ADAMANT TEXTILE

THE RECIPROCAL IMPACT OF CONCRETE AND TEXTILE

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ABSTRACT

The primary goal of this study is to investigate the combination of concrete merged with textiles. Furthermore, it investigates exchanging the characteristics of these contrasting materials. Consequently, the work shows the reciprocal influence of both textile and concrete to each other. The resulting final collection presents six pieces with the main intention to present different expressions of flexibility. These appear through the interaction of textile and concrete, with the textile providing the flexibility. Depending on the precise characteristics of the used textiles, the flexibility can be shown through the tension in a fabric, the ability to be squeezed or the movement. A subsequently range of experiments investigate techniques, methods and material qualities to prove, that the required effects of the end result can be fulfilled. The crucial factors are the textile materials, the connection between concrete and textile and the treatment of the resulting surface or object. Depending in which way the crucial components are fused, a variety of expressions in the results can be accomplished. These can be described as rather organic through to geometric, and also depends whether the piece is in motion. The outcomes provide an overview of design possibilities, of incorporating such contrasting materials to create different properties and unexpected characteristics in each piece. Based on the final results, it can be concluded that the major objective, to explore design possibilities through a reciprocal interaction of textile and concrete, gives a strong and impressive expression. The approach of this relatively broad research is nevertheless important for the textile field. Therefore, it suggests further exploration, using the results as a foundation and narrowing it down by focusing on specific factors.

KEYWORDS

textile design, material mix, concrete, conjunction, contrast, characteristic exchange, flexibility, movement
1. INTRODUCTION

The work Adamant Textile addresses the field of textile design, however it deals with a, for this field, unusual material combination: concrete and textile. In the title ‘adamant’ describes an utterly unyielding substance, in this case with reference to the concrete, whereas ‘textile’ is defined as any cloth produced by weaving, knitting or felting and therefore imagined as a soft and flexible material.

In general concrete is conceived as a cold, hard and acromatic substance with an even surface, whereas on the contrary textile is mostly experienced as a warm and organic material with a smooth and soft surface. Textile together with concrete is more common in architecture, when the textile either provides a mould or a reinforcement for the concrete. In turn, Adamant Textile has its focus on the actual fusion of these contrasting materials. The project explores unexpected properties within the material combination through an exchange of the materials characteristics. As an example of a newly created property flexibility can be listed, which is unexpected in this context, since it contrasts with the concrete. By blending textile and concrete together in either a surface or an object, it firstly demonstrates how the textile can be influenced by the concrete and secondly how the role of the textile can alter the behaviour of the concrete. During the process as well as in the outcomes movement became an important part and is given through the flexibility.

1.1 Concrete in general

Concrete is a well-known building material, which also has applications in design fields. For most concretes Portland cement is the main ingredient, a material processed and mined to give concrete its unique properties. When it is mixed with water, a chemical reaction is released and provides after drying a hard, rocklike material. In order to withstand various conditions, for instance high heat, concrete can be formulated with other substances such as sand, gravel, fly ash or slag cement. These added matters can also create different finishes, strengths or colours. Through its liquid consistency, concrete can take any shape by pouring it into a mould. As well as being mouldable, it is not just therefore an attractive material, because of its strength, permanence, weather-resistance, low cost and plasticity (Alesina, Lupton, 2010).

1.2 History of concrete

Already thousands of years ago the Egyptians used early forms of concrete to build the nowadays famous pyramids. They mixed mud and straw to form bricks and used gypsum and lime to produce mortar (Pepin, 2017). Even though the ancient Romans developed the material further, it was still not the same as the modern concrete. However, they achieved a remarkably close mixture, often blend with animal products as admixtures. With this created cement the Romans built many of the still existing architectural marvels of that time. Two outstanding examples are firstly the Pantheon, known for the dome with its unique opening in the middle and secondly the Colosseum, which is the largest amphitheatre ever built (Concrete Network, n. d.).

By experimenting in his kitchen, Joseph Aspdin (Concrete History Timeline, n. d.) explored in 1824 the first hydraulic cement, one that hardens by the addition of water. With this invention of Portland cement, Aspdin provided the foundation for the modern concrete industry. The first large application and engineering use of this contemporary Portland cement, was in a tunnel under the Thames River in 1828. From then on an increased application of concrete could have been noticed. It was used from single architectural sensations to common uses as pavement surface or mass-building material. The grey hard substance is still in a constant development, for example regarding reinforcement through fibres or decoration through different colours, textures or finishings. The development within the decoration aspect leads to the design and art field and opens up a variety of unexplored trails. These can be realized by experimenting with concrete itself, but also in combination with other materials.
1.3 Concrete in design and art

Concrete is a material which inspires plenty of designers and researchers and became therefore established in the design and art field. Even though it might be an exceptional material in textile design, there are other fields where concrete is an common and often used material. For instance architecture field, where concrete commonly as a strong and shapeable material. Concrete can be used for more than jus construction, it can also find smaller implementation, such as in interior or product design. Furthermore, it does not just provide stability, durability and formability, but has also visual qualities that designers who work with the raw material can take advantage of. One example is the appearance of cracks in the concrete surface. This occurrence can happen through an accident or on purpose, whereby it can either be part of the design or be involved in the design. “Kintsugi” is a Japanese tradition, which deals with this exact issue. This cultural accomplishment turns the breakage and the consequent repair of an object into an important part of its history. This even includes to not just glue two pieces back together, but rather make the meeting edges, which leave a crack mark on the object, visible. By colouring the joints, in typically gold or silver, it makes the piece even more beautiful than it was before (Harvey, 2016).

When designer or artists work with concrete or similar solid materials, one can often find textiles in the process. Therefore, the textile can be called a tool, which means it is removed after it has fulfilled its purpose and thus is not part of the result. After all concrete is a formable material, which can take any shape one gives it and can therefore be easily moulded. By using textile to build a mould, one can give the end result a soft looking shape or surface by reproducing the textile folds out of concrete. Also the texture of the textile can be transferred onto the concrete surface by using a textile with a deep structure or different qualities on the surface.

In 2009 the fabric-cast facades of the Hanil Company Visitors Centre (West, 2017) were realized by using textiles to build the needed moulds. Those show an example of open trough moulds used for pre-cast wall construction. Linear impactors were placed underneath long straight open troughs and covered with a big sheet of fabric. By pouring concrete in these prepared moulds, deeply creased concave lines will be visible in the façade panels. By making the open troughs wider and narrower, different sizes of folds will appear in the outcomes. The finished facade gives the impression of a huge fabric curtain, which is snatched up more or less in different parts.

Also Grey Concrete (Jones, 2010) uses the moulding technique to produce the iconic Chesterfield Sofa entirely out of concrete. Instead of building the mould out of textiles Grey Concrete uses the already existing sofas and takes a mould from them. As a next step the emerged mould is filled with concrete. After drying the mould can be removed in order to make the detailed copy of the sofa visible. “It even comes with a 50p concrete coin stuck down the back of its cushions.” Jones explained in 2010. The concrete is able to reproduce every little feature given by the fabric and shows therefore a remarkable similar and soft looking copy of the original sofa.

In the two previously mentioned examples the textile is not visible in the end, because it is actually not existing in the result. In the work Fabríc of Miriam Estévez (2015) the textile is included in the pieces from the beginning until the end. This is because she uses Concrete Canvas, which is a spacer fabric filled with concrete powder. Therefore, it is flexible, bendable and thus shape able as long as it is dry. She uses the properties of this special concrete fabric to shape sitting accommodations. When she forms the wanted shape she fixes certain parts by sewing them together. The next step is to dip the whole piece into a water drum, so the concrete becomes saturated with water and can dry afterwards. The expression of the final outcome is soft and seems therefore unstable, although it is hard and stable enough to sit on it. Even though the textile is still included, it is not visible in the result.

As mentioned before concrete in combination with textiles is a popular material mix for designer and artists. Although textiles have often a subordinate role in the end result, it can serve as a decorative part. Bethany Walker (2016) creates surfaces, where textile is not used as a tool in the process, but incorporated in a decorative way into the outcome. To get individual results, she brings handwoven textiles together with hand cast concrete to create unique compositions. She developed her own hand techniques, which as she says: “...is a bit of a messy process but that makes it all the more interesting (Walker, 2016).” Each piece is individual and shows captivating expressions and presents immense tactile qualities through the interaction of the integral shape, colour and relief.

The Tactility Factory (2013) produces wallpapers in which the textile is also still visible and therefore provides decoration. Compared to the previously described work of Bethany Walker the textiles in this case have an additional purpose. This becomes clear by having a look into the process. The designers at Tactility Factory print their designs with concrete on the fabrics. That means that the textile serves also a base for the printing process. In the result the fabric is partly visible and partly covered with concrete. This fusion between these conflicting materials includes comparisons such as hard and soft and stable and flexible. These aspects influence the visual expression as well as the tactility, which makes the surface even more impressive.

An increase of the importance of the textile role within the combination with concrete appears by letting the two materials depend on each other. Memux (2010) shows an actual incorporation between concrete and textile in their work Concrete Curtain. In this piece the used textile mesh works as a flexible carrier for several soft looking concrete elements. These were placed with a small distance in between next to each other, which means the textile is still visible in the outcome. Compared to the earlier mentioned examples the textile in the Concrete Curtain gives the function of flexibility and makes the entire piece moveable. That means that the textile is needed during the process in order to be able to apply the concrete and also needed in the end result to make the piece flexible. It shows therefore a great dependence of the materials with an additional characteristic exchange.

Elisa Strozyk (2010) works with an unusual material combination consisting of a hard and soft material. By deconstructing wood veneer and apply it next onto a textile surface, she creates Wooden-Textiles with an unexpected expression and behaviour. By combining flat geometrical forms of wood with the flexible textile underneath, a transformation from a two-dimensional surface to a three-dimensional object is given by moving the pieces. By doing so Strozyk’s work can be shaped in varied ways and provide therefore unexpected expressions, even though the wooden surface itself looks familiar. The capability of movement within her work is provided through the textile characteristics and points out how important its influence is.
2. MOTIVE

By looking into the field of interest, the combination or more precisely the fusion of concrete and textile, one may recognise a lack of further exploration. In most projects, textile has been used during the process as a tool, rather than being a part in the end results. Even though there are some designers and artists who fuse these conflicting materials into one object, the further exploration which could lead to a purpose or function of the textile or even make the materials influence each other, are missing. This brings up the following questions:

- What is already existing within the area of interest?
- Is there something already done, that can be improved or developed further?
- Is there a different perspective to look at this material combination?
- What if textiles and concrete work together or even depend on each other?

Through these reflections the idea to turn textile into something unseen and unexpected, by combining it with concrete, was developed. Consequently the focus is on the incorporation between these contrasting materials by taking them out of the fields they are usually applied. There are certainly varied ways how to implement such a material combination, especially in terms of the textile design field.

As explained in the example of the façade of the *Hanil Company Visitors Centre* (West, 2017) produced in 2009, textile served as a mould to imitate the soft expression of a snatched-up curtain. By casting the concrete in fabric moulds, impressive objects or surfaces can be achieved through giving the hard concrete a contrasting soft look. As also described earlier, the *Chesterfield Sofa* (Grey Concrete, 2010), which is produced similarly, shows a detailed ‘textile’ surface through mimicking the structure of the textile perfectly. Even though the textile is just used during the process, it is still able to share two major expressions. Those are visible on the concrete’s surface through the texture and soft looking shape of the textile. Considering textile not just as a tool, but as a material with valuable properties, it seems to be a pity to only use the apparent and visible characteristics. *Adamant Textile* looks for a fusion of concrete and textile and consequently attaching equal importance to the two elements.

Maria Estévez created seat accommodation by using Concrete Canvas. Even though, the textile is still included in the results of her work *Fabric* (2015), it is not visible. On the one hand she creates a fusion of concrete and textile, but on the other hand the textile is again only used to hold, in this case, the dry concrete in place. Otherwise the textile has no further influence and has in fact no purpose in the outcome. Instead of using the textile exclusively during the process, Maria Estévez incorporates it in her work. However, the dependence of concrete and textile from each other and the use of design properties of both materials are still missing.

By contrast Bethany Walker (2016) uses hand crafted weaves as decorative part in her work. Even though, the textile is involved in the process and in the result, it serves neither as a mould nor as a supporting structure, but is visually presented in the same amount as the concrete. Compared to the earlier mentioned works, the artist brings in the design properties of the textile, but skips at the same time any function which could be provided by textiles.

The *Tactility Factory* (2013) brings the decorative as well as the functional part of the textiles together in their pieces. By printing the concrete onto fabrics, the textile serves as a base, where the concrete can stick on and is therefore kept in place. Additionally, the textile underlayer is visible through certain parts of the concrete pattern and fulfills therefore the decorative part. Even though in the work of Tactility Factory textiles and concrete are equally visible and need each other during the process as well as in the result, an influence between the contrasting materials and therefore a further development of the design possibilities are still missing.
The dependency, influence and thus fusion of textile and concrete among others investigated by *Adamant Textile* is unified in the *Concrete Curtain*. Memux (2010) shows within this piece one possibility how textile and concrete can work together by creating an impressive object including contrasts between expression and behaviour. While the piece expresses lightness, the weight and therefore the behaviour is ponderous nevertheless also flexible. This clash of the experienced contrasts creates a surprising moment by working against people’s expectations. The surprising effect is an individual’s psychological and emotional response, which one can find in plenty different areas (Smith, 2017). It can be cleverly used to support the expression of a piece, if the designer considers people’s expectations, while planning his or her work. The work of Memux presents a strong example of concrete merged with textile in which the materials are equally important. This becomes clear through the dependence and influence of both materials to each other, which create consequently unexpected expressions and an exchange of the materials characteristics. Even though the *Concrete Curtain* is an expressive object, further explorations regarding the use of textiles characteristics in different ways are still missing.

There is an enormous lack of subsequent investigations to exhaust the design possibilities by merging textile and concrete to achieve unexpected expressions in the outcome. While *Adamant Textile* deals with these factors, it has its focus on flexibility and investigates different ways how this can be presented. Additionally, this research introduces treatments implemented on the concrete surface to release flexibility within a piece if needed. These additional approaches extend the area of interest and provide new insights of an unusual material combination.

The inspiration for the treatment of the emerged concrete surface came from the artist Graziano Locatelli (2016). While he breaks already existing solid materials and put them back together to create a motif, *Adamant Textile* uses the treatment not only for decoration purposes but also to achieve desired requirements, for example to make a concrete surface shapeable.

The similarity within the *Concrete Curtain*, *Wooden-Textiles* and *Adamant Textile* is the capability of the piece to move. This is provided through the combination of a solid and a non-solid material. When it comes to textile and concrete, logically one would determine the concrete as the solid and textile as the non-solid material. However, in *Adamant Textile*, even though the textile contains flexibility, it serves the solid part and concrete on the other hand, even though it contains stability, is the malleable part.

The same principle can be observed in the work of Hilla Shamia (Ganea, n. d.). She works with wood and aluminium as her main materials. Even though aluminium is a hard and stable material, by heating it up it becomes liquid and malleable and consequently the non-solid material in Shamias work. Wood on the other hand can be processed more easily and can be defined as a soft material compared to aluminium, but serves in her work as the solid material anyway. In both cases the soft material becomes the solid element and the hard material the formable component, whereas the original characteristics are retained within the outcomes.

Although concrete is an already well-known, explored and developed material, which can find use in varied fields, the most common use occurs still in the construction field. By reading the previous section, one gets an insight how concrete is also used in other design fields. Those projects can be inspiring and motivating to develop the unusual material mix of textile and concrete even further by enhancing the approach within the own area of interest. When it comes to concrete in textile design, one can clearly see a lack of exploration and development. Therefore, *Adamant Textile* deals with establishing possible ways to merge such contrasting materials. Through this and a subsequent treatment of the emerged surfaces, one of the main objectives is to get an unforeseen expression in a visual way. Equally important is the exchange of the materials characteristics to create unexpected properties in the end result, which in turn effect tactility and movement of the piece. This strategy generates several different implementations, which create numerous outcomes and provide therefore a valuable addition to the textile design field.

*Fig. x. Close up of concrete surface (page 15).*
3. DESIGN PROGRAM

Looking into design research, establishing the design program through experimentation is needed to know what is possible. For Adamant Textile, previous design experiments were used to explore and formulate the program. The design program defines an area of development and exploration by setting goals, which the design should be able to attain, but leaving it open how this can be realized. Thus the design program creates the framework for the designer regarding what can be done and how can it be accomplished (Brandt and Binder, 2007).

The following chapter describes a series of experiments which were explored and developed within previous projects. These were needed to define the design program and formulate the base for the degree work discussed in this thesis.

3.1 Textile qualities

The choice of material specifies the textile quality needed for each piece, preconceiving the role of textile. Fabrics need to be tested regarding certain factors, such as flexibility, texture and stability. To be able to attach concrete in a strong way to textiles, the texture of the used fabric and the weight of the concrete needs to be considered in first place. Especially when it comes to movement one wants to be sure that even through the gravity the applied concrete stays in place. Furthermore, the used textile has to have a particular stability to serve as a carrier for the heavy material. In general, one can say the deeper or rougher the texture of the textile, the stronger is the connection, since the concrete needs structure to stick on. As next step it needs to be decided if and what kind of preparation or changes the textile needs in order to fulfill the requirements. The following questions are examples, which can help to analyse: Will the textile provide enough flexibility? Does the concrete stick to the chosen textile? Is the textile stable enough to hold the weight of the concrete? (Fig. 1-6)

![Fig. 1-6. Different textile qualities, providing enough structure for the concrete to stick on.](image-url)
3.2 Connection between textile and concrete

A connection describes a link between textile and concrete by only using these two materials and no additional joints. There are several possible techniques how to connect these contrasting materials, which have all in common that for this working step the concrete is wet. To name a few there is firstly dipping, which describes, as its name implies, the action of dipping the textile into the concrete. That can be done with any clothes, nevertheless suggests this technique the use of threads as a textile (Fig. 7-9). For the drying process the textile needs to be hung up.

Fig. 7-9. Results of connection 'dipping'.

Another way is to simply pour the wet and therefore liquid concrete on a textile. The concrete soaks into the textile as much as the fabric texture allows and dries in this position. Even though a strong connection is provided, the concrete gets an uneven and rough surface (Fig. 10-12). Furthermore, the materials can be joined as single pieces. That means a concrete surface alternates with a textile surface, which are only linked on the edges without having the other material on the back or front side. The last connection described in this paragraph is done by placing the fabric upside down on the wet concrete. This is similar to the second described method but can achieve a smooth and even surface by letting the concrete dry on the bottom (Fig. 15-17). By putting a weight on top of the textile while drying one can make sure that the connection is as strong as in the other examples.

Fig. 10-12. Technique pouring. Wet and dry concrete surface.

Fig. 13-14. Alternating concrete surfaces linking just on the edges.

Fig. 15-17. Producing concrete surface upside down to achieve even surface.

3.3 Role of textile

The textile provides firstly a base material for each piece and secondly a possible impact to the concrete. This impact of textile to concrete is visualized in form of flexibility, which is expressed in the pieces. It can either be shown through shapeability, the ability to be squeezed together or movement. In the work discussed in this paper, the flexibility occurs in three different motions: bending, shaping and moving. These movements emerge through a characteristic exchange and a consequently interaction of textile and concrete. Bending describes for instance a piece, which becomes physically malleable through the use of textile, in this case sponges (Fig. 18).

Fig. 18. Bending

Fig. 19. Shaping.

Fig. 20. Moving.
3.4 Treatment of the emerged surface

By treatment of the emerged surface is meant a manipulation through different possible techniques, done after the textile and the concrete are connected. The treatment can support either the motif or the flexibility or both at once. The possible techniques are firstly printing, in form of transfer or screen printing, secondly openings and thirdly hammering. Transfer printing as well as screen printing work as good on the concrete surface as it does on textiles. While screen printing on concrete can be done with the exact same procedure as on textiles (Fig. 21-22), for transfer printing a different solution was needed. Instead of transferring the motif with the heat press, lacquer was used (Fig. 23-24). For openings and hammering a template, given through the before developed motif, is needed. Openings describe literally openings in the concrete surface, seen as spots, which were not covered during the pouring process and allows therefore a glance on the textile underneath (Fig. 25-26). Through hammering along the contours of a motif, given by the template, cracks appear on the concrete surface (Fig. 27-28). Even though treatments could be applied on all pieces, in some does the manipulation fulfill a purpose, while for others it is not needed and therefore decoration.

3.5 Dyed concrete

Concrete powder usually comes in its typical grey colour. By adding water, the mixture gets firstly darker, whereas after the drying process it has a light grey shade. The inspiration to give concrete a different colour came from the screen and transfer printing, where colours were added onto the concrete surface. While through printing bright and popping colours were achieved, by dying the concrete the colour turns out rather dull. Therefore, strong contrasts and exciting colour combination are difficult to accomplish. However, the dyed concrete can be used to either visualize a motif or pattern or to support such, by combining it for example with transfer printing (Fig. 29-31).
3.6 Motif

When it comes to the motif it needs to be decided firstly, if a motif is really needed secondly, if it would support the piece and thirdly, how it could be transferred onto the either textile or concrete surface. Since the main focus in this work is not on the motif, but on the interaction of textile and concrete and their characteristic exchange, a need is not given in all pieces. It was decided that the motif is just involved in a piece, if it supports the requirement of the end result. Therefore, it is used as a template for treatment, such as opening and hammering, instead of a decorative image on the surface without any function or purpose.

In this project the motif is developed from photographs of faces through different manipulations either through Photoshop (Fig. 32-34) or through crafting. For the second option, images were printed out on paper and distorted either by cutting the printouts partly in stripes, cutting them entirely in stripes and weave them back together or folding them in different ways (Fig. 35-40). The outcomes of those manipulations can serve as templates for treatments of the concrete surface as explained earlier. It is noted that the face image was chosen based on the authors personal interest.

3.7 Choice of colour

Regarding the choice of colour firstly there is the need to decide, if either textile or concrete should come in colour. Since the concrete could be dyed, there is the possibility to let the colour appear in the concrete and use in turn a neutral colour for the textile. In this work the decision was made that the emphatic concrete colour should be kept in all pieces, since it cannot assume as popping colours as the fabrics. Consequently, it is decided to let the textile colour vary for each group. To create a great contrast to the common grey a bright colour range is used (Fig. 41-45). For the choice of colour for each piece, the desired final expression needs to be considered as well.

3.8 Union

The unity of the explained experiments outlines the design program and build the foundation of the degree work. The common objective of the experiments is the combination of textile and concrete within one surface or object. Therefore, a broad area of interest is provided, which allows the designer a free investigation to discover boundaries of the work. The framework combination of textile and concrete led to plenty of unexpected discoveries, which are valuable results, showing the expressive qualities of this unusual material mix.
4. AIM

The aim of Adamant Textile is to explore design possibilities of concrete merged with textiles in order to create unexpected expressions through an exchange of the materials characteristics.

5. METHOD

Methods are necessarily part of every design process. In general, they can be defined as an action a designer performs during the design process. Either traditional methods are used or individual ones are adapted to the circumstances of the process. Either way, one should choose a method, which clarifies what one does not know, but needs to know to be able to continue the progress. Inducted by professional designers, who refuse to use proceedings they were taught, several new methods are conceived to replace the traditional ones (Jones, 1992, p.3).

Experimental design research does not produce something finished but is rather an ongoing series of experimentations (Brandt, Binder, 2007). Design experiments, in form of sketches and prototypes, are supposed to provide an overview of the process loop. The experiments and insights affect each other and continued adjustments of experiments stabilize the research attempt (Krogh, Markussen and Bang, 2015).

The same principle was applied on the design process discussed in this thesis and is exemplified in the following figure.

Fig. 46. Loop structure of experimentation method.
Experimental research could be conducted in many ways including, for example, experimental work to open up new design spaces (Hallnäs, Redström, 2006, p.133).

In the work discussed in this thesis the author challenged the common understanding of textile design by introducing a for this field unusual, material. Therefore, alternative ways for incorporate such a material into the design process to create design possibilities were suggested. The boundaries of the textile design field were discovered by dealing with a new material combination, which invited the designer to think and work freely and move away from traditional textile design. The horizon was expanded through emerged results, which were again taken further, whereas such could completely loose the connection to textile design (Steffen, 2014). To avoid moving too far away from the field of interest, the unusual material combination had additionally to the concrete, the steady parameter textile.

The choice of materials in Adamant Textile was made considering crucial factors, such as the contrast in structure, texture and weight, which supported the behaviour and expression within a final piece. The realization of previous test series as well as final pieces were implemented through the method experimentation. To avoid unnecessary material waste and too heavy examples, experiments conducted before the end results were achieved through small scale models. The experimentation was important to accomplish interim findings, which presented the reciprocal impact of concrete merged with textile through flexibility. At the same time the test results created the base for the next working step or stage of development. These outcomes were progressed and formed into three groups of flexibility: bending, shaping and moving. All of them were presented in Adamant Textile. To visualize the three forms of flexibility within the final outcomes, textile was a crucial need in each of them. The ‘need’ of textile could be defined differently, depending on the implementation of a piece. By using textile as a mould, one could describe the use of textile as ‘needed’, however in a different way than if it would appear as decoration. In Adamant Textile the textile was defined as ‘needed’ if it provided a function or purpose within the result. Through evoking the required effect through flexibility in each piece, the textile fulfilled a function and was therefore indispensable.

Even though it is possible to reproduce outcomes emerged through this research, it was not the designer’s intention to do so. The research and its physical results should rather inspire the reader or observer to develop the idea or a part of it further (Hallnäs, 2010). Consequently, a research with a different focus could provide several opportunities within the field of interest. It could be narrowed down for a deep exploration of a smaller section since the project’s exploration field now was rather broad.

Fig. xx. Example of test series focused on dyed concrete (page 27).
6. PROCESS

The following pages describe the procedure of each piece. Starting with early related experiments, analysing and developing them further into plans and create the final piece are outlined.

The below presented illustration shows the crucial factors of the process regarding each piece. Through tracing the coloured path, one gets a clear idea about the relation between the significant factors within each piece.

![Diagram showing the process of each piece with factors like dipping, pouring, threads, 2D-3D, and final groups.]

6.1 Threads.I

As first experiments circular knits were tested in combination with the technique dipping. Since the edges of the knits were not fixed, the yarn came apart during the dipping process. As a consequence of this accident threads were hanging loosely from the cloth covered with concrete (Fig. 48). By analysing the trial after the drying, one could notice the fragility of the test. The concrete crumbled easily away because of its thin layering. At the same time the knit was shown very detailed. At the same time the knit was shown very detailed, including the rip binding, loops, mend ladders and loose threads, which provided interesting structures. The fragile expression was taken further in the next experiment. A messy bunch of threads were dipped from just one side into the wet concrete mix and hung up for drying. It was expected that the threads separate themselves automatically, which did not happen. The outcome showed partially the thread structure underneath the concrete, in some parts the concrete created a solid block and in few places the threads are recognizable as single ones (Fig. 49). The just described experiment was scaled up and dipped into the wet concrete mix in a not planned and uncontrolled way. In the result parts, covered the most with concrete, pull themselves out of the messy bunch since they were heavier than other parts. Therefore, the outcome showed an unregular object with a rather chaotic expression (Fig. 50). Through the, in this case, uncontrolled dipping from different sides, also single threads were covered with concrete and able to dry separately from others.
Because of this discovery of single threads covered with concrete instead of having a messy bunch of threads the following trial tested a regular bunch of threads. Furthermore, different thicknesses of threads were questioned to get a clearer idea how thin or thick the covering concrete layer could get (Fig. 51). Since the fragility was still a problem, the stability of the differently thick concrete layers in relation to the textile thread were investigated as well. The emerged threads with a middle-sized diameter (approximately 4mm including the concrete layer) seemed to be the most stable trials. First experiments with textile design techniques were done. Firstly, numerous of threads in different lengths were produced and woven afterwards. Primarily the tests were made on a traditional hand loom, where the concrete threads were used as the weft threads. By implementing the thread, the concrete touched the warp threads and made the concrete consequently crumbling away again. Throughout these tests it was not possible to produce one example where concrete was still existing in the outcome. A consequent experiment was to work with a weaving frame which allows the designer to be more flexible in producing the weave and therefore more careful with the concrete threads. In the results concrete was still sticking to the threads, however, it still crumbled away easily (Fig. 52-53). By touching or lifting the test more and more concrete fell off and therefore became an issue which needed to be solved.

The next experiment had its focus on the solution for the explored problem of the concrete crumbling away. The solution found was lacquer originally used for furniture. By dipping the entire thread into the can of varnish the concrete was coated with lacquer, which stopped the concrete from crumbling away. Consequently, a range of new possibilities regarding the use of the threads were provided. After repeating earlier tests to create different thicknesses of the concrete thread it was discovered that those can achieve a numerous variety from thin to thick (Fig. 54-56).

The textile technique weaving was now tested again and was able to show weaves with concrete weft threads. This time it was tried on a weaving frame, firstly because the designer could work more carefully on these compared to the hand looms (Fig. 57-58). The process did not show any difficulties, on contrary, while working with these unusual threads, it got clear that the fragility was completely gone and the threads became even bendable. With this knowledge the following experiments could be implemented on the hand looms. The outcomes could even provide deeper structures and patterns created by different bindings (Fig. 59-60).

The pattern visible in the woven examples gave the inspiration to have a deeper look into how a pattern could be achieved. Firstly, the pattern given through the binding on the hand loom was manipulated. Instead of using the concrete thread for the entire weft length, it was differently shortened and replaced with normal yarn. Thus, the pattern was recognizable on parts woven with concrete threads, but got distorted as soon as the normal yarn met the warp threads, since those visually melted together (Fig. 61). A further development of using the concrete threads just partly could be seen in the next experiment. In this case the weaving was done on a weaving frame to be able to decide the quality and colour of the warp threads.
This was crucial later in order to show the pattern in the weave together with the weft threads. The pattern was planned beforehand which meant that each thread needed to be covered with concrete in different parts to show the pattern after weaving them in a certain order (Fig. 62).

The focus in the following test series was on other traditional textile techniques to test firstly, a more extreme form of flexibility within the concrete threads and secondly, the possibility of achieving different expressions in the outcome. Therefore, hanging, knitting, knotting and crocheting were chosen. For the first example, which consisted of hanging threads, the overall shape of the object was defined beforehand. To achieve the desired form the concrete covered different parts in each thread. By hanging them in a before well-conceived order the shape, planned as the upper part of a diagonal divided cube, was presented in the outcome (Fig. 63). Since the threads were hanging with a specific distance in between each other the piece was received with a certain lightness and expressed airiness as well. The next test was done with entirely concrete coated threads in combination with the technique knitting. First trials were made with thin threads, while the following tests proved thicker threads to be more suitable. These were also used as double threads in knit (Fig. 64-65). The needed stitch size varies by the thickness of the threads. Although the knits were done with the same loop size within each example, it was hard to see a regular structure. The most obvious difference by analysing the tests were the different expressions, caused through the capability to see through. It was depending on the thickness of the thread. Compared to the knitting technique, knotting did not need as a high quantity of threads, which means the surface could expand quicker with the same amount of threads. Also, in this test a thread completely covered with concrete was used. As one can see in the images below, the technique knotting allowed to make a pattern visible and had therefore an even, regular and decorative expression (Fig. 66-67). For the last example, which tested crocheting, the technique of finger crocheting was used. Therefore, the outcome showed a tube out of concrete threads, interrupted two times by switching to normal textile yarn (Fig. 68). As the knitting technique, crocheting worked up a big amount of threads, especially if one compared it to the size of the outcome.

The next test series focused on the hanging threads by developing important factors further, to be able to define the final piece. Therefore, the thread quality was investigated, which can gather more or less concrete, depending on the thickness. By using a very thin thread quality, the yarn was just able to gather a small amount of concrete, which made the difference in the outcome almost invisible. To be able to use a thin textile thread anyway this issue needed to be solved. A thicker thread quality was attached on the thin thread exactly on the part where the concrete was applied later. In this way a suitable amount of concrete could have been applied and no restrictions regarding the decision of the thread quality were left. As next step, colours in the textile threads were tested and analysed in order to achieve a great contrast to the concrete appearance. For this it was also important to prove different distances in between the single threads, to get a more dense or airy expression (Fig. 69-70).
The next step was to dip the prepared threads into the wet concrete mix on the exact calculated parts. These were also marked through the wool threads, which were not visible anymore after the dipping since the concrete covered them entirely. For the drying they needed to be hung up, to have a regularly looking concrete surface all the way around. Both ends of the textile thread were reeled in to prevent them from entangling during the process. To avoid the falling-off of the meanwhile dried concrete lacquer was applied on such. Since it was not a continuous concrete thread, but interrupted through the textile yarn it could not be dipped as a whole into the lacquer. Instead the varnish was applied with a brush on the concrete with the result of a well-covered coating. Before the next process steps could be done the threads needed to dry again before they were finished (Fig. 74-76).

To hang the prepared threads in the right order with the correct distances in between two acrylic glass surfaces, one bottom and one top piece, were prepared with the laser cutter. Beginning with the top part, one thread after another was threaded through a hole and fixed with tape (Fig. 77). After one row was finished, the level of the hanging concrete part was evened out and the position was fixed by filling the holes in the top acrylic surface with glue (Fig. 78). After all threads were threaded the planned shape in form of a cube split diagonally in two halves was generated (Fig. 79).

For the first final thread piece, Threads.I, the hanging technique was chosen. The light expression of the trial stood in contrast to the usually heavy and clumpy conceived concrete and created therefore a certain excitement in the outcome. Furthermore, the idea of creating a before planned shape by firstly coating each thread differently and secondly hang them in a specific order, was implemented. The process started with deciding and planning crucial elements of the piece, such as colour of textile thread, size of the piece, thickness of the concrete thread, distance in between the single threads, shape of the appeared form, consequently in which parts each thread needs to be covered with concrete, hanging order of the threads, etc. After these important decisions were made the length of the textile threads were cut (Fig. 71). Since the used mercerised cotton threads were too thin to took on enough concrete, wool threads were used as an additional carrier for the concrete. Consequently, the wool threads needed to be cut in the exact length the concrete was going to cover later and were then glued onto the cotton threads (Fig. 72-73). Since the shape, which appeared through the concrete, described a cube split in two halves through a ‘slot’, each thread had two parts, which needed to be covered with concrete.

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To avoid the entangling also in the bottom part, the threading was repeated. Starting from the middle, each thread was stretched with the same tension to the bottom acrylic glass surface and temporarily fixed with tape. As before the holes in the acrylic glass surface were filled with glue as soon as one row was finished (Fig. 80-82).

As the last step, the tape on both acrylic glass surfaces was removed after the glue was completely dried. The final piece showed an arrangement of threads, creating a floating cube out of concrete, which was diagonally split in two. By moving the piece around, the slot appeared and disappeared depending on the placement of the observer (Fig. 83-85).
The impact of the textile within Threads I could be noted in two different ways. Firstly, there were the visible, thin, aqua-coloured cotton threads. Those were serving as the core of each thread and additionally gave the desired length of the piece. The effect of the textile yarn regarding the concrete was shown through the different appearances. The thin textile thread got more or less visible depending on the observers position and made the concrete cube almost look floating. This effect was also supported by the chosen aqua colour. The second impact of the textile was illustrated through the thickness of the concrete. An additional thicker textile thread was needed to be able to gather a thicker layer of concrete and made therefore the contrasting expression between textile and concrete threads clear.
6.2 Threads.II

For the second final thread piece, Threads.II, the previously discussed experiments were equally valid as for Threads.I. It was decided to create an additional thread piece to present the flexibility of the concrete threads in the outcome, since this was not shown in Threads.I. The desired accomplishment of this piece was to create a shape given through the natural behaviour of the concrete threads and their ability to bend. Thus, the straight hanging and stable looking bunch should transform partly into a see through and organic shape.

The process started with the consideration and decision of crucial factors like desired thickness of the concrete threads and consequently the needed thickness of the textile yarn, the colour of the textile thread, the amount of threads in the result needed to present the desired effect. Since this piece should show the bendability of the concrete threads the focus was not on the colour of the used textile. The expression of the textile yarn was supposed to be neutral. To achieve the desired expression a grey coloured yarn was chosen, which was closest to the concrete colour. Furthermore, it was decided to use a wool quality, because earlier tests proved it as a textile material that concrete stuck on well. The height of Threads.II was adjusted to the first thread piece, which meant the length of the piece is 250cm. As the next process step the threads were cut to the length of 300cm, while 50cm were calculated to knot the threads together (Fig. 87). Next, all cut threads were individually dipped into concrete in a variation of lengths and thicknesses. The longest covered parts were up to 200cm long, while the shortest were just up to about 60cm. As a consequence, the textile thread underneath was shown in the top part of each thread. To achieve two different thicknesses of concrete threads, the textile thread was either used as a single or double thread. The result showed various behaviours while bending. The double thread could gather more concrete and was therefore stiffer and more stable. After all concrete threads had dried, the concrete parts needed to be dipped in transparent lacquer to stop the concrete from crumbling away during bending. As soon as the lacquer had dried the concrete threads were finished and able to hang in a bunch and be bended.

To create a visual connection to Threads.I the bunch of produced threads were hanged from an acrylic glass platform. The before prepared surface included four holes to be able to hang the threads evenly spread out (Fig. 88). Another visual connection to the first thread piece was the colour choice for the hoop, which held the bunch together (Fig. 89). This was placed in approximately the middle of the piece and marked the position where the bunch should be lifted in order to create a shape through the bended threads. To hold this shape in place, needed for example in an exhibition, a monofilament thread was incorporated in the hoop. This could be connected and fixed to the before prepared hole in the middle of

Fig. 87. Threads knotted together.  Fig. 88. Template for acrylic glass platform.  Fig. 89. Hoop holding threads together.

the acrylic glass platform (Fig. 88). The transformation from the straight hanging bunch to a drop shape, appearing through the self supporting concrete threads, presented the flexibility of those, it stood in contrast to Threads.I, because of the concrete threads’ natural behaviour of bending (Fig. 90-95).

The outcome presented a bunch of concrete threads which visualized the created flexibility in each individual thread through bending. The textile thread, used as a core material, gathered concrete during the dipping process, which created the opposite expression at first: a rough, hard and stiff concrete thread. However, when it came to bending the concrete cracked, but was held together by the textile yarn at the same time. The textile threads shared their flexibility with the concrete which in turn was able to bend through the cracks. This interaction of the contrasting materials created self supporting threads, which were able to keep themselves up and not collapse.

Fig. 90-95. Transformation from straight hanging bunch to drop shape.

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Fig. 96. Detail of Thread.II (page 40-41).
6.3 Sponge

In first experiments, the interaction between the squeezable sponge and the stiff and hard concrete were tested. Therefore, a thick sponge surface was covered with a thinner layer of concrete (Fig. 97). As long as the concrete surface was a whole, the flexible underlayer was almost not noticeable. For this reason, the hard top layer was broken to achieve possible movement within the result. First the surface was firstly broken into a few bigger parts, providing the opportunity to push them down individually (Fig. 98). In the next steps the concrete layer was cracked more and more with the discovery of heightened movability (Fig. 99).

Fig. 97. Concrete layer on sponge.  Fig. 98. Individual concrete tiles able to be pushed down.  Fig. 99. Enhanced movability through higher number of cracks.

In the previously mentioned experiment flexibility was achieved through one layer of sponge combined with one layer of concrete. In the next tests the procedure of pouring concrete on a sponge surface was repeated to create a higher object with the ability to bend. Therefore, a form was built with the length and width of the sponge. By pouring the wet concrete mixture in the form and placing the sponge on top, the two layers connected and had the same size. Figure 100 and 101 show a slight bendability, but just a little. To enlarge the flexibility the concrete and sponge layers were made thinner and the total number of layers was increased (Fig. 102-103). Through the thinner concrete layer, the result was supposed to bend more, but the thinner sponge layer nullified this again as analysed afterwards.

Fig. 100-101. More layers of alternating concrete and sponge created bendability.  Fig. 102-103. Number of concrete and sponge layers were increased again.

For the following experiment it was decided to make the concrete and sponge layers the same thickness, narrow the width and length down but increase the height. The outcome showed a tower of alternating concrete and sponge layers, which, while standing straight, would not give the impression of flexibility. When moved, the piece presents a noticeably bendability (Fig. 104-106).

Fig. 104-106. High sponge-concrete tower, showing flexibility by moving it.

The next test investigated possible changes of the behaviour of the pieces by scaling previous examples up. The size of the first up-scaled test was largened in the width and length rather than in the height (Fig. 107). Regarding to the size also the thickness of the concrete and sponge layers were increased. The result provided a stable and self-standing object, which was able to bend even though only in small extent (Fig. 108).

Fig. 107. Scaling up in width and length.  Fig. 108. Bending in small extent.

Another trial was scaled up in its height, while keeping the approximate size from the very first experiments. Therefore, more bendability was accomplished, which provided the possibility to create shapes out of the long and flexible piece (Fig. 109-110).

Fig. 109-110. Another trial was scaled up in its height, while keeping the approximate size from the very first experiments. Therefore, more bendability was accomplished, which provided the possibility to create shapes out of the long and flexible piece.
To achieve the greatest flexibility the final sponge piece was a rather narrow but high object. Furthermore, the thickness of the sponge layer was double as thick as the concrete layer to decrease the weight and enlarge the bendability within this piece.

The process started by cutting the sponges in its desired size (Fig. 111-112). To achieve the same size in the concrete layer and therefore an even outcome, forms were built with the exact measurements (Fig. 113). Firstly, there were produced several shorter pieces, which were put together in the final working step. For this reason, each single segment had to start and end with a sponge layer, since these could be connected by a concrete layer to join two individual prepared pieces. After putting a sponge into the form concrete was poured on and the next sponge was added on top of the wet concrete mix. Thereby it was important to gently press the sponge into the concrete to accomplish a strong connection between the two materials (Fig. 114-116). After the prepared segments had dried the next step was to put them together in order to accomplish the total length of the piece. Therefore, the moulds itself were relocated to the top of each segment, where the conjunction needed to be implemented. To be able to complete the height of the piece vertically, which helped to get a certain pressure on the linking part, putting the segments together with the sponge ends, was repeated until all single parts created the entire piece (Fig. 117-119). After drying and removing all forms the final result presented a long, flexible and bendable piece (Fig. 120-122).

The sponge as textile in this piece could be squeezed together and gave therefore the opportunity of bending the piece in all directions. The concrete influenced the behaviour of the movement within Sponge through its weight.

Fig. 110-111. Scaled up piece showing notably flexibility.

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Fig. 114-116. Process of putting sponge and concrete layers together.

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The sponge as textile in this piece could be squeezed together and gave therefore the opportunity of bending the piece in all directions. The concrete influenced the behaviour of the movement within Sponge through its weight.

Fig. 123. Sponge piece of final collection.
6.4 Ribbon

For the experimentations for the ribbon piece it was crucial to use firstly elastic ribbons and secondly ribbons with a textured surface. For the first test an elastic ribbon was stretched as much as possible and fixed in this position. Next, an even concrete layer was added only on the front side and let dry. Through the texture on the ribbon surface the concrete was able to stick on it. To release the tension of the stretched elastic ribbon, the concrete was broken. Consequently, the ribbon contracted itself and shaped the concrete in an organic way (Fig. 124). The application of the concrete just on one side caused a spiral-shaped line by lifting the ribbon up (Fig. 125). When the concrete was applied on both sides equally, the shape was notably changed. Instead of the before achieved spiral shape, the outcome of the alternating concrete application presented a rather wavy shape (Fig. 126).

The next test focused not just on which side the concrete should be applied on but also the size respectively length of the concrete surface and the consequently influence of those factors on the behaviour of the outcome. In this experiment the concrete was applied on both sides of the elastic ribbon (Fig. 127). In this way it was explored how big the wave shape could be and how stable it was. Additionally, the length of each applied concrete area differed, since in that way smaller and bigger shapes could be accomplished in the result. Depending on the amount of appeared cracks and the size of the broken concrete pieces more or less flexibility could be achieved (Fig. 128). Through draping the emerged concrete strap, three-dimensional objects could be created, whereby the concrete was even able to hold itself up (Fig. 129).

In the following examples it was tested if the ribbon was in fact necessary or if it could be replaced with a stretchy fabric in order to fulfill the required effect in the result. Therefore, an elastic textile was stretched as much as possible and fixed in this position. The concrete, applied in form of small rectangular surfaces, was regularly spread out on the face side of the textile (Fig. 130). Next the fabric was loosened, and the breaking of the concrete surfaces followed. The result showed the same effect as in the ribbon experiment described previously. Through the released tension of the fabric the concrete was shaped into a three-dimensional organic form (Fig. 131-132). By hanging the piece, it started automatically creating a spiral, as also observed in an earlier experiment through the one-sided concrete application. The test illustrated that the same principle, before tested on elastic ribbon and in this case on stretchy fabric, was able to achieve the desired effect in the result. However, since textile had not the same strength than elastic ribbons the emerged shape was not as stable.

The following experiment investigated again the same principle, but combined elastic ribbons and stretchy textile. Another difference was the application of concrete. It was not just applied vertically, but also horizontally and created therefore a different form. Firstly, the ribbon was cut in the desired length, stretched and then fixed onto a board in the before determined form. Glue was added on the ribbon to make the textile, which was stretched over the ribbons, stick to them. Afterwards the concrete was applied on the textile surface and placed exactly where the ribbons were (Fig. 133). After the concrete had dried the textile was loosened from the board and the breaking followed. Cracks appeared in the concrete surface, which gave the ribbon the opportunity to contract. The concrete was curved horizontally and vertically like a cross form. This created a dome shape. Since several forms, each one of them shaped to a dome, were placed on the surface the textile in between gathered (Fig. 134-135). Therefore, the result presented an organic expression emerged from a geometrical arrangement.
In order to test how different arrangements of the concrete can achieve different organic shapes, the upcoming experiments were implemented. In both tested arrangements, oktogon and triangle, just the outlines in form of a concrete surface were used. These were not connected to enhance the possibility to move. Through the contraction of each concrete stripe, the idea was to accomplish a gathering of the textile material in the middle to support the required organic expression. Through analysing the outcomes it was noticed that shorter concrete stripes in the oktogon form had less influence on the textile, compared to the longer ones in the triangle form (Fig. 136-141).

To create the final ribbon piece the idea of combining elastic ribbon and fabric was undertaken. The geometrical form and arrangement was developed further, in order to create an organic expression in the outcome.

The process started by planning the pattern, which appeared as the concrete form, in this case three lines which created a triangle on the textile surface. The planning of the form implied the exact proportion, the arrangement on the textile and the distances in between (Fig. 142). After these factors were decided the elastic ribbons were cut in the needed length and, as marked on a board beforehand, stretched and fixed onto it (Fig. 143). As in the previous experiment the next step was to glue the fabric to the ribbon (Fig. 144).

After spreading the prepared moulds on the fabric, again exactly where the ribbon was placed underneath, the next step was to apply the concrete. The wet concrete mixture filled the mould until the edge, was subsequently covered with a plastic foil and then gently pressed flat by placing a lid on top (Fig. 145-147).

After drying the moulds were removed and the textile was loosened from the board. To release the tension in the ribbon the hammering technique followed. Based on the knowledge from previous experiments, that each concrete surface behaves differently when it comes to breaking, the hammering was implemented.
In this case it was important to start with the first hammer blow in the middle of each concrete surface and move from there to the ends, where additionally the concrete parts got smaller through more cracks. As described earlier, the breakage of the concrete gave the elastic ribbon the opportunity to release its tension and shaped therefore the concrete. One could observe firstly the ribbon underneath the fabric contracted that secondly, shaped each concrete stripe into an arch-form, which thirdly gathered the fabric in the middle and around the form and created therefore an exciting appearance (Fig. 148-150).

The outcome presented a surface with a deep structure and an organic expression. To create this, two textile qualities were needed. Firstly, the in the outcome not visible but crucial elastic ribbon and secondly the cotton velvet. While the latter served the rough surface where the concrete could stick on and furthermore, provided a slightly shiny appearance of the chosen colour, the former was responsible to shape the broken concrete through the release of its tension.
In first tests two layers of knit were placed on top of each other and covered with concrete from both sides. By letting the concrete withstand from the knit surface, the wet concrete mix connected and closed therefore the form on three sides. Through the double textile layer, the concrete was not able to soak all the way through, which was the reason that each knit surface was only connected to the applied concrete on its outside. Therefore, a concrete form attached on three edges was achieved, whereby one edge was not connected. By breaking the concrete surfaces on the front and back side, it was possible to curve both layers to the outsides. As a result, a three-dimensional hollow object was created, which was able to stand by itself (Fig. 152). The following experiment investigated a bigger scale regarding the textile and concrete surfaces, but also the thickness of the concrete layer. It needed to be determined, if a larger piece needed consequently a thicker concrete layer to support its standing ability (Fig. 153-154).

After exploring the relation between the size of textile and concrete surfaces and the proportional up-scaled thickness of concrete layer, the following experiment focused on different shape. Instead of putting two layers of textile on top of each other, a tube out of fabric was sewn beforehand. The prepared textile was covered with concrete, whereas the top and bottom end was left out to keep the tube open. Through breaking the concrete surfaces, the piece could be shaped to a cylinder and was able to stand by itself, as previous examples, as well (Fig. 155-156).

The following experiment investigated again a different shape, by adapting the same principle than in the examples before, but focused additionally on openings in the concrete surface (Fig. 166). In this trial it was approved if the openings had an influence on the behaviour of the piece, regarding breaking and the following shaping (Fig. 167). As the result presented, the openings in small size compared to the entire piece, had no negative influence on the shaping behaviour of the piece, but added details to the visual expression.

Through earlier tests it was known that the openings in the surface firstly, allowed the observer to get a glance on the fabric underneath and secondly, brought the tactility and a certain aesthetic back on the concrete surface. The next tests amplified those insights, by not just allowing a glance on the fabric, but letting the textile grow out of the concrete surface. Therefore, a three-dimensionality, given through the textile, appeared on top of the two-dimensional concrete surfaces. The outcomes were accomplished with notable differences in its expressions, influenced through the qualities of the used textiles (Fig. 168-170).

For the final realization the rectangular shape from the first experiments in combination with openings in the concrete surface were chosen. To bring the textile on the concrete surface, a fur quality was chosen. This can be used as textile underneath, but still reach the concrete surface through its long hair. The overall size of the piece was up-scaled, and the openings were placed regarding a before developed template.
In order to know where to pour the concrete, the first working step was the development of the needed template. As a starting point for this, the generated motif from the previously described design program was used (Fig. 171). For this piece it was progressed in order to serve a template for the placements of the openings in the concrete surface. For further manipulation the technique melting was used which required therefore a meltable material. As such wax crayons were chosen, which were grated and regarding to the motif placed on a glass surface (Fig. 172). Through heating it up the wax pieces melted and created a rather abstract motif (Fig. 173). Last finishings were implemented in Photoshop, which meant to define each gained crayon puddle to a clear area (Fig. 174). At this point the template for the desired openings in the concrete surface was prepared.

To start the pouring process a surface was prepared, covered with plastic foil to achieve an even surface in the outcome. In order to place the openings correctly, a print out of the before progressed template was put underneath the transparent foil (Fig. 175). Subsequently the wet concrete mixture was poured on the surface, leaving open spaces where the template specified (Fig. 176).

To achieve a strong connection between the concrete and the textile the concrete mix had to be still wet when it came to the merging of the fabric on the concrete. For this reason, the previous working step needed to be done quickly. The prepared fabric had exact fitting measurements and was placed, as in earlier tests, as double layer onto the wet concrete (Fig. 177). To accomplish a strong joint, not just between the concrete and the fabric but also on the three edges between concrete itself, the application of the top concrete surface needed to be implemented quickly as well. However, before the second concrete layer could be applied the openings had to be marked (Fig. 178).

After covering the entire top of the surface, the edges were cut straight (Fig. 179) and an acrylic glass pressed on top of the created piece, in order to achieve an even surface (Fig. 180).

Even though, the acrylic glass was supposed to achieve an as even surface as the surface drying on the plastic foil, a difference in the outcome was perceivable anyway. Another variation could be seen in the size of the openings. While the openings in the top concrete surface still had the exact proportions as the template, the openings in the surface dried on the bottom got smaller, through the pressure from above (Fig. 181-182).
In order to transform the emerged two-dimensional surface into a three-dimensional object, the technique hammering followed. A previously developed motif was used to lead the hammer bows. Contours and shadows directed the hammer blow, whereby darker parts were beaten more than lighter areas. However, the motif was supposed to navigate where and how many cracks should appear, the total amount of cracks in the outcome was still not controllable (Fig. 183-185).

The result showed a two-dimensional surface, which could transform into a three-dimensional object with the ability to stand by itself, through the interaction of concrete and textile (Fig. 186-188).

The double layered textile inside the piece served firstly as the base for the concrete, secondly provided a strong colour and texture contrast and thirdly brought the tactility back to the surface through the openings. Since the concrete stuck well to the textile it could be broken and would still stay in place. Through the flexible textile and the cracks in the concrete, the surface could get three-dimensional. Regarding the capability to stand upright, the concrete saved the textile from collapsing, since the single concrete pieces got caught up and support each other to be able to keep up.
6.6 Grid

The Grid started with basic tests within the technique screen printing (Fig. 190-192). The printed regularly repeated pattern served inspiration to develop this further. The idea to produce a surface with such a pattern out of concrete, but by additionally adding movability, through the textile, came up.

To create the capability of moving within the piece the concrete needed to become several single pieces, which are still connected through the textile. The following experiment contained a series of tests with the laser cutter. Therefore, a mesh covered with concrete was prepared, whereas the focus was to produce it as thin as possible, to be able to cut it. The first example showed the opportunity of engraving a pattern on the concrete surface (Fig. 193). By improving the settings of the laser cutter deeper lines could be accomplished, whereby the cut did still not go all the way through. However, the test showed firstly a better recognisable pattern and secondly, it could be noticed that the laser removed the top concrete layer exactly until the textile was visible (Fig. 194). The final trial achieved the required effect of cutting the concrete, by enhancing the settings of the laser cutter again (Fig. 195).

Since the laser cutter cut the thin concrete surface, but also the fabric in between, the textile was not able to provide a connecting base anymore. Therefore, the next experiments investigated other ways how to cut or break only the concrete surface without demolishing the textile underneath. In the presented test series, the concrete was cut with a knife when it was in a condition in between liquid and hard. The cut lines are supposed to direct where the concrete should break after it dried entirely. For the first example ripped knit was used as textile, since it provided a great stretchability. To use such, the concrete was cut along the knitted rips and were broken on these marks after it dried. The outcome showed concrete stripes, which showed the textile in between the concrete by stretching the piece (Fig. 196). The next trial was looking for more stability, while not losing the movability. Therefore, instead of a stretchy knit, a terrycloth quality was used as textile. The width of the concrete stripes was largened, in order to enhance the capability to stand by itself (Fig. 197). The following experiments focused on different patterns, which could cut in the concrete and the subsequently influence to the flexibility. The circle pattern cracked where it was cut before, but did not enhance the movability (Fig. 198). On the contrary, the squared pattern improves the flexibility, since it broke regularly and was able to move in both directions compared to the earlier tested stripes (Fig. 199).

Through the discovery of the advantages of a squared regular pattern to achieve flexibility within a piece, the upcoming test presents a different approach. Instead of using an even fabric surface, a waffle weave was produced, which provided a three-dimensional structure. Through the used wool quality of the woven threads it provided a surface where the concrete could stick on.
Through filling each immersion with concrete on the one right side of the weave, but decrease the amount while moving to the other side, a concrete gradient was created. The single concrete elements added a certain weight and influenced therefore the movement of the piece in an interesting manner (Fig. 200-201).

In the next experiments the previous achieved squared form was developed further. The following investigation tested the cube instead of the square, applied as concrete on a textile (Fig. 202). The outcome presented a flexible surface, whereby the movability was restricted by forming the piece upwards. This was caused through the too small distance in between the cubes. In the other direction the result was as movable as the textile underneath (Fig. 203).

To avoid the restriction of movability and achieving as much flexibility as possible in both directions, the trial was repeated, whereby small changes were made. Firstly, the height of the cubes was reduced again, and secondly bigger distances in between the single concrete elements inserted (Fig. 204). The outcome presented a noticeable flexible piece, even though it was not without any restrictions of the movement (Fig. 205-206). By analysing the result, it became clear that for a completely unlimited flexibility in all directions, the distances in between the concrete elements needs to be wider.

The subsequently trial focused on a up-scaled version of the previous test, whereas rather the width and length of the concrete elements were enlarged and measurements of height and gaps in between those were kept (Fig. 207). The analysis of the result provided a newly insight in terms of shaping the emerged surface. While earlier tested smaller cubes were able to bend in rather tight curves, the up-scaled version showed that the corners of each concrete element got loose by bending it too much (Fig. 208). This describes another restriction of the movability within this experiment.

In the following investigation, the idea was to create a motif with differently formed concrete elements and test the consequently influence of the movement of the piece. For the realization, geometrical forms and the needed gaps in between the concrete elements were kept.
As indication for the size, form and arrangement of the concrete pieces, an earlier developed motif was used (Fig. 209). By moving the outcome, it was explored that the movability was not as fluent as in previous examples, since no straight continuous lines were existing. Instead of those several short ones, which pointed in different directions were given. Instead of influencing the movement the short lines directed the shaping of the occurred surface naturally and accomplished therefore an interesting and strong expression (Fig. 210).

In the following experiment before gained and crucial insights, such as form, proportion, arrangement and number of the concrete elements to achieve movement were unified. Therefore, the outcome exposed a larger surface, where the concrete in form of cubes was applied with specific distances in between the single pieces (Fig. 211-213).

For the final piece it was decided that the concrete appeared as cube form and was arranged in a regular linear pattern with wider gaps in between, to improve the flexibility.

As soon as the crucial factors of this piece, such as proportion, number, arrangement, width of distances and total size of the piece, were determined, the mould needed to be planned and built. Therefore, sleeping mats were used, since they were easily treatable, flexible and even enough to loosen the dry concrete (Fig. 214). After determining the exact measurements of all factors, the mould could be planned and cut by the laser cutter (Fig. 215). When all the needed pieces were cut, one could assemble them to create the moulds (Fig. 216). Since there were restrictions in size through the laser cutter, but also the mats, twelve moulds were produced in order to cover the required size. Subsequently the twelve prepared moulds were placed on the fabric and weight down to hold them in place (Fig. 217-219). The used textile quality was fleece, which was strengthened by attaching viesofix on the back to reduce the stretchability, but without effecting the great flexibility of the fabric.

The next step was to fill the mould with concrete. Therefore, the concrete powder was mixed with water and poured on a part of the grid. To fill each hole evenly the concrete was spackled smoothly over the mould and removed at the same time redundant concrete. To achieve a plain and even surface of each concrete cube a plastic lid was placed on top (Fig. 220-225).
After the drying the mould and also the lids, which were placed on each concrete element, needed to be removed (Fig. 226-227).

The result presented an even and regular pattern out of concrete cubes on top of the textile. Through the distances in between those the entire surface was able to move and exposed therefore a great flexibility within the piece including an impressive expression (Fig. 228-230).

The chosen textile provided a base where the concrete could stick on and additionally presented a great colour contrast. Through the flexibility of the textile the regular arranged concrete cubes could be moved, whereby it seemed like the pattern would fall apart. Depending on how the textile moved the concrete cubes were either hiding or disclosing the textile. The weight of the concrete influenced the movement, given through the textile, within the entire piece. The more the surface was moved, the more exciting the expression got.
7. RESULT

7.1 Result description
The results of this investigation exposed a different approach of textile design by introducing an, for this field, unusual material combination. Furthermore, the outcomes showed design possibilities through a fusion of the exceptional material combination textile and concrete.

The final results were presented in five groups, consisting of six pieces in total. Those showed flexibility, through a characteristic exchange, emerged through different connections of the used materials. Depending on these, respectively the influence of such within a piece, flexibility was shown in form of bending, shaping and moving.

The expression of the final collection varied from notably organic to rather geometric. In some cases this was also depending, if the piece was in motion.

7.2 Complete overview
The illustrations on the following pages provide an overview, containing information about each of the six pieces, to give a first idea of the result’s appearance and behaviour. The brief description provides the most important factors within the final outcomes and helps to notice the same or different occurrence of the components by comparing the results.

Fig. 232. Overview of most important factors of final pieces (page 72-73).
**Threads.I**
- Dipping: Concrete is added through dip threads into the concrete
- Concrete poured on textile - wet concrete is poured in a prepared form on the textile
- Concrete -> Textile
- Stiffness, Hardness
- Impression of floating and light weight
- Concrete to Concrete
- Flexibility
- Choice of Colour: Aqua

**Threads.II**
- Dipping: Concrete is added through dip threads into the concrete
- Concrete poured on textile - wet concrete is poured in a prepared form on the textile
- Concrete -> Textile
- Stiffness, Hardness
- Impression of floating and light weight
- Concrete to Concrete
- Flexibility
- Choice of Colour: Grey

**Sponge**
- Concrete poured on textile - wet concrete is poured in a prepared form on the textile
- Concrete -> Textile
- Stiffness, Hardness
- Impression of floating and light weight
- Concrete to Concrete
- Flexibility
- Choice of Colour: Peach

**Ribbon**
- Concrete poured on textile - wet concrete is poured in a prepared form on the textile
- Concrete -> Textile
- Stiffness, Hardness
- Impression of floating and light weight
- Concrete to Textile
- Flexibility
- Choice of Colour: Ocean Blue

**2D3D Grid**
- Concrete poured on textile - wet concrete is poured in a prepared mould on the textile
- Concrete -> Textile
- Stiffness, Hardness
- Impression of floating and light weight
- Concrete to Textile
- Flexibility
- Choice of Colour: Brilianz Yellow

**Grid**
- Concrete poured on textile - wet concrete is poured in a prepared mould on the textile
- Concrete -> Textile
- Stiffness, Hardness
- Impression of floating and light weight
- Concrete to Textile
- Flexibility
- Choice of Colour: Flamingo Pink
### 7.3 Threads I

<table>
<thead>
<tr>
<th>Property</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>250 cm x 42 cm x 42 cm</td>
</tr>
<tr>
<td>Size of concrete cube</td>
<td>46 cm x 40 cm x 40 cm</td>
</tr>
<tr>
<td>Colour</td>
<td>aqua</td>
</tr>
<tr>
<td>Quality of textile</td>
<td>mercerized cotton thread</td>
</tr>
<tr>
<td>Materials</td>
<td>concrete, mercerized cotton,</td>
</tr>
<tr>
<td></td>
<td>wool, transparent lacquer,</td>
</tr>
<tr>
<td></td>
<td>acrylic glass, glue</td>
</tr>
<tr>
<td>Amount of threads</td>
<td>441 threads</td>
</tr>
</tbody>
</table>

Fig. 233, 235-238. Result of first thread piece (page 74, 76, 77).
Fig. 234. Technical drawing of first thread piece.
7.4 Threads II

Size: height: 250cm, diameter: 11cm
Size of concrete drop: diameter: 40cm
Colour: grey, aqua
Quality of textile: wool thread
Materials: concrete, wool, translucent lacquer, mercerized cotton, acrylic glass
Amount of threads: 200 threads

Fig. 239, 241-246. Result of second thread piece (page 78, 80-81).
Fig. 240. Techniual drawing of second thread piece.
7.5 Sponge

| Size: | 250cm x 8cm x 8cm |
| Size of concrete layer: | 2cm x 8cm x 8cm |
| Size of sponge layer: | 4cm x 8cm x 8cm |
| Colour: | peach |
| Quality of textile: | polyurethane sponge |
| Materials: | concrete, polyurethane sponge |

Fig. 247, 249-251. Result Sponge piece (page 82, 84-85).
Fig. 248. Technical drawing of Sponge piece.
7.6 Ribbon

Size: 120cm x 60cm (original size: 270cm x 142cm)
Size of concrete form: 28cm x 32cm (triangle: three stripes á 22cm x 5cm x 0,5cm)
Colour: ocean blue
Quality of textile: cotton velvet
Materials: concrete, cotton velvet, elastic ribbon

Fig. 252, 254-256. Result Ribbon piece (page 86, 88-89).
Fig. 253. Technical drawing of Ribbon piece.
7.7 2D3D

Size: 62cm x 64cm
Colour: flamingo pink
Quality of textile: fake fur
Materials: concrete, fake fur

Fig. 257, 259-263. Result 2D3D piece (page 90, 92-93).
Fig. 258. Technical drawing of 2D3D piece.
7.8 Grit

Size: 300cm x 155cm
Size of cube surface: 207cm x 135cm
Colour: blazing yellow
Quality of textile: polyester fleece
Materials: concrete, polyester fleece, vliesofix

Fig. 264, 266-269: Result Grid piece (page 94, 96-97).
Fig. 265. Technical drawing of Grid piece.
8. DISCUSSION

The gathered information about concrete and the work of designers and artists discussed in the introduction chapter show a gap regarding the importance of textile in combination with concrete. Curiosity and involvement are necessary within this research including the design work to have an open-minded view on unusual material combinations and their uncommon expressions.

In this degree work it is stated to accomplish an exploration of design possibilities by fusing textile and concrete into one surface or object and additionally by exchanging the material’s characteristics. By doing so it is suggested that the concrete and furthermore the textile gain a function, which is supposed to be shown through the influence on each other.

The required accomplishment is achieved, which can be clearly seen through the interdependence of textile and concrete in each result. In all outcomes except Threads.1 flexibility is created and shows a function because of the interaction of both materials. Creating this unexpected function, in terms of the building material concrete, is just possible because of the influence of the textile. The different qualities of used textiles share their characteristics of texture and flexibility with the concrete and make therefore shaping, moving and bending within the results possible.

In Threads.1 the textile influences not the properties of the piece itself but the expression of it in a strong way. It challenges the common expectation of the concrete appearance and converts it into the opposite. The thin thread quality, able to appear and disappear depending on the position of the viewer and the angle of the light, is able to give the impression of floating concrete. Also, the concrete itself can be produced thin in its appearance through the textile yarn and is therefore again able to give a light weight and see through expression.

The results of this degree work present the relation between movement and the material appearance and open up possibilities to develop or adapt the findings to certain design fields or applications. The following paragraphs discuss discoveries and reflect on the methodology of combining textile with other materials.

8.1 Discoveries

The number of textiles that can be combined with concrete is limited because of the needed texture but nevertheless can be found in a certain range. As just mentioned the most important criteria for selection is the structure of the fabric or more precisely it must have a textured surface. Such fabrics could be fleece, velvet, wool yarn, Terry cloth, fake fur, sponge, etc. Through their surface properties they provide a base for the wet concrete material to soak in and stick on. This is a crucial factor and necessary to coalesce textile and concrete. For instance, metal or glass would not be able to provide such a structured surface except it would be treated. Making holes in it would be one way to give the wet concrete a chance to connect with such a smooth surface. This knowledge suggests that not just fabric with rough surfaces could be used but also meshed textile qualities like tulle, fishnet or filet net. The wet concrete mix can find its way through the ‘holes’ to the other side and covers the textile completely from both sides.

The just explained describes the need of textile and the required quality to connect to concrete and indicates already one situation for connecting a meshed textile material with concrete. When it comes to the connection between a textile with a rough surface and concrete the textile offers stick out fibres, loops, hair or pore structures that the wet concrete mix could grab and stick on or be soaked in. While drying, the concrete encloses the textile and holds on to it in a strong way.
This in turn, indicates that the strength of the connection varies depending on the textile properties. If one compares a woollen upscaled purl-knitted textile with a fleece quality it becomes clear that, even though both textile materials could be used, the connection to the first one must be much stronger. This again suggests the weight and therefore the thickness of the concrete layer the textile can carry. The rougher the texture of a textile, the stronger the connection to concrete, the thicker the concrete layer can be.

The influence of the concrete to the textile is shown in different ways. Firstly, the textile gets stronger and more stable by the application of concrete. This means while the textile itself would collapse by putting it up, when supported by the concrete it is able to stand upright or hold up itself. Another factor to consider, regarding the weight of the concrete applied on the textile, is the elasticity of textiles. The thicker the concrete layer the heavier it gets and therefore the textile stretches by lifting the piece. This impact can be used and applied on purpose but it can also become a problem. If the applied concrete surface is rather small the textile pulls itself off the concrete. Another possibility could be that the applied concrete surface is bigger the textile pulls itself off the edges, but has still a strong connection in the middle. Thirdly, the concrete influences the movement of the textile enormously through its weight and the arrangement or pattern it is applied in. The heavy material makes out the direction and controls therefore the motion of the textile and the movement of the entire piece. Motion, enabled through the textile, became an important part in this work, since the visualization of the impact of both materials to each other lifts the expression of a piece to another level. It presents the gained properties and expressions achieved through the characteristic exchange of textile and concrete.

The following paragraphs present two discoveries, which were not developed further in this research, because the focus was rather on the concrete material itself than the usage of textile techniques on concrete material. However, the results suggest several possible ways of continuative explorations.

As discussed in the design program, experiments with dying the concrete and printing on concrete surfaces were done through the use of conventional dyes and paints. These tests also included thermochromic ink, which opened the discussion how smart materials could influence the project and if, for example smart textiles could be achieved through the material combination of textile and concrete.

Furthermore, experimentation with light, respectively thin and therefore translucent concrete surfaces, advice further research as well. The incorporation of light increased the contrast between the usually opaque, hard and stable expression of the concrete and the, in this case, translucent, light and fragile expression of the emerged surface.

8.2 Thermochromic ink

Through the method experimentation, among others thermochromic ink was tested within the techniques printing and dying. The first experiments were done out of the author’s curiosity for the principle of the special substance, to let the colour disappear by heating it up, could be accomplished on the concrete surface as well. Therefore, a test pattern was screen printed on the concrete surface and heated up through hot air to analyse the outcome after drying (Fig. 270-271).

The positive analyses of the previous experiment gave motivation to test the thermochromic ink within the dying technique. Therefore, the wet concrete mixture was dyed with a small amount of the ink and poured into a prepared form. In this form a conductive yarn was placed beforehand. Both ends protruded to connect the electronic device later. After the concrete surface dried entirely the first interim result, that concrete could be dyed with thermochromic ink and showed therefore colour in the cold condition as well, was achieved. Furthermore, the ability of colour change, through heating the dyed concrete surface, was tested. Also, in this case the outcome showed a clear change in the colour appearance and fulfilled therefore the required effect (Fig. 272-273).

Through earlier experiments it was known that dying the concrete could rather achieve dull and quiet colours. The following tests focused on enhancing the intensity of the desired colour, presenting only one option. The process of the concrete threads, as described earlier, included the lacquer coating as last working step. Therefore, firstly concrete threads were produced with thermochromic ink dyed concrete and coated with normal transparent lacquer (Fig. 274). As second test, normal concrete was used to produce the threads. Thermochromic ink was added to the transparent lacquer and was used to coat the grey coloured threads (Fig. 275). The results showed a considerable difference in the colour appearance achieved through the two different dying approaches.

Since the previous test showed a great accomplishment in terms of the intensity of colour appearance, by dyeing the lacquer instead of the concrete, it was subsequently tested if the colour change through heat was still working. By using a common textile thread combined with a conductive yarn as the core material, the electronic devise could be connected later. The result showed a clear colour change in the beginning, interrupted and therefore stopped through a kink in the thread (Fig. 276-277). This means by adding thermochromic ink into the lacquer the required effect could be achieved, however the conductive yarn needs to be straighten.
Another discovery through the application of the method experimentation, was the ability of a concrete surface to let light shine through. Since this interim result suggested, as the previous described finding, further development rather within the material concrete instead of the combination with textile, it was not further pursued within Adamant Textile. The exploration within this test was focused on how thin a concrete surface could be accomplished without losing the entire stability. In the experiment presented in the following images, the wet concrete mix was rolled out and included a fine meshed textile. By placing a layer of bubble wrap on top of the concrete and the consequent pressure through the rolling pin, extraordinary thin areas were achieved, while keeping comparatively thick parts to improve the stability. In the outcome tiny air bubbles, mainly visible on the thinnest parts of the concrete surface, allowed the light behind to shine through (Fig. 278-279).

The interim results, in terms of thermochromic ink and shine through concrete, presented an interesting approach, rather in terms of enhancing the concrete properties than improving the role of textile. For this reason, these promising discoveries were not further developed within this investigation. However, it invited for further explorations and served as an inspiration for a continuative research with hopeful results.

8.4 Contribution

Adamant Textile is an investigation that deals with an, for the textile design field, unusual material combination and challenges the common perception of textiles. However, this research addresses clearly the textile design field, since textiles have the most crucial importance. Even though they are manipulated and influenced by an additional material, the concrete, the textiles direct the expressions in a significant manner within this degree work. Since concrete is a material coming from architecture, this work is an interdisciplinary investigation from a textile design point of view.

The contribution of this research to the textile design field is seen in the methodology of the combination of textile with other materials. In this sense the investigation starts to fill the discovered gap in the textile design field by exploring the dependency and interaction of textile and concrete, which cannot be found in the works of the designers and artists introduced in the introduction chapter. By doing so this research is not just interested in combining these materials but discovering and developing unexpected properties like flexibility just by using the reciprocal impact of these contrasting materials to each other. The results provide a rich foundation, which suggests continuative research within this subject matter. This can be advised to the textile design field but could also be boost in another design field, such as obviously architecture.
9. REFERENCES


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9.1 Image References

Graphics of autors: Fig. 46-47, 83, 232, 234, 240 248, 253, 258, 265

Photographs of author: Fig. x, xx, 1-82, 97-122, 124-150, 152-188, 190-227, 270-279

Photographs of Jan Berg: Fig. 83-87, 89-96, 123, 151, 189, 228-131, 233, 235-239, 241-247, 249-252, 254-257, 259-264, 266-269