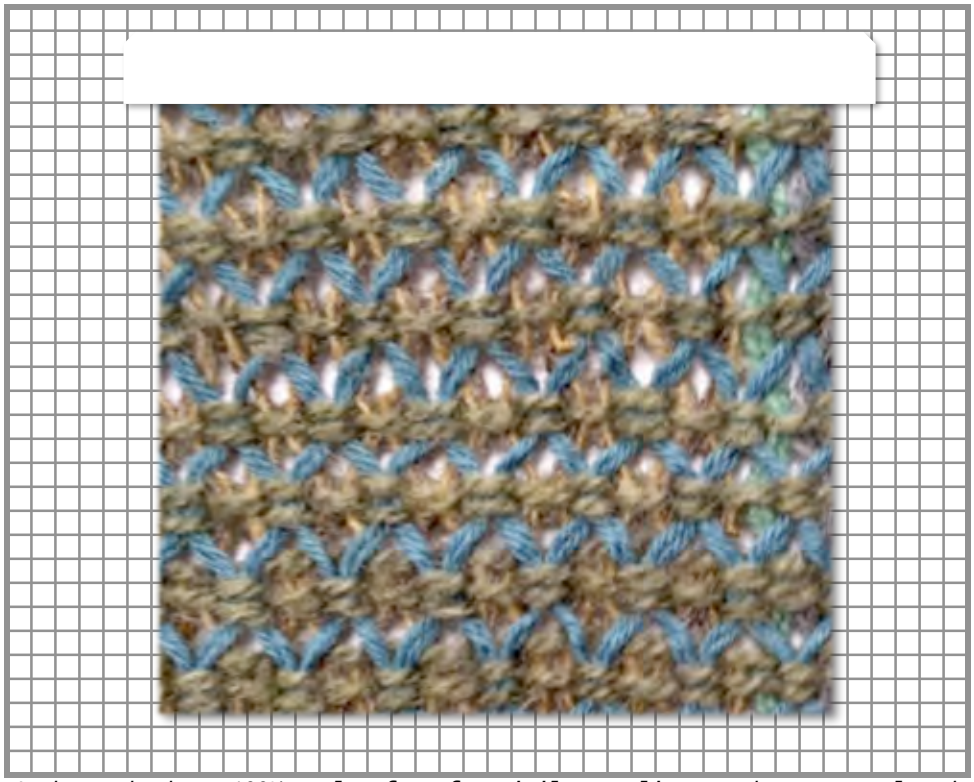
Peg Plan



Wefting plan

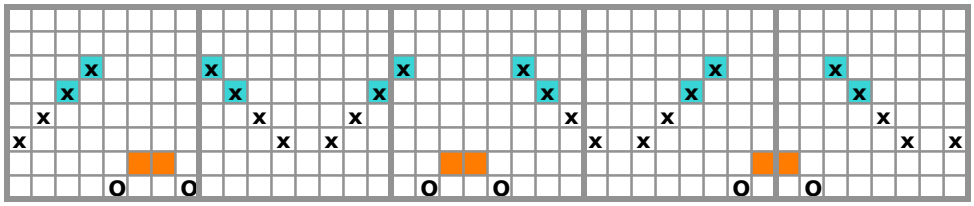
Green wool 2/32 YSW	S	O	L	I	D		

Fabric



A change back to 100% wool wefts of a similar quality to the warp employed in this sample has produced a fabric with a soft hand. The colour combination and lack of definition in the design have combined together to leave a rather dull and lifeless fabric. More technical weft yarns with some lustre may help to elevate the appearance somewhat.

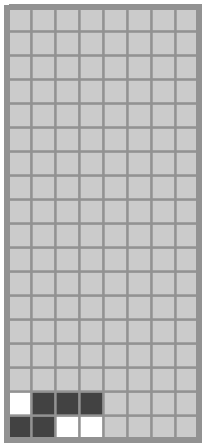
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

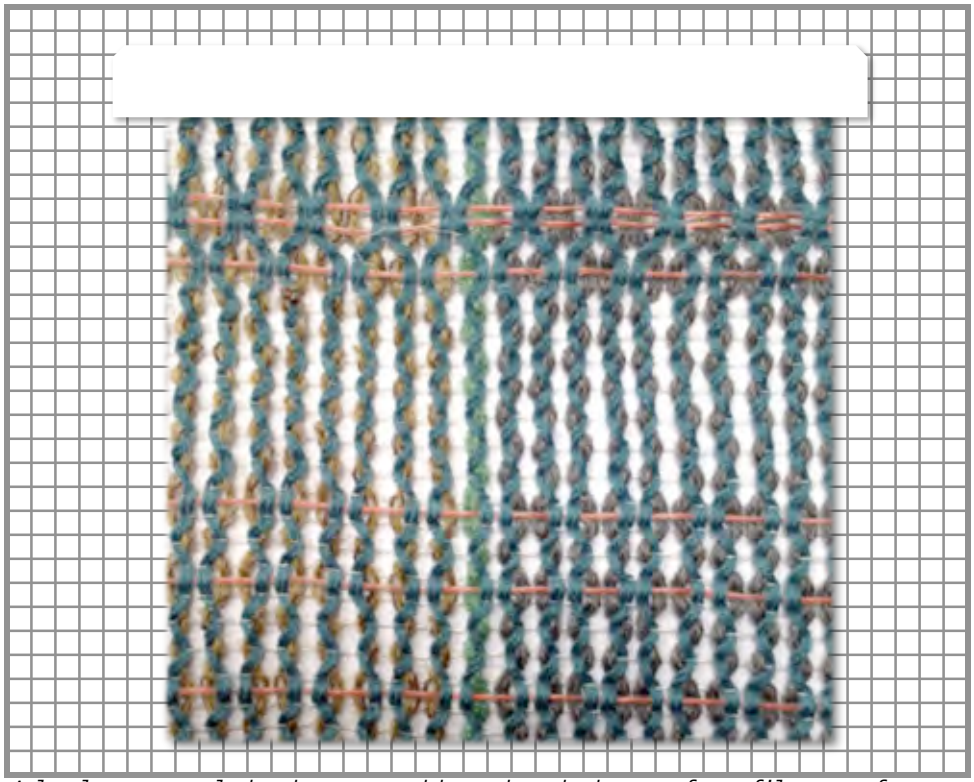
Peg Plan



Wefting plan

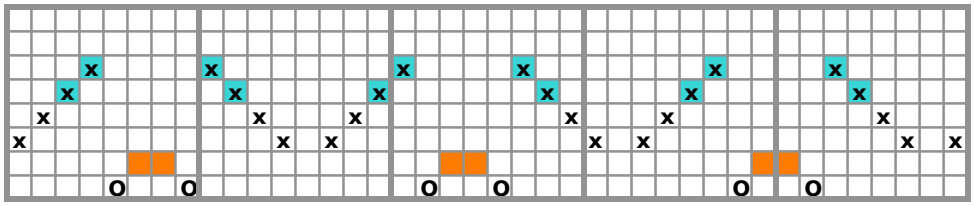
Bronze monofil	S	O	L	I	D		
Pink Rubco 2.5 nm	FE	AT	UR	E			

Fabric



A lovely open sample has been created here through the use of monofilament weft yarns interspersed with a Rubco coated yarn in pink. The use of a see through weft yarn has allowed me to see the twists of the warp threads in isolation and is an interesting sample from this point of view. The final fabric is very linear in nature and has little or no body due to the employment of the fine monofilament yarns.

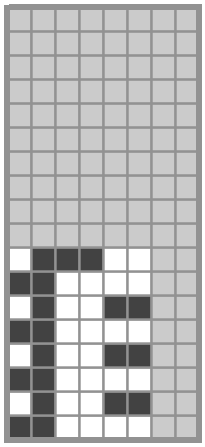
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

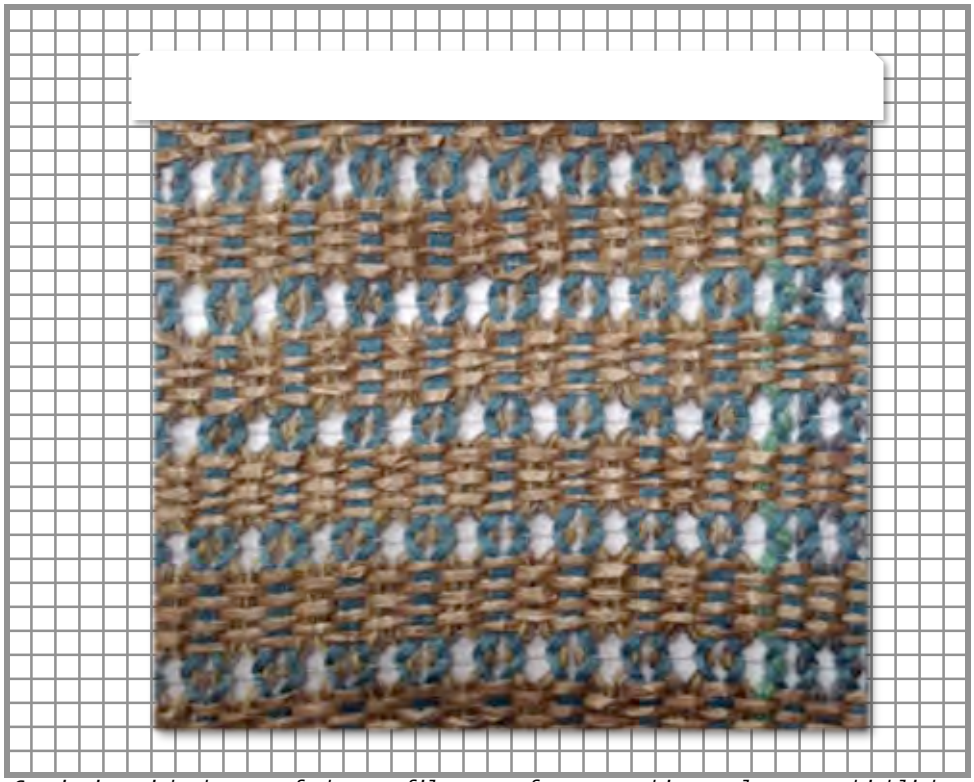
Peg Plan



Wefting plan

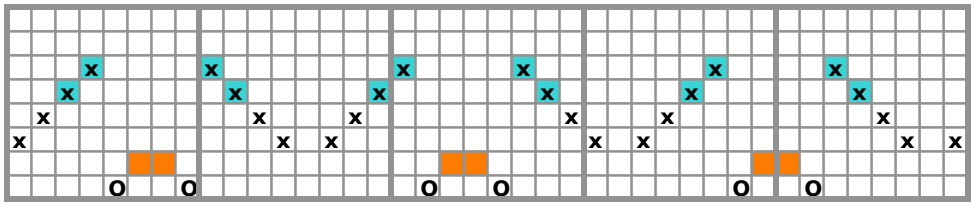
Bronze mono/Rafia	7						
Bronze monofil		1					

Fabric



Continuing with the use of the monofilament weft yarns, this sample uses a highlight of the monofilament in and amongst concentrated picks of the copper raffia yarn. This sample is rather reminiscent of the type of woven raffia and cane used in a lot of outdoor furniture and allows us to see a glimpse of the open leno crossings at the point that the monofilament crosses the warp.

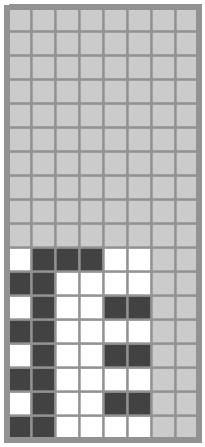
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

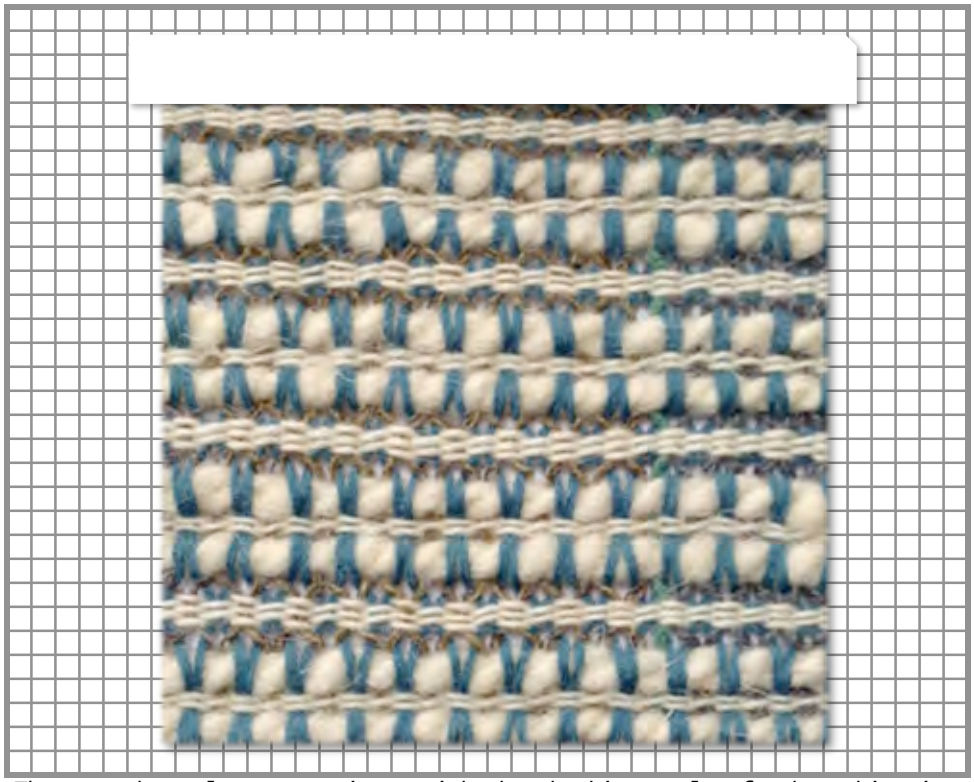
Peg Plan



Wefting plan

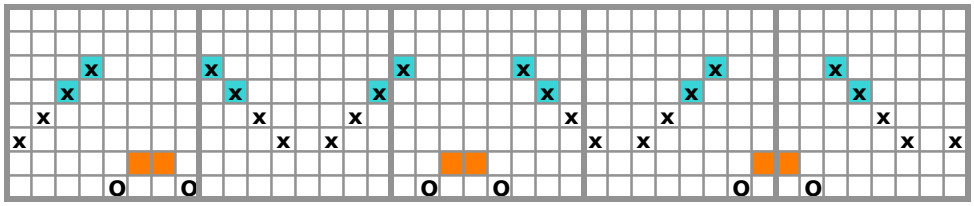
Thick Cream wool 2115 tex	1		1				
Thin Cream wool 17 YSW		3		5			

Fabric



The second sample to experiment with the chunkier wool weft, but this time used in combination with the singles cream wool. The angle of the leno crossings are clearly defined and altered by the count of the yarn that is put across the warp. Another attractive sample, but there is a need to move towards an aesthetic that matches the open transparency of the webs

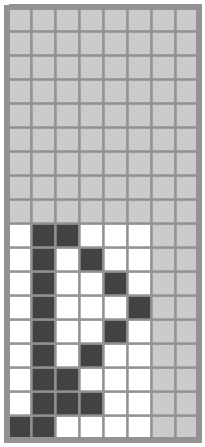
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

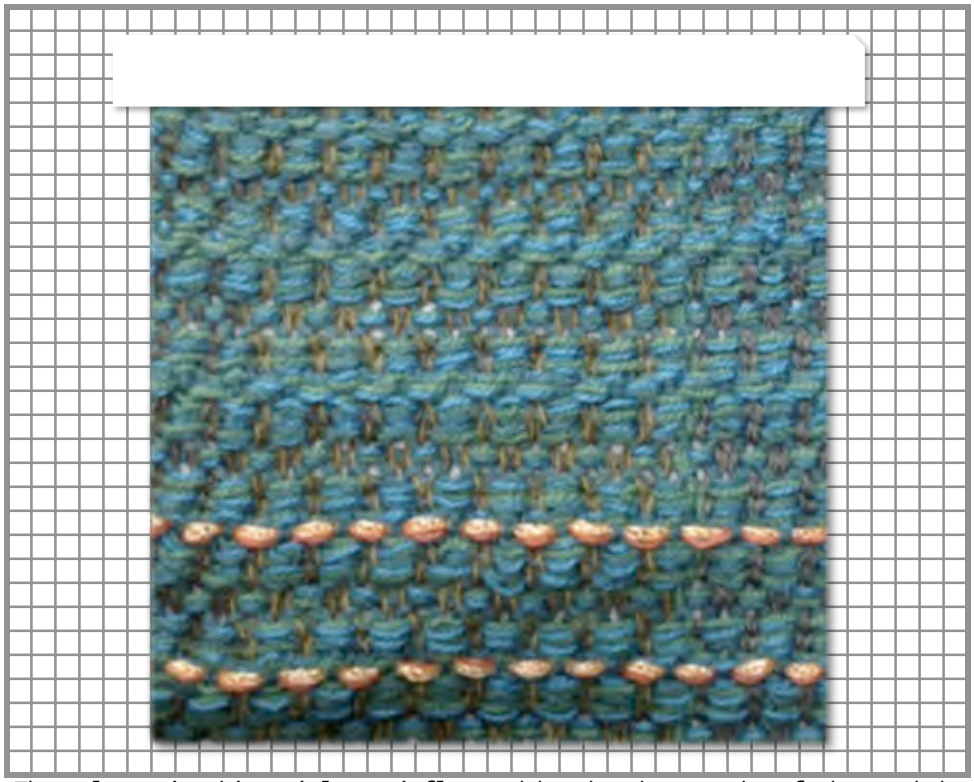
Peg Plan



Wefting plan

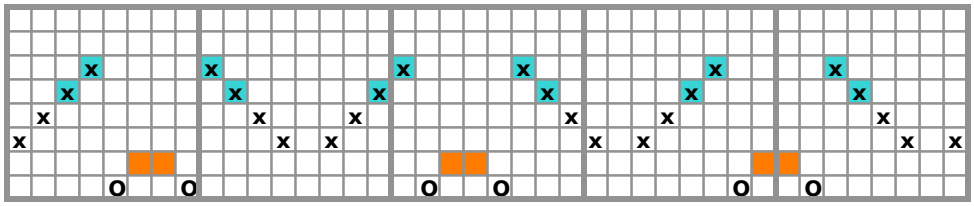
3 ply Green	S	O	L	I	D		
Orange Mix	A	C	C	E	N	T	

Fabric



The colours in this trial are influenced by the photographs of the mended fishing nets taken in Gairloch, with their synthetic turquoises and contrasting orange repairs. A colour combination that I am drawn to, but in this sample the predominance of the wool has resulted in a wooly rather than net-like design.

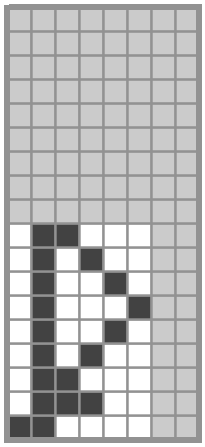
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

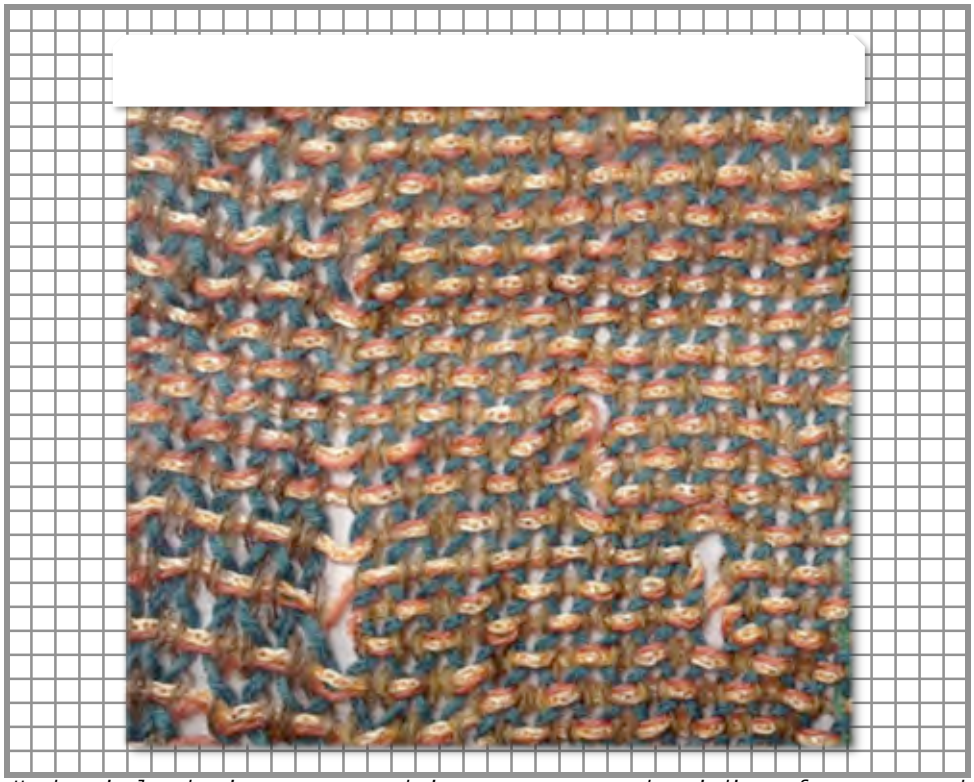
Peg Plan



Wefting plan

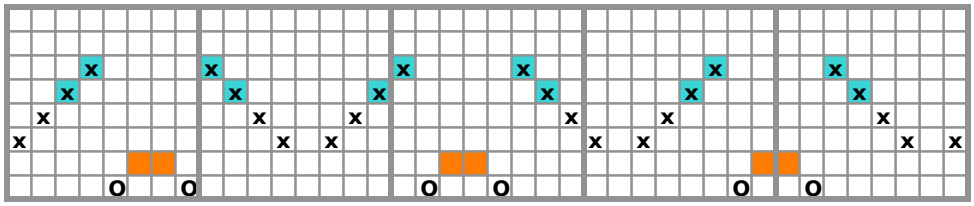
Orange Mix	S	O	L	I	D		

Fabric



Hand manipulated using tapestry techniques to create random winding weft patterns and natural holes where wefts don't quite cross over. This sample has a better appearance on loom where the hole remain open and therefore look more planned than in this photograph. The holes were further attempts to create an open look with weft yarns that ran at slight angles to the warp rather than perpendicular as in a standard cloth.

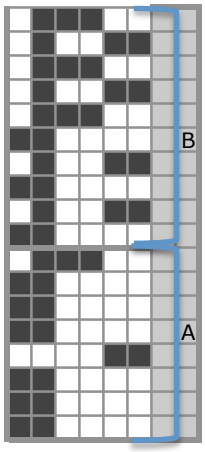
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

Peg Plan

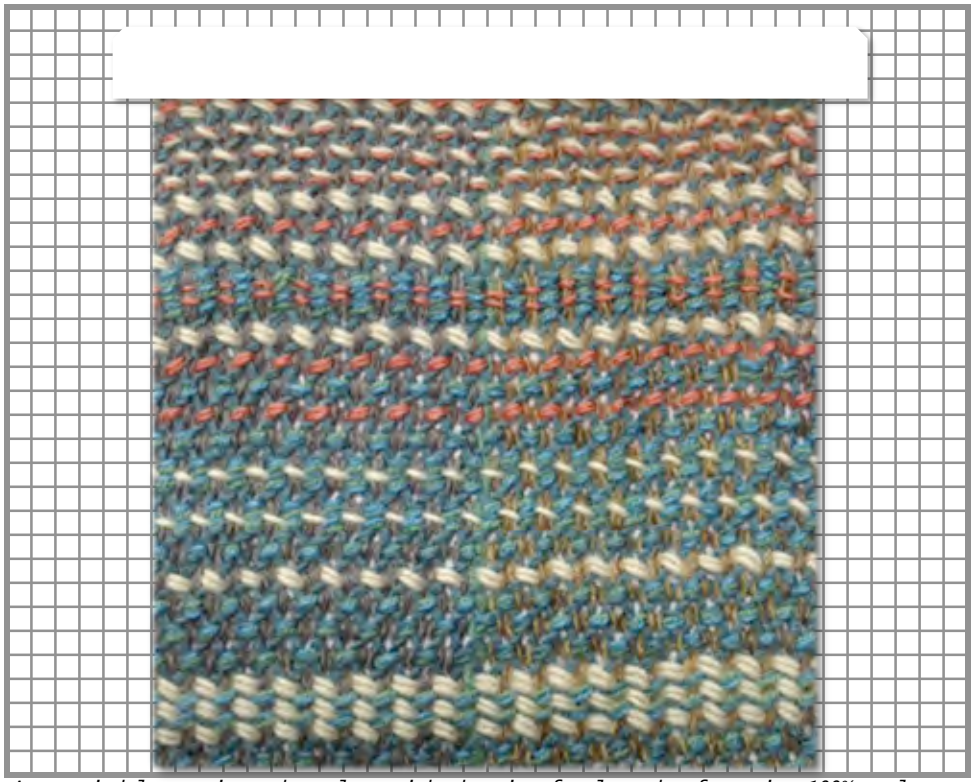


Wefting plan

Coral Wool 2/16 wstd	1		2	1			
Cream Wool 17 YSW	1	2		1	2		1
Turquoise/Green Wool						1	

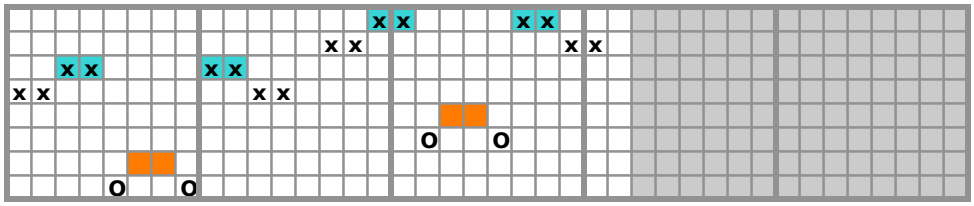
X 4 x 3 x 3

Fabric



A very indulgent piece that plays with the mix of coloured wefts using 100% wool throughout. One section of the weft order for this 50 cm piece is indicated above, which was created on the loom rather than trying to plan out the colour order. After a light washing/steaming this sample has created some fascinating angular weft patterns as the yarns have shrunk upon finishing and responded to the warp crossings.

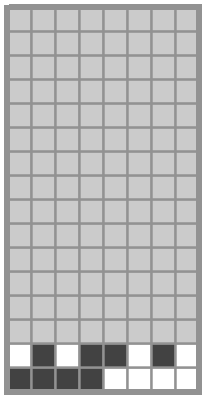
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

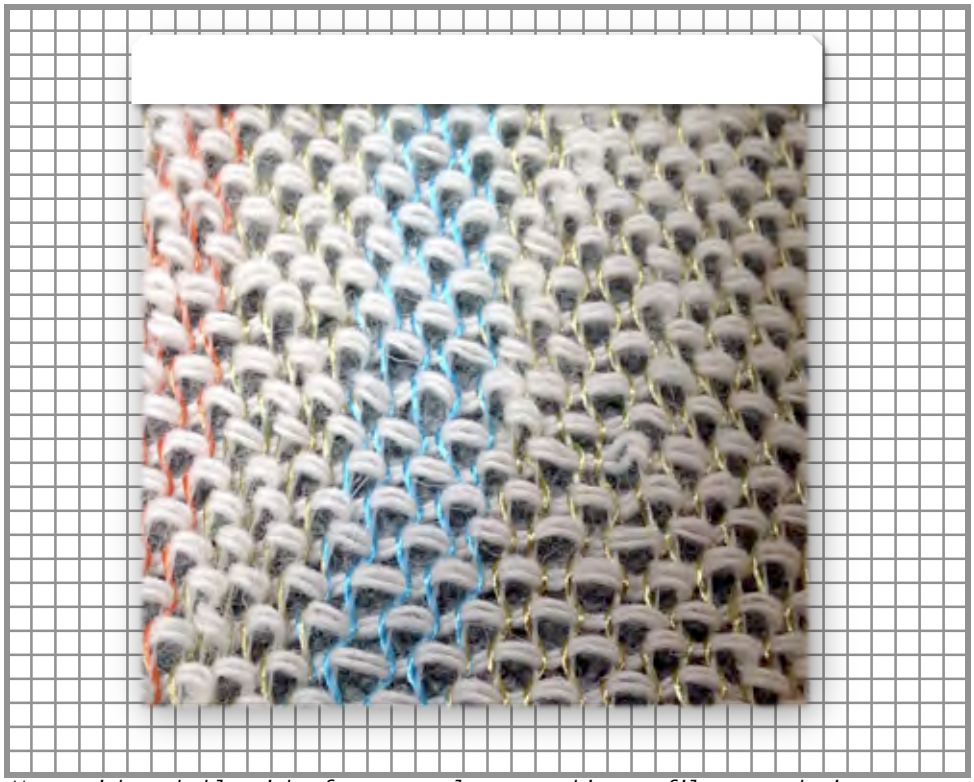
Peg Plan



Wefting plan

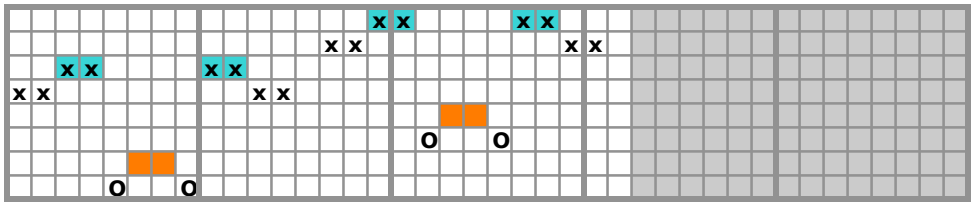
Cream Wool 17 YSW	2

Fabric



Woven with a double pick of cream wool across this monofilament and viscose warp, using a basic leno gauze structure. This sample was subsequently dipped into boiling water, to felt the yarn. The felting process although brief caused large movement in the warp and weft yarn. The warp yarns were pulled out of place as they were not held under any tension. Creates an interesting effect, not dissimilar to a knitted fabric in appearance.

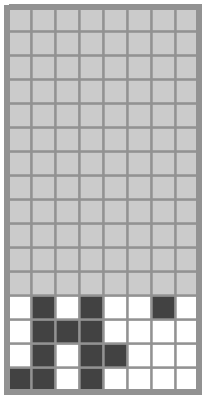
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

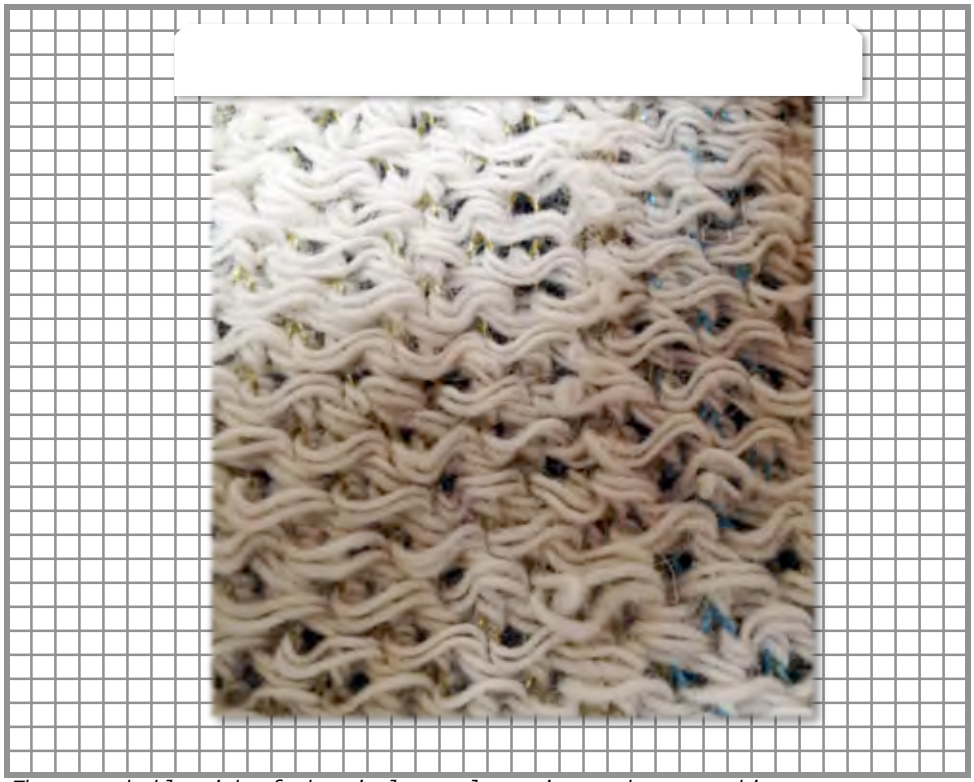
Peg Plan



Wefting plan

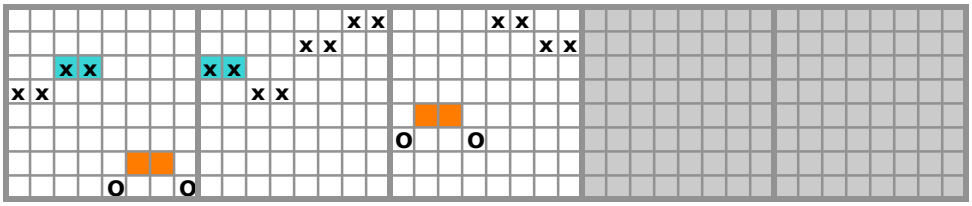
Cream Wool 17 YSW	1	
Cream Wool 17 YSW		1

Fabric



The same double pick of the singles wool was inserted across this gauze structure. In this case the yarn was able to deform even further on finishing with boiling water as the length of the floats in this structure are longer than in 3-1a. The lack of grip from the smooth warp yarns allow this yarn to curl and shrink into a very loose and again knitted fabric type of appearance.

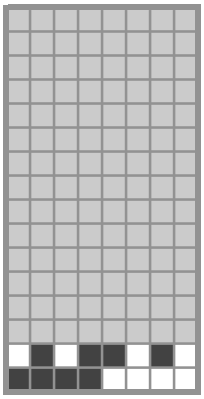
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

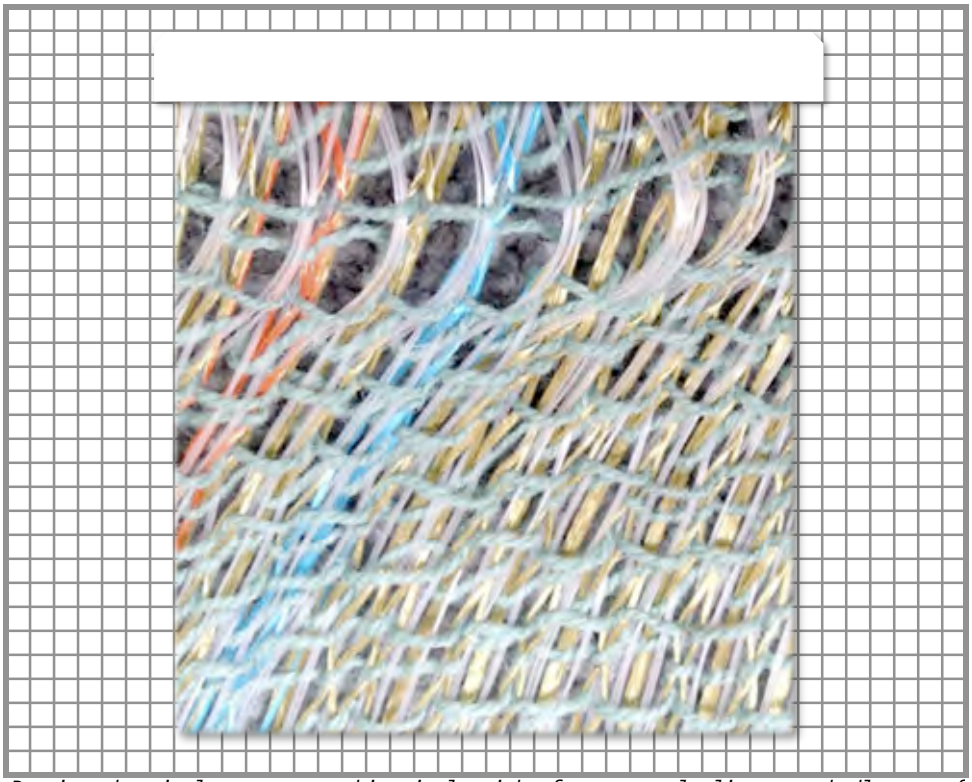
Peg Plan



Wefting plan

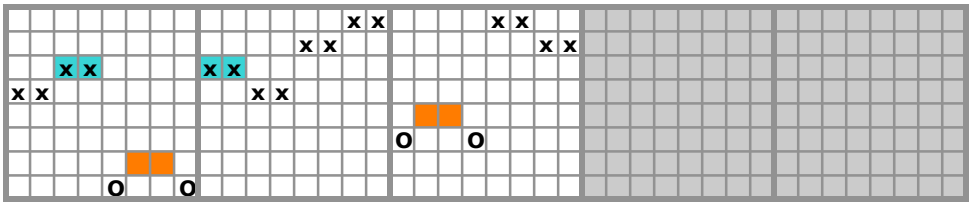
Green wool 2/12 wstd	S	O	L	I	D	

Fabric



Despite the simple structure this single pick of green wool slips very badly out of the grip of the warp yarns and the structure is all but lost. The inbalance of the strength of the warp yarns means that the whole sample twists into a shape dictated by the monofilament shape on the original cone of yarn. The sheen of the viscose/monofilament warp is the only attractive element of this sample, and the fishing net colours are evident.

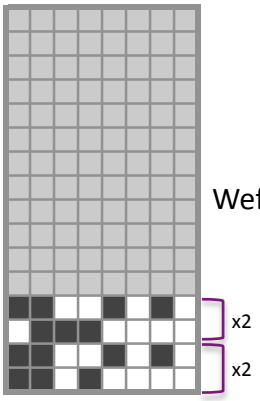
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

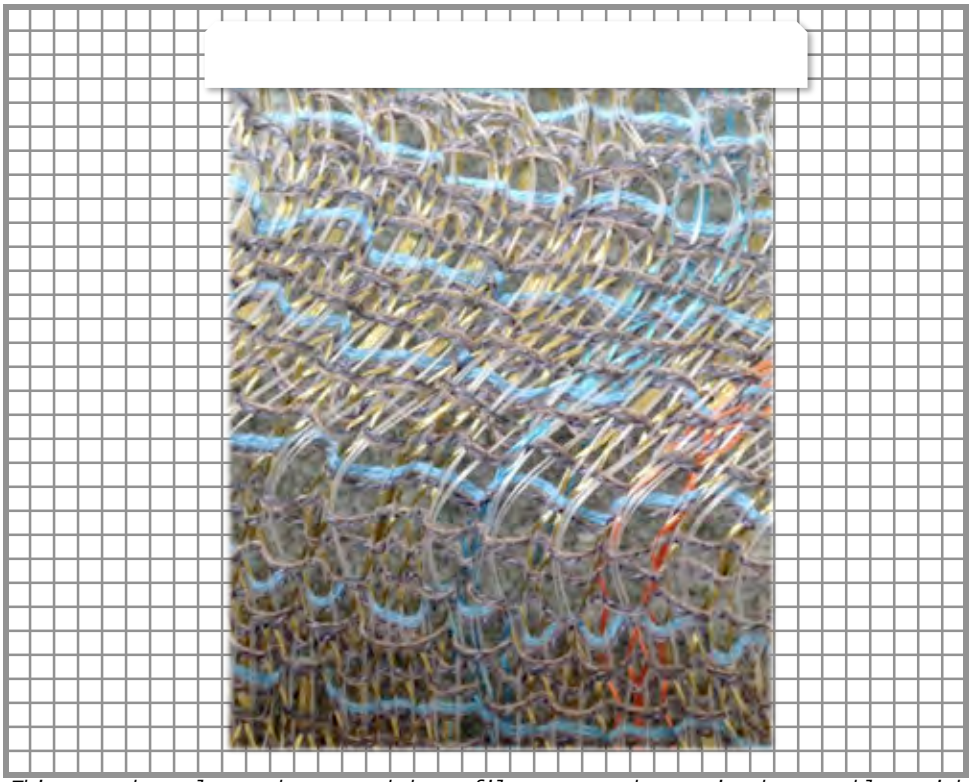
Peg Plan



Wefting plan

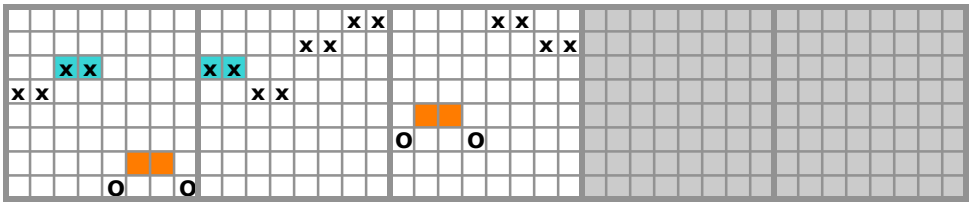
Doubled Blue/Brown	3					
Turquoise wool 70 tex		2				

Fabric



This second sample on the re-reeded monofilament warp has again shown problems with the stronger warp threads pulling the wool wefts out of alignment. The overall appearance is too random and entangled to truly represent the inspiration. The next stage could be to work with yarns that are equally matched the warp qualities in order to make a sucess of this lustrous warp.

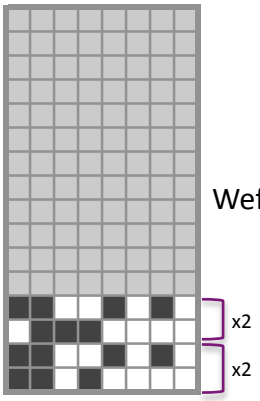
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

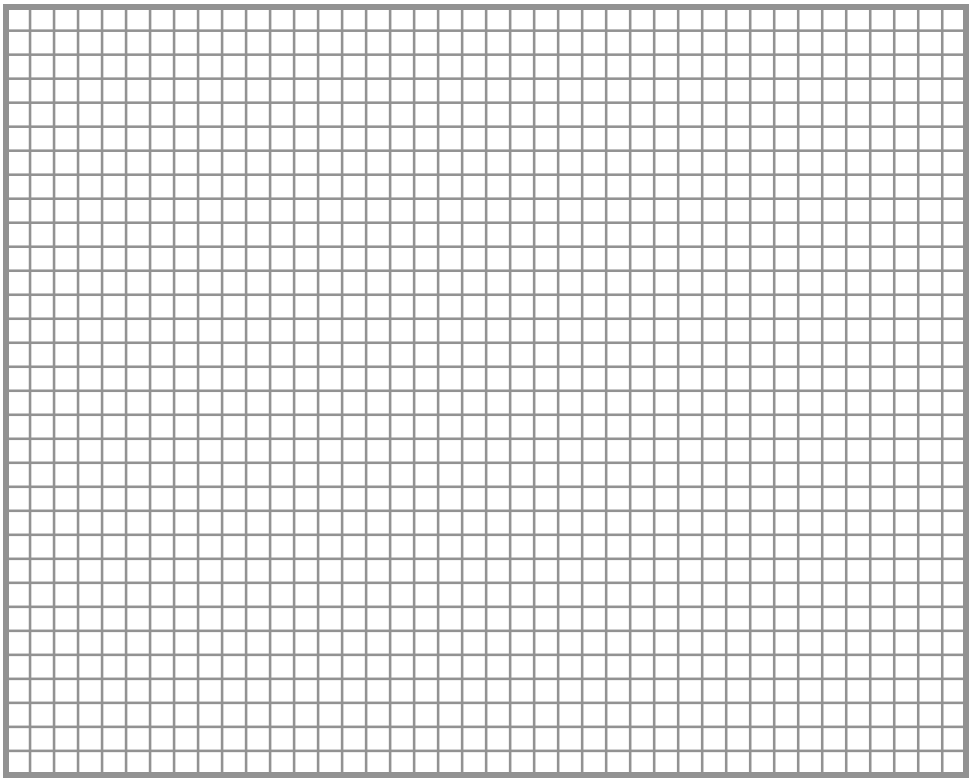
Peg Plan



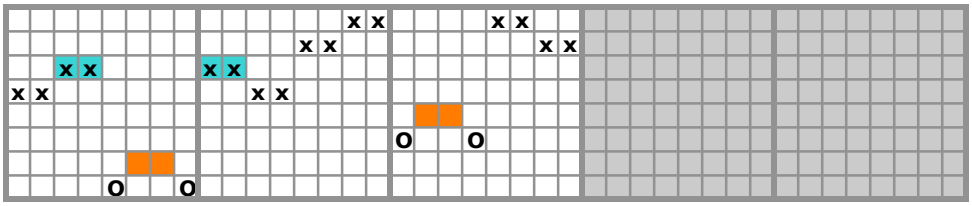
Wefting plan

Viscose 670 dtex		4		4		
Monofilament	2		4		2	

Fabric



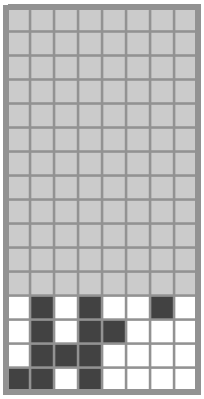
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

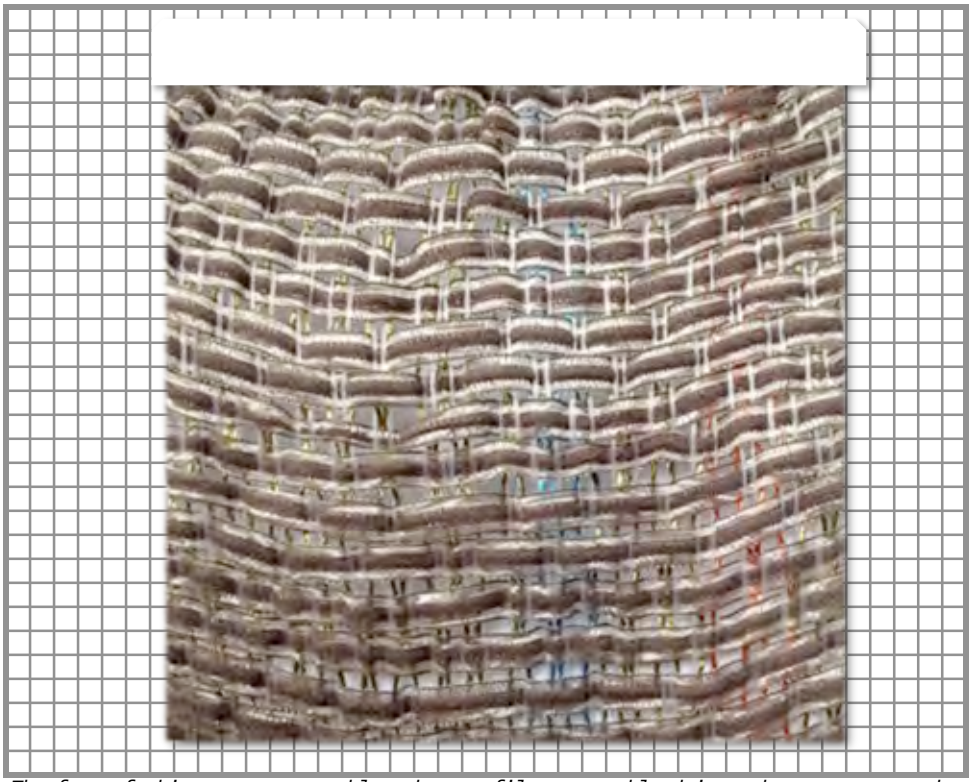
Peg Plan



Wefting plan

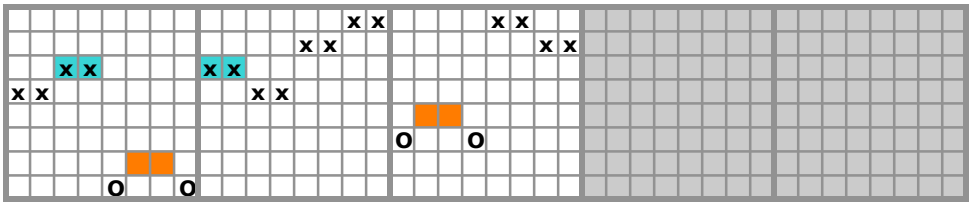
Tape yarn 430 tex	S	O	L	I	D	

Fabric



The face of this structure enables the monofilament to blend into the tape yarn and create a fairly uniform all-over appearance, where the viscose brighter coloured warp yarns are pushed to the back of the cloth. The width of the tape yarn hides the viscose on the whole but allows an occasional glimpse of the accent viscose shades. An attractive fabric, but the leno structure is not as prominent as desired.

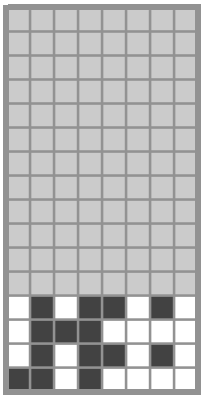
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

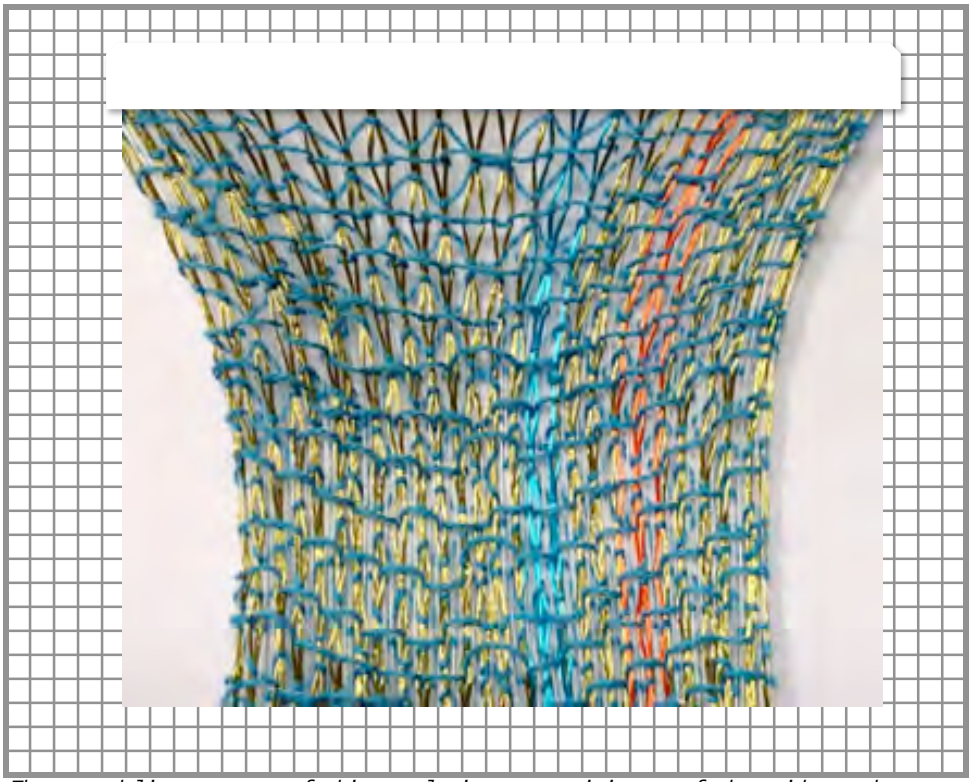
Peg Plan



Wefting plan

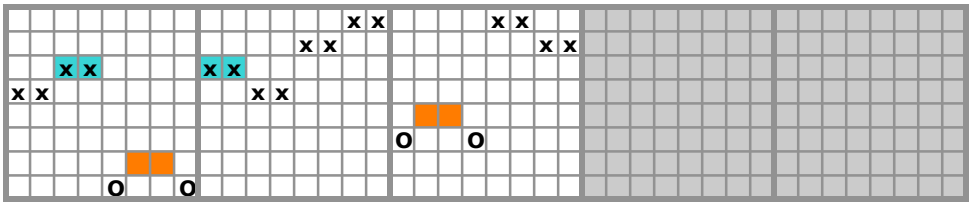
Turquoise wool 70 tex	S	O	L	I	D	

Fabric



The open delicate nature of this sample is very reminiscent of the spiders web inspiration with this tight fine yarn allowing the warp to shine through. As in previous samples with lighter weight yarns the warp is again very strong and is dictating the final structure when the sample is taken off the loom. Colour and appearance are attractive - so further trials along this line should be developed

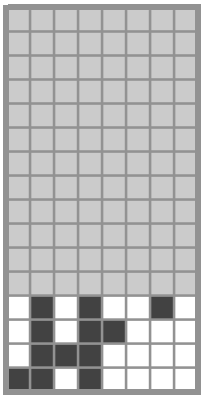
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

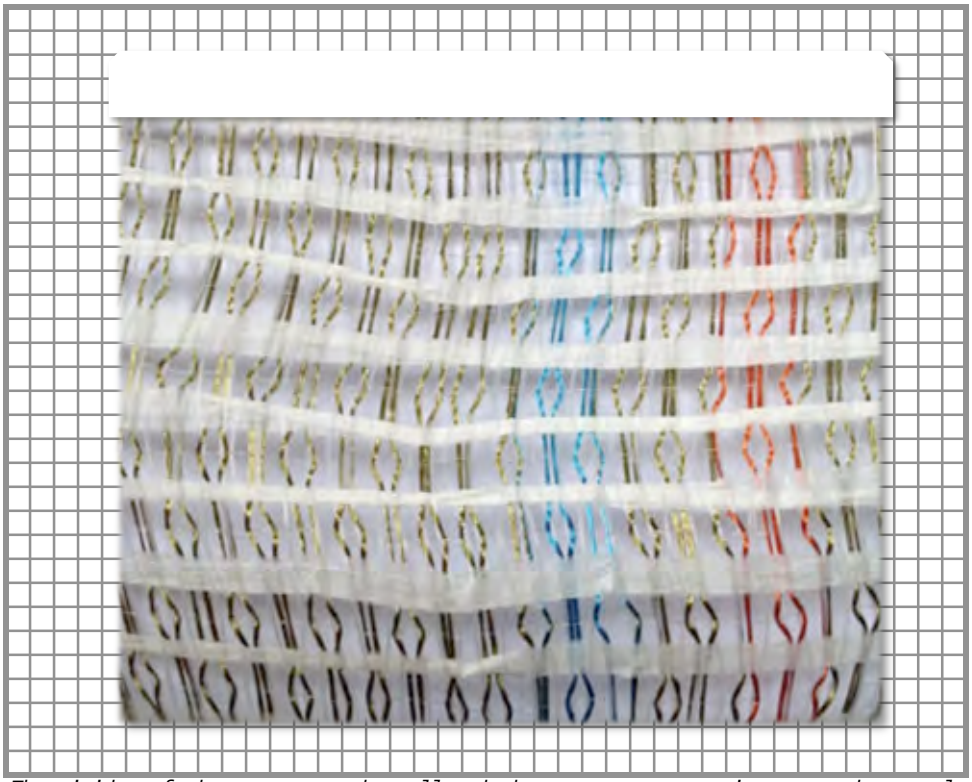
Peg Plan



Wefting plan

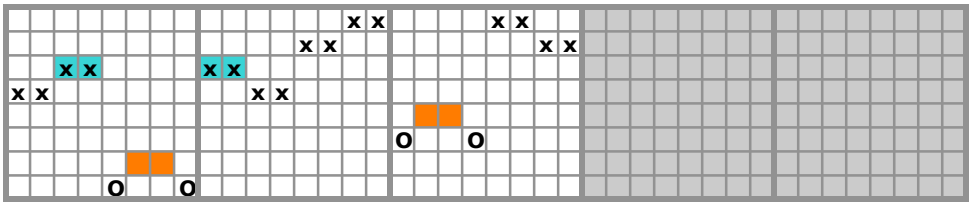
Paper Yarn	1					
Monofil		1				

Fabric



The rigidty of the paper yarn has allowed the struture to remain open and to truly reveal the weave structure employed in this leno sample. The combination of the paper yarn and the monofilament in the weft create the illusion of an open pattern with no apparent support. As much as this is interesting, the lack of flexibility creates a rather too flat and straight path for the weft to follow.

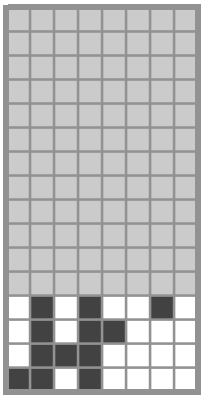
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

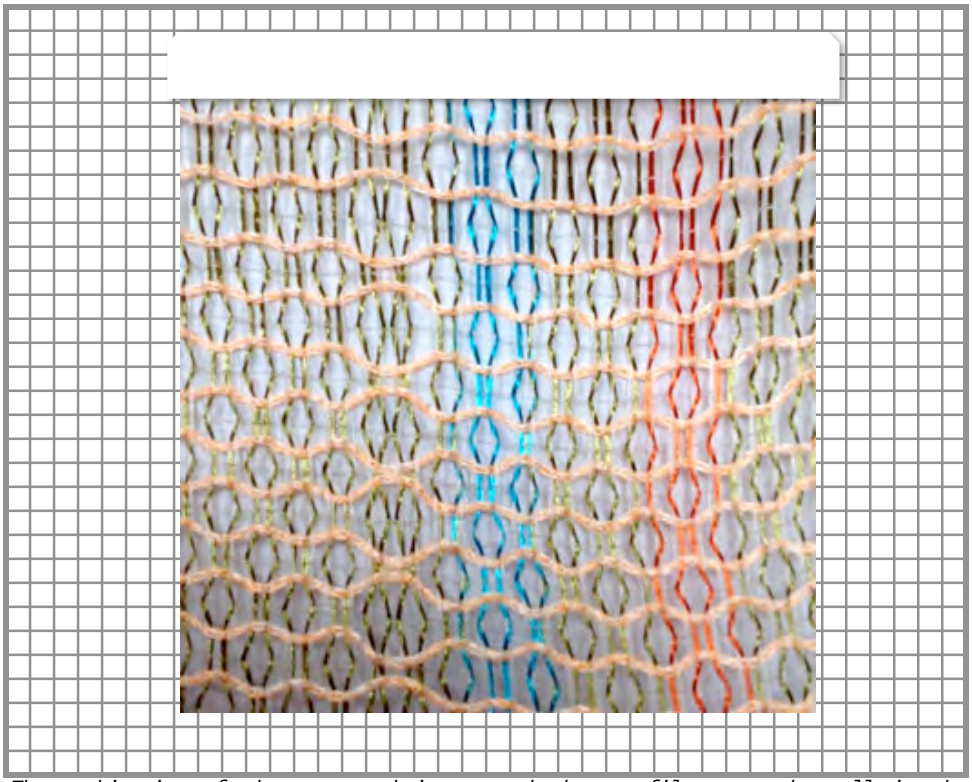
Peg Plan



Wefting plan

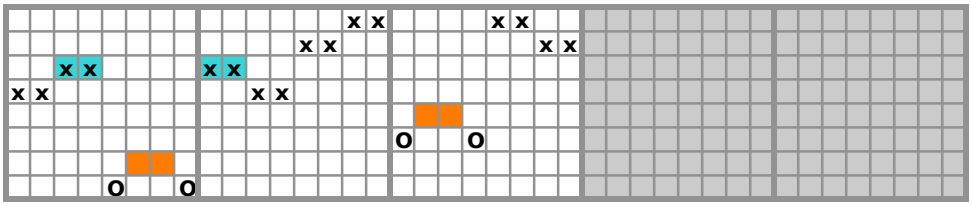
Orange Chainett 258 tex	1					
Monofil		1				

Fabric



The combination of the orange chainette and the monofilament works well in the attempt to represent the fishing net influence in this woven sample. The mix of the blue and orange naturally work in and are clearly visible in this open sample. As with the paper yarns the chainette helps to stiffen the structure and reveal the leno attributes.

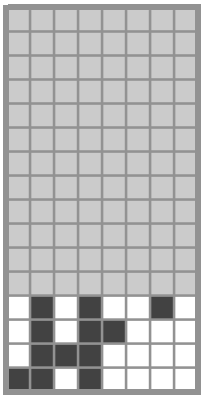
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

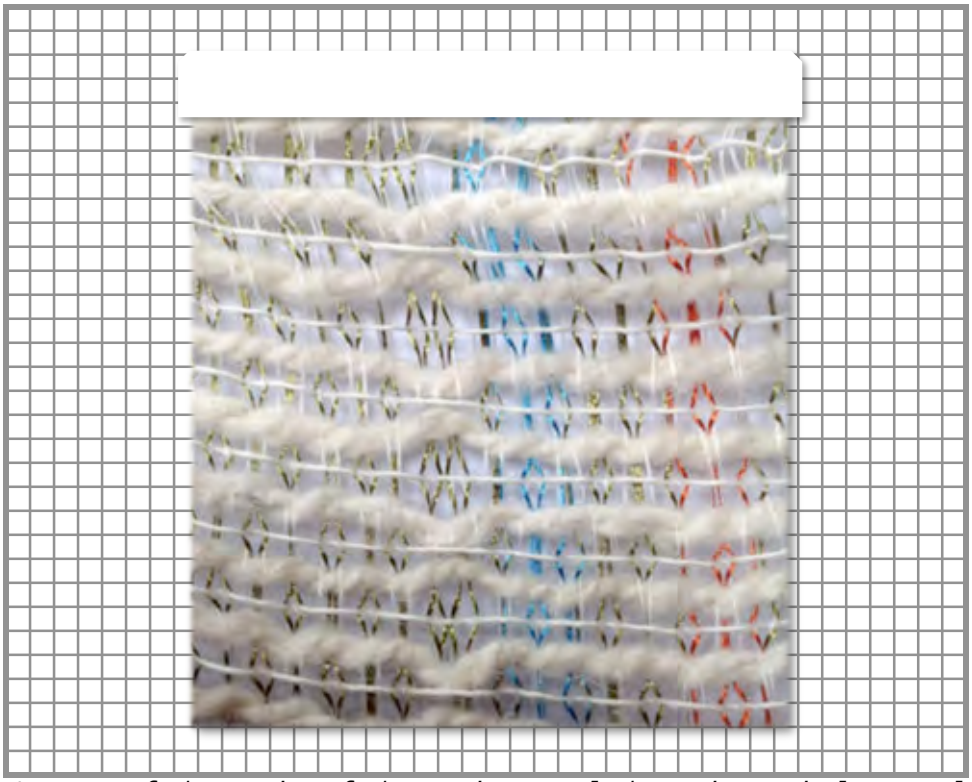
Peg Plan



Wefting plan

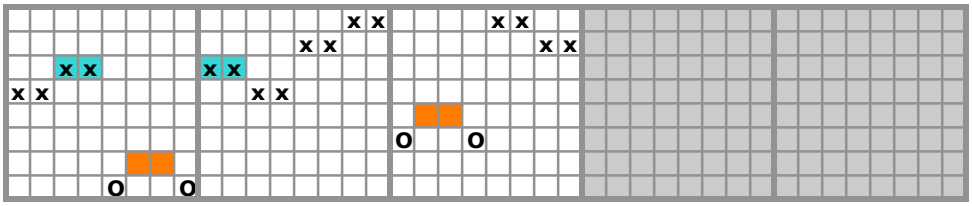
Thick cream wool 2115 tex	1					
Thin cream wool 10 YSW		1				

Fabric



A repeat of the weaving of the previous sample but using entirely natural (wool)yarns of extremely differing counts. The thickness of the heavier wool yarn, exagerates the length of the warp floats, but at the same time tends to dominate the whole look of this sample. This combination of thick and thin is moving too far from any of the original inspiration.

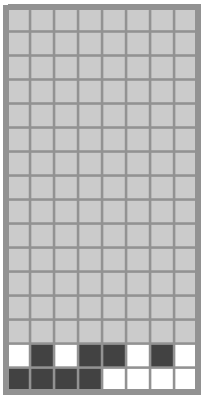
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

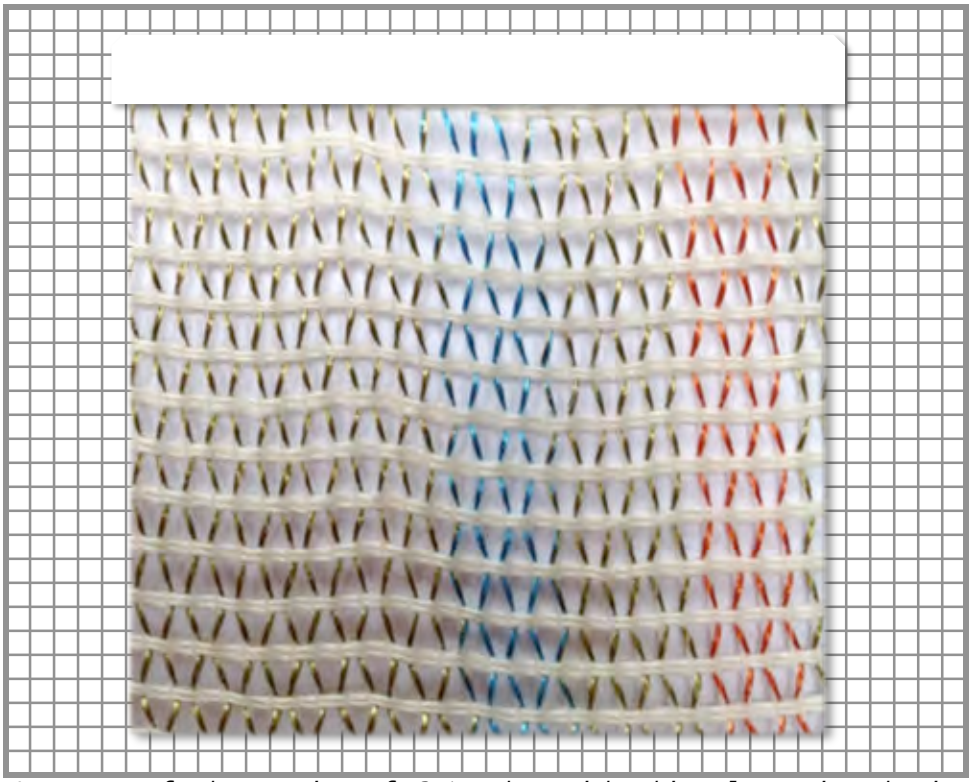
Peg Plan



Wefting plan

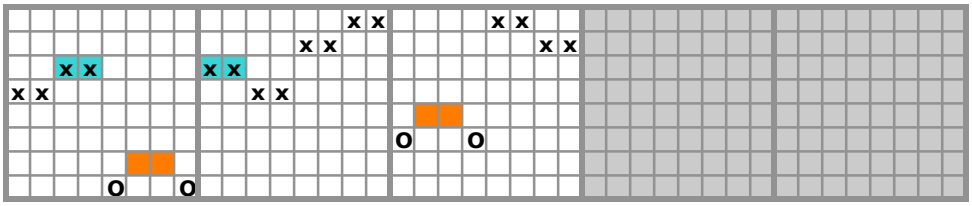
Cream wool 10 YSW	2					

Fabric



A repeat of the weaving of 3-1a, but with this alternative denting arrangement and no wet finishing carried out , the result is a more even and open attractive cloth. The structure can still be clearly seen and this is more reminiscent of the original inspiration. Colour and the fineness of the weave appearance could still be improved upon.

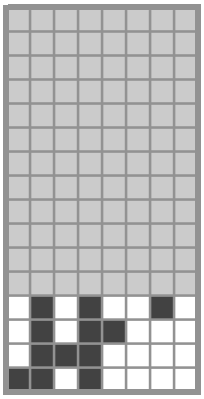
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

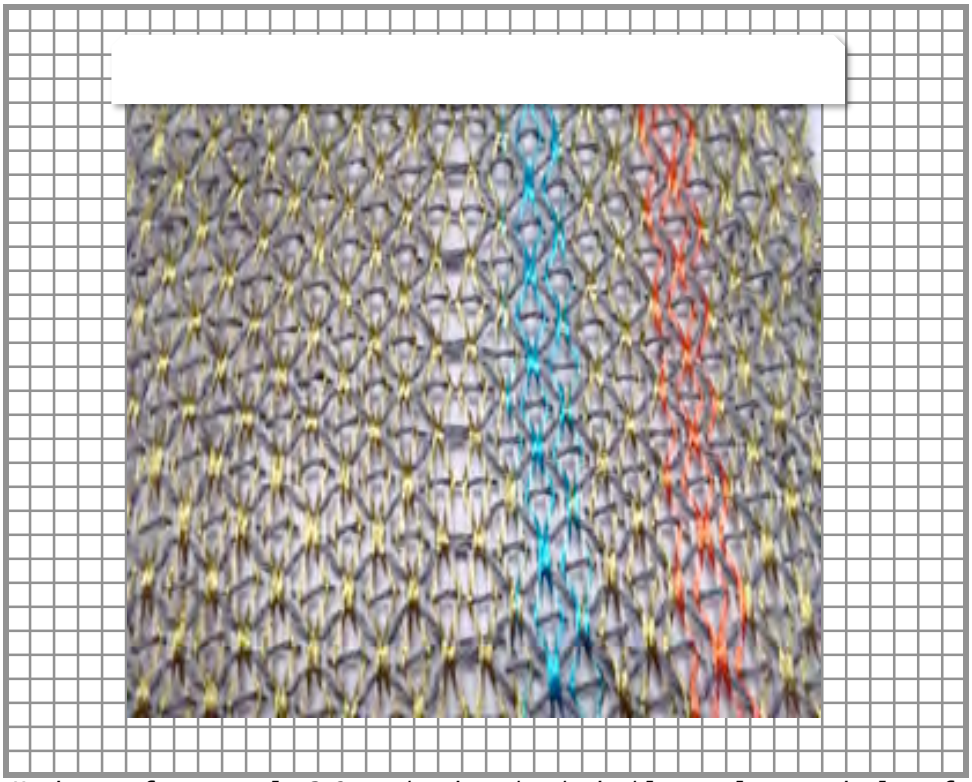
Peg Plan



Wefting plan

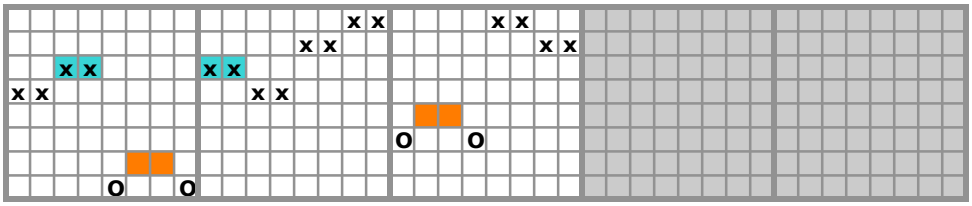
Denim Blue wool 2/12 wstd	1					

Fabric



Moving on from sample 3-2g and using the denim blue wool as a single weft pick. The resulting fabric has allowed the warp yarns to deform the weft into very effective open networks with extreme angles much as the spiders web inspiration. The accents in the warp sine through and this sample really demonstrates a great stability and yet maintains stretch

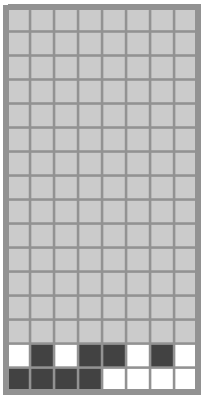
Draft



Denting

twisting ends x sleeper thread x doup tied on empty heddle O

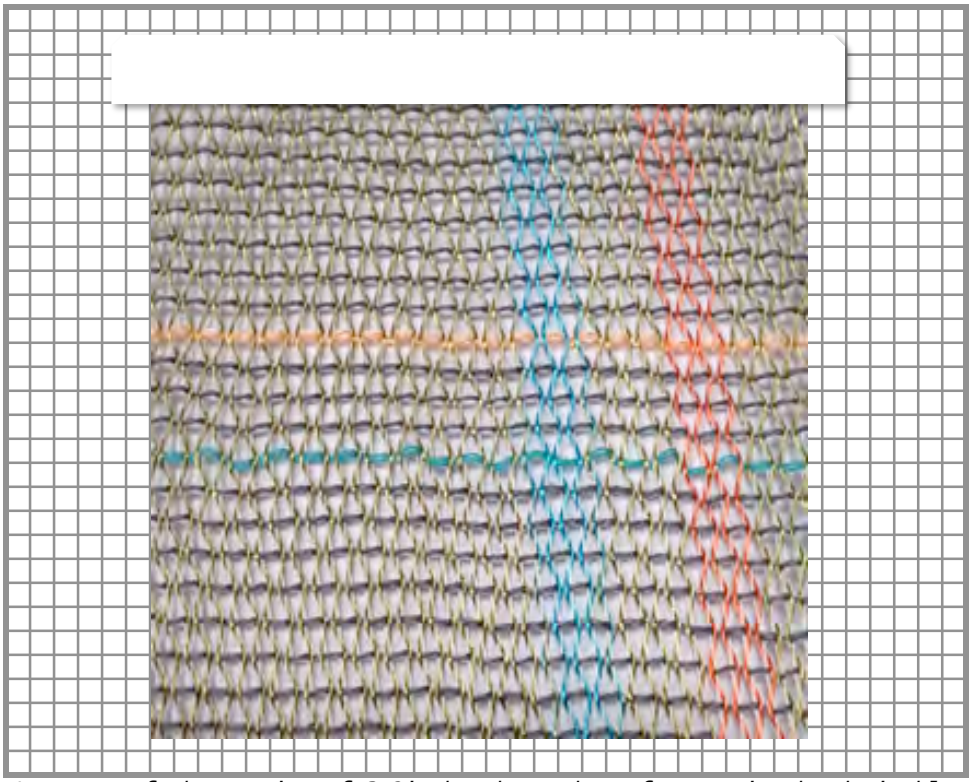
Peg Plan



Wefting plan

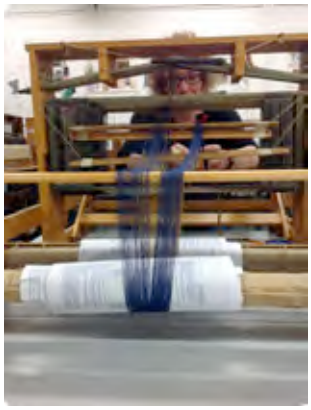
Denim Blue wool 2/12 wstd	1	

Fabric



A repeat of the weaving of 3-2i, but here the weft yarn is the denim blue with a couple of picks of accents in the chainette orange and the turquoise. The resulting cloth is very pleasing in both its colour and the open stable appearance which picks up on many of the early design cues which have influenced this work.

Appendix 3.



1. Warping up the loom

2. Doup ready to draw in twisting thread

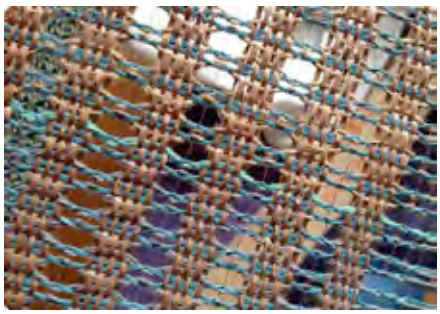
5. Doups lifting monofilament

3. Fixing monofilament onto cloth roller

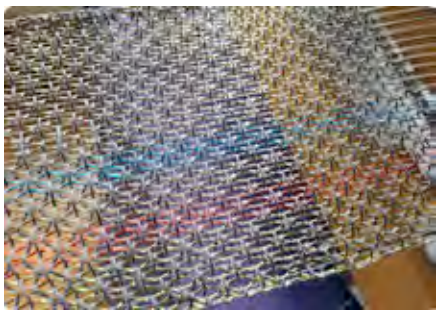
4. Warp ready to sley

6. Sample weaving in progress

7. temple set-up to retain width of sample



8. Raffia and monofil. sample in loom



9. Final sample 3-3k in loom

Appendix 4.

Sock on fence project May 2014
Barron, C. Moore, J. Price, A. Evans, J.