This licentiate thesis focuses on surface patterns, spatiality, and pattern relations in textile design, and aims to explore surface patterns as spatial definers and what they mean in the context of surface patterns. A secondary focus relates to applying conceptual spatial determinations as alternative design variables in design processes, and exploring how these could be used to define and analyse pattern relations.

Through a series of exploratory design experiments that used printed and projected surface patterns in a three-dimensional setting, which were documented using photographs and film, the notion of pattern relations, wherein scale was used as a design variable, was explored. The outcome of the experiments showed the expressional possibilities that surface patterns may provide in a defined space, and how these are connected to pattern relations. In order to encourage an accompanying discussion regarding alternative methods of analysing surface patterns, the construction of a theoretical model was initiated. Workshops with design students were used as another practical method in this work.

The results showed that there is great potential in using conceptual spatial determinations to define pattern relations by viewing surface patterns as spatial definers, rather than taking a traditional perspective on their functions. Another outcome is the theoretical model, which proposes a specific approach to pattern relations.

This research demonstrates how conceptual spatial determinations can benefit the textile design process, as well as design teaching, which could in turn provide the field with new expressions that may lead to a change in or fruitful addition to the practice.

Keywords: Surface patterns, textile design, spatiality, spatial definers, design variables, pattern relations, conceptual spatial determinations
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Turning from textile art to textile design, the notion of surface patterns came to be preeminent among my interests. During my art education at the Oslo National Academy of the Arts, I was taught to focus on expression, proportions, form, and line, thinking primarily of unique objects and freestanding works of art. As an exchange student in the textile design programme at HDK – Academy of Design and Crafts in Gothenburg in 1995 I had the opportunity to work with design-related issues, giving them a new significance and providing a natural context for my sense of order. The introduction of Swedish textile designers at the Röhsska Museum in Gothenburg swept me away entirely. We were asked to visualise surface pattern characteristics through diverse working methods and relate it to a spatial context – I had never been so excited! The meeting between art and design gave rise to an interest in combining these areas. The most fascinating phenomenon for me was the relationship between surface pattern, space, and spatiality in textile design or, more specifically, between surface pattern and motif; when the pattern becomes a motif, and vice versa.

I came to several crucial realisations regarding surface patterns, each of which had a great influence on my future as a textile designer. Firstly: repetition is the core of all surface patterns. Secondly: joints are central to units in repetition. Thirdly: a sense of order – a systematic and logical structure, or a distinct order. Fourthly: a critical component in understanding surface patterns is scale, which relates to my attraction to visual surfaces wherein the border between motif and surface pattern is fluid. Scale also connects to repetition, and so is explored to a great extent in this thesis.

The research that is presented in this licentiate thesis has three primary points of departure: Several years of teaching surface pattern design in textile design education programmes have provided many valuable insights, but also suggested several critical considerations relating to design methods, tools, and techniques within the design process. They have also raised questions regarding alternative ways of developing surface patterns and pattern thinking. The experience of teaching surface pattern design to students at the Bachelor’s and Master’s degree levels, and supervising projects in this field, is the central reason for this research having been conducted. Other motivations include personal knowledge as a practicing textile designer, a wish to develop and achieve a specific visual theme, and an interest in pattern relations that grew as I became aware of the connection between space and surface pattern, and how the two relate. It was apparent that surface patterns have a
strong impact on aesthetics and spatiality, but are given a low priority within design processes. Last but not least, surface patterns and pattern thinking continue to catch my attention time after time, year after year, over and over again.

With a starting point in interior design and architectural approaches to defining space using material, colour, plane, and surface, this work focuses on pattern relations in spatial contexts in textile design, and aims to explore surface patterns in terms of both their possible function as spatial definers [which are distinct from conceptual spatial determinations due to the fact that they are used as tools to explore how surface patterns can clarify spatial relationships] and what they mean in the context of surface patterns. A secondary focus relates to applying conceptual spatial determinations as alternative design variables in design processes in order to develop current knowledge, and to find alternative working methods for surface pattern design.

This thesis is divided into practical and theoretical sections. Part I describes the design experiments - Pattern Relations Exercises 1-3 – which showcase an alternative perspective on pattern relationships and expressional appearances with regard to scale. Each exploration focuses on specific viewpoints in relation to this, and the description of each exercise is followed by analysis and reflections. The development of a theoretical model is traced over the course of the thesis, introducing conceptual spatial determinations as a tool for analysis that was based on reflections on the experiments.

Part II presents an additional analysis of the design experiments using the theoretical model, and describes the two workshops, undertaken with design students, that tested the use of conceptual spatial determinations in the process of designing surface patterns. This section concludes with a presentation of the results, recommendations for future work, and a reflection.
The Power of Pattern

The term ‘pattern’ has been widely discussed from many perspectives, and its meaning varies dependent on the context in which it is used; consider, for example, ‘pattern cutting’, ‘patterns of movement’, and ‘patterns of behaviour’. According to the Merriam-Webster Dictionary, a ‘pattern’ is “[a] repeated form or design especially that is used to decorate something [...] The regular and repeated way in which something happens or is done. [...] Something that happens in a regular and repeated way” (2016).

In the fields of interior architecture, design, fashion, and textiles, the term ‘pattern’ is defined quite specifically: Day describes patterns as the natural outgrowth of repetition, where the repeat system discloses the construction, and states that, “Technically speaking […], we understand patterns not merely as the recurrence of similar forms, but of their reappearance at regular intervals” (1999 [1933], p. 4). Patterns are often viewed in terms of visual pleasure, used to organise surfaces, and strongly associated with textiles.

Fenn has a similar conception of patterns, claiming that their essence is repetition, ensured by the production processes of wallpaper and printed and woven textile design, for example. Seen in this light, a pattern consists of a mechanically repeated unit that covers a small part of the printed or woven area (1993 [1930]).

Kraft discusses textile patterns and their production processes with regard to textile techniques, presenting a formulated definition of the term ‘pattern’ and introducing the ideas of rhythm, symmetry, repetition, and dimension in relation to the term in order to establish a scientific approach to the concept (2004).

Bell, a landscape architect, argues in Landscape: Pattern, Perception, and Process that the most general definition of a pattern is “the opposite of chaos” (1999, p. 85). Pattern recognition is important in helping us to understand and relate to the world around us.

Within architecture, Knight discusses patterns in relation to regularity and transformations of geometric structures, arguing that “[a] pattern is a set of spatial elements: points, lines, planes, or volumes, in two or three dimensions” (Knight, 1998, p. 306).
In addition to visual patterns, which can be considered to be concrete in the sense that they are easily observed using our sight, there are also abstract patterns, as can be found in the fields of mathematics and psychology, for example.

The mathematician and writer Devlin considered mathematics to be the science of patterns, which can be found everywhere in the physical universe, including in the living world and our own minds (1996). Similarly, Feynman offers a concise definition, claiming that "mathematics is looking for patterns" (Feynman & Dyson, 2005, p. 175).

The term ‘spatial pattern’ is used in a relatively restricted sense within the field of psychology. The Online Psychology Dictionary (2017) defines a pattern as a “temporal or spatial arrangement of independent components to make an involved whole”. Here, then, patterns are limited to the domains of time and space.

Development of repeating patterns in relation to printing methods
Like most industries, the textile industry has changed a great deal in recent decades, and this has had a large impact on surface pattern design (Gale and Kaur, 2002). One important issue that is related to textile design is its connection to surface patterns. Repetition is essential for creating a pattern and the core of all pattern designs, and the correlation between pattern unit and repetition is crucial in allowing people to recognise a textile in terms of its construction and production. This interplay is fundamental for textile design practice, as well as for an understanding of manufacturing and production methods.

During the period of industrialisation, production was the absolute ruler; machines set the conditions and provided the instructions for repeating a pattern. Manufacturing played an important role in this, and the processes involved standardised, repeating patterns; woven patterns were constructed using horizontal and vertical threads, while printing techniques facilitated other types of pattern, and sophisticated, organic lines gave expressive possibilities (Ibid.).

William Morris began to design textiles in the 1860s, claiming that mechanisation had resulted in a lowering of design standards and manufacturers focusing on quantity rather than quality. Morris researched medieval manufacturing methods that used traditional craft skills, techniques, and processes, and was opposed to most contemporary forms of production for both aesthetic and political reasons (Mabb, 2009). This was visible in his designs which, in advocating transparency, always revealed the structural, material, and functional properties of objects. Morris reintroduced an experimental, artistic method of block printing, which demonstrated the basic idea of interweaving foreground and background motifs into a more or less two-dimensional picture (Tilburg, 2012). Morris’s way of experimenting with methods and production provided a recognisable aesthetic expression, and exploited the available techniques to enable pattern repetition.

Examining printing techniques throughout history, shows that certain mechanical prerequisites govern pattern repetition. Resist-printing patterns are applied using a paint brush or a special, pen-like tool called a ‘janting’. In tie dying, small objects are knotted or stitches are sewn into the cloth to create a repeating pattern. Mordant printing is similar to resist printing; a pattern is applied using painting, printing, or a block (Russell, 2011). These printing techniques involve a great deal of work by hand, and repetition is not restricted by any mechanical process; rather, the maker decides how it is to be achieved.

In block printing, the pattern motif is carved into pieces of wood, and dyestuff is applied; through pressure, the motif is transferred onto the fabric. Pattern repetition is restricted by the size if the blocks which must, for example, not be too heavy to be lifted by one person.

In copper-plate printing, a design is cut into the surface of a copper plate and transferred to the fabric with a press (in the manner of graphical printing). With this technique, pattern repetition is limited by the size of the plates and, as most copper plates are very large and heavy, ‘island designs’, wherein elements of the design are placed independent of other elements, are common (Briggs-Goode, 2013).

Copper roller printing and rotary screen printing each involve a similar approach. The designs are cut into or engraved on the surface of copper or nickel tubes; pattern repetition is constrained by the size of the roll, and each repeat is generally 64 or 91.3 cm long.

In flat screen printing the pattern is transferred onto the fabric using a coated mesh, with a squeegee often being utilised to push the dyestuff through the stencilled pattern onto the fabric. The sizes of the screens vary, but are usually 1.5 m wide and between 1 and 3 m long (Russell, 2011). Repetition is not necessarily technically
restricted in terms of height, but width. For financial reasons, however, patterns are often limited to one screen, but double- and triple-height patterns do occur.

In heat-transfer printing, a design is printed onto paper with disperse dyestuff using heat to transfer the design onto the fabric, which needs to be made of a synthetic material [Briggs-Goode, 2013]. Pattern repetition is not limited; rather, the size of the heat-transfer machine and the paper regulate the print size and pattern repeat. An engineered or placed pattern is ideal for use with this technique.

In digital printing, the motif is created digitally and printed directly onto the fabric by inkjet printing [Clarke & Harris, 2012]. The repetition of the pattern has neither horizontal nor vertical limitations, nor is it constrained as regards the amount of colours that it may contain. Moreover, there is no need to repeat the pattern laterally.

Laser cutting is not, in technical terms, a printing technique, but may be used to cut a design out of a piece of fabric or remove a thin layer of fabric from the surface, etching a pattern into it [Russell, 2011]. Pattern repetition has no limits; rather, it is the size of the fabric that governs the pattern/motif. With digital tools and software the same is true; computational design could be used to apply or project patterns onto any surface. Pattern repetition is unlimited, and dynamic and movable features are possible.

In mechanically produced fabrics, the repetition of a pattern unit is a technical requirement. The continuing development of machinery and computerised manufacturing methods challenges the ways in which textile designers design, and demands new ways of thinking [Briggs-Goode & Townsend, 2011]. Technical development within printing techniques has broadened perspectives on the concept of pattern repetition, affecting the scale of surface patterns. Designers are today less controlled by production methods and able to actively ignoring the restrictions that were once imposed, opening up for the possibility of experimenting with aesthetics and means of expression. Links between science, design, and new technologies are also having an enormous effect, challenging the ways in which people think and design.

Repetition, joints, order, and scale
There are several components that are vital to understanding patterns. In this thesis, the definition of the term ‘pattern’ relates to the following concepts, and has its foundation in the above-mentioned sources. Repetition is essential for creating a pattern, and is the core of all pattern designs, while joints bind a pattern’s units together such that a pattern is created. Seen from a psychological perspective, order is our search for meaning, and our efforts to find order determine the appearance of patterns. A systematic and logical structure facilitates understanding of a pattern [Gombrich, 1979]. Scale is a relative level or degree, and communicates relationships between elements. A change in scale means new challenges and new design decisions.

Spatial definers and conceptual spatial determinations
In this thesis, surface patterns are regarded [or interpreted] as spatial definers; a pattern is looked upon as something that decides [or states/establishes/governs/determines] a room or spatial area. Surface patterns thus contribute to defining rooms/spaces. Conceptual spatial determinations are tools in the design process that can be used to explore how a surface pattern can clarify a spatial relationship.

Pattern relations
Pattern relations is a concept that is used in various settings contexts, and has several meanings. It could be found for instance in mathematics and geometry, computing engineering, and in biomedical matters [Toussaint & Toussaint, 2014]; in each, it has its own meaning. In this thesis, the term of ‘pattern relations’ refers to the relationship between a surface pattern and a spatial area.

Design variables
When designing patterns, design variables are used in order to achieve a certain expression. These are the designer’s ‘tools’, the information that is needed to express intentions within a textile [Worbin, 2010]. A textile designer is presented with a near-endless number of design variables to work with in the design process; colour, form, line, texture, volume, etc. Designing surface patterns in spatial contexts demands knowledge regarding which space to work in, kind of material to use, and type of expression to be achieved [Ibid.]. A design variable is simply something that the designer decides upon during the process of designing.

Surface design and surface patterns
Today, surface design means different things to different people, and can refer to applications as diverse as textiles, architecture, and software. The definition of the term varies: in an interior textile context, it relates to the appearance of the fabric
BACKGROUND

Surface in terms of colour, texture, and, if applicable, pattern (Rowe, 2009); to The Surface Design Association (SDA):

Surface design encompasses the colouring, patterning, and structuring of fiber and fabric. This involves creative exploration of processes such as dyeing, painting, printing, stitching, embellishing, quilting, weaving, knitting, felting, and papermaking. (2017).

Alternatively:

The design of surfaces affects the appearance of everything we see and touch, e.g. interiors, exteriors, floors, land, gardens, ceilings, and lightning [sic], as well as everything we use, such as decorative objects, cutlery, crockery, etc. (Briggs-Goode & Townsend, 2011, p. 89).

Although this multitude of applications has given rise to a large number of design disciplines, such as interior design, architecture, product design, wallpaper design, and graphic design, all of them design surfaces in one way or the other (Kristensen Johnstone, 2014). In this thesis, the term ‘surface design’ is used as a combination of the descriptions discussed above: Pattern, colour, and texture, applied on a surface that alternates between paper, fabric, relief materials, and screen.

The concept of pattern in artistic disciplines

The concept of the pattern has been considered from various perspectives, including those of artists, writers, interior architects, and architects who work with ornamentation and patterns in both a non-visual sense and as forms of visualisation. The examples discussed below (which were chosen to exemplify other types of thinking) explore and utilise patterns and ornamentation in ways that raise the level of abstraction in relation to the concrete function of a pattern, and assist in discussing the concept in terms of media, material, and methods.

Literature

Charlotte Perkins Gilman’s *The Yellow Wallpaper* (Gilman, 1899) is the story of a young woman who descends into madness: Having given birth, she is left to recover in a room of a summer mansion that is covered in a patterned, yellow wallpaper. Her husband, a doctor, prescribes medical treatment, and she becomes obsessed with the pattern and colour of the wallpaper, believing that women creep behind the patterns and, eventually, that she is one of them. Another world is created between the room’s interior – the wallpaper – and what lies behind it. The story ends with the woman confronting the wallpaper, in an attempt to release the imaginary women, and then her husband, and so the relatively minor – decoration – destroys the major – sanity.

There are several interpretations of this short story: That the wallpaper represents a hierarchal dominance and the repression of a wife by a dominant husband; from a feminist perspective, that it explores women’s position within a patriarchal society and secondary role in a male-dominated establishment, being ‘imprisoned’ within the domestic sphere. Anthropomorphic qualities are assigned to the wallpaper, giving it a psychological dimension that is not ordinarily addressed in relation to the interior (Weinthal, 2011). The yellow wallpaper itself stands for something that is entirely different to an embellished surface, and Weinthal claims that reading *The Yellow Wallpaper* through the lens of interior design gives wallpaper the opportunity to bring forward the importance of subtle, background imagery (Ibid.).

The concrete function of the wallpaper is no longer decorative or cosy; instead, it raises the level of abstraction of the pattern. In relation to the work described in this thesis, the wallpaper represents a conceptual spatiality (or a pattern relationship, in a broad sense); the thin layer between the wallpaper and what lies behind it. Gilman
Background

Ornaments have emerged as tools for addressing varied audiences, ensuring the efficacy of buildings, and achieving novel structural and constructional effects (Massey, 2013). Today, ornaments are intrinsically tied to architecture, and intended to both engage with urban settings and open up for new forms of experience (Moussavi & Kubo, 2017).

The Institute du Monde Arabe building, designed by Jean Nouvel and Architecture-Studio and constructed between 1981 and 1987, is an example of ornamentation being given a leading role and its function having a novel significance. The façade of the south side of the building consists of metallic, light-sensitive diaphragms featuring moving, geometric motifs that regulate the amount of light that enters the building (Winstanley, 2011). “During the various phases of the lens, the shifting geometric pattern is formed and showcased as both light and void, using archetypal element of Arabic architecture. Squares, circles and octagonal shapes are produced in a fluid motion, as light is modulated in parallel.” (Ibid.). Interior spaces are dramatically modified, as is the exterior appearance of the building (Moussavi & Kubo, 2017). This creates an incredible aesthetic, as well as several ornamental functions: The diaphragms protect the interior of the building from the sun and create privacy for those inside, and are functional from an environmental standpoint, as closing or reducing the aperture sizes controls solar gain.

Kengo Kuma’s 2009 boutique for the fashion label Lucien Pellat-Finet uses a three-dimensional pattern system made of plywood as a main element in distributing structural and spatial qualities (Siddiqui, 2013). The boutique also contains a café and a small library. “The plywood honeycomb pattern is calibrated based on the needs of those within the building in terms of required functions: In the shop within the building, the pattern functions as a storage shelf and privacy screen, as well as a display system for merchandise; in the library, the pattern acts as book displays, and in the café the pattern is shallower and its depth is regulated, mimicking the glassware in the bar and functioning as a decorative layer in the background” (Ibid., p. 463.). Ornaments play multiple roles in this space, from defining wall and ceiling surfaces to acting as storage devices and decorative wallpaper. The functions of ornaments are thus reconsidered and abstracted to functional needs, as well as to the aesthetic experience.

Music

Mundry examines the significance of patterns in her musical composition No one (Mundry, 2009), which was influenced by a textile pattern of the African Bakuba tribe with interweaving contours and large transformations. The pattern units were created using complex interlaced elements, such as diamond forms, that were composed of lines and small squares. Repeating the units gradually changed their elements, along with the contours, until the impression of a new pattern was created. Mundry used similar processes when composing her string quartet, in that pattern formation was utilised as a medium of change. Throughout her work, she links the concept of pattern to the parameter of time; pattern formations and their transformations are genuine, time-based phenomena in Mundry’s compositions. In music, the concept of architecture is analogous to the relationship between large arrangements and subdivisions, which behave like rooms in a building (Gleiniger & Vrachliotis, 2009). This is particularly interesting in relation to the research presented in this thesis, where conceptual spatial determinations are used as a means of abstracting the function of a surface pattern.

Art and design

Grignani’s art is characterised by distinctive, geometric, and monochromatic expressions, and his imagery is innovative from a conceptual point of view, anticipating the visual qualities of the styles of kinetic, programmed, and op art by at least ten years (Meneguzzo, 2017). Grignani’s consistent use of black and white forces the viewer to focus on the actual expression, ensuring that they do not instead seek to find some significance or meaning in the use of a particular colour. Through the use of a minimalist vocabulary, he distorts the way in which people perceive reality (Ibid.). There are similarities between Grignani’s work and that presented in this thesis: The deliberately repetitive visual qualities, and the use of black and white, for example. It is undoubtedly true that black on white – or vice versa – is the most fundamental and simple way of working, keeping ‘the scene’ clear of elements that do not serve expressive ends and thus avoiding confusion.

Architecture and interior architecture

In the field of contemporary architecture, ornaments have other purposes than they did in the past. Reinterpreted in terms of contemporary techniques and aesthetics, ornaments have emerged as tools for addressing varied audiences, ensuring the efficacy of buildings, and achieving novel structural and constructional effects (Massey, 2013). Today, ornaments are intrinsically tied to architecture, and intended to both engage with urban settings and open up for new forms of experience (Moussavi & Kubo, 2017).

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Another example of patterns with a function in architectural settings is Curtain as architecture, which consists of sound- and light-regulating curtains, is located at
Casa da Música, Porto, Portugal, and was designed by Petra Blaisse of Inside Outside in conjunction with OMA in 2005. The curtains were created as walls – or façades – that are integral parts of the architecture, i.e. structures that complete the room. The spatial effects are triggered through structure and scale, with light, weight, and movement all being involved [Weinthal, 2011]. In total, 11 curtains were designed and placed in layers; some of these are three-dimensional rhythmic structures that claim space, some are transparent to varying degrees, and some disappear quietly into hollow walls. Each adds to the acoustic and atmospheric definition of the rooms, together with sound-reflecting and -absorbing surfaces, orchestra pits, and public spaces – all of which feature planes, forms, and volumes that are hard and soft, porous and massive [Ibid.]. Blaisse works with visual and physical features, namely surface, spatiality, pattern, material, and, most importantly, scale, in a manner similar to that of the research work presented in this thesis. With a background as a designer in apparel construction, Blaisse moves easily between the scale of the body and the scale of the building, as is apparent in the execution and expression of the curtains.

The John Lewis department store in Leicester, UK, designed by the design studio Foreign Office Architects and built in 2007, clearly illustrates how ornamental features can be used in a novel context, and how the function of ornaments can obtain greater significance. The swirling décor on the façade features four panels that can be easily combined due to the fact that they share the same pattern at their edges, with the multiple layers producing a three-dimensional impression, and the two surfaces creating an effect that is reminiscent of embroidery, although with a greater level of opacity [Picon, 2014]. The net curtain works in the manner of a translucent fabric, creating a sense of privacy within the shop by enabling those inside to look out but preventing those outside from looking in. The ornamentation also functions as a practical benefit, in that it provides shade from the sun.
The research presented in this thesis began as an exploration of a personal interest, and the research issues arose from experience of both the practice and teaching of textile design. This is comparable to what Bye refers to as “research through practice” (Bye, 2010), wherein a problem or question is derived from practice, and practice is the main method of discovery of other appropriate methods that could be adopted, adapted, or developed. Analysing and questioning these experiences leads to the identification of problems and potential gaps in the research. “Applied research” is another term for the same approach (Muratovski, 2015), as is “constructive design research” (Koskinen et al., 2011), which integrates design and research.

**Design examples**

The relationships between the concepts outlined above – pattern relations, spatiality, and surface patterns – were experimentally investigated from various viewpoints so as to ensure a strong synergy between theory and practice. Initially, several minor experiments were conducted, which eventually became the design example ‘Pattern Relations Exercise 1’. This was followed by analysis, evaluation, reflection, and the formulating of new ideas for subsequent exercises. During evaluation, questions were asked to form a direction for the next experiment, and the outcome of that experiment generated yet more knowledge, guiding the work and moving it forwards. The set-up of the experiments was generally predefined, and the aim had a clear formulation from the beginning. However, a trial-and-error method was applied, and the experiments were carried out with an open mind, accepting the outcome no matter what it was.

For all of the experiments, surface patterns were designed in order to assist in examining pattern relations in spatial contexts. The forms of the pattern units that were used in the examples originate from the work of the Bauhaus regarding elementary geometrical forms (Itten, 1975; Lupton & Miller, 1991), which are the fundamental grammar of the visual. The basic forms of the square, circle, and triangle were chosen because of their status as universal form elements but, as colour was not a focus of this research, black and white were used in the interest of achieving maximum contrast, ensuring that the resulting patterns were clearly visible. Sketching was performed both digitally and physically, and the materials used were paper and textiles.

Scale models were used in Exercises 1 and 2, and were constructed using appropriate sketching materials in order to represent reality. Visually testing ideas in practice

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**METHODOLOGY**
has been essential in this work, giving concrete responses to issues relating to both materials and surface patterns, which often interact with and respond to one another. Exercise 3 merged both two- and three-dimensional elements, which is why projection was used as a tool when combining these features.

Analysis of experiments
The relationship between analysis and design is essential in design research, and this research repeatedly alternated between analysis and design, in the manner described by Hallnäs and Redström (2006). Photography and/or film were used to document all of the experiments, and the produced material was scrutinised and evaluated by the author, using explicit criteria such as pattern expression and transformation, three-dimensional shape and volume, spatiality and spatial appearance. The analyses and reflections highlighted certain characteristics and led to an opinion of the image material, providing a perspective on the outcome.

Theoretical model
In order to encourage an accompanying discussion regarding alternative methods of analysing surface patterns, the construction of a theoretical model was constructed specifically for this research work. The images were analysed again using the model.

The workshop as a method
Workshops with design students were used as a practical method in this work, providing testing of and feedback on the ideas and thoughts that occurred following the analysis of the experiments. Workshops are, by definition, active learning environments in which participants expect hands-on practice and a high degree of interaction and collaborative learning (Sork, 1997), corresponding well with my own ambitions and prospects. The idea of using practical workshops to introduce foundational concepts, methods, and models was proposed by Bergin et al. (2007), who argue that the workshop is a basis for critical reflection and discussion.

The theory and working methods used in the experiments were intended to function as inspiration for future explorations in surface pattern design, rather than to produce identical results. Other pattern units, colours, and settings could easily replace the ones that were used here in order to continue the investigation. The workshop descriptions were specifically designed for this research, but the ‘task of the day’ could easily be exchanged for similar projects with comparable content. The same approach goes for the theoretical model; parts of it might be applicable to or could be adjusted to suit similar contexts, but the model was created for this specific work.
PART I
Pattern relations exercises

The experiments

The experiments are referred to as Pattern Relations Exercises, and are presented here in chronological order. However, the analysis process has involved a certain amount of jumping back and forth to find similarities and differences. The experiments rest upon and continue from one another, further deepening our perspectives on pattern relations.

Pattern Relations Exercises 1-3 constitute a refinement of current knowledge, and the methods are somewhat specific to textile design. The main result of the design examples is the expresional possibilities that a surface pattern may provide in a defined space, and how this is connected to the notion of pattern relations. The scales of surface pattern play an important role as it is utilised in order to explore pattern relations, and permeates all of the experiments.

Pattern Relations Exercises 1 and 2 were carried out by the author, while Pattern Relations Exercise 3 was conducted in collaboration with Professor Linda Worbin. The programming was undertaken by PhD candidate David McCallum, and all photography and filming was performed by photographer Jan Berg and the author.
Pattern Relations Exercise 1

2D meets 3

In this first design example, pattern relations between a three-dimensional object and a two-dimensional surface were investigated. The initial aim was to explore the transformations of a surface pattern throughout the process of scaling the surface pattern up and down, and to examine the meeting between a two-dimensional surface and a three-dimensional object, and how that creates spatiality (Kristensen Johnstone, 2014).

The setting was a simple model, consisting of a flat wall, a three-dimensional object – a half-scale mannequin – and a basic black and white surface pattern in six different scales. Using printed versions of the surface pattern on paper and fabric, the six scale steps were applied to both the object and the wall pattern.

Pattern Relations Exercise 2

2D generates 3D (the power of scale)

Pattern Relations Exercise 2 was comprehensive, and the main experiment of this thesis. The resulting photographs provided a huge quantity of working material and gave the project a number of opportunities for further development. Certain choices were made, then used to derive and identify pattern relationships in spatial contexts with regard to scale. The aim here was to explore scale as a design variable, and to investigate how the scale of a surface pattern can dissolve the plane, surface, and direction of a three-dimensional space and ascertain how this affects visual expression. Basic block-repeated black-and-white surface patterns were designed in three different scales, and each surface pattern was studied in a spatial context using printed versions of the patterns in a scale model. This thesis presents a selection of the results of the entire experiment.
Pattern Relations Exercise 3

**Textile material**
This design experiment focused on textile materials and scale-changing surface patterns in connection with pattern relations. Its purpose was to explore how the movable scales of a surface pattern interact with colourless textile materials, using projection as a design tool. Pattern units were projected onto three types of material, with zooming in and out changing the scale of the surface pattern. The merging of material and movable pattern scale was the main focus of this exercise.
2D meets 3D

2D meets 3D is a project that explores the pattern relations between a three-dimensional object and a two-dimensional surface. This design experiment has its point of departure in three minor experiments that were undertaken earlier in the process, which assisted in framing the direction of the main design example and functioned as guidelines to and foundations for a new perspective on pattern relations. After experimenting with projection, printed fabrics, and digital models, it was decided that the best course of action was to use a physical model and a three-dimensional object (a half-scale mannequin). The first experiments led to the insight that, in order to explore the notion of pattern relations, one must go past established ideas and methods and raise the level of abstraction further.

A basic surface pattern was designed in six different scales, from small to large. The pattern unit was a geometric, non-representative, all-over pattern, and was chosen because of its simplicity. To achieve maximum contrast, the surface pattern was black and white, and repeated using the block method (Fig. 1).

These design choices were made in order to clearly illustrate changes in the spatial environment, including both similarities and differences. Printed versions of the surface pattern were attached to a plain wall, and the mannequin was draped in digitally printed fabrics. Altering the surface pattern in six scales on both the wall and the mannequin produced 36 variants (Fig. 2). The experiment was conducted in a photography studio, and documented by photographs that were all taken from the same position and using the same lighting conditions.

Figure 1. The Grid pattern.
The result of Exercise 1 was an object in front of a surface or, in other words, two items that interact with each other – an object and a background. The object overlapped the background and functioned as a spatial shaping component. The format included the properties of shape, surface, plane, position, and orientation and was portrait, with the object at the right-hand side. The composition consisted of one vertical plane with two dimensions (those of the object and the wall). There is nothing else in the images that suggests spatiality; there are no perspectives as such.

Figure 2
Analysis 1

Discussion
In Exercise 1, the relationships between a three-dimensional shape, the scale of a surface pattern, and a surface were investigated. The initial aim was to explore the transformations of a surface pattern throughout the process of scaling the pattern up and down (Kristensen Johnstone, 2014). Figure 3 shows the smallest-scale grid pattern printed on the textile, which was draped on the mannequin, with the wall pattern’s six scale increments labelled a-f.

In Figure 3a, the scale of the surface pattern on the wall is so small that its visual appearance is akin to a grey fog, and the surface pattern of the textile draped around the mannequin harmonises with that of the wall to the point where it functions in a similar manner to camouflage. After the fourth scale step (Fig. 3d) the surface pattern on the wall no longer repeats, and the contrast between the mannequin and the wall increases with the scale of the pattern. The characteristics of the grid pattern (the distinct square) change at a certain scale step, at which point the pattern becomes what can be described as a separate shape or an engineered pattern (Figs. 3e and f).

A further insight that was gained from analysing the results was the way in which the mannequin dominated the scene and drew the viewer’s attention away from the wall. It was also concluded that the systematic approach of the experiment could be sharpened even further.

The main finding was that, as the surface pattern reached a certain scale, the pattern expression changed from a repeated surface pattern to a form. It is important to note that these findings are only valid for the expression produced by the specific combination of this surface pattern and these settings, and that other design variables such as style, colour, texture, repetitions, and visual expressions, which are other factors that influence an outcome, have not been investigated; altering these variables in the design would produce very different results in terms
of pattern expression. Furthermore, the expressions could also be perceived differently depending on the context, purpose, and position of the surface pattern. The design examples presented here confirm that the scale of a surface pattern is related to the viewer’s experience of the pattern, and that it influences the pattern’s expression but not the magnitude of that relation/influence. This knowledge may be helpful to textile designers when designing a large-scale pattern intended for use on walls, for example.

Reflections

Exercise 1 explored the influence of scale and expressional possibilities on surface patterns, as well as the function of scale as a tool/method in a design process and the relationship between surface pattern and scale.

The size and scale of the room in which the exercise was conducted appeared to be important, as did the role of the viewer; viewing distance and the movement pattern of the viewer are essential considerations, together with the activities taking place in and the furnishing of the environment/room. In this context, the properties of the surface pattern, including scale and expression, are crucial parameters to consider during the design process. For textile designers, this means that knowledge regarding and an understanding of the spatial context that is to be designed may improve the final design solution.

Using the body as a reference object was, however, not entirely unproblematic. It was noted that the mannequin attracted more attention than the rest of the scale model, showing that reference objects cannot be chosen without due consideration. Another way of discussing the reference object would be to simply use a more neutral object than the body and zoom out to include more of the spatial context. Further limitations on and systematisation of future experiments may include a reduction in the number of scales, from six to three, and systematically altering the placement of the surface patterns.

An additional finding was that it would be worthwhile to conduct experiments using a more complex surface pattern with a different set of pattern characteristics in order to study the scale, viewing distance, and viewing angle in comparison to the surface pattern used in this project.

Two different perspectives on pattern relations gradually emerged during the analysis; ‘pattern expression’ and ‘pattern in a spatial context’. As changes took place in either the pattern’s expression or the spatial context, how might these perspectives have influenced each other? After this insight had been obtained, attempting to identify the design parameters that defined these perspectives became of interest with regard to further research. The experiment had an interpretative approach, and so the aim was easily modified to focus on pattern relations with regard to spatiality.
This design example examined pattern relationships in a spatial, three-dimensional context. The aim was to explore scale as a design variable, and investigate how the scale of a surface pattern can dissolve the plane, surface, and direction of a three-dimensional space and how that affects the visual expression. This experiment also had a background in the pre-experiments performed, and was based largely on the results and reflections of Exercise 1. As is discussed above, Exercise 2 was the main experiment of the work described in this thesis, and served as a continuation of Exercise 1 that sought to investigate more deeply. The project was comprehensive, provided a huge quantity of working material, and gave a number of opportunities for further development. Due to this breadth of working material certain selections were made, which were then used to derive and identify pattern relations in spatial contexts with regard to scale.

**Method: experimental setup**

A simple scale model was constructed, consisting of three vertical cardboard walls that formed two corners. The walls were placed on a horizontal surface, which represented spatiality (Figs. 4 and 5). Based on the vocabulary of architectural design, the planes were termed ‘wall plane’ and ‘base plane’ (Ching, 2014).
Six surface pattern units were designed in three different scales, forming the Small, Medium, and Extra-Large series. The pattern units were circle, diamond, dot, grid, square, and triangle, and were all basic and geometrical (Fig. 6). The units originate from the work of the Bauhaus on elementary geometrical forms (Itten, 1975; Lupton & Miller, 1991), the fundamental grammar of the visual. To achieve maximum contrast, the surface patterns were black and white and repeated using the block method (Figs. 7-24). Printed versions of the surface patterns were attached firmly to the walls and floor of the scale model.

Figure 6. Circle, Diamond, Dot, Grid, Square and Triangle
Figure 7. Circle Small
Figure 24. Triangle Extra Large
The setup

Each set of surface patterns was arranged in the same way. In rectangular or square rooms, architectural surfaces are experienced as either frontal or depth planes, depending on the viewer’s orientation. Frontal planes appear to be rectangular or possibly square, whereas depth planes appear to be wedge-shaped, or foreshortened as they recede (Miller, 1997). Because frontal and depth planes are experienced quite differently, the viewer’s initial perspective when entering a room and their various orientations once inside are important design considerations.

The model was photographed from five side-on angles in order to facilitate analysis of the visual appearance of the surface pattern. Figure 25 shows the camera angles; left (Position 1), semi-full front left (Position 2), full-frontal (Position 3), semi-full front right (Position 4), right (Position 5).

Only one shape and size of pattern unit was used at once. Two sets of lighting conditions were used: general lighting from the ceiling, and an external light source that was directable. This was undertaken in order to study light as a creator of varying hues. A scale model of Arne Jacobsen’s classic three-legged Ant chair was used as a reference object. One experiment did not include the reference object in order to ascertain whether and how it constrained the experience of scale. Figures 26-29 show the dot pattern in the Small scale, with general and directional lighting and with and without the reference object. These setups were used for each surface pattern and scale.

After the photography was completed, evaluations that compared and categorised the images were performed. The categories were: pattern units (dot, triangle, square, grid, circle, and diamond), pattern unit sizes (Small, Medium, and Extra-Large series), lighting conditions (general or directed), and whether the reference object was present or not. Figures 30-32 show the triangle pattern in all sizes and positions without the reference object.
PATTERN RELATIONS EXERCISE 2

Figure 26a-e. Dot Small. General lightning with reference object.

Figure 27a-e. Dot Small. General lightning without reference object.
Figure 28a-e. Dot Small, Directional lightning with reference object.

Figure 29a-e. Dot Small, Directional lightning without reference
Analysis 1

Exercise 2 resulted in 360 images of six different patterns (printed on paper and attached to a scale model) in three different scales, photographed from five angles in two sets of lighting conditions, with and without a reference object. The initial aim was to explore pattern scale as a design variable, and to see how scale can dissolve the plane, surface, and two-dimensionality of a three-dimensional space. When working with basic forms, form itself is a design variable. The circle – a distinct circular shape without angularity or direction (Wong, 1993) – was interesting to use in this experiment because of the differences in expression it displays when it is scaled up and down. The square – the finest expression of a spatial idea, complete in itself (Munari, 2016) – also resulted in intriguing outcomes in the scaling process. The equilateral triangle has the most stable form, with its distinctive structure, and signifies stability (Ibid.). Using these basic forms provided many possibilities.

The analysis of the experiment was based on the visual expression of the image material. Two criteria were used in the evaluation:

- **Spatiality and spatial appearance**
- **Pattern transformations**

Spatiality and spatial appearance

Spatial properties were discernible in many of the images and several topics that facilitate spatiality were identified in order to analyse them:

- The **reference object** (the Ant chair) cast a soft shadow on the ground, making its three-dimensionality – as well as that of the entire composition – easier to recognise. Spatiality and spatial appearance are visible in all of the images where the chair is present, regardless of which angle the photograph was taken from [Figs. 33-36].

- The **corners** indicate a three-dimensional space, composed of a floor and three walls, and serve to define the limits of the space and ‘cut off’ the surface pattern. Spatiality as enabled by corners is visible in all of the images, regardless of the angle that the photographs were taken from, but is less obvious in some of the Extra-Large series images that were shot from Position 3 [Figs. 37-40].

- If the viewer squints, the surface patterns become different values of grey, independent of which plane they are situated on. Spatial appearance made possible by values of grey appeared primarily in the Small series, mostly in photographs taken from Positions 1, 3, and 4, all with general lighting [Figs. 41-44].

- **Pattern scale** influences spatial experience. In the Small and Medium series the scale of the surface pattern facilitated spatiality, partly because of the perspective of the planes but also due to the way in which the surface pattern manifests itself when – due to its small scale – it is seen in its totality. The perspective, size, and direction of surface patterns enabled spatiality, as is most obvious in Figures 45-48.

- The opposite – **lack of spatial appearance** – occurred in the Extra-Large series. Without the reference object, spatial understanding disappears, as the corners ‘cut off’ the surface pattern in such a way that there is no clear view of the space [Figs. 49-52].

The lighting conditions were utilised in such a way that they influenced spatial perception, regardless of which light source was being used. To some extent the direction of the surface pattern indicated spatiality, resulting from the various angles from which photographs were taken, as did the angle of the plane that the surface pattern was attached to. These above-discussed topics were used as main principles during the analysis.
Spatiality created by reference object

Figure 33. Dot Small, position 3.

Figure 34. Dot Extra Large, position 1.

Figure 35. Triangle Small, position 5.

Figure 36. Square Medium, position 3.
Figure 37. Circle Medium, position 3.

Spatiality created by corners

Figure 38. Triangle Medium, position 5.

Figure 39. Square Extra Large, position 1.

Spatiality created by corners

Figure 40. Grid Small, position 4.
Spatiality created by values of grey

Figure 41. Diamond Small, position 1.

Figure 42. Grid Small, position 3.

Figure 43. Dot Small, position 4.

Figure 44. Dot Small, position 3.
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Spatiality created by pattern scale

Figure 45. Diamond Medium, position 4.

Figure 46. Square Medium, position 5.

Figure 47. Dot Medium, position 3.

Figure 48. Circle Medium, position 2.

Spatiality created by pattern scale
PATTERN RELATIONS EXERCISE 2

Spatiality dissolved by pattern scale

Figure 49. Triangle Extra Large, position 2.

Figure 50. Dot Extra Large, position 4.

Spatiality dissolved by pattern scale

Figure 51. Diamond Extra Large, position 1.

Figure 52. Circle Extra Large, position 3.
Pattern transformations

When structuring the analysis of this part of the experiment, it was decided to first consider the pattern unit categories; in identifying the pattern transformations, particular features emerged. When the surface pattern was scaled up and down, it was found that certain aspects came to the fore:

Form

Stripes and surfaces

The lighting conditions did not seem to influence pattern transformation. Optical effects, such as the Moiré effect, were observed, but were not included in the analysis as it was felt that they did not affect the transformation to any significant extent. Figures 53-70 show all six surface patterns in three scales, photographed from different positions.
PATTERN RELATIONS EXERCISE 2

Figure 53-55. Grid Small, Medium and Extra Large, position 5.

Pattern units

Pattern units

Figure 56-58. Dot Small, Medium and Extra Large, position 1.
PATTERN RELATIONS EXERCISE 2

Figure 59-61. Diamond Small, Medium and Extra Large, position 1.

Pattern units

Figure 62-64. Square Small, Medium and Extra Large, position 2.

Pattern units
PATTERN RELATIONS EXERCISE 2

Figure 65-67. Circle Small, Medium and Extra Large, position 5.

Figure 68-70. Triangle Small, Medium and Extra Large, position 4.
Transformation from surface pattern to form

The changes from surface pattern to form were most evident in the surface patterns in the Extra-Large scale (Figs. 71-76), in which the pattern units were no longer repeated, but rather freestanding compositions. As the wall and base planes delimited the pattern unit, what was left were black and white areas. What was particularly noticeable in the images was that the spatial qualities produced by the patterns became less clear, with no reference object suggesting space. Although the corners delimited the surface pattern, the effect produced was not spatial, but consisted of an abstract, black and white composition. The surface pattern changes were largely evident without the reference object.
Figure 73. Dot Extra Large, position 5.

Transformation from pattern to form

Figure 74. Square Extra Large, position 5

Figure 75. Circle Extra Large, position 1.

Transformation from pattern to form

Figure 76. Triangle Extra Large, position 5.
Pattern transformations to stripes and surfaces

In the Small-scale series, the surface pattern changed to stripes and surfaces. As can be seen in Figure 77, the surface pattern units on the right wall plane became vertical stripes, while the floor plane pattern changed to horizontal lines due to the surface pattern scale and camera angle. It is difficult to distinguish the black dots on the rear wall, which appear to have merged into a diamond-like surface pattern. Thus, the pattern appears to have become a Small-scale surface pattern. It is apparent that the Small dot (Fig. 77) has lost its strength and qualities as a shape when compared to its Medium counterpart (Fig. 78).

Figure 77. Dot Small, position 4.

Figure 78. Dot Medium, position 4.
The transformation from surface pattern to stripes and surfaces is most obvious in the smallest-scale surface patterns, photographed in Position 3 (Figs. 79-84). The wall planes, because of their vertical orientation, are active in the normal field of vision and vital to the shaping and enclosing of the architectural space (Ching, 2014). Here, the surface pattern changes are primarily apparent in the photographs in which the reference object is not present.

Figure 79. Grid Small, position 3.

Pattern transformations to stripes and surfaces

Figure 80. Square Small, position 3.
PATTERN RELATIONS EXERCISE 2

Figure 81. Circle Small, position 3.
Pattern transformations to stripes and surfaces

Figure 82. Triangle Small, position 3.

Figure 83. Dot Small, position 3.
Pattern transformations to stripes and surfaces

Figure 84. Diamond Small, position 3.
Reflections

Several possible ways of understanding pattern relations and expressional appearances on flat surfaces in a defined space were explored, emphasising scale as a design variable in surface pattern design. The experiments served as a foundation for the initiating and development of ideas, as well as a basis for description and examination. The results can be categorised into three main areas:

Spatiality and spatial appearance: The scale of the surface pattern creates spatial characteristics in addition to those of the reference object, the corners, and the grey hue. In the Extra-Large series, spatiality dissolved when the reference object was not present. The corners did not facilitate spatial properties.

Transformation 1 – from surface pattern to form: The surface pattern on the Extra-Large scale dissolved the repetition and transformed the surface pattern into an abstract composition.

Transformation 2 – from surface pattern to stripes and surfaces: The surface pattern on the Small scale changed the pattern to stripes and/or surfaces, and generated a diagonal, checked surface pattern.

Applying scale as a design variable turned out to be key in exploring these areas, as scale has a large impact on visual expression. Using scale as the core of the design experiment gave rise to three questions: In what ways could these results influence the design processes of textile designers? Is it reasonable to assume that they might lead to certain kinds of aesthetics? How could these discoveries be developed into valid design methods?
Textile material

This design experiment focused on scale-changing surface patterns, textile materials, and pattern relationships. Its purpose was to explore how the movable scales of a surface pattern interact with undyed textile materials using projection as a design tool.

Exercises 1 and 2 involved a systematic method of investigating surface patterns, spatiality, and pattern relations, and provided a foundation for continued exploration. Surface patterns in three to six fixed-scale stages were used to explore scale as a design variable in a spatial, three-dimensional context. Traditionally, one scale is picked for a certain situation or use; for example, small-patterned textile fabrics are generally used in car interiors. Throughout the evaluation of Exercises 1 and 2, new thoughts and questions relating to static and dynamic patterns arose: Is scale always static? Does it have to be without motion? Does scale have to be static? How might it be possible to design surface patterns that change scale over time, like a lamp’s dimmer switch? How can we design with these variables/conditions in mind?

Working with movable scale—examining the phases between static and motion—became an intriguing part of the investigation. Having used fixed increments of scales in Exercises 1 and 2, between 50 and 60 scale steps were available in Exercise 3.

Exercise 3 did not have any obvious connection to spatiality nor three-dimensionality, as was the case in Exercises 1 and 2. To expand the concept of ‘spatial area’, textile fabrics with embossed, three-dimensional surfaces that evoked spatiality were used. The textiles should be seen as an area containing spatial properties and appearances, even though the surface patterns were projected onto surfaces that were attached to a wall.

The intention in conducting this exercise was to gain more knowledge about the use of fluid, non-regimented changes in scale as a design variable and expressional method of surface pattern design, projected onto a textile. Having used paper printouts in the previous exercises, the desire to use textile material in this one was strong. The experiment was undertaken primarily to use textiles to explore pattern relationships, and textile materials were created especially for this exercise. Projection facilitates experimenting with every possible scale step and provides instant results, and thus was chosen for use in Exercise 3.
Experimental setup:

Three types of textile material with different spatial qualities were produced for Exercise 3. The jersey bubbles were developed in the knitting lab at The Swedish School of Textiles and produced using cotton and filling yarns [Fig. 85]. The bubbles stand out from the background as a relief pattern, with ‘relief’ referring to elements of a surface that are raised above its base plane, expanding the textile’s depth and texture thickness. The mixed materials in layers (Fig. 86) were created using square pieces and leftovers consisting of organza polyester and mixed materials. The surface could be perceived as being quite flat, but had an uneven surface. The polyester tubes were three-dimensional, as the tubes each hung individually, having been attached to a soft wall (Fig. 87). The material pieces were sewn, glued, and stitched together to create the desired shapes, which were varied, embossed, and three-dimensional.

The basic forms of circle, square, and triangle were used [Fig. 88] due to their simple expressions, allowing results to be displayed clearly and distinctly, as well as because they functioned as a good starting point for exploring changeable scale and form.

The software program Processing was used for the projection, enabling the scale of the surface pattern to be manipulated by zooming in and out using the computer’s trackpad, and this process was filmed and photographed (Figs. 89-90). Theoretically, an infinite number of scales are possible, but due to space limitations a selection was made. Figures 91-99 show the circle, triangle, and square patterns on the three different materials in 25 scale steps.
Figure 91. The Circle pattern in 25 scale steps on jersey bubbles.
Figure 92. The Circle pattern in 25 scale steps on mixed materials.
Figure 93. The Circle pattern in 25 scale steps on polyester tubes.
Figure 94. The Triangle pattern in 25 scale steps on jersey bubbles.
Figure 95. The Triangle pattern in 25 scale steps on mixed materials.
Figure 96. The Triangle pattern in 25 scale steps on polyester tubes.
Figure 97. The Square pattern in 25 scale steps on jersey bubbles.
Figure 98. The Square pattern in 25 scale steps on mixed materials.
Figure 99. The Square pattern, in 25 scale steps on polyester tubes.
Analysis 1

Exercise 3 resulted in a rich selection of images, documenting three basic surface patterns projected onto three different textile materials and photographed in 25 scale steps. The aim was to explore how the movable scales of a surface pattern interact with undyed textile material using projection as a design tool. The analysis was based on the image material and the ‘live’ aspect that the use of projection provided. The merging of material and surface pattern scale was central to this exercise; however, pattern expression and pattern scale were the main criteria used in the analysis, as well as spatial appearance to a slightly lesser extent.

_Jersey bubbles: expression and scales_

In the first scale steps, the bubbles ‘forced’ the surface pattern to follow the circle form. The bubbles are concave rather than convex, unlike an actual bubble.

Figure 100. The Circle pattern on jersey bubbles, small scale.

Figure 101. The Triangle pattern on jersey bubbles, small scale.

Figure 102. The Square pattern on jersey bubbles, small scale.
When the bubbles and the pattern unit were the same size, the transformation was striking, producing an intriguing and astonishing look.
The jersey bubbles deformed the surface pattern in an even way due to the uniform nature of the surface that they formed, and which the surface pattern was projected onto. This effect was most obvious for the middle scales.
In the largest scale steps, the bubbles were distinct surfaces, clearly part of either the black or white areas.

Figure 109. The Circle pattern on jersey bubbles, large scale.

Figure 110. The Triangle pattern on jersey bubbles, large scale.

Figure 111. The Square pattern on jersey bubbles, large scale.
Mixed materials in layers: expressions and scales
The surface pattern in the smallest scale was projected onto the material, and the combination of the two created the appearance of a grey surface, with the material possible to discern in spite of the surface pattern.

Figure 112. The Circle pattern on mixed materials in layers, small scale.
Figure 113. The Triangle pattern on mixed materials in layers, small scale.
Figure 114. The Square pattern on mixed materials, small scale.
The visual characteristics of the mixed materials in layers were lost in the middle scales, where the surface pattern dominated the surface onto which it was projected. In the larger scales, however, the textile’s characteristics outshone the surface pattern (Figures 115 and 116 show the smallest and largest scales for the purpose of comparison).

Figure 115. The Triangle pattern on mixed materials, middle scale.

Figure 116. The Triangle pattern on mixed materials, large scale.

Figure 117. The Square pattern on mixed materials, middle scale.

Figure 118. The Square pattern on mixed materials, large scale.
The surface pattern was blurred less by the smoother surfaces of the mixed materials than the rougher ones, creating an overall expression that blended sharpness and diffusivity. This is most obvious in the square series in the medium and large scales.

Figure 119. The Circle pattern on mixed materials, middle scale.

Figure 120. The Triangle pattern on mixed materials, middle scale.

Figure 121. The Square pattern on mixed materials, middle scale.
Polyester tubes: expressions and scales
In the small and middle scales, the fluffy polyester tubes overpowered the surface pattern, light, and colour. Spatial appearance, however, was clearer due to the three-dimensionality of the tubes. Changing the kind of surface pattern did not result in any major differences.
The distinct expressions of the surface patterns became soft and fuzzy shapes in the small-scale steps. The outlines of the surface patterns lost their strength, making the black seem weaker. Contrast in the images was very low, particularly for the triangle and square forms.

Figure 125. The Circle pattern on polyester tubes, middle-large scale.

Figure 126. The Triangle pattern on polyester tubes, middle-large scale.

Figure 127. The Square pattern on polyester tubes, middle-large scale.
Reflections

Exercise 3 investigated the nature of scale by scaling up and down repeating surface patterns on textile materials. The experiment involved using digital projection to explore scale and create an expression that was in constant change. The merging of material and surface pattern scale was the main focus of this exercise.

The projected surface patterns behaved differently with each material. In the smallest scales the material dominated the surface pattern completely; the textiles’ qualities were visible as the material could be seen through the projected surface pattern. In the middle scales the surface patterns and materials merged equally, and the two integrated with each other. In the middle to large scales the surface pattern dominated the material completely, but in the largest scales the material took over again.

How do the textiles interact with surface pattern? In Exercise 1, the pattern expression was changed by altering the scale, changing both the expression and the textile material itself. The textile material affected the pattern’s expression, but did not transform the surface pattern into forms, stripes, and surfaces, as was seen in Exercise 2. Other features, however, were affected, as sharpness, contrast, and the outline of the surface pattern varied depending on the textile material. Which is dominant; the surface pattern or the material? At what scale step does the shift become apparent? How does the combination of projection and textile materials work as compared to paper printouts?
The analysis of the design experiments (Exercises 1-3) resulted in an improved understanding of the relationship between surface pattern and scale. However, there are likely other aspects to learn about, and more matters to discover in the material that was produced. There is a need to explore the subject further, to push the limits and open up for a broader discussion. How can the experiments be used to develop current knowledge and find alternative working methods in surface pattern design? How can the essence of the research be fully explicated?

**The function of a surface pattern**

What is the usage/function of a surface pattern? Surface patterns have different kinds of practical and decorative functions depending on the context in which they appear; they may be used on a carpet, incorporated into wallpaper, or placed in a car interior. The purpose of a surface pattern could be anything from covering a surface for the purposes of comfort and satisfaction to contributing to the construction of a product’s identity, hiding dirt and abrasions on a subway seat, or highlighting something. Surface patterns can be used to guide and indicate directions in public spaces such as hospitals and schools. Surface patterns can also occur on a psychological level as carriers of form, colour, and narrative, and can affect rooms, spaces, and surfaces – an important consideration. Additionally, a surface pattern can be linked to the manufacture of a product; sewing a quilt or constructing a textile material, for example. A patterned product (not necessarily a textile one) is constructed using materials and techniques. The appearance of a product’s surface pattern results from the possibilities and limitations of the materials and technologies used in the product’s manufacture. Among all of these aspects, it can be argued that surface patterns also act as spatial definers.

Thus, it is of central importance to consider surface patterns in terms of spatial definers, and how surface patterns and spatiality introduce a relationship between themselves. This can be examined by changing scales (as was undertaken in Exercises 1, 2, and 3), as well as by establishing what a spatial definer actually is in a pattern context. The patterns are active; they are more than ‘just’ surface patterns.

Design variables are specified in a design brief and implemented during the design process. From a methodological perspective, design variables affect the final expression of a textile and are decided at the beginning. What if conceptual spatial determinations were a design variable? This should cover spatial concerns; position, direction, plane, format, and so on. Could this be a way of introducing pattern...
relations in surface design and, in so doing, place the function of the surface pattern in brackets? Moreover, understanding how a surface pattern can clarify a spatial relationship is of great value. Thus, conceptual spatial determinations could be utilised as tools in the design process to explore this – but how might this affect the actual design outcome?

A surface pattern determines space in a concrete manner. Another way of connecting surface patterns and conceptual spatial determinations is to employ theoretical classifications in the form of word classes. The notion of adverbs comes from grammar, and may be defined as words that describe relationships between people, places, and objects [Cambridge Dictionary, 2017], and is a broad collection of concepts that describe how, where, and when an action takes place: over, under, on, at, behind, in front of, next to, through, above, after, against, along, before, below, beside, inside, between, up, around, etc. What is meant by ‘conceptual spatial determinations’ in this context is non-representational (intangible or abstract) expressions (or notions) in connection with spatial contexts (such as a three-dimensional setting). This can be viewed as contrasting with expressions/notions within architecture and interior design that describe actual and concrete spatial matters such as plane, space, form, volume, etc. This is where adverbial concepts – up, in front of, behind, etc. – enter, as these are seen as abstract determinations (or ‘attributes’) that say something about sequences of events, in turn describing relationships between objects and places. In this thesis, these are referred to as pattern relations – the relationship between a surface pattern and a spatial area. There are certain similarities between pattern relations and adverbs: both propose relationships between one feature and another, for example. Thus, it makes sense to adapt adverbial concepts in order to designate and describe conceptual spatial determinations as tools of analysis.

Adverbial concepts can also tell us something about textiles themselves. Many textiles are constructed and created in such a way that they consist of a ‘front’ and a ‘back’, raising the issue of definitions. What, for instance, is ‘up’ in a textile product context? On a tablecloth, for example, it could be a seam or stitches, the pattern may have a clear reverse side, or there may be small details, such as fringes or corners with a specific finish, that indicate ‘up’ or ‘down’.

Scenario I:

Place a patterned tablecloth on a table in a room. What does the tablecloth [the surface pattern] do in the room? What spatial function determines the tablecloth in this setting? The patterned tablecloth determines ‘up’, and establishes a relationship within the room. How does this happen?

Scenario II:

Design a wallpaper pattern and a surface-patterned garment. Could this brief be replaced with ‘Design ‘behind’ and ‘in front of’ using surface patterns’? By doing so, an alternative design variable is introduced as a tool in the textile design process – or, more precisely, in the surface pattern design process.

To widen the analysis and open up for greater variation, it is necessary to supplement the adverbial concepts, which have thus been complemented with notions from the design and architecture fields. Conceptual and visual elements such as plane, surface, space, texture, form, and dominance should be able to suggest other possibilities in the analysis process. These notions are the primary elements of form used in architecture and design theory [Ching, 2007; Itten, 1963] as both conceptual and visual elements. This means that conceptual spatial determination in this context comprises both adverbial notions and concepts from design and architecture.

Practice can be developed by opening up for new design spaces [Hallnäs & Redström, 2006]. The work described in this thesis seeks to expand conventional working methods by presenting conceptual spatial determinations as design variables in the design process. These could provide alternative ways of design thinking that result in a strengthened connection between spatiality and pattern relationships in textile design. What does the surface pattern do? It defines spatial determinations. What determines what is expressed? The design method and the working approach are in focus. How does a designer working in this manner change the way in which they design? How does this change the process of teaching surface pattern design? Wallpaper patterns are designed every day, but what happens when a conceptual spatial determination is applied as a design variable in the design process/teaching?
Consider the possibility of, just as conceptual spatial determinations are utilised as design variables, a spatial dimension being added to the process of analysing surface patterns. One way to continue development is to discuss the methods of analysis: to expound a theoretical model that focuses on the surface pattern as a spatial definer, contributing to the growth of the surface pattern design field.
The theoretical model created for the work described in this thesis is based on the reflections described in the previous chapter, wherein conceptual spatial determinations were introduced as an analysis tool. The model was somewhat inspired by the structure of CARS (Creating A Research Space), a model that was developed by Swales (1990) and based on his analysis of journal articles representing a variety of discipline-based writing practices. The CARS model is used to create a research space and context in which writing may take place. Two types of challenge [competition] are introduced: 1) Creating a rhetorical space, and 2) Attracting readers into that space (Swales, 1990).

Like Swales’ model, the name of this model derives from its subject matter:

Analysing
Conceptual
Spatial
Determinations
= ACSD model

The model proposes three actions or “moves” [in the diction of Swales], accompanied by specific questions that relate to what is being analysed. These moves can be used as a template for establishing relationships, classifying concepts, and defining determinations. However, the model does not claim to be a universal one; rather, it has been created specifically for the research project described in this thesis. Aspects of it may, however, be applicable to similar surface patterns in other contexts.
Move 1 Establishing relationships
Start by discerning what relationships should be defined. What types of relationships are to be scrutinised? Which features are to be analysed? Is it, for instance, the relationship between the object and the background, surface pattern and spatiality, or scale and material? With a starting point in the exercises described above, the relationships simply presented themselves. Considering surface patterns from a general viewpoint, the relationships described above could be adapted relatively easily, although more specific relationships, such as that between a repeating method and a motif or between colours, could also be explored.

Move 2 Classifying concepts
Continue by stating the categories of concepts. What kind of concepts are to be applied: word classifications, conceptual elements, visual components, or others? Again – based on the outcomes of Exercises 1–3 – the various setups provided the conditions for choosing one or another, and facilitated exploration of the motif and its expression in each example. The categories of concepts were notions deemed by the author to be of value in analysing surface patterns.

Move 3 Defining determinations
Finally, employ conceptual spatial determinations to describe relationships. What kind of concept/expression is adequate? This follows on from Move 2, and depends on which concept is chosen. If word classification is picked, adverbial concepts should be employed; if conceptual elements and/or visual components are selected, tangible conceptions that describe form and space should be applied. As in Moves 1 and 2, having an idea of what to analyse simplifies the choices to be made.

Design theorists, designers, and scientists have developed various models for analysing surface patterns and conducting pattern recognition. Hann carried out an extensive survey of the fundamentals of pattern structure, utilising conceptual developments in the analysis of surface patterns (2003b). Focusing mostly on the geometrical aspects of surface patterns, Hann identified and classified the symmetrical characteristics of motifs, border patterns, and all-over patterns (2003a). His main findings concern symmetry classification as an analytical tool, and how it benefits our understanding of surface patterns and their cultural significance.

Kraft proposes pattern analysis as an analytical model in her search for subjective influences, and claims that surface pattern research can contribute to scientific theory (2004). Using textile analysis as a model, she states that the primary function of surface patterns is complexity reduction, and focuses on textile production processes and the related environment in order to show that surface patterns do have potential epistemological functions – that patterns are able to show something. Kraft’s model touches upon several subjects, including philosophy, science, and biology, and has the stated intention of positioning the surface pattern as an epistemological object.

The ACSD model is a design model, and dependent on its context. In contrast to the models of Hann and Kraft, this model focuses on explaining how surface patterns that are deployed in a three-dimensional setting contribute in an active manner to defining spatial determinations. It has been created in order to challenge established practice and conventional analytical tools. By analysing the experiments for a second time using this model, it is hoped that our knowledge will be expanded through an increase in the level of abstraction regarding surface patterns.
Analysis 2:

Exercise 1: 2D meets 3D

The ACSD model was used to analyse the design exercises for a second time; to interpret surface patterns as spatial definers and further develop the project. In order to determine Moves 1-3, the actual outcomes of the examples were scrutinised. Based on the setup of the work and the visual expression of each exercise, the moves were decided.

**Move 1 Establishing relationships**
The relationship that was to be analysed was that between object and background. This was explained by the arrangement of the exercise; a mannequin placed in front of a backdrop, which in turn was wrapped in fabric printed with a surface pattern.

**Move 2 Classifying concepts**
Word classifications in terms of adverbial concepts were chosen. Once again, the arrangement of the exercise settled the prerequisites; a freestanding object, positioned in an environment that encouraged the use of adverbial concepts that describe where an action takes place.

**Move 3 Defining determinations**
The adverbial concepts that were utilised in the analysis of the examples were in front of, behind, and next to. As above, this was based on the setup and arrangement of the exercise.
In front of

The full-colour images in Figure 128 are the clearest examples of instances in which the object was in front of the background, having been ‘pushed’ forwards by the different scales of the surface pattern. The concept of ‘in front of’ defines pattern relations. The surface pattern determines a relationship within the room and introduces a connection between the object and the background. In this respect, the scale of the surface pattern governs what is expressed – ‘in front of’.

Scale, size, and distance define pattern relations. The size of the pattern unit in the surface pattern implies the scale, and indicates the relationship between the surface pattern and the background. The scales of the object and the background shown in Figure 128 were very disparate, facilitating an understanding of both and outlining the pattern relations.

The mannequin is recognised as an object that has three dimensions; a three-dimensional form. The object in Exercise 1 had a strong and evident presence in the images, and strengthened the relationship between the pattern and spatiality due to its three-dimensionality. This is noticeable in Figure 128, where the object and the background contrast strongly with each other in all of the images. The images are thus strong examples of how a three-dimensional object affects the relationship between the surface pattern and a spatial area due to the scale of the pattern. This occurred in all of the scales, from the smallest to the largest, although the object and the background were clearly distinct due to this shift in scales. Figures 129-134 provide a closer look at ‘in front of’, presenting the images of Figure 128 row by row.
ANALYSIS 2: EXERCISE 1

In front of Figure 131.

In front of Figure 132.
ANALYSIS 2: EXERCISE 1

Figure 133. In front of.

Figure 134. In front of.
ANALYSIS 2: EXERCISE 1

Behind

The opposite of 'in front of' is 'behind'. The full-colour examples shown in Figure 135 emphasise pattern relations when the object is situated behind something – in this case the background. The object is 'pushed' back by the larger scale of the background than that of the object, and so the latter dominates the former. Even though the object is interposed between the surface pattern and the viewer, the pattern of the background itself is strong enough to override it. Figures 136-138 present a closer view of 'behind'.

Figure 135. Behind.
ANALYSIS 2: EXERCISE 1

Figure 136. Behind.

Figure 137. Behind.
Figure 138. Behind.

Behind
The relationship between the object and the spatial area (background) is ambiguous, because the scale of the background is (generally) the same as that of the object. *Next to* is most visible in the full-colour photographs in Figure 139, demonstrating that scale does not enable pattern-relationship recognition purely on the basis of the closeness of two scales. The object and the background are laterally related; they are, ultimately, at the same level, to the point that they almost disappear into each other. When the scales correspond as they do here, it is difficult to distinguish the object from the background; they merge into a single surface in the manner of a camouflage pattern, with the object becoming unclear and blurry. Note, however, that a larger scale results in it being easier to recognise the object’s three-dimensionality, and this is true in general. Figures 140–145 show larger photographs of ‘next to’.

Figure 139. *Next to*. 
ANALYSIS 2: EXERCISE 1

Figure 140. Next to.

Next to

Figure 141. Next to.
ANALYSIS 2: EXERCISE 1

Figure 142. Next to.

Figure 143. Next to.
ANALYSIS 2: EXERCISE 1

Next to

Figure 144. Next to.

Figure 145. Next to.
Reflections

The outcome of Exercise 1 was 36 images with the same composition; one object in front of a surface, which can also be seen as two items that interact with each other in a spatial setting. The same surface pattern in different scales was applied to both the object and the background. The ACSD model was employed to analyse and interpret the surface pattern as a spatial definer, and adverbial concepts were used to define pattern relations. Images that best represented ‘in front of’, ‘behind’, and ‘next to’ were picked as concepts for the analysis, as well as to clearly illustrate the logic of pattern relations. The categorisation of the photographs based on each concept was related to the scale of the surface pattern (on both the object and the wall), the three-dimensionality of the object, and how these related to each other. It was concluded that the surface patterns in Exercise 1 had an active role in the spatial determinations.

The results of this analysis clearly demonstrate the potential of surface patterns for clarifying spatial relationships using an alternative analysis model – and exploring how this kind of design thinking can be translated to the textile design process is an intriguing thought. How might conceptual spatial determinations being employed as design variables affect the surface pattern design process? During the design process, the design brief could include spatial determination (instead of e.g. function), such as ‘in front of’ or ‘next to’ in a space. How should this be understood from a design perspective? Exercise 1 used surface patterns with scaling to explore this, finding that the surface pattern contributes to defining the room. Scale is not the most important issue here, however, as the use of conceptual spatial determinations – such as in front of, behind and next to – was the primary result of the analysis of Exercise 1, even though the point of departure for this investigation was entirely different.
Analysis 2:

Exercise 2: 2D generates 3D (the power of scale)

**Move 1 Establishing relationships**
The relationship that was to be analysed was that between *surface pattern* and *spatiality*. The overall arrangement of Exercise 2 – the scale model with wall and base planes – determined which relationship was examined.

**Move 2 Classifying concepts**
*Conceptual elements* and *visual components* were analysed, based on their clear connection to three-dimensionality and interior architectural spaces.

**Move 3 Defining determinations**
The terms that were utilised in the analysis of the examples were *plane*, *direction*, and *volume*. The scale model ‘demanded’ the use of classical notions taken from design and architecture.
The setup

Several relatively radical decisions regarding the working material were made: The project was streamlined, with greater focus placed on the analysis. The surface pattern unit group was kept but, as the lighting conditions seemed to have little effect, the decision was made to proceed with directional lighting, as this offered the clearest light distribution. The full-frontal camera angle (Position 3) was selected as, while visual appearance was of importance in relation to the analysis of the surface pattern itself, it was found to be less crucial in relation to examining pattern relations. After considering the function of the reference object, the decision was made to skip the image series that contained the chair, as this was deemed to be inessential to the desired outcomes of the research. This reduced the number of images analysed from 20 per series to one, which was felt to be more manageable for Analysis 2, which ultimately investigated a total of 18 photographs. Figures 146-151 show the photographs that were used in this final stage of analysis.
ANALYSIS 2: EXERCISE 2

Figure 146. Circle pattern in 3 scales photographed in position 3.

Figure 147. Diamond pattern in 3 scales photographed in position 3.

Figure 148. Dot pattern in 3 scales photographed in position 3.

Figure 149. Grid pattern in 3 scales photographed in position 3.

Figure 150. Square pattern in 3 scales photographed in position 3.

Figure 151. Triangle pattern in 3 scales photographed in position 3.
Identifying conceptual elements and visual components

**Plane**

Conceptually, a plane has length and width, but no depth. Planes in architecture define three-dimensional volumes of mass and space (Ching, 2014).

In Figure 152 the planes are clearly defined, even though their shapes are distorted by foreshortening. The base plane is the horizontal element that sustains the force of gravity, and its shape and surface pattern determine to what extent it defines spatial boundaries and serves as a unifying element for the other planes in the model [the wall planes]. The wall planes govern the size and shape of the internal space within the model and mould an interior space. Their visual properties and relationship to one another regulate the qualities of the space that they define. As design elements, the wall planes merge with the base plane and assert themselves as visually active elements through their form and surface pattern.

**Volume**

A plane extended in a direction other than its intrinsic direction becomes a volume. Conceptually, a volume has three dimensions: length, width, and depth (Ching, 2014). As such, the scale model consists of planes that converge as either lines or edges and define the limits of a volume, which is empty space surrounded by planes. This volume can be seen as a portion of space, contained and defined by wall and floor/base planes.

**Direction**

The variations of the basic grid are constituted by the angling of every vertical and/or horizontal line. Such digression from the original vertical-horizontal stability can create a sense of movement (Wong, 1993). 'Direction' is a spatial term that is used in design and architecture to refer to how planes visualise the environment, and scaling the surface pattern up and down causes the dissolution of planes.

In this extended interpretation of Exercise 2, it is suggested that surface patterns placed in a spatiality [in this case, a scale model] play an active role in defining spatial determinations. The surface patterns establish spatial determinations in a space, and determine what they actually mean in concrete terms. The 'task' of the surface pattern is to map out spatial determinations. How do the surface patterns define spatial determinations?

In order to broaden the exploration of the spatiality of surface patterns – more specifically, to distinguish a pattern in relation to the environment – additional clarification was needed. Thus, the photographs shown in Figures 146-151 were further divided into sub-categories, and another selection, based on pattern size, was made (Figs. 153-158).
Figure 153. Circle Small.
Figure 14: Diamond Small.
Figure 155. Dot Small.
Figure 158: Triangle Small.
Conclusion 1

The Small series shows how the smallest scale of the surface pattern highlights the spatial determinations, namely plane, direction, and volume (Figs. 153-158). These determinations are strengthened because of the small-scale pattern, with the scale facilitating an understanding of the spatial determinations.
Figure 160. Diamond Medium.
Figure 161. Dot Medium.
Figure 162. Grid Medium.
ANALYSIS 2: EXERCISE 2

Conclusion 2

The Medium series demonstrated that plane, direction, and volume are confirmed/stressed/proved by using a medium-sized surface pattern (Fig. 159-164), which provides a clear perspective on spatial qualities.

Figs. 159-164. The Medium series; Circle, Diamond, Dot, Grid, Square and Triangle.
Figure 165. Edge Extra Large.
Figure 166. Diamond Extra Large.
Figure 167. Dot Extra Large.
Figure 168. Grid Extra Large.
Figure 170. Triangle Extra Large.
Conclusion 3

Spatial determinations in the Extra-Large series were dissolved by the large-scale surface pattern (Figs. 165-170). At this point, plane, direction, and volume were no longer obvious; the base and wall planes vanished because of the surface pattern size, deconstructing the space such that it became something abstract – almost a two-dimensional surface.

Figs. 165-170. The Extra Large series; Circle, Diamond, Dot, Grid, Square and Triangle.
Reflections

For Analysis 2, the surface patterns were separated into groups according to scale and investigated based on the plane, direction, and volume of the spatial determinations. The question that arose was: How do the surface patterns define spatial determinations? The answer to that is clear: Their ability to define spatial determinations is relatively simple, and based on scale; Small patterns strengthen the planes, direction, and volume; Medium patterns confirm them; Extra-Large patterns dissolve them.

How can these words be used to describe relationships between surface patterns and space? What is the outcome if spatial determinations (plane, direction, and volume) are used as design variables in the surface pattern design process? What kind of change/challenge could doing so bring into the design process?
Analysis 2:

Exercise 3: Textile material

Move 1 Establishing relationships
The relationship that was to be analysed was that between surface pattern, scale, and material. The setup of Exercise 3 included these three components, which were consequently studied.

Move 2 Classifying concepts
Word classifications in terms of adverbial concepts were used. The textile material used in the setup was essentially flat, but its relief effect and tactile qualities suited the use of adverbial concepts.

Move 3 Defining determinations
The concepts that were utilised in the analysis of the examples were inside, on top of, and under. Projection was the design tool, and was used to apply the surface patterns to the material, which was interesting as they challenged the clarity of the concepts, (as can be seen in the photographs).
Figures 171-173 show examples wherein the surface pattern appears to be ‘inside’ the material when it is projected onto it due to the structure of the material. The surface pattern ‘wobbles’ around the tubes, establishing a relationship with the material and introducing a joining between the surface pattern and the material, and makes it more difficult for a viewer to see that the surface pattern is in fact projected onto the material. ‘Inside’ is mainly visible in the Small and Medium scales, where the pattern unit corresponds to the size of the polyester tubes. As was found in Analysis 2 of Exercise 1, it is the scale of the surface pattern that regulates how ‘inside’ is expressed.

As was discussed in relation to Exercise 3, there was a need to expand the concept of spatial area to include textile fabrics with three-dimensional qualities, reminiscent of a conception of spatiality involving spatial properties. As was stated in Analysis 2 of Exercise 1, scale, size, and distance are factors in defining pattern relations. However, the setup for Exercise 3 did not include an arrangement comparable to that of the object and the background in Exercise 1; rather, there was one surface in Exercise 3, and no object.
Figure 171. Dot: Medium scale projected on polyester tubes.
Figure 172. Triangle Medium scale projected on polyester tubes.
Figure 173. Square. Medium scale projected on polyester tubes.
On top of

The mixed materials in layers have a patchwork-like surface and are the flattest of the materials studied. Of particular interest was how the different pieces provided both sharpness and diffusivity at the same time, with the projected surface pattern 'on top of' the surface. Figures 174-176 show how the projection on the surface created sharp shadows, as well as the distinct squares of the material.
Figure 174. Circle Small scale projection on mixed materials.
Figure 175: Triangle Small scale projected on mixed materials.
Figure 176. Square Small scale project on mixed materials.
ANALYSIS 2: EXERCISE 3

Under

The jersey bubbles have an even surface that create shadows when the material is projected on. In Figures 177-179, ‘under’ is used to interpret the surface pattern as a spatial definer. The bubbles ‘pop out’ from the surface, ‘pushing’ the surface pattern down. The relationship between the surface pattern and spatiality (here, the material) established ‘under’ as a spatial determination.
Figure 177: A medium-scale project on jersey bubbles.
Figure 178: Triangle Small scale projected on jersey bubbles.
Figure 179: Square Medium scale projected on jersey bubbles.
Reflections

In Analysis 2, the material influenced the categorisation of surface patterns. The concepts ‘inside’, ‘on top of’, and ‘under’ were utilised in the analysis. All of the materials that were used in Exercise 3 have three-dimensional characteristics, even though they differ from one another. The degree to which these qualities are visible depends on the projected scale of the surface pattern, and this experiment produced between 50 and 60 scale steps in each surface pattern and material, meaning that it was possible to examine a wider range of scales than in Exercises 1 and 2. The materials enabled adverbial concepts to be explored and, in so doing, the spatial determinations clarified the relationship between the surface pattern and the spatial material. How can materials facilitate an understanding of pattern relations? Does scale add to our understanding of pattern relations?
Exploring the relationship between surface patterns and spatial determinations from different perspectives can add to our understanding of pattern relations. The exercises undertaken for this research project play an important role in improving that understanding.

Exercise 1: The result of this exploration demonstrates the potential of surface patterns to contribute to clarifying spatial relationships.

Question asked: How might abstract spatial determinations being employed as design variables affect the textile design process? During the design process, the design could be focused on achieving a spatial determination (instead of e.g. a function) such as ‘in front of’ or ‘next to’ in a space. How should this be understood from a design perspective?

Exercise 2: Depending on the scale of the surface pattern (Small, Medium, or Extra-Large series), its ability to define spatial determinations is relatively simple to explain: The scales either strengthen, confirm, or dissolve planes, direction, and volume in a spatial area.

Questions asked: How might it be possible to use these words to describe the relationships between surface patterns and spaces? What would be the outcome if spatial determinations (plane, direction, and volume) were used as design variables in the surface pattern design process? What kinds of changes/challenges could that bring into the design process?

Exercise 3: The materials enabled the terms ‘inside’, ‘on top of’, and ‘under’ to be considered, and in so doing the spatial determinations clarified the relationship between the surface pattern and the spatial material.

Questions asked: How can materials facilitate our understanding of pattern relations? How does scale add to our understanding of pattern relations on a flat surface with three-dimensional qualities?

The surface pattern functions as a spatial definer. How could this be comprehended from a design perspective? The original intention behind this research was to explore scale and its ability to influence surface pattern expression. However, using conceptual spatial determinations as tools in the analysis turned out to be a far more stimulating approach. In addition to adding to our knowledge of the field, these examples can be used by designers who seek alternative working methods, or as material for reflection and inspiration when teaching surface pattern design in
The conclusions that were reached following the conducting of Analysis 2 gave rise to several questions regarding design variables and design processes. In order to improve our understanding of the connections between surface patterns and spatial determinations, it was felt that the concepts and ideas that were evoked should be tested. Taking this one step further involved trying out the ideas in actual design processes in collaboration with textile design students, as such people have the opportunity to test methods and approaches without worrying about the commercial implications of success or failure. Their methodologies are initially formed during their education, then later used in practice. Introducing alternative design variables in the design process, and using them as tools for exploring and developing the area of surface pattern design, was very much of interest, and so workshops were organised.
The idea of using conceptual spatial determinations as design variables in the design process was tested in two workshops with textile design students. The primary focus of the workshops was to ascertain whether a surface pattern could clarify a spatial relation, and how this might affect the outcome and design process.

**BA1 textile design students**

First-year Bachelor’s degree students who had been studying for just under three months were chosen for the first workshop. Their backgrounds were varied, although most had attended technical colleges that specialised in art and design, and were aged between 20 and 30. Both men and women were present, but the majority were women. It should be noted that the date of the workshop was the first time that I had met the students, aside from during the admissions process six months earlier, and so we did not know each other very well.

**BA3 textile design students**

The second workshop took place a few months later, and involved third-year Bachelor’s degree students who were nearly two-and-a-half years into their education. The students had similar backgrounds to the BA1 group; some had attended technical colleges before beginning their textile design education. This class consisted of male and female students of between 25 and 30 years old; most were Swedish, but one third of the participants came from other countries. I had taught this class several times before the date of the workshop; thus, they knew me and I knew them.
The structure of the workshop was as follows:

A) Introduction
A short presentation of the author as a doctoral student and teacher
The lecture began with a short overview of design research, as it seemed important to introduce textile design research for the first-year students as a way of preparing them for the workshop and informing them about design research as a career within academia. Moreover, the lecture introduced practice-based design research as a means of performing artistic research, and continued with an introduction of the aim of this research and an overview of the research area.

B) Presentation of previous projects
The projects that I have previously conducted in collaboration with design students were presented. I have been teaching for several years, and have a great deal of experience in involving students in my projects. The majority of the previous workshops have focused on surface patterns, scale, spatiality, and pattern thinking. However, I chose not to discuss the exercises that were conducted in connection with this research in order to avoid influencing the students.

C) Handing out of the task of the day and commencing of work
The students were given the workshop brief and encouraged to start by discussing it with one another. Over the course of the day the students were left alone for some time, and I checked in with them from time to time. This was a conscious choice on my part, and allowed them to work on their own without me looming over them.

D) Short presentations
Some of the students were chosen to give visual and oral presentations.

WORKSHOP BRIEF
TITLE: Spatial determinations in surface pattern design
Introducing alternative design variables as tools in the design process
DATE: November 10, 2016
TIME: 09:00-16:00
PARTICIPANTS: 13 first-year BA students in textile design

The following brief was handed out to the students:

BACKGROUND:
Surface patterns and ornaments have been around for thousands of years, and the designing and making of patterns are and always have been important human activities (Jones, 2001 [1856]). Regardless of the cultural aspects that exist, patterns have a timeless quality that relates to the relationship between figure and background and the ways in which elements are organised on a surface (Liedholm, 1963). When designing surface patterns, various design variables are used to achieve a certain expression. Design variables are a designer’s ‘tools’; the information needed to express intentions within a textile (Worbin, 2010). A textile designer is presented with an almost endless quantity of design variables to handle in the design process; colour, form, line, texture, volume, etc. Designing surface patterns in spatial contexts with an entirely different design variable would be challenging. What kind of thinking is required, what materials should be used, and what kind of expression do you wish to create?

This workshop is intended to introduce alternative design variables as tools in the design process. How is the textile design process affected if abstract spatial determinations are employed as design variables?

AIM:
The aim of the workshop was to explore spatial determinations as tools in the design process, and to provide a foundation for reflection and critical discussion regarding this.

WORKSHOP OVERVIEW:
The workshop was conducted as follows: We met in the classroom at 9 o’clock, and began with a short introduction of myself and my research interests. The task was then presented and the release form handed out. The students were then left to
decide whether they wanted to work in pairs or alone, and began discussing how to approach the task with one another. A short presentation was given at 15:00.

**TASK OF THE DAY:**
1. Design a surface pattern.
2. Create a design proposal that expresses ‘in front of’, ‘behind’, or ‘next to’ using:
   - A two-dimensional surface pattern with an abstract motif featuring a maximum of three colours and a repeating pattern with pattern units of optional size. The time limit for designing the surface pattern was one hour.
   - Scale.
   - Optional sketching techniques.
3. Place your design in a context: Think about how the surface pattern defines spatial relationships, how it actively takes part in defining the space. Ask yourself the following question: How does the surface pattern act as a spatial definer?
   - If you design a tablecloth, it is natural to think that it should define spatial relationships such as ‘up’, ‘above’, and so on. How does it affect your design process if you design ‘up’ and ‘above’, instead of a tablecloth?
   - Avoid design proposals that are directly related to or focus on specific functions, products, or materials.

**ITEMS FOR PARTICIPANTS TO BRING:**
A2-3 sketching paper and sketching materials such as pens, brushes, paint, scissors, tape, markers, and cardboard.

**LEARNING OUTCOMES FOR THE PARTICIPANTS:**
It was hoped that, having attended the workshop, the students would be able to reflect critically on the relationship between design variables and their function within their own practise.

**LEARNING OUTCOMES FOR ME:**
Input on the subject, with particular regard to whether the developed theories are comprehensible.

**Other remarks:**
The presentation was recorded using the Macintosh software Photo Booth and subsequently discussed.
The student’s work

13 of 15 students took part in the workshop, with nine presenting their outcomes visually and/or orally and one sending her presentation the day after. The initial task was to design a two-dimensional surface pattern of any theme and featuring a maximum of three colours. The time limit for designing the surface pattern was one hour. For the rest of the day, the students were to express ‘in front of’, ‘behind’, or ‘next to’ in a design, then place this design in a context and think about how the surface pattern acted as a spatial definer. They were instructed to avoid design proposals that were directly related to specific functions, products, or materials.

Selected image material and quotes from the workshop:

I saw the pipes in the stairway; it was obvious that they could be considered to be in front of, behind, and next to. I think that the three are quite close to being the same thing – if one thing is ahead, there must be something behind it. My design has a spatial character because of the perspective and placement of the pipes. Three-dimensional shapes form the space. Using other kinds of variable freaked me out, mostly because of the short time that we had to work.

I designed the surface pattern and was thinking about human beings and their relationships. You meet new people and put old relationships behind you. I felt trapped by the rules given to us; it was very hard to work within them. I wanted to break free and find my own track to follow. I can’t really say how the surface pattern defines the space, as that is dependent on the viewer.
Starting this task was quite intimidating. I began with watercolours and a fineliner and, thinking about a city, created four sketches. I would have liked to project the sketches onto a wall, or make an installation in which two- and three-dimensionality were mixed. I had ‘in front of’ and ‘behind’ in mind when designing the surface pattern.

We merged our designs together. We sat next to each other and thought ‘why not?’ We think that the people strengthen the city, and that the overlap functions well.
I was immediately intrigued by the task – straight away I saw an orange surface pattern on a black and white surface in front of me. The intention was not to design a beautiful pattern, but to create a design that featured an ‘in front of’/’behind’ effect. I experimented with scale, and that resulted in significant spatial properties. It was nice to be given such a simple task that didn’t have a ‘right’ or ‘wrong’ solution. Focusing on spatiality and spatial creation was a new approach to the design process; exciting, relevant, and rewarding!

I was somewhat nervous about the task and approaching the question of what ‘in front of’ and ‘behind’ actually mean. My initial thoughts related to something sinking and wavy, like water or gas – gas that enters from behind, unseen. It could be anything. I started to sketch gas (and what that might look like) in the form of three-dimensional shapes in layers, and this led to wavy shapes. I have a somewhat fuzzy and mixed-up way of explaining this work, just like this task...
Reflections

General observations

Most of the students incorporated all three concepts into their designs, although some only incorporated ‘in front of’ and ‘behind’. All of them used traditional means of expression such as overlaps, perspective, scale, layers, placing dark colours behind a lighter shape, and cutting holes. The design proposals that were produced were, with a few exceptions, vertically hanging textiles. All of the students worked individually, although two students decided to combine their designs towards the end of the process.

The question of how a surface pattern acts as a spatial definer was very difficult for all of the students to grasp. Moreover, the task itself seemed to be quite difficult to comprehend, with total silence in the room throughout most of the day. The students seemed unsure how to proceed, and few dared to ask questions or discuss with each other or myself. However, the students worked intensively throughout the day, even though it was quite apparent that the task was unfamiliar to them.

Possible improvements:

Although the design brief was clear regarding avoiding design proposals that were directly related to specific functions, products, or materials, several of the students missed that information, and many of the students’ presentations dealt extensively with materials and product issues. I can only speculate as to the reason for this: is it easier to talk about something tangible than something abstract? I should have been clearer about this matter and emphasised the aim of the brief; exploring spatial determinations as tools in the design process. This could have been underlined even more clearly during the presentation of the brief.

Many of the students placed their designs in an actual context, positing them as room dividers, wallpaper, and so on. I should have provided a better explanation in relation to this; the task was not about placing the design in an environment, but rather discussing how a surface pattern can function as a spatial definer. One of the students approached the task thoughtfully and with great care in relation to this, but did not have sufficient time to fully explore the brief during the workshop. This consideration could simply be removed from the brief in the interest of clarity, as it distracted from the focus of the task.

I cannot help but think that I should have asked the students to work in pairs, as my earlier experience of student workshops is that they are generally more successful when undertaken in this manner. The students discuss and compromise, open up, and dare to tread less sure ground. Thus, this might have been a good approach for them to take.

A few of the students performed quite weakly, producing predictable and poor designs. There are various possible reasons for this; the students may have been uncertain, critical of the workshop theme, or simply having a bad day. I feel that the blame is mine, for not communicating in a better way and being a better educator.

There is a potential to further develop the workshop brief through improving and clarifying certain aspects, such as the context and material considerations.

Conclusion:

It was clear that the majority of the students really wanted to deliver; they were eager to think in a new way and worked with a method that was new to them and unexpected. Even though they were first-year students, each already had their own manner, aesthetically, and way of working. The students tested this alternative approach, and some of them really enjoyed it. I am quite sure that the workshop provided several new insights and opened up the eyes of at least some of the students, who threw themselves into the workshop and were brave and enthusiastic.

However, as regards the concrete outcomes of the workshop – the design proposals – the students illustrated and worked with the concepts of ‘in front of’, ‘behind’, and ‘next to’ using traditional means of expression, rather than designing the concepts. One theory is that, at this point, I myself was not sure how to convey the surface pattern as a spatial definer – I had not figured out whether surface patterns are spatial definers, or what surface patterns might do as spatial definers. This subtle balance could be explained in a better way, and by communicating more convincingly.

It may have been a good idea to have started the workshop by defining the concepts ‘in front of’, ‘behind’, and ‘next to’, as these notions likely have different meanings.
to different people. The students could, for instance, have discussed keywords that may have helped them in their processes.

None of the students understood the question of how the surface pattern defined the space, and were entirely perplexed. This may have been related to my own uncertainty regarding how surface patterns define spatial relationships. Nevertheless, it was a thought-provoking question about what surface patterns can do in a spatial setting. Everyone (except for the student who sent her thoughts to me after the workshop) had difficulty putting their ideas about the designs into words. This workshop was problematic for the students.

Not showing or talking about the exercises created as part of this research was a conscious decision, and meant that the students were not influenced by me and free to grasp the design challenge in a number of different ways. The far more interesting aspect of the process was trying out the concepts and ideas that were developed during Analysis 2.
Workshop with BA3

The organisation of the workshop was similar to that conducted with BA1, although the introduction of myself was unnecessary as the students already knew me well as a teacher, and had participated in one of my workshops during their first year in the programme. That workshop had a similar structure, but focused on exploring whether there is a connection between surface patterns and rules (see Publications, Paper III).

With the experience of the first workshop in mind, the brief was refined and modified. While the first brief focused on spatial determinations in surface pattern design, this one introduced alternative methods in surface pattern design. I divided the students into groups in advance, and these groups worked in different rooms. Each group was then given the task of the day and, as there was an element of surprise involved in the workshop, they were asked not to discuss the task with other groups during the lunch break. I spent the day moving between the groups, conducting short interviews that were recorded and photographed. In general, the students worked independently, and my presence did not affect them.

WORKSHOP BRIEF

TITLE: Alternative methods of surface pattern design
A method for raising awareness of abstract design variables in the design process
DATE: December 12, 2016
TIME: 10:00-16:00
PARTICIPANTS: 10 third-year BA students in textile design

The following brief was handed out to the students:

BACKGROUND:
All forms of design deal with limitations, guidelines, and rules. When designing surface patterns, various design variables are used to achieve a certain expression. Design variables are a designer’s ‘tools’; the information needed to express intentions within a textile (Worbin, 2010). A textile designer is presented with an almost endless quantity of design variables to handle in the design process; colour, form, line, texture, volume, etc.

Regardless of what, how, and where a design is situated, the designer needs to relate the design to a context or spatial environment. Designing surface patterns in spatial contexts with an entirely different design variable would be challenging. What kind of thinking is required, what materials should be used, and what kind of expression do you wish to create? This workshop is intended to introduce an alternative design method to increase our understanding of using abstract, spatial design variables in the design process. How do they affect ways of working? In what way could an abstract design variable influence the physical outcome?

AIM:
The aim of the workshop was to explore how concrete and abstract design variables are interpreted, understood, and applied in the design process, and to stimulate a discussion regarding this.
WORKSHOP OVERVIEW:
The workshop was conducted as follows: We met in the classroom at 10 o’clock, and the class was split into two groups, which were placed in separate rooms that were identical, with tables situated in the middle. The task was given, and release forms handed out. The students worked in groups of two or three beginning by discussing how to approach the task, and spent the majority of the day working. Short presentations were given at 15:00 and, with two sub-groups per group, a total of four presentations of 15 minutes were given. The students were asked not to discuss the task with other groups during the lunch break.

TASK OF THE DAY

Group 1: Design a tablecloth
Design a tablecloth pattern for the table in this room. Use the materials provided, and make proposals for innovative tablecloth designs.
Concrete variables: beauty, high complexity, joints, repetition.
Materials provided: sketching paper on a roll, brushes, paints, markers, scissors, tape, glue.

Group 2: Design ‘up’
We always place a textile [a pattern] in a spatial context. What does the textile [pattern] do? The textile [pattern] defines, or contributes to defining, what a spatial determination is – for instance behind, in front of, or above. In this way, we design ‘up’ when we design for a carpet or a tablecloth.
Design a pattern that defines ‘up’ in a spatial context, relating your design to the table. Think about how the pattern should define spatial relationships, how it actively takes part in defining the space. Ask yourself the following question: how does the pattern act as a spatial definer?
Materials provided: the same as for Group 1.

ITEMS FOR PARTICIPANTS TO BRING:
Sketching materials such as pens, brushes, paint, scissors, tape, markers.

LEARNING OUTCOMES FOR THE PARTICIPANTS:
It was hoped that, having attended the workshop, the students would be aware of the relationship between design variables and their function within their own practise.

LEARNING OUTCOMES FOR ME:
Input on the subject, with particular regard to whether the developed theories are comprehensible, and comparison of the outcomes of the two within the workshop. It was also desirable to observe how the students interpreted the abstract approach.

Other remarks:
Release forms were handed out.
The presentation was recorded using the Macintosh software Photo Booth and subsequently discussed.

Questions to ask during the students’ presentations:
- Tell us about your design process for this task.
- What is the relationship between design variables and design method?
- To the ‘tablecloth’ group: How did you interpret or apply the idea of concrete design variables?
- How did design proposals that are directly related to specific functions, products, or materials affect your design process?
- Could the designed tablecloth function as a spatial definer? If yes, how?
- To the ‘up’ group: How did you interpret or apply the idea of abstract design variables?
- How did it affect your design process that you designed ‘up’ instead of a design directly related to specific functions, products, or materials?
- How does the surface pattern act as a spatial definer?
- Does the surface pattern define planes?
The student’s works

A course in design methods was selected for this workshop, and all 10 of the students participated.

The tablecloth group’s task was to design a tablecloth pattern for the table in the room using the materials provided, and to propose innovative tablecloth designs. The concrete variables were beauty, high complexity, joints, and repetition.

The task’s introduction was met with many questions regarding the product, the table, and the design variables that they were asked to relate their design to. The word ‘innovative’ in relation to a tablecloth caused confusion as well. The answers that I gave were few; the interesting part for me was how they interpreted the brief.

The ‘up’ group’s task was to design a surface pattern that defined ‘up’ in a spatial context, relating the design to the table placed in the room. They were to think about how the surface pattern should define spatial relationships and how it actively takes part in defining the space, and ask themselves the following question: how does the surface pattern act as a spatial definer? There were very few questions after the introduction, likely because the students wanted to think. The word ‘tablecloth’ was consciously not used during the introduction, although it was stated that the design should relate to a table.

Selected image material and quotes from the workshop:

When the design task is given – in this case designing a tablecloth – you don’t spend time thinking about its possible uses – its definition, so to speak. The function is so clear. We wanted to focus on a few things, such as the design variables and the joints, because of the short time limit. Maybe that was one of the reasons we didn’t question the function of the tablecloth. A duk is a duk! (Tablecloth Group 1)
We made an interactive tablecloth for children that features patterns that can be changed while waiting for your food. There are three movable layers. We wanted to use the story as a conversation-starter. The concept could be developed, and has great potential. (Tablecloth Group 2)

We thought about the concept of ‘up’, and came up with the idea of using an overhead projector. From what direction can ‘up’ be understood? As we worked with things to project, we simply entitled the design ‘tablecloth’. The abstract brief governed our work; we really wanted the notion of ‘up’ to be seen in relation to the table. (‘Up’ Group 1)
We started to brainstorm 'up', spending three minutes simply connecting anything we could to the idea. From this the words ‘growing’, ‘multiplying’, and ‘staircase’ became important. We discussed the table and its function: Does a table support a tablecloth, or is it a tablecloth just because it is placed on a table? Our proposal represented ‘up’ in the form of differences in height and direction. (‘Up’ Group 2)
Reflections

General observations

The general observations are divided into two parts; one for the tablecloth groups, and one for the ‘up’ groups.

Designing a tablecloth:
Neither of the groups spent any time analysing the function of the product, fully embracing the idea that a tablecloth has an intrinsic function. Their focus was on fulfilling the design brief in relation to the design variables, rather than focusing on function and the table. The students emphasised the actual result, and the concept behind it. However, the results produced by both groups were strong, convincing tablecloth designs.

Designing ‘up’:
The desire to experiment was present in all of the workshop groups, but more so in the ‘up’ groups, who explored many different concepts, with boundless energy and enthusiasm. The discussions that took place were continuous, perhaps because the students enjoyed doing so or possibly because the specificity and abstraction of the brief fuelled debate. They touched upon questions of an almost existential character in relation to the table, considering its functions, such as carrying and holding up objects, as well as questioning whether the objects that are placed on a table define it.

It is interesting that, despite the fact that the word ‘tablecloth’ was not mentioned at all during the introduction, in which the students were asked to relate their design to a table, it nevertheless arose in both groups’ discussions. Are tables so strongly associated with tablecloths? Both of the ‘up’ groups used three-dimensional pattern attributes in their designs, particularly the second group. The term ‘surface’ was also deliberately omitted from the brief, not in order to force them to work with surface patterns but to open up for three-dimensional patterns and other types of pattern – which both groups worked with.

Analysis of the outcome

An analysis of the results of all of the groups, as well as what the students highlighted during their presentations, was performed. Focusing on the concepts of method, process, result, discussion, and function, a simple process chart was made. These concepts are commonly used in design analysis and design critiques, and the aim here was to ascertain whether anything was different or unusual in any way.

<table>
<thead>
<tr>
<th></th>
<th>Up 1</th>
<th>Up 2</th>
<th>Tablecloth 1</th>
<th>Tablecloth 2</th>
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<tbody>
<tr>
<td>Method</td>
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<tr>
<td>Process</td>
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<tr>
<td>Result</td>
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<tr>
<td>Discussion</td>
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<tr>
<td>Function</td>
<td>-</td>
<td>•</td>
<td>-</td>
<td>•</td>
</tr>
</tbody>
</table>

0 = to a great extent
• = to a small extent
− = not at all

Tablecloth 1: The group never considered ‘up’ during their process, and instead focused on the given design variables, nor did they think about whether the pattern was a spatial definer. This was due to the fact that they knew that they were supposed to design a tablecloth. Their result was a two-dimensional surface pattern that was intended to be placed on top of a table, and satisfied the brief. Two things may have caused this chain of events: 1) The students were particularly good; 2) a well-formulated design brief. With design briefs, it is generally the result that counts, and this is the case in this instance. The students did not discuss the concepts of tables, patterns, or functions.

Tablecloth 2: The group worked as anticipated; they came up with a fun idea that could function as a starting point for a real product. The result is important, but the concept was to be more so, and the students were unable to answer the question of how a tablecloth could define a room – although they were fairly certain that it does. They discussed the function of the tablecloth, considering the concept.
Up 1: This group’s work focused largely on method and process, designing ‘up’ rather than sketching patterns. Projection was used as a method, and the table was included in the process. It is likely that their result would have been wholly different if the brief had said ‘design a tablecloth’. The aspect of the group’s work that could be seen as imitating a ‘normal’ design was the traditional design variables used, such as form, direction, and pattern expression. The actual outcome and function of the design were considered to be of lesser importance.

Up 2: The discussions that this group of students had seem to have been unique, and led to existential questions concerning the logic of tables, carrying, and patterns. The task seemed to intrigue their minds far more than tables and patterns do, and they considered the processes of their thoughts to be more important than the results achieved. Their questioning of concepts that might seem obvious, such as tables and patterns, would likely not have occurred if the task had been to design a tablecloth.

Conclusion and possible improvements

All of the students performed at a high level, commencing work immediately and without any hesitation. After two and a half years in the programme they were clearly quite used to the ways in which teachers work and teach, and designing based on abstract briefs. There was no social or performance anxiety among them; they simply worked.

The ‘up’ groups approached the task in a different way and worked hard to design the concept. During their presentation, when asked whether they had illustrated or designed ‘up’, the second group answered that they had created a visual proposal. The process sketches illustrate the concept, while the finished result shows ‘up’ as a more complete design suggestion.

The students in the tablecloth groups used relatively traditional ways of design thinking, while those in the ‘up’ groups were more innovative. Several reflections arose in relation to the idea of the surface pattern as a spatial designer. A pattern can define a room because of its ability to delimit and highlight parts of it.

It would be truly exciting to see what would happen if a class was left to work with this theme for a longer period of time, as would running the workshop with different types of students, such as those studying sculpture, architecture, or mathematics. Students of other fields would certainly have viewpoints that differ from those of textile designers, whose knowledge of the field is already fairly consolidated. It is unclear whether the fact that I knew the students well influenced the workshop. Another interesting idea is having the participants design both the tablecloth and ‘up’, as well as testing other concepts.
RESULTS AND FUTURE IDEAS

The research described in this licentiate thesis aimed to explore surface patterns as spatial definers, and what this means in a surface pattern context. It also intended to apply conceptual spatial determinations as alternative design variables in design processes, and explore how they could be used to define and analyse pattern relations. This has resulted in three outcomes:

The design experiments: Pattern relations in spatial contexts were explored using scale as a design variable. Three design exercises addressed the issue from different perspectives and demonstrated the expressional possibilities that a surface pattern can create in a defined space, and how this is connected to pattern relations.

The theoretical model: The ACSD model used conceptual spatial determinations to analyse the design experiments, raising the level of abstraction in relation to surface patterns. The outcome of the second analysis, which was carried out using the model, showed that alternative analysis methods have great potential in relation to surface design, in that they allow to view surface patterns in terms of conceptual spatial determinations, rather than as traditional, functional patterns.

The workshops: Abstract design variables with regard to conceptual spatial determinations were introduced into the design process to provide an alternative working method in surface pattern design. The results of the workshops demonstrated the potential of using conceptual spatial determinations as design variables, as the design solutions were clearly influenced by the introduction of these design variables.

These three outcomes may contribute to the field of textile design, and surface pattern design more specifically, the process of which could become increasingly abstracted, leading to a change to/supplement of the design process by:

- Defining pattern relations in a textile design context.
- Analysing patterns and positing them as spatial definers.
- Developing surface pattern design processes by introducing conceptual spatial determinations as design variables.
- Highlighting an area that is rarely in focus within design research – surface pattern design – and exploring it further in relation to the broader concept of patterns.
Several possible avenues of future work have arisen in relation to this research. Due to the limitations of this work, certain aspects of surface pattern design were not investigated, and these further approaches could enhance and expand upon the contribution to knowledge as it stands at present.

With regard to the design experiments, there is an opportunity to examine pattern relationships, surface pattern, and scale in spatial contexts in relation to human interaction by producing counter-examples to Exercises 1-3. The intention with such an exploration would be to see these issues from new perspectives, rethink conventions, push the limits of the field, open up for further discussion, and problematise the matter. Using the same digital tool as was used in Exercise 3, this process would involve examining a surface design that changed scale based on the distance between the viewer and the projected surface pattern: The closer the viewer, the larger the scale of the surface pattern would appear to be. In that experiment, things would be turned upside-down in order to engender a ‘re-understanding’ and reconsideration of established practices.

As is briefly discussed in the previous chapter, the workshops have great potential, and could serve as a foundation from which to develop surface pattern design processes. Using workshops as a means of gaining valuable insights and knowledge is an idea that is close to the author’s heart, due to the fact that working with design students is great fun, unpredictable, and most of all, rewarding.

Another possibility would be to conduct experiments using more complex surface patterns with different characteristics in order to be able to study scale, viewing distance, and viewing angle. The surface patterns that were used in this project were relatively simple; complexity could be increased through greater pattern intricacy. This approach would benefit from the research including varying types of form. Surface patterns and form are closely related areas, and studying the two together would be an interesting next step.

Monochromatic colour combinations were used in the design experiments, but other colour combinations could be explored. Several ideas for using colour with surface patterns have occurred over the course of the work, but have proved to be beyond the scope of this research. Investigating colour in more detail has great potential for future studies, and could involve repeating the experiments that have been carried out with other colour combinations. The current theoretical frameworks relating to colour could benefit from scientific exploration in the context of surface patterns. The possibility of investigating phenomena in which colours appear to advance and recede, or visual effects occur when certain colours are used together, is discussed by Itten (Itten & Birren, 1970) and Albers (2013), and could be a fruitful avenue of future research. This area would benefit greatly from experimentation in a surface pattern context following some of the methods used in this thesis.

Reflections

How could this knowledge change ways of working with design? The availability of a different method in design processes would certainly be of value to designers and design students who seek to further deepen and develop their work, as this knowledge may provide a heightened awareness of the function of surface patterns. However, the method has yet not been tested by designers in real-life workshops outside of academia, and so has not been subjected to the real complexities that come into the process; this could be an interesting next step for the research.

Surface patterns are designed every day, but what happens when a conceptual spatial determination is applied as a design variable in a design process? How could this new understanding lead to innovative expressions within the field of surface pattern design? The design proposals produced by the BA3 students were surprisingly unpredictable due to the level of abstraction, which was raised in relation to the actual function of the surface pattern. Thus, the alternative way of thinking led to unexpected expressions in terms of both the design process and the result.

How might the knowledge gained through this research influence the teaching of surface pattern design? Transforming it into teaching methods and pedagogical tools would allow methods and ideas to be re-thought, and alternative ways of surface pattern design thinking to be explored. It seemed natural to implement teaching in this research, considering the fact that my time is split between being a senior lecturer and a doctoral student. In my opinion, one of the teacher’s tasks is to challenge students to gain new skills and widen their perspectives, and to provide the opportunity for exploration. Presenting new design challenges and introducing unconventional design methods to students is one way of doing this.
RESULTS AND FUTURE IDEAS

Repetition constitutes the essence of pattern, and is the basis of our most fundamental actions (Araujo, 2010). As is discussed in the preceding chapters, one of the main characteristics of a surface pattern is its repetition. The methods used in this work connect to patterns of movement. When conducting the exercises, which to a large extent involved performing the same tasks repeatedly, reflections on the actions themselves occurred. With reference to Bell and his general definition of a pattern as "the opposite of chaos" (1999), wherein a pattern is characterised by order, the exercises offered a concrete logic but also a kind of consolation. Pattern recognition helps us to understand and relate to the world around us, which is one of the reasons that a great deal of trust and faith was placed in the process and the practice. This way of implementation might be referred to as "a pattern method", meaning a system of ideas or a method of process (Araujo, 2007, p. 10). Going back to the idea of surface patterns, this ties things together in a satisfying way.

This research has relevance to printing techniques in relation to repetition. All of the exercises demonstrate the way in which a repeated pattern unit can be transformed into multiple elements using scale. The surface patterns were digitally printed on fabric, laser printed on paper, or projected using software. All of these printing techniques do not restrict repetition; rather, they allow experimentation. A simple pattern unit, such as that of a grid pattern, can become entirely different from a strict black-and-white lattice through changing scale (see Figs. 165-170). Repetition was essential for conducting the exercises, but scaling up the surface patterns meant that there was no longer a repeat; thus, the repetition was lost but something else – a significant and eloquent artistic expression – occurred.

There are several further considerations in relation to the development of repeated patterns and repetition with regard to printing methods (as was discussed in the 'Background' chapter). Repetition, as a basis for pattern design, now has a novel significance due to the fact that it is no longer related solely to production technology. Why should designers continue, then, to use repetition as a means of expression? There are several possible answers to that question. Strong motifs and figures can lose their strength when they are repeated; on the other hand, a weak and commonplace motif can 'grow' when repeated. Thus, repetition can have a strong effect on a surface pattern.

As stated in the introduction of this thesis, joints are central to units in relation to repetition. By making the joints invisible, the illusion of infinity can be accomplished in a surface pattern. One alternative is to highlight and integrate joints as a conscious element of the repetition, stating their presence clearly and as part of the rhythm of the pattern. The idea of limitlessness and a pattern being never-ending is captivating, as is discussed in relation to the definitions of patterns in the 'Background' chapter.

The art of designing surface patterns is strongly connected to the textile designer’s profession. Graves (2002) links textiles and pleasure, and describes how the textile designer is free to play with the powerful qualities of pattern, and the subconscious is drawn to pattern for its addictive and disorienting qualities. A sense of order is connected to the aspect of pleasure, and was used as a variable in the workshop brief given to the students. The complexity of a surface pattern is not to be underestimated, nor are the difficulties that arise when designing a pattern. It is not enough to repeat a single unit; the challenge is to create a pattern that retains the viewer’s gaze and provides mental stimulation for as long as possible. The human brain enjoys exposure to order with a high degree of complexity – recognising and being challenged in this recognition or, as Arnheim (2004) phrases it: "Brain and mind envisage change and crave it; they strive for growth, invite challenge and adventure". The intricacy that repetition provides is a strong attraction, and is included in every textile designer’s arsenal of techniques.

What does freedom from mechanical repeating conditions mean for surface design? Is this the end of the field? Will surface design disappear from the field of textile design? Has the harsh debate, initiated by Adolf Loos in the early nineteenth century, finally been settled, with the conclusion that ornament is crime (Loos & Opel, 1998)? Hopefully, a thunderous ‘no’ is the response to these questions. Although repetition is not strictly necessary with new printing technologies (e.g. digital printing), I am of the opinion that pattern design is an art form in its own right; one that requires specific skills and is a challenge for the designer. It is comparable to how an artist within fine art creates a visual composition featuring unique elements; the designer designs a surface pattern with high complexity through repetition, joints, order, and scale. What is it, then, that continues to catch the attention of not only designers, but the wider public (because something certainly does)? Several voices within architecture, interior architecture, and design are discussing the return of ornamentation in varying ways, claiming that contemporary ornamentation tells us something meaningful about current design and architecture – and this revival is frequently looked upon as radical, even if it is acknowledged, by both theorists and practitioners (Moussavi & Kubo, 2017; Picon, 2014).
It has been a challenge to enter an area that is so well-known and established, and which many people have an opinion regarding. It was quite difficult to find my approach to the field of surface patterns, and to figure out how to deal with it. Surface patterns may seem fairly obvious and universal, but I found that the more I worked on and read about it, the less I knew. In the end, I had to extend my search to other fields to find what became the core of this work. With that said, I am truly grateful for the possibility of immersing myself in the world of patterns, which has never stopped fascinating me.

Would it be relevant to the field of textile design for this design direction to be further explored? The answer to this question is undoubtedly yes. Much of the research carried out in the field of textile design relates to material development and expression-changing materials, but this research seeks to open up for alternative thinking regarding surface pattern design. The act of considering surface patterns to be spatial definers has the potential to open up for new and interesting questions to explore in relation to textile design. It is hoped that this work will further develop the subject and highlight the importance of reflecting on designing surface patterns, and the impact that this has on the working process and resulting designs.
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Appended papers


THE IMPACT OF SCALE ON A BLOCK-REPEATED SURFACE PATTERN IN SPATIAL CONTEXTS

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1

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Abstract
This paper explores and discusses the expression of a basic surface pattern in relation to scale seen from a textile designer’s perspective. The study aims to explore pattern relations and expressional appearances on flat surfaces in a defined space and focuses on investigating pattern and scale through a number of design experiments. The intended impact of this study on the textile design area is to provide textile designers with a better understanding of scale in relation to spatial contexts in the design of surface patterns.

The starting point of this research project was an interest in learning how decisions about scale, as a part of a pattern expression, are made in surface pattern design in a spatial context, and, moreover, how the elements of a pattern are related to scale.

The relationship between pattern and scale was investigated in a number of explorative design experiments. A basic black/white surface pattern was developed in different scales and using several types of pattern repeats. Through projection and using printed versions in a scale model together with reference objects, the pattern was studied in an actual spatial context and photographed in order to facilitate analysis of the visual appearance of the pattern. The main finding is that, as the pattern reaches a certain scale, the pattern expression changes from a repeated pattern into a form. Analysis shows that, depending on the scale of the pattern and viewing distance, the pattern characteristics of the wall pattern (a distinct square) transform into stripes, shapes, or disappears altogether. The finding is illustrated with examples of how the results show that design variables such as style, colour, texture, pattern repeat methods, and visual expression are other factors that influence the outcome. The results of the research carried out here may be used to assist practitioners in developing designs by proposing a structured approach and increasing awareness of the need for a systematic approach in pattern design projects.

In addition to visualising and systematising patterns, the design examples highlight the spatial relationship between pattern and scale, thus emphasising the importance of a systematic working method and the use of reference objects when making decisions related to scale in the design of surface patterns. The research presented in this paper confirms the relevance of the scale of the pattern to the experience of the pattern in a spatial context, and shows how it influences the pattern expression. It is concluded that further research is required on to the design of surface patterns with regard to scale.

Keywords: Pattern relations, surface pattern, scale, textile design

1 Introduction
The progression of the field of textile design opens possibilities for designers to combine broad scientific knowledge with professional excellence. Stevenson and Steed [1] find that textile designers assume many different roles during the design process as they are required to make a wide range of decisions regarding e.g. colour, pattern, and aesthetics of the fabric. On a related note, they describe the textile designer as a type of designer who is trained to produce designs for a particular type of fabric, such as printed, knitted, or woven textiles; this is connected to the fact that the primary function a textile designer employed by a company producing e.g. printed textiles is to adapt the size and repeat of both existing and new designs in order for them to suit the intended end-use [2]. Textile designers are skilled in the development of textile designs suitable for a given purpose; for example designs for use on the body, such as fabric design for fashion, accessories, and clothing, or for use in a particular space, such as textile and material design for the built environments, interiors, furnishings, and transportation. Despite a high degree of specialization, most textile designers consider design variables such as scale, surface, and expression is nevertheless to be considered during the design process. The importance of surface design increases in the field of design because it is seen to contribute to the definition of textile design and the profession of textile designer [3].
2 Materials and methods
The starting point of the project was an interest in learning how decisions about scale as a part of a pattern expression are made in the design process of surface patterns for use in a spatial context and, moreover, how the elements of a pattern are related to scale. Despite the spatial context, the investigation is, however, conducted primarily from the perspective of a textile designer and does not take an architectural point of view, which means that certain elements, such as material proportions, window units, and doorways, are not taken under consideration; rather, the perspective concerns itself more with how a pattern unit is repeated and applied to a surface and with studying the effects of the pattern on the surface expression. A series of design explorations have been planned with the aim of developing an understanding of the influence of scale on decisions regarding expressional properties; some of the initial experiments are presented briefly below. They assisted in framing the direction of the main experiment and were planned so as to serve as guidelines to and foundations for a new perspective on pattern relations.

2.1 The Grid pattern
In this study, the same two-dimensional surface pattern was used in all experiments. The pattern unit was a distinct square with three lines starting from the bottom left-hand corner, one vertical, one diagonal, and one horizontal, which, in the interest of achieving maximum contrast, was black/white; the pattern was constructed using the computer program Adobe Illustrator (Figure 1). This basic geometric all-over pattern, named the Grid pattern, has a slightly diagonal upward direction towards the right side, and was made in ten different scales in order to include all the extremes from very small to very large. Four different repeat systems were used in the experiment; block, drop, brick, and diamond. The purpose of the experiment was to understand and to analyse the process of scaling a pattern design.

2.2 The Pattern Lab project
The design experiments started out with projections in a Pattern Lab, which is a full-scale laboratory, equipped with projectors, computers, cameras, and textiles, and an initial attempt at finding the appropriate design approach was made. The Grid pattern served as a test pattern, and different scales and pattern repeats were tried out by projecting it on a wall and studying it in relation to a reference object, in this case a chair (Figure 2).

The project was exploratory in character and had no predefined set-up or aim, and the reflections emerging during the course of the experiment included the insight that, in addition to viewing distance and the viewer’s movements, the size and scale of the laboratory environment (the room), appeared to be important to consider. Furthermore, the expression and features of the pattern were also found to play a central role in the overall appearance of the pattern. The Pattern Lab project demonstrated ways in which the scale and size of a specific pattern could be used to achieve a certain pattern expression in a full-scale environment (only a selection of the image material is presented above). The results of the project also provided an example of a pattern and scale experiment conducted without a systematic approach, which in turn helped identify the need for/formulate the requirement of consistency in the research approach. Finally, as the results also indicated that projection is a possible method for performing this kind of experiments, the experiment pointed to the need for a wider perspective on pattern relations.

2.3 The Scale model project
Based on the experience from the Pattern Lab project, the research approach in this project was more systematic. For this experiment, a simple scale model containing two walls, floor, a textile drapery, and a small mannequin, was constructed (Figure 3); the drapery and the mannequin was included as a reference objects. The Grid pattern was digitally printed on a cotton satin fabric (which it was possible to drape) and printed on plain paper; a total of ten scales and four different repeat systems were investigated, and provided design examples of how scale and size affect the pattern expression of the Grid pattern on three flat surfaces, draped against the wall, and around the mannequin.

An analysis of the results with regard to the scale of the Grid pattern indicate that, depending on viewing distance and scale of the pattern, the characteristics of the pattern appear differently to the viewer; it transforms into stripes, shapes, or disappears altogether. Additional conclusions include that the mannequin was a potentially ideal reference object as it represents both a three-dimensional shape and the shape of a body, which is easy to relate to in terms of scale. Furthermore, other essential discoveries of this project concerned the Grid pattern in relation to space and the pattern expression, which are here defined as “pattern relations”. Other significant outcomes of the project concerned the usefulness of the immediate visual response which working in a physical model provides, and it was further deduced that performing these experiments in a three-dimensional CAD software could potentially present a considerable improvement in terms of working time. Although the results of this experiment are clearly those of a systematically performed experiment, they indicated that there were room for improvements to the systematic approach. In some of the combinations it was difficult to determine the outcome because the mixture of repeats and scales was perceived as disorderly and provided no clear interpretation of the pattern expression. Nevertheless, the project established that the aspect of scale was to be the theme for the main experiment as the scale of the Grid pattern played a significant role in the definition of the expression; this turned out to be highly important for the development of the experiment, as well as the understanding of the scope of the project, which proved to generate a huge amount of material.

2.4 The Mannequin project
In this design experiment, the relationships between a three-dimensional shape, the scale of the Grid pattern, and the surface was investigated. The aim was to explore the transformations of the Grid pattern throughout the process of scaling the pattern up and down. The setting was a basic model of a room, a reference object (a half-scale mannequin), and the Grid pattern in different scales. The Mannequin project was delimited in several ways in order to streamline the experiment in terms of the amount of material generated for analysis. Out of ten scales, six were chosen and only one type of repeat was used, block-repeat. The smallest scale of the block-repeated Grid pattern was used in the textile draped on the mannequin and on the floor, both of which were held constant while the wall pattern went through all six scale steps (Figures 4a-f).
The results show that the characteristics of the Grid pattern (the distinct square) changed at a certain scale step, at which point the pattern transformed and turned into what can be described as a separate shape or an engineered pattern (Figures 4 e and f). After the fourth scale step (Figure 4 d), the pattern on the wall no longer repeats in relation to the scale object, and the contrast between the mannequin and the wall increases with the scale of the pattern. Moreover, in Figure 4 a, the scale of the pattern was so small that the visual appearance approached that of a grey fog, depending on viewing distance, and the pattern on the textile draped around the mannequin harmonised with that of the wall to the point where it practically became a camouflage. The pattern on the floor had the same scale as that of the wall in all pictures in Figure 4, but the angle changed the appearance to that of stripes stretching towards the viewer, causing the distinctive square to disappear altogether. A further insight gained from analysing the results was the way in which the mannequin dominated the scene and drew the viewer’s attention away from the wall and the floor. Finally, it was concluded that the systematic approach of the experiment could be sharpened even further.

3 Results and discussions
This research project has explored pattern relations and expressional appearances of a Grid pattern on flat surfaces in a defined space, and investigated the relationship between pattern and scale through a number of design experiments. The Pattern Lab project resulted in a series of images in which the Grid pattern, in several different scales and using various types of pattern repeats, is projected on a wall with a chair as a reference object. The result of the Scale model project comprises photographs of the Grid pattern printed on fabric and plain paper in ten scales and using four different types of pattern repeat, placed in a scale model with a patterned textile drapery and a small mannequin draped in the patterned fabric as reference object. In the Mannequin project, the Grid pattern was block-repeated in six different scales on the wall, while the pattern on the textile draped around a half-scale mannequin and on the floor was based on the smallest scale of the six used on the wall.

3.1 Discussion
The design examples enabled the identification of design variables which impact the overall pattern expression and methods for performing examinations of the relationship between scale and pattern and document the results. The main finding is that, as the pattern reaches a certain scale, the pattern expression changes from a repeated pattern into a form. The key in pattern construction is repetition, as it is the defining feature of a pattern [6]. It is important to clarify that these findings are only valid for the appearance produced by the specific combination of this pattern and these settings, and that other design variables such as style, colour, texture, repeats, and visual expressions, which are other factors that influence the outcome, have not been investigated here; altering these variables in the design would produce very different results in terms of pattern expression. Furthermore, the expressions could also be perceived differently depending on the context, the purpose, and position of the pattern. The design examples presented here confirm that the scale of the pattern is relevant to the experience of the pattern, and that it influences the pattern expression, but does not propose to say anything of the magnitude of that relevance/influence. Thus, the knowledge may be helpful to textile designers in the design of e.g. a striped pattern intended for use on floors.

In the analysis of these design examples, pattern relations were seen to run in several different directions. Regarding all three examples some reflections can be made. The size and scale of the room/environment/room appear to be important, as do the role of the viewer; viewing distance and the movement pattern of the viewer are also essential considerations together with the activities taking place in and the furnishing of the environment/room. In this context, the properties of the pattern, including scale and expression, are crucial parameters to consider in the design process. Moreover, for textile designers this means that knowledge about and an understanding of the spatial context which is to be designed may contribute to improve the final design solution.

All the design examples illustrate the importance of a systematic approach and of using a reference object when deciding on scale in the design of patterns for application on surfaces. Using the body as a reference object is, however, not entirely unproblematic, as was seen in the Mannequin project, where it was noted that the mannequin attract more attention than the rest of the scale model; this shows that reference objects cannot be chosen without due consideration. To explore this matter further, additional experiment was performed using the Mannequin project set-up (Figure 5) with the aim to raise questions about how to interpret three-dimensional shapes and pattern expressions in relation to scale.
During the analysis of the experiments, two different perspectives on pattern relations gradually emerged, “pattern expression” and “pattern in spatial context”, as changes are either taking place in the pattern expression or in the spatial context, respectively. How do their perspectives influence each other? An attempt at identifying design parameters which define them would be highly interesting to investigate further.

3.2 Conclusions
The research project presented in this paper explored the influence of scale on the expressional possibilities in the design of surface patterns. Furthermore, the possibility that scale may function as a tool/method in the design of surface patterns has also been explored through design experiments investigating the relationship between pattern and scale.

One of the starting points of this research project was a desire to discover new methods and approaches to the subject of pattern and scale. Although the design experiments have utilised both projections and physical models, it is seen that there is further need for explorations in an even broader sense in terms of research methods; for example, the photographs of the design examples clearly show that the pattern undergoes a transformation from a repeated pattern into an individual form at a certain scale. Furthermore, it is seen that the properties of the pattern, including scale and expressions, are crucial parameters to consider in the design process, as is the role of the reference object.

The use of projection and scale-modelling in the design experiments carried out was both rewarding and demanding; rewarding because of the direct (instantaneous, in the case of projection) visual feedback that both methods provide, as it is highly desirable for textile designers to be able to see the appearance of the pattern with their own eyes, and demanding due to the time and effort required by scale modelling. If the research project develops towards further exploration of flat surfaces, it would be highly interesting to utilise a three-dimensional CAD program in future experiments. If continued research will involve investigations of soft shapes, which have properties traditionally associated with textile materials, the research approach will instead include physical examples.

The results of the research presented in this paper are design examples that visualise the relationship between pattern and scale in spatial contexts in a systematic way. Furthermore, the results support the importance of a systematic approach and the use of a reference object when making decisions regarding scale in surface pattern design of patterns. The paper confirms that the scale of a pattern is relevant to the experience of the pattern, and that it influences pattern expression. Additional research is required to form a foundation on which to base methods for the design of surface patterns with regard to scale.

References
In the Clouds: the workshop as a method of exploring the relationship between rules and pattern design

Researcher 1, institution, email
Researcher 2, institution, email

Abstract

Surface pattern is a fundamental component of human expression, especially in textile design. It is often influenced by patterning in nature, structures that are also often easily described by mathematical principles. This paper presents the workshop as a method for exploring the relationship between rules and pattern. A workshop was conducted with textile- and fashion design students and it involved two assumptions: Design guided by rules would create a recognisable pattern, and, Visual patterns would easily be reducible to rules. The aim was to explore the relationship between pattern and rules in design processes, and to provide a foundation for reflection and critical discussion of this relationship. The results of the workshop could not reliably prove either assumption because, as was discovered through the workshop, the concepts of pattern and rules are neither universal nor obvious, and as such cannot be so simply tested. Pattern and rules are varied and nuanced phenomena and their relationship equally so.

Keywords
Pattern; Rules; Textile Design; Fashion Design; Design Processes

Pattern design and pattern making is and always has been an important human activity (Jones, 2001[1856]). We live surrounded by patterns that can be found as micro- and macro structures, from fabrics to tires to animal coats (Kraft, 2004). The word pattern has many meanings dependent on context, such as pattern cutting, patterns of movement, patterns of behaviour. This article will discuss pattern in the context of surface-pattern design from the perspectives of textile- and fashion design.

Patterns in nature, such as crystalline structures and camouflage can often be represented using mathematics. Patterns usually provide foundation for a material construction, as in architecture, or as surface decoration and ornament. Surface pattern design by humans regularly reflects the phenomena that are observed in nature, and as such can often also be described using similar methods. This predictability provides a strong relationship between pattern, and rules or algorithms.

Writing at the turn of the last century, writer and designer Lewis F. Day described pattern as the natural outgrowth of repetition, in whose form its construction can be seen (Day, 1996[1935]). "Pattern is here and there and everywhere about us". Day states that, technically speaking, we understand pattern not merely as the recurrence of similar forms, but of their recurrence at regular intervals. Day also saw the art of the pattern designer as not merely devising pretty combinations of forms, but working within a set of geometric rules to produce beautiful results no matter how unpromising the conditions of origin (Home, 2000).

Austrian art historian E. H. Gombrich (1984) claimed that, from a psychological perspective, it is our search for meaning and our effort to find order that determines the appearance of patterns, rather than the structure described by mathematicians. Taking the perspective of Gestalt psychology (Carlson et al., 2000), Gombrich argued that there is a link between the logic of structure and the ease of perception. A pattern with many details is easy to perceive if it has a systematic and logical structure, that is to say, a distinct order. During the process of handicraft production, elementary schematic patterns are gradually adjusted by means of the artisan’s aims, choice of materials, methods and functional needs. During the working process, complexity will be balanced and easier to receive if there is a basic system governing the design (ibid.).

In the Clouds: the workshop as a method of exploring the relationship between rules and pattern design

More recently, writing specific of Islamic tiling, Eric Broug (2008) has claimed that a geometric composition is the product of rules and creativity. The rules are an integral part of geometric design and, paradoxically, without such strict rules creativity could not flourish. Comprehending those rules and recognizing them in a design opens the way for a better understanding of the design process and of the creative choices that Islamic geometric design offers.

Exploring the connection between rules and pattern in an applied way is Monfort et al (2013), exploring the depth of meaning in a single line of computer code for the Commodore 64 personal computer from the 1980s. “10 PRINT CHR$(205.5+RND(1)); : GOTO 10”, an algorithm, a strict set of instructions and rules, guides the creation of an endless, beguiling visual maze pattern.

These sources, as well as our own practices designing rules and patterns, and our lived experiences, mystified by pattern, have encouraged us to explore the relationships between pattern and rules more thoroughly. From the simplest occurrence to the endless repetition of a basic unit, to complexities of symmetry, rhythm, and other factors whose products embody form and motion expanding through time and space.

The workshops

We devised a workshop to explore the relationship between pattern and rules at [a textile and fashion design school]. Students were asked to complete a design challenge, but were divided into two groups that received the same design challenge but different instructions for how to meet the challenge.

We wanted to test two opposite assumptions about the relationship between pattern and rules. First, that Design guided by rules would create a recognisable pattern, and second, that Visual patterns would easily be reducible to rules. Are these true? And if not, what does this tell us about patterns and rules?

The workshop was conducted twice, December 2014 and April 2015. The participants of Workshop 1 were first-year Master’s students in textile design and fashion design, the participants of Workshop 2 were first-year Bachelor’s students in textile design. All of the participants were given the same design challenge and were asked to work in pairs to create a prototype to respond to the challenge. Afterwards, all groups presented their prototypes and discussed their process and its relationship to the design challenge.

The design task was created for Workshop 1, where both textile- and fashion design students were asked to work on the same problem. We wanted a task that wouldn’t favour the knowledge and abilities of any one group, but could still be relevant as a visual-design challenge. The challenge presented to them was:

Scientists have designed a machine that can create clouds, and need help designing new clouds to be created by the machine. You have the possibility to design clouds never yet seen by humanity. Use the materials provided and make proposals for innovative cloud designs.

For both workshops, the participants were separated into two classrooms. Each classroom was further divided into smaller groups of two or more participants. The first classroom (named the “pattern groups”) was given a short presentation on visual pattern, showing geometrical conditions for patterning (such as mirroring or repetition), but with no mention of rules or the generation of patterns. The second classroom (the “rules groups”) was given a short discussion of rules in various contexts, not only limited to rules in visual composition. The classroom was also given a set of rules to govern their design creation. This presentation never mentioned the word “pattern”.

Patterns usually provide foundation for a material construction, as in architecture, or as surface decoration and ornament. Surface pattern design by humans regularly reflects the phenomena that are observed in nature, and as such can often also be described using similar methods. This predictability provides a strong relationship between pattern, and rules or algorithms.
For both workshops, the participants were separated into two classrooms. Each classroom was further divided into smaller groups of two or more participants. The first classroom (named the “pattern groups”) was given a short presentation on visual pattern, showing geometrical conditions for patterning (such as mirroring or repetition), but with no mention of rules or the generation of patterns. The second classroom (the “rules groups”) was given a short discussion of rules in various contexts, not only limited to rules in visual composition. The classroom was also given a set of rules to govern their design creation. This presentation never mentioned the word “pattern”.

In Workshop 1, the participants were given rules that were borrowed from the Swedish friggebod law, a law that allows homeowners to construct a small guesthouse on their property without applying for a building permit (Boverket, 2014). Rather than selecting individual rules for the participants that might unconsciously steer them in directions that we wanted—that is, that might force them to create patterns—the friggebod ruleset was an attempt to remove ourselves from this decision process, and to choose rules that would not necessarily create pattern. The participants were unaware of the origins of the rules they were given until after the exercise was finished.

In Workshop 2, the participants in the rules groups were given a list of possible rules to choose from—borrowed from various sources, such as friggebod, as well as rules for visual composition, rules from competitive aerobics, and rules for murder investigations—and collectively chose five rules that would govern their design process. The rules chosen for the second workshop, and their source in parentheses, were:

- hate randomness (murder investigations)
- have an element of surprise (visual composition)
- ask for permission from your neighbour (friggebod)
- one lift must be included (competitive aerobics)
- height maximum of 3 (friggebod, with the units of measurement removed)

The participants knew very little about our backgrounds, so we hoped that it would be unlikely that they would be able to guess what the purpose of the workshop was by knowing our interests and bodies of work.

Discussion, analysis

It would be simple to say that the workshops did not produce the results that we had anticipated. None of the individual pieces from the pattern groups could easily be reducible to rules, nor did those participants say that they ever thought of rules when they were creating the prototypes. Likewise, none of the pieces from the rules group could be seen as a pattern, nor did the participants say that they were thinking about pattern when using the rules to design the prototype.

Results: Workshop 1

The outcome of pattern group number 1 we interpreted and nicknamed “stained glass”. The design is flat, made out of scrunched, coloured paper and is meant to be lit from behind (figs. 1-2).

Figs. 1-2: Stained-glass cloud design by Johanna Samuelsson and Lisa Andersson

Pattern group number 2 made six pieces from torn paper, which we will refer to as “torn paper” (fig. 3).

Fig 3: Torn paper by Elias Högberg and Sif Drua Albrechtsen

Rules group 1 created “cloud capsules”, containers that could be purchased and opened, releasing a cloud of a specific design in the space where it was opened (figs. 4-5), though there was no information as to what these clouds would look like.

Fig 4-5: Cloud capsules by Sara Valenci and Sandy Tai

The second rules group created a “cloud hotel”, a hotel made of imaginary clouds (figs. 6-7). None of the results from the rules group could be said to represent a pattern. The results were, in fact, incredibly conceptual, more in line with product design than fashion- or textile design.

Fig 6-7: Cloud hotel by Evelin Kågo and Sofie Di Bartolomeo
Results: Workshop 2

Even though the conditions were slightly different than Workshop 1, there were similarities in the outcome and results. The pattern group made two designs: the first example was a tube-shaped mass of cloud modules that was designed to cast a shadow pattern as it filtered sunlight (figs. 8-10).

Figs. 8-10: Lovisa Norrsell and Anna Arthur present the cloud-mass shadow caster, playing with light and shadow with a flashlight

The second design was a paper construction containing 16 clouds in a drop repeated arrangement, attached and functioned by pulling strings. The modules were clouds with the iconic cloud shape (fig 11-14).

Figs. 11-14: Ida Andersson explains the drop-repeated cloud string construction

It could be said that the pattern group did create some kind of patterns, and used repetition as a design choice. However, they did not think consciously about pattern during their work, even though they were given a lecture about pattern. When asked how their work satisfied a concept of “pattern”, the participants maintained that the repetition of the unit in their work was sufficient.

Both the rules groups constructed 3D shapes, but did not create obvious spaces, as in Workshop 1. The first rules group made three pyramids in three different scales, with changeable facial expressions to satisfy the “surprise” rule (fig. 15).

Fig. 15: The outcome of rules group 1; Mathieu Porcher and Hanna Klasson

The second rules group built a cylindrical shape hanging from the ceiling (figs. 16-17). The cylinder contained a water balloon that was popped and lifted to, surprise, splash!

Figure 16-17: Bettina Blomstedt and Louise Christiansson demonstrate the cylindrical cloud that rained when punctured.

In the following discussion, the participants explained that the word pattern did not enter their minds during the workshop. Their results were also conceptual, similar to Workshop 1. The group was very eager to follow the rules they picked, and justified all of their choices thoroughly and convincingly.

Analysis

Let us examine the two assumptions that the workshop was supposed to test. The first, Design guided by rules would create a recognisable pattern. Did this happen? No, not as such. The rules groups of both Workshop 1 and Workshop 2 produced conceptual products, not visual design products. From the cloud hotel and cloud capsules of Workshop 1 (figs. 4-7), to the geometric clouds with changing facial expressions and the cylindrical raining cloud of Workshop 2 (figs. 15-17), the focus of the groups was not of an aesthetic communication but of the embodiment of a kind of experience or performative function. As such, none of the groups produced visual pattern.

But if we step back and consider the output we can see an obvious pattern of behaviour, or at least a similarity of output. They did produce something similar to each other, and the products within each workshop bear a similarity to each other, perhaps a product of the nature of the rules that the participants were given. Both of the products of Workshop 1 deal with space in a very obvious way. The products were not flat patterns, they were specifically three-dimensional. The hotel was a structure that is inhabited, and the cloud capsules produced clouds that occupy a volume in a way that is to be experienced by a participant. It seems obvious in hindsight that the friggebod rules, which were designed to govern the creation of a house, lend themselves to creating spaces, even when the participants were unaware of the rules’ origin. This would suggest that, rather than assuming that rules create a pattern, but that, in the space of all possible rules there is a subspace of rules that lead to the creation of spaces. The phrasing of these rules may not even communicate that they create spaces—this can only be discovered when the rules are used to create something.

The products of the rules group of Workshop 2 were also geometrical, though were not as explicitly architectural as the output of Workshop 1.

The rules groups of both workshops also created conceptual solutions, rather than visual, aesthetic solutions. Why was that? The backgrounds of the participants were varied, some had training in industrial design, but the majority had backgrounds in visual, aesthetic branches of design: textile and fashion. It’s possible that the rules also suggested a conceptual solution to the design challenge, just as they suggested the creation of a space.

It became clear that our use of the word rules in this experiment was a naïve application of a word with many meanings. When we explore relationships between rules and patterns, what do we mean by rules? Do we mean prescriptive instructions? Do we mean limitations to design actions?
Do we mean limitations of the final product? When discussing the results of the workshop it became clear that we, the workshop leaders, have different understandings of rules. Researcher 1, who thinks of software, sees rules as explicit instructions to be followed, such as a cooking recipe. Researcher 2 thinks of rules as guidelines or instructions that inform but don’t prescribe, such as a design brief.

We also interpret the word pattern differently. Researcher 2 has three main principles for understanding a pattern (in a design context): repetition, joints and aspect of pleasure. Repetition is the main characteristic of a pattern. When the same unit is used more than once in a design it creates a pattern. Any motif could be repeated after a geometric system and immediately a pattern emerges. The joints are central to units in repetition. Using the joints in a conscious way could either highlight or hide the repeat. The last principle is the aspect of pleasure. The brain wants to be exposed to order with a high degree of complexity. The brain wants to recognise and be challenged in the recognition, and it enjoys this process. Researcher 1, who does not come a visual field, has a less defined view of patterns. Researcher 1’s understanding depends more on general concepts of loosely recognised repetition and systems. This difference has made agreement on the interpretation of the results difficult, but has also created incredibly fruitful discussions about the multiple understandings of these concepts.

Did the rules create patterns? No. But that still does not mean that rules don’t create patterns, merely that the rules that were chosen for this exercise didn’t create patterns. Just as the friggebod rules occupy a segment of the rule space that suggests the creation of spaces, it could also be that there is a segment of rules that suggest the creation of surface pattern. An obvious rule would be that of repetition.

Wong (1992) described repetition as the simplest method of design. Repetition of unit forms usually conveys an immediate sense of harmony, and each repetitive unit form is like the beat of some kind of rhythm. Wong does not talk about “pattern” as such, but only about the repetition of respect unit forms. As stated by Wong, repetition should be considered with respect to each of the visual and relational elements: shape, size, colour, texture, direction, position, space and gravity. In the narrowest sense, repetition of unit forms means that all the visual elements of the unit forms should be the same. In a broader sense, identical colour or texture among unit forms can constitute repetition. Of course, the unit forms still must relate to one another by similarity or gradation, otherwise they cannot be grouped as unit forms (ibid. p. 284).

We deliberately did not chose repetition as a condition for the workshop because we knew, or suspected, that the outcome would definitely be pattern, and we would be learning something. As well, choosing repetition as a condition would have eliminated types of patterns such as those found in non-periodic medieval Islamic tiling, designs that cannot be said to have a strict repetition, but are still interpreted as patterns.

Kraft (2004) compared ideas of pure symmetry—constructed by transformations such as translation and relative positioning—to human perception and patterns of nature, which are not as perfect as mathematical ideals. As with Wong, Kraft also used the word rhythm, though to describe repetition, not of exact units but of things that are similar. This definition encompasses things that are not perfectly symmetrical but are nevertheless recognised as a pattern by the human eye. This is the definition of pattern which makes the most sense to us, though its vagueness weakens our belief in a connection between pattern and rules.

Our second assumption: Visual patterns would easily be reducible to rules. Did this happen? The results were not initially convincing as patterns, which prompts the question, can we even evaluate the assumption if we don’t believe that the groups created pattern? Each group did have characteristics that suggested pattern, and perhaps a discussion of this will help us understand that conditions that we require to perceive pattern, or quasi-pattern, be they rules or not.

Though none of the groups used the kind of strict repetition that we are familiar with in pattern, they did all use multiples of a kind of unit. In Workshop 1, the “stained glass” group (figs. 1-2) created multiple “windows”, though their shapes were not the same, and their arrangement was not strict in any way. In Workshop 2, both of the creations used a base unit of the traditional cloud shape, though the units weren’t arranged in a strict way to suggest pattern (figs. 8-14). The starting position of the “cloud string” creation was a strict grid, though this was upset when the clouds were pulled into a jumbled mass. The use of the multiples by the group suggests something about what we want or expect from patterns.

When do we see a pattern, and when don’t we? Are we being loose with pattern perception because we, as the workshop designers, want to see pattern? Because we have been tacitly conditioned in our professional lives or upbringing to see pattern? Gestalt psychology suggests that with the units separated we see their relationship, allowing for perception as a pattern, but when the units are placed together we perceive them as a mass without a pattern. Arnheim (1974) discussed simplicity in patterns: patterns can be identified by how easily we can imagine or remember them, and by how easily they can be described in words, though not by counting the number of units or elements.

This suggests a requirement of perceiving a base unit if we are to perceive the pattern that the base unit creates. What about situations where a base unit can’t be perceived? What about situations where there is no base unit, yet we still perceive a pattern, such as medieval Islamic tiling? A solution may be that there need not be identical base units, but only base entities that are similar enough so as to be perceived as the same thing.

The participants in the pattern group did not “see” rules in their creations. If we were to process the material again, it might be useful to ask the participants to extract rules out of their result, ask a second group of participants to design based on those rules, and compare the results.

If we were to organise the workshop again, we may also need to rewrite the design challenge to soften the conceptual output of the rules groups. In seminars the workshop has been suggested that terms such as “never yet seen by humanity” and “innovative cloud designs” may have encouraged conceptual rather than aesthetic solutions. We also would consider including the term repetition in the rules, to see if the output is as predictable as we assume it would be.

Conclusion

Assessing the results of the workshops, and comparing the results to our assumptions, led us to see that our conceptions of what we were studying, patterns and rules, are less clear than we had thought. The more that we tried to define what it is that we meant by patterns and rules, the more we felt like relying on U.S. Justice Cotter Stewart attempting to define “obscenity” in 1964: “I know it when I see it.” (Jacobellis v. Ohio, 11) We know pattern when we see it. This obviously represents an internalised knowing of pattern, created either through the tacit construction of the mind (Polanyi, 1983), or through physiological, evolutionary or cultural mechanisms. The workshop was held at a Swedish school, but one of the participants, from Taiwan, described her interpretation of pattern as any non-symbolic surface ornamentation (that is, no letters, no images), a concept totally foreign to our understanding.

The aim of this workshop was to explore the relationship between pattern and rules in design processes, and to provide a foundation for reflection and critical discussion of this relationship.

Conclusion
Future workshops may focus rather on exploring the participants’ understandings of rules and patterns, rather than attempting to shoehorn their designs into our preconceptions of rules and pattern. It may be more fruitful to map out the nooks and crannies of the space of things that we call “pattern”, instead of creating definitions that ignore unique variations and restrict the room for interpretation.

References


Jacobellis v. Ohio, 378 US 184 (Supreme Court 11).


