Embodied self-expression through textile design

Ana Cecília Martins Barbosa

Interaction Design
One-year Master’s Programme
15 credits
Spring / 2016
Supervisor: Anne-Marie Hansen
Abstract

Motivated by studies of dress and the importance that it has on identity formation and expression of self, this research tries to answer the question of how can an interactive tool create greater means for self-expression of the dressed body through the design of textiles? The goal of pursuing the question is to ultimately promote a more sustainable fashion culture that relies on the creation of long-lasting products.

Employing Research through Design as the main methodology, this research went through a series of sequential design experiments – namely workshops and prototypes – with the ambition of generating knowledge in the context of the design space, and in order to inform the design of the interactive tool proposed by the research question. The main research findings suggest that the direct engagement with the painting of textiles through ruled self-reflection tasks, in collaboration with a machine, provides great means for the creation of long-lasting products – showing, therefore, a fruitful path towards fashion sustainability. In addition to the conception and building of a final artifact, this research resulted in a set of guidelines that aims at advising the creation of other future artifacts.
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1. Introduction

Studies of dress and fashion demonstrate that the act of getting dressed is an experience and presentation of one’s self – the ubiquity of clothing, which is inherent to human cultures, points that “dress and adornment is one of the means by which bodies are made social and given meaning and identity” (Entwistle, 2000, p. 7). Drawing from the importance that dress has to identity, one can grasp how the visual display of clothing – the textile – can also provide important means of expression of the self, and of identity building. As Quentin Bell puts it, “it is as though the fabric [of dress] were indeed a natural extension of the body, or even the soul” (Entwistle, 2000, p. 9).

This research is set out to explore the analog form of textiles as an open canvas for the representation of aspects of the self by proposing the design of an interactive tool that enables the generation of personal expressions. The overall goal of this research is, therefore, to explore: How can an interactive tool create greater means for self-expression of the dressed body through the design of textiles?

Positioned within studies of dress and fashion, this research has the goal too of probing how the introduction of participation and co-creation in the fashion design process can create means for a sustainable fashion culture. As suggested by Fletcher (2008), fashion sustainability can be nurtured through the design of long-lasting products, which, in turn, can be be created through an inclusive fashion design process (as she poses, long-lasting products are different from products that last long). The approach from this research, therefore, questions the fast-paced, top-down hierarchy employed by the current world-wide fashion dynamics (Busch, 2008). Such fashion scenario increases consumerism in an unhealthy buy-discard cycle, and undermines possibilities for self-expression, which are issues that this research is preoccupied with and aims to explore.

Following the serial approach to Research through Design proposed by Krogh et al. (2015), a sequential series of design experiments and prototypes were executed in order to probe the design space and generate learnings and insights about the topic throughout the process. As a result, a final proposed artifact was built as a representation of all of the built knowledge, and as an example of concept that answers to the research’s posed question. Additionally, guidelines were created in order to inspire the design of future explorations of the design space.

This document starts by setting up the theoretical background that both inspired and guided the course of the research. First, an analysis of the importance that dress has to the construction of self is posed as the starting point. The document, then, moves on to explain the theoretical reasons behind the choice of textile – specifically analog textiles – as the main design material explored in the design process. After the motivations are set, a brief overview of the current fashion industry scenario is exposed in order to explain where this research is positioned within the dynamics of fashion, and how improving its sustainability is the target problem. The research background is then followed by a brief analysis of related work, illustrating the general efforts put into the different research areas, and how they relate to the present research.

After presenting the background and related work, the chosen design methodology – Research though Design – is introduced and defended, followed by a thorough description of the design
process. Each design experiment is explained in details, and the means by which it informed the following activities through the results and insights is clearly demonstrated.

Finally, the document provides an analysis of the results from the overall design process, and initiates a discussion around the generated knowledge. As an output of the discussion, a set of guidelines for the co-creation of textile design is presented as the main collaboration of this research. The final working prototype – the proposed artifact – is in turn presented as the pilot example of the guidelines execution.

2. Background

This research aims at creating a design space around three main relevant research areas, which will be examined in the following sections, and tries to position the proposed artifact in the intersection of them. Firstly, motivations to pursue the research topic are drawn from studies of dress, which opens up for the importance of the relationship between self, body and dress. Secondly, the research’s reasons to work with textile as a design material are exposed through the discourse of self-expression through smart textiles. Finally, an analysis of the current fashion industry positions this project within the aspirations of a more sustainable fashion consumption culture.

2.1. Dress, body, self

“The body is a dressed body”.

Anthropologists find it true for all human cultures that dress is a ubiquitous aspect of social life. It is a basic fact that one dresses to experience the world, and through this exposure, dress becomes like a cocoon with which one can feel comfortable and learn to live with their bodies. “Dress is both an intimate experience of the body and a public representation of it” (Entwistle, 2000, p. 7).

In line with studies of phenomenology, it can be said too that it is through the positioning of the – dressed – body in space that one experiences and makes meaning of the world and their reciprocal relation. Dourish (2001) states that the act of just being in the world “shakes” the way one understands it, because the world is apprehended through the understanding of how one is positioned in it – meaning that the body and its conditions shape one’s perception of the world. Merleau-Ponty (1964), in turn, expresses that the body is “our expression in the world, the visible form of our intentions” (p. 5), which suggests that the body is also the channel through which the world makes meaning of oneself.

By understanding that the reciprocal relation between the self and the exterior happens through the body, and that the expression of self is made possible through the body, one can reflect upon the importance of – what can be considered – the interface between the body and the world: dress. As an embodied practice, dress can greatly influence the construction and perception of the self,
which is in turn indivisible from the body. Following the notion of distributed personhood, the pieces of clothing in a wardrobe can be considered to be a collection of fragments of one’s self; an externalization of their personhood (Küchler & Miller, 2005). Putting clothes on, therefore, becomes an act of expressing oneself, and an invitation for the outside world to interpret the pieces of the personhood that the wearer decides to put on.

The relationship between the self, the body and the world positions clothing as an immediate mean for communication. Multiple ways of dressing communicate different messages to different audiences and cultures. Pieces of clothing are essentially extended signs and symbols of one’s self externalized to the others; they are different representations of one’s self-image – either the aspired one, or the image one is socially bound to represent. The constant assembling of layers of communication symbols – i.e. clothing – is therefore an act of constantly putting together a self-image. Thus the communication that happens to the exterior ends up also constructing the definition of the interior. As Joseph (1995) puts it, “the external and the internal, the public and the private are expressed in these attitudes toward layers of dress as they are toward layers of the self” (p. 81). In other words, dress is as important for the one-to-world communication, as it is for the one-to-oneself relationship.

In line with the understanding that the communication through dress has great influence on the construction of the self, this research aims to explore the posed question of self-expression from the one-to-oneself angle. Instead of exploring how others can make sense of one’s self-expression, this research intends to strengthen the connection that one has with their self, built through their own expression.

### 2.2. Expression through textile

As stated above, dress is its own form of communication. It is layers of symbols assembled together to communicate the wearer’s current state of intentions – both to the world and to themselves. The message carried by the clothing is transmitted through the different layers of visual input associated with dress: the cut, the volume, the color, the texture, the silhouette are examples of it (Gökhan, 2008). These are all variables that textile allows for manipulation, and hence communication.

With the advent of smart textiles, the intersection of interaction design and textile design studies have become closer and clearer. In the past years, the field of smart textiles have seen great development with research and commercial initiatives working on applications like body monitoring, knitted blood vessels and sports heat garments (Persson, 2013), which in turn opens up for various interaction design opportunities of practice. The research field has also long seen the communication and expressivity potential carried out by the textiles, and has since embedded technologies into the wearables to explore how interactivity can tap into the different forms of expression allowed by fabric. Some examples of textile and interactive expressions that have been explored in this field are the works of Persson (2008) with the table cloth that creates burn patterns according to people’s phone activities, and of Bondesson et al. (2009), with the wall textile that reacts to a dance performance.
For the casual consumer and wearer, however, the use of smart textiles is still a novelty and, for many, not yet a reality. The exploration of smart textiles for real-time and interactive self-expression in some cases ends up being yet another technological gimmick. The “Wearable Folding Display” project (Moere & Hoinkis, 2006), for instance, claims that through the combination of sensor input data from accelerometers and muscle wires that folds textile to create patterns, one can express themselves to the world. It can be argued, however, that the involuntary display of patterns created through variables external to the self does not translate into self-expression. It is a gadget with relevant technological developments, but with shallow meanings for the wearer.

This research has, therefore, recognized that the exploration of textiles within the field of interaction design has made a premature jump when it comes to textiles and self-expression: The use of technology embedded in textiles, even though promising of a fruitful path, is not yet ready to be a natural part of the everyday dressed person. It is believed that studies in interaction design could meanwhile explore the analog version of textiles – i.e. it’s original format – to a fuller potential. Hence the focus of this research is not on developing or inspecting technical functionalities of textile, but rather on understanding how the representation of identity can happen through the fabric, and which are the meanings created through such manipulation and use of the textile. The proposed interactive tool by this research, therefore, uses “non-smart” materials for the textile design exploration, i.e. paint on fabric.

2.3. Fashion and sustainable consumption

Fashion and clothing – dress – are two different entities that come together through the body. Clothing is directly related to the human need for protection, shelter and subsistence. Fashion, on the other hand, supports one through their non-material needs, such as identity, freedom and communication. Fashion is symbolic while clothing is functional and material. As Fletcher (2008) illustrates, fashion can be the response resulting from a new collection presented at a catwalk in Milan, but also the act of a teenager cropping off, adding badges and painting their clothes. According to her, when fashion and clothing come together, one’s needs and personal expressions are embodied as garments.

Being related to such basic human needs of emotional and material value, fashion is a central aspect of human lives. As the notion of distributed personhood supports it, people often meet their need for identity by constructing themselves through the acquisition of goods, which are often clothes. The basic need for identity, in turn, comes with needs of pleasure, status and new experiences – all of which can be found through the purchase of the new items (Fletcher, 2008). The current state of the fashion industry, however, has created a culture of high consumption, where the fast paced trends put people in a buy-discard cycle that only conflicts with any world sustainable goals.

The modern fashion culture shapes, too, people’s attitude towards their own sense of identity and expression. Fashion trends and its their paced cycles forces the belief that one needs and should be in constant reformulation of their identity. This loop of constant search for the “new me” that is incited by fashion collections of ever-shorter intervals can be pointed as the culprit for the high consumerism reality – the unsustainable consumer cycle of buying and throwing away.
The consumerism instigated by fashion cycles also comes with the problem of homogeneity. As the fashion industry moves from local producers to global chains, the same garments that are seen in the retail outlets in London, can be purchased through the streets of New York and Tokyo (Fletcher, 2008). In the fashion literature, the emergence of the globalized chain of fashion distribution is often characterized as McFashion¹, seen as “as unsatisfying, commonplace and utterly forgettable as the fast food equivalent” (Busch, 2008, p. 32). If one of the reasons one buys and puts clothes on is to construct a sense of self and identity, this basic need is greatly threatened by the McFashion culture. Moreover, other non-material human needs such as creation and participation are also jeopardized with the homogenous and top-down approach employed by the fashion industry.

The approach to a sustainable fashion future doesn’t just lie in the drastic cut of clothes consumption. In addition to developing more environmental and human friendly production strategies, the path to a future that strays away from unsustainable cycles of consumption and disposal needs to lie on the fundamental understanding of why one consumes fashion in the first place. Relying solely on a “can’t-have” message of anti-consumption is ignoring the significance that fashion plays in the human culture, while not addressing the root-causes of the issue. The approach should be of a “can-do” message instead, where human needs of participation, creation and recreation are accentuated (Fletcher, 2008), together with the ever-present basic quest for identity.

2.3.1. Made by me, made to last

One of the key aspects that concerns the fast paced scenario – fast to produce, fast to consume, fast to dispose – that the fashion and textile industry finds itself in, is the durability of clothes. Durability is often related to as a key solution to the problem of unsustainability in fashion: durable textiles and clothes will extend the life-cycle of the products, and therefore less products will have to be created. As Fletcher suggests, however, a deeper understanding to why people consume fashion is the key to thinking of solutions that can fix the issue at its root – which she argues will not be solved through durability. Assuming that the durability of textiles and clothes will stop people from recycling their wardrobe is not necessarily understanding the consumer needs in its fullest – “Not all things are thrown away because they are worn out, but rather, in most cases, because people are bored with them” (Fletcher, 2008, p. 165). There’s a difference between making products that last and making long-lasting products, and the understanding of this difference is the understanding how and why the products are used.

A list of considerations should be taken into account when designers try to create long-lasting products, like the balance between the investment in making durable clothes vs. the actual expected life duration of the piece – research has shown that designers have an unbalanced view, for they want materials to be as durable as possible whilst garments are expected stay on trend for an average of six months only (Fletcher, 2008). In the context of this research, however, the

¹ Term coined by journalist Michelle Lee in her book “Fashion Victim: Our Love-Hate Relationship with Dressing, Shopping, and the Cost of Style”, 2003
most pertinent consideration when it comes to the creation of long-lasting products is the facilitation of emotional connection between product and wearer, which is believed to encourage ongoing and long-lasting use.

In the current mainstream scenario of fashion consumption, users are bounded to participate in the process through mere choosing; a passive role. In a world where fashion is so central to culture, there are far too little opportunities for one to have a saying in the making of what they wear, and “no real opportunity is offered to ‘talk-back’ to the system, which some would argue to be somewhat undemocratic” (Busch, 2008, p. 32). This research is, therefore, in line with the view that opening up the fashion stage for a participatory design approach, where the consumers are no longer passive choosers, but rather co-creators of their goods, is a substantial path to sustainable consumerism. Allowing users to participate in the creation process is believed to generate long-lasting products through a creator-design bond. The empowering act of user involvement, therefore, goes to fulfill some of the most basic of their needs: participation and creation (Fletcher, 2008).

Through the questioning of how an interactive tool can create greater means of self-expression through the design of textiles, this research is therefore proposing an approach that bridges the gap between fashion production and consumption. It attempts to connect the users directly to their products, generating long lasting bonds that are triggered by the meanings generated through the inclusive creation process.

### 3. Related work

Within the design space created by this research, four different related projects will be examined in the following section. Each of the projects touches upon different relevant aspects introduced by the theoretical background, namely: sustainable fashion, interaction design and analog textile exploration, and smart textiles for fashion customization.

**Hacking-Couture**

Initiated by Giana González (2013), Hacking-Couture is a series of workshops that aims to reverse engineer fashion patterns of luxury designer brands, such as Gucci and Burberry. In the workshops, González invites the participants to analyze the different materials, structures and signals that composes the fashion signature of certain brands, and to map it out in diagrams. From there, people can reuse the bits of deprogrammed fashion codes and build them into their own pieces of clothing, repurposing them. See Figure 1 for an example of a diagram resulted from deconstructing Chanel.

González’ initiative invites people to engage creatively with fashion creating unique clothing through the upcycling of second-hand articles. It is a form of fashion activism that questions the top-down approach of the fashion industry, while promoting participation, identity, DIY and fashion engagement. The workshops promoted by González is, therefore, well in line with the notion that a sustainable fashion format can be achieved through a shift in production-consumption relationship, bringing those two closer together.
Abstract_

Abstract_ (Karmann, n.d.) is a project that combines interaction design with fashion and textile. It intends to map user’s emotions into textile design, which is ultimately transformed into clothing. With Abstract_, the users are invited to create their textile design through the tracking of their facial expressions and the rhythm of their keyboard as they write a story. The tracked information is translated into a unique design, which is then finally weaved into a textile and transformed into clothing (see Figure 2).
The efforts of the Abstract_ project show the potential that textile in its analog form has to self-expression and personalization, thus posing as a strong source of inspiration for this research. It can be argued, however, that the gathered information used as input for the textile design doesn’t clearly connect to one’s true emotions and self-expression: the tracking of an intentional facial expression is not believed to convey an emotion, and neither is the rhythm one’s typing.

**ShiftWear**

ShiftWear is a customizable line of sneakers that connects a mobile app to a flexible e-paper technology built onto the canvas of the shoes (ShiftWear, n.d.). The wearers can, via the app, upload any designs they want to display in their sneakers (Figure 3).

![ShiftWear sneakers](image)

*Figure 3. ShiftWear line of sneakers allows the wearer to upload their own designs to their shoes through a connected app (ShiftWear, n.d.)*.

The initiative shows how efforts in the development of smart textiles and wearable computing finally have the potential to reach the masses: The project, which started off from a crowdfunding platform, gathered a total of $928,777 (3092% of their goal), which demonstrates the urge for customization from fashion consumers. ShiftWear shows, too, that a fruitful path to a sustainable fashion lies with the understanding of how consumers want to express themselves through their garments, and what makes, in fact, a long-lasting product last long. The interactive and customizable sneakers are promising of having a long wearing life-cycle because it allows the wearers to constantly recycle the shoes according to their own needs for identity communication, instead of buying new ones. ShiftWear is a direct inspiration to this research, for it succeeds in the quest for self-expression through textile, and it does so in a smart, dynamic way.
4. Design methodology

The aim of this research is to ultimately propose the design of an artifact that attempts to embody the background theories and questions presented thus far. The design methodology applied in this research, therefore, works within the design space created by the exploration of the different theories through the process of designing the artifact (Gaver, 2012).

In order to attain the preferred suggestion of a design artefact that fits in the design space, iterations of design activities and experiments were at the core of the process, guided by the research question introduced above. The practice of focusing research on designerly activities is characterized as Research through Design (RtD) – an approach to research that has been increasingly growing in the HCI community and which employs the skillful practice of design activities as core means of research inquiry (Krogh, Markussen, & Bang, 2015) (Zimmerman, Stolterman, & Forlizzi, 2010).

The growing interest of the HCI community in RtD emerged from the fact that the practice has been challenged more and more with “wicked problems”, which are often complex societal problems that are difficult to solve or to reduce to parts that can be tested for usability. Wicked problems have no right or wrong solutions, but rather good or bad. Research through Design, therefore, suggests that “the goal of solving a wicked problem is a solution that is optimal for the current situation and not a focus on the discovery of truth.” (Zimmerman, Stolterman, & Forlizzi, 2010, p. 311)

The questions proposed by this research are not necessarily wicked. However, even though the posed questions don’t point towards societal change, they do inspire a quest for societal improvement by exploring ways in which one can take part of the creation process of their goods, and therefore creating long lasting products in a sustainable fashion. The scope of this research is, therefore, set up in line with a broader view of RtD that follows the notion that the research is “a way of broadening the scope and focus of designers, of challenging current perceptions on the role and form of technology” (Zimmerman, Stolterman, & Forlizzi, 2010, p. 311). Rather than aiming for big a societal change, this research intends to explore the role of technology in a particular social aspect – fashion and consumption – in order to promote societal improvement.

4.1. Drifting through a serial approach

Design activities and exploratory sketches are at the core of the RtD practice – as Krogh et al. (2015) puts it, sketch “is the dominant means by which ideas are described and evaluated for their quality and appropriateness in responses to a design challenge” (p. 6). In RtD, at each iteration of the process, experiments – or exploratory sketches – are designed as knowledge-building activities, guided by the research questions and insights generated by previous initiatives.

The iterative loop of conceptualizing, making and evaluating opens up the process to the possibilities of drifting the research focus, and adjusting its goal as it goes. Even though drifting is perceived as failure in other research approaches, the act of wandering through a design space
is a benefit in Research through Design, seen as “a quality measure as it tells the story of a designer capable of continuous learning from findings and of adjusting causes of action.” (Krogh, Markussen, & Bang, 2015, p. 2)

The combination of the drifting nature of RtD and its sketches, experiments and questions is greatly benefited from the work of Krogh et al. (2015), which suggests the use of a typology to better substantiate the RtD process, creating a framework that allows the experiments to be closely evaluated and validated throughout the process. The close attention to the iterative steps and the relationship between the different sketches and activities emphasizes the importance that RtD assigns to “how one got there” (Krogh, Markussen, & Bang, 2015) and places it above the actual importance of the final product. In line with the the suggested typology, therefore, this research follows the “serial” implementation of design activities. The serial approach to RtD executes explorative sketches in a chronological order, allowing for insights and findings from previous activities to influence the future ones, therefore leading the work onward at every iteration (Krogh, Markussen, & Bang, 2015).

The initial set of serial activities employed in this research were structured as lab research in workshops format. The lab approach, as introduced by Koskinen et al. (2008), was chosen as a preferred initial method because it allows the research inquiry space to be explored through different systemized setups – the workshops in this case – where participants are exposed to different variables and different outcomes can be analyzed. Casual mechanisms observed in the workshops could, therefore, serve as solid ground for the following design process steps (Koskinen, Binder, & Redström, 2008): concept development and prototypes.

5. The design process

*How can an interactive tool create greater means for self-expression of the dressed body through the design of textiles?*

The goal of the design process implemented in this project is to explore the the main question around which this research is framed. Through further unpacking of the research question, it can be revealed that the design of an interactive tool that creates means of self-expression through textile opens up to yet other three important areas of inquiry. Through the design process, therefore, this research is set out to explore:

1. How can one express themselves, and through which means?
2. How can a textile design (paint on textile canvas) convey one’s self-expression?
3. How can machine and painting tools (such as brushes) work together in efforts to aid the self-expression?

Figure 4 illustrates how the posed questions create an inquiry space, delimiting the overall area of exploration of the design process.
In order to start the exploration of the research space, a first design activity was designed to probe the question of how one can attempt to express aspects of themselves through paint on textile. The first exploration, therefore, lies on the middle of the edge between the vertexes “expression of self” and “mapping of expressions” from the inquiry triangle. With the results and insights gathered from the first activity, a second design exploration was designed to slightly modify the first one in order to further explore the matter, leading the experiment towards the “material & machine” vertex. Thereafter, a third design experiment used the tangible results from the first and second activities to probe the overall inquiry space of how one perceives the transformation of the textile that was painted through their self-reflection (such exploration floats around the middle of the triangle).

With the insights and learnings gathered from the design experiments, a concept for the proposed artifact emerged from brainstorming and sketching, which was then taken through prototyping explorations. Different prototypes were built to test and reflect upon different aspects of the concept – look and feel, role and implementation – and finally the design process was concluded with the design of a final working prototype.

![Design process inquiry space created by the 3 posed questions](image)

### 5.1. Design activity 1: Mind and Paint

The *Mind and Paint* design activity was designed to explore how one can use paint to create patterns on textile while trying to translate different aspects of themselves onto the canvas. Formatted as a workshop, the activity aimed at probing the possibilities of expression and aesthetics delivered by participants with no experience in painting. Ultimately, the *Mind and Paint* workshop was conceived to introduce and expose the participants to the design materials (textile, paint, painting tools) and to open up the task of self-expression.
5.1.1. The painting exercises

The workshop was comprised of a set of painting exercises to be executed by each participant onto an empty textile canvas with the intention of creating textile design. Because the participants were unfamiliar with painting practices, the tasks aimed at exploring what could be the possibilities of aesthetics and expression developed by the laymen participants through paint. Thus the different exercises were designed to call for different levels of artistic freedom: from completely free to to rule-based painting.

The main elements of the workshop – painting and textile design – naturally created an environment that stimulates creativity. Following studies on creative cognition, rules were therefore introduced in the painting exercises to primarily nurture the creative process. It is proved that, through a creatively demanding activity, the existence of constraints boosts the creative level employed by the actor through the process, and seen in the outcome (C. Page & Darren W., 2005). These constraints, which are treated as rules in the Mind and Paint workshop, are more likely to stray the participant away from following the “path of least resistance” (C. Page & Darren W., 2005) – i.e. performing the commonly known; the first thing that comes into mind – and therefore engaging the participants in a more creative mindset when creating the textile design.

Rules in drawings can be said to be the pre-computer version of generative art (Boden & Edmonds, 2009) – a form of art making that is done by through a computer taking decisions according to a rule-based system. Works of Kenneth Martin with ‘Change, Order, Change’ are examples of how procedures and chance were introduced to art-making – he started using rules after becoming “uneasy about his current processes of abstracting and constructing from nature” (Tate Museum, 2004). In the context of the Mind and Paint workshop, however, the use of rule-guided painting was introduced as a way to aid the participants in their painting exercises, in addition to stimulating creativity –i.e., to evaluate whether such rules system would be perceived as an obstacle or a help in the participant’s expression on the canvas.

5.1.1.1. Self-reflection in the painting exercises

In order to explore the translation of aspects of one’s self onto the canvas – a key aspect of the workshop inquiry – the rules system of the painting exercises was applied to a set of self-reflective exercises. The practice of self-reflection has been proven to promote self-insight, (Hixon & Swann, 1993), thus painting while engaging in a self-insight fostering activity is believed to ultimately stimulate paint strokes that carry meaning and aspects of one’s self.

All of the painting exercises involved the self-reflection tasks as either a start or as a continual input to the painting. The nature of the reflective tasks is also key to how the activity can foster self-knowledge, and what type of self-insight it promotes. According to Hixon & Swann’s research (1993), triggering questions of “what” in regards to one’s self promotes better self-insight, while questions of “why” undermines it. The self-reflection tasks in the workshop, therefore, employed matters such as “what memories” or “what belongings” as input to their painting exercises. Two examples of painting exercises created for the workshop can be seen in Table 1.
Exercise | Instructions
--- | ---
Food dreams | Close your eyes. Think about sitting at a dining table. You are waiting for your favorite dish. Look around. The dish arrives and you start eating. The dish tastes better than ever. Now paint how this experience feels like.
Circles in us | While thinking about your past month, keep painting circled shapes. Don’t stop. When you think of a memory that makes you happy, paint one circled shape of another color.

Table 1. Two examples of painting exercises created for the Mind and Paint workshop. The first is an example of a free drawing exercise, while the second is a rule-based example.

The introduction of rules in addition to the reflective quality in the exercises was an attempt to investigate how one could bridge their sense of self and their paintings, in either a free or rule-based painting. An important issue that can be raised about the free vs ruled painting matter is that, when following rules, the ability to express one’s self is considerably reduced. This is a problematic that was paid close attention to during the workshops and will be discussed later.

Refer to Appendix A for the full list of the exercises created for Mind and Paint and where they are positioned in a range spectrum of painting freedom.

5.1.1.2. Creating the right exercises

A brainstorming process was set up for the formulation of painting exercises that could yield different aesthetics in the outcomes, through different self-reflective tasks. The strategy chosen for the brainstorm was to gather various different references of painting styles as a mood board (Error! Reference source not found.), and to write down as many different ways that one could reflect upon their lives. Later, the painting exercises were created through attempts of mapping the reflective tasks to the different painting references. The mapping was done by creating rules that, once followed, could possibly reproduce the chosen painting aesthetics through the chosen self-reflection.

5.1.2. The painting tools

An important goal of the Mind and Paint workshop was to encourage the participants to paint through their self-reflection, expressing themselves in abstract paint strokes, rather than concrete illustrations. The reason for trying to achieve such abstract results has to do with the goal of creating an aesthetics through the painting that could be better utilized as textile pattern.

The abstract brush strokes aimed for through the painting exercises can be said to be essentially the result of gestural manipulations of the drawing tools. Being much more than just purely hand movements, gestures are symbols that display meaning that is “freely designated by the speaker” (McNeill, 1992); which in turn can exhibit either concrete or abstract intentions (i.e., what words are unable to express). In the context of the Mind and Paint workshop, abstract gestures –
symbols – are expected to be fostered by the combination of the self-reflective tasks (which will prompt for expression through paint gestures) with a set of crafted painting tools. The tools (Figure 6), ranging from sponges to feathers, were assumed to invite abstract exploration due to their unfamiliar nature (a large brush was still made available, in case one felt like needing a proper brush). In the workshop setup, the brushes were used in combination with different textile colors to be painted onto the canvas through the painting exercises. Figure 7 shows the a participant painting the textile in the workshop setup.

Figure 5. Mood board section of painting aesthetics meant to guide the creation of the painting exercises.
Figure 6. Tools created for the Mind and Paint workshop in order to encourage abstract paint strokes.

Figure 7. Participant painting "a quote they like" as part of an exercise.
5.1.3. Workshop insights and conclusions

Six people participated in the *Mind and Paint* workshop, ranging from 23 to 32 years old. They were all students of the School of Arts and Communication at Malmö University. Each participant went through 4 different exercises with varying levels of painting freedom (Figure 8 shows results from both free and rule-based painting exercises). The *Mind and Paint* workshop delivered important insights into the relationship between the expression of self and the painting activity. Overall it could be observed that the connection between the the painted textile and the participant happened mainly through the self-reflective process involved in the exercises. When asked which painted pattern they would choose to have an accessory made out of, the participants mainly chose meaning over aesthetics – or had a hard time choosing aesthetics over meaning – which shows that the participants, in fact, connected mostly to the paintings that fostered deeper self-insights. Moreover, it is believed that the textile-participant connection stands because the participants were the actual creators of their own expressions (with no intermediary medium). The engagement in the actual painting activity – from mind through body to paint – is believed to play a strong role in the creation of meaning. As Overbeeke (2007) puts it, “meaning cannot be detached from action. Meaning is (inter)action” (p. 4). The observed strong connection created between participant-textile through the self-reflective tasks and direct interaction shows a promising path for the creation of long-lasting products – which is this research’s premise for improving fashion sustainability.

<table>
<thead>
<tr>
<th>Insight</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Painting exercises are a great way to guide the participants into self-reflection and self-expression.</td>
<td>• Continue exploring the use of painting exercises as the start of the painting experience.</td>
</tr>
</tbody>
</table>
| Rule-based painting offered greater possibilities for self-reflection, therefore creating a stronger connection between the participant and the final result. | • Explore rule-based painting as the core of the experience;  
• Explore the rule-based exercises so that the participants still have some level of creative input, while following the rules; |
| The engagement in the painting activity with their own hands – mind through body to paint – is key to creating a stronger bond between the participant and the textile design. | • Continue exploring the hands-on engagement of the participants as a core element of the experience.                                                                                                                                 |
| Aesthetics is a decisive factor when choosing to wear the textile pattern as clothing or accessory – sometimes even prevailing over meaning. | • When formulating painting exercises, explore the aesthetics of the rule-based painting, so that the repeatability of the designs appeals to the participants  
• Create painting exercises that balances aesthetics and self-reflection. |

Table 2. Summary of insights and actionable items from the *Mind and Paint* workshop

20
The insights from the *Mind and Paint* workshop provided essential input for the creation of the second workshop – *Mind, Paint and Machine* – which had a similar set-up as the first one, but with a focus on ruled-based paintings. Refer to Appendix B for a detailed report on the workshop results. Table 2 shows a summary of the workshop insights and the action points related to them.

![Figure 8. Painting results examples. The top 4 paintings were created through rule-based exercises, whereas the bottom 4 were created through freer exercises. Notice how the diversity of paint strokes is higher in the bottom results.](image)

### 5.2. Design activity 2: Mind, Paint and Machine

From the insights drawn from the *Mind and Paint* workshops, a second design activity – *Mind, Paint and Machine* – was designed to initiate the exploration of a possible machine role in the painting experience. When designing the activity, *Mind, Paint and Machine* quickly became a variation of the first workshop, with a clear focus on the actionable items taken from the insights, plus the introduction of the machine actor.
5.2.1. The new set-up

In order to explore a possible role for a machine in the experience, the painting exercises from the first workshop were re-formulated to allow for the collaboration between participant and machine. Because the Mind, Paint and Machine workshop was only the start of the exploration of a human-computer co-painting, the machine role was given to the instructor in the exercises, rather than an actual computational hardware.

The collaborative task between participant and instructor could be framed in multiple ways by the painting exercises, from how close they would be painting to each other, to the varying the levels of influence. The exercises were, therefore, designed so they could explore the different collaborative scenarios. Figure 9 shows the ‘collaborative matrix’, where its quarters represent different scenarios of influence vs. togetherness in the painting. For the full list of the different exercises and their position in the matrix, refer to Appendix C (table X shows two examples).

Following the insights from the Mind and Paint activity, new aesthetics for the exercises outputs were too explored (following the same brainstorming technique applied for the first workshop). After all, the greater the variations in the results from the workshops, the clearer the picture of how meaning and aesthetics can come together.

Finally, the overall setup of the first workshop was kept intact: tools, textile and paint. Figure 10 shows the new workshop setup, with the participant and the instructor collaborating in a painting exercise.

Figure 9. The Collaboration Matrix. Each quarter represents a collaborative scenario between the participant and the machine-role: 1 – Loose collaboration; 2 – Pseudo-collaboration; 3 – Strong collaboration and 4 – Disconnected collaboration.
<table>
<thead>
<tr>
<th>Exercise</th>
<th>Instructions</th>
<th>Matrix quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Triangles in-between</strong></td>
<td><strong>Instructor/Machine</strong> &lt;br&gt;Draw triangles in the canvas, leaving spaces in-between. &lt;br&gt;<strong>Participant</strong> &lt;br&gt;Draw a triangle in-between instructor’s triangles for every Facebook friend you can think of. Whenever you feel you miss that friend, mark that triangle somehow.</td>
<td>2 – Pseudo-collaboration</td>
</tr>
<tr>
<td><strong>2. Lines and shapes</strong></td>
<td><strong>Participant</strong> &lt;br&gt;Draw whatever shapes over the instructor’s lines while you think about things you have in life. Don’t stop. When you think of something you have but could live without, paint a shape in a different color. Continue on. &lt;br&gt;<strong>Instructor/Machine</strong> &lt;br&gt;Draw lines. Whenever the participant changes color, change the direction of the lines. Whenever the participant stops to think, draw dotted lines.</td>
<td>3 – Strong collaboration</td>
</tr>
</tbody>
</table>

Table 3. Two examples of painting exercises created for the Mind, Paint and Machine workshop.

Figure 10. Participant and instructor (playing the machine role) collaborating in a painting exercise for the Mind, Paint and Machine workshop.
5.2.2. Workshop insights and conclusions

Five people participated in the *Mind, Paint and Machine* workshop, ranging from 26 to 35 years old. They were again all students of the School of Arts and Communication at Malmö University, and each of them engaged 3 different exercises in collaboration with the instructor.

Upon analysis of the workshop, it can be concluded that the combination of a rule-based painting system and a collaborator following machine-like instructions provides a favorable balance of meaning, expression and aesthetics. The rule system, being flexible enough to support different types of expressions, creates a space that fosters a mindful activity and, therefore, a tighter connection between mind, body and paint. The machine, in turn, was shown to provide further guidance to the participant’s painting experience, in addition to ensuring that the final result has a consistent aesthetics and textile pattern quality that is expected from textile design. Refer to Appendix D for a detailed report on the workshop results. Table 4 displays a summary of the main insights gathered from the *Mind, Paint and Machine* workshop, and its actionable items.

<table>
<thead>
<tr>
<th>Insight</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>The introduction of a machine-like collaborator in the painting activity created a satisfactory balance of expression and aesthetics in the experience.</td>
<td>• Further explore the role of the machine in the collaboration – its qualities, form and functions.</td>
</tr>
</tbody>
</table>
| Due to the introspective nature of the painting exercises, the machine’s actions and reactions through the activities weren’t at all noticed by the participants. | • Design collaborative painting exercises that doesn’t necessarily focus on high levels of influence (as per the “collaborative matrix” shown in Figure 9).  
  • Explore the aesthetics of the machine drawing as its core contribution to the collaboration. |
| Even though the machine was played by a person (the instructor), the collaboration between the actors was silent. The silent set-up was seen as a comfortable experience. | • Understand what qualities the machine should have in order to keep a comfortable setup for the participants. |

*Table 4. Summary of insights and actionable items from the Mind and Paint workshop*

5.3. Design activity 3: Transformation Time

Following the *Mind and Paint* workshops, a third design experiment was employed in the design process of the research: the transformation of the painted textiles into personal accessories for the participants. The preferred scenario for this experiment would have been to transform the textile into clothing pieces – since it is the premise of this project – but for time efficiency reasons (it would take a relatively much longer time to design and sew 11 pieces of clothing), and because the areas of painted textile were rather small, pouches and small bags were created instead.
The goal of this experiment was to understand how one would feel when seeing the transformation of their painted textile, and what meaning that piece of accessory would have to them. The experiment also intended to explore whether the participants perceived their painted creations as a textile pattern – i.e. a material that could be cut through, and rearranged for other purposes – or more as a “painting” that should be displayed in an intact way – i.e. untouched, uncut.

5.3.1. The sewing

A bag was created for each of the 11 participants using the textile painting that they had selected at the end of their workshop activities. Each bag was uniquely designed, taking into account each uniquely created pattern and how they could best be transformed. Some of the painted textiles were intentionally cut into smaller pieces – then sewn together – than others, in order to compare reactions to the textile treatment. The paintings that resembled repeatable textile patterns (the ones created through rule-based exercises) where cut through the most, as opposed to the paintings that were known to portray a picture more than a pattern (the ones created through freer painting exercises). Figure 11 shows an overview of all of the sewn bags.

Each bag was tagged with a label that indicated how that piece of accessory was created (e.g., “Made by me and my past month’s memories”). The label was an added detail that served the purpose of refreshing the participant’s memory about the workshop and their chosen painting. Figure 12 shows some of the labelled bags.

Figure 11. Overview of the 11 transformed painted textiles.
5.3.2. Experiment insights and conclusions

The results from the Transformation Time experiment showed that a great value lies on the transformation cycle that the textile goes through: from being transferred meaning through the participant’s paint, to its form alteration – i.e. when the textile stops being a mere canvas to being carried through someone’s life. Different meanings are attached to the textile at the different steps of the cycle, and each step is believed to strengthen the connection between the painter and the product. It’s through this cycle that the textile slowly starts to come closer to becoming, in fact, “an extension of the soul” (Entwistle, 2000). Refer to Appendix E for a detailed report of the Transformation Time experiment. View Table 5 for a summary of the experiment’s insights and their actionable items.

<table>
<thead>
<tr>
<th>Insight</th>
<th>Actions</th>
</tr>
</thead>
</table>
| The transformation and manipulation of the participant’s paintings boosts the aesthetic value of the textile, and therefore is deemed and crucial for the acceptance of the final product. | * Proceed with exploring the canvas painting as textile pattern.  
* Further explore aesthetics possibilities, and how can the participant input their own sense of aesthetic to the final design. |
The participants didn’t see the machine’s work as an overshadow to their own work. In fact, they felt full ownership over the painted design.

- Further explore the machine as a collaborator of the work.

The explicit awareness of “designing textile” might influence the way the participants engage in the painting activity. It’s possible that they would distance themselves from the reflective nature of the exercise, to focus on creating “proper” designs.

- Understand how the task of designing textile could be introduced in a way that won’t negatively influence the participant’s mind-set through the experience.

The added labels in the packaging played an important role in the unpacking experience, because it reminded the participants of how they painted the textile.

- Explore how labels can be integrated in the clothing – through packaging or embedded in it.

| The participants didn’t see the machine’s work as an overshadow to their own work. In fact, they felt full ownership over the painted design. | The explicit awareness of “designing textile” might influence the way the participants engage in the painting activity. It’s possible that they would distance themselves from the reflective nature of the exercise, to focus on creating “proper” designs. | The added labels in the packaging played an important role in the unpacking experience, because it reminded the participants of how they painted the textile. | Explore how labels can be integrated in the clothing – through packaging or embedded in it. |

Table 5. Summary of insights and actionable items from the Transformation Time experiment.

5.4. Prototyping

The insights generated from the Mind and Paint workshops and the Transformation Time experiment provided a great amount of input for the start of the exploration of the interactive artifact. A number of prototypes were created in order to probe the different options and states of the artifact’s design. Following Houde & Hill’s (1997) model of what prototypes prototype, each prototype created for the interactive painting machine will be positioned according to the “role - implementation - look and feel” triangle and their main goals.

Upon analysis of the previous design experiments and conceptualization of the desired artifact, its main qualities could be established for further exploration with the prototypes. Overall, it was defined that the artifact should allow for one to directly paint on a textile canvas together with a computer-controlled collaborator. Additionally, the participant should paint through rules over a self-reflective task, guiding their brush and their mindset. The machine, in turn, should have the role of setting the overall aesthetics of the textile design, while providing further guidance for the participant’s painting experience.

Apart from the overall directions presented above, more detailed explorations and questionings – such as how one can influence the machine with their own personal style – will be presented in the following sections through the introduction of the different prototypes.

5.4.1. The Rotating Canvas concept

With the results from the design experiments, brainstorming sessions kicked off the creation of the first concept prototype. Different setups for interactive machines were explored through paper and 3D rendered sketches. They all probed different ways in which the machine could address the research insights and overall decisions taken upon the artifact. The different suggestions generated through the brainstorming were then evaluated and finally one idea shone
through, presenting potential to keep up with the insights and decisions. The chosen idea derives from the 3D render displayed in Figure 13, which was created in order to evaluate the possible look-and-feel of the artifact (and ultimately to boost personal motivation for the construction of the machine).

The concept mainly consists of a wide cylinder that rotates through its horizontal axis and that is covered (wrapped) by a textile canvas around its surface. The canvas on the cylinder is approximately 100 centimeters wide, and has an approximate circumference of 140 centimeters (i.e., 44 centimeters of diameter). Such measurements are key to ensure that the resulting fabric is large enough to be used in the creation of different types and sizes of pieces of clothing. The magnitude of the canvas is also the reason why a cylindrical canvas was chosen instead of a standard flat variant – less space in the room is therefore appropriated with a large canvas surface.

In the concept, the user paints onto the canvas through a self-reflection task, with their own paint and tools and sitting in front of the cylinder as it rotates. The computer collaborator, in turn, controls both the rotating cylinder and a brush that stands on the top of it. The computer controlled brush moves horizontally through a linear motion shaft as it also paints the canvas as it rotates.

Figure 13. 3D render of an idea for the painting machine. 3D renders were created in order to evaluate a possible look-and-feel of the artifact.

5.4.2. The Mini-Machine prototype

In order to explore how the Rotating Canvas concept could be implemented, a miniature version was designed with cheap material, such as cardboard, tape, a few electronics and fabric. The Mini-
Machine is essentially a tangible sketch and initial exploration of what the final artifact could be. The prototype aimed at exposing the construction implications of the Rotating Canvas concept, as well as the software and hardware requirements for building the machine. Moreover, beyond exploring the technical implications of the concept, the prototype also aimed at investigating how the experience of painting in such setup would feel like, and what were the aesthetic possibilities for the collaboration between user and machine. Thus, if positioned in Houde and Hill’s (1997) triangle model, the Mini-Machine prototype would be placed around the middle of the triangle, but leaning towards the “look and feel” vertex.

In the Mini-Machine, the rotating cylinder was built to be controlled by two electronic buttons, which moved the cylinder backwards and forward through a programmed stepper motor. The computer-controlled painting tool was emulated by an analog version of it, which consisted of a brush standing on a cardboard rail placed on top of the cylinder. One could drag the brush left and right to emulate the computer-controlled brush.

![Figure 14. The Mini-Machine prototype. The left image shows how the cylinder could be controlled by the backwards and forward buttons. The right image shows how the collaboration between machine (emulated by the top brush held by a hand) and participant could be set up.](image)

The composition of the cylinder and the brush rail basically creates a XY plotter setup. Plotter machines are standard computer-controlled devices that translate virtually produced graphics into real canvases by moving one or more drawing tools (such as a pen) through X and Y axis (Tighe, 1987). In the case of the Rotating Canvas concept, however, the XY movement is slightly modified from the standard: the drawing tool (the brush) only moves in the X axis, while the relative movement of the cylinder controls the Y axis of the drawing. On the extremes of the X axis lays a small bucket of paint, so that the brush can refill when needed.

The XY plotter emulation represents the computer side of the painting collaboration. The participant collaborates by painting in front on the cylinder, as presented in the concept description. See Figure 14 for an understanding of how the Mini-Machine was built and controlled.
5.4.2.1. Sketches, prototypes, prototype sketches, sketchy prototypes

Buxton (2007) argues that sketches are not prototypes, for they serve different purposes and are created in different phases of the design process. According to him, sketches are quickly created in the ideation phases, in the beginning of the process; whilst the investment on building prototypes happens when ideas are converging. Houde and Hill (1997), however, opens up the definition of prototypes to include any execution of a concept (a sketch, a performance or even a brick), or part of a concept, at any iteration of the design process.

To reduce the overwhelming feeling of building a machine from scratch (even if it’s just a prototype), with little to no experience in doing such a job, the Mini-Machine prototype was approached with a sketching attitude: fast, cheap, little details. It embodied the qualities of Buxton’s sketch placed in a transition phase of the process, where ideas have converged. The Mini-Machine became essentially the sketch of a prototype, built to incite learning and stimulate a craftsmanship mindset. Ultimately, the adopted sketching attitude was imperative to overcoming any inertia I was experiencing when it comes to building machines.

5.4.2.2. Insights and conclusions from the Mini-Machine

The sketching of the Rotating Canvas concept through the Mini-Machine prototype played a crucial role in the design process, providing not only means to overcoming inertia, but exposing valuable insights to the concept. The prototype was tested in lab by myself, where I played the role of the machine and the participant at different moments. When playing the machine, I controlled the brush through its horizontal rail and the cylinder with the buttons. When playing the participant, I drew over the “machine’s” painting using a variation of one of the exercises from the Mind and Paint workshops.

It could be observed that the dynamics of the collaboration between participant and machine could take two different directions (view Figure 15). In the first direction, the machine draws first and rotates until reaching the participant, who, in turn, uses the machine’s painting as a guide to their own painting exercise. Such approach was also executed during the Mind, Paint and Machine workshop. The second direction inverts the painting order so that the participant starts the drawing and the machine paints over it.

The two collaborative scenarios offer very different painting experiences. The first scenario has the potential to offer painting guidance to the participants by pre-painting the canvas before them, and to add an aesthetic lead to the painting (both qualities were appreciated by the participants in the workshops). The second scenario would fail to provide guidance to the participant, even though it could also allow for the machine to contribute aesthetically. On the other hand, the second scenario has the potential to allow the machine to paint in accordance to the participant’s painting, reacting to their brush strokes and movement. This potential, however, was deemed irrelevant through the workshop experiments, when it was observed that “due to the introspective nature of the painting exercises, the machine’s actions and reactions through the activities weren’t at all noticed by the participants.” The first scenario, therefore, is concluded...
to be more in line with the results and insights from the workshops and was chosen as the preferred direction.

Figure 15. The machine-participant collaboration scenarios. In the first direction, the participant paints after the machine. In the second direction, the opposite happens.

Because the collaborative painting happens on a rotating canvas, there must be a compromise from the machine’s behalf on the amount of movement employed in the painting in order to better accommodate the participant’s experience (too much movement from the cylinder could jeopardize the participant’s painting). Thus the machine should be programmed to work on smaller scale strokes, which preferably uses the X axis more often than the Y; i.e., less cylinder rotation and more horizontal brush movement. Additionally, the machine should also understand when the participant is painting on the canvas, and perhaps wait for its turn to paint.

In theory, the Rotating Canvas could paint any desired aesthetics that uses 2D vectors as input, as can any XY plotter. After constructing the Mini-Machine and exploring its technical implications, however, it could be understood that the drawing of straight lines is far less complex to implement than different types of curves. If less complexity means faster but effective results, then it is the preferred path for this research project, considering its restricted timeline. By exploring the aesthetics that could be achieved through the plotting of lines (see Figure 16 for an example), it became clear that the visual output of line drawing routines could be in fact very satisfying. Thus it was decided that the machine would collaborate in straight lines only, while the participant could contribute with any type of brush expression.
Table 6 summarizes the learnings and insights gathered from the *Mini-Machine* prototype and its actionable items.

<table>
<thead>
<tr>
<th>Insight</th>
<th>Actions</th>
</tr>
</thead>
</table>
| The machine setup offers two dynamics of collaboration: machine paints first then the participant paints, and the vice-versa. The first scenario is the preferred one because it allows for the machine’s painting to guide the participant’s, while setting the aesthetics of the design. | • Proceed with exploring the first scenario as the main mode of the collaboration.  
  • Explore how can the qualities of the second scenario be applied to the first one, for an optimal experience. |
| The rotating cylinder poses a challenge for the dynamics of the collaboration, which requires the machine to move the cylinder as little as possible when the participant is painting. | • Explore how the machine can create paintings that creates minimal cylinder rotation.  
  • Explore how the machine can detect that the participant is painting, so that it tunes down the cylinder rotation. |
| Line drawing is more efficient than curve drawing, and still offers great aesthetic possibilities. | • Program the machine to paint drawings using straight lines only. |

Table 6. Summary of insights and actionable items from Mini-Machine prototype.

*Figure 16. Aesthetics exploration using lines only. The black lines represent the machine's share of the collaboration. The blue pain represents the participant's addition.*
5.4.3. On generative drawings

In order to collaborate in the painting on the Rotating Canvas, the machine must receive drawing instructions from its computer controller. Such instructions could, in theory, be any type of 2D vectorial design. From the learnings and insights gathered from the Mini-Machine prototype, however, it was decided that the drawing instructions would only include straight lines.

The input of 2D line instructions to the machine could happen in different ways: from uploading scalable vector graphics to the machine controller, to drawing the lines directly onto it. The chosen method for generating line designs is this project, however, is through computer generated art (CG-art). The creation of CG-art is based on a set of pre-programmed rules that defines the intentions of the artist (in this case, the programmer is the artist), which in turn is manifested through the execution of the code. The design and programming of the code is, therefore, a pivotal step of the process.

The use of generative art in the context of the interactive painting machine opens up for two qualities that are deemed relevant for the artifact’s design and experience. Firstly, the output generated from the set of rules would be unique for every participant, since it is up to the computer to make choices along the way, usually through random input. The uniqueness of each design is a desirable quality because it enhances the sense of individuality of the textile designs. Secondly, a variation of generative art, called Computer Interactive Art (CI-art), seems promising in the context of the painting machine. CI-art allows for the choices made by the computer to be affected by the audience’s behavior, thus altering the visual output (Boden & Edmonds, 2009). Such quality goes well in line with the context of the interactive painting machine, since it could allow for the aesthetics of the textile design to be adapted to the participant’s own sense of aesthetics – which is a desired quality derived from the insights from the Mind and Paint workshops. Lastly, since the aesthetic decisions taken by the machine would have to ultimately come from its designer, generating design through code is a strategic choice because it plays to my strengths (I’m a better programmer than I am a visual designer).

Figure 17. Mood board created to inspire the programming of generative line drawings.
5.4.3.1. The prototyping of generative line art

In order to probe the possibilities of line CG-art, different generative drawings were explored and prototyped. Still following Houde and Hill’s (1997) model, this prototype exercise lies exactly in the middle of the edge between the “implementation” and “look-and-feel” vertexes.

The initiation of the generative drawings exploration happened similarly to the creation of the drawing exercises of the Mind and Paint workshops: a mood board of visual references was created in order to inspire the programming of rules that could reproduce the aspired aesthetics (view Figure 17).

![Figure 18. Generative line drawings chosen to be further explored within the interactive painting machine: Crooked Lines, Sea of Dots and Straight Up.](image-url)
From the prototype exploration, three different generative drawings (Figure 18) were chosen to be further explored with the interactive painting machine: Crooked Lines, Sea of Dots and Straight Up. For each of the drawings, a number of adjustable parameters (seen on the right side of the images) can be modified in order to adjust the aesthetics of the output – a feature that can be used in the context of a CI-art experience.

5.4.4. The painting exercises

As stated before, the combination of rules and self-reflection put into the drawing exercises in the Mind and Paint workshops was proven to be a key aspect of the experience. Due to its importance, therefore, the formulation of the right painting exercises is crucial to the experience.

Even though the exercises from the Mind and Paint workshops yielded good results, it was deemed necessary to revisit them, since the exercises would have to comply to the new setup (the artifact’s brand new concept). The triggering of positive and meaningful self-insights is the desired scenario for the self-reflection aspect of the exercises: Since the textile design will essentially carry a “memory” of the painting activity, it is preferred that the memory is positive.

In order to understand how people think of themselves, and how they think when prompted with self-reflective tasks, a questionnaire was designed as an attempt to gather insights, and to ultimately serve as inspiration and input to the design of the painting exercises. The questionnaire had six different open-ended prompts, which together tried to map out different aspects of one’s life: “I can…”, “I have…”, “I like…”, “I am…”, “I remember…” and “Today I…”. As a result, 33 people responded and almost 5000 words were collected from the experiment (most of the answers were long, showing how people open their minds to self-reflection). Since the prompts were – purposely – vague, the responses approached different topics, which were categorized together with keywords extracted from the answers (Figure 19).

Figure 19. Clustering of responses from the questionnaire designed to inspired the formulation of painting exercises.
Moving forward with the formulation of the painting exercises, the same approach implemented for the design of the Mind and Paint workshop was implemented here: the mapping of self-reflective tasks with the desired visual output through the application of rules (self-reflective task + rules = visual output). The visual outputs used in this case were the drawings produced through the generative lines prototype. Figure 20 shows how the process was done.

The gathered inspiration from the questionnaires and the mapping exercise led to the creation of six different painting tasks, which can be reviewed in Appendix F.

Figure 20. Exercise of mapping self-reflective tasks to the visual outputs through painting rules. The self-reflective tasks are listed on the left side, and on the right side the visual outputs are displayed. On top of the visuals lie the respective rules.

5.4.4.1. Choosing your style

Most of the participant’s choices in the Mind and Paint workshops were influenced by their sense of aesthetics. When faced with the choice between their painted textile patterns, personal style often prevailed over meaning – even though this was an admittedly a hard choice to make. Therefore, as a conclusion from the workshops, it was judged to be crucial that the participants can have a say on the textile design aesthetic imposed by the machine, so that meaning and personal style can come together. It is only fair too that the participants can choose the aesthetics since, after all, the textile will be later transformed into clothing to be worn by them.

The defined concept behind the choice of style lies on a set of theme cards. In the cards, the different generative drawings employed by the machine are combined with the different self-reflection tasks to be performed by the participant in the collaboration. Each theme card has a visual clue of how the machine will more or less paint, together with the enunciate of the painting task to be followed by the participant. The defined concept is believed to be a solution that is
close to optimal, because it combines two different inputs (style and painting task) into only one selection. Figure 21 shows the mock-up created for the cards. Within the model of what prototypes prototype, the theme cards mock-up lies on top of the “look and feel” vertex.

In practice, these cards have RFID tags embedded in them, and can be placed in a dock station within the machine. The machine, in turn, contains an RFID reader that senses the selected card and starts the generative drawing process according to the participant’s choice of style.

![Figure 21. Mock-up of the theme cards for style selection. On the left side of the card is the visual clue of how the machine will paint if the card is chosen, and on the right side is the enunciate for the participant’s self-reflective painting task.](image)

5.4.5. Unwrapping memories

The insights from the Transformation Time experiment showed that the “made by me” labels used to wrap the sewn products were an important detail, because they triggered the memories from the painting experience and allowed the participants to connect back to their designs. Following the direction from the Transformation Time experiment conclusions, different clothing labels were prototyped with different materials (Figure 22 shows an overview). Some of the labels were designed to be sewn onto the garments, and some of them were designed to be placed as detachable wrapping label (view examples in Figure 23). The first would act as a long-lasting reminder of the painting experience, and the later would trigger the memories on the unwrapping moment. In the ideal scenario, both labels would be used for one piece of garment.

The prototype, which falls onto the “look-and-feel” vertex of the what prototypes prototype model, provided insights to the label design in regards to label legibility, sizing and positioning.
The shown prototype, for instance, needs further work on legibility if a transparent material is to be used (preferably solid materials should be explored instead).

Figure 22. Prototypes for the garment labels. The copy under “made by me” is a placeholder text, which would be replaced with the topic of the self-reflective exercise used to paint the garment’s textile.

Figure 23. Example of the clothing labels prototypes used in garments. The left label is designed to be sewn onto the garment, and the right one is meant to be detached from the garment.
5.4.6. The Real Deal

The goal of this research is to ultimately gather the results generated by each iteration of the serial design process implemented thus far, and aggregate them into one working version of the proposed artifact. This section will therefore introduce The Real Deal – a prototype that realizes the Rotating Canvas concept in an attempt to embody the theoretical background combined with the research learnings.

In essence, The Real Deal is the enlarged, working variant of the Mini-Machine. It encompasses the same concept description, with the additional insights gathered from building its smaller version: the computer-generated drawings will be restricted to lines of small scale and the machine will detect when the participant is drawing so that it can adjust its painting pace. Moreover, the Real Deal includes the mechanism from which one can choose their style together with the self-reflective painting task.

Building The Real Deal was a combination of different challenges, which will be described in the next sections. The ambition for the prototype was to place it in the very middle of Houde and Hill’s model for what prototypes prototype, where all of the three different aspects of the concept could be tested: technology, look and feel and role. With the time constraints of this research project, however, the prototype could not complete its full cycle to be tested with users – it had to, then, be shifted inside Houde and Hill’s model towards the “implementation” and “look and feel” vertexes, moving away from “role”.

The construction of The Real Deal was divided in three different parts (challenges): 1 – hardware construction; 2 – software implementation and 3 – hardware & software integration. The parts were done in sequence, except for the software implementation, which was done in parallel to the hardware construction. Figure 24 shows a simplified diagram of the communication flow of the artifact’s parts, which guided the execution of the challenges.

![THE REAL DEAL FLOW](image)

*Figure 24. Simplified diagram of the artifact’s communication flow.*
5.4.6.1. The challenges

The first challenge posed by The Real Deal prototype was the physical construction of the machine. From building the cylinder, to creating a cog system for torque transmission, to realizing the brush painting mechanism and integrating the hardware, the physical construction of The Real Deal was, in itself, the biggest of the challenges. The images below show the building progression.

Figure 25. Process of building the cylinder. The top-middle image shows a first failed attempt, followed by the final solution, which uses: cardboard for the exterior shell, circular panels of foam paper to create the internal cylindrical form, PVC tubes for stabilization, MDF wood panels to close the cylinder sides and a metal shaft to act as the horizontal rotation axis.

Figure 26. The cylinder integrated with its outer structure, which allows for suspension and rotation. The image on the right shows the cylinder covered with waxed table cloth for waterproofing (preventing from the fabric paint to penetrate the cylinder).
The second challenge was the software implementation, which has two parts to it: the one that controls the hardware, which was written using the Arduino platform; and the one that creates the generative drawing instructions, which was written using the Processing programming language. For time efficiency, the generative drawing implementation was initiated while the hardware integration was still ongoing.

Because the coding started before the hardware was fully integrated and functioning, a simulator of the physical machine was created in software in order to test the generative drawings and to
simulate the hardware’s interpretation of the drawing instructions. The prototype created to test the CG-art (explained a couple of sections above) was the center player of this phase in the process – its reuse saved a lot of time and effort when creating the simulator (Figure 29 shows a screenshot of it in action).

![Figure 29. Painting simulator. The grey lines illustrate the generated drawing, the pink lines show the simulation of the machine moving from A to B to start painting a new instruction, and the black lines show the progress of the painting simulation.](image)

Finally, once all of the main hardware modules were fully functioning, it was time to integrate hardware and software together for the third and last challenge. For that, the software component that controls the hardware (written with Arduino) had to be implemented. A state machine was then conceived and implemented in order to receive the drawing instructions from the Processing code, and to thereafter control the hardware modules accordingly. Figure 30 shows a simplified overview of the state machine.

![Figure 30. Simplified diagram of the artifact’s state machine. Each circle shows a state of the machine, and the arrows show what triggers the start or end of each state.](image)
5.4.6.2. Prototype insights and conclusions

The implementation of the state machine was virtually the last step accomplished by this research. The Real Deal prototype, therefore, is a working representation of the essential components of this research’s proposed artifact. Further testing and refinements did not make it into the process due to timeline constraints, along with other relevant features that were also unable to be implemented.

Even though not all of the features we integrated and no thorough testing was executed, the machine was still evaluated in lab throughout its construction: Just before software and hardware were integrated, a few sessions of painting onto the rotating canvas were carried out. The same setup used for the testing of the Mini-Machine was applied to The Real Deal, where I played the machine and the participant at different moments. Standing on top of the construction, I played the machine by painting in straight lines, while rotating the cylinder with the two buttons. Later, when the canvas was fully painted, I sat in front of the cylindrical canvas and painted through the shapes set by the machine’s painting routine. See Figure 31 for a result of one of the testing sessions (which also shows the machine’s full setup).

Figure 31. Overview of the machine. The canvas was painted through the testing process where I played the machine and the participants at different times.

One important insight from doing such exercise was that, while the cylindrical aspect of the machine allowed for long textiles to be designed in relatively small room spaces, it also proved to be key for the “designing textile explicit awareness” issue exposed by the Transformation Time experiment. The issue points out that the explicit awareness of designing textile might influence the way participants engage in the painting activity – meaning they would distract themselves from the self-reflective task and focus too much on the looks of their textile design. One way that
the cylindrical shape proved to help on the issue is by limiting the participant’s view of the canvas. Because they can only see a proportionally small area of the canvas while sitting in front of it, their “full-picture” of the textile is positively hindered, thus restricting them from over-analyzing the design.

Ultimately, The Real Deal is an attempt to address all of the actionable points gathered through the learnings and insights of the design process thus far. It shows how the design space theories can be embodied through the proposal of an artifact – conceptually and practically. Since not all of the desired features could be implemented, however, a few points from the learnings were not addressed in the current format of the prototype. The to-do list for future work includes the implementation of the RFID theme cards to be used as the initial step in the machine interaction, and the addition of sensors to the machine so that it can recognize when the participant is painting, in order to adjust its painting pace.

6. Results and analysis

Following the serial approach suggested by Krogh et al. (2015) for RfD, the research process went through a series of design experiments in order to probe its design space. Each design experiment informed the next, until a final suggestion and prototype of an interactive artifact was achieved. The first design experiments aimed at starting the exploration of the research inquiry space created through the posed research question: How can an interactive tool create greater means for self-expression of the dressed body through the design of textiles? Following the experiments, a concept was defined and later set of prototypes were built to test the different aspects of the proposed artifact.

6.1. The design experiments

The first experiment (workshop), Mind and Paint, was designed to kick-off first learnings and open up for initial insights. The results from it, however, showed such promising results that it essentially guided all of the following experiments. The outcomes ultimately suggested that the self-reflective nature of the experience was a fruitful path to explore the connection between the user and their generated designs.

The second workshop, Mind, Paint and Machine, explored human-machine collaboration and the role of rules in the painting experience. The results too, pointed towards a favorable direction. The machine, acting as a background player, was appreciated for setting the aesthetics and providing guidance; the rules, in turn, were confirmed to be a help in the creative process, allowing for greater engagement in the self-reflection tasks. A downside of the experiment, however, was that since the machine was played by a person, any feedback received about the machine’s role could not, in theory, be translated one-to-one from the human collaboration to an actual machine’s collaboration. This matter was expected to be explored further through prototyping.
The *Mind and Paint* workshops together fundamentally shaped the research’s path, which, in retrospective, seemed unexpected. Two of the main aspects of the findings – self-reflection as means for self-expression, and direct hands-on painting with brushes as interaction – were not on the radar of the research at all. If any assumptions were made prior to the start of the process, they were that self-expression and interaction would probably happen through some type of tangible tool, instead of mind through body to paint, as uncovered.

Finally, the *Transformation Time* experiment was created as a wrap up of the workshops, putting to test the research’s premise of creating personal products designed through the user’s self-expression. The findings of the experiment confirmed that a connection between the user and the product was in fact created through the hands-on design of the textile. The experiment couldn’t, however, test how much the participants would be willing to wear the textile (as opposed to carrying it), since, due to practicalities, small bags were sewn instead of garments. Although not as ideal, the participants were, instead, asked about the matter, which produced positive responses.

In conclusion, it can be said that the *Mind and Paint* workshops and the *Transformation Time* experiment were fundamental exploratory design activities for the research process, promoting valuable input for the prototyping phase. Figure 32 shows where each experiment is positioned within the research’s design inquiry space.

![Diagram](image)

*Figure 32. Design experiments positioned within the model for the research’s design inquiry space.*

### 6.2. The prototypes

Following the path set by the design experiments, a concept for the interactive artifact was conceived as the *Rotating Canvas*, which allows machine and participant to paint together on a cylindrical canvas that rotates as the collaborators paint on it. Five prototypes were created in
sequence to explore the different aspects of the concept. Figure 33 shows where each prototype lies within Houde and Hill’s model for what prototypes prototype.

The *Mini-Machine* was initially an attempt to sketch *The Real Deal* prototype, and proved to be an invaluable step of the process for it propelled the physical building process. *The Real Deal*, on the other hand, was built in the pursuit of testing the full working realization of the research’s proposed concept. The ambition set for the prototype, however, was higher than the project’s timeline could accommodate, and therefore it could not be fully implemented with all of its features in order to be tested with participants. Nevertheless, it is believed that the execution of *The Real Deal* was key to the research because, as Gaver (2012) puts it, “Design examples are indispensable to design theory because artefacts embody the myriad choices made by their designers with a definiteness and level of details that would be difficult or impossible to attain in a written (or diagrammatic) account” (p. 944).

Apart from the *Mini-Machine* and *The Real Deal*, a prototype was created to investigate the creation of generative drawings, as it was a key quality of the interactive artifact. The prototype, in addition to opening up for the exploration of aesthetics and implementation possibilities, served as a direct asset for the building of *The Real Deal* (saving it from a lot of implementation time).

![Figure 33. The positioning of the the different prototypes within Houde and Hill’s model for what prototypes prototype.](image)

Finally, the theme cards and clothing labels prototypes were more localized on the look-and-feel aspect of the concept, for the benefit of the project’s internal evaluation – as with most aspects of the other prototypes as well. Their executions were so focused on look-and-feel, however, that the prototypes ultimately played more of a “sales-pitch” role, creating a greater understanding of the conceived concept with appealing assets (although the clothing labels prototype did provide insights to the material execution of the labels).
Overall, the prototyping path was a challenging and fruitful exercise, presenting numerous learning outcomes to the one person leading the research.

7. Discussion

This research is built on the premise that creation and participation fosters the generation of long-lasting products, and therefore provides a fruitful path towards a more sustainable fashion scene. Positioned in the intersection of fashion, sustainability and interaction design (Figure 34), the research was designed to explore ways in which an interactive artifact could be used as means of textile design for self-expression through fashion clothing.

The chosen methodology – Research through Design – allowed the process to explore the design space through a “skillful practice of design activity revealing research insights” (Krogh, Markussen, & Bang, 2015, p. 4). Such practice was central to this research’s process, as it aimed to build knowledge by drifting through the design space, raising unexpected results. Prior to the start of the design process, the only known quality of the final solution was that it would be an interactive artifact, with which one could paint. It was unknown, however, how such artifact would look like or behave, how could one interact with it, and what would the interaction consist of. No assumptions were taken through the exploration – the three vertexes from the research inquiry space were clean slates.

The results brought up by the Mind and Paint workshops and the Transformation Time experiment showed that the direct engagement with the design of one’s own textile through the practice of self-reflective tasks creates a meaningful bond between the product and the creator. By being an embodiment of one’s self-insights, the product is therefore bound to last for a long time in the user’s wardrobe. The result falls well in place with the research’s design space, since, as introduced before, a key aspect for a sustainable fashion future is the creation of long-lasting products.

Figure 34. Venn diagram showing the positioning of this research practice within the intersection of fashion, sustainability and interaction design.
The use of rules in the painting system was also a key aspect explored in the design process. The results proved that the introduction of rules in one’s experience of painting through direct engagement with brush and ink aids and stimulates their creativity, opening up space for even further self-reflection. It can be said, therefore, that the product-creator bond was catalyzed by the introduction of rules.

Finally, the introduction of a machine role as a collaborator in the experience was a further attempt to expand on the use of rules and constraints in the system. It was believed that, as with the rules, the collaboration with a machine would alleviate creative pressure and allow for greater self-expression. The results demonstrated that, not only the machine provided further guidance in the painting experience, but the added aesthetic value from the machine’s collaboration was a key aspect for the final design’s acceptance by the participant.

The combination of the three main findings – self-reflection, rules and collaboration – can be posed as the main contribution of this research to the intersecting field between fashion, sustainability and interaction design. The built knowledge can be essentially realized as a guideline of how analog textiles can be explored for means of self-expression, self-insights, and, consequently, long lasting product life cycles. Figure 35 shows, in a Venn diagram, of how the research’s contribution is positioned within the previously presented design space diagram (pardon my overuse of Venn diagrams). Table 7 lists, in turn, the guidelines and their respective rationale.

![Figure 35. Venn diagram showing how the research contribution is positioned in the intersection of co-creation, painting rules and self-reflection.](image-url)
The user should participate in the collaboration by performing self-reflective tasks. Self-reflection fosters insightful self-thinking, which in turn is translated through the mind to the textile, creating a strong bond between the creator and the design.

The user should interact directly with the textile, with little or no intermediary medium. As meaning derives from interaction, it was observed that the direct manipulation of the textile was key for the user’s feeling of authorship and ownership.

The self-reflective tasks should involve questions of “What” instead of “Why”. “What” questions (such as what are your memories) foster self-insight, while questions of “Why” (why you believe this) undermines it.

The self-reflective tasks should be guided by rules throughout its entire course. The rules ensure that the user remains engaged in the self-reflective task, while guiding and fostering their creative activity.

The other collaborator in the co-creation should contribute with guidance and aesthetics, but should not overshadow the user’s sense of authorship and ownership. The collaborator is positively welcomed to the creation process when it provides guidance and ensures a pleasant visual aesthetic.

The textile should be transformed into products, rather than exhibited on a spotlight. The transformation of the designed textile is key to its acceptance. Using the textile as “something to be looked at and scrutinized” will not trigger the same results.

Table 7. Resulting guidelines for the exploration of textile design as means of self-expression through the practice of self-reflective painting exercises.

As a final discussion, the prototyping activities employed by this research can be seen as an attempt to embody the generated knowledge through the execution of one selected concept. The combination of the five prototypes – Mini-Machine, The Real Deal, generative line drawing, clothing labels and theme cards – sheds light on the process of realizing the proposed guidelines, thus generating learnings and ideas for future implementations. Ultimately, the final manifestation of the proposed artifact, The Real Deal, can be seen as one of many ways of exemplifying the theory and questions proposed by this research.

8. Conclusion

Motivated by studies of dress and the importance that it has on identity formation and expression of self, this research has created a design space that works in the intersection between fashion, interaction design and sustainability through the posing of its main question: How can an interactive tool create greater means for self-expression of the dressed body through the design of
textiles? The efforts in pursuing the research question was to ultimately attempt to promote a more sustainable path for the fast paced consumerism-centric fashion dynamics of today’s world – hence the intersection with sustainability.

Following the practice and philosophy of the Research through Design methodology, this research went through a series of sequential design experiments with the ambition of not only succeeding in answering the research question, but of generating knowledge along the way; knowledge that is expected to be used as a generative input to further explorations of the design space. As Gaver (2012) puts it, “research through design should be appreciated for its proliferation of new realities, and its theory considered as annotation of the artefacts that are its fundamental achievement” (p. 941). As a result, this research generated one artefact annotated by the presented theory, in addition to a set of guidelines that aims at advising the creation of other future artefacts.

The main research findings suggest that the direct engagement with the painting of textiles through self-reflection tasks has great potential for promoting a strong connection between the creator and the final product (the textile which later becomes a garment) – and therefore generating long-lasting products for a more sustainable fashion approach. Moreover, the findings show that the introduction of rules to the painting exercises greatly aided the creative process, while ensuring the user’s engagement in the self-reflective task. Finally, the addition of a machine as a collaborator to the painting experience enhanced the aesthetics level of the final piece, and provided further guidance for the participant in the painting experience. The three main findings were the basis of the research’s resulting guidelines. In turn, the final proposed artefact – The Real Deal – is an example of how the theory and the findings exposed through the RtD process can be realized in practice.

8.1. Future work

Although in the RtD methodology, “how one got there” is more important than the actual final artefact (Krogh, Markussen, & Bang, 2015), the ambition for a future work is to transform the final proposed artefact – The Real Deal prototype – into reality. Because the insights and learnings gathered throughout the process of this research showed such a fruitful path towards self-expression and fashion sustainability, it is believed that putting the proposed concept in the real world could actually make a difference. Painting on textile through self-reflection in an inclusive fashion design process could actually inspire change. Or at least the beginning of it.

As for the interaction design and fashion communities, this work is expected to inspire further research on the use of analog textile in the context of sustainability and self-expression. For the practitioners, the suggested guidelines offer a start point to exploring the matter further. The proposed artefact, too, is expected to be evaluated and iterated upon. This project in an invitation for an entire community of research and makers to, together, make a difference.
9. Acknowledgements

I would like to extend my sincere gratitude, first and foremost, to my supervisor, Anne-Marie Hanson. As a true designer, she inspired the awakening of the maker, coder and thinker inside of me. Serenely walking me through the roller coaster that was this research, she provided me with great guidance and insights. I am also indebted to David Cuartielles, a dear professor and mentor (who happens to be one of the brains behind the Arduino platform), for the hours spent next to me trying to solve the mysteries of hardware. Thanks are also due to Matthias and Johannes, the wizards of the Malmö University’s workshop, without whom I could have never built The Real Deal.
10. Bibliography


## Appendix A

**Drawing exercises from the *Mind and Paint* workshop.**

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Warm-up</td>
<td>Participant paints the canvas with instructor taking turns, or at the same time.</td>
</tr>
<tr>
<td>2. Morning Ritual</td>
<td>With colors and shapes, paint the story of your day – from waking up until now.</td>
</tr>
<tr>
<td>3. Food dreams</td>
<td>Close your eyes. Think about sitting at a dining table. You are waiting for your favorite dish. Look around. The dish arrives and you start eating. The dish tastes better than ever. Now paint how this experience feels like.</td>
</tr>
<tr>
<td>4. Feel the music</td>
<td>Choose a song that you identify with (instructor then puts song on headphones). Now paint the song, as you listen to it.</td>
</tr>
<tr>
<td>5. The different shapes</td>
<td>Trying to cover the entire canvas, paint 5 different shapes to describe ______ (participant picks a card with a word from a deck – see image below).</td>
</tr>
</tbody>
</table>
| 6. Friends in life        | Choose a random shape and paint it repeatedly for every friend from your Facebook that pops in your head. Cross the shape if you haven’t talked to this person in 3 years.  
                           | *After finished:* Now mark the shapes of which you can recall the friend, however you prefer.                                                 |
| 7. Circles in us          | While thinking about your past month, keep painting circled shapes. Don’t stop. When you think of a memory that makes you happy, paint 1 circled shape of another color. |
| 8. Lines of memory        | While thinking about things that you have, draw short parallel lines. Don’t stop. Whenever you think of something that you could live without, change the direction of the lines. |
Workshop exercises positioned in the spectrum of painting freedom.

Deck of cards used in exercise 5 as the exercise input.
Appendix B

Detailed results and insights from the Mind and Paint workshop

Six people participated in the Mind and Paint workshop, ranging from 23 to 32 years old. They were all students of the School of Arts and Communication at Malmö University. Each participant went through 4 different exercises with varying levels of painting freedom. The first exercise – the warm-up – played an important role in the workshop because it allowed the participants to get familiar with the different tools, the textile and the paint. Because the warm-up exercise was carried out by the instructor and the participant together, the instructor was also able to set the abstract tone of the painting, thus influencing the way that the participants would paint from that exercise on.

- **A mind exercise**

After the warm-up, all of the other tasks were performed by the participants alone. Their overall response to the exercises was that the painting tasks transported their minds into a thoughtful state, surfacing emotions and memories they weren’t expecting. From observing the participants performing the tasks, they seemed in fact very concentrated – sometimes lost - in their thoughts and their painting. As one participant said: “This was the deepest workshop I’ve ever participated in.” It seemed that the self-reflective tasks, after all, in fact promoted self-insight, as stated before.

- **Rules or no rules**

Some of the participants had difficulties starting to paint in the free-painting exercises, for they claimed it was hard to translate the thoughts they wanted to express onto the canvas. On the other hand, when rules were introduced, the participants said the experience was smoother because they were provided guidance through the rules. Thus it can be said that the introduction of painting rules through the exercises was perceived by the participants as a help, rather than an obstacle in their expression.

One concern with the free vs ruled matter was that the ability of self-expression could be substantially reduced with the introduction of painting rules. The workshop results demonstrated that, in fact, the presence of rules constricted the possibilities of visual expression (as it could be deemed obvious) – the combination of painting strokes were more diverse in the results from the freer painting exercises (view Figure 8 for comparison examples). However, it was observed that the level of self-reflection put into the rule-based exercises was greater, due to the fact that the system of rules demanded the participants to remain engaged in the meditative process throughout the whole exercise; as opposed to the free-painting, where in some cases the participants admitted they started painting with little connection what they were trying to express in the first place.

In addition to inspiring mindful paintings, the system of rules in the exercises better afforded the repeatability of shapes and expressions, which is a standard in traditional textile printing.
The results from the rule-based paintings could, therefore, be more easily treated as textile pattern.

- Reflection from the participants

After the four exercises, each participant was asked to reflect back on the paintings they had just created and which ones had left stronger impression on them. Overall, they felt the most connection with the paintings that allowed them to identify the meaning put into the different shapes or paint strokes – the traces of information visualization seemed to be appealing to the participants. The paintings with such distinguishable features were created through ruled-based exercises – Figure 36 shows an example where the participant could more or less recall who the circles represented through the “friends in life” exercise.

![Pattern painted through the "Friends in Life" exercise.](image)

On the other hand, the participants who managed to satisfactorily express themselves through the free exercises also felt a strong sense of bond with their paintings, because, as one said, “when I look at it, I can feel exactly what I was feeling when painting it”. Figure 37 shows an example of a painting that triggered the feeling recollection, which was created by thinking about a food experience.

Finally, all the participants said that the painting created through the warm-up exercise (were no rules were applied) didn’t have any meaning to them. The brush strokes in the painting were said
to be meaningless because the participants claimed they were in a “mindless” state when painting, since the warm-up exercises didn’t have a self-reflective task related to them.

As the closing question of the workshop, the participants were asked to choose which of their paintings they would like to see something made out of (clothing or accessory), and why. The responses were mixed between choosing due to aesthetics, and choosing due to the meaning carried by some of the paintings. Some of the participants who chose aesthetics over meaning said it was a hard choice to make, and that it felt like denying all of the meaningful thoughts they had put into the other paintings. It can be said, therefore, that some of the paintings exercises promoted a greater sense of self-insight, and that different types of self-knowledge have different levels of meaningfulness to different people.

Figure 37. Pattern painted according to a “food feeling”.
Appendix C

Painting exercises from the *Mind, Paint and Machine* workshop.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Instructions</th>
<th>Matrix quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Warm-up: Mirroring rules</td>
<td>First person paints a shape then shows the second person where lies a mirror-line in the canvas. The second person draws the same shape, mirrored according to the mirroring line. The second person then draws a new shape, in a different color, and shows the mirror line. And so on, until the canvas is filled.</td>
<td>3 – Strong collaboration</td>
</tr>
</tbody>
</table>
| 2. Triangles in-between               | **Instructor/Machine**  
Draw triangles in the canvas, leaving spaces in-between.  
**Participant**  
Draw a triangle in-between instructor’s triangles for every Facebook friend you can think of. Whenever you feel you miss that friend, mark that triangle somehow. | 2 – Pseudo-collaboration |
| 3. Colors and arrows                  | **Participant**  
Choose 2 colors. Paint a small area in the canvas. Start expanding it slowly as you think about your past month. Whenever you remember someone smiling at you, start over in another area, with another color.  
**Instructor/Machine**  
Draw arrows around the participant’s previous area, towards their current painting. | 4 – Disconnected collaboration |
| 4. Music lines                        | **Instructor/Machine**  
Ask for the participant to choose a song they like/identify with and put on headphones for them. Draw lines on the canvas. If there’s a lot of activity from the participant, start curving the lines.  
**Participant**  
As you listen to the music, modify the instructor’s lines according to the song and what it makes you feel (add to the lines, thicken them, whatever you feel like). | 3 – Strong collaboration |
| 5. Lines and shapes                   | **Participant**  
Draw whatever shapes over the instructor’s lines while you think about things you have in life. Don’t | 3 – Strong collaboration |
stop. When you think of something you have but could live without, paint a shape in a different color. Continue on.

_Instructor/Machine_

Draw lines. Whenever the participant changes color, change the direction of the lines. Whenever the participant stops to think, draw dotted lines.

<table>
<thead>
<tr>
<th>6. Surrounded with dashes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Participant</strong></td>
</tr>
<tr>
<td>Paint a small area of the canvas with a color. As you think about your past years in life. Surround the area with another color. Then again with the previous color. Keep doing it until you think of a moment in your life when you learned an important lesson – then start over at another empty area.</td>
</tr>
<tr>
<td><strong>Instructor/Machine</strong></td>
</tr>
<tr>
<td>Draw dashes right next to the participant’s paint. Whenever the participant changes location, change with them. If they stop to think, change to little circles instead. If they reach your drawing area, change to little X’s.</td>
</tr>
</tbody>
</table>

3 – Strong collaboration
Appendix D

Detailed results and insights from the Mind, Paint and Machine workshop

Five people participated in the Mind, Paint and Machine workshop, ranging from 26 to 35 years old. They were again all students of the School of Arts and Communication at Malmö University, and each of them engaged 3 different exercises in collaboration with the instructor.

After the exercises were enunciated, the collaborative activity naturally became a silent experience. Similarly to the first workshop, the participants were deeply concentrated in their activity and, even though it is not of the nature of a collaborative task (Bryan-Kinns & Hamilton, 2012), they didn’t feel the need to communicate with the instructor.

When talking about their silent concentration in the task, some of the participants shared that their contemplative session allowed them to scrutinize their own beliefs and habits. Placing one’s self under scrutiny is at the heart of critical reflection practice, which carries a contemplative inwardness that has many parallels with practices of meditation, mindfulness and even Christian prayer: the consistency among these practices being “the central attention to the quest for wisdom, lucidity, and knowledge of ourselves and the world, attained through disciplined attention to inner stillness” (Dawson, 2003). Inner stillness and self-knowledge are, in turn, fostered and nurtured by contemplation and silence. The self-reflective nature of the exercises, therefore, can be said to have created a space that encouraged a silent experience through critical reflection.

The role of the “machine” (played by the instructor) in the exercises explored different ways in which its performance could be affected by the participant’s. In some of the exercises, the machine had clear instructions of what clues to search for in the participant’s actions and how to react to them; in some others, the machine would simply not react to the participant at all. It turned out, however, that the participants didn’t understand or even cared about what the machine was making, since they were so concentrated in their own activity.

The combination of the rule-based system and the restrictions imposed by the machine routine (in most of the exercises) was foreseen as a potential pain point for the expressivity factor. However, just as in the first workshop, the self-reflection nature of the exercises fostered the creation of brush strokes charged with such meaning that it allowed for a strong connection between the participant and their painted expression to be created.

Overall, the addition of the machine’s routine in the exercise was seen first and foremost as an important layer of aesthetics contribution to the painting. On top of that, the machine’s role was positively perceived as further guidance in the painting activity for the exercises where guidance was applied (guidance wasn’t provided in the exercises with loose collaboration). Examples of both scenarios – machine perceived as aesthetic layer vs. guidance – can be seen in Figure 38.

Still on the topic of the machine’s role, the presence of the instructor was said to have created a more comfortable atmosphere for some of the participants. The silent collaboration and concentration seemed to have had a positive effect on people’s responses to the exercises.
At the end of the workshop, when asked which pattern they would choose to own as an accessory, the responses were similar to the equivalent question in the first workshop: some had a hard time choosing between meaning or aesthetics, but most of them picked the pattern that was most in line with their taste (except from the lucky ones that managed to find a pattern that was both the most meaningful and the most aesthetically pleasing).

Figure 38. Examples of pattern outputs from the Mind, Paint and Machine workshop. The top image is an example of how the machine’s routine didn’t affect the participant’s decisions, but was perceived to add an aesthetic layer to the final piece. The bottom image is an example of how the participant appreciated the guidance of the machine’s routine to their painting (in the exercise, the participant was asked to follow the instructor’s lines when painting).
Appendix E

Detailed results and insights from the Transformation Time experiment

All of the participants of the workshops were pleasantly surprised when receiving their bag – they didn’t expect that their painted textiles could look as good when transformed into an accessory. Even though they were told, prior to this experiment, that the textiles would be transformed into a personal accessory, a few of the participants imagined that I would have treated their paintings as “something to be looked at”. They all agreed, however, that having it as a bag – something they deemed usable and useful – was more valuable.

It is believed that the transformation aspect of the textile – from canvas to product – played a big role in people’s acceptance of their painted textiles. When seeing their design in a different context, their view of their paintings changed from not being so excited about the aesthetics of it, to feeling proud about their efforts – and therefore creating a tighter connection between them and the painting experience. Because the participants are not artists or designers, it could have seemed forced, or rather senseless, for them to have their paintings displayed as “art-pieces”. It is believed that if their work was portrayed as so, it could have created a distaste for the memory of the experience, because the participants wouldn’t think their work was worthy of being on a framed canvas or on a t-shirt spotlight. These are assumptions drawn from the observations of this experiment, and can only be used as source of inspiration.

Above all, when receiving the bags, the participants were capable of reflecting back on their experience of the painting exercise, and some could recollect what they were feeling when painting it. Some of the participants felt emotional about it, for they expressed that those memories meant a lot to them (one participant even said she would forever keep her bag). These results again show how promising of a path it is to engage the user directly with the analog manipulation of their textile through self-reflection. As stated before, the potential to generate long-lasting products is a desirable quality for the outcome of this research because it fosters a sustainable fashion system.

Moreover, most of the participants felt a great sense of authorship and ownership over the product. Some also recognized that it carried a shared authorship, since I was the one who had transformed the textile into bags. Interestingly enough, however, none of the participants of the second workshop (where all of the tasks were collaborative) considered that I shared an authorship in the actual painting of the textile, which demonstrates that the machine’s role didn’t overshadow the participant’s perception of their work value. As stated before, the machine’s role was primarily seen as just an added “layer of aesthetics” over the participant’s original work.

When asked about whether they’d consider using that same textile pattern as pieces of clothing, some of the participants reported they would be happy to use their designs as pieces of clothing, like shirts, skirts, scarfs or even jackets. Most of the participants, on the other hand, said that they would have probably painted the pattern differently, like changing the colors. They also added that if they were aware of the fact that the paintings were in fact going to be used for clothing design, it would have probably influenced the way that they painted the fabric. Because this was a statement coming from most of the participants, a careful consideration ought to be
taken when balancing the participant’s sense of awareness while painting (awareness that they are creating a piece of textile design) with their freedom of self-reflection. It is believed that because the participants were not so aware of the fact that their paintings would be turn into clothing (they were told so in the beginning of the workshop, but with not much emphasis), their expression was more authentic and less influenced by attempts of creating “proper” design, or being “proper” designers.

Finally, the added detail of the bag labels played a rather important role in the experience of “unwrapping” the product – as the first thing they saw, it immediately reminded the participants of the workshop experience, and lead them into looking at the bag as not just a mere product, but as a personal creation from a personal experience.
Appendix F

List of exercises created for the Rotating Canvas concept. Each exercise relates to a type of generative drawing presented in the body of the document.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Related Generative Drawing</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lines of me</td>
<td>Straight Up</td>
<td>While painting in between the lines, think of things that describe yourself. Don’t stop. Whenever you feel proud that thing, change the color of your brush once. Start again.</td>
</tr>
<tr>
<td>2. Dos and Dots</td>
<td>Sea of Dots</td>
<td>Connect dots, however you’d like to, as you think of things you like to do in life. Don’t stop. Whenever you feel you’d like to do it today, circle a dot. Start again.</td>
</tr>
<tr>
<td>3. Dos and Dots II</td>
<td>Sea of Dots</td>
<td>Think of things you can do as you connect dots. Don’t stop. Whenever you think of something you feel happy doing, circle one dot. Start again.</td>
</tr>
<tr>
<td>4. Friends in lines</td>
<td>Crooked Lines</td>
<td>As you think of things you like doing with your friends / family, close the shapes in the painting. Don’t stop. Whenever you feel you miss doing it, paint a closed shape with another color. Start again.</td>
</tr>
<tr>
<td>5. Vertical impressions</td>
<td>Straight Up</td>
<td>As you think of people you’ve met through your life, paint in between the lines. Don’t stop. Whenever you feel you’ve left an impression on them, change the color of your brush once. Start again.</td>
</tr>
<tr>
<td>6. Crooked memories</td>
<td>Crooked Lines</td>
<td>While drawing shadows to the shapes, think of your life memories. Don’t stop. Whenever you think of a memory that changed you somehow, draw a new shape yourself. Start again.</td>
</tr>
</tbody>
</table>