Hima & Kaffi

A Study of a Weaving Mill and the Textile Design Process
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Abstract
This thesis is a study of a Norwegian weaving mill called Gudbrandsdalens Uldvarefabrik, also known as GU. GU is a vertically integrated woollen mill that is specialized in producing woollen textiles for upholstery and Norwegian folk costumes. The objective of in this study was to gain knowledge about the processes, and the role of a textile designer in a weaving mill.

The study was conducted during an internship in the mill in 2016, and the written report is dealt into two. The first part consists of a written approach to the mill, its working methods and processes. The second part is a description of an individual design project of two upholstery textiles, Hima and Kaffi.

The internship, the study and the productive part together gave me a holistic understanding of the complexity and demands of textile industry and product development. One of the textiles, Hima, was chosen to the company’s collection, and the end result showed the contrast between a low-pressured thesis project and the commercial world, where the stakes are higher, where choices have a bigger impact.

Keywords  textile design, woven textiles, upholstery textiles, weaving mill
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TABLE OF CONTENTS

1 Introduction

2 Purpose of the Study
   2.1 Main Objective and the Research Question
   2.2 Research Methods

3 Introducing Gudbrandsdalens Uldvarefabrik
   3.1 The mill
   3.2 The Departments and Processes
      3.2.1 Dyeing
      3.2.2 Preparing the fibres: Opening and Carding
      3.2.3 Spinning, Twisting, Doubling
      3.2.4 Well Warped is Half Woven
      3.2.5 The Weaving Department
      3.2.6 Wet and Dry Finishings

4 The Design Project
   4.1 The Assignment
      4.1.1 What and How
      4.1.2 Project Plan
   4.2 Part I: Work that Requires a lot of Sitting
      4.2.1 Data Collection
      4.2.2 The Markets and the Clients Point of View
      4.2.3 Textile Design and Product Development
      4.2.4 Values
   4.3 Part II: Work that Requires a lot of Walking
      4.3.1 Conclusions of the Interview
      4.3.2 Hima & Kaffi
      4.3.3 Woven Structures and Materials
      4.3.4 Test Weaves
   4.4 Part III: RUN, DESIGNER, RUN!
      4.4.1 Colourways and woven samples
      4.4.2 Finishings
      4.4.3 Internal Testing Laboratory

5 Designs and Portfolio

6 Conclusions

7 Reflections

8 References
1 INTRODUCTION

On May 2016 I arrived in Lillehammer, Norway, to work as an intern at Gudbrandsdalens Uldvarefabrik weaving mill (GU). The mill is specialised in producing woollen fabrics for interior and Norwegian folk costumes, and is one of the leading textile producers in Norway. I had met the in-house designer and product developer, Ragnhild Nordhagen, two years earlier at a digital weave design course at Bergen Academy of Arts and Design. Later, when it was time to find a place for internship, I remembered her stories of her work. I contacted her and asked if they might have a place for an intern. Lucky for me, they said yes.

As a textile design intern at GU my main task in the mill was to assist the in-house designer. I also started my own design project for GU, which I will present in this thesis. In this project I design and produce two upholstery fabrics that in my view would complement GU’s future collections. These textiles will also be presented to the mill in the end of this project. My motivation stems from the will to learn the design process in a weaving mill, and to fully comprehend which stages and procedures stand in-between sketches on paper and a finished woven fabric on a roll. Woven textiles had been the main interest in my studies quite early on. It was the puzzle of building bindings, the tranquillity of the process and the multiple possibilities that kept me fascinated.

To fully understand the mills needs and what’s going on in the Nordic interior markets I interviewed GU’s marketing people, their customers as well as Finnish and Norwegian textile designers. Also a good deal of the information in this thesis came from the informal interactions in daily work. In the design process, adapting GU’s design philosophy was essential as well. In order to deliver a good design it is essential to make sure that it lives up to the standards that the mill sets for its own products. The research combined with GU’s design philosophy formed the backbone of my designs. The result comes in two upholstery fabric designs: Kaffi and Hima.

My thesis consists of two parts. The first part introduces the Gudbrandsdalens Uldvarefabrik weaving mill and how it functions. The second part demonstrates the product development by introducing the design project for this thesis. For confidential reasons this thesis does not include detailed information of the processes.
2 PURPOSE OF THE STUDY

2.1 Main Objective and Research Question

In my textile design studies at Aalto University I had learned the techniques and design processes, nevertheless I was unfamiliar with how these skills were utilized in the working life. The objective of this thesis is to define the product development process and the role of a textile designer in a weaving mill. As the study was conducted in GU, the main research question is:

How to design a textile in a vertically integrated woollen mill specialised in middle and high end upholstery fabrics?

Typically the mill may spend a lot of time on product development to achieve the high quality standards they’re aiming for, and could easily spend months, even years for one project. As there was a limited time for my project, I also examine the possibilities to perform a product development project in a shorter time frame. In order to know how to plan the design process, I need to know which tasks must be prioritized, and whether there are stages that could be left out.

2.3 Research Methods

Before starting to work in the design department, I went through a month-long introduction period to the mill. In practice I worked in each department of the mill for a week, learning from the workers and getting involved in the production as much as a first-timer could. Many members of the staff had worked for the mill for decades, even for 30 years, and a good deal of their knowledge and the tricks of the trade were gained by years of experience. The conversations with the staff were variably in either English or in a mix of Norwegian and Swedish, so the textile terminology became familiar in those languages as well.

The purpose of the introduction period was to provide a thorough education of the complexity of the production, from the beginning to the end. As a vertically integrated woollen mill, GU was an ideal place for learning about the textile production.

Every week I wrote reports of the work, and in the end of the week I went through them together with the Quality Director Frode Svarstad, who also supervised my introduction period. In the conversations I could reflect the previous week and get specifications and clarifications to each subject. In July 2016 I wrote a summary of these reports using supporting litterature (see: ooooo). This summary served as a base for the first part of this thesis, where I describe the processes in the mill. The information learned during the introduction was a holistic description about the processes in GU. Litterature in textile technology provided supporting facts and information about textile industry in general. For example, Handbook of Weaving

In the design project, the intention was to learn the product development process by following the same schedule as the in-house would in a product development project. The object in this project was to create designs that would bring something new to GU’s collection, and at the same time relate to GU’s identity. In order to achieve this goal, the project started with a thorough research that included gathering of visual material and inspiration, and informal interviews with people from various backgrounds. Also, Victoria Fislages Masters Thesis “Textiles in Transit - An Investigation of Contract Textiles in Airport Terminals” was an important source for information about standards and requirements for upholstery textiles in the contract market.

Figure 1. Notes and corrected reports.
3 GUDBRANDSDALENS ULDVAREFABRIK
3.1 The Mill

Gudbrandsdalens Uldvarefabrik is a 130-year-old family business located in Lillehammer, Norway. Since the mill is a vertically integrated woollen mill, all the processes in textile production, ranging from the yarn production to the finished fabric on rolls, are under the same roof. The mill produces yarns, as well as weaves, dyes, finishes and sells the goods directly to both furniture manufacturers and retailers. According to GU’s Quality Director Frode Svarstad, having all of the processes inside one mill is rare in Europe, with many of the mill’s competitors being specialized in only selected stages of the production. The advantages of integrated woollen mills is that they can fully control the whole process and therefore do not have to depend on other manufacturers. Being able to control the design, quality and materials also provides flexibility and a possibility for smaller volume production.

GU is specialized in woollen textiles, and the majority of the mills products are upholstery textiles. These designs are presented in the standard collection, which consisted of 22 textiles in Autumn 2016. The oldest and the most popular design in the collection is Hallingdal, which was published already in 1965. GU also develops custom made textiles for

Figure 2. Designs from the mill’s selection. Hallingdal, Jostedal (above) and Hemsedal (below, left) are from the standard collection. Trønderforkle (below, right) is a bunad fabric.
clients, and works in collaborations with designers outside the mill as well. In addition to this, the mill also produces clothing textiles for the Norwegian folk costume bunad. According to Ragnhild Nordhagen, after taking over the bunad production from Mandal weaving mill in December 2015, GU became the biggest bunad producer in Norway.

3.2 The departments and processes

The mill is divided into departments, which perform various stages in the production, namely dyeing, carding, spinning, twisting, warping, weaving, finishings, and mending. Each department has its own team of 2-10 persons, and each team has its own responsibilities. The team leader has an important role in managing the production schedule and handling challenges, such as delays and unexpected situations. Each shift starts with a team meeting that updates the day’s production schedule.

Workers in the department are experts in their own areas. During my internship I learned that since every stage of the production is complex, the workers might not be familiar with the tasks in other departments. Nevertheless, the value of each process is understood, and everyone knows how their work affects other departments. For example, if yarns are not ready in time, the dyeing and weaving department will be delayed as well. Therefore, the departments communicate with each other and inform of detected flaws and delays.

3.2.1 Dyeing

The dyeing department dyes fibres in three forms: as loose fibres, as yarns and as woven textiles. The in-house designer Ragnhild Nordhagen explained that loose stock dyeing is preferred when the purpose is to produce mélange yarns. Yarns spun in GU are typically made of wool and viscose, and as loose stock they are dyed separately due to their different responses to dyes. Nordhagen continues that the advantage in piece dyeing is the flexibility, since it provides a possibility to weave raw material that can be stored and dyed “according to orders that come in.”

Colours are carefully controlled during the dyeing processes. Every dyeing wash is paused in order to cut a sample for the control. The samples are monitored on a computer with a colour control program, which measures the lightness and saturation of the colour.

3.2.2 Preparing the fibres: Opening and Carding

In the departments that are responsible for opening and carding I learned, that the purpose of these processes is to prepare the fibres for spinning. Before the preparations the loose stock is in tangled lumps, which must be opened. The first thing to do is open the tangles and separate the fibres from each other in a process called opening. Here the
different fibres, wool and viscose, are blended evenly in different measures, depending on the wanted result. The blend becomes so even that, for example, a mix of black wool and white viscose results in a lively grey mass. Yarns that are a blend of two different colours are called mélange yarns. The mill produces both mélange and uni-coloured yarns.

According to Frode Svarstad, the wool delivered to GU for the yarn production is cleaned and washed by the supplier. The reason is the significant amount of nature-based dirt raw wool contains. Washing cleans the fibres from excess dirt, such as grass, seeds, and sweat, but it also removes most of the natural fat. To replace the fat, the fibres are sprayed with spinning oil when wool and viscose are blended. Spinning oil is a synthetic based, environmental friendly lubricant that improves fibre cohesion and shields from fibre breakage. (Sinclair, 2014, 198; Boncamper, 2011, 163)

The next step in the process is carding. Carding is a mechanical process that combs the tangled fibres into a more aligned position, and forms them into continuous threads that can be later spun into yarns. In order to rearrange the fibres, they must be separated almost to a single-fiber state. This happens, when the material is taken through several, rotating cylinder covered with short but sharp spikes. Carding also enables cleaning the fibres from vegetable impurities that it still contains. The impurities are crushed and shaken off, so that the dust would fall down along with extremely short fibres to a basement that lies underneath the machinery. As one can imagine, the process also produces a significant amount of dust.

Carded, roughly parallel fibres are called roving. The yarn count, that is the thickness of the yarn, is also determined in carding process. In GU, the yarn count is counted in Nm numbers, which tells the meters of yarn per one kilogram (Adanur, 2001).

3.2.3 Spinning, Winding, Doubling and Twisting

The weak roving threads are strengthened in the spinning process. Ring spinning is one of the most common spinning methods in the industry. In practice, yarns are formed by a traveler that twists the fibres while rotating around a cone. (Adanur, 2001)

The yarn count determines the amount of twists per meter. Thin yarns contain fewer fibres compared to thicker ones, and are therefore weaker. In order to increase the strength they require more twist. Yarn count is carefully controlled during ring spinning process by weighing the yarns.

During the process, yarns are spun onto small cones, called spinner’s packages or bobbins, that would run empty quickly in further processes, such as weaving or warping. Therefore, yarns of several bobbins are wounded onto a single cone. Winding also gives a chance to control the yarn quality. The machine detects all irregularities in the yarn, such as
thicknesses, loose yarns or slubs, and cuts the yarn whenever one is found. The working tempo in this department is fast, as the cut yarns must be fixed frequently, and the empty bobbins must be changed into new ones.

Winded and controlled yarns are ready for doubling. As the name indicates, this process combines two or more yarns by winding. Different thicknesses can be combined as well to gain interesting effects. Doubling prepares the yarns for twisting, where the combined yarns are twisted together. These two processes give the yarn more strength and volume. Twisting is the last stage in yarn production, if the yarn batch is not meant to be dyed.

3.2.4 Well Warped is Half Woven

A woven textile is formed by interlacing warp yarns, or warp ends, with weft yarns. The warp is attached to the weaving machine that keeps the yarns under a right tension, while the weft is inserted. The modern weaving technology has set more demands on warp preparations. The weaving speed is faster, and the warp must have a uniform tension as well as endure the frictional abrasion and stress during weaving. (Adanur 2001, 49; Holyoke 2013, 66)

In GU the warps are prepared in a process called sectional warping. Sectional warping good for small and customised production, such as striped warp, and for specialized yarns. This method consists of two stages. In the first stage, called warping, the warp is built by winding yarns on a warping drum in several small sections. Once all of the yarns are on the warping drum, they are transferred onto the weavers beam by unwinding drum. This second stage is called beaming.

Throughout the whole process, there is a constant pull keeping the yarns tight. The yarns, the drum and the beam are so to speak braking constantly in order to create tension and to pack the warp tight. To secure an equal winding hardness,
the tension has to be constant throughout the whole warp length by adjusting the braking force. Variation in warp tension can cause irregularities in the woven fabric during weaving. (Adanur 2001, 49; Svarstad 2001)

How well the warping is done affects the production in the long run. Fixing mistakes, such as twisted yarns and knots, take time in the weaving and mending departments and slow down the production. Since warps for industrial weaving can be tens, even hundreds of meters long, a warp cannot be remade. As Svarstad noted, “well warped is half woven”.

### 3.2.5 The weaving department

There are two kinds of weaving machines, or looms, in the weaving department: dobby and jacquard looms. The main difference between these two is the way warp yarns are controlled. In dobby looms, the warp ends are lifted in a regular order by shafts. The amount of shafts determines how big the woven pattern can be. In jacquard looms, the heddles that control the warp ends, can be controlled individually. Therefore there are no limitations to the size of the pattern. (Sinclair, 2014)

In GU, dobby looms are used for weaving designs with small scale patterns. These kinds of designs are Odal (figure 5) and Hallingdal. As Hallingdal is the most popular design, one loom is especially reserved for weaving this design in

![Figure 4. Sectional warping.](image)
particular. The jacquard looms are used to weave intricate and complex designs, such as bunad textiles. Bunad is a Norwegian folk costume, and the textiles used for the clothes are often full of traditional patterns.

Yarns produced in GU are all used for weaving, and the mill purchases yarns from outside as well. Every yarn batch from the dyeing department is used separately. This means that yarns from different batches are never used as a weft in the same fabric, because these yarns might have slight differences in the shade of the colour. The difference can seem small when the yarns are in cones, but the difference can be more visible on a woven fabric. The designs are woven on either custom-made warps, or on a standard warps. The warp built up from a fine, wool and polyamid yarn.

**Wet and dry finishings**

A ready, woven textile that is taken off the loom is in ‘loom-state’, and needs finishing processes to improve the qualities and render the fabric in a condition that is ready to use (Sinclair, 2014, 283). After the fabric is taken off a loom, it is taken to the mending department, where every single woven meter is mended by
hand. These textiles will also go through finishing treatments. There are two departments in the mill that take care of these processes: wet and dry finishing departments.

**The department of wet finishings** is responsible for washing, drying, milling, fixing and carbonising. **Washing** is usually the first of the finishings, and also a process that is done to every design in the mill. The purpose is to clean the fabric from last traces of spinning oil and other impurities, and to prepare it for other finishings. Dyed textiles do not require washing, since the dyeing wash removes the excess oil.

According to the staff member of the department, washing also prepares the fabric for **drying and stretching**. Even moisture content in the fabric enables an even result after the treatment. In the process, the fabric is attached on a frame that stretches it horizontally to its final width, and pulled through a drying oven. (Sinclair 2014, 465)

**Milling** is a process that is also known as felting. According to the department leader, ability to felt is characteristic for wool. When helping in the process I learned that the aim in this here is to make the fabric more full and dense by felting and shrinking. The treatment also affects the appearance, elasticity and strength. In practice, the fabric is sewn together from its ends and run it in the machine in a loop, using water and milling aids, such as soap and soda. During milling the fabric becomes very warm afterwards due to the speed and pressure of the process.

**Fixing** is a process that provides shape retention and stability to the fabric. As the fibres would shrink when exposed to heat, this process stabilizes the internal structures with higher temperatures than the textiles would encounter later in the production or in consumer use. After the treatment the state of the fabric is permanent, and can be changed only by treating it in a higher temperature. (Sinclair 2014, 465)

The purpose of **carbonising** is to remove the cellulosic impurities trapped in the wool, such as grass, splinters and seeds. The fabric is treated with sulphuric acid that chars the cellulosic fibres in high temperature. The charred impurities would afterwards appear as dark spots on the fabric. These brittle parts are easy to remove by shaking mechanically. The fabric is washed and neutralized after the treatment.

**The dry finishing department** is responsible for processes such as shearing and decatising. The workers also control the finished products for the last time before taking them to the mills storage. **Shearing** is reducing the surface hair of a textile by cutting with sharp blades. The reduces pilling and brings softness (Sinclair 2014, 722). As upholstery and clothing textiles are in close contact with skin, tactile properties have a high importance. Cutting off the excess fibres from the surface can also make the colour seem deeper.

**Decatising** process is used for woollen and woollen blended fabrics. Ragnvald Svarstad, who is a member of the owner family, told how the function of the process is to relax various stresses built up in the material during spinning and weaving, and to stabilize the fibres into a new and desired construction.
Stabilization prevents shrinking and limits unpredictability when working with a finished fabric, for example in clothing industry. Decatising is the final process responsible for the appearance and handle of the fabric. The machine controls pressure, heat, humidity and speed. By adjusting these factors one has a countless amount of combinations and different effects. In addition to this, each fabric quality responds differently depending on the density, material and thickness.

**Testing laboratory**

Frode Svarstad explained, how all upholstery fabrics are expected to have certificates as a proof of endurance and safety of the product. These certificates are granted according to standardised tests, such as Martindale abrasion and pilling tests and fire resistance tests. In order to ensure objectivity, the certificates are granted only for tests performed by someone else than the manufacturer. GU has its own laboratory in the mill where the fabrics can be tested during the product development to see whether something must be improved. The laboratory is equipped to test fire resistance, abrasion, pilling, and stretching.
4 THE DESIGN PROJECT
4.1 THE ASSIGNMENT

Going through the background: what, why and how
4.1.1 What and How

I started working in the design department right after the introduction month in August 2016. That was also the time I started to work on my Bachelor thesis. It had been planned beforehand that the thesis would be integrated to the internship and developed in GU’s facilities. The only thing that was not yet decided, was the topic itself.

During the first month I had gone through different options that I found interesting. For some time I considered on conducting a research related to weaving mills in Scandinavia and thought of using my experience in GU as a case study. Because I was interested to learn the design process in a mill as well, I decided to do a design project. During the introduction Svarstad stressed how valuable it is for a designer to fully understand the work behind the designs. The knowledge gives the designer the ability to recognize what can and cannot be done. Knowing this, a design project seemed to be an even better idea.

Performing a thesis project during an internship is common among design students, as it is an effective way to learn about the industry in detail. Textile design student Lotta Paananen (2017) conducted a material research for her Bachelor thesis during her internship at Lodetex Spa weaving mill in Italy. She studied the combination of digital printing on woven textiles with a pattern or a three-dimensional structure. Tiina Paavilainen (2015), who did her design project for her Masters thesis in the same company, studied the various possibilities of weft floats and clipping finishings on woven textiles. In her study she utilized practice-led research and and lessons she learned from the professionals at the mill.

To have a goal for a textile design project, I decided to design two upholstery textiles for GU. During the introduction I had seen from close distance a wide variety of these fabrics, their advantages and challenges and how they were produced. Using this experience as a starting point, I decided to designs fabrics that would be my interpretation of what could complement the mills existing collections.

4.1.2 Project plan

At the time I started working on this project, I had nine weeks of internship left. The aim was to have finished, woven samples of the two designs on the ninth week. In order to get everything done within these weeks, I had to have a carefully planned schedule for the project. As a model for the timetable I used a project plan that was used in product development in the mill. I also received help with the planning from Ragnhild Nordhagen.

As mentioned before, GU can spend a long time on one product development project. One of the reasons is that the mill has the ability to control all of the stages of the production. As one can imagine, the project plan is therefore very detailed. As the time I had was relatively short, some tasks, such dyeing, had to be left out. Also, because of the small volume of this project, designing of yarns and the warp were not my list.
I divided the schedule into three stages. The first stage consisted of work that required a good deal of sitting: researching and designing the concepts. The second stage was more about legwork: designing the woven structures and trying them with different materials in the weaving department. In the third stage I did most of the final preparations, such as weaving the final samples and testing them with standardised tests. The final task was to present the designs for the senior management team.
4.2

PART I: WORK THAT REQUIRES A LOT OF SITTING

Starting the project with a thorough research
4.2.1 Data collection

In order to find out what new I could bring to GU’s collection, and what I had to know about upholstery textiles, I started my research with informal interviews. Seven of the interviews took place within a week in the middle of August 2016 via e-mail, meeting at the mill and telephone. One of the interviews was done by e-mail in March 2017. I prepared 3-4 questions beforehand, but most of the questions came up during the conversations.

I talked with experts from various backgrounds. These people talked about the clients point of view: Marius Gjerde (MG) and Anita Tønnessen (AT) from GU’s marketing department, and two furniture manufacturers and GU’s clients (here as AB and CD), who preferred to remain anonymous.

These people talked about the textile design and trends in the interior world: freelance designer Sari Syväluoma (SS), designer Ragnhild Nordhagen (RN) from GU, designer Pernille Stoltze (PS) from Scandinavian Business Seating, and teacher Heidi Paavilainen (HP) from Aalto University.

The information in the following chapter is gathered from the conversations and supporting litterature. There were three main themes that occurred in the interviews: the markets and their requirements, the design, and the increasing importance of comfort.

4.2.2 The Markets and the Clients Point of view

People at GU’s marketing department are in close contact with the clients, and have a lot of knowledge of the markets and the customers. Knowing what kind of textiles sell the most and what requirements the clients have had, they have an impression of what is going on in the interior markets.

According to MG and AT, the mill produces textiles for both contract and home markets. Contract textiles are developed for public spaces and buildings. Due to the demanding usage of these textiles they have high technical requirements regaring endurance and safety. (Fislage 2012, 15) RN described home market as a diverse segment. The standards here are not as high as in the contract market.

GU textiles are targeted for the higher mid-end and high-end segments. Customers in these segments are willing to invest in the quality and use the same textile for years, rather than going for the lowest prices and changing the fabrics often. As people are looking for long-lasting solutions, they have very high standards for what makes a good upholstery textile.

GU informs the clients of the quality of each design by attaching a tag with information about the technical properties, such as material, fire resistance and so forth. In addition to the technical information, customers trust their intuition. Therefore the visual and tactical properties of the design are very important. According to AT, the weight of a textile gives an impression of strength. GU products are often thick and heavy, which gives an impression of strength and quality. Also, thin textiles that one can look through when the textile is held against light, often seem too weak for upholstery.
AB, a seating manufacturer, agrees on the importance of the look and hand of the textile. As an office furniture manufacturer, he told that slightly robust upholstery is good for chairs where people sit for long time. They intend to avoid too slippery upholstery, so that the person sitting would not slide off the chair:

All of the interviewees agreed that when it comes to higher prices and long lasting decision people often tend to make the safest choices. In Scandinavia, the best selling colours are the neutrals, such as grey and beige, and it is important that the colour map for textiles include a good variety of these colours. Colours are among the first things one sees in a room, and thus it is often the main criteria for choosing textiles (Fislage 2012, 20). Neutral tones combined with subtle or classical patterns are easy to combine with other materials and colourways in the interior. CD, who is a furniture manufacturer as well, adds that textiles with a clear direction in the pattern dictate how the fabric can be upholstered. For example, textiles without a pattern can be turned and placed more freely.

### 4.2.3 Textile Design and Product Development

While working in GU I learned the main difference between a designer and a product developer. In a broad sense, a textile designer creates concepts, and a product developer executes the designs. The task of the mills in-house designer is to create the concepts, and work in with product development. As the chain of production is complex, the product development is done with a close contact with the experts in the mill, department leaders, and marketing. In the data collection, I was interested to learn about product development in detail, and to know what one must take in consideration when designing a textile.

One of the first things that has to be defined when starting to develop a textile is the expected lifespan of the product. Is it for people who follow trends, and renew the furnishing accordingly and often, or is it for those who want to invest in good quality and use the same fabrics for years? The question is answered by defining the target group and the use of the textile.

What affects on the lifespan, as well as other properties such as endurance and safety, are materials and structural characteristics (Fislage 2012, 16). There are several yarn properties that affect the hand and endurance of the textile, such as type of fiber, yarn number; twist, woven structures, density, shrinkage, and weight.

It is also essential to know what kind of pressure the textile is under, when it is in use. Knowing this, the fabric can be prepared to endure stresses such as pressing, bending, stretching, pilling. RN explained that in the contract market, the standard for abrasion resistance is 50 000 martindales. The Martindale method is a standardised testing method widely used in Europe (Fislage 2012). They have also seen contractors with using higher requirements, such as 100 000 or even 200 000, and this is what they call an inflation in numbers. In the home markets the standards can vary from 25 000 to 50 000. The mill aims for 50 000 martindales, but according to RN 30 000 - 40 000 are also acceptable, if they are developing a textile for a client in the home segment, who has lower standards.
The product development in GU sometimes includes designing of yarns, since the structure of a yarn can change remarkably the tactile properties and “behaviour” of a textile. At the same time it is important to a round estimate the price per meter that the target group is prepared to pay. Materials, the number of processes and the weight of the product together add in the sum. For example, heavy fabrics have more raw material in them, and are therefore more expensive than light fabrics.

RN explained that in order to reach the high standards the mill sets for its products, the product development can require a long time. The fast moving trends do not dictate the design process, but rather trust their intuition. but the product development team keeps an eye on the coming colours and values in the interior world.

### 4.2.4 Values

In a conversation with PS I learned that the aspect of comfort and the wellbeing of an individual has become more and more important in the private and public sectors. PS, who is a designer at Scandinavian Business Seating, gives an example from her field. In the 90’s office chairs were designed to be mainly ergonomic, rather than visually pleasing. Today, the workers are wanted to feel themselves more at home, and it is believed that the working conditions are improved by creating a more comfortable atmosphere. Pleasing colours, forms and textures have become very important selection criterion.

HP confirms, that this is a slow moving trend that has evolved gradually through decades. Common view in futures studies and trend research is that due to economically and politically difficult times, people are buying more traditional products and paying attention to comfort. As AB noted, when people travel less and spend more time at home, they start to pay attention to the interior and plan how it could be improved.

PS argues that as the focus is now more on structures, tactile properties and natural materials, people are more aware of what the products contain and interested to know where they were made. In Scandinavia, wool and local production have become valuable. In comparison, synthetic fibres were hot in the 90’s.

PS noted that modern offices are now visually more equal to home. MG adds that nowadays it is possible to develop a textile that could be sold in both contract and home markets. At that time the mill was developing a new collection of home textiles, and MG mentioned that they could be interested in a design that combines two segments. AT also mentioned that as the mill has a good selection of robust, strong textiles, the collection could complemented with fine and delicate designs as well.
4.3
PART II: WORK THAT REQUIRES A LOT OF WALKING

Building moodboards, choosing the materials and weaving the designs for the first time.
4.3.1 Conclusion of the interviews

The interviews gave me clarity and guidelines to what had to be done. There were two things I was curious about: how to make a comfortable textile, and how to combine home and contract markets. As GU was interested in having more home textiles at that time, it felt important to concentrate on it.

Even though it seemed demanding, a fabric with as diverse target group was interesting among the textile producers. The challenge was the fact that these two segments have very different requirements for textiles. In a nutshell, the home segment has lower standards for technical properties and safety than the contract market. Also, the customers in the home segment are more sensitive with price and colours. The question was, how to design a textile that is both economical and still reaches the high standards of the contract market?

All of the interviewees stressed the importance of neutral and muted colours. At the same time, GU was well known for having large colour maps that included bright, cheerful accent colours, in addition to the neutrals. I also wanted to bring such colour combinations to my designs. Also, in order to relate to GU’s identity, it was clear that the designs should include woollen yarns.

I decided to design two upholstery textiles with different identities and different target groups. On the base of these plans I started collecting pictures and materials for moodboards. The designer Ragnhild Nordhagen advised me to collect more abstract pictures that would communicate the mood and the story and the product identity, rather than give ready-thought ideas of the style, such as images of interiors. The mood is effectively told with pictures of surfaces, colours, things that relate to the story, materials and atmosphere.

4.3.2 Hima and Kaffi

The first design, Hima, was a fine, delicate home textile. ‘Hima’ is a Finnish slang word for home. The moodboard was filled with Nordic imagery: down-to-earth tones, photos of open landscapes, rough nature, and minimalistic design. The colour map was filled with muted colourways that were familiar from the Nordic nature: cold greens, greys, and also shades of burnt orange and ochre. I wanted to create a soft and delicate textile with a marble-like surface that would be easy to blend in in the home interior.

The second textile, Kaffi, was a textile for both public spaces and homes. The name was inspired by a company where I used to work some years earlier. It was a young company with a modern office, where workers and visiting clients were encouraged to feel themselves at home. The coffee they had was from a brewery only two blocks away. The coffee reflected the values Kaffi stood for: excellent ingredients, transparency of the production and good quality. The keywords in this theme were bold, urban and robust. Natural fibres, such as wool, and the robust look and feel were part of the image. In addition to neutral tones of grey and light brown, the colour map also included shades of navy blue and ox blood.
Figure 7. Selected inspiration pictures and colour ideas from Hima’s moodboard.

Figure 8. Selected inspiration pictures and colour ideas from Kaffi’s moodboard.
Woven structures and materials

In a weaving mill, the patterns and play of colours are not printed, but woven. Planning the woven structures is a intriguing puzzle game with warp and wefts. To avoid creating a visible pattern for Hima and Kaffi, I started planning small-scale structures. I looked for inspiration from GU’s standard collection, archive of old designs, and from Franz Donat’s The Large Book of Textiles (1895). The book is a tremendous collection of basic woven structures. Even though it was published over a hundred years ago, the patterns are still relevant and in use.

There are many ways to create an organic, marble-like surface. An irregular woven structure can create interesting surfaces, and the pattern can be hidden with yarns that have irregularities in colour, such as mélange yarns, or in structure, such as slub yarns. Using several different wefts can also change the way the pattern looks like.

The looms that were available for me were the jacquard looms, and therefore the textiles were designed for the standard warp. As the yarns in the standard warp were lightweight and low-cost, it was a suitable choice. The yarn itself is not strong, but a weft-dominating structure shields the warp yarns and prevents breakage. Frode Svarstad explained that this is because upholstery textiles are worn out only from the face-side.

Figure 9. Sketches of woven structures.
I built the structures on either Photoshop or NedGraphics. NedGraphics provided the possibility to simulate the structures with different densities and yarns. The simulating program was a helpful tool, since it was not possible to test weave often. Nevertheless, the reality can turn out to be something different than what the computer suggested. The computer cannot simulate tactical properties, or the behaviour of the fabric, and sometimes colour combinations can seem different when woven. Therefore the simulations had to be regarded more as guidelines.

The strategy was to try to create intriguing surfaces and test them in the weaving department before deciding. After seeing the samples woven I would know how they could be developed, and which patterns would suit best for Hima and Kaffi.

**Test weaves**

There was a possibility to weave samples in the weaving department when there was a free slot in between the production. The woven structure was saved as a .ep-file, and taken to the looms with an USB flash drive. The weavers had a tight schedule every day, so once a designer had a chance to weave tests, everything had to be prepared in order to be effective with the given time. The .ep-file had to be ready, the USB in the pocket, and all yarns ready for weaving.

The first structure I tested, was a braid-like pattern (1). The scale of the structure was larger than what I had expected and the combination of green and blue yarns did not work. As a result I reduced the scale (2) and broke the pattern (3).

These patterns were interesting, but there were two elements that I was not sure about. Firstly, the patterns were still visible, and secondly, the warp floats were
long. As the yarns in the standard warp are not especially strong, the textile is more vulnerable for abrasion if the warp floats were too long.

Frode Svarstad kindly borrowed me notes and papers from his studies in textile engineering. The material included information about the basic woven structures. The papers about tabby derivates was an eye opener. It indicated several interesting effects and surfaces one can create with the most simple structures, and revealed that there is no need for overcomplicated patterns. Throughout my studies I had been concentrating on designing the most complex structures, since in my mind complexity equaled innovation and skill. In reality, oftentimes innovation lies in the most basic things. The study material was an inspiration for sketching tabby derivates on paper.

As mentioned earlier, the look of most simple structures can be changed by using different weft yarns. Thus I decided to weave both Hima and Kaffi with two wefts. One of the wefts in both designs would the same material as the warp. This yarn was also lowered the estimated price per woven meter of my designs. The second weft was a thicker woollen yarn that would highlight the appearance and the handle. As Kaffi is the bold one, the second weft is a thicker, woollen mélange yarn. Hima is the delicate one, so for this design the second is a beautiful, thin mélange yarn. In addition to the appearance, another major criteria for the yarns was that they were easily available for the mill. The chosen weft yarns were found in the yarn storage, where they had a wide supply of their own yarns and from other suppliers. After test weaving the structures and materials I was confident I had found the right structures for Kaffi and Hima.

Figure 11. Kaffi on the left, Hima on the right.
4.4

PART III: RUN, DESIGNER, RUN!

Weaving more, trying finishings and testing the designs in the laboratory
4.4.1 Colourways and Woven Samples

In a weaving mill, the information regarding a design is written on a recipe. The recipe includes information about warp and weft yarns, colours, finishings, and the order of processes. I had planned that I would be able to work on the product recipe after the sixth week of the project. To be able to do so, I was on a hurry to make the final decisions about the colourways for both designs, and possible finishings. Due to practical reasons, most of the colourways in the colour map were as simulations on computer. The reality had to be taken in account when selecting the yarns, as there was a limited range of different yarn colours available in the yarn library.

Weaving was the most reliable way to try how different yarn colours look together. An effective way to try several colours at the time was to weave on a blanket warp. The blanket warp consisted of the eight colours for the standard warp. Each colour section was approximately 20 centimeters wide. By weaving with different colours on weft direction it was possible to create several warp and weft combinations. The warp was set up in the weaving department if it fit in the production schedule. There was another aspect to take in consideration. Every time a warp is changed, a certain amount of the meters is cut to waste in the process. Therefore it was preferable that a warp was changed only when there was enough to weave.

There were two things that had two be decided: the yarn colours, and the order of the colours. As seen in figures 12-17, the colour of the yarns can change the look significantly, even though the structure and materials stay the same. In other words, the number of opportunities is countless. Nevertheless, it had to be remembered that even though the colourways of a design are different in colour, they must be similar in how they are structured. Ragnhild Nordhagen describes this as “the DNA of the product”. Here, the figures 14 and 17 illustrate how Kaffi and Hima were structured. The main selection criterion was the organic look I aimed for in the very beginning.

4.4.2 Finishings

Woven Kaffi and Hima were at this point in loom-state, which means that they have not been treated with finishing processes. Planning of the finishings is also a relevant part of the product development, as the treatments are the final processes that influence the end result.

Many of the GU textiles are washed after weaving, this was also recommended for Hima and Kaffi as well. At first, it seemed very likely that washing and drying would have been the only treatments needed. However, it turned out that the handle of the textiles could be improved. Anita Tønnesen estimated that many might think of Kaffi as too robust. The handle of the fabric is very important for a upholstery fabric. As Kaffi was woven with a woollen yarn, the textile felt itchy on skin. In order to cut off the excess, tickling fibres on the surface the fabric was sent to shearing. The challenge in this treatment was that it takes a while to adjust the settings in the shearing machine, and usually the real effect shows in the fabric after some meters. Despite the fact that the sample of Kaffi was approximately one meter long, the face-side of the fabric lost some amount of the excess
This sample was woven with dark warp, dark first weft and a light second weft. The light second weft pops up from the sample as stripes on a dark surface.

The look changes completely, when the colour of the warp is white. This way, the first, dark red weft creates a vivid pattern. The strong contrast between the warp and wefts makes the pattern seem too restless.

The surface becomes more easy on the eye, when the colour of the warp and second weft are similar. The first weft is a mélange yarn, which creates a more irregular surface, which was exactly what I was looking for.
Figure 15. Hima, example 1.

The weft yarns are here the same and in same order as in figures 12 and 13. The contrast between the warp and wefts is too strong here as well.

Figure 16. Hima, example 2.

The warp and the second weft are very similar in colour, only the second weft is slightly lighter. As the first weft is only a little too dark, it creates wave-like stripes on the surface. Learning from this, I started to search for a yarn colour that was similar in colour saturation, but different in tone.

Figure 17. Hima, example 3.

Here the warp and the second weft are the same as in figure 16, but the first weft is a sky-blue mélange yarn. The result is a blue-shaded grey blend. The colour of the textile seemed to alter depending on the light: sometimes it seemed grey, and sometimes it was more blue. I wanted to achieve this effect with other colourways as well.
Figure 18. Test weaving on a blanket warp.
fibres from the surface. In order to flatten the fibres and smoothen the surface, Ragnhild Nordhagen recommended decatising as well. As the rough feel was the characteristic of the weft yarn, at some point it would be more effective to use another weft material. As there was only two weeks left of the project, there was not enough time to try other yarns. Instead, I accepted the situation as it was. Decatising also releases tension, thus we estimated that it would loosen the stiffness in Hima. Shearing was also recommended to try to see if it removes the fluffiness from the surface. Removal of excess fibres can also improve pilling resistance.

4.4.3 Internal testing laboratory

It is a custom procedure to test the fabrics during the product development, as result are often used as guidelines for the process. In my project I concentrated on testing the pilling and abrasion resistance, since it strongly affects the lifespan of the textile. I was taught by Frode Svarstad to test pilling and abrasion resistance of the textile by using the Martindale method, which is a standardised testing process widely used in Europe. In this method, the testing machine simulates the abrasion and use by rubbing the textile sample against a cloth. (Fislage 2012, 22) In the pilling test, the samples are rubbed in predetermined intervals. In between the intervals, the sample is graded from one to five judging by how much the rubbing has caused pilling. In the abrasion test the samples are rubbed until two or more yarns break. The number of rubs serves as the final result.

Figure 19. A sample of Hima on Martindale abrasion test.
I performed these tests on Hima and Kaffi before and after shearing and 
decatising. As hoped, the results of both designs improved after finishings. In the 
first testing round, the results for Kaffi was 57 000 rounds in abrasion and 3-4 
in pilling test. After finishings the results were 92 000 and 3-4. With Hima, the 
impact of finishings was even more astonishing. The results in the first abrasion 
test was 50 000, which was already a good result. On the second time, the samples 
endured the test until 162 000 rubs. The pilling resistance improved from 3-4 to 4.

According to Svarstad, short floats and a tight structure captures the individual 
yarns and prevents the moving of the fibres, which reduces pilling. Therefore 
tabby derivates proved to be a good choice. Also, shearing of the excess fibres and 
flattening of the surface in decatising had significantly improved the endurance.

Pilling and abrasion resistance are properties that improve the look and strength 
of a textile, and thus can lengthen the lifespan of a product. Nevertheless, these 
are two properties out of many. As Fislage writes about the Martindale method: 
“The test … should be regarded as one selection criteria out of many, rather than 
the only one. Evaluating a fabric always requires many tests and attention to many 
aspects.” Ragnhild Nordhagen noted that even though the Martindale test tells a 
lot about the endurance, the method does not represent all types of strain on the 
fabric, such as stretching, pulling of threads and tearing. (Fislage 2012, 23)
5 THE DESIGNS AND PORTFOLIO
Hima’s colour map is filled with muted, cold greens and shades of grey and brown, as well as warmer shades of ochre and burnt orange. The colour of warp and second weft are is slightly different from the first weft. This variation in colour creates a lively surface.
Figure 21.
Kaffi’s colour map consists of two light and two middle dark, neutral colourways. Changes in the colour are created by the warp and the second weft. The contrast between the warp and wefts is more mellow in the neutral colourways, and slightly stronger in the accent colours navy blue and ox blood.
6 CONCLUSION

I presented Hima and Kaffi for the senior management team in October 2016. The designs were well received, and especially Hima’s good results in pilling and abrasion tests drew attention. Soon after the presentation it was confirmed that Hima was considered to be part of GU’s new Home collection for 2017.

The great news also meant that small modifications had to be done for the design. At that moment, the colourways in Hima’s colour map had slightly different shades than the colour map for Home collection. For example, this collection did not include colours such as burnt orange. Therefore, Ragnhild Nordhagen and I modified Hima’s colourways. The purpose was to bring Hima closer to the other designs in the Home collection, while still preserving the original atmosphere and style. As Clarke (2011, 178) writes, designs in a collection do not have to be coloured in the same way, but there should be a colour relationship between them.

The reason why coherence had to be taken in consideration was that it helps the customer to recognize the designs that belong in the same collection. Nordhagen also explained that when a new design is introduced, it is common that the colourways are more gentle and the emphasis is on the “good neutrals”, such as different shades of beige and grey. The colour map is often complemented with new, more bold colourways once a design has been on the markets for some years. It was namely the customer’s point of view that had to be taken into consideration when planning a kinder and coherent combination of colours. I also learned that if possible, designing colourways that could be woven on a same warp is more preferable for the producer, as it is more economical and effective. This way the warps would not have to be changed as often, which saves time and also saves warp meters from going to waste.

Name of the product and the colour ways is one of many ways to tell the story behind the product. For example, I named a dusty beige colourway ‘Nordic Beach’, since it reminded me of the colour of the sand at many Southern Finnish beaches. All textiles in GU’s collections have names of Norwegian valleys, and have the word ‘dal’ in them. ‘Dal’ is Norwegian for ‘a valley’. In addition, the names must be easy for foreign clients to pronounce.

There was a contrast between a low-pressured thesis project and delivering a product for a commercial world. Looking back, the beginning seemed like a rehearsal to what was to come. The main difference between a thesis project and a commercial product development is the impact all choices have. As mentioned earlier, every decision must be reasoned and thought through.
7 REFLECTIONS

My main objectives in this thesis and my design project were to learn the design process in a weaving mill. I also wanted to find out whether it was possible to deliver a successful product development project in a shorter time frame. The internship and the design project together felt almost as educative as the Bachelors degree. The hands-on work provided a very holistic understanding of textile designers work and responsibilities. It was also intriguing to see how multidisciplinary the work is. In addition to artistic skills, the product development requires knowledge in textile technology and the markets. The most valuable lesson for me was to have the courage to ask help from the experts, instead of trying to do everything oneself.

Having the experience of industrial product development, weaving and standardised tests is an valuable asset when thinking of the future as a designer. Also, being able to carry through an independent project gave me confidence and helped me to find effective working methods. The trust from the mill played a significant role here.

The detailed structured project plan that I used was one of the reasons I managed to do everything in time. I discovered that the most effective way to work is to divide everything into bits. Instead of doing a little of everything, I concentrated on taking one or two tasks at a time. As a result I had better control of the project, which lowered the stress level. In a way I enjoyed the fact that the schedule was precise, and that there was no time to wander about. On the other hand, sometimes it was hard to estimate how much time each task would require. For example, designing the patterns required several trials and errors. In the future it is good to add enough margin for delays and changes in a schedule.

GU had a very pedagogic and an engaging approach to this internship, which also showed also as support to my project. It was motivating experience to work in a company where people were proud of what they do.
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Pernille Stoltze, Scandinavian Business Seating
Sari Syväluoma, freelance textile designer
Anita Tønnessen, Gudbrandsdalens Uldvarefabrik
Images

page 10 figure 2:
Jostedal: Fin Serck Hanssen
Hallingdal: Morten Brun
Hemsedal and Trøndeforkle:
Source: www.gu.no (14.4.2017)

page 13 figure 3:
From Textiles and Fashion by Rose Sinclair (2014), page 203

Page 27 figures 7 and 8:
Inspiration pictures for the moodboards from www.pinterest.com, collected during August-September 2016

Rest of the photographs taken by Lotta Köhler.

Cover Images:

p. 1: Dyeing department, GU
p. 6: Maihaugen Outdoor Museum, Lillehammer, Norway
p. 9: Weaving Department, GU
p. 18: Dry Finishings Department, GU
p. 21: Large Book of Textile Designs by F. Donat (1895)

p. 25: A Close-up of Kaffi's Moodboard
p. 31: Weaving Department, GU
p. 38: Yarn Storage, GU
p. 43: Lysebotn, Norway
p. 46: Maihaugen Outdoor Museum, Lillehammer, Norway
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