On form thinking in knitwear design

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Through conducting a series of design experiments using knitting and crochet techniques, the notion of form was explored from the perspective of the way in which we make a garment. The outcome of the experiments showed that there are possibilities for development of alternative working methods in knitwear design by viewing form in terms of topological invariants rather than as abstract geometrical silhouettes. If such a notion, i.e. a notion of a more concrete geometry, were to be implemented in the design process for knitwear, it would provide another link between action and expression that could deepen our understanding of the design potential of knitting techniques and provide the field with new expressions and gestalts.

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ABSTRACT

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**Keywords**: fashion design, knitwear, form, silhouette, practice-based design research, design methods, knitting, making, concrete geometry, topological invariants.
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Form and form-thinking have always intrigued me.

When taking courses in textile print at the School of Design and Crafts, HDK, University of Gothenburg, I concentrated far more on forms than I did on colour settings, which in retrospect may be said to have been something of a disaster when looking at the results. On the other hand, I was swept away entirely by the courses in sculpture, which I think were even called “form-classes”, as we were told to visualise different notions through three-dimensional shapes. We were free to use any material. I understood what to do. I was inspired, intrigued and I found that relating to this kind of assignment came naturally to me. I quite simply liked them.

But what then are these notions of form and form-thinking that so clearly captured my passion?

Fig. 2. (Opposite) Garment 14 holes
The main aim of the research presented in this licentiate thesis is to explore the foundations of form-thinking in the design process for knitwear with the objective to develop concepts and working methods and to discuss results of practice-based design research conducted as a combination of experimental and theoretical work.

As the making process of knitwear is different from the making process of woven garments, form-thinking may also differ between design processes. In particular, this research questions the prevalent distinction between form and material in the design process for knitwear.

What defines a knitted garment? What is form? Is form an abstract notion? Can form be concrete? Is form what the material is made of? Is form what the material does? Is form a visual impression? What are the difficulties in using silhouette, garment type and pattern construction as descriptions of form in fashion design? What does it mean to create the material and the garment at the same time?

The subject matter of the experiments discussed in this thesis deals with the intersection between knitting, form and making. The notion of form is not specific to fashion design but is also one of the central notions in garment design; it can even be said to be fundamental. Furthermore, knitting is not designing in yet another technique; it is designing from a different perspective. The knitting technique enjoys a special status and also the possibility to both create the material and shape it. When making a knitted item, we do not first have to knit the material, because form and material are created simultaneously. The core of the design practice for knitwear lies in the designer accepting a design process where there is only one design parameter, because form, material and making come together as one, with form as a foundation. Hence this thesis aims to develop the design process for knitwear by focusing on alternative ways of understanding the notion of form, which may lead to new expressions in knitted garments.

At first, a few initial projects are described briefly followed by a presentation of three elaborate design experiments. These three experiments are explained in-depth in relation to a theoretical framework,
INTRODUCTION

which proposes a certain concrete geometry; the use of topological invariants as an alternative way for form-thinking in knitwear design.

The personal experiences and knowledge I bring to this research endeavour are primarily based in my dual background as a designer of knitwear and in teaching knitwear as a lecturer and supervisor at the BA and MFA levels at the fashion design education.
Many things have been said about knitting. It has been described as a part of textile history, as a well-known and popular handicraft, as one part of the industrial development, and as a trigger for development of new software. Finally, it has also been mentioned in connection with the invention of new knitting machines that will (almost) be able to create what has been done by hand for many thousands of years. For the past thirty years, the industry has focused on the development of three-dimensional knitting, which in short can be explained as the possibility to create everything at once, i.e. simultaneous creation of material and shape.

Design-wise, we are presented with intriguing new expressions in knitted garments and new materials. Knitwear is an obvious part of fashion. However, has there been any development in the design process for knitwear?

Whether the designers have been the driving force behind technological innovations in knitting or the technological innovations have been the driving force and inspiration behind the development of new designs is a question at issue. Personally, I support the latter opinion.

Most technological innovations in the field of knitting stem from a need to improve efficiency and thus increase profit margins rather than an urge to create new expressions. This opinion is also supported by the fact that most technical innovations mimic existing knowledge and practices in hand knitting.

In 1995, the Japanese knitting machine company Shima Seiki introduced the SWG-series, the Shima Seiki Wholegarment® knitting system, at the 12th ITMA fair in Milan, Italy. This line of knitting machines constituted a major breakthrough in the development of industrial production of knitted garments as they delivered complete, seamless garments directly from the machine without the need for additional work prior to use. The invention was a development of the fully automatic knitting machine for gloves Shima Seiki had released in 1964 that made seamless, knitted gloves with no assembling work needed. The starting point of the development process for the Wholegarment® system was when an employee at Shima Seiki studied the shape of a glove and while holding it upside down realized that – oh, this looks like a sweater! (Personal communication at Shima Seiki headquarters, Tokyo, 2011)
Ever since the first knitting machine, the stocking frame, was introduced in 1589 by William Lee (Brackenbury, 1992) manufacturers have strived to be able to make complete garments or, in the terminology of the time, to be able to make garments the same way those made by hand were. Of course, between the stocking frame and the Shima Seiki Wholegarment® System, development has been through a number of important steps and phases.

In beginning of the 20th century, the idea of knit to fit – fully fashioned knitting – was established. Machines used to manufacture underwear were modified to be able to shape the garments through a combination of fully fashioning and changing of stitch structures. “Much had been learnt from the toe shaping from the prior decade” (Power, 2007). The cut and sew method was established in the 1910s, although at first its proponents found that it was difficult for people to accept it.

After the First World War, manufacturing of knitted products split into two main directions: cut and sew and knit to shape (fully fashioned). Important developments in the field of assembling knitted garments, such as flat lock seams, took place during this period, which probably increased the popularity of the cut and sew method. Also, the fact that the House of Chanel used the cut and sew method probably furthered acceptance of the method (Power, 2007).

In the 1930s, effects such as knitted darts and rib for waist shaping made it possible for garments to have more three-dimensional shapes. In the 1960s Kenneth MacQueen unsuccessfully tried to compose an electronic computer-controlled knitting machine (Spencer, 2001). The idea came from his patent of flechage; shorter row knitting, for outerwear production. The technique had been in use before, especially for the making of Basque berets, and in 1950s designer Emma Pfauli recognized the potential of the technique and realized it could be used to shape whole garments.

In the 1960s, Frank Robinson developed the presser foot for knitting machines. This made knitting on empty needles possible and opened up for a new era in the field of knitting (Spencer, 2001). Also, a team (led by Frank Robinson) at the British knitting machine company Courthaulds held a patent relating to production of seamless garments through the production of tubes.

In the 1980s, lots of time was saved as new, strong and light-weight motors on the cam box made it possible to move over only the active needles, especially when knitting with shorter row techniques and using this technique opened up more design possibilities. During the second half of the 1980s, a research program established in collaboration between the Japanese company Shima Seiki and British company Courtaulds resulted in the development of integral knitting machines (Power, 2007). A great deal of technical development took place over a short period of time despite the fact that the use of them was somewhat hindered by two factors: firstly, the designers’ and technicians’ knowledge of/ability to program the machines and, secondly, the fact that prototypes took a long time to develop (Brackenbury, 1992).

Some designers have allowed the use of specific technical equipment to become their artistic signature. For example, the significant zig-zag patterns by Missoni result from their use of Rachel machines and the Australian knitwear company Coogi used an, at the time, novel solution for making complex combinations of colour Jacquard and stitch patterns that became their visual signum (Black 2004). Comme des Garçons took the use of machines as a visual signum a bit further. In their lace collection from 1982, the knitting machines were manually manipulated to make the machine “limp” in order to create an expression of unevenness and unpredictability (Sudjic, 1990).

The most important technical innovation, next to the Shima Seiki Wholegarment® knitting system, is probably the A-POC. The development of the research project began in 1997 under the leadership of Issey Miyake and engineering designer Dai Fujiwara at Issey Miyake Design Studio and resulted in the creation of a revolutionary technique: a manufacturing method using a specifically developed warp knitting machine that created whole garments from a continuous length of fabric made in the machine. Garments were made directly in a sort of tubular knitted material and were disentangled from the roll by a simply cutting around it – the seams were already knitted in the knitting machine and the seam allowance would not unravel (Kries, 2001). The research conducted involved both development of new technology (development of machines) and development of new construction systems and design possibilities.
BACKGROUND

The difference between the innovation of A-POC and the other innovations mentioned above is of great importance. Most of the other technical innovations were created by technicians and engineers and their solutions mostly mimicked already existing hand-knitting solutions. In light of that, the innovations have been new as technical innovations, but not new in the sense of “never seen before”. In contrast, the development of A-POC was designer-driven and the result was something truly new and original; A-POC did not merely mimic hand-knitting, but invented a completely new system for creating and manufacturing garments.

Since the late 1990s, the field of knitwear has been the subject of design research. Analysing what has been written regarding that research, the main subject matters can roughly be divided into a few broad categories: dealing with shaping/forming, dealing with learning/the design process, dealing with technical innovations, dealing with production/economic issues. Of course, many of the articles and theses discuss more than just one of the aspects above. In this thesis, I will not discuss research results related to production and economy. My focus is on the aspects of shape, process and, in some respects, technical innovations (if related to the designer). The aim of this section is to provide a brief summary of the directions research has taken in the field of knitwear and point to a knowledge gap in that field.

One crucial issue related to knitwear is the symbiotic connection between form and material. Although this connection is fundamental for the understanding of knitting, it is rarely discussed in educational material and not much explored in research, probably due to the complexity of the subject. However, the importance of understanding this connection has been highlighted in other fields of research and notions and methods from that research can be translated and used in the field of knitwear. In the field of textile print, K. Townsend (2003) argued for the need to develop a closer relationship between two-dimensionality and three-dimensionality in the design process. In her thesis, Townsend identifies three different design methods: textile-led, garment-led and the simultaneous approach. Translated into more general terms, the recognized methods imply that textile = material and garment = form. Hence, the field Townsend explores in her research is the same as the field of research of this thesis, although within the framework of another textile technique and with the restrictions and possibilities inherent in that technique. In knitwear, the different dimensions have been discussed as form and surface (Underwood, 2009), which points in the same direction.

The notion of form in a knitwear context has been approached mainly to find methods that will allow the use of machines or software to arrive at specific shapes. However, Sharon Evans-Mikellis (2011) also brings up the differences in thought-process when dealing with new technological possibilities: “I will also require the development of new teaching approaches...”
to understand and adopt this new mindset and take us into an era of three-dimensional knitted products” (Evans-Mikellis, 2011). Her thesis establishes that it is important for designers to re-interpret the fashion context they work within in order to create new expressions, which will also support viability in the knitwear industry. She acknowledges that the innovation of seamless garment production offers an opportunity for designers to re-think the evolution of the forms and silhouette of garments: “…even when working with conventional garments, a non-standard process could result in a variety of new outcomes” (Evans-Mikellis, 2011). Her thesis also suggests it would be interesting to see new experimental teaching methods using three-dimensional models instead of sketching.

The use of mathematical models for more efficient production is put forward in several places in the research as a way to come to terms with the difficulties in grasping the complex nature of knitwear (Yang, Love, 2009) (Eckert, Cross, Johnson, 2000). Although C.M. Eckert, Nigel Cross, J.H. Johnson (2000) state that “The interplay between shape and form is a major difficulty of knitwear design” and put this forward as an issue, their research do not mention the possibility that this issue may be solved by exploring this relationship further.

Earlier research in the field of knitwear quite often concentrates on the possibilities created by a certain machine or technique (Eckert, 1997) (Guy, 2001) and as technical innovation moves fast, there is a constant demand for research that explores new techniques (Choi, Powell, 2005). Jenny Underwood presents descriptions of complex shape-possibilities (preforms) that are possible to achieve with the Shima Seiki Wholegarment® system. Transferring this knowledge to designers is important and much needed. Also regarding three-dimensional knitting, Underwood identifies a significant gap between the literature published and digital knit programming (Underwood, 2009). Although the need for new design methods in connection with the invention of the new seamless technology has been raised, the solution proposed is to acquire more knowledge in the programming of knitting machines (Sayer, Wilson, Challis, 2006) instead of rethinking the foundations of the design process.

In conclusion, there is a knowledge gap here.

The dominance of the technical and economic side of innovations within research conducted in the field of knitwear is clearly visible. Throughout the 20th century, innovations have predominantly been created by technicians developing new equipment and systems, with the consequence that many innovations have merely mimicked already existing knowledge from hand-knitting as opposed to the designer-led innovation A-POC, which presented a completely new solution and system. In the field of research, knitwear is mostly investigated with the aim of improving production efficiency in order to increase profit margins. Another major area that has been the subject of explorations is the potential to develop new knitwear software, i.e. using software to create the possibility to help users (often directed towards designers). There is a gap between these two areas of exploration, a gap that concerns expression and method. This leaves us with an opportunity to further challenge the development of new design directions.
In the manufacturing/production process for knitwear different ways can be used. The variants used are connected to different knitting machines as well as different construction-systems. Do the production mode affect the designing mode? Are the design process and manufacturing striving in the same direction?

Here a short overview of different methods for producing a similar garment will be presented. (Brackenbury, 1992) (Peterson, 2012) (Spencer, 2001)

**KNITWEAR: PROCESS**

**Cut and sew construction method**

In this method the garment-making process is the same as for garment making in woven materials. Firstly the textile is knitted on running meter, followed by the garment components (pattern components) being cut out and finally assembled/sewn together.
Complete garment construction method
(also known as Wholegarment® and seamless garment)

The garment is knitted and ready-made directly in the knitting machine. The method uses tubular knitting (on flat bed knitting machines).

Fully-fashion construction method

Each garment panel (component) is knitted in its final shape. The panels are then assembled/sewn together.

Hand knit seamless

Tubular knitting is created using either a circular needle or five needle-pins. The basics are the same as in the Complete garment construction method. Cylinders are knitted, joint together into one cylinder and ended at the neck.

Hand knit fully fashioned

The process is identical to that of fully fashioned construction method.
Ever since Shima Seiki developed the Wholegarment® system (Peterson, 2012) it is possible to start the production process with a yarn and end up with a garment without doing any cutting or sewing – just like in hand knitting and crocheting. The differences in the steps of the processes between yarn and the final garment in the two examples in the figure to the left are obvious. Is this reflected in the design process for knitwear?

In the first example (A.), the process is familiar as it is the same as when making garments in woven materials. The process is founded on the principle of a two-dimensional material that becomes a three-dimensional shape through cutting and assembling. Here, material and form are two separate parameters and the existing parameter (the material) is used to create the other, desired parameter (the form). The other example (B.) shows the special status of knitting and its intrinsic possibility to create both material and shape. When making a complete garment, no material has to be/can be made beforehand. It is a single-step process that has to begin with only yarn.

Despite this, it is common to use the same way of thinking for these two different making processes both in teaching and in designers’ practices. The missing link between the two examples seems to relate to the relationship between material and form. As the notion of material is a tangible one, it could be argued that yarn is the lowest common denominator for the materials in the illustration (one could also argue that it is the garment). Through knitting, yarn transforms and changes its denomination to garment (form?). Traditionally, form is an abstract notion. In the illustration, is it possible to identify a lowest common denominator regarding form? Form is not easy to come to terms with and it seems it is the most unclear notion in this process. Hence, it seems to be the most important parameter to explore.

What are the potential benefits of an alternative design process? The complete garment system was developed to achieve more efficient and less costly production, i.e. to be able to cut down on the costs for cutting and sewing to nothing when making knitted garments. It was also developed because of the functional benefits it provided, e.g. no seams in small, narrow items such as gloves. However, the system has more potential than those relating to aspects of economy and efficiency. A new way of making garments also opens up for new ways of thinking, which may lead to new expressions and gestaltungs.
When describing the form of a garment, the most commonly used terms are garment type and silhouette. Because everyone interacts with clothes on a daily basis, an easy, common language for describing them is also the most useful. However, this way of describing the form of garments is just as common within the academic field of fashion. Is this language adequate and exact enough to be of use to an academic field? Do these notions point in a certain direction? Do the notions widen or narrow the scope of possible developments of form-thinking?

When speaking about clothes in our daily lives, we most commonly speak of garments in terms of their types, e.g. trousers, skirts, jumpers, etc. (Barthes, 1967). This definition system tells us something about the function of the garment and also gives information on its shape: for example trousers are presumed to have two legs, sweaters two arms and a torso (Kawamura, 2004). We are used to read and describe the form of garments using the garment type system. A fashion design process often starts by stating to which garment type the result is to belong. Thus, the garment type system influences the thought process already at the beginning of the creative process and continues to do so throughout the creation process. The intrinsic notions of form the words carry as such will thus affect the creation and possibly inhibit an open mind towards unknown shapes.

When a breakout from this form system occurs, the result is often rejected. In the long run, however, these results have the potential of expanding our notions of what is considered a garment type, why it is possible for us to learn to understand new shapes. This was the consequence of the Japanese fashion revolution in Paris in the early 1980s. Issey Miyake, Yohji Yamamoto and Rei Kawakubo showed clothes that had no predecessors in western clothing. They introduced new approaches to garment and body and also new perspectives on what was presumed established garment types (Fukiko et al, 2010). “These designers reinterpreted western sartorial conventions, which I call a clothing system, by suggesting different ways if wearing a garment… They also redefined what clothes look like or can look like” (Kawamura, 2004). A pullover designed by Rei Kawakubo for Comme des Garçons in 1982 exemplifies the difficulties of the majority to understand a form-thinking that deviated from the prevailing one. “Ten sleeves on one pullover does not exist in our universal cultural memory. (...)”
This kind of innovation results in tremendous uncertainty and usually meets with rejection due to our previously acquired or learnt knowledge” (Loschek, 2009). Although the example above is old, the same difficulties remain and reappear in new areas. In the newest software created for Shima Seiki, the system for description of forms builds on the use of garment types, which does not only limit the steps of the creative process in which form is created for fashion designers, but it also problematizes the use of the software for textile designers (Underwood 2009). To some extent, the possibilities of new technology are still held back by old perceptions of form.

The “silhouette” sometimes means the complete outfit (worn by a model), sometimes refers to an abstract representation of a form (a sketch) and sometimes to the fit of a garment. The silhouette could be what we see when looking at a dressed model; if squinting, we will see something that looks like a French silhouette, a monochrome, two-dimensional picture where only the outline is relevant. Although everyone agrees it is the correct term to use, there is no consensus about the exact denotation of the term. Accordingly, the concept of the “silhouette” may be used to denote both dress and body or only to describe form. In the early stages of learning, it is common to design by viewing the sketch (the silhouette) as an abstract form just waiting to be embodied through the material of choice.

The myth of the silhouette refers to the fact that form-thinking in fashion design is all about the silhouette (though this is in fact not a fact but merely a myth). The idea of the silhouette as a guiding principle also introduces a seemingly natural dichotomy between form and material.

The “silhouette” describes what we see, not how we make/create it. The notion is in itself a step away from making as it divides action from expression. In knitting, this distinction can be questioned and problematized as material and form are created simultaneously. Hence, the myth of the silhouette hides the intrinsic association between material and form and its potentials in terms of form-thinking. This consequently leads to distinctions between action-expression (making-form), abstract-concrete and form-material, which in turn lead to a narrowing of the perspective on form in the fashion design process, especially with respect to knitwear.

The idea of the myth of the silhouette constituted the foundation for the initial design experiments described in the next chapter.
The research undertaken combines practice-based experimental design research with theoretical considerations. It is vital to bring forward the applied research methods in a comprehensive way for the research findings to be of use to others. For this reason, detailed descriptions of the methods used for each of the main design experiment can be found in the chapter Design experiments.

Below follows a brief discussion on some initial experiments that helped to frame the direction of the main experiments.

The route of research is not linear. When summarizing a long-term project, it is easy to forget things/experiences/projects that did not turn out to be fruitful in relation to the outcome of the entire project. This is precarious as all parts of a project serve the thought process and generate issues or answers that are important to the research process. The objective of the research presented in this thesis is not to conduct experiments that are reproducible in an exact way, but to conduct and present experiments that serve as sources of and guidelines for another perspective on form. Thus, the theories and methods in each experiment are designed to be generic and reusable as general tools for form-thinking in knitwear design.
Balloon project

The Balloon-garment experiment was the start of the design experiments, and the methodological straits during the early stage of the research process. The aim of the experiment was to apply a wider form-thinking in the use of complete garment knitting machines through the making of a balloon-like garment in monofilament yarn. The mismatch between the 3d knitwear software/possibilities of the knitting machines and a free form-thinking revealed itself during the project.

The fact that flat-bed knitting machines operate/knit tubular shapes without being circular (but being two needle beds parallel to each other) is an influential cause in the mismatch. In some machines the take down causes difficulties in the implementation of a free form-thinking. Early in the project these difficulties were noticed and picked up as part of the research exploration with the result that the planned knitted piece was not carried through as such. A decision was taken not to proceed with the balloon-garment as at that time of the research period the questions raised during the try-outs of the project could be better explored through other design experiments.
METHODOLOGICAL ISSUES

Photo-sketch project

An early project (which was exhibited later on) turned out to be highly important for the development of the experiments discussed in chapter Design experiments and the directions of theoretical considerations.

Initially, no exact set-ups had been decided or prepared for this project and the aim was somewhat unclear. The project was carried out in a quick, sketchy manner and the short distance between idea and realization was pronounced already in the beginning. Many questions appeared along the way. The outcomes of the project were photos (taken in collaboration with PhD candidate Ulrik Martin Larsen) of me posing behind miniature garments made in tissue paper. The exploration was about scale, fiction-reality, live sketching and the transition between surface and shape (between two-dimensionality and three-dimensionality). First, naïve sketches were made for each garment, focusing on achieving a specific shape. When translating the sketches into three-dimensional prototypes, I reached a turning point. When sketching, there is no need to pay attention to the logic of construction as the viewer will be able to conceive the object as a garment anyway. In the sketches there were no cuts, e.g. an arm could simply grow out of the torso. The construction had to be altered for the new material and technique. Cuts had to be made in order to shape the garment and to integrate different sections with each other. In crocheting or knitting, however, it would have been possible to use the first sketch without alterations. The sketched form connected well to those techniques. In knitting and specifically in crocheting, it is possible for new sections to simply grow out of another shape.

The turning point and what appeared to be the key findings of this project was the role of the openings in the garment, here identified as the differences in construction between crocheting, knitting and assembling in paper or woven materials. The project also identified the crux of knitting: holes cannot be made afterwards without destroying the stitch-system, with unravelling as an unavoidable consequence. This in turn led to another, more elaborate design experiment later on.

Fig. 13. (Opposite) Photo-sketch project: sketches and photos. Photos with model by Ulrik Martin Larsen
METHODOLOGICAL ISSUES

Fig. 14. Photo-sketch project: miniature tissue garment

Fig. 15. Photo sketch project: photo by Ulrik Martin Larsen
Sihouette project

One experiment was set up to explore “the myth of the silhouette”, i.e. the relationship between form and material and also the notion of form. Form and silhouette was approached via flat pattern construction.

The setting was to implement two different constructions, each construction in three different examples using three different textile materials. The process started out with sketches, moved on to pattern construction and, finally, to assembling. Although research is an activity concerned with uncertainty (Loschek, 2009), this experiment was not. Because all materials inhibit certain kinds of draping, the choice of materials impacted the so-called silhouette. The problem with the experiment were that it had too many aims (unfocused) and that it was trivial and not truly exploratory (as the result was already known). However, the most important fault was to approach form via flat pattern construction. By doing so, the form-thinking of the silhouette was embraced and prohibited the finding of new perspectives. However, the experiment was useful in another way. The analysis of the samples gave rise to thoughts regarding the question “what is form?”. As a thought experiment, it is possible to argue that the three different variants of each pattern construction have the same form, despite their different appearances.

Thus, the experiment clearly illustrated the need for a wider perspective on the notion of form. The experiment helped formulate a key issue through form explorations, i.e. that form-thinking has many alternatives and in exploring the notion of form it is less fruitful to follow familiar routes.
An expanded notion of form.

The initial design experiments presented in the previous chapter pointed out and revealed difficulties with form-related conceptions as well as uncovered a possible space for a wider understanding of the notion of form. This opened up the possibility of alternative form-thinking, i.e. other approaches to form than silhouette and geometrical figures. Form-thinking, i.e. the chosen approach to the notion of form in an experiment or a design process, is essential and fundamental and affects the design process, the making and the result. The use of geometrical figures in form-thinking points clearly towards the result, i.e. the desired look of the result. It is connected to the definition of form as that which we see when looking at something. The notion of form also carries the inherent ability to be “the way to”, i.e. the way something is made, which is connected to the verb “to form”. If choosing the latter focus, there is also a need for a wider notion of form.

- Geometrical figures, abstract – form being that which we see when looking at something.
- “The way to”, concrete – form as connected to the verb “to form”.

The idea here is to use the notion of invariants in form-thinking both because they may constitute an alternative to abstract geometrical figures and because they correspond to “the way to”.

An invariant is:
- A topological property.
- A geometrical notion that is not connected to a specific shape.
- A property that is invariant under non-destructive forms of making and uses (i.e. if not cut, torn apart or manually destroyed in any way)
- Something that stays “invariant” when exposed to non-destructive transformations.

Work guided by invariants means establishing/defining/excogitating an elementary topological property in the beginning of the design process that will then guide the process of making, of “forming”. As an invariant property remains constant throughout the whole process (and afterwards), the property has a direct and, in some sense, basic connection to the technique/construction used.
**The two alternative kinds of form-thinking could be described as follows.**

1. **Working from the form-thinking of geometrical figures:** If wanting to create the geometrical figure of a cone (when making a knitted item), there are many different knitting techniques the maker can use to complete the task, e.g. assembling of cuts of a knitted material, knitting a cylinder that decreases in width, knitting a part of a circular piece and assembling it. The objective is set, i.e. what the end result will look like.

2. **Moving on to working from the form-thinking of invariants:** First, a technique is decided upon, e.g. knitting. Then, necessary functions are determined, e.g. one small and one big opening, and where after the maker find ways to connect the functions to the technique. After this, there is an early sketching phase where the technique and the materials function as sketching tools.

The latter method of form-thinking establishes a close connection between shape/material/making. This method may have potential uses in the field of knitwear and crochet, where the dichotomy between form and material is somewhat dissolved. It also opens up the opportunity for ending up with a gestalt that has not been seen before and yet is well-functioning. This corresponds well to the demands and wishes for newness in fashion.

”Knitting at its most fundamental level is an operation that makes something from nothing”

*(Jonathan Faiers: The void in Knitting, Unravel 2012, p.78)*
In this chapter, three design experiments will be presented. They display and explain the possibilities of invariants as direction for form-thinking in the early stages of the design process for knitwear.

**The design experiments are:**
- Exploring nothingness
- Exploring somethingness
- Exploring inward/inside-outside

**The notion of form in knitwear design has been approached through the following three guiding categories:**
- Nothingness
- Somethingness
- Inward/inside-outside

(All “parts” of a form can be placed under one of the three categories.)

**The invariants corresponding to these notions of form were later identified as:**
- The hole – the nothingness of a form.
- The surface – the somethingness of a form.
- The knot – the integration of the inside and outside of a form.

The invariants are not supposed to be understood as a kind of basic parameters and are not meant to correspond to the equivalence of basic shapes. Instead, they make up an open system where new invariants can be established for each project in relation to the specific techniques used in that project.

The invariants used here and the methods used to work with them as guiding principles in form-thinking will be more closely illustrated in each of the design experiments presented below.
EXPLORING NOTHINGNESS: HOLES

The main inspiration for this experiment stems from an insight I had during the photo-sketch project (see chapter Methodological issues): the importance and value of the openings of a garment.

What functions and meanings do openings have in a garment? Every garment ever constructed has some kind of opening. Either the garment has the shape of a cylinder (giving it natural openings), one or more openings have been cut in the piece, or some kind of fastening (buttons, zip or similar) causes an opening to appear in the garment. As garment types made of uncut fabrics such as saris, togas, etc. are folded and wrapped around the body, they in fact take the form of a cylinder. A flat, uncomplicated garment such as an apron is tied around the waist with straps, thus creating an opening. Openings make a garment stay on the body; they are essential to the “clothing function”. A three-dimensional textile shape without any openings is not referred to as a garment, but as a textile shape. From this perspective, openings are fundamental as they are part of the definition of what constitutes a garment.

In contrast to sewing/making/assembling garments in woven materials, in knitting and crocheting holes can be made without cutting and without any risk of unravelling the fabric. However, that is – nota bene – as long as the holes are made simultaneously with the material and the shape. This is a very specific connection between holes and knitting/crocheting. Holes are a natural part of the knitting and crocheting techniques. Holes are constructed by casting off and casting on or by transferring stitches. Openings can be used to pattern a surface or to make a hole that will have a specific use in the construction of the garment. If one does not want to cut and sew in the knitted piece, one has to plan all openings from the very beginning. Knitting and crocheting are considered relatively free techniques as many decisions can be made along the way, apart from the fact that one cannot add even a single little opening in retrospect without cutting and sewing.

These two conditions, i.e. the hole as an important part of the definition of what is considered a garment and the prominent position of holes in the knitting design process, were the starting points of this experiment.

A hole is the part of a form that is non-tangible, its nothingness. It is purposely encircled by the tangible part, the somethingness.

The invariant in focus here is holes.

The experiment

The aim was to:
- explore another way of form-thinking by allowing openings to define the logic of a garment.

Made through:
- a series of crocheted garments.

The reason for choosing crocheting as the textile technique used in this experiment lies in the relative freedom this technique allows in comparison to knitting. In knitting, all stitches on the same row are open at the same time why it is possible for them to unravel, whereas in crocheting, only one stitch is open at a time. This makes crocheting a quick and easy technique to use in order to achieve three-dimensional forms and in some ways it may even approach sketching as a method. Also, using a large-sized hook increases the feasibility of rapid construction and thus allows the designer to come closer to the process of sketching and thinking through action. In this experiment, a certain formula was set up and it was decided that the outcome would be six garments for the upper part of the body. In order to suit this part of the body in a conventionally recognizable way, the garment would have to have two, three or four openings. I decided to work with four openings (head, torso and arms) in this experiment.
The following pre-set rules direct and explain the experiment and define the form of the garments:

- Four openings with no requirement on their sizes (although two of them cannot be smaller than the approximate size of the head and the torso)
- Crochet hooks, size 1.5 cm, 5 mm
- Double crochet stitches
- Yarns: wool, bamboo, polypropylene, polyester, mercerized cotton (one yarn in each garment)

Start the construction (action) by crocheting four separate chains of predetermined length; optionally, the chains may be of individual lengths (Fig. 23). No measuring with tape around the body or along the chains is allowed, only judging by the eye. Connect the first stitch with the last one for each of the chains in order to make four circuits = the outlines of holes. Continue crocheting in the round around each hole individually, using double crochet stitches. Decide how many rows each one will have before joining them together. In the end, the four holes are to be openings into the same garment. What is in between the holes is connected in the process of making the garment. The exact moment joining is to take place, i.e. the number of rows crocheted prior to joining the circuits together, as well as in what order the four circuits are to be joined together is entirely up to the crocheter. A joining is created by crocheting through the outer edges of two circuits held together with no restrictions on the number of stitches used (Fig. 25). It is possible to join two or even three holes at the same time. Because of the decision to have all garments begin with the openings, one cannot end in an opening, why it is not possible to join all four circuits at the same time in the same manner described above, as that would lead to an opening. However, it is possible to join together all four openings in this formula if the joining is a closure. After a joining, continue to crochet only around the new outer edge and leave the joint behind as a partition wall. Finally, only two circuits remain.

The last joining is made in the same way the previous ones were, only this joining includes the full length of both circuits. If they are not of the same size, one of them will be ruched. The joining of the last two circuits will be the very last row to be crocheted. As the starting point of each garment is very clearly defined (the four holes), the ending also has to be visualized. This is done by crocheting the last row in a contrasting colour. To further illustrate the process and logic of the experiment, no yarn endings were fastened but left as they were on the right side/outside.

A technical description of a piece of crochet commonly looks like this (pic) and serve as a description of how each stitch is to be made. The technical description for this project is the one above and uses the invariant hole as guide for form-thinking in the fashion design process for knitwear. Any set of rules can be defined in the same manner.
DESIGN EXPERIMENTS

Fig. 27. Exploring nothingness: garment 4 holes; action step by step.
Fig. 28. Exploring nothingness: garment 4 holes, polyester yarn

Fig. 29. Exploring nothingness: garment 4 holes, polyester yarn, detail
Fig. 30. Exploring nothingness: garment 4 holes, bamboo yarn

Fig. 31. Exploring nothingness: garment 4 holes, bamboo yarn, detail
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Fig. 34. Exploring nothingness: garment 4 holes, wool yarn, white

Fig. 35. Exploring nothingness: garment 4 holes, wool yarn, white, detail
Fig. 36. Exploring nothingness: garment 4 holes, polypropylene yarn

Fig. 37. Exploring nothingness: garment 4 holes, polypropylene yarn, detail
DESIGN EXPERIMENTS

Fig. 38. Exploring nothingness: garment 4 holes, mercerised cotton yarn

Fig. 39. Exploring nothingness: garment 4 holes, mercerised cotton yarn, detail
Exploring Somethingness: Transformations of Surface, Definers of Normal Forms

In this experiment, the close relationship between shape and surface in knitted materials is in focus and the aim is to explore transformations of a knitted surface.

The surface is the tangible, exposed part of a form/shape/material. In garments, the surface is that which faces up and faces down, i.e. the outside and the inside of the material; in other words what we see or touch. How do we describe the notion of surface in knitting? In the field of fabrics, the notion of surface usually refers to the right and the wrong side of the material. The constitution of the surface is determined by the textile technique used or the finishing applied. Although touch and expression change with transformations of the surface, transformations of the surface in knitting also possess the ability to change the measurements, the outer contours and the function of the material. Some knitting stitch techniques have the ability to transform the surface and the outer contour, i.e. they are shape-changing (Yang, Love, 2009). The shape-changing effect referred to here is an effect achieved without changing the number of stitches used (meaning no casting off or casting on other than in the beginning and at the end). As we are in the habit of dividing our comprehension of form in two-dimensional and three-dimensional forms and also in material and shape, the interrelation between surface and shape in knitting is complex and can be difficult to grasp during the first stages of the learning process, which is especially true as one is about to incorporate this potential in one’s own design work.

The construction system used in knitting is built around a continuous length of yarn and the ability to control each stitch individually, which is similar to the function of a Jacquard loom (Spencer, 2001). (Illustration) The basic stitch in knitting is the plain/purl stitch, which is often referred to as two different stitches although it is in fact the front and back side of the same kind of stitch. One side of the stitch appears to be more flat (plain) and the other more knobbly (purl). A plain knit surface will appear flat and curls horizontally towards the plain (right) side and vertically towards the purl (back) side. A purl stitch surface curls horizontally towards the back and vertically towards the front. This curling effect is caused by the way the stitches hook into each other (Spencer, 2001) within the stitch itself, why it is sometimes possible to flatten the knitted material by steaming or to use the curling as a design parameter. When applying both plain and purl stitches on the same side, the effect/function may become shape-changing. Depending on the amount and distribution of each stitch type, the effect can vary from negligible to vast. Another radical change in shape is possible to achieve by using partial knitting. This change of shape is not caused by changes in the stitches: its logic is instead based on the idea of inserting extra stitches within the “working area”, between the full rows. Yet another form of shape-changing effect is achieved through tubular knitting. As it is not based on stitch change, tubular knitting builds on the construction of an endless, serpentine–like row going from front bed to back bed, never changing direction. It creates a cavity inside the structure and although the width is double that which is seen when flattening the piece, it is not possible to flatten out the hole as it would no longer be a tube then. A tube can be split into several tubes, knitted next to one another, unconnected with one another (Tellier-Loumagne, 2005) (Sissons, 2010). When using any of these techniques (logics), a transformation of the surface appears.

To be able to perceive that transformation, it is necessary to define a normal form. After establishing the normal form, the definers of the normal form have to be determined.

The invariants in focus here is the definers of normal forms.

The experiment

The aim was to:
- explore another way of form-thinking by letting surface transformations define the form.

Made through:
- a series of knitted samples and knitted sketches.
To explore the transformation of a surface, a normal form has to be established. In knitting, the plain stitch is the basic stitch type. The description of every other stitch type is based on how the stitch differs from a plain stitch. In this experiment, a surface comprising solely of plain stitches will represent the normal form from which transformations of the surface is explored. The definers of the normal forms, the invariants, are the number of stitches (needles) and the number of rows. For this experiment, it was decided that the work would be guided by these invariants and that the shape-changing stitch techniques described in the previous section would be used.

When designing a knitted pattern a technical drawing can be made. (show illustration) The different symbols represent different kinds of stitches. Vertical lines symbolize plain stitches (the normal form), horizontal lines symbolize purl stitches, etc. In whatever way the design of the pattern is made (in the technical drawing), the outer contour of the drawing is still the same. However, this was not the case with the tangible knitted sample.

Tools, formula, action
The following pre-set rules direct the experiment and show the interrelation between surface and shape, through transformations of normal forms:

• Knitting machine gg 5.5
• 60 needles (stitches) x 80 rows
• Yarns: wool, bamboo, cotton, polyester, polyacrylic
• All constructions start by casting on 60 needles and end by casting off all needles after 80 full rows (the transformations are implemented within this frame/setting.)

Three different stitch techniques were used within the pre-set rules:
1. Start the action by casting on 60 needles. Within the area of 60 needles x 80 rows, alternate between knitting plain and purl stitches. Use any amount of each stitch type and in any order. Cast off all 60 needles.
2. Start the action by casting on 60 needles. Within the area of 60 needles x 80 full rows, insert extra stitches: parts of rows, knit any amounts of stitches in any order. Cast off all 60 needles.
3. Make a tubular by casting on 60 needles on each needle bed. Within the area of the 60 needles on each bed and 80 rows, knit any amount of tubulars, changing from one number of tubulars into another number at any time. After 80 rows, cast off all 120 needles without closing the tubular.
The samples on the previous page state the logic and potential of the shape-changing effect and describe the foundation of working with definers of normal forms as invariants at an elementary level.

Another experiment was carried out in a more free way, guided by this invariant as form-thinking. No exact numbers of needles or rows were set. Stating how it could look when applying the transforming of normal forms as explorative design method. The close link that exists between making and form is obvious to the maker.

Knitting machine: gg5,5
Yarn: wool
Size: roughly the amount needed to fit a half scale draping stand
Fig. 47. (Top) Exploring somethingness: shorter row knitting, applied sample 1
Fig. 48. (Bottom) Exploring somethingness: shorter row knitting, applied sample 2
Fig. 49. (Top) Exploring somethingness: shorter row knitting, applied sample 3
Fig. 50. (Bottom) Exploring somethingness: shorter row knitting, applied sample 4
DESIGN EXPERIMENTS

Fig. 51. (Top) Exploring somethingness: tubular knitting, applied sample 1
Fig. 52. (Bottom) Exploring somethingness: tubular knitting, applied sample 2
DESIGN EXPERIMENTS

Fig. 53. (Top) Exploring somethingness: tubular knitting, applied sample 3
Fig. 54. (Bottom) Exploring somethingness: tubular knitting, applied sample 4
EXPLORING INWARD/INSIDE-OUTSIDE: KNOTS

After having explored the notion of form through the aspects of nothingness and somethingness, focus was turned towards the inside of the form and specifically towards the possibility of merging the inside and the outside.

A constructed garment usually has a right side and a wrong side (if it is not a reversible garment). It is usually possible to turn clothing inside out and the seams are either found on one side or hidden in the lining. Commonly, the inside of a garment is the backside of the outside, although this is not necessarily so. As pointed out in the experiment Exploring nothingness, a garment can be constituted of cylinders; either a single cylinder or several cylinders connected to one another in different ways. Usually the cylinders are external and grow out of another cylinder with one end open (as in recognizable/traditional arms). What happens if the cylinder were to be internal instead? With one or more internal cylinders, the ability to turn the entire shape inside out is drastically reduced. It may still be possible, but the result will in no way resemble what the shape looked like before. An internal cylinder is a cavernous tube leading through the space inside a form. Both ends of the cylinder are connected to the other form/another cylinder. The inside of the internal cylinder connects with the outside of the other cylinder. Internal cylinders blur the borders between inside and outside.

A seamless knitted garment (Wholegarment®) has no seams. However, it is still possible to define the right and wrong side of the garment and turn it inside out. When casting off after knitting a tubular shape, it is possible to connect the circular opening at the bottom with the circular opening at the top in a seamless connection when casting off, making it a knot. In mathematical terms, a knot is a thread or a cylinder where the ends are connected with each other. Before the ends are connected, the cylinder/thread can be twisted in different ways. A knot is impossible to unknot or turn inside out.

These conditions, the interest in merging the inside with the outside, and the potential of the knot in form-thinking were the starting points for this experiment.

The invariant in focus here is the knot.

The experiment

The aim was to:
- explore another way of form-thinking by allowing knots to define the form of the garment.

Made through:
- a series of knitted, half scale, garment-like items.

The material chosen for this experiment was monofilament yarn. The reason for this choice was its properties: it is almost see-through (making it possible to see the internal cylinders) and also a lightweight, stiff material (as it does not drape, it allows the cavities to be shown clearly).

The set-up was to use the concept of no inward - no exterior (and the possibility of merging them) as a form concept when making knitted pieces for a body. Make knots. It was decided to work in half scale in this experiment. Cylinders, some with openings along the sides and connected to themselves, constituted the technique used in this experiment so as to get another view on the notion of form.

Tools, formula, action

The following pre-set rules direct and explain the experiment and define the form of the garments:

- Knitting machine gg 5.5
- Yarns: monofilament
- Tubular knitting
- Plain stitches
- Size: enough to fit a half scale draping stand.
- For this particular setting, the colour used was transparent white.
The main rule for the knots is that none of the ends of the tubes is to be left open or to be completely closed. They all have to be connected to another opening. Before connecting the openings, the tubes may be twisted (or not). The connection of openings can be done already in the knitting machine or afterwards, using a needle. Openings made in the form of slits (lengthwise openings in the sides of a tube) do not have to, but may be, connected to other parts of the structure.

First of all, each knot was planned in simplified, two-dimensional sketches in order to arrange/plan/determine/appoint the connections of each ending. The sketches did not visualize the possible look of the end result dressed on a body. If only concentrating on the method, i.e. the form-thinking (here: the knot), fewer preconceptions and visual examples will affect the making process, which allows for a greater concentration on exploring the possibilities in the making of the form. In the end, this may provide new expressions and gestalts.

Start the construction (action) by casting on a tubular with an open ending, i.e. not closed at the start. In this case, I followed the technical drawing/two-dimensional sketch when knitting. Alternate between tubular knitting, tubular knitting with split sides (knitting on both beds but with separate yarn systems), and tubular knitting split in one side (alternate between turning on the back bed and the front bed). When connecting the bottom opening with the top opening, lift up the start (the cast-on tube) through the knitted tubular, i.e. through itself, hang up all stitches on the needles in use and cast them off together. If done on a machine, one end (circular opening) is lifted up and hooked onto the needles on top of the stitches already in the needles. Then, the two stitches on each needle are cast off together.

Fig. 15. (Opposite) Exploring inward/inside-outside: knot nr 1
DESIGN EXPERIMENTS

Fig. 56. Exploring inward/inside-outside: working sketch of knot nr 1

Fig. 57. Exploring inward/inside-outside: description of knot nr 1

A. Yarn carrier movements

B. C. Final knot
DESIGN EXPERIMENTS

Fig. 58. Exploring inward/inside-outside: knot nr 1

Fig. 59. Exploring inward/inside-outside: knot nr 1
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Fig. 60. Exploring inward/inside-outside: knot nr 1

Fig. 61. Exploring inward/inside-outside: knot nr 1
DESIGN EXPERIMENTS

A. Yarn carrier movements

B. C. Final knot

Fig. 62. Exploring inward/inside-outside: working sketch of knot nr 2

Fig. 63. Exploring inward/inside-outside: description of knot nr 2
DESIGN EXPERIMENTS

Fig. 64. Exploring inward/inside-outside: knot nr 2
DESIGN EXPERIMENTS

Fig. 65. Exploring inward/inside-outside: knot nr 2

Fig. 66. Exploring inward/inside-outside: knot nr 2
DESIGN EXPERIMENTS

A. Yarn carrier movements

B. C. Final knot

Fig. 67. Exploring inward/inside-outside: working sketch of knot nr 3

Fig. 68. Exploring inward/inside-outside: description of knot nr 3
DESIGN EXPERIMENTS

Fig. 69. Exploring inward/inside-outside: knot nr 3
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Fig. 70. Exploring inward/inside-outside: knot nr 3
Literature, innovations and research referred to in the background chapter showed that there is a knowledge gap regarding the exploration of form and knitwear in a design direction with expression as its main focus. Would it be relevant for the field of fashion design to explore this design direction? New expressions form one of the fundaments of the fashion system: the driving force behind the need to create, behind the fashion industry, behind innovation, behind the possibility to have a collection elevated as “original”. Newness can be mentioned as a possible interpretation of fashion. How then do we achieve new expressions?

One way of opening up for the possibility of newness is to re-think habitual ideas and methods. In research regarding newness in expressions, the predominant tendency has been to place focus on the use of new technology, i.e. techniques, machinery and software and little effort has been spent exploring the design process and questioning ingrained ideas. This is where explorations of alternative ways of form-thinking become relevant.

The findings presented in this thesis can be looked upon as a complement to other research, findings which are possible to use in other research endeavours together with explorations of new technology.

This licentiate thesis identifies and considers two viewpoints on the notion of form: it is either what we see or how we create. The ideas developed here serves as the foundation of an alternative approach to the notion form in the design process and they are based on the viewpoint that form is how we create.

The importance of connecting the act of making to the notion of form have been noticed also by other researchers. For example, at the Industrial Design program at the School of Architecture + Design, Virginia Polytechnic Institute and State University, USA, the connection between the notion of form and the act of making has been identified as crucial to the students’ understanding of three-dimensional designing and this development resulted in a transformation of the education. Because the School was founded by a former Bauhaus student, voices were raised in favour of returning to the initial Bauhaus philosophy. All workshops were connected via a hub, both two-dimensional and three-dimensional labs.
DISCUSSION

The students were given the task of exploring a certain notion of form through as many different media as possible and then go on to explore the next notion of form in the same way and so on. The tutors developed a form-matrix for the students to follow as a form of instructional material. The matrix states notions of forms such as a need for more knowledge about form, the need to be able to connect one’s understanding and development of form to its making and “to push forward a language of form that addresses the qualitative nature of form-giving” (Vernon, Sharma, Sullivan, 2011). As a consequence of this connection between notion and making, the result of the students’ “own” design work have become much more convincing than before (M. Vernon at the Making-conference, Telemarken University, Notodden, Norway, September, 2012).

Methodologically, the research presented in this thesis has used design experiments both to explore and to find ideas and theories. The main theoretical contribution put forward is the use of invariants as an approach to form-thinking. Using invariants in the design process provides an alternative way of form-thinking that results in a strengthened connection between form, material and making, i.e. the key core of knitwear design. This could lead to an expanded notion of form, develop the design process for knitwear, and open up possibilities to arrive at new shapes and techniques.

Invariants in the design process for knitwear are not to be seen as replacements for geometric shapes. The use of invariants is a working method in which the designer has to consider all aspects of the specific situation, i.e. technique/manner, material, function, planned exploration, in order to pinpoint an adequate invariant for the particular design at hand.

Let us assume that we think of the invariants as the form of the garment. What does that mean? What would it lead to? What would it mean to the notion of form and to the design process for knitwear if this kind of form-thinking were to be implemented? What relevance would it have to the field of design? How would it affect the notion of form? What possible effects would it have on educations in fashion design?

In the elaborate design experiments, three different invariants are in focus. The holes and the knots define the logic of the garments, as well as the design experiment itself, and both are clearly properties that remain invariant under non-destructive transformations of the garments. The shape-changing effect in knitting comes through in the experiment on definers of normal forms. The effect itself is of course known in the field of knitting, although it is not as widely used as a way of understanding the interconnection between two-dimensional and three-dimensional knitting. It could be both a good educational tool and a method for use in the early stages of the design process.

If this way of form-thinking were to be implemented, it could lead to a better understanding of the relationship between form, making and material, which in turn would lead to a new understanding of techniques and which forms are potentially useful when utilising a particular technique. The relevance of the research conducted in this thesis to the field of fashion design lies both in the connection between new alternative working methods and in that the methods as such provide possibilities to create new expressions and shapes and thus serve to satisfy a fundamental ambition inherent in the field of fashion. In educational settings, knitwear is a complex subject matter as it deals with both two-dimensional and three-dimensional aspects and perspectives in the same process. Although this is often observed in educational literature on knitwear, it provides little discussion and few explanations. Opening up for alternative ways of form-thinking is one way of addressing these issues.

An important question related to form-thinking revolves around the notion of “what it looks like”. Does it not matter what things look like? Is it true that anything goes? Start with nothing and end with something, whatever it is? Then it is not relevant to fashion! The “looks”, i.e. the expressions, of things are of course a very basic issue or perhaps even the fundamental one.

However, the question “what does it look like?” is complex and needs to be problematized. If the question refers to what a garment looks like on a model, on a hanger or on me, the answer cannot help but be highly
DISCUSSION

Relational/comparative. However, the question “what it looks like” is exactly what is being examined in this thesis, as referring back to the notion of form as being how something is made is also a description of what something looks like. What does it look like? – Nice, loose-fitting, sexy. Most people will find these answers uncontroversial. – It has four holes. This description is as adequate as the first one, although much less used. Or perhaps even more adequate? The latter answer describes the properties the garment possesses precisely. In an explorative design process, the first answer is not considered very relevant. The latter answer, on the other hand, opens up possibilities to examine the on-going exploration and determine how things can be further developed. On the way towards completion of the design examples, many decisions have been taken based on aesthetics.

The research presented in this thesis deals with the act of creation as a comprehension of the notion of aesthetics, although this notion is often mistaken for the experience of the completed object.

The conclusions drawn in this thesis can thus be summarized by the following questions:

• What would it lead to if:
  …form is a notion not connected to specific shapes…
  …making is central to the notion of form…
  …the question “does it look good?” can be answered according to the logic of the garment…

– The symbiotic relationship between form and material in the process of knitwear is usually not problematized in pedagogical literature regarding knitwear.
– More possibilities for creating unknown shapes – highly relevant for fashion design, as creating new shapes and garment types is a genuine ambition in the field of fashion.
– If making is central, the logic of the garment is central.
– More possible working methods for knitwear.
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