Metaphone: Machine Aesthetics Meets Interaction Design

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ABSTRACT
Through our art project, *Metaphone*, we explored a particular form of aesthetics referred to in the arts tradition as machine aesthetics. The Metaphone machine collects the participant's bio-data, Galvanic Skin Response (GSR) and Heart Rate (HR), creating a process of movement, painting and sound. The machine behaves in machine-like, aesthetically evocative ways: a shaft on two large wheels rotates on the floor, carrying paint that is dripped onto a large sheet of aquarelle paper on the floor according to bio-sensor data. A soundscape rhythmically follows the bio-sensor data, but also has its own machine-like sounds. Six commentators were invited to interact with the machine. They reported a strangely relaxing atmosphere induced by the machine. Based on these experiences we discuss how different art styles can help to describe aesthetics in interaction design generally, and how machine aesthetics in particular can be used to create interesting, sustained, stylistically coherent interactions.

AUTHOR KEYWORDS
Machine Aesthetics; Bodily Interaction; Affective Computing; Interactive Arts; Interaction Design; Media Arts

ACM CLASSIFICATION KEYWORDS
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Recently, the CHI-conference has started to embrace interactive arts, recognising that some aspects of interaction design are overlapping and lessons learnt can be shared between the two worlds. In the past, we have also seen how art concepts, such as ambiguity [9], defamiliarisation [1], alienation [2], somaesthetics [29, 33] or characterizations of aesthetic experience [24], can come to have an influence on the design of interactive systems in general. In a slightly different strand, HCI-researchers have sometimes been involved in creating interactive art projects as a means to explore crucial, sometimes controversial research topics e.g. [16, 19, 23]. In parallel a large body of work in interactive art is produced in the digital art community [20, 28].

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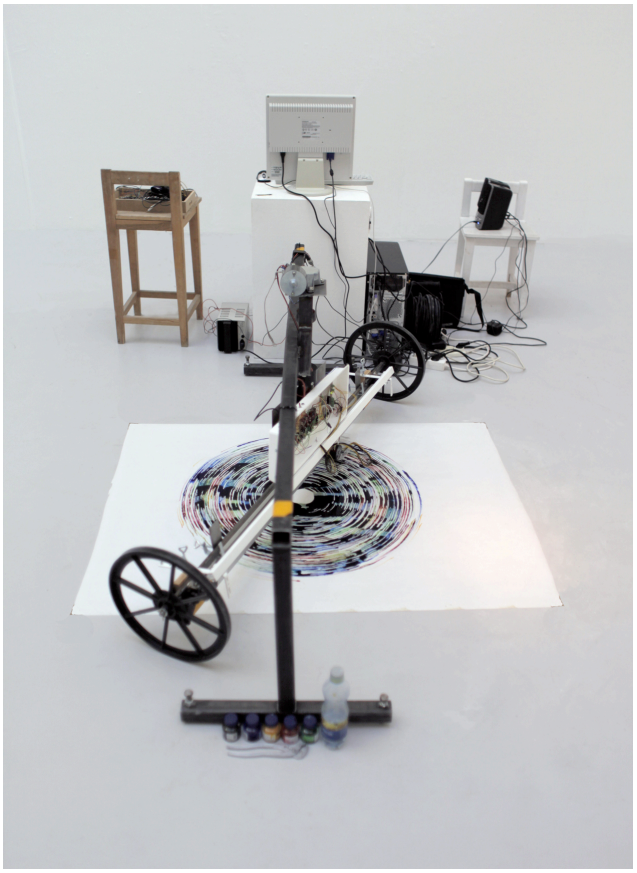

Figure 1. The Metaphone.

Here we would like to approach the topic of how our interactive experiences can meet with machine aesthetics through an art project, we named Metaphone (http://metaphone.net), see Figure 1. The Metaphone creates for an atypical form of interaction – a slightly frightful experience, where the machine autonomously creates its own behaviour, out of the users' control. As such, the Metaphone adds to the contemporary HCI-discussion on what we mean by a user experience [24]. Apart from more utilitarian interactions that require a user experience mainly focused on ease of use and feeling good, we may want to design for uncomfortable interactions [2], becoming scared, thrilled or obsessed as in computer games [34], or curious about what an autonomous system is really up to [14, 32].

Secondly, through the Metaphone project, we also want to open a discussion on how to approach aesthetics in HCI.

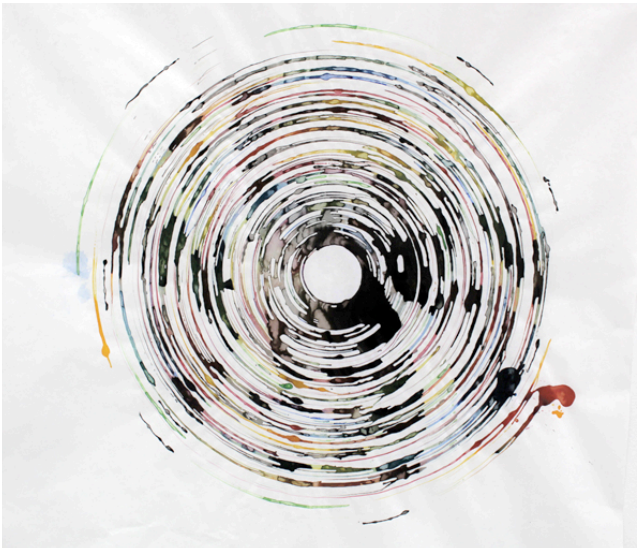

Figure 2. Spiral painting pattern.

Recently, Gross and colleagues discussed how *art styles* could be used to understand styles in interaction design [11]. As they point out "*style is an important tool for understanding and communicating the creative design processes that generate experience-focused tangible interactions*." But while they focus mainly on how an art or interaction design critic can use a particular style as a lens when analysing products, we will instead use their strategy in a slightly different manner. We focus on how an art style can shape the creative process and be instrumental in fostering, or setting up the scene, for certain aesthetic experiences – recognizable to participants. A particular choice of art style will guide decisions regarding the relationships among different stylistic aspects and their expected outcome in terms of experiential qualities. As discussed by Dewey [6], all the different elements that make up an artwork need to come together as a whole to create for an aesthetic experience. For interactive arts, that involves not only the various materials that the artwork is constructed from, but also the dynamics of how the interaction unfolds over time, in other words, the aesthetics of interaction [21].

Our aim is to show how an art style can become a form of intermediate-level knowledge [22], guiding the design process. As discussed by Höök and Löwgren [15], there are many different forms of intermediate design knowledge, such as strong concepts or experiential qualities, that go across domains and particular design examples (or ultimate particular [31]). Some are used to generate new design concepts, others to evaluate whether the design process is on track. In the Metaphone project, the chosen art style (machine aesthetics) was used mainly in a generative sense – guiding design decisions and choices of design materials.

Setting up ideals for the aesthetics of an interaction is a documented practice in the games industry [13]. An aesthetic ideal set up early in the design process is used to guide teams of game developers through years of development work where major and minor design decisions come together to create for the particular experience of the game.

Through the Metaphone, we will introduce a particular art style, or generative ideal, *machine aesthetics*, rooted in the Futurist [27] and Constructivist [10] art movements. By showing the raw interiors and processes of a machine, it was originally a comment on mass-production and our culture's obsession with automation. In a similar vein, our Metaphone project explores the tension between the human body and the artefacts that thrive on our bio-data. It thereby problematizes recent movements such as affective computing, the quantified self-movement, commercial developments of sports, as well as wellness and health applications making use of bio-sensors.

In short, the Metaphone consists of an interactive apparatus, a machine, transforming participant's bio-data derived from Galvanic Skin Response[1] (GSR) and HR sensors into colours resulting in aquarelle paintings in a pre-programmed pattern (see Figure 2). The bio-data is transformed into behaviours and sounds that are not at all anthropomorphic or harmonic, but instead express their own machine-like ways.

Let us start by providing some background to machine aesthetics, before we describe the Metaphone project in detail.

ART STYLE AND MACHINE AESTHETICS

According to Gross et al., art theory offers *"a set of tools to stylistically understand, compare, and interpret creativity in the construction of its own artefacts"* [11]. They refer to those tools as art styles. An art style will influence the artistic process of bringing forth an art project, the tools and methods used, and the aesthetic expression of the art project itself. As they point out, style is a holistic or gestalt phenomenon that permeates the whole interaction with it. Art projects in a particular style will also resemble one-another – they will be characteristic of an "author, period, place or school" [19]. Typically, these art styles are not articulated or discussed until years after they have been formed, while often not considered a particular style at the time.

Machine aesthetics originates from the constructivist movement with its own methods, aims and ways of engaging with the materials. Construction happens through experiencing the *formal* properties of the materials. Russian constructivism emerged with the Soviet revolution of 1917 and sought a new approach to making objects, abolishing the traditional concern with composition and replacing it with "construction". As such it called for a new attention to the technical character of the materials used to construct products as well as art. It was hoped that these inquiries would yield ideas for mass production. On the latest stage

[1] GSR is a method of measuring the electrical conductance of the skin, which varies with its moisture level. Skin conductance is used as an indication of psychological or physiological arousal.

of the movement the constructivists abandoned their inquiry into the nature of art as a mode of production and entered the realm of industrial production itself. A traditional artist was transformed into the artist-as-engineer with all its aspects of engineering, construction and production. The artist is "*to set about real, practical work in production*" [10].

A theoretical stance that emphasises the meaning of the directly perceivable aesthetics and puts abstract concepts, content and substance as secondary, is *formalism*. Formalism turns to the form and style of the object (e.g. how it formally looks in terms of shape, composition and colour), in this way it views these formal values as the object's primary values. As such, formalism posits ways of analysing and comparing artworks based on the elements they consist of. That is, if the formal aesthetics of an object look, sound or smell in ways that fit with a particular art style, then it is classified as such. In this work, we used this stance in the construction process in search of a particular aesthetic style, namely machine aesthetics.

In light of formalism and constructivism, machine aesthetics can be described as exposing the inner aesthetics of technology – its mechanics or algorithms used – by turning the machine inside out. That is, no casings or other means of hiding technological details of the built artefact are used. Exposing functions and operational properties of the artefact become core values (or formal elements) of machine aesthetics. In a way this could be viewed as anti-style, as machine aesthetics rejects any attempts to apply an aesthetic layer as a surface (decoration) to the artefact. However, this of course becomes a style in itself and in this paper we will refer to it as an art style.

Machine Aesthetics – the Machinic

Jean Tinguely (1925-1991) is one of the main figures of the machine aesthetics tradition in fine arts. He explored the role technology and industry has in modern art. In his work, he provoked the core idea of what it means to be an artist: questioning the authorship of the resulting artwork. Instead of creating the artwork himself, he created mechanical machines – Métamatic (1955-1961) – where the artworks were produced by the machines. As described by Guy Brett [3], this was not only a means to question the role of the artist, but also a comment on industrialism at the time: Tinguely's art is querying the mindless overproduction of material goods in the advanced industrial society of the last century.

Tinguely's machinic performances[2] communicate with the viewer on a purely aesthetic level. By letting the machines run and perform their autonomously created artistic processes, exposing their formal elements as core figures, these machine performances have come to be associated with a particular aesthetics. As Broeckmann frames it:

"As an aesthetic principle, the machinic is associated with process rather than object, with dynamics rather than finality, with instability rather than permanence, with communication rather than representation, with action and with play. Machinic art acts as the facilitation of aggregations of bodies and forces in which no meaningful differentiation can be made between human and machine. The functionality of the machinic itself becomes the core of the aesthetic force it exerts, creating a phylum that does not distinguish between human and machine agency" [4].

The first modern interactive artwork was created by Marcel Duchamp (1887-1968) and his first kinetic interactive work called Bicycle Wheel (1913) and second – a similar one – Rotary Glass Plates (Precision Optics) from 1920, where participants had to rotate a wheel by mechanically turning it in the first example. In the second artwork the participants had to switch the machine on by turning the switch on.

Harold Cohen's (1928) generative methods and the system AARON (from 1973) focus on expressing artistry through technology in this machinic tradition. The AARON system produces original Cohen artworks without the need of the human artist's intervention using an automatic painting machine, much like a printer but instead using painting technique and materials [5]. Through AARON, Cohen asks similar questions as we do with the Metaphone about the production and reproduction of artworks and sharing authorship between artist and machine.

The futurist art movement has strongly shaped the understanding of machine aesthetics from their earlier generations on art exploring dynamism, to their later manifests promoting aesthetics that draw more directly on machines. One such example is the aesthetics of the sound of the machine. As the Italian futurist and composer Luigi Russolo (1883-1947) noted in his manifesto L'Arte dei Rumori (The Art of Noises) from 1913:

"With the invention of machines, Noise was born" [27].

Russolo invites musicians and artists to embrace the aesthetics of noises created by machines and use them for artistic expressions by tuning the polyphony of noises into *"an intoxicating orchestra of noises"*. His definition of noise is broad and ever growing as new machines continuously gives rise to new forms of noise. For example, in addition to direct mechanical noise, it could be noises such as scrapes, hisses, grumbles, or even explosions.

CREATION PROCESS

The project started as an exploration of interactive techniques within the arts and gradually evolved into a research project. Most recently the project was shared, developed, and explored by a collaborative multidisciplinary collective and turned into an open artistic research platform. The creation and implementation process can be characterized as a process of iterative reflection-in-action, combining methods from iterative design, reflective practice, and theory.

[2] http://www.tinguely.ch/en/museum_sammlung/sammlung.1970-1979_0112.html

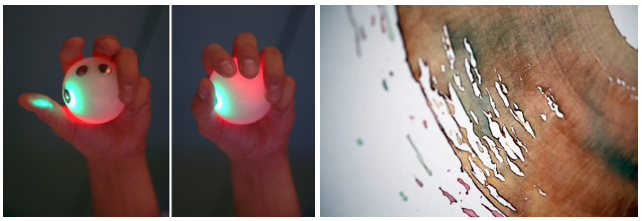

Figure 3. a) The bio-ball, placement of fingers made an impact on the glow (left). b) Colours blending (right).

Three aspects of the machine were approached and revisited repeatedly through the project's development: (1) the formalism method of analysing the materials, (2) thoroughly examining the content – that is the bio-data provided by the participants, and (3) examining the context in which the machine would be placed.

The formal aspects were concentrated on designing the project and working with materials, form, patterns, colour and sound mapping. Many different versions of the machine were tested as well as several sensors like microphone, accelerometer, and electroencephalography (EEG).

To address the influence of the context in which the Metaphone would be used, we had to discuss with participants, as well as analyse the cultural and social properties introduced by different situations and at different locations. The version of the Metaphone discussed here was exhibited in an art context at European Media Art Festival (EMAF) in Osnabruck, Germany; Den Frie art center in Copenhagen, Denmark; DKTUS and Digital Art Center in Stockholm, Sweden; and in a human-computer interaction context at the CHI 2013 conference [30].

THE METAPHONE

Let us now describe how machine aesthetics is explored and expressed in the paintings and the soundscapes generated from the participants' bio-sensor data in our project.

Metaphone – Technical Description

The Metaphone is an electromechanical and computational device that transforms participant's bio-data signals into colourful spiral patterns and sounds, where different colours and tuned noise represent different bio-data signals.

In essence, the Metaphone is constituted by three main elements, namely, (1) a bio-ball (Figure 3a) that fits in the palm of the hand, picking up on the biological signals of the participant, converting it into a stream of bio-data transmitted wirelessly to the rest of the machine, (2) a drawing machine that converts sound as input into drawings on a large aquarelle paper underneath it, (3) a sonic core that both converts the bio-data into sounds (internal, not heard) that the drawing machine can understand, and makes it audible to the participants. Let us describe each of these in more detail.

Bio-ball

The bio-ball is a wax ball designed to capture bio-data and entail wireless interaction between the body and the machine. Inside the bio-ball there are several PCBs (printed circuit boards) for wireless transmission, battery management, optic heart rate sensor, and electrode patches for capturing GSR. The ball also mirrors and externalizes the heart rate with several colour-LED lights flashing and pulsating in accordance with the participant's pulse and GSR.

Drawing Machine

The drawing machine, see Figure 1, is a 2 meter wide welded machine body that holds a centre motor that rotates a shaft with two wheels on each side around its own centre point like a propeller. The main motor speed is controlled by a separate adjustable power supply and set to a specific speed that is maintained for each drawing. On the rotating shaft, there is a motor controlled cart that can be moved along the shaft, much like a printer head in a regular printer. On the cart, there are five small ink tanks with silicon tubing on the bottom that rest on the paper. Each silicon tube goes through a valve that can open or shut each individual tube by squeezing it. In this way the machine can control the flow of ink dripped onto the aquarelle paper.

In addition to the mechanical and electromechanical setup described, there is an electronic unit controlling the valves and the position of the cart. This unit uses electronic components for analogue filtering of predefined frequencies of an audio input. This signal is sent into an Arduino[3] that interpret the amplitudes of each frequency and responds by opening the valves that let paint flow onto the paper.

Sonic Core

The sonic core is built in Max/MSP and receives midi notes wirelessly from the bio-ball[4]. The software then converts the midi notes into sawtooth waves (sound) and adjusts the amplitude of the notes to better fit the audio analogue filtering circuits on the input of the drawing machine. In sum, it creates a soundscape for the audience that aims to enhance the experience with the machine.

The Drawings of the Machine

As the participant interacts with the Metaphone through the bio-ball, a multi-coloured circular trail is created on the paper for participants to explore.

Four of the colours are used to express variations in the bio-data while the fifth colour, black, expresses how near the participant is to the machine. The closer, the more black is applied to the paper. The proximity is calculated based on the Received Signal Strength Indicator (RSSI) of the radio communication between the bio-ball and the drawing machine. The environment and people in the space effect this measurement. For example, the participants can "hide" the ball from the drawing machine by putting it behind themselves, dampening the signal through their bodies. Being closer or further away from the machine or hiding it behind

[3] http://www.arduino.cc/

[4] http://cycling74.com/products/max/

your body or some object, becomes a means to affect the amount of black in the drawing.

For the other four colours, we used the following mappings:

- red expresses the raw signal coming from the optical heart rate sensor. As beats occur, the signal increases and decreases triggering the amount of paint the machine drops every beating.
- yellow expresses the beats per minute (BMP) of the heart rate – the amount of yellow gradually increases on the paper as the BPM rises between 42BMP and 165BMP, with 42 as the zero point resulting in no yellow colour on the paper.
- green expresses a drop in GSR – which may indicate that emotional arousal has decreased.
- blue expresses GSR rising – which may indicate that emotional arousal has increased.

Green and blue never appear simultaneously as GSR can only go up or down, but not both at the same time. The amount of green or blue is determined by how fast the response is changing at the particular moment. However, since GSR sometimes changes rapidly, the machine might draw both green and blue to such an extent.

As the machine continuously drips paint, and the colour application tubes are touching the surface of the paper, a natural flow and blending of the ink occurs. This creates new blends of colours that eventually move towards brown (Figure 3b) if the machine continues to draw. Additionally, the paper warps (visible in Figure 2) as it absorbs the wet ink. If even more paint is added, pools of ink may appear.

Soundscape

The soundscape consists of three separate layers of sound.

First, an *individual level* that aims to connect the participants with their own individual biological signals. It was designed to strengthen and re-enforce the painted biofeedback. It enhances the experience of being connected to the apparatus through creating sounds that directly map to the real-time feed of bio-data.

Second, a *collective level* aims to represent the collected drawing. It uses a camera attached to the paint cart of the Metaphone, hovering over the painting as it moves in circles over the created drawing, thereby capturing previous layers of ink. The captured video is then run through a colour tracking software built in Max/MSP that looks for traces of up to five different colours. The software then gets the vertical and horizontal positions of the tracked colour areas and uses these to modulate the frequency and amplitude of predefined tones that are added to the soundscape.

Third, a *machine level* is added to the soundscape. It aims to blur the borders between the machine and the participants by amplifying the sounds of the machine itself, mixing them with the sound of the participants. It is created by amplifying the sound captured by a piezoelectric microphone[5] attached to the main motor driving the circular motion of the machine. Amplifying the mechanical noise of the motor, but the natural sounds of the valves opening and wheels moving on the floor also contribute to this level.

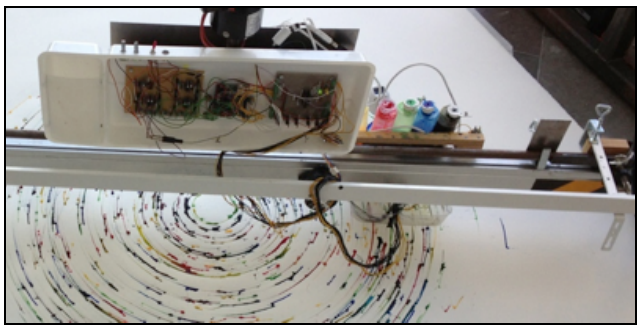

Figure 4. Some "interiors", bare circuits, of the machine.

The Machine Aesthetics of the Metaphone

The Metaphone differs from both Tinguely's and Cohen's machines, described above, in that it is its participant's interactions that influence the machine and the drawing, instead of the machine directly generating the drawing without audience interaction.

With the Metaphone we aimed to design a proper balance between the technological milieu combined from different technologies – the hardware of the machine with its circular movements as well as the software behaviours responding to the participants' bio-sensor data – emphasize the hidden artistry involved to question the approach of the translation between the two. An interdisciplinary approach became essential to the project as well as a transition between several media, a translation of one medium to another and a connection of digital with analogue, involving computer-based processes with traditional art techniques.

As can be seen in Figures 1 and 4, there is no casing enclosing the machine. Instead we see the raw internal structure of the machine – it is turned inside out.

The algorithm used to convert bio-sensor data into colour and sound is also, in a sense, made tangible, but only through observing the dynamics of the interaction over time. While exposing moving mechanical parts and hardware constitutes what a typical machinic perspective would emphasize and expose, in our design process, we became worried that the Metaphone's software does a lot of the hidden work to make the *interaction* happen. It became key to us that the Metaphone would expose the machine aesthetics not only through the moving mechanical parts but how those movements are stitched together by the software (see Figure 5). We therefore mirrored the inner logics and machine properties by using sounds (different frequencies), as a direct mapping of the instructions sent to control the machine.

[5] A contact microphone designed to sense audio vibrations through solid objects.

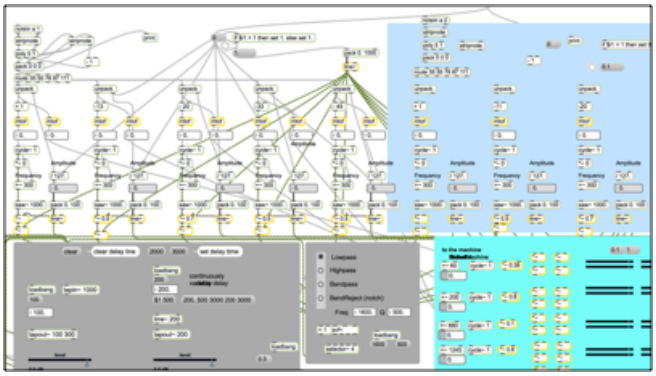

Figure 5. Interiors (software) of the machine.

Another layer of the software comes into account in combining the mechanical machine with a sensor. By using biosensing technology and connecting it to the hardware of the mechanical machine we use another software code that immediately reacts between participants' bio-signals and the painting that emerges as a result of their interaction.

We also tried to reveal the hidden seams embedded in the software by using sounds. The participant should be able to discern how the machine immediately notices a changed GSR-level in real-time. We therefore made sure that such a change is immediately communicated through the sound.

As the apparatus was constructed following the ideals and ideas of machine aesthetics, we embraced the noises of the Metaphone by amplifying inner mechanical noise and tuning the polyphony of noises generated from the bio-data, turning aural aspects of the machine inside out. Thereby also following the ideas of Luigi Russolo [27]. The tones used were generated using what we found to be machine-like, both aurally and technically. Therefore, we generated them from oscillators using sawtooth waves and selected a set of tones that emphasized what we thought of as machinic "chords" (used tones A, Bb, B, C, D, Eb, E, F) that we didn't find to be any known scale used in music. In addition, the colour tracking software frequency modulated the tones to such an extent that it sometimes sounded more musical as tones were bended to another tone, however, other times it just sounded weird. However, since dry sawtooth waves can sound a bit harsh and because dry sound coming from speakers on the side of the actual apparatus may appear detached from the piece, we decided to create space for the sound to fill the room around the machine and create a more unified art project. By using delays and reverbs an "otherworldly" appearance of the machine emerged.

CULTURAL COMMENTATORS EXPERIENCES

Inspired by Gaver's Cultural Commentators' [8] approach to evaluating and contextualizing our art project, we invited six "commentators" to reflect on our project. Gaver's cultural commentators method requires choosing commentators relevant to the project at hand. Since the Metaphone aims to open a debate in academic research on aesthetics in interaction design, biofeedback technology and the meeting between body and machine, we needed to involve commentators from a variety of fields. Therefore we selected commentators from different contemporary art, culture and design communities – from dance (Mischa), fine arts (Frida, Hampus, Ulla) and design (Cheryl). As it happened, as we were about to invite participants, our machine was mentioned and commented upon in a cultural program on national radio by a psychologist, who is also a writer (participant Per). He had seen the machine briefly mentioned in a newspaper article and was fascinated by how it interacted with emotional and artistic processes. In short, he was commenting that now people would not have to use their own artistic skills to express themselves creatively and emotionally, instead they could use machines.

Setting

The six commentators were asked to interact with the machine while we filmed their interaction and then comment on their experience – both right after interacting with the machine and later through a cultural commentators approach. They were asked to comment in any form they wished, such as a drawing or dance, however all participants chose to present their reflections as a written account.

The study was conducted in an art project space named DKTUS in Stockholm, Sweden, chosen for its intimacy and for providing the required "art context" for our project. To deliver some space for our participants to make their own interpretations and to engage in the experience, we encouraged them to critically examine our project as they would any work of art. By leaving them alone, one at a time, with the artwork, we hoped they would forget about the cameras and interact freely.

Experiencing the Metaphone

Before describing the commentators' experiences, let us provide a short scenario to provide some context.

The DKTUS art space is located in a cellar, in the old town of Stockholm. You enter by walking down a stone block staircase. Below is a small room where the machine took almost half of the floor space.

The room has an arched ceiling and stones protrude from the white walls. There is a red carpet on the floor – reminiscent of a theatre. A small window does not provide enough light, so some spotlights illuminate the Metaphone. Underneath the machine there is a large sheet of white paper.

The participant is introduced to the space and asked to hold the bio-ball. It is the only object around making some visible interaction at this time – it blinks in red according to your pulse as you touch it. The red light reflects on the white walls and the dark environment starts pulsating. The participant gets a short description on how the bio-data is captured by the bio-ball and translated into colours. Then we turn on the big apparatus on the floor and leave our participant alone. The wheels start to rotate and the machine

Figure 6. a) Trying to figure out the Metaphone (left). b) Calming down (middle). c) Kung-fu kick (right).

occupies even more space. The rotation is constant, monotonic, and repetitive – making one rotation every 4 seconds.

After a few seconds there is a pulsating sound, as the soundscape starts following the participant's pulse. This sound mixes together with the squeaking sounds of the machine twirling around on the floor.

The small cart carrying bottles with liquid colour paint starts moving along the iron shaft, back and forth between the two rotating wheels. It mechanically clicks and ticks, stopping in certain positions, dripping paint in different colours onto the large white sheet of paper, before moving on to a new position, dripping more and more paint. The white sheet starts to be filled with circles of colour, slowly blending, partly dissolving into the paper.

As the participant watches and reacts to this spectacle, the relationship between movements, pulse, and sweat begin to influence the machine and the soundscape starts to become a focal point. Or as expressed by one of the commentators:

"I remember becoming involved in the way the red colour spread out and how I started to become conscious of how my actions might be affecting the way the pattern was progressing. Oddly enough I was not actively thinking of how I could control the painting when I did things. I was more spontaneously interacting with the movement of the instrument and then later transforming the sound." (Cheryl)

Overall, through our video analysis and our participants' reflections of their experiences, we noted how the whole setting created an experience where they lost track of time and space. Some participants came after their busy working day, others were on their way to jobs, but most of them slowed down during the interaction and came back up from the crypt in a quite different mood from when they entered.

Machinic Experiences of the Metaphone

The focus here is not on describing every aspect of their experience, but instead on providing some account of how machine aesthetics contributed to the experience.

There are two reoccurring themes we pull from the video-analysis and commentator's accounts that may help deepen our understanding of the machine aesthetics of the Metaphone. The first theme concerns the issue of control, influence and authorship: where is the control over what ends up on the paper and in the soundscape? The second theme concerns our commentators' account of their aesthetic experience. While each commentator had his or her unique interaction, resulting in unique drawings and soundscapes, a reoccurring report talks about the monotony of the machine and how that provides for a relaxing yet slightly creepy machine-dominated experience. Let us provide a bit more detail on these two themes.

Control, Influence and Authorship

The machine has its own strong rules and direct control over it is impossible. Still, participants will notice connections between their movements, pulse, sweat levels, and the machine behaviours. Often, the participants started to interact by trying to control – or at least influence – the machine (Figure 6a). As an example, Per struggled for a long time to get something to happen, initially trying to scare himself to see what that would render. But when something did happen he realized that he had no clue what was going on:

"something is happening! But I have no clue about what's the connection…but something is happening and then there is sound feedback from the camera, and I can see a pale pattern... I don't know what colours, but blue seems to be the most dominant… and red… there is some red …"

After a brief break, where he seems to think about what just happened, he takes a deep breath and decides to give it another try with a new approach – instead of trying to be scared he would try to make himself angry. But again, he is confused by what he gets.

The urge to figure out the machine and control it and its outcome is strong among the other participants as well. But gradually they start to realise that they are not in control, and that maybe, this is not about being in control at all. As time passed, the commentators realised that they needed to create a space in-between control and being influenced by the machine. Often they first figured out how to manipulate and play with the sound, e.g.:

"The sound that was coming from the loudspeaker would react if I turned my back to it, so I fiddled some with that" (Hampus)

As the participants struggled in different ways to get in control and understand how to affect and how they were reflected in the feedback, they also surrendered to the machine and reported how they almost felt captured by it:

"the machine somehow captures my feeling" (Mischa)

Others focused on controlling what they could control without really bothering too much about the machine:

"I could decide my time in the room created a closeness and freedom and responsibility" (Mischa)

Lastly, some seemed to just assume that everything was working perfectly fine and that the machine was doing exactly what it was supposed to do and they were happy that the machine was working for them:

"You have a sense of machinery working for you and it makes me relax. I tried to do relaxation as someone is doing the work [for me]." (Frida)

Bio-sensor-input is, of course, quite an indirect way of controlling interaction. You have to make yourself excited or move vigorously to get your GSR-readings to peak or your pulse to increase. The relationship is not always straightforward. However, our commentators all knew that this was their way of influencing the machine, and so, of course, this is what they wanted to do: control or at least influence it. But for all participants, the impact of the machines behaviour on their experience and mood seamed to increase over time. In a sense they surrendered to the machine, letting it take control over their experience.

There is also something else at stake here – the authorship. Machines in general are culturally perceived as objects that we control – not as autonomous systems that create their own art expressions. Most of our commentators reclassified the Metaphone from being a machine that can be controlled, to being an artistic machine – a strange mixture of machine behaviours and art. Those comments of our participants connect us back to the whole idea of a machine as an "author" or "artist", as was the original aims of automatic production, generative art and Tinguley's machinic movement. This is also often a main topic explored in interactive arts. By asking questions of what is meant by shared production when we use bio-sensor data as input, we place this century old question relative to an on-going debate in our field. With the introduction of affective computing [26], the quantified self movement [see e.g. a critique [28]), or other health applications, we are getting more and more interactions feeding off our bio-sensor data. Who is the author and owner of such data and the interactions they generate? Who is the author of the output from the Metaphone? Our participants commented on this question through their interactions and also explicitly stated:

"Is the painting meant to be an illumination of my personality?" (Ulla)

Ritual, Rhythm and Repetition: a machine aesthetics experience

Our participants repeatedly reported on their experiences in ways that may seem paradoxical: on the one hand they spoke of monotony, rhythm and repetition as leading to relaxation (Figure 6b), while on the other hand, they refer to the machine as scary. It appears paradoxical but this paradox seems to be resolved through the experience.

Most of the participants mentioned the monotony and repetitiveness of the soundscape. As the sound came from their bio-data and most of rhythms were heard from participants' heartbeat, they started to calm down. Low frequencies of sound were disturbing to some participants – they spoke of their darkness and repetitiveness. At the same time, those low sounds made them relax:

"- M-M-M… [imitating the sounds of the Metaphone] – It's kind of spooky. Because of being repetitive… I am always more on high levels, and this M-M-M… makes you calm down." (Cheryl)

There were similar experiences arising from the repetitiveness of the rotational wheel, or as Frida describe it: "*the creepy movement of the wheel*". The commentators spoke about how the machine brought them into its ritual repetitive dance, grabbing their attention:

"Time and monotonic movement and sound grabs attention, whether you want it or not." (Hampus)

One commentator, Cheryl, compared the looks of the Metaphone to that of a guillotine and made comparisons to Frankenstein. Per saw the machine as a monster from a horror movie:

"colour of bloodstains… I mean bright red like blood dripping down…[…]…horror movie fantasies… […]…it is really a monster" (Per)

At the same time, the circular and organic shape of the drawings often led to other connotations (Figure 6c):

"A shape of circle, I associate it with relaxation. Like a Buddhist's circle (Mandala)… I have close connection to it by doing a lot of kung-fu" (Frida)

Another commentator, Mischa, compared its movements to a ritual and claimed to be very comfortable with the space and the machine:

"The circular redundant movement of the machine gave me a certain sense of rhythm so I felt I had some kind of physical relationship with it."

The monotonic repetitiveness of the soundscape and machine movements in the strangely relaxing atmosphere was even considered to have almost therapeutic effects:

"When spending time with the Metaphone device I reacted very calmly to it, not much interaction in the beginning. Mainly looking at it and relaxing. Found it soothing for the

mind, almost like some kind of treatment. Helped me let my thoughts travel." (Hampus)

We end up with paradoxical descriptions – scary and relaxing – but these are not necessarily opposite. For our commentators, they seem to melt into one. An irresistible machine-induced, monotonic and repetitive movement that brought them into the Metaphone sphere of behaviours. In a sense, this is really where we see how the machine aesthetics comes through in the interaction over time. It is not the bare parts of the machine that creates this experience. It is the monotony of the interaction over time that is the basis of becoming relaxed and being transported into the strange and somewhat scary land of machines.

SUMMARY AND DISCUSSION

Our commentators' experiences and critique confirms that the machine aesthetics influenced their experiences in the ways we aimed for – creating questions of authorship, control, monotony – allowing them to visit the machine-like ways of being in the world. The Metaphone experience also laid the ground for asking questions about authorship and the role of bio-data in our interactions with technology. Perhaps most clearly for Per who had high hopes that the machine would translate his emotional reactions into an artwork. Instead, the machine pulled him into its activity, influencing him more than he was able to influence it.

Lessons Learnt

Let us now return to the claim in the beginning of this paper – that art styles can inform interaction design. By choosing a particular art style we steered all the major and minor decisions about choice of materials, interactive behaviours, and aesthetic expression. It became a generative as well as evaluative ideal that kept the project on track. Through setting up a particular aesthetic ideal we also ended up with an art project that created for a particular aesthetic experience. It set the scene for particular user experiences. For others (designers or artists) who aim to create for similar experiences, machine aesthetics can be one source of inspiration.

The description of machine aesthetics in the background, as well as, the description of the Metaphone above, may have erred on the side of decorative machine aesthetics. But we want to emphasize that machine aesthetics was not used only for the surface, but at the core of its behaviours. Exposing the inner aesthetics of technology and of the functional machine is just one but very important part of machine aesthetics. What we find in our commentators descriptions is instead a machine aesthetics of the *interaction,* as it unfolds over time [21]. To design for machine aesthetics in interaction, it is not enough to turn the machinery inside out, avoiding a casing, and show the internals of the machine working. We also need to uncover and show aspects of the software, the wireless connectivity and the biosensor in terms of machine aesthetics.

But how do you turn the software "inside out" in the same way that you turn a mechanical machine inside out? In this version of the Metaphone, we worked hard to make the algorithms and interpretations of the machine accessible and visible or audible to the participants, but we did not show the raw code, executed line by line. On the other hand, going back to our understanding of formalism, if it looks, sounds and interacts like a machine without hidden parts, it is a machine. The call to turn the machine inside out, showing all its hidden functions, should not be taken too literally. Instead, to draw on machine aesthetics, you need to create for an experience that unfolds in its own machine-like ways through the interaction.

Asking Questions Through Art

Connecting back to Tinguely's original intentions, the Metaphone allowed us to ask questions about control, influence and authorship with technologies that feed off our biosensor data. The authorship question repeatedly arose in our study and was informed by the machine art tradition as inspiration for the Metaphone. It entails a political question: who is in charge when machines become not only tools, but also take active part in creation of art or act creatively?

The issues discussed in the paper can be summarized in several points, but "machine control" is a seemingly important insight arising from one's project study: moving from a strict to loose control, and switching from trying to influence the machine to surrendering to the machine. Other research on control was conducted by Benford et al. [2] who wrote about control as one of the primary forms of discomfort and as a new trend for designers to consider. Höök et al. [16] speak about the balance between control and complete randomness in their Influencing Machine project, Fällman [7] talks about well-defined controllable and less controllable problems in design research as well as taking control over objects in virtual environments.

Kinetic Interactive Arts

The Metaphone is part of an interactive arts movement exploring movement and bio-data as materials in art (as, for example, in [17, 18, 25]). These art projects point to limitations in the ways we think of today's wearable and mobile technologies and their impact on bodily behaviours and practices. As our bodies are shaped by the tools we surround ourselves with – not only in a metaphorical or 'cultural body'-sense but also in a concrete corporeal sense [12], we have a great responsibility whenever we design with bio-sensor data or movement. All bodily experiences with digital technology are not impoverished, limiting or painful. The art projects mentioned here, as well as the Metaphone, open a much richer design space, with many different possible aesthetic experiences.

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REFERENCES

1. Bell, G., Blythe, M., and Sengers, P. Making by making strange: Defamiliarization and the design of domestic technologies. *Proc. TOCHI '05.* ACM Press (2005), 149-173.
2. Benford, S., Greenhalgh, C., Giannachi, G., Walker, B., Marshall, J., and Rodden, T. Uncomfortable interactions. *Proc. SIGCHI '12.* ACM Press (2012), 2005-2014.
3. Brett, G. *Kinetic Art*. Studio-Vista, London, 1968.
4. Broeckmann, A. *Remove the Controls - Machine Aesthetics.* (1997) http://v2.nl/events/machine-aesthetics
5. Cohen, H., *Reconfiguring*. In: Gere, Ch., Brown, P., Lambert, N., and Mason, C. (eds.) *White Heat Cold Logic: British Computer Art 1960 – 1980*. MIT Press, 2008.
6. Dewey, J. *Art as experience*. Penguin, London, 2005.
7. Fallman, D. The new good: exploring the potential of philosophy of technology to contribute to human-computer interaction. *Proc. CHI '11.* ACM Press (2011), 1051-1060.
8. Gaver, W. Cultural commentators: Non-native interpretations as resources for polyphonic assessment. *International journal of human-computer studies 65*, 4 (2007), 292-305.
9. Gaver, W., Beaver, J., and Benford, S. Ambiguity as a resource for design. *Proc. CHI '03,* ACM Press (2003).
10. Gough, M. *The Artist as Producer: Russian Constructivism in Revolution,* University of California Press, 2005.
11. Gross, S., Bardzell, J., and Bardzell, S. Touch style: creativity in tangible experience design. *Proc. C&C '13,* ACM Press (2013), 281-290.
12. Grosz, E. *Volatile Bodies: Toward a Corporeal Feminism.* Indiana University Press, Bloomington, IN, USA, 1994.
13. Hagen, U. *Lodestars for Player Experience: Ideation in Videogame design*. Diss. Södertörn University, 2012.
14. Helmes, J., Taylor, A.S., Cao, X., Höök, K., Schmitt, P., and Villar, N. Rudiments 1, 2 & 3: Design Speculations on Autonomy. *Proc. TEI '11*. ACM Press, (2011), 145-152.
15. Höök, K., and Löwgren, J. Strong Concepts: Intermediate-level Knowledge in Interaction Design Research. *ACM TOCHI '12, 19,* 3 (2012), 23.
16. Höök, K., Sengers, P., and Andersson, G. Sense and Sensibility: Evaluation and Interactive Art. *Proc. CHI '13*, ACM Press (2003), 241-248.
17. Ilstedt Hjelm, S. Research Design: The Making of Brainball, *Interactions 10,* 1 (2003), 26-34.
18. Khut, G. Development and Evaluation of Participant-Centred Biofeedback Artworks. *Unpublished doctoral exegesis,* University of Western Sydney, 2006.
19. Kirsten, B., Sengers, P., Medynskiy, Y., and Gay, G. Opening the Frame of the Art Museum: Technology Between Art and Tool. *Proc. DAC '05*, ACM Press (2005), 123-132.
20. Latulipe, C., Carroll, E., and Lottridge, D. Love, Hate, Arousal and Engagement: Exploring Audience Responses to Performing Arts. *Proc. CHI '11*. ACM Press (2011), 1845-1854.
21. Lim, Y., Stolterman, E., Jung, H., and Donaldson, J. Interaction gestalt and the design of aesthetic interactions. *Proc. DPPI '07*, ACM Press (2007), 239-254.
22. Löwgren, J. Annotated portfolios and other forms of intermediate-level knowledge. *Interactions* 20, 1 (2013). 30-34.
23. Mateas, M. Expressive AI: A hybrid art and science practice. *Leonardo, 34,* 2 (2001), 147-153.
24. McCarthy, J., and Wright, P. *Technology as experience.* MIT Press, 2004.
25. Moen, J. KinAesthetic Movement Interaction. Designing for the Pleasure of Motion. *Unpublished Doctoral Thesis in HCI*, KTH, Sweden, 2006.
26. Picard, R, W. *Affective computing*. MIT Press, 2000.
27. Rainey, L., Poggi, C., and Wittman, L. *Futurism: An Anthology.* Yale University Press, 2009.
28. Schiphorst, T. Soft(n): Toward a Somaesthetics of Touch. *Proc. CHI '09*, ACM Press (2009), 2427-2438.
29. Shusterman, R. Somaesthetics: Thinking Through the Body and Designing for Interactive Experience. *The Encyclopedia of Human-Computer Interaction, 2nd Ed.* Aarhus, Denmark. The Interaction Design Foundation (2013). http://www.interaction-design.org/encyclopedia/somaesthetics.html
30. Simbelis, V., and Höök, K. Metaphone: an Artistic Exploration of Biofeedback and Machine Aesthetics. *Ext. Abstracts CHI '13*, ACM Press (2013), 2995-2998.
31. Stolterman, E. The nature of design practice and implications for interaction design research. *International Journal of Design 2,* 1 (2008), 55-65.
32. Taylor, A. Machine intelligence. *Proc. CHI '09*. ACM Press (2009), 2109-2118.
33. Wilde, D. HipDisk: Using Sound to Encourage Physical Extension, Exploring Humour in Interface Design. *International Journal of Performance Arts & Digital Media 4,* 1 (2008), 7-26.
34. Zimmerman, E., and Salen, K. *The game design reader*. MIT Press, Cambridge, 2006.