NEW ZEALAND'S NUYARN

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ORIGINALITY DECLARATION

New Zealand's Nuyarn

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ACKNOWLEDGEMENTS

Special Thanks To:

Fig 2

ABSTRACT

New Zealand's Nuyarn

The purpose of this research is to develop and refine new yarn and knit textile combinations using Nuyarn technology for a selected niche market. New Zealand's Nuyarn is an industry-connected project with Massey University and Levana Textiles. Levana Textiles is a woolen mill based in Levin with over 50 years industry experience. Through the exploration of trend forecasting, iterative design process, market research as well as finding a gap in the market, this result in unique New Zealand products that can demand a premium price.

Nuyarn technology is a new and innovative way of spinning yarn. The technology enhances the yarn performance by taking the twist out, and instead it lays the fibres along the same orientation as the rest of the yarn. Levana Textiles have purchased Nuyarn spinning technology. Through the use of this technology, Levana is producing and introducing innovative and newly improved products into the textile market. This technology is paramount in setting them apart from other textile mills as well as bringing a point of difference in the market.

There is a need to achieve smarter performance in blended yarns for circular knitwear apparel. The wool industry endured hard times in previous years due to the rise in demand for synthetic fibres in the 1960s. Wool is now re-emerging with companies focusing on new developments and innovation with the fibre.

As a result of intensive research and development, cutting-edge design process and contemporary insight into the industry have enabled Levana to lead the way in the development of new yarn combinations and improved yarn performance through the use of new spinning technology. Resulting in specialty blended yarn and circular knitted fabrics that provide opportunity to target niche markets, high profitability, and increased brand awareness for Levana Textiles.

CONTEXT

Wool Industry

The primary focus of this project is to advance the research and development of wool using Nuyarn technology, by creating new woolen blended yarns for specific markets. The new spinning technology purchased by Levana will add value to yarn and fabrics produced at their mill. It will highlight their products as modern and unique, resulting in higher profitability along with a stronger market brand saturation.

The wool industry has experienced a deterioration in demand in the past decades and now equates to less than two percent of export earnings in New Zealand. Wool was once thought of as New Zealand's most valuable export commodity stated by Wool Levy Group chairwoman Sandra Faulkner an expert in the wool industry (Faulkner, 2012). Competition from China's mass production of yarn and fabrics has made it difficult for New Zealand woolen mills to compete (Phillips, 2014), there are now only eight woolen knitting mills in New Zealand and only two are larger knitting mills (Tolerton, 2012).

A successful marketer and producer of woolen goods is, Peri Drysdale founder of Snowy Peaks Ltd, Drysdale states that unprocessed wool is being shipped out of New Zealand as a raw material. This results in little capital gain for farmers and wool companies (Callaghan 2009). New Zealand woolen mills cannot decrease costs to compete against growing global giants such as China's mass manufacturers. This has forced many New Zealand mills to close. Jim Phillips the yarn market editor for Textile World Magazine, encourages spinners not to supply the masses but instead suggests looking at the concept of supplying unique specialty products for market that have not yet been met. This is essential for spinners smaller in scale who are competing alongside global giants. Phillips goes on to say, "we have to be willing to develop products that nobody else will because of their relatively small volume. But, at the same time, such products can and do command a price premium. We have to change over a lot, but our margins remain good because we are doing what others either can't or won't" (Phillips, 2014, para. 6). Low wage economies overseas enable mass manufacturers to continue to supply the masses, according to Kate Fletcher who is prestigious for work with sustainable fashion and textiles. Fletcher explains mass manufacturing achieves the volume and product they create, through exploiting workers with providing low wages, forcing them to work excessive hours and overtime, lack of job security and denial of trade union rights. The creation of 26 million jobs worldwide and generation of wealth does in turn bring a financial gain, but at a social cost.

Fig 3

Fletcher advocates building awareness from a design perspective to help shape more sustainable product design as well as promoting social change. According to Fletcher "the goal is to show there is a wealth of different ways in which we can go about building a long lasting environmental and social quality through the design, production, and use of fashion and textiles that go beyond traditional ideas or expectations" (Fletcher, 2008, p. 12). Fletcher hopes to shape the future of fashion and textiles into an increased sustainable trade but with mass manufacturing competition, New Zealand mills are being forced to close down. They cannot compete with mass production abroad. While struggling to remain viable it is difficult for the New Zealand mills to invest in research and development. Levana is an exception since purchasing the innovative Nuyarn spinning technology.

Oamaru Summit woolen mill is an example of a New Zealand mill that felt the effects from mass manufacturers. Formed in 1881, they were New Zealand's largest independent spinner, supplying rug yarn and carpet for New Zealand and international markets. They announced the closure of the mill in 2013. Paul Watson of the National Distribution Union states, "The redundancies at Summit are indicative of the problems facing the manufacturing sector. We are constantly hearing from export firms who are struggling to compete and find markets in the current global economic downturn" (Business Day, 2012, para. 4).

Although there are still opportunities for woolen mills, Drysdale (2009) suggests there is opportunity to add value to New Zealand wool through application of design. New Zealand designers are advantageous in their thorough knowledge and use of the raw material, coupled with innovative design. This produces woolen products for export, resulting in higher value for export, an example of how Drysdale is dealing with global competition is the production of her knitted capes. Thirty-seven knitted capes have been produced, consisting of a blended combination of wool, possum and silk, with a trim of possum fur, specifically designed and marketed at the Chinese consumer who are purchasing high end woolen goods. This product shown in Fig 3 reinforces and highlights the value that blended yarns can bring to a product. Similarly to Phillips who is producing unique specialty products. Drysdale's knitted cape designs would be difficult for China to mimic due to its provenanceand unique blending of yarns. Drysdale suggests, "What I would really like to see coming out of New Zealand is very, very good design and brand developments that are distinctive and unique. That will be the best thing for the country. That will grow awareness of us as original thinkers and original designers" (as cited in Callaghan, 2009 , p.47).

Fig 4   Fig 5

Ismail Moffit, a partner in the Levana consortium and my principal mentor, can see opportunity for New Zealand mills, his opinion is that it is not necessary to try and compete with mass-producers but instead, New Zealand woolen companies should look to open up new markets such as sportswear markets with a focus on performance and luxury markets focusing on Nuyarn blending capabilities. China are focused on supplying the bulk of the world, which is why New Zealand woolen companies should look to luxury niche markets, this is where the opportunity lies, in finding a gap in the market.

Based on this evidence, the New Zealand wool industry will prosper from focusing on niche markets, trying to develop products that others can't or won't, as well as looking to add process innovation and design to raw wool for export. Innovation and point of difference in process and design will play a key role in the recognition for luxury New Zealand products. Icebreaker is a great example to validate this point. Ice breaker is a successful New Zealand merino apparel company which draws inspiration from New Zealand's landscape and nature. Their inspiration is evident in their choice of pattern design shown in Fig 4/5 - motifs in the pattern design show the outline of New Zealand repeated to appear like a camouflage print the second a design made up of New Zealand native ferns. The pattern designs create a unique feel to the clothing which is what Drysdale refers to when speaking about adding design that is unique to New Zealand.

Market

Identified is a gap in the market for blended yarn combinations using Nuyarn spinning technology. Viable yarn combinations would be fibre blends that appeal to a niche market such as luxury animal fibres. The technology of Nuyarn spinning machines will play an important role as they deliver yarn with enhanced performance properties. There is opportunity to discover exciting enhanced performance properties by blending different fibres together coupled with using the new and innovative Nuyarn spinning technology. This could potentially open up new areas within many markets that are looking for the latest technical advancements in textile performance.

Levana Textiles is focusing on niche markets interested in luxury fibre combinations for sportswear performance and high-end fashion. Levana view the niche markets as untouched by the global giants in the textile industry, and can see opportunity for a gap in the market. Currently Levana have tested the following fibre combinations with Nuyarn technology: cotton, Tencel ™, soy, merino wool, bamboo and bamboo cotton blends, Modal™, Viscose™, Dyneema™, and FR Lenzing™ [1]. There has been limited trials in new yarn combinations developed using Nuyarn spinning machinery, reasons include financial expenses, such as the cost involved in the development of small product runs. Levana outsource some of their yarn from overseas and there is always a minimum amount of fibre that is required when ordering. Another reason is running risk of damaging machinery through the testing process as well as finding technical staff for this type of research and development, as it can be time consuming. Client orders are prioritised over testing new yarn developments.

Woolmark is an industry leader in raising consumer awareness through their major marketing initiatives throughout the world. They have put forward three global marketing campaigns. The latest campaign launched in 2012 is the Woolmark Gold Campaign, this campaign targets the Chinese domestic market where merino wool is placed as a prestigious luxury textile. Woolmark Gold communicate that the campaign "was established to meet this increasing demand for premium products and fibres, and allows luxury consumers to know more about the story behind the merino wool product" (Woolmark, 2015, para. 2). Woolmark Gold aim in producing products even more luxurious than the already prestigious Woolmark-branded products. The first launch of branded Woolmark Gold products in China, this is to build a database of high-end apparel consumers (Woolmark, 2015). Woolmark have presented a case to date of a growing market for luxury fibres in the Chinese high-end fashion market. Similarly there is a growing market for blended luxury fibres, and with new innovative technology such as Nuyarn, this places Levana in a position of leading contemporary textile design.

[1] See glossary for definition of terms.

A market for high performance is present, this is because Nuyarn spinning technology gives knitted fabrics enhanced performance properties. This innovation is what is needed for athletes involved in high performance sports where the performance of clothing is crucial.

A market point of difference as well as a great source of market trends is the influential trend forecasting magazine, Textile View. Textile View provides predictions of future trends for the subsequent four years. It showcases a variety of predictions including colour trends, yarn trends, knitwear trends, materials, reports on consumer behaviour, fashion and design. Textile View Magazine states that reconnecting with nature is smart and companies are starting to take this on board. It "Involves celebrating nature and striving to regain contact with it by learning wise lessons. Nature is not only a holistic system; it also resolves its own problems, evolves with time and creates its own innovations. Human beings are also part of this ecosystem, but we do not behave accordingly. Fortunately designers and (some) industries are increasingly listening to the voice of nature" (Textile View Magazine, 2012, p. 258). The story Textile View shares brings to light the special properties and integrity that the merino fibre possesses. Merino wool is a beautiful natural material with strong integrity that humans can connect with. Merino has a fantastic story to tell, the trend prediction from Textile View Magazine of humans reconnecting with nature links to merino fibre as it is natural. Playing on the concept of merino's innate natural qualities could play a role in the marketing of merino.

The development of specialty yarn and fabric sampling can put Levana in a position of presenting innovation and luxury fabrics on a global scale. Levana need the physical sampling to show potential customers how the fabric performs and feels in the hand, this is where some time needs to be taken for development and trials. There needs to be trend forecasting to decipher the trend for yarn blends and fabrics. Once the trend forecasting has taken place, the yarn and fabric needs to be developed to show clients for the forecasted season. Haptic response through physical sampling allows one to respond to the tangible as opposed to vocal presentation or "the idea". Ultimately providing a sensory experience for clients, to impact sales.

Comparably, Woolyarns New Zealand, a Wellington based yarn company is producing blends of yarn. The blending of different yarns is proving to be very popular. Woolyarns have been innovating to produce a fibre blend called Perino, a blend of possum fur combined with cashmere. Perino is attracting attention as it has proven to be a warmer, lighter and cheaper alternative to pure cashmere as well as having excellent heat retaining qualities. Woolyarns are looking to target some of the biggest international buyers and designers with Perino (Woolyarns, 2015). In contrast Levana have knitting machines whereas Woolyarns do not, they only sell the yarn. This could lead to some interesting future collaborations between the two companies if Woolyarns were looking to have their Perino yarn knitted in New Zealand.

In summary it is clear that Levana Textiles are heading in a promising direction with the help of innovative Nuyarn spinning machines. Nuyarn spinning machines offer a point of difference in the market and will prove to make Nuyarn knitted fabrics stand out in luxury markets. Nuyarn spinning machines prove that they will be able to target luxury markets with its exception blending qualities and improved performance. Blending fibres with Nuyarn spinning machines allows for various luxury fibres to be spun together in one yarn, a quality that will appeal to luxury markets searching for something new and innovative. Hence the development of blending luxurious fibers of alpaca and merino.

Fig 6

Nuyarn Spinning Technology

There are a variety of different spinning machines in the worsted industry throughout the world - the reason being that there are various worsted yarns produced. These yarns differ in terms of yarn count, raw material, twist, appearance and features required for knitting and weaving. These differences in the yarn are the main factor that there is not a single system or machine to meet all of the specifications. There are three spinning machines in particular that are commonly used in the worsted industry. These are, Ring, Flyer and Cap. All of these spinning machines use a roller drafting method, but the way in which the methods of winding and twisting the yarn differ.

What sets the Nuyarn spinning frame apart from other types of spinning machines is the method of winding and twisting the yarn. The driving innovation and market for Nuyarn technology is that the machinery blends fibres exceptionally. Nuyarn provides opportunity to create luxury blended fibre combinations. Nuyarn spinning technology maximizes wools natural performance properties; the lightweight merino wool breaks records in standard testing for strength, drying time, durability, resistance to abrasion and eliminates problems with seam slippage. Nuyarn creates fabrics that are comfortable, they have enhanced stretch, great thermal properties, and improved strength (Nuyarn, 2014).

Yarn spinning company Yarn In Motion (YIM), a division of the German Sudwolle Group, is an association committed to sustainable production, displaying environmental leadership in the fashion and textile industry. YIM focus on developing traditional fibre of merino with state of the art technologies in yarn spinning, as well as high tech circular knitwear systems. The end product is targeted for fashion fabrics, outdoor fabrics and elite sportswear. Yarn In Motion are forward thinking, driven by leading edge innovation and supreme quality while having a strong focus on sustainable improvement and social responsibility (YIM, 2015).

Levana have bought state of the art spinning technology Nuyarn which is also forward thinking and innovative, but in comparison Levana Textiles values towards sustainability are not are strong as YIM. With further sustainable development Levana Textiles could follow in the same footsteps as YIM, but in order to do so Levana Textiles would need to take a more sustainable direction within the company. This would involve supporting further experimentation to achieve sustainable yarn and fabric. There is opportunity for Levana to pursue a similar direction as YIM although it would involve applying practice that follows social responsibility and an environmentally sustainable approach.

ALPACA FIBRE PROPERTIES

- fine + soft () (less prickle factor than most animal fibres)
- micron 13-30+
- does not shrink when washed
- luxurious
- beautiful lustre
- processes well on worsted and woolen processing systems
- does not pill easily
- range of natural colours
- blends well with other animal fibres
- machine washable
- 30% warmer than the equivalent weight of merino wool
- odour resistant
- lightweight
- insulating properties
- no lanolin, greaseor oil and does not smell
- strong and durable (four times more abrasion resistant then the same fibre weight of merino)
- hypoallergenic
- wicking properties
- thermal properties
- can resist solar radiation
- water resistant

Fig 7

Alpaca Fibre

The potential for an alpaca and merino blended yarn in apparel industry is expansive for manufacturers, spinners, knitters and weavers. The properties of the alpaca fibre show its practicality for outdoor thermal gear, hats, underwear, gloves, scarves, fashion garments and socks. I believe that the qualities of the alpaca fibre will surely captivate the conscious consumer and establish a prosperous future for New Zealand's alpaca industry as well as the New Zealand wool industry if the fibre is blended. A benefit of blending the fibre is that it significantly reduces the cost of the finished yarn, without blending alpaca fibre the price significantly increses.

Alpaca fibre is an animal protein fibre from the fleece of alpaca. Alpaca fleece is a special fibre shown through the properties in Fig 7, these qualities make alpaca a luxury fibre.

Komafram based in Chicago is currently exploring the alpaca market through production of various blends of the fibre. Komafram have produced an alpaca and Tencel™ blended yarn used to produce garments such as thermal base layers and socks. Komafram have blended these two fibres for their high performance properties. The composition of the alpaca fibre is auspicious with a semi-hollow core enabling it to be extremely lightweight, providing high sought after properties of moisture wicking and natural heat regulation.

The finished fabric obtains a luxurious soft handle, has both hypoallergenic and odour free properties. The fibre Tencel™ has skin-friendly attributes, soft handle and an ecological production that is closed-loop, the closed looped production makes the fibre a more sustainable product (Roadie 2013).

Komafram were looking at synthetic fibres for high performance clothing, they discovered synthetics were lightweight compared to merino wool but the downside was that synthetic fabrics do not have the same handle. Whilst searching for an alternative they found alpaca fibre. Research shows that merino fibre needs to have a fine micron count to display a soft handle equivalent to a higher micron of alpaca fibre. Although alpaca yarn tends to be bulkier than other wool yarn of comparable weight Komafram saw potential to blend alpaca with Tencel™, resulting in a lighter textile (Roadie 2013). This has created a new and exciting blend for high performance clothing. The development of Komafram's alpaca and Tencel™ fabric validates a new market for the alpaca fibre to be blended and sold as a luxury high performance sportswear garments.

Currently information relating to the composition of alpaca fibre is limited one accessible source states that, alpaca fibre has a longer staple length, is more heavily medullated, and considerably stronger when compared to sheep wool. Alpaca fibre has lower levels of crimp, resulting in lighter, smoother fabric and yarn and blends well with other fibres according to (McColl, A, McColl, Y, Lupton & Stobart, 2004). These attributes are required for worsted constructions. This confirms alpaca fibre shows promising attributes as a blended yarn.

Silverstream Alpacas is a New Zealand South Island Alpaca Stud. Their view on the Alpaca industry in New Zealand is that the industry is in a progressive stage at this point in time. Currently there is approximately only 10,000 alpacas providing 22 various fleece colours in New Zealand. This will limit the speed at which the commercial alpaca fibre industry will grow, lengthening the fully-fledged establishment of this industry. The demand for fine, quality, clean alpaca fibre is not attainable due to limited supply available currently in New Zealand. When there is demand for alpaca wool it needs to be outsourced from other countries (Silverstream Alpaca Stud, 2013). I believe that if alpaca farmers worked together they may be able to make developments in selling their fibre to New Zealand companies, as the amount will be larger and more sustainable. A following option could be for the alpaca farmer and the textile mill to make an arrangement where the textile mill could promise to order X amount of fibre if the farmer bought X amount of alpaca. This would create a mutually beneficial relationship between both parties and increase production of quality New Zealand products.

BRIEF
INNOVATION
VIABILITY

INDUSTRY
CENTERED
DESIGN

LEVANA
TEXTILES

MASSEY
UNIVERSTIY

CALLAGHAN
INNOVATION

CRITICAL
SELF INITIATIVE
SELF EXPRESSIVE

MYSELF

FEASIBILITY
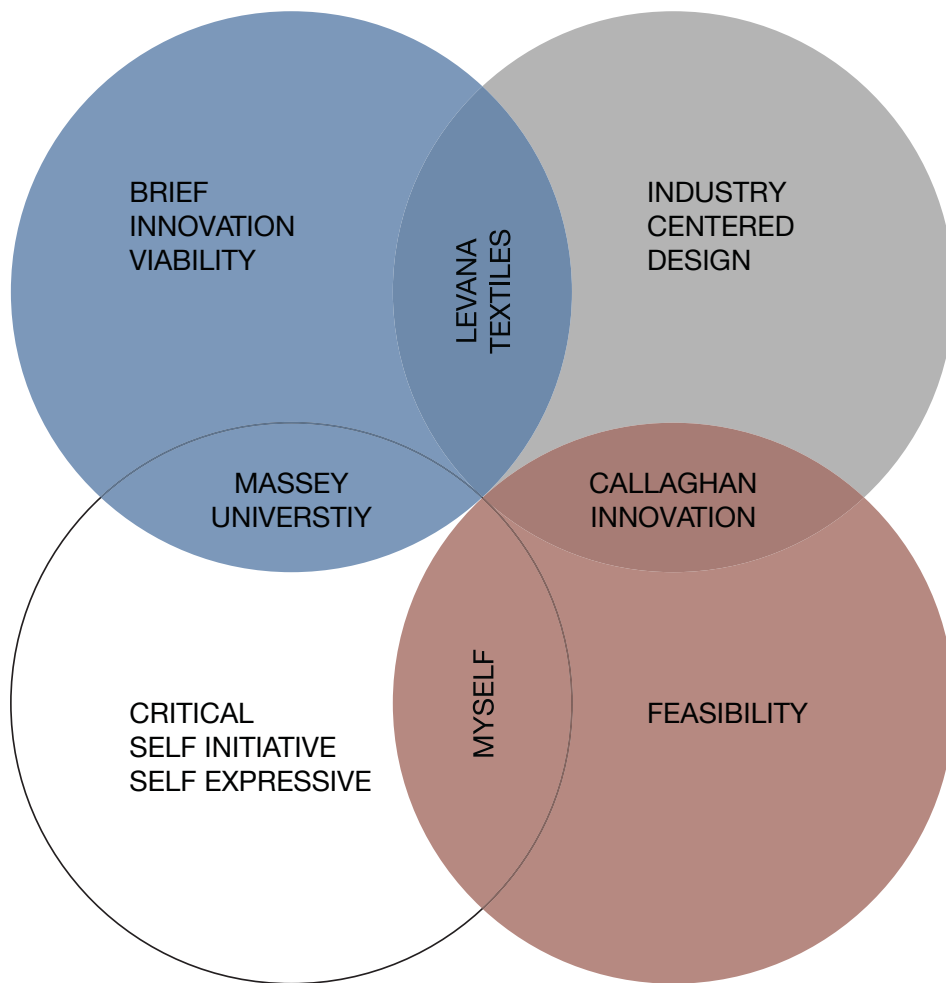
Fig 8

Design Process

Fig 8 indicates the relationship between Massey University and Levana Textiles. It is important to note that this research and development requires different outcomes and expectations from each party involved. Fig 8 helped to develop a clear process.

TESTING
FEASIBILITY
SPECIFICS
DESIGN
DEVELOPMENT

QUALITATIVE
RESEARCH

TESTING
DESIGN
ANALYSIS
DEVELOPMENT
MATERIAL
RESPONSIVE

METHODOLOGY

TECHNOLOGY
OLD + NEW

SEQUENTIAL
ITERATIVE
PROCESS

TESTING INNOVATION
DESIGN DEVELOPMENT
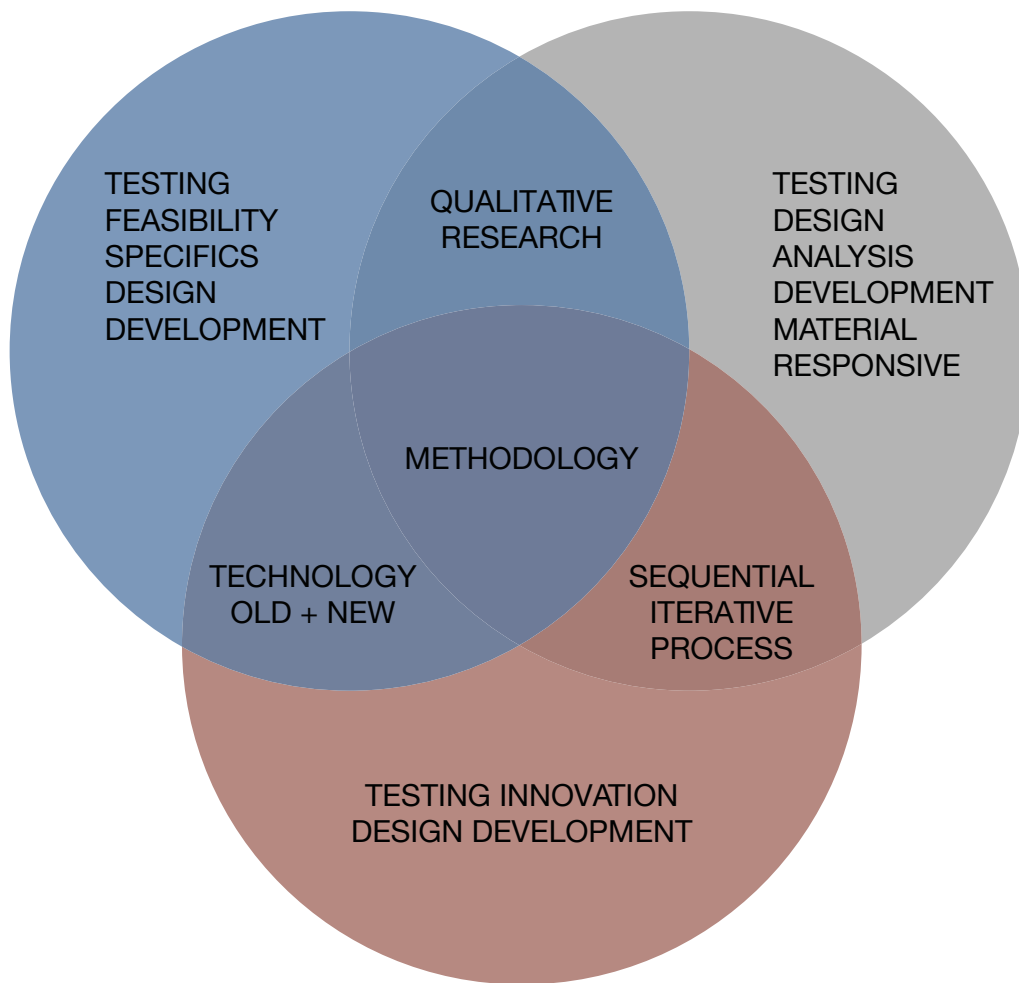
Fig 9

Methodology

The research methodology of this project displayed in Fig 9 is industry centered with an experimental, sequential iterative and material responsive design process. Critical in-depth analysis and evaluation was crucial to lead the future direction of design and research.

Outlined in the aim, objectives and milestones, Callaghan Innovation Contract, is the method to six key stages of the project. The six stages were refined into crucial steps to outline the objective achievement measured to ensure the project would stay on track, and all objectives and milestones could be achieved and progress on time.

1. Scoping of project
2. Tooling and technology competency
3. Literature review
4. Yarn design development
5. Spinning to create blended yarn
6. Confluence of spinning, design, and knitting technology
7. Development of yarn promotional images

The sequence of what was achieved went above and beyond was required, below is what was achieved in the research and development.

1. Scoping of project
2. Tooling and technology competency
3. Literature review
4. Yarn design development
5. Spinning to create blended yarn
6. Confluence of spinning, design, and knitting technology
7. Design research, trend forecasting
8. FDS knitting software
9. Knitted garment

The original sequence of milestones changed as there was a need for original and unique design to develop fabric that would stand out in the market. Design research and trend forecasting helped to develop pattern and future trends for the up and coming seasons. It was important to master FDS knitting software to enable personal production of knitted fabric collections utilising my original pattern designs. The last step involved the production of a few long sleeved thermal garments made and sent to various Levana Textile clients. Achieving beyond what was required of me in this research and development allowed me to gain invaluable knowledge of industry software while becoming versed the full process involved in the development of yarn and knitted fabric within Levana Textiles.

Fig 10

TOOLING AND TECHNOLOGY

Machinery Research

The initial steps of this project were to use a broad range of equipment and machinery to attain a wider understanding of how and why machines went through certain processes. This informed design decisions as it gave me an understanding of the limitations as well as areas that could be explored with fibre and knitting. There are many processes within the Levana mill and each machine plays an important role in the production of yarn and fabric.

The following machines are used to produce yarn and fabric, they are an integral initial stage of the design process: gilling machine, roving machine, Nuyarn spinning machine, winding machine and circular knitting machine. The knowledge of this machinery proved to be invaluable as it is extremely informative for underlying design decisions.

HELLY HANSEN

Client Based Design and Development

The Helly Hansen project was client-based, to develop merino and polypropylene blended yarn for elite sportswear apparel. Helly Hansen produce a large range of apparel for men, women and youth. With focus on extreme high performance mountain-wear clothing. Levana noticed a gap in the market with the discovery that Helly Hansen currently uses polypropylene fibre throughout their product range. Levana wanted to present them with a high performance fabric that nobody else in the world can provide. Levana proposed to Helly Hansen the notion of blending merino with polypropylene to enhance the fabrics desired performance properties, as this would benefit their particular target market for elite sportswear apparel.

There was an outline of yarn specifications for the development, this particular fibre blend has not been developed with Nuyarn technology but the development process allowed us to reach the desired yarn specifications through an iterative process. Helly Hansen provided slivers of polypropylene in 3 colours, neon green, white and black. This was to be blended with Levana's un-dyed merino sliver. The yarn was to be knitted on a jacquard circular knitting system in a collection of patterns, Helly Hansen were receptive to the idea of Levana designing the patterns for the finished fabric.

Development involved working with Levana staff to blend merino slivers and polypropylene slivers through the gilling machine. The polypropylene and merino blended fibre combination had not been trial on Levana equipment before, this involved being aware that certain parts of this trial may not go as planned, although looking through previous yarn developments provided an idea of suitable machine settings and possible setbacks. The polypropylene sliver was dyed in colours and the merino was un-dyed. We were confident through knowledge gained in past developments that the combination of the dyed and undyed slivers would blend the two fibres together in a beautiful way after the gilling process. It became apparent that the polypropylene sliver was becoming static as it was being processed, it began to catch around the rollers at the front of the machine multiple times. A solution was to put a tray of anti-stat above the polypropylene fibre so the merino could be placed on top of the trays. This allowed the antistatic formula to be applied to the wool slivers only and decreased the amount of static between the fibres as shown in Fig 11, this solved the problem of the fibre getting caught around the rollers.

Fig 11

The static issue was the only problem to develop as the roving, spinning and winding processes went to plan. This final result after processing the yarn was extremely positive for a new trial development, the outcome as specified was the correct tex and percentage of each fibre. Specifications were met through a strict weighing process after the fibre had completed its course through the machine. This action has been documented well so that in the future this trial can be easily replicated.

Trend Prediction | Pattern Research

Following the fibre processing, Helly Hansen desired a collection of newly designed fabrics with patterning. This request required intensive exploration into Helly Hansen's values as a company as well as pattern design and trend prediction to develop a fabric collection to correspond with the Helly Hansen brand. I believe It is important as a designer to research the company and their consumers for whom you are designing, as this increases the likelihood of a successful sales outcome and partnership.

To ensure a thorough meticulous design process I wanted to cover all bases within my pattern design research, I set out investigating companies similar to Helly Hansen. I was able to get a gauge on the current market as well as searching for potential gaps in the market in terms of pattern design. I considered the style of pattern Helly Hansen have used in past collections to gain an understanding of their aesthetic, my intention was to design patterning analogous to the Helly Hansen brand. Acknowledging trends in sportswear, high profile fashion designers and knitwear gave insight into various fields in the apparel industry resulting in an amalgamation of trend knowledge to guide the direction for trend forecasting for winter 15/16. My findings from this research gave me the knowledge necessary to predict a trend for winter 15/16 that expresses a desire for bold geometric prints.
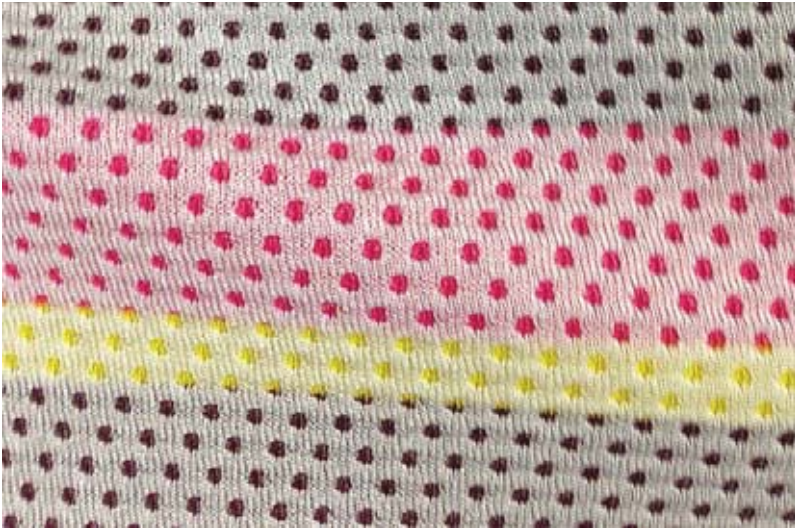
Fig 12

Fig 13

Fig 15

Fig 14

I received an image from a Levana staff member who had returned from a business trip with a photograph of fabric from a textile fair that they believed to be very on trend for sportswear apparel. I was asked if I could replicate the design as shown in Fig 12.

The fabric displayed in Fig12 is knitted on a double jersey jacquard knitting machine. I would be unable to replicate the fabric, because Levana only own a single jersey jacquard knitting machine. In order to provide Levana with a fresh insight into new pattern ideas I solved this problem by providing them with the latest knowledge in trend prediction through intensive research. I dissected the design of the fabric and pattern to expose key aspects that could be taken forward into the designing process. The spot and stripe became key words in producing new designs.

Spot and stripe were the keywords I identified. I began to critique trends that could integrate these two words. I adopted the following trends as I could envision these trends sourced from (Textile View Magazine, 2013) within the Helly Hansen brand such as colour geometry, black keys and house rules shown in Fig 13-15 these trends had key words such as:

GEOMETRIC
GEOMETRICALLY MEASURED ANGLES
TRUNCATED STRIPE
INTERSECTED
CUT UP
GRAPHIC
ABSTRACT STRIPE
OPTICAL ILLUSION
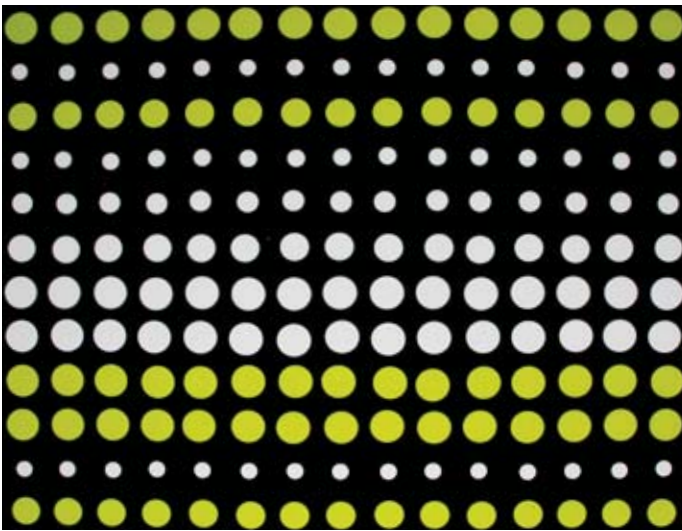
Fig 16
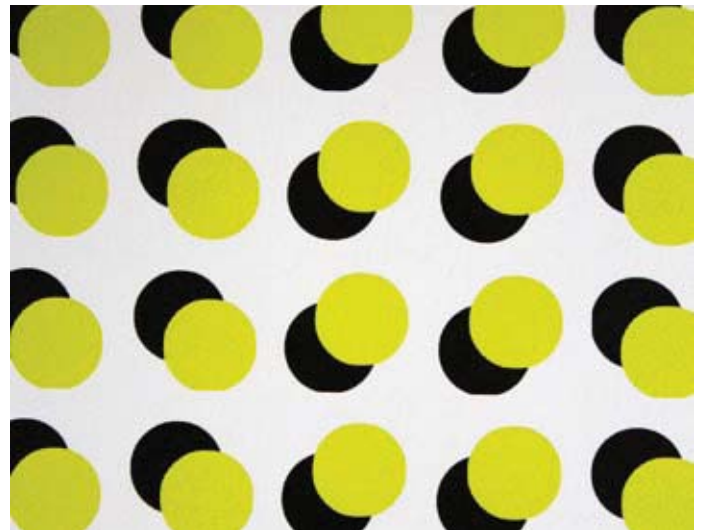
Fig 17
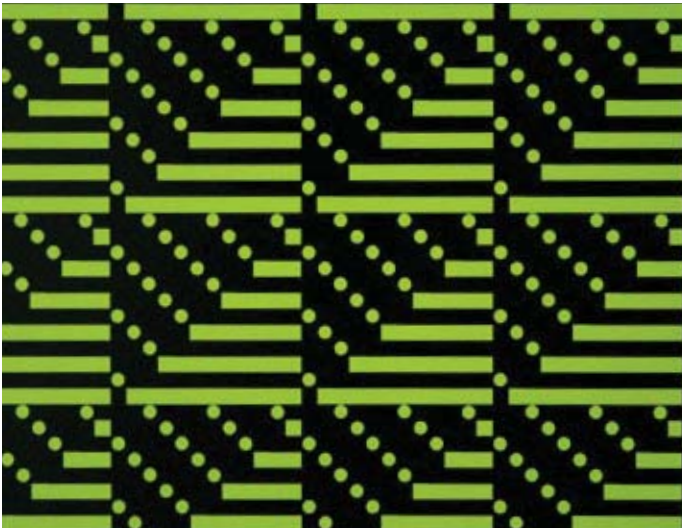
Fig 18
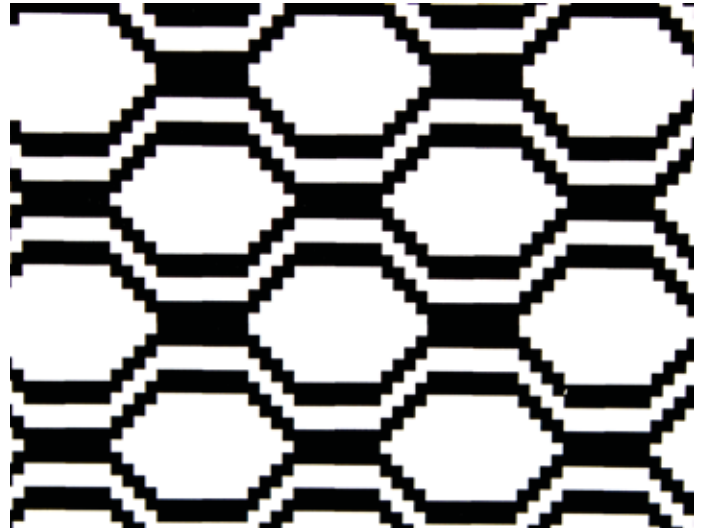
Fig 19

Fig 20

Fig 21

Design and Development

The trend concepts and technology considerations signalled the role Photoshop softwarevwould play in designing pattern for the collection of fabrics. With my knowledge of designing repeat patterns I have found from past experience the most effective and efficient tool for me to design a collection of patterns is to use Adobe Photoshop. This computer program is a designers way to develop ideas quickly as well as being able to adapt, change, add colour, manipulate and duplicate motifs that can be transformed into repeat easily through the various tools in the software. Photoshop was a tool that envisioned would enable me to translate my designs in the FDS knitting software. Fig 16-25 are a series of iterations of initial designs displayed in the three yarn colours specified by Helly Hansen.
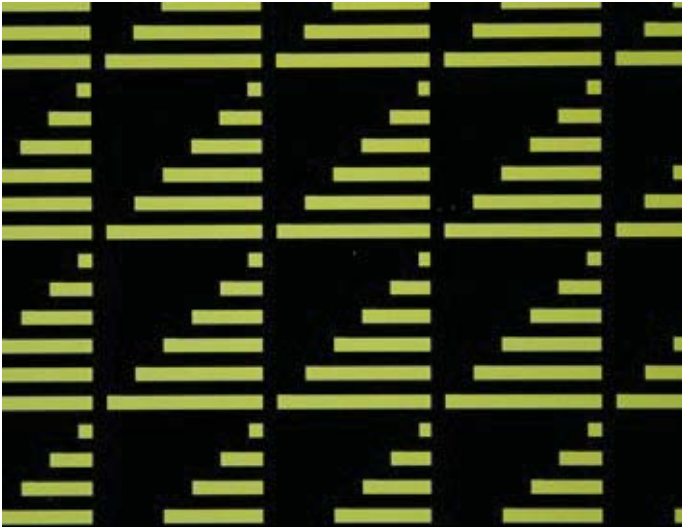
Fig 22
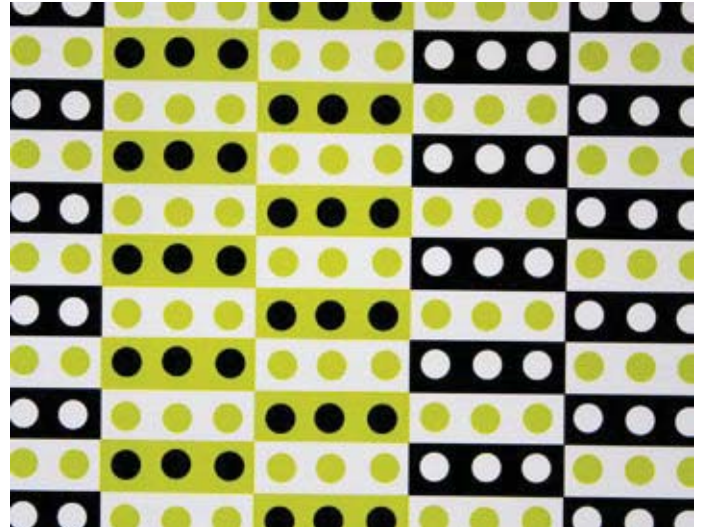
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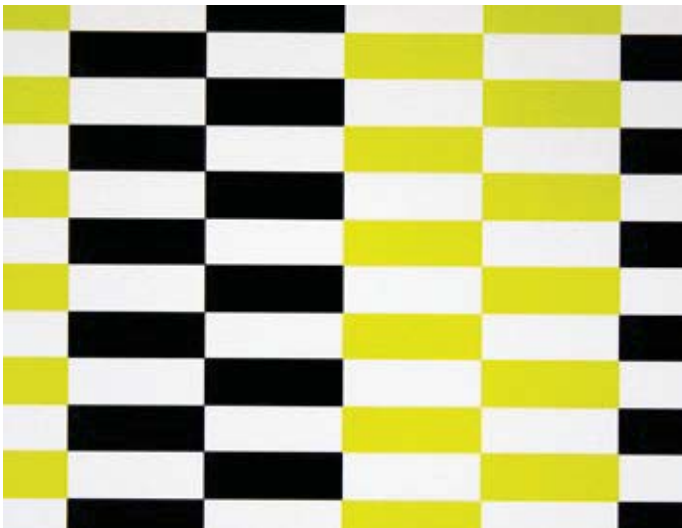
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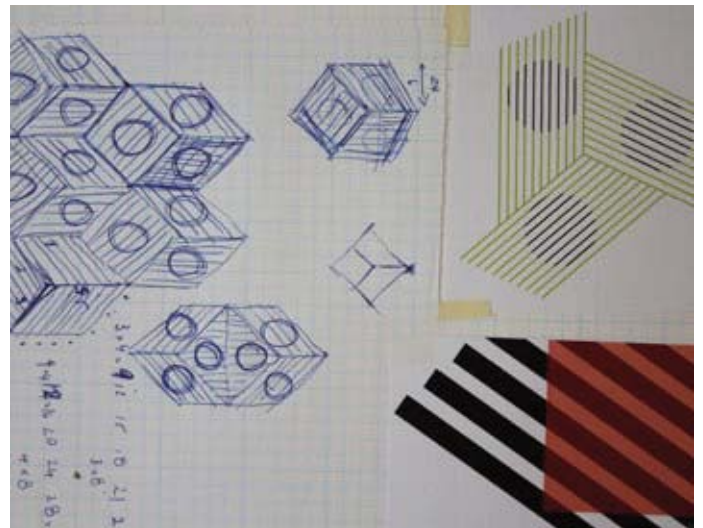
Fig 25

A discovery after a discussion with the Levana design and development team proved that I needed re-evaluate my designs as some of the colour combinations I presented were unachievable. It was necessary undertake further research into the setup of the knitting machine process and operation. The way I introduced colour to some of the patterns would not be possible, with the particular machine I would be knitting with required one colour yarn present throughout the whole design and there needed to be alternate stripes where the second colour would run through. My vision of designing a three coloured design was a complex process for a first attempt at using the knitting software and I was encouraged to design with two colours at this stage. This realisation directed me to spend further time learning the software as well as the knitting machine set up before I re-worked my designs as this would enable myself to get a better understanding of how the whole processed operated.
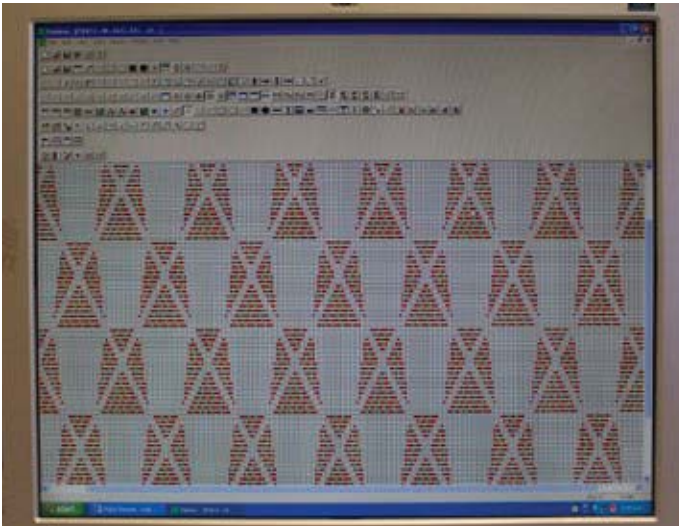
Fig 26

Further experimentation and practice of FDS software as shown in Fig 26 enabled me to develop and re-work a collection of patterns. A valuable lesson learnt from my time in the Levana Textile knitting mill was that investing time there and making connections with the employees gave me valuable knowledge from industry experts, spending as much time at Levana mill is the best thing I did, it made everything come with ease.
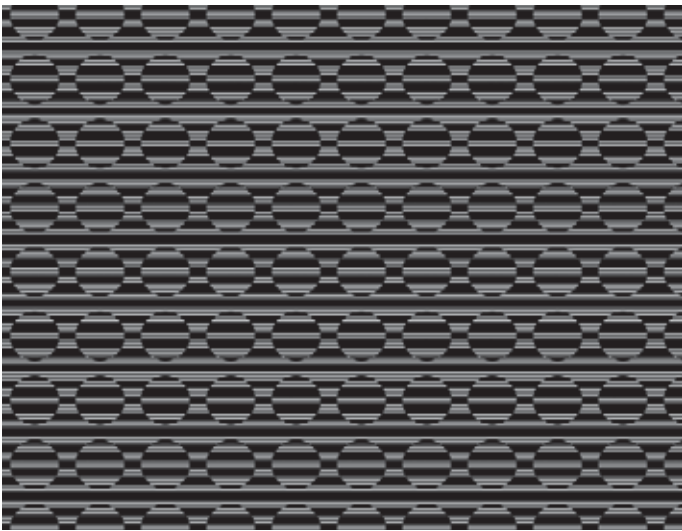
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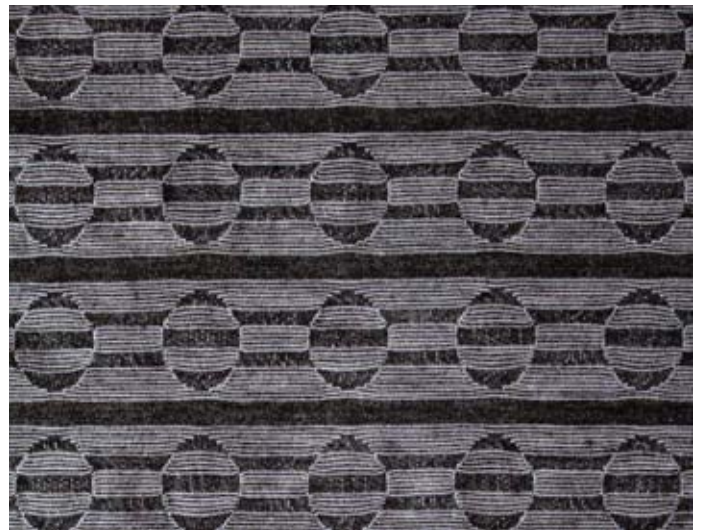
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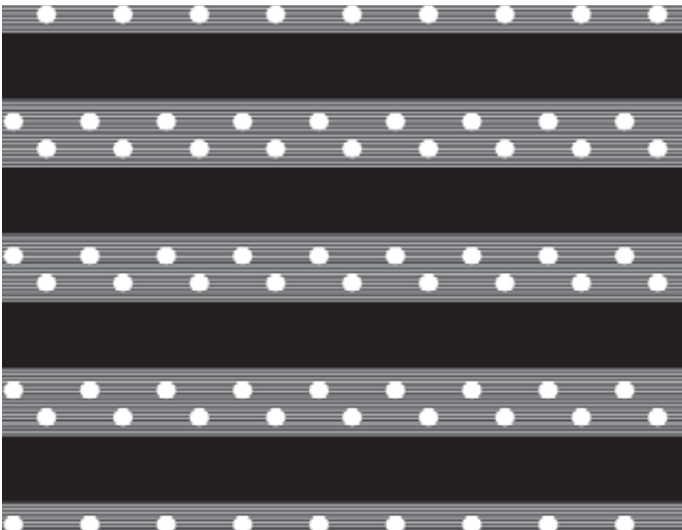
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Fig 30
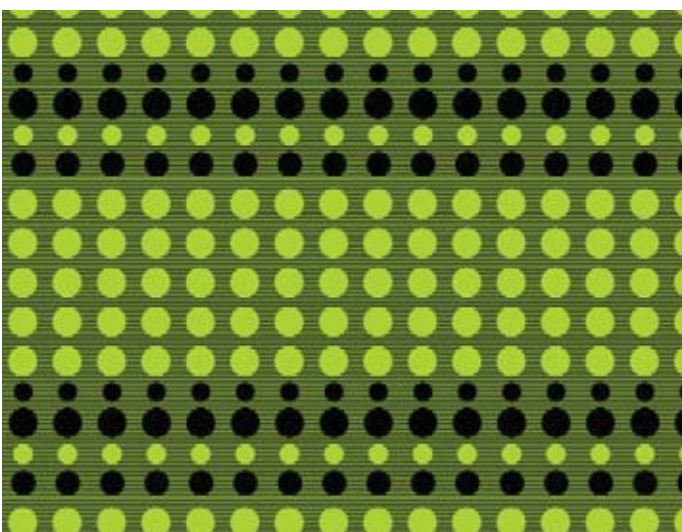
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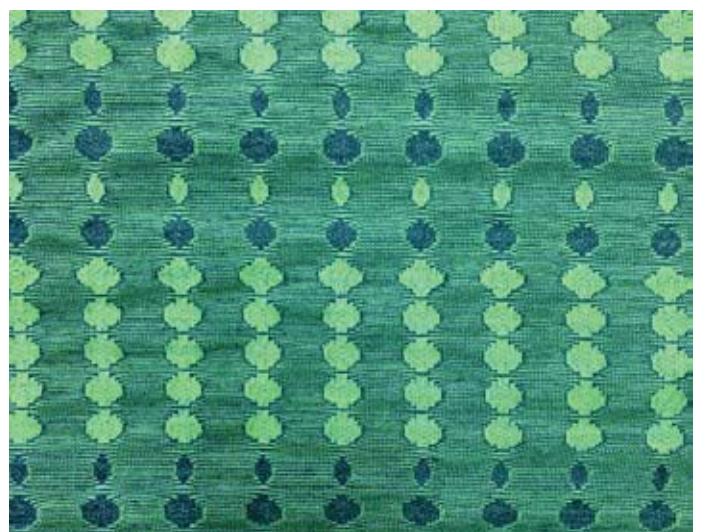
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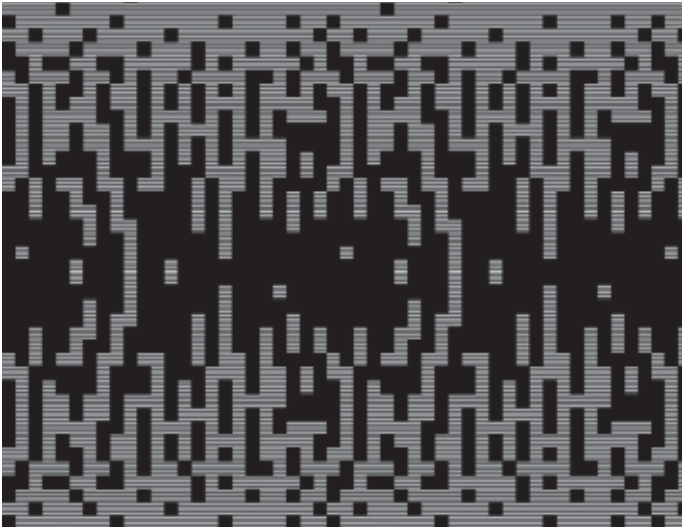
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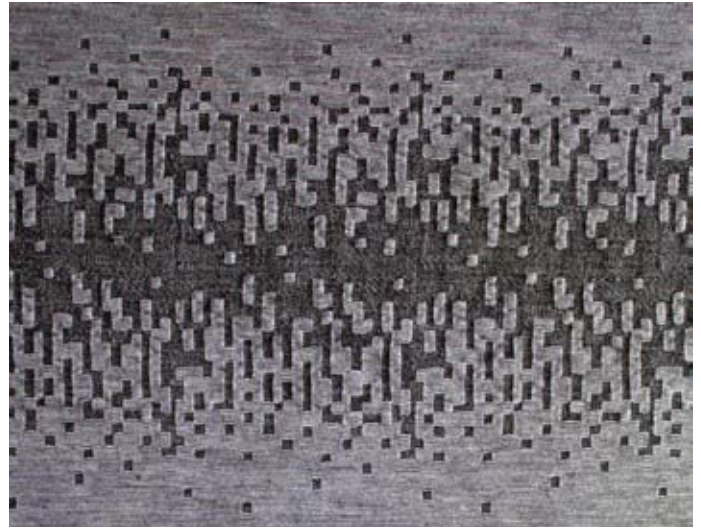
Fig 34

Fig 35

Fig 36

Fig 27, 29, 31, 33 and 35 are five designs that I decided to take forward as a collection. Fig 28, 30, 32, 34 and 36 show the outcome of the knitted fabric collection. It is evident the Photoshop software translates the designs well into Knitted fabric. Overall I was pleased with my knitted designs although there was one particular design displayed in Fig 32 was a fabric I ended up stopping as it was being knitted on the machine. This was for two reasons, the first being that the neon green and the black did not complement eachother aesthetically, I had some uncertainty about this design before it was knitted but I wanted to create patterning using every colour combination with the three colours of fibre Helly Hansen provided. Secondly the smaller circle knitted appears as an elongated circle, this was not how I intended the design to look. After getting advice on how to improve this in the future, the design and development team suggested looking at old designs with similar sized circles to replicate the previous design. It was also stated that circles were one of the trickier shapes to get right. In the future I think that it would be good practice to cut a sample of the fabric and print out the FDS pattern to compile a folder of theses types of errors, so that next time when a more complex shape is being developed there could be a file to refer to.

HELLY HANSEN

Following the advice from the design team I set up a file of circle designs so that this can be referred to when design circle motifs of various sizing. This was also confirmed by the team as a good idea and proves to be taking out guess work from the designing of circles. An unexpected result in Fig 36 is the slight puckered feature of this fabric. This was created through the triangle design, where certain yarn are coming to the front of the design and the rest are tucked to the back of the design. This feature was a pleasant surprise, it adds a point of difference as well as a textural feel. I think this puckering effect could really appeal to certain markets. This is a design feature I would like to explore in the future, as I believe various yarn and fabric structures could have interesting effects to the surface appearance of a design.

Selecting Photoshop software as a main tool to design, enabled me to visualise how the fabric would look before translating it into FDS knitting software. Photoshop facilitated understanding the entirety of the process to be revealed in a visual way. A finding from this stage in development was trying to translate the patterns from Photoshop in FDS software. They are different software and work separately, this gave an idea to develop specific layers in Photoshop, such as an 'alternate stripe' layer that I could layer over my designs to give an effect of how the fabric would appear when knitted and gave an effect of how colour worked within the pattern.

Fig 37 reveals how the design appears different with the alternate stripe when compared without, it almost creates a third colour (grey) in the design. This layering system was helpful in terms of visualising how colours would look together and if the design was going to work well with the alternate stripe. From my knowledge of learning different design software I thought the FDS knitting software was difficult to master, as it was not intuitive and appeared as though the software had been designed by a 'knitter' not a 'designer'. This difficulty could be biased and due to my comparison of FDS knitting software to 21 century software, FDS is now over 20 years old.
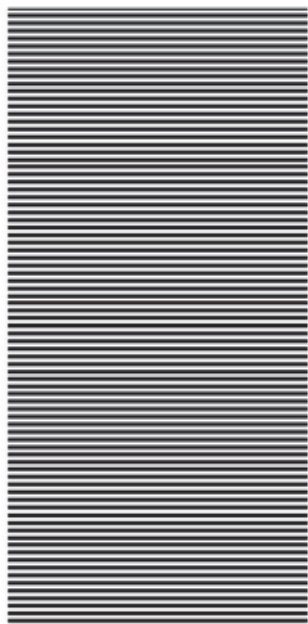
1 | Alternate stripe layer

2 | Design

3 | Design with alternate
stripe layer

Fig 37

Fig 38

The tests were up to standard after the completion of testing the fabric, and were ready to be sent to Helly Hansen. We are still waiting to hear Helly Hansen's opinion on the blend of the fabric and the pattern design. The purpose of this fibre blend and pattern collection was for Helly Hansen although Levana were really pleased with the results of the fabric and further samples were made to be taken to different clients over the world to places such as South Africa and Norway. Long sleeved thermal garments were also constructed to give clients.

There is now a record at Levana of how each stage of this new blended yarn was created through each stage of processing, in the future this blend can now be easily replicated. There have also been valuable findings throughout this yarn trial, I have overcome problems such as finding a way to visualise knitted fabric when designing. I found a solution through the development of creating a layering system in Photoshop that allows me to visualise a designs appearance when knitted. I have also compiled a folder for referencing circular motifs to minimise design error and take out an element of guess work. The fibre processing can run smoothly as we solved the issue of static fibre through laying the merino fibre over a tray of antistat solution.

The Helly Hansen trial has been very successful, a new market was targeted and I was able to produce them with new blended yarn produced with Nuyarn spinning machines, a product that nobody else in the world can produce. Through the knitting of the yarn this has proven that the yarn is viable as it proves the yarn can be knitted into a fabric to be made for apparel. Providing Levana with my design knowledge and researching skills has brought a fresh insight into the company. There is also success that this blended yarn can also be sold to other clients who are in need of a polypropylene and merino high performance blend. Levana responsed by sending out samples of fabric to customers around the world, this has provided strong evidence that they were extremely impressed by my pattern design and work put into research and development.

Fig 39

ALPACA AND MERINO BLENDED YARN

Trend Forecasting

A key aspect of this research was to identify and create viable yarn combinations to potentially open up a new market, the type of market Levana need to target is luxury markets. Levana is able to target and absorb this type of market well through their capability to do smaller product runs, ownership of unique equipment enabling the use of luxurious and desirable animal fibres that will appeal to this high end market. Researching into high end luxury markets led to the development of an alpaca and merino blended yarn. From my understanding of the machinery at Levana Textiles I had acquired knowledge to make an informed decision about the viability of this yarn combination. Absorbing knowledge from industry experts and learning from past developments helped with how to proceed with this type of development. Although there was limited information to draw upon about alpaca fibre and alpaca blended yarn, I utilised the small amount of details I did come across and all references had positive views about the fibre. It was promising from this information the fibre could perform and sit at the luxury end of the market as the fibre has exceptional potential through its performance properties shown in Fig 7.

A company looking to source an alpaca blend known as The Reformation is a fashion forward label based in New York who was in search of an alpaca blended fabric. Their ethics are based around sustainability, ethically made, reusable, quality products and up-cycling. The Reformation brand is what I have based the alpaca and merino blend research around.

Fig 40

Design and Development

The initial testing for an alpaca blend were two tests the first being 100% alpaca and the second a blend of 50% alpaca and 50% merino. These combinations were successful in terms of creating a yarn but to be used in the application of apparel the tex was too high. This result was due to way in which the alpaca fibre had been processed, I received it in a thick roving form, usually Levana would work in a sliver form. I knitted a sample on the sock knitting machine as a test shown in fig 40 and the result was a very thick rough fabric. I needed to acquire the fibre from a reliable source to be able to specify the exact micron and fibre length required to work with Levana's machinery.

Sourcing fibre lead me the Waimarie Alpacas Stud, specialists in breeding and rearing and are one of the largest alpaca herds in Hawkes Bay. An order was placed to supply natural white un-dyed and natural grey un-dyed fibre with a staple length of at least 70mm and micron of 17. They were unable to supply a micron on 17 but could supply a micron of 22-23. My preference would have been a lower micron and therefore a softer fibre, but being only 20% of the yarn I thought this would be an interesting initial trial to see what the outcome of the fabric would be in terms of handle, softness and finish.

Blending Waimarie Alpaca fibre with merino was produced to create a 20 tex yarn, a mathematical equation took place in order to work out the percentage of what each fibre needed to be inserted to each fitting of the gilling machine. The correct percentage would produce a blend of 20% alpaca and 80% merino. It is important that this information was specific because it was a trial run for the first time so this information could be referred to in the future. The gilling stage of this development went smoothly, shown in Fig 1 displays the finished yarn. Although there was a problem with the alpaca fibre being processed elsewhere, and not with Levana's trusted sources as it was evident the alpaca sliver was not as strong as the merino sliver which resulted in the alpaca sliver breaking multiple times. This problem was solved by two people working on the machine, one person operating the machinery and the other rubbing the broken slivers together. The team effort worked in this case but for future developments with this fibre it would be uneconomical for two people to be working on one machine as it requires more labour resulting in higher cost for Levana. This issue could be discussed with Waimarie Alpacas in the future to overcome this problem by working out a way of producing stronger alpaca slivers.
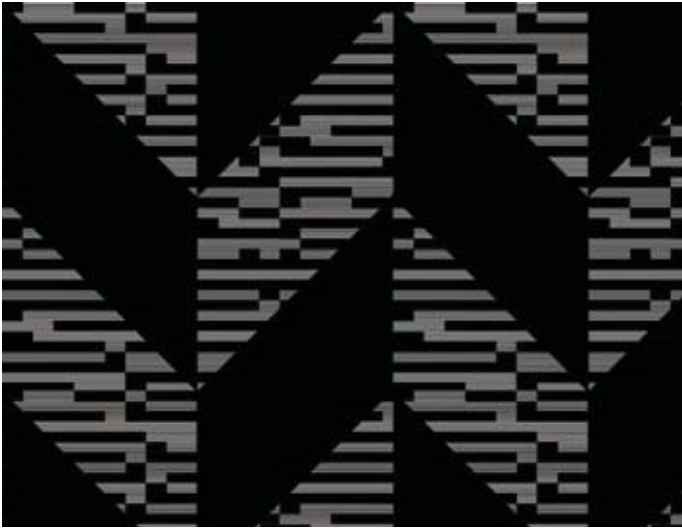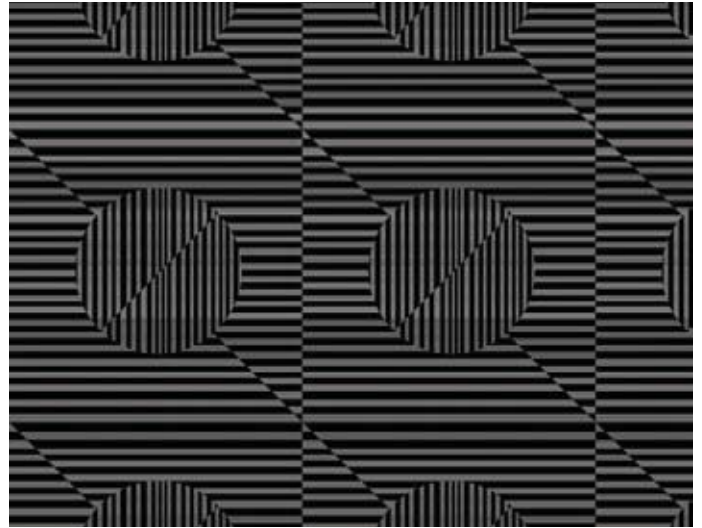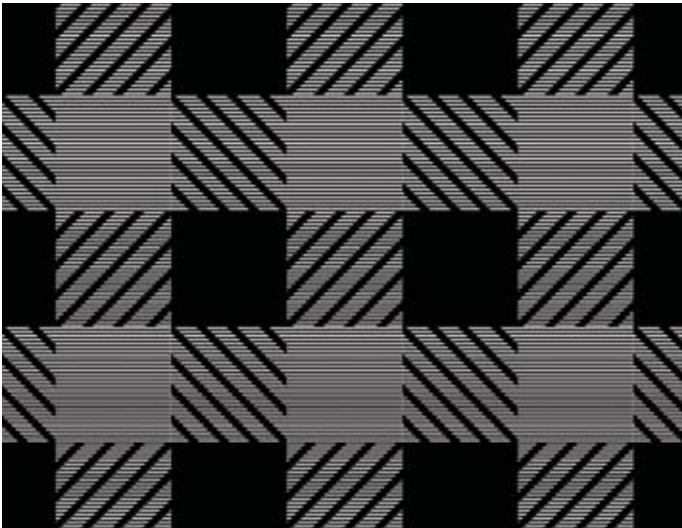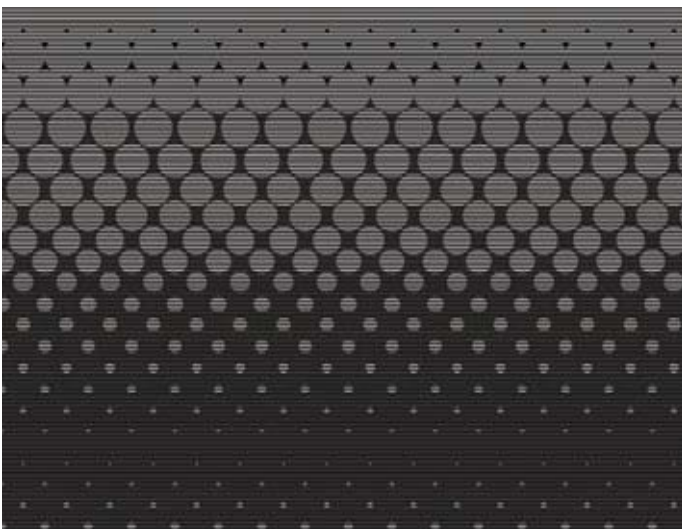
Fig 41

Fig 42

Fig 43

Fig 44

Fig 45

There were no issues with the roving process or the spinning process, all went smoothly. Winding was the next step in production, this proved to be difficult to find a time slot to process the fibre through the winder as Levana had a lot of orders to fill over Christmas and New Year, there was pressure to fill orders for international clients. There was a large delay in this part of the process to have the yarn ready for knitting. This was overcome by being patient and working with the team to find the best time to put the yarn through the winder so that it wouldn't disrupt their production run.

While filling in time for the yarn to be processed through the winder I was able to work on developing jacquard patterns. I developed a new trend for winter 15/16 'reimagine' inspired by reimagining traditional patterns to create a juxtaposition of new and old. I thought this trend was fitting for this research as it encompasses what the research is about in terms of using new and old technology and trying to revive the Levana products with Nuyarn. The designs were influenced from traditional textile patterns such as herringbone, gingham, spot and stripe to be regenerated with a contemporary quality shown in Fig 41-45.

This collection of pattern design shown in Fig 41-45 could not be taken through to the production of knitting as Levana had a substantial amount of orders to fill on the particular knitting machine that I needed to use in order to knit these designs. To solve this issue I looked for an alternative option for knitting the alpaca yarn into a jacquard fabric. I decided work with the punchcard jacquard knitting machine, this would result in having to re-work the designs shown in Fig 41-45 to fit into 30mm by 30mm repeat design as this is the maximum size the machine can knit. Fig 46-49 show a new collection of reinvented designs to fit the specifications of the punchcard knitting machine while still capturing a similar aesthetic. I have produced as much difference in the scale of each design to create a collection with variation. This is one of the main restrictions of using a punchcard jacquard machine as opposed to the digital jacquard machine. I have tried to create as much variation in the scale of each design to create a collection that works together.
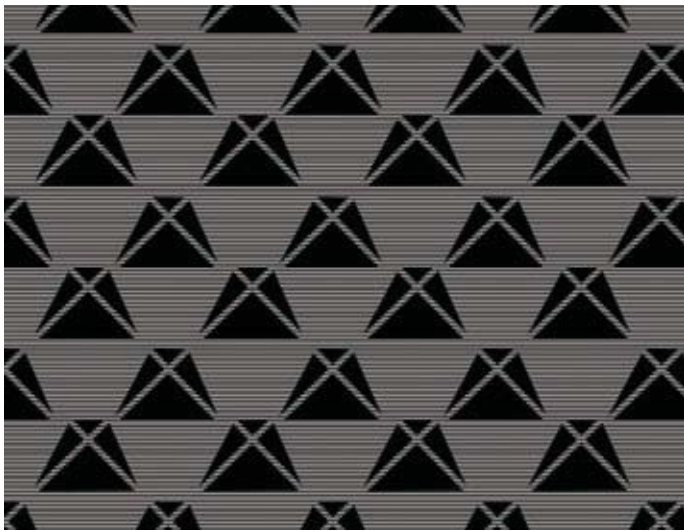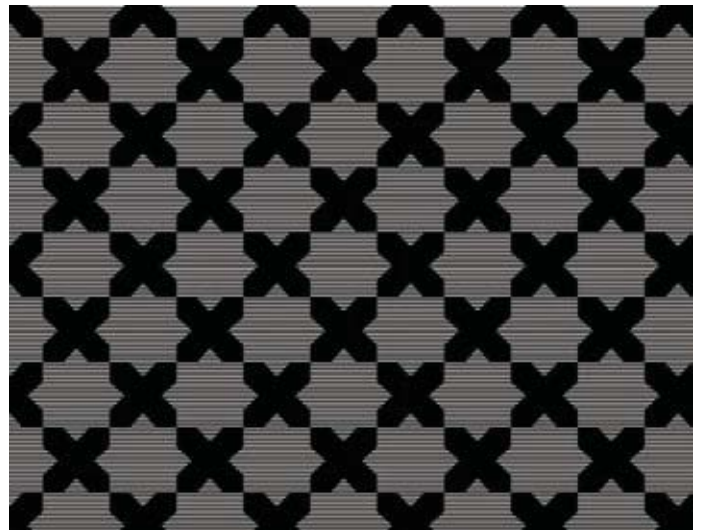
Fig 46

Fig 47

Fig 48

Fig 49

Fig 50

Knitted Fabric Samples

The initial knitted sample shown in Fig 50 was to establish if the alpaca and merino blended yarn was viable to be knitted. The test was completed using a sock knitting machine. Successfully it proved the yarn could be used for knitting production on larger scale. This was evident as there were no problems such as yarn breakage, holes or broken needles.

Fig 51

The initial jacquard pattern did not knit as expected, when compared to the original Photoshop design. The reason was due to the yarns subtle difference in colour. This was unexpected because comparing the cones of yarn together showed the two colours were distinct in colour, one being grey and the other a natural undyed colour shown in Fig 50. The yarn is blended 20% alpaca 80% merino the amount of grey alpaca is rather small, my intention was to have soft subtle designs that would give a natural sustainable look to encompass the feeling of The Reformation values. Despite the fact I did not replicate the original Photoshop patterns, I discovered that the knitted fabric I developed had an interesting textural handle as well as a 'marl' look to it from they grey blended yarn. I began experimenting with cone loading on the knitting machine to produce a stripe within the design of the jacquard presented in Fig 51.

Fig 52

I thought that this was an attractive outcome for the design, the way the structure of the jacquard was designed it manipulated the stripe to display a 'pinched in' response shown in Fig 52. The design pattern was defined through texture and not colour, This has given the design a more sophisticated appearance. The stripe in the design is subtle, working in the patterns favour as it does not overpower the textured appearance of the fabric. I desired exploration into this new area of designing pattern with texture. The decision to work with undyed yarn portrayed a narrative of provenance that I believe fits the story of this research. Laura Daza a Colombian designer also interested in colour identity states, "today, colour is a commodity industrially produced for mass consumption. However, there was a time when the story of origin was integral to colour identity, the narrative of provenance possessing a power and a sense of magic" (Daza, 2015).

ALPACA AND MERINO BLENDED YARN

Final Knitted Design

Fig 53

The final knitted designs shown in Fig 53-56 display a unique look coupled with sophistication. The knitted fabrics no longer appear like the original design, instead they show a new depth of intelligence through the understanding of the knitting machine operation. Electing a stripe for the machine setup has eliminated the need to dye the yarn. Resulting in one less step in the production of the fabric, subsequently the fabric is cheaper, appeals to buyers as a more natural product and more environmentally sustainable.

Fig 54

ALPACA AND MERINO BLENDED YARN

Fig 55

Fig 56

The entirity of the development was successful throughout all processing. Levana Textiles now have an international client requesting a similar blended yarn. This solidifies my trend prediction for creating this fibre blend. Levana will now have a base of information from this trial of blending alpaca and merino they can work from to create an alpaca blended yarn using Nuyarn spinning machines. I have discovered a new market for alpaca blends as well as producing a viable yarn combination that works on Levana machinery that can be knitted into fabric. The sophisticated unique pattern design I have produced within my experimentation of the knitting machine yarn set up has presented a fresh insight to the industry.

Fig 57

Fig 12

CONCLUSION

New Zealand's Nuyarn

The research and development executed has proven to advance the development of Nuyarn blended yarns, achieved by the innovation in blended woolen yarns using Nuyarn technology. Subsequently adding value to New Zealand wool and products for export, establishing specific markets as well as identifying gaps in the market.

Nuyarn's innovation in blending yarn combinations has opened up a gap in the market. Nuyarn spinning technology proves through testing analysis that innovation is evident in the blending of fibres, providing opportunity in the creation of luxury blends unique to Levana Textiles. I have Identified the need for smaller woolen companies such as Levana Textiles to target niche markets resulting in a shift from producing products for mass market. Focusing on niche markets allowed this research to take advantage of the innovation in Nuyarn spinning technologies blending capabilities as this informed the production of specialty blends focusing on luxury niche markets. Original design and market trend research emphasised the importance of adding value to New Zealand wool in order to create products with a point of difference and uniqueness in the market. There is prosperity that the newly blended yarns can be sold to new clients who are also interested in these high performance blends. Through the knitting of yarn it is proven the yarn is viable as it has now proven that the yarn can be knitted into a fabric to be made for apparel.

The purpose of this research and development was develop and refine new yarn and knit textile combinations using Nuyarn technology for a selected niche market. I have brought a fresh insight into Levana Textiles by providing design knowledge and researching skills I have done this by questioning ingrained beliefs. Through researching market trends I was able to recognise the potential of an alpaca and merino blended yarn, through my own initiative a development was carried out. Levana now have a client requesting a similar blend. This solidifies my trend predictions for creating a new fibre blend and shows this has brought a fresh insight to the company as being forward thinking. Fresh insight is indisputable within the pattern design of the jacquard fabric I have produced, they are unique and fashion forward while displaying my mastery of FDS knitting software.

This opportunity has allowed myself to gain phenomenal industry experience in the woolen industry and also provide the opportunity to develop client based work. Throughout this research and development Levana Textiles had been impressed by my design, research and development skills I was offered employment as a knitwear designer/developer. My design skill and research have proven valuable to the company as I have successfully created jacquard designs for clients who have responded well through ordering the jacquard designs.

REFERENCES

Alpaca Culture. (2011, March 14). *Alpaca United Press Release. Alpaca culture.* Retrieved from http://50.63.56.65/alpacaculture/index.php?option=com_content&view=article&d=47:alpaca-united-press-release&catid=35:north-america&Itemid=78

Business Day. (2015). *50 Jobs to go at Oamaru Wool Mill.* Retrieved from http://www.stuff.co.nz/business/farming/7057671/50-jobs-to-go-at-Oamaru-wool-mill

Boland, C. (2013, Winter). Textile View Magazine: *Lifestyle.* (104), 258-259.

Callaghan Innovation Aim, Objectives and Milestones. (2014). *Contract between Levana and Monique Bowers.*

Callaghan, P. (2009). *Wool to Weta.* Auckland, New Zealand: Auckland University press.

 Daza, L. (2015). Colour Provenance. *The Project.* Retrieved from http://www.lauradaza.com/T-h-e-P-r-o-j-e-c-t

Faulkner, S. (2012). *"Hello New Zealand - This Is The Future Speaking..."* Nuffield New Zealand Farming and Agriculture. Nuffield.

Fletcher, K. (2008). *Sustainable Fashion and Textile: Design Journeys.* UK and USA: Earthscan.

McColl, A., McColl, Y., Lupton, C., Stobart, B. (2004). Fibre Characteristics of U.S. Huacaya Alpacas. *Alpacas Magazine*, 186-196. Retrieved from http://www.alpacaresearch.org/resources/dyn/files/319759z7dbdf304/_fn/fiber-characteristics-of-huacayas.pdf

Nuyarn. (2014). *Better Fabric.* Retrieved from http://nuyarn.co.nz/benefits/#proof

Phillips, J. (2014). *Innovative Spinners Look for Alternative Opportunities.* Textile World. Retrieved from http://www.textileworld.com/Articles/2014/June/Innovative_Spinners_Look_For_Opportunities

Silverstream Alpaca Stud. (2013). *Alpaca Fibre.* Retrieved from http://www.alpaca-stud.com/alpaca-fibre.htm

Textile View Magazine. (2013, Winter). Reconnect to the Source. *Textile View Magazine*, (104), 258.

Textile World: Performance Meets Luxury and Style. (2013, August 27). Retrieved from http://www.textileworld.com/Articles/2013/August/Quality_Fabric_Of_The_Month/ Performance_Meets_Luxury_And_Style

Tolerton, J. (2012). Agricultural Processing Industries: *Wollen mills in the 20th and 21st centuries.* Retrieved from http://www.TeAra.govt.nz/en/agricultural-processing-industries/page-4

The Woolmark Company. (2013). *Woolmark Gold*. Retrieved from http://www.woolmark.com/woolmark-gold

Woolyarns. (2015). *Perino*. Retrieved from http://woolyarns.co.nz/yarns/knitwear-apparel-hosiery-yarns/perino-yarns/

YIM. (2015). *About YIM*. Retrieved from http://www.y-i-m.com/about_yim.html

BIBLIOGRAPHY

Adams, D. (2014). *Apparel Fabrication Updates: The Australasian Textiles + Fashion Magazine*, 2, 22-23.

Alpaca United Press Release. (2011, March 14). *Alpaca Culture*. Retrieved from http://50.63.56.65/alpacaculture/index.php?option=com_content&view=article&id=47:alpaca-united-press-release&catid=35:north-america&Itemid=78

Business Day. (2015). *50 jobs to go at Oamaru wool mill.* Retrieved from http://www.stuff.co.nz/business/farming/7057671/50-jobs-to-go-at-Oamaru-wool-mill

Callaghan Innovation Aim, Objectives and Milestones. (2014). *Contract between Levana and Monique Bowers.*

Callaghan, P. (2009). *Wool to Weta*. Auckland, New Zealand: Auckland University press.

Chesky, V. (2013). *Wool a – Niche Fibre*. Retrieved from http://issuu.com/woolnews/docs/wool_trade_2013?e=3675203/4967174

Faulkner, S. (2012). *"Hello New Zealand - This is The Future Speaking..."* Nuffield New Zealand Farming and Agriculture. Nuffield.

Fletcher, K. (2008). *Sustainable Fashion and Textile: Design Journeys*. UK and USA: Earthscan.

Franck, R. (2001). *Silk, Mohair, Cashmere and other Luxury Fibres*. Cambridge, England: Woodhead Publishing ltd.

Helly Hansen. (2014). *Helly Hansen Heritage*. Retrieved from http://www.hellyhansen.com

Hibbert, R. (2001). *Textile Innovation* (2nd ed.). London, United Kingdom: Line.

Kadolph, S. J. (2007). *Textiles* (10th ed.). New Jersey, USA: Pearson Education, Inc. Levana. (2014). Envision, Design, Create, Experience. Retrieved from http://www.levana.co.nz

McColl, A., McColl, Y., Lupton, C., Stobart, B. (2004). *Fibre Characteristics of U.S.* Huacaya Alpacas. Alpacas Magazine, 186-196. Retrieved from http://www.alpacaresearch.org/resources/dyn/files/319759z7dbdf304/_fn/fiber-characteristics-of-huacayas.pdf

Nuyarn. (2014). *Better Fabric*. Retrieved from http://nuyarn.co.nz/benefits/#proof

Performance Meets Luxury and Style (2013, August 27). *Textile World*. Retrieved from http://www.textileworld.com/Articles/2013/August/Quality_Fabric_Of_The_Month/Performance_Meets_Luxury_And_Style

Phillips, J. (2014, June). *Innovative Spinners Look for Alternative Opportunities*. Textile World. No volume page num etc Retrieved from http://www.textileworld.com/Articles/2014/June/Innovative_Spinners_Look_For_Opportunities

Philp, M. (2014, December). *Hello Possums.* Kia Ora: Air New Zealand's in-flight magazine. 92-92.

San Blue Enterprises Pvt. Ltd. (2013). *TMC Buys Out Renowned Spinning Facility NUYARN.* Retrieved from http://www.fibre2fashion.com/news/companynews/merino-company/newsdetails.aspx?news_id=121748

Textile View Magazine. (2013, Winter). Reconnect to the Source. *Textile View Magazine*, (104), 258.

The Woolmark Company. (2013). *Woolmark Gold*. Retrieved from http://www.woolmark.com/woolmark-gold

Tolerton, J. (2012). *Clothing and Footwear Manufacturing: From mass market to niche.* Retrieved from http://www.teara.govt.nz/en/clothing-and-footwear manufacturing/page-3

 Woolyarns. (2015). *Perino*. Retrieved from http://woolyarns.co.nz/yarns/knitwear-apparel-hosiery-yarns/perino-yarns/

YIM. (2015). *About YIM*. Retrieved from http://www.y-i-m.com/about_yim.html

IMAGE LIST

Fig 1 -
Auhtor's own 2015

Fig 2 -
Author's own 2015

Fig 3 -
http://www.merinomink.com/

Fig 4 -
http://us.icebreaker.com/en/firstlayers/aero-long-sleeve-half-
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Fig 5 -
http://www.tdl.aut.ac.nz/showcase/digital-prints

Fig 6 -
Author's own 2015

Fig 7 -
Author's own 2014

Fig 8 -
Author's own 2014

Fig 9 -
Author's own 2014
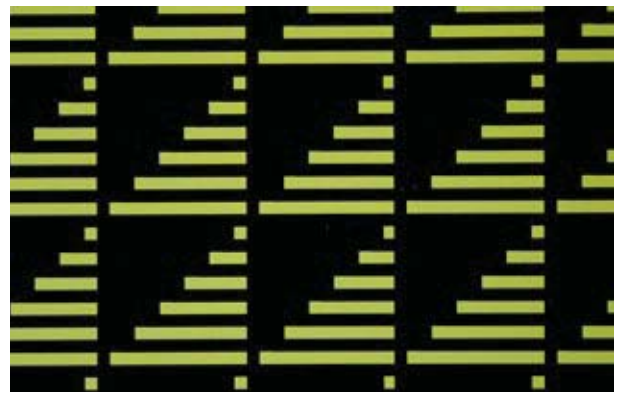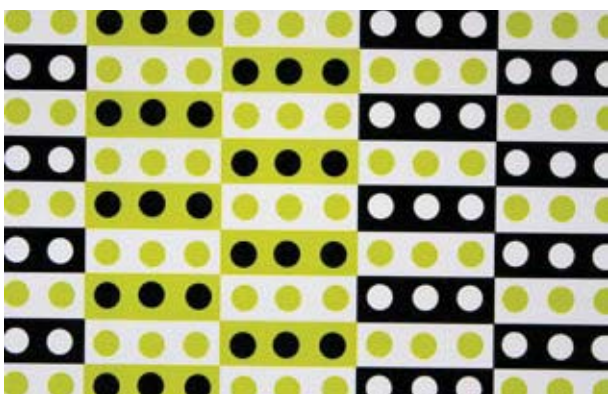

Fig 10 -
Author's own 2015

Fig 11 -
Author's own 2014

Fig 12 -
Andy Wynne 2014

IMAGE LIST

Fig 13 -
Textile View Magazine 2014

Fig 14 -
Textile View Magazine 2014

Fig 15 -
Textile View Magazine 2014

Fig 16 -
Author's own 2014

Fig 17 -
Author's own 2014
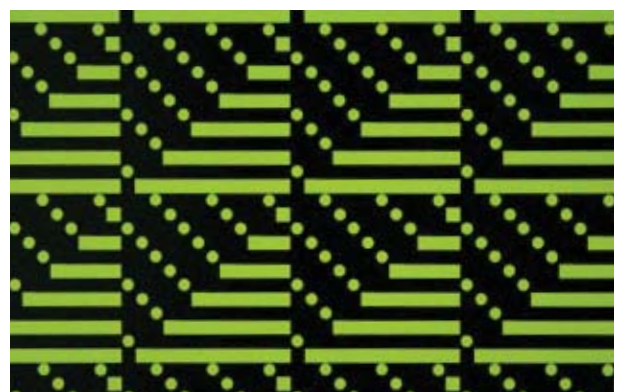
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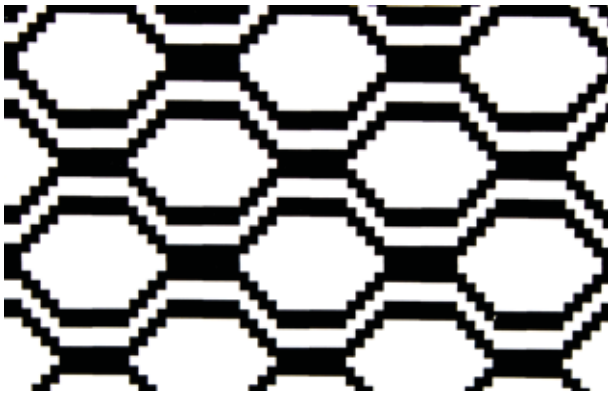
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Fig 20 -
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Fig 21 -
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Fig 22 -
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Fig 23 -
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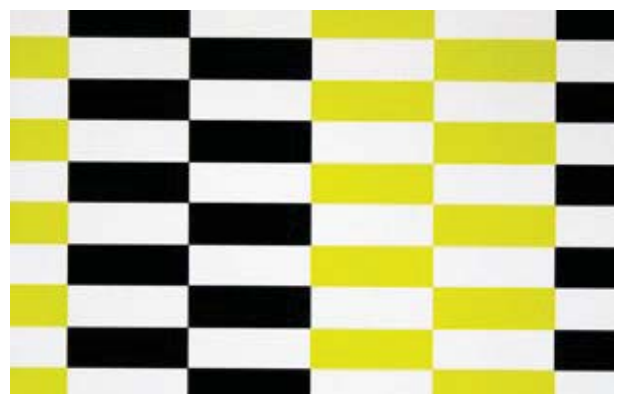
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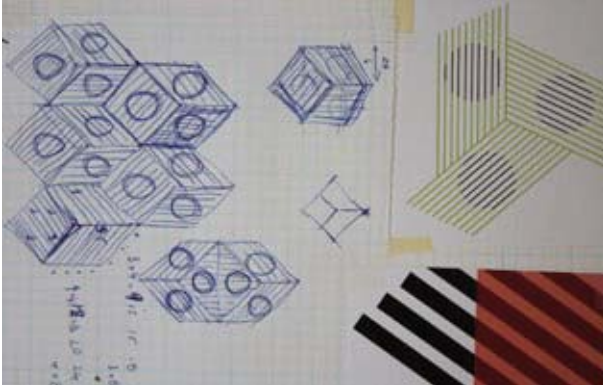
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Fig 26 -
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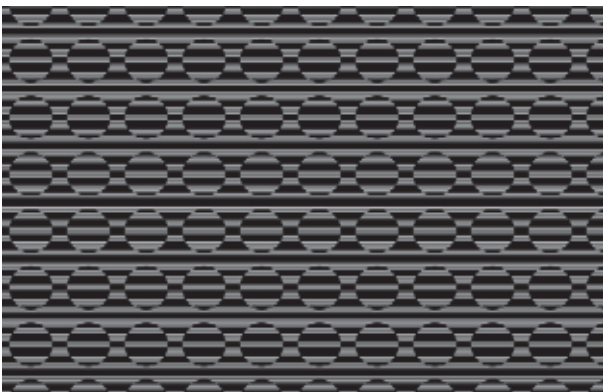
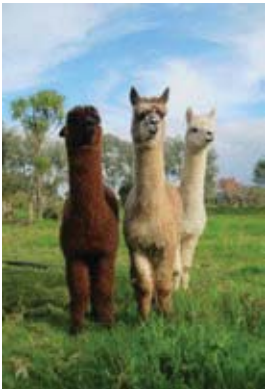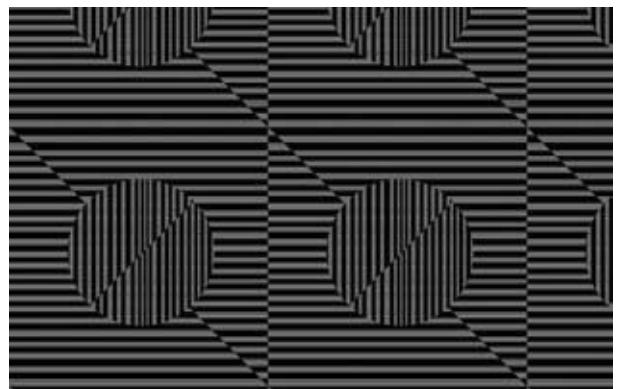

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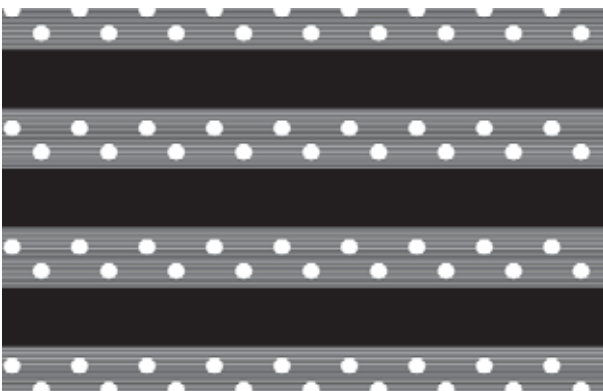
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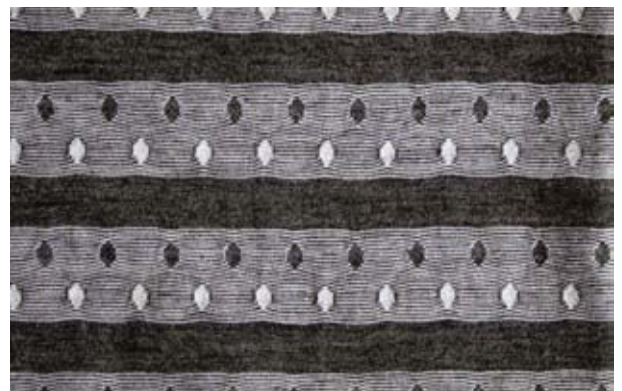
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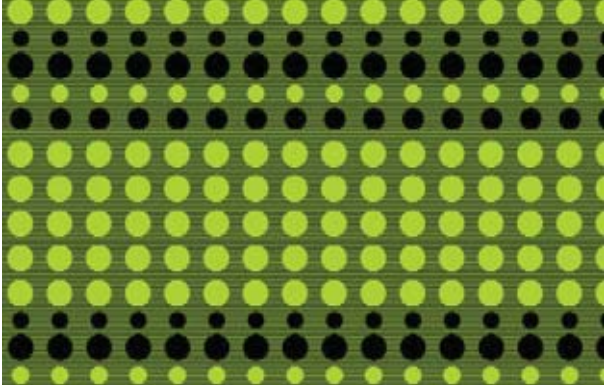
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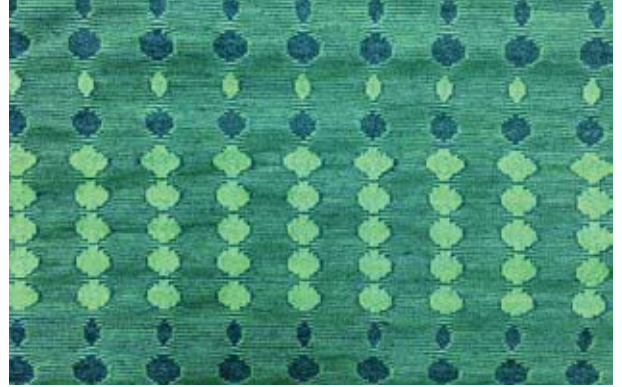
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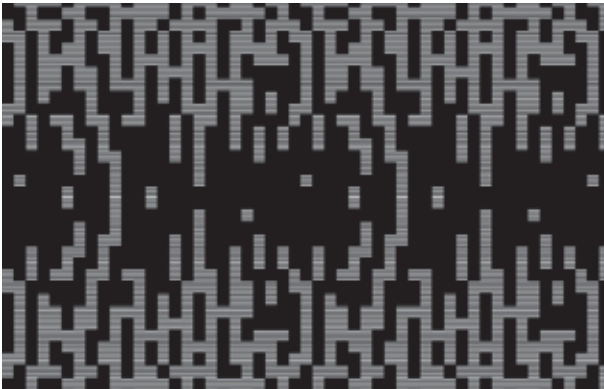
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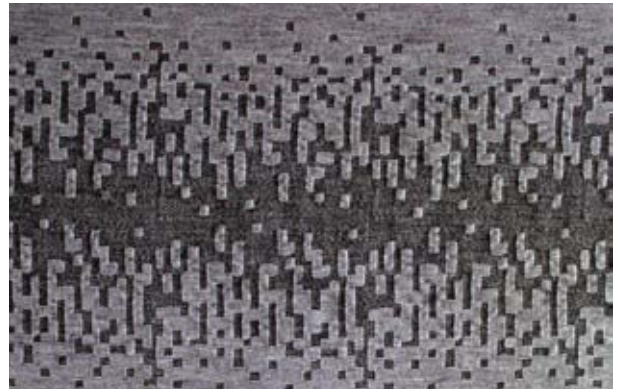
Fig 34 -
Author's own 2014

Fig 35 -
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Fig 36 -
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Fig 37 -
Author's own 2014

Fig 38 -
Author's own 2014

Fig 39 -
http://theguiltysheep.blogspot.co.nz/2013_07_01_archive.html

Fig 40 -
Author's own 2014

Fig 41 -
Author's own 2014
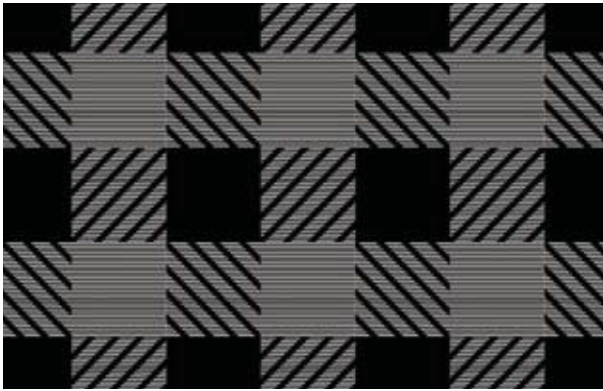

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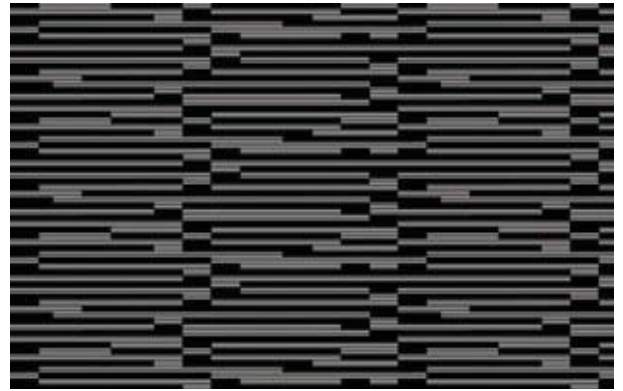Author's own 2014

Fig 43 -
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Fig 44 -
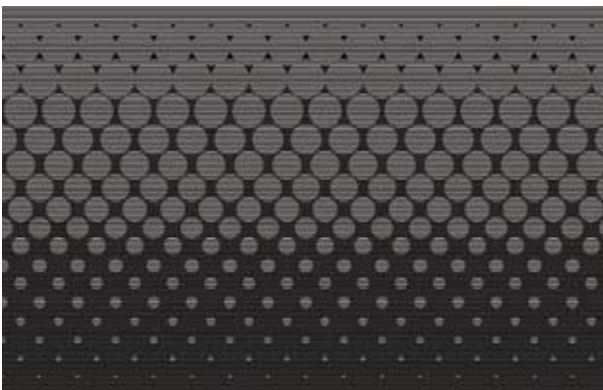Author's own 2014
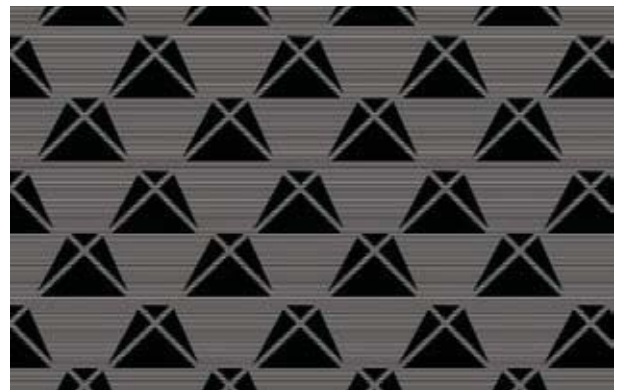

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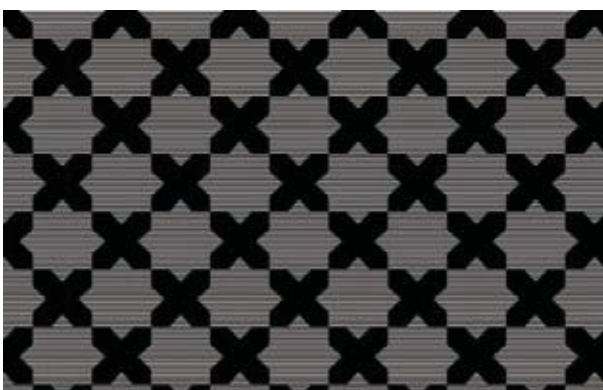

Fig 46 -
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Fig 47 -
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Fig 48 -
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Fig 49 -
Author's own 2014

Fig 50 -
Author's own 2014

Fig 51 -
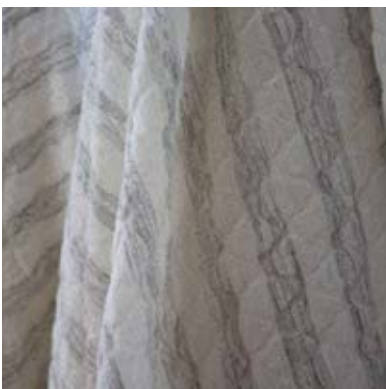Author's own 2014

Fig 52 -
Author's own 2014

Fig 53 -
Author's own 2014

Fig 54 -
Author's own 2014

Fig 55 -
Author's own 2014

Fig 56 -
Author's own 2014

Fig 57 -
Author's own 2014

Fig 58 -
Levana, March 1987
Property of Levana Textiles

GLOSSARY OF TERMS

The glossary is a personal perspective of the meaning of words, phrases and terms used in relation to this exegesis.

Alpaca Fibre - Natural fibre from alpaca fleece

Bamboo Fibre - Cellulose fibre from bamboo plant

Cellulose - Cellulose fibres are man-made fibres, regenerated from natural cellulose

Cotton - A cellulose fibre derived from cotton plant

Crimp - The number of bends per unit length along the wool fibre

Double jersey - A fabric produced on a knitting machine with two sets of needles, producing a thicker fabric

Dyneema™ - Trade name for ultra high molecular weight polyethylene

FDS™ Knitting Software - Computer software Levana use to develop pattern for jacquards

Fibre - A filament or thread that a textile is formed from

FR Lenzing™ - Trademarked Fire Resistant cellulose fibre

Gilling - The action of using a gill box while combing

Innovation -Introduction of new things or methods

Iterative design - Developing and refining a design through discovery, feedback and evaluation.

Jacquard - An elaborate pattern in a knitted textile using a jacquard knitting machine

Merino Fibre - The fiber from merino sheep

Methodology - A system of methods, rules and principles, to regulate design

Modal™ - Trademark name for a semi-synthetic cellulose fibre

Niche - A distinct segment of a market

Nuyarn™ - A trademarked process of spinning yarn

Photoshop™ - Adobe™ computer software for image editing

Possum fibre - Protein fibre from the possum

Punchcard - Process for creating patterning on knitting machines

Research and development (R&D) - An investigation into a particular field with the intent of finding a discovery

Roving - Prepares the fibre for spinning by rubbing the fibre together loosely through rubber aprons

Scales - Cuticle cells seen under microscope on animal fibres

Silk Fiber - A filament from the cocoon of the silkworm

Soy - Derived from the soybean

Spinning - Creating continuous length of fibre through spinning of fibre

Staple length - Reference to length of a fibre

Sustainable - Capable of being maintained leaving no long-term consequences on the environment

Tencel™ - A cellulose fibre made from wood pulp

Tex - Unit of weight used to measure the density of yarn

Viscose - A synthetic fabric also known as rayon

Warp - The yarn that runs vertically through the fabric

Weft - The yarn that runs horizontally through the fabric

Wicking - Absorb or draw off liquid

Yield - A unit of measurement

APPENDIX

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named below are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the research(s), please contact Professor John O'Neil, Director (Research Ethics), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".

John O Neill (Professor)
Chair, Human Ethics chairs' Committee and Director (Research Ethics)

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