Generative Art as Experiment

By

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Abstract

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This thesis investigates my generative art[1] practice with mechanical drawing machines, for which the relationship between humans and technology provides the larger context. The comparison between machinic and software-based generative art systems acts as a starting point for reflections on technology in general.

Producing pictures with self-made, commissioned or appropriated drawing machines, my practice aims at subverting the instrumental nature of technology, and emphasizing its anthropological dimension.[2] The practice focuses on inaccuracies, errors and deviations from my attempts at control. The glitch (a short lived, unexpected disturbance) is discussed as a way of highlighting the production process of a picture.

My research explores the media-specific *Eigensinn* (obstinacy) of drawing machines, a synergetic force colliding with the intentions of myself as a human creator. Calling up technological history, I argue that making art with technology is a paradoxical endeavour, which I embrace as a way of investigating subjectivity in my aesthetic decisions and art making. The emotion of surprise, resulting from this collision, is presented as my primary motivator for engaging with generative art.

The seeming autonomy of generative art systems brings up questions about the authorship[3] of such practices. These are contextualized with other practices less based on the hand of the

[1] Galanter, Boden and Edmonds

[2] Heidegger

[3] Irvin

artist than on the manipulation of symbolic entities,[4] e.g. readymades (Duchamp), and conceptual art (LeWitt).

I draw a connection from my hands-off methodology to the scientific experiment, which runs without the interference of the scientist. My machine drawings are compared to scientific graphs and the artist studio is paralleled to the science laboratory.[5]

[4] Roberts

[5] Latour

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1. Introduction

With a background in physics and visual communications, my interests focus on the intersection of art and technology. I create evolving pictures through rule-based machines and robots. These pictures document the struggle between me as an artist, and the specificity of the machine with its generative process. My practice is situated in the realm of generative art. For the work in the Master's program of Emily Carr University, my focus shifted from software-based generative art to mechanic and robotic drawing machines, to clarify how much the emerging aesthetics are a result of a computational versus a mechanical generative process.

This thesis essay starts with a subchapter on my most recent work, *The Robot Quartet*, in which many concerns culminate, and that best represents the works built up in the last two years in the program. As a second part of the introduction, the history and discourse of generative art is outlined, and common motivations for generative art are related to my practice. The chapter "Stages of Discovery" traces my working process in the studio: I portray myself in different stages: as an artist, I inhabit the technical figures of the inventor, the engineer, and the scientist. The "Theoretical Concerns" chapter is structured into subthemes and describes how different theoretical concerns motivate my practice: the chapter reflects on the relation between technology and our human lives, and justifies the choice of physical, mechanic machines for the works. Further on, the specificity and *Eigensinn* (Own Sense)[6] of media are discussed and related to the way in which technologies shape our relation to the world. More particularly, the glitch is presented as an unintended feature of a computer program, and its potential is disussed for highlighting a non-instrumental technological perspective and revealing the way a picture comes into existence. The subchapter "Hands-Off" contextualizes my practice with other artistic practices, in which the work is not directly produced by the hand of the artist, and the authorship of such practices is investigated. These reflections are contrasted by a counterexample in "deviating from my own rule: hands back on". The following subchapter outlines the seemingly paradoxical relation between machines and subjectivity, and questions the implications for making art with machines. Finally, in the

[6] The Concept of Eigensinn, as established by Giacco Schiesser, will be discussed in a later chapter.

"Experiment" subchapter, this practice is compared to a scientific experiment, and the hands-off approach is further motivated through this analogy.

With these relations to artistic and scientific practices, this thesis essay contextualizes my practice as a hybrid enterprise between Art and Science.

The Robot Quartet

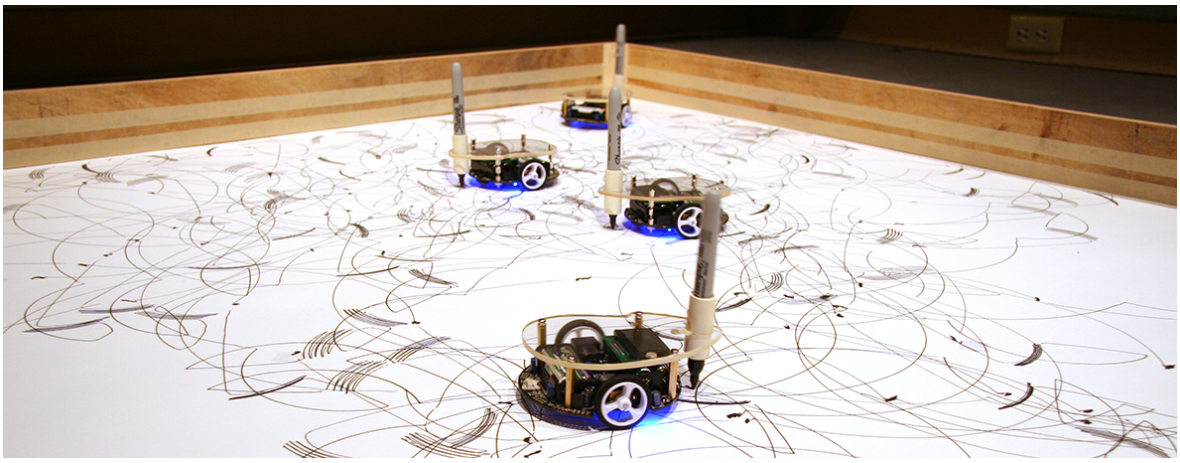

Figure 1: Andres Wanner, *The Robot Quartet*, 2012. Robotic drawing installation, dimensions variable. Used by permission of the artist.

> *Robot Quartet is a fluxus project.*
> *Robot Quartet is a ballet.*
> *Robot Quartet is a poem.*
> *Robot Quartet is a drawing device.*
> *Robot Quartet sings a love song to imperfection.*
> *That's why I think I fell in love with it.*
> *And I'd love to hear a musical interpretation of its score.*
>
> *Anonymous reviewer of my demonstration paper*
> *at the xCoAx 2013 conference.*

The Robot Quartet is the final project within my inquiry into mechanic drawing machines. Four drawing robots, equipped with identical repetitive instructuions, start with symmetrical motions. With time, their drawings get increasingly distorted by mechanical influences: Figure 1 shows the four robots after having run for a while. The distribution of their positions is no longer symmetrical, however their motions remain synchronous in time. Being a reflection on properties of a mechanic system as a form-

giving framework, the piece embraces imperfections, rather than eliminates them. Repetitive software patterns, as well as seemingly organic traces of mechanic deviations, generate an aesthetic between analog and digital.

This project investigates the relation between an abstract idea and its physical manifestation and explores the poetry of this divide - an aesthetic space that lies beyond human control over machine. A choreography with drawing robots is developed: it results in a series of drawings, paying attention to both the kinetics and visual aesthetics. The project builds on earlier drawing machines that will be discussed later in this document. In this case, several identical pre-assembled devices are contrasted against each other. Paralleling these four machines offers a new perspective on issues I have been investigating throughout this body of work: authorship with autonomously evolving artworks, and the balance between process and resulting picture.

Figure 2, Andres Wanner, *scribbles; and curves;*, 2013. Robot drawing, marker on primed canvas, 165x165cm. Used by permission of the artist.

Figure 3, Andres Wanner, *scribbles; and curves; (detail)*, 2013. Robot drawing, marker on primed canvas, 165x165cm. Used by permission of the artist.

The drawing *scribbles; and curves;* was produced by *The Robot Quartet* and is based on the repetition of elementary forms. Through the contrast and composition of these forms, the technical accuracy moves into focus, and there is interplay between desired shapes and the emergence of unexpected patterns. The drawing is composed of arcs with different diameters and arc lengths. As is visible in Figure 3, some arcs are drawn back and forth several times, some consist of wide curves, and some are short scribbles more

closely resembling dots than curves. Looser areas of the drawing appear more geometric, and the congruence between identically programmed curves is more apparent. In denser areas, the lines play a more textural role. Figure 2 shows the overall composition; the more concentrated area on the lower right of the centre emerged as a result of the defined process, though without being directly programmed, intended or even predicted.

Lines to Points on a Grid was drawn according to Sol LeWitt's instructions for *Wall Drawing #273*. Figure 4 shows the picture, consisting of lines from the corners, sides, and center that are drawn to random points on a grid. My interpretation differs significantly from LeWitt's picture (Figure 5): the inaccuracies of the vehicles while moving back to their point of origin overpower the geometric regularity of LeWitt's reference. Yet there remains a correspondence between generative art and his understanding of "The idea becomes a machine that makes the art" (LeWitt and Museum of Modern Art, 166) – an abstract concept as a driving principle that defines the execution of a work of art.

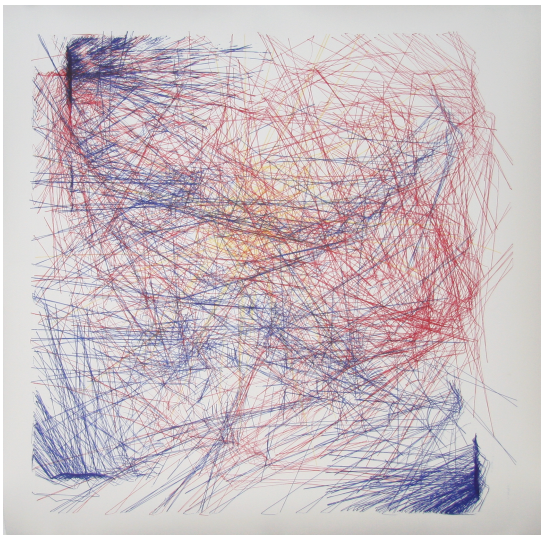

Figure 4, Andres Wanner, *Lines to Points on a Grid*, Robot Drawing, 2012. Robot drawing, marker on paper, 127x127cm. Used by permission of the artist.

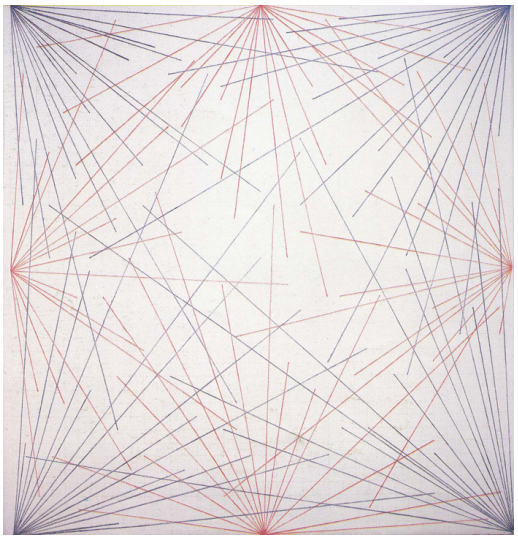

Figure 5, Sol LeWitt, *Wall Drawing #273*, 1975, water-soluble crayon on wall. Installation view, Dia:Beacon, New York, 2007. Photo: Bill Jacobson. Used by permission of the artist. © 2013, Pro Litteris, Zurich.

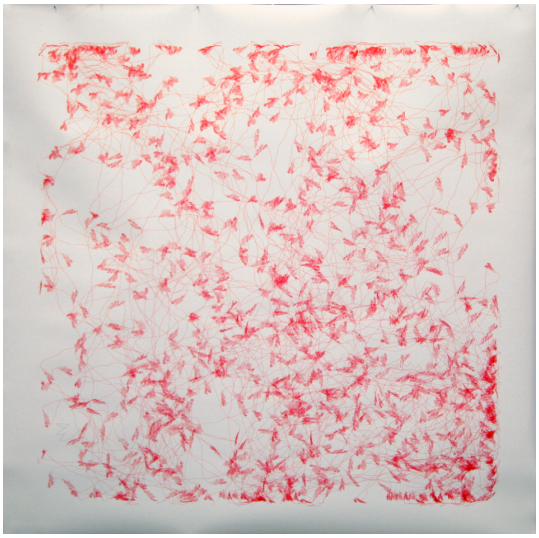

Figure 6, Andres Wanner, *Farewell to Canada*, 2013. Robot drawing, marker on paper, 150x150cm. Used by permission of the artist.

Figure 7, Andres Wanner, *curve; straightLine; curve; straightLine;*, 2013. Robot drawing, marker on primed canvas, 165x165cm. Used by permission of the artist.

Generative Art

The concept of generative art was introduced in the 1960s, at a moment when computational machines started to mimic and replace cognitive (as opposed to physical or mechanical) functions of humans. The German pioneers Gregor Nees, Frieder Nake and others used the term generative for their 1965 exhibition "Generative Computergraphik" ("generative computer graphics") – a collection of algorithmically produced artworks with enough ambiguity to suggest that they might have been done by a real person. Various attempts to define the field agree that generative art is based on a partly autonomous system that produces visual works. The system may be computational or non-computational, always relies on some sort of rules and principles, and may or may not depend on technical interaction with human users during its presentation.

Philip Galanter is one of the leading contemporary researchers on generative art and a contributor to the annual "Generative Art International Conference." He defines generative art as a "practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art" (Galanter n. pag.). Boden and Edmonds, two scholars who are known for a paper providing an overview of the theory and practice of generative art, specify that the artwork be generated "at least in part, by some process that is not under the artist's direct control" – the system may take over some self-direction, while it is still the artist who defines the rules (Boden and Edmonds 29). The degree of human involvement during execution appears to be a critical question, and various definitions differ in the amount of control they allow the artist to exercise, and the interference effected by the audience. Due to its procedural nature, the time-based presentation in front of an audience may play an important role for generative art. By creating a subcategory of "interactive art" for participatory works, Boden and Edmonds frame the role of the participating audience in technology-based art.[7] Their taxonomy distinguishes between interactive art, generative

[7] In this body of work, the audience will not be granted any interactive privileges with the work that I do not allow myself as the creator: the work is defined as generative art – as opposed to interactive art. Motivations for keeping my hands off the drawing board will be discussed in the subchapter "Hands-Off".

art, computer-generated art, non-digital generative art, and computer-assisted art (among others) (Boden and Edmonds 27), but does not differentiate between possible forms of authorial control over the generative process.

Galanter's definition of generative art – a system with autonomy that results in a work of art – does not consider the art-making process to be part of the work. Similarly, Boden and Edmonds define the work as the result of the process (29) (and thus equally exclude the process from being part of the work). Later in their paper, they introduce German conceptual artist Hans Haacke (30), who in his early work in the 1960s was concerned with processes of physical and biological systems and states of water and wind. In his manifesto for systems art, "Hans Haacke Statement, 1965," he anticipates many of the criteria that later became defining for generative art: its time- and process-based nature ("something which lives in time"), its potential for exploiting instabilities and glitches ("something which … is unstable") and its capacity to surprise the viewer and even its creator with "something indeterminate, which always looks different, the shape of which cannot be predicted precisely" (Haacke qtd. in Boden and Edmonds 30).[8] Boden and Edmonds reconcile the positions of an art-generating process, and Haacke's systems art by postulating the "art system" which comprises "the artist, the program, the technological installation and its observable results, as well as the behaviour of the human audience" – the work is the system, including its result (Boden and Edmonds 40).

Personally, the strongest force pulling me towards making generative art relies on the idea of surprise: the possibility of setting a system in motion and receiving back an unpredicted outcome drives my curiosity. It may also be a common root of both my artistic and my past scientific endeavours, of which I will speak in a later chapter. I agree with the contemporary electronic musicians that Galanter cites who use randomization to

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[8] HANS HAACKE Statement:
…make something which experiences, reacts to its environment, changes, is nonstable…
…make something indeterminate, which always looks different, the shape of which cannot be predicted precisely…
…make something which cannot 'perform' without the assistance of its environment…
…make something which reacts to light and temperature changes, is subject to air currents and depends, in its functioning, on the forces of gravity…
…make something which the 'spectator' handles, with which he plays and thus animates…
…make something which lives in time and makes the 'spectator' experience time…
…articulate: something natural… (Haacke)

"add an element of surprise to make things more interesting" (n. pag.). Galanter reflects "the more 'surprise' a given communication can exhibit the more information it contains." [9]

German artist Gerhard Richter uses chance in his work to achieve this element of unpredictability. Concerned with the quality of his creative process, he explains in an interview: "it's a chance that is always planned, but also always surprising. And I need it in order to carry on, […] to introduce something different and disruptive. I'm often astonished to find how much better chance is than I am." He frames chance as a creativity method to surprise himself with something unexpected (Richter 23).

The urge to be surprised is not my only motivation to engage in generative art. John Cage inspires me with his egalitarian "acceptance of all sounds as being equally worthy" (Galanter n. pag.) and modestly identifies as an author who wants to "remove [himself] from the activities of the sounds [he] make[s]" (Montfort, et al. 126), as a rationale for using randomness to compose musical scores. Partially removing myself from the process by letting my machines function on their own is important for my presentations, allowing me to question my authorial contributions and responsibility (which I will discuss in a separate section).

Deconstructing expectations of art-making, generative art resonates with post-structural thinking, as Galanter outlines: "Some generative artists work specifically in the vein of problematizing traditional notions about authorship" (n. pag.) – in other words, he argues that generative art is often used to specifically question the role of a human creator, in contrast to an algorithmic program. This critical approach plays into my practice as well, as I aim at revealing characteristics of the technologies I work with, and questioning their impact on the authorship and aesthetics of my work. Generative art may also trigger and guide artistic insight by allowing concentration on the rules that underlie the practice, "the structures that define the artwork, as against the surface" (Boden and Edmonds 26).[10]

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[9] This link to information theory is based on an argument of philosopher, physicist and acoustic engineer Abraham Moles, who values the unexpected (e.g. "free jazz") as novelty, in contrast to the familiar and predictable ("traditional folk music") that he depreciates as "banal" (qtd. in Galanter n. pag.).

[10] Boden and Edmonds clearly associate this position with a modernist "distaste for decoration and ornament" (Boden and Edmonds 26).

These different rationales show that generative art has a very broad scope, in terms of the reasons and motivations practitioners hold. Galanter maintains that generative art is not the name of a genre, but simply refers to a way of making art: “the generative approach has no particular content bias, and generative artists are free to explore life, death, love, war, beauty, or any other theme” (n.pag.). It allows different approaches and content matter.

As my primary motivation, I foreground here the desire to be surprised by something indeterminate and unpredictable. I am intrigued – as a condition of being in the world – by the difference between what I can affect in the world, and how the world speaks back to me, responding to my attempts at control. This dichotomy may lie at the origin of the conceptual separation I make between my interference and the generative process, the plan and its execution. In Boden and Edmonds’ terminology, the process and the result are considered integral parts of my work, and I acknowledge my own role as an agent of the art system (Boden and Edmonds 40).

2. Stages of Discovery – Engineering Works of Generative Art

In my practice, I design, build and appropriate technology, such as mechanical devices and robots. These are used as drawing machines, for the purpose of producing pictures. Derived from mathematical proportions, mechanical construction specifics or glitches of technology, my work is rule-based and produced without my direct intervention: I create the rules for a process that creates pictures – entirely *before* the process starts. My influence may take on different forms and principles: it may happen through setting numerical parameters, writing software code, but at times it will also consist of fabricating mechanical implements that give rise to particular figures. During the generation of the pictures, urging myself to keep my hands completely off the drawing board allows for an undisturbed actualization of the work according to the previously defined principles. The practice is a struggle between controlled and uncontrolled aspects, and is a way of eliciting surprising and unexpected results and aesthetics. I do this by carefully choosing the amount of control that best produces an outcome which is neither completely random, nor completely predictable. It is also a struggle between my aesthetic intentions and my observations of emerging phenomena, lying on a continuum between observing given material realities and using these realities to deliberately shape pictures.

The studio in which I created most of my thesis work was an appropriation of my office at Simon Fraser University: on Fridays – my studio days – it would get covered with cardboard, markers, tape, cables. My creations in that space had a temporary life however, and by Friday night all the utensils had to be tidily placed back on shelves and in filing cabinets, so the space could be used for other purposes during the rest of the week. These circumstances may have given reasons for me to exercise even more control on my drawing machines: not only did they have to behave according to a set of generative rules, they also had to remain removable and contained within the boundaries of a small space; this also urged me to minimize the quantity of marks my devices were leaving on their environment.

The academic context, mostly dedicated to scientific research, may also have fertilized the practice as a hybrid endeavour between art, science and technology. In the studio I go through different stages presented here as different technical trades that I inhabit as an

artist: the inventor, the engineer, and the scientist. This chapter will concentrate on my processes – the discussion of what is at stake artistically will be addressed later. I invite the reader to first observe my actions, and await my interpretations that will be provided in the chapter "Theoretical Concerns".

The Artist-Inventor – Identifying a Feasible Idea

In early stages of developing a new piece, I work as an *artist-inventor*, who tests the feasibility of ideas, establishing a "proof of concept," before bothering about its refinement. The German media theorists Daniels and Schmidt in their anthology "Artists as inventors, inventors as artists" have pointed out the parallels between artists and inventors who both create the "absolutely new and never before seen or conceived." They trace this analogy back to historic inventors such as Edison or Tesla in the second half of the 19th Century, when this "creative profession" was born. Both artists and inventors engage in innovation, and both become known as singular authorial figures at the origin of their work (Daniels and Schmidt 13). The comparison of my artist practice with technical trades refers to this hybrid identity of creators who freely borrow methods, resources, goals and discourse from different domains.

As an artist-inventor, modifying an existing machine, or using a self-built one for the first time, I explore its potential to be used as a drawing implement, attaching a drawing utensil allowing for the generation of an image. The machine runs freely for a while: from 30 seconds up to several minutes, until this configuration produces a drawing with clear characteristics, but without any ambitions of completeness or aesthetic perfection at this point. It is a stage of discovery, of finding out if the system is able to run without my interference. The goal of this initial phase lies in identifying technical processes with potential for mark making, that will be extendable to longer durations. Even at this initial stage, the expressive potential of my processes starts becoming visible, and they allow me to look for parallels between machinic motions and the shape of the traces. If the pen only remains at the same spot for a long time, or if the process is too irregular to result in continuous motions, I modify the implement until it produces a picture with a balance between diversity and regularity.

The *Mixer*, for example, is an appropriated kitchen device from my series *Machinic Trajectories.* One of two whisks is removed from an ordinary kitchen mixer, a black pen

attached to the other one with scotch tape. [11] The rotation of the whisk, causing the underlying plate to rotate, produces spiral-shapes on the paper attached to the plate. Once such a basic configuration with the potential of running autonomously is established, I look for ways of producing visually interesting figures. I am fascinated by the tension between the regular and the unexpected, geometric shapes and deviations, contrasts between fine lines and highly complex shapes, and by compositions with some degree of regularity, without being overly uniform.

[11] In this document, I am not discussing DIY culture in detail. It has been an influential context for my practice, and I observe an increasing public interest in DIY, e.g. through online platforms like instructables.com and etsy.com – both founded in 2005 – which promote the creation of analog technologies and hardware, and encourage a use of technology that is not prescribed in an authoritarian way by manufacturers, but individually interpreted by each user.

Figure 8, Andres Wanner, *Mixer*, 2011. Drawing machine. Used by permission of the artist.

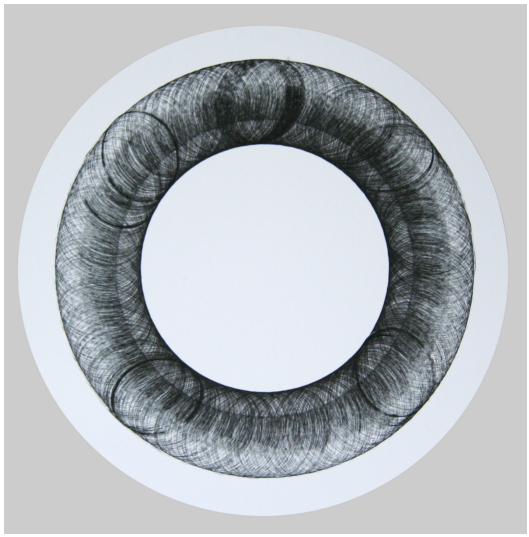

Figure 9, Andres Wanner, *Mixer Drawing Nr. 6*, 2011. Machine drawing, gel pen on paper, 30x30cm (round). Used by permission of the artist.

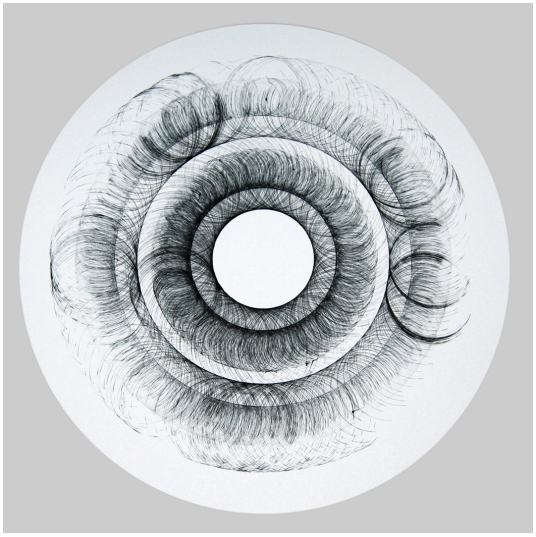

Figure 10, Andres Wanner, *Mixer Drawing Nr. 11*, 2011. Machine drawing, gel pen on paper 30x30cm (round). Used by permission of the artist.

Figure 11, Andres Wanner, *Mixer Drawing Nr. 8*, 2011. Machine drawing, gel pen on paper, 30x30cm (round). Used by permission of the artist.

The Artist-Engineer – Stabilizing a Process

After the discovery stage of the artist-inventor, I become an *artist-engineer*, and work at gaining more control over the duration and stability of the technical process. But my aim in this stage also lies in refining the aesthetic tension discovered earlier. In the inventor stage, I may have discovered an intriguing pattern, such as the parallel circles in the three mixer drawings shown in Figure 9, 10 and 11. As an artist-engineer, I further elaborate this pattern and allow the small circles to complete a big circle around the drawing surface. I look for variations in their density and consider, how much I want them to cover the surface. In Figure 10, the variations result in a formal rhythm between more and less defined circles. The image gains its intrigue through zones of different density, open and closed circles, the interplay between dark and focused areas with more open and seemingly random ones. The precisely defined inner radius provides an overarching geometric principle. The drawing on the bottom right of Figure 11 is more regular, but features the same quality of an inner circle. By operating the machine at a different speed, and differently attaching the marker, the geometry looks more regular. I also decided to stop the drawing at a moment of great regularity and symmetry, creating a picture with a sense of completeness, in which the nuances are subtler.

Stability plays an ambivalent role in my work: on one hand instabilities are a welcome source of unexpected forms; on the other hand the processes need to be stabilized for them to be presentable to an audience, and behaving within predictable boundaries during their presentation. Many times I look for a pathway that keeps the instability alive as long and continuously as possible – a way of maintaining the erroneous process, while not allowing the system to block, crash, or go completely out of control. As a technically oriented artist, I try to be one step ahead of my audience, able to estimate the range of inaccuracy quite accurately, and make things appear unpredicted and surprising that are really quite planned – “précis, mais inexact” [“precise but inexact”], as Lyotard quotes Duchamp, describing his use of instability as an artistic strategy (Lyotard 113). The work will be precise, within the boundaries I define, but it will be inexact – it will embrace the inexactness resulting from malfunctions of technology, and the exact paths of line drawings will never be entirely predictable. This can be a difficult balance to maintain. It

is a fine line balancing an apparently self-sustaining generative process with a subtle but substantial aesthetic control. To stick with technical language, this step of my practice might be called "testing." I repeat the crucial operations many times, until I feel comfortable with the process and reach a version with more stability.

The Harmonograph

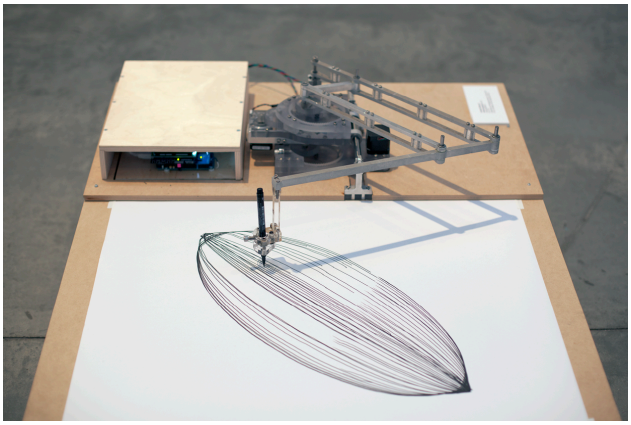

Figure 12, Andres Wanner, *The Harmonograph*, 2012. Drawing machine, dimension variable. Used by permission of the artist.

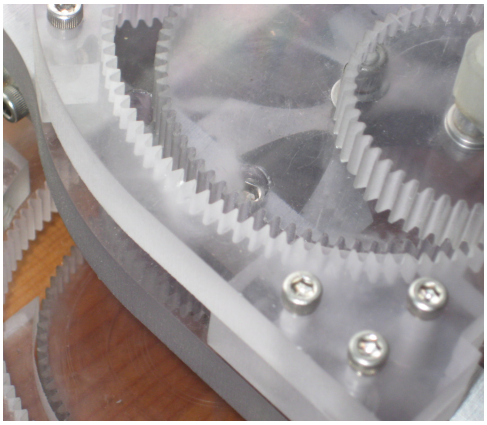

Figure 13, Andres Wanner, *The Harmonograph (detail)*, 2012. Drawing machine, dimension variable. Used by permission of the artist.

The *Harmonograph* (Figure 12) is an electro mechanic drawing machine that translates rotations of mechanical gears into large-scale Lissajous figures: two-dimensional oscillating curves, originally created with the help of pendulums or oscilloscopes. The *Harmonograph* physically translates rotations of mechanical gears into mathematic curves. Mechanical inaccuracies and deviations compete with the original intentional figure, and both forces give rise to a distorted mathematic composition. Figure 14 shows the *Four Meditations* – four Lissajous figures drawn with the *Harmonograph*. Their irregularities interrogate their machinic origin.

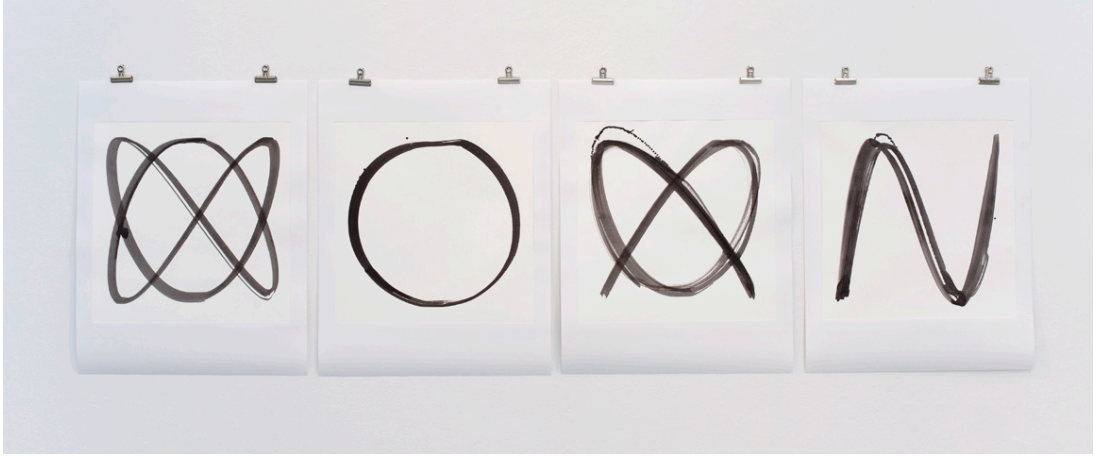

Figure 14, Andres Wanner, *Four Meditations*, 2012. Harmonograph drawings, brush on paper, 45x45cm. Used by permission of the artist.

The *Harmonograph* was built by the engineers Balasubramanian, Lathiff and Prof. Nakane from the University of British Columbia, according to my instructions. Their ambitions countered my interest in errors and glitches: they built the machine as stable and reliable as possible; causing it to draw exactly the figures I designed it for. In Figure 15, taken from their project report, the engineers suggest a way of quantifying unintended mechanical oscillations, thus making them predictable (Balasubramanian and Lathiff 28).

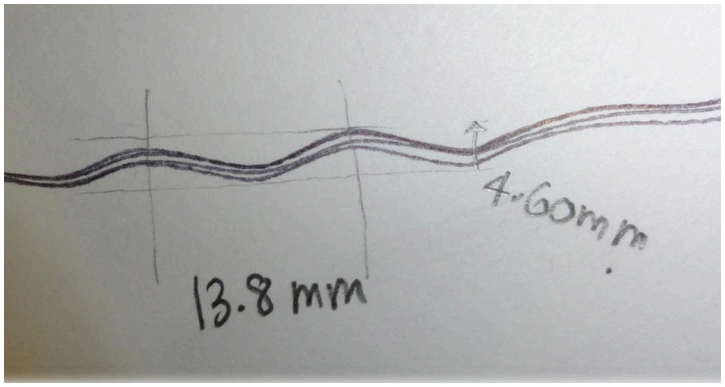

Figure 15, Measurement of unintended oscillations of the *Harmonograph.*

Forcing screws into its mechanics caused the pen to stop moving in a continuous straight line and thus provoked variations in the drawings. These result in irregular jumps of the pen, giving rise to corners and cracks that appear as modifications of the original smooth harmonic mathematical curves.

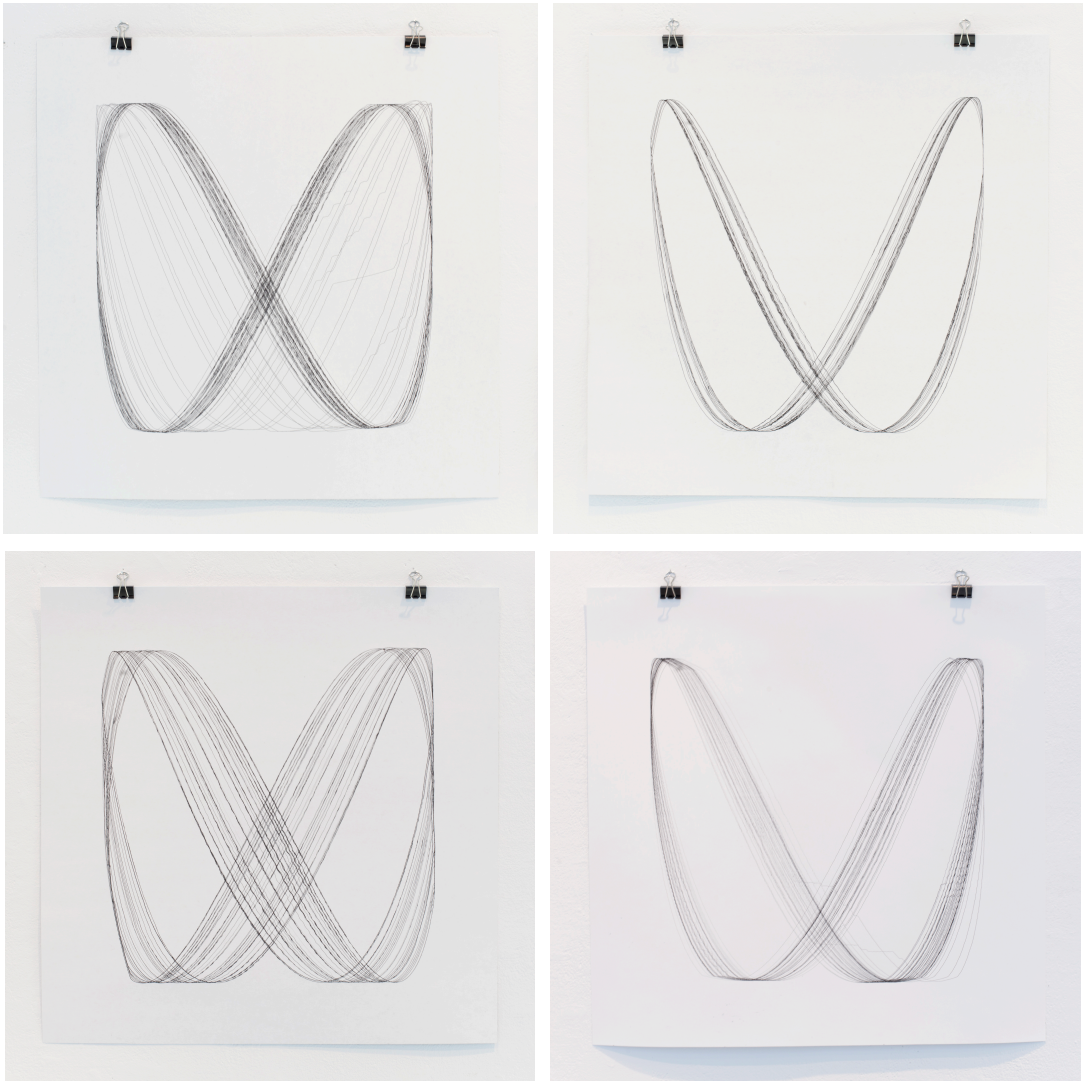

Figure 16, Andres Wanner, *Four Deviations*, 2012. Harmonograph drawings, gel pen on paper, 45x45cm. Used by permission of the artist.

The Artist-Scientist – a Position of Observation

At some point in the development of a work, I reach a liminal moment between plan and execution, a moment in which I feel my interference is no longer necessary for the work to be completed on its own. From then on, I turn from the originator of an aesthetic process into its viewer. I ask myself: will it be interesting to watch? Will it sustain attention? Should it be faster? Slower? Should the changes be more significant, radical, surprising? It is this instant, when I release the machine and the process from my direct control, though it still remains within the predictable boundaries and language I have defined. Keeping my hands off the drawing board, I temporarily release the system into its own life, and observe in what ways it responds to the imposed contingencies.

To continue the analogies with technical trades, at this point I become an *artist-scientist* and move into a position of observation. Like in a scientific series of measurements, the work often results in a series of pictures, as it is shown in Figure 16. This serves to compare and contrast different productions of the same process and thus highlights its inaccuracies.

While iteratively developing and testing this process, I often find myself hypnotized by the dynamically evolving image: even with processes sufficiently stable to run without my presence, I often attend to the evolution in silence and watch the new image slowly emerge. Other viewers of my work have experienced a similarly captivated response to it. I actively direct the dynamics, speed and intermissions of my kinetic works, with the goal of managing and directing this hypnotic state in viewers, and finding appropriate stages of captivating and releasing them.

Presentations

While preparing a generative process for an exhibition, I decide what kind of presentation it lends itself to and how much time its execution is going to take. Robot artist Leonel Moura answers this question "the viewer feels that the painting is 'just right' and stops the process" (Moura and Pereira n. pag.). However, the duration of a repetitive and ongoing procedure is not self-evident to define, depends on the envisioned presentation and reception, and is also linked to compositional decisions. Should I make an authorial gesture and call it off whenever I find it has achieved the aesthetic appeal

that it had as a goal? Or should my own decision be hidden behind a technical constraint – let the machines draw as long as batteries last? Or should the viewers decide, as they could with the *Plotter*, a Lego robot featuring a red button that viewers could press to stop the process (no one did, and the robot gradually filled its entire drawing surface)? [12] Tentative answers to these questions will be presented in the subchapter "The Experiment", which parallels generative processes with scientific inquiries.

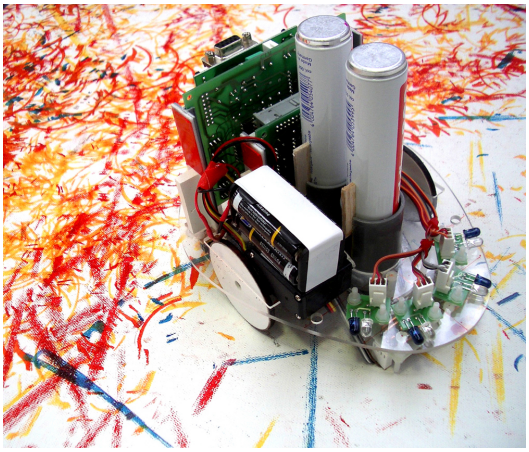

Figure 17, Leonel Moura, *ArtsBot,* 2004. Robot drawing installation, dimensions variable. Used by permission of the artist.

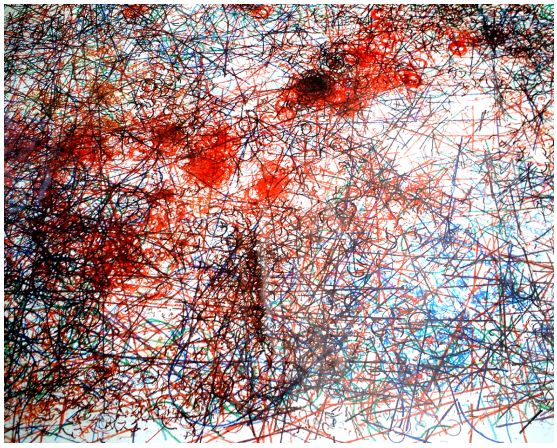

Figure 18, Leonel Moura, *10 mbots*, 2004. Ink on canvas, 400 x 500 cm. Used by permission of the artist.

The mentioned presentations of this body of work occurred at festivals, in a science museum, in talks and conferences, and in gallery contexts. Process and result in my view both deserve to be shown, and the work can not be considered complete if either one is missing. This point of view differs from Moura and Pereira's as they foreground the process of "picture construction" over the finalized paintings which are only "a memory of the exhilarating event". Moura's Artsbot-project (see Figure 17 and Figure 18) is a result of a "chaotic process" and the output is "impossible to determine" (Moura and Pereira n.pag.).

I have experimented with different presentation formats, attempting to do justice to the work as an art-system, and looking for an appropriate balance in the display of process,

[12] As explained in the introduction, I consider this body of work to be generative – as opposed to interactive. Since completing the Plotter, I have not given viewers any opportunities to interact with the process. I have become more interested in observing a technological system evolving entirely by itself, and thus excluding the audience as well as myself from interfering. This "hands off" approach will be discussed later in this document.

machines, resulting drawings and my appearance as the originator and presenter of the work.

The gallery exhibitions, during which I showed the work, required ways of leaving room for imagination and allowing viewers to complete the work. In their first presentations, the devices of *Machinic Trajectories* were presented as static sculptural objects, and were shown in relation to their drawings. Presenting the devices as if they had just finished or interrupted their drawing process, allowed viewers to complete the work and speculate on how the pictures came about. This way of hinting at the process and not making it explicit emphasized the role of the devices as sculptural found objects and equally valued the pictures as artefacts in their own right. During this format of display, I was not permanently present, as I felt the omission of the process allowed the works to stand independently of an operator. Many viewers, obviously conditioned by interactive presentations of technological works, expected participatory ways of interacting with the devices.

In a solo exhibition at station21, an artist space in Zurich, Switzerland, the works *The Robot Quartet* and *Harmonograph* were presented as continuously running processes. The kinetic element drew a lot of attention away from the wall-mounted pictures on display, but clearly made the importance of the process visible. To reemphasize the role of the pictures, the exhibition was rearranged before the closing event, and the completed pictures were presented spatially separate from the running process, at a place where they could be perceived *before* the process. This resulted in more appreciation of the drawings as aesthetic artefacts and created further opportunities for different readings and interpretation.

At New Forms 2012, a media art festival in Vancouver, a permanent wall display of drawings was complemented with a daily demonstration event of one of the machines. I took on an artist-scientist presenter persona to run short commented demonstrations of the machines that were otherwise displayed as non-moving objects. This allowed me to build a bridge to the audience and make the work more approachable. There was less desire from the audience to touch and operate the machines, and the running processes were balanced with a gallery-style exhibition of their pictorial results.

Figure 19 – Andres Wanner, *Demonstration with Juicer*, 2012. Demonstration, New Forms 2012. Photograph by Sakino Sepúlveda. Used by permission of the artist.

The more hands-on a situation is, the more literally the image-production is restaged. At the Maker-Faire 2012 in Vancouver – a crafty DIY event with an audience of geeks and tinkerers –a workshop-like atmosphere was installed with helpers, and many pictures were produced in front of the audience, splashing around a lot of paint (to the great amusement of everybody involved).

These performative demonstrations, and the roles I play within them, are constitutional for Boden and Edmonds' "art system" (Boden and Edmonds 40), which includes the presence of the artist in the consideration of the work.

3. “I do not draw the graph. An instrument draws it.” – Theoretical Concerns and Implications for My Practice

My work is situated as generative art that at times is software-based, and at times relies on mechanical implements as generating principles, as described in the chapter “Stages of discovery.” In order to discuss implications of making art with technology, I will discuss ways in which technology affects our human lives. The influential Swiss writer Max Frisch in his novel “Homo Faber” from 1957 describes technology as “the knack of so arranging the world that we don't have to experience it.” The technologist puts “the Creation to a use, because he can't tolerate it as a partner” and eliminates “the world as resistance, for example, of diluting it by speed, so that we don't have to experience it” (Frisch 178). Frisch criticizes technology as a way of avoiding life and subjective experience. This seems opposite and even contradictory to the goals of art, which I understand to be all about life and human experience. Whoever makes art with (and about) technology is challenged to address this contradiction in one or the other way.

But how does technology affect our relation to the world? The post-phenomenological philosopher of science and technology, Don Ihde has argued that experiences are transformed by the use of technologies. Telescopes, for example “magnify what can be seen”, but they also limit the field and depth “within which the object domain appears”. Technology here mediates this trade-off between perception of detail and context. The use of technologies change our environment by the way these technologies emphasize some aspects over others (Ihde 73). Others argue that technologies not only change the world around us, but also within us. Nake has specified that we can only do with machines, “what we ourselves are used to doing machine-like.” (“was wir selbst schon maschinenähnlich zu tun gewohnt sind”) (Nake n. pag.). The substitution of our activities by machines implies that we have to adjust these activities to make them executable by machines. From the idea that humans have to act like machines, it is not a far step to comparing the two, and to looking for human features in machines. But this can be a problematic perspective. The philosopher of technology Neil Postman warns of a “shift of responsibility away from human agents” as a consequence of anthropomorphizing

computers (Postman 114). By making the machines appear as people, we are tempted to hide our own liabilities behind the machines.[13]

The robots in *The Robot Quartet* are often compared to living beings, and some viewers have suggested giving names to them. While anthropomorphizing them in such a way seems problematic, it is hardly surprising that robots are equated to physical bodies. Their very existence can be understood as arising from attempts to enhance, complement or replace the human body.

But if computers are not beings, what constitutes life, and how is it different from computation? Sherry Turkle, one of the early academics to research digital culture in the 1990s, has interviewed children in order to examine their notion of aliveness. In early developmental stages, "alive" is synonymous with "moving" – anything that moves is perceived as alive. Later on, children come to terms with computers as something between a thing and a person (Turkle 33-36). A self-moving computer, a robot, is an irritating entity, and not only to children: it acts intelligently and with autonomy, yet it is made of cold, metallic material, does not show signs of fatigue and can be decomposed and recomposed at will.[14] We are tempted to conflate it with a living creature – and yet are irritated, if we do so.

Donna Haraway's *Cyborg-Manifesto*, an "ironic blasphemy" written from a feminist perspective, disrupts such concerns of identity. It builds on the science fiction notion of a cyborg, "a hybrid of machine and organism." This dualism (among others) is challenged by our high-tech culture. As a core part of the essay, she holds that "it is not clear who makes and who is made in the relation between human and machine. It is not clear what is mind and what body in machines […]." As she concludes, "there is no fundamental, ontological separation in our formal knowledge of machine and organism, of technical

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[13] The communications professor Raymond Gozzi equally fears that equating computers with humans might "undermine human identity" and affirms, "humans are not machines, computers cannot think. Each term may resemble the other in certain respects, but they should be kept conceptually separate. If not, we may wind up granting greater rights to computers and at the same time taking them away from humans" (Gozzi 52). Elevating machines to the status of living beings implies lowering the privileges of humans.

[14] Quite late in the process of finalizing this thesis, the ideas of "New Materialism" were brought to my attention. The American scholar Jane Bennet and others criticize the dichotomy between living and non-living and postulate an agency of any matter, human or non-human (Bennet). These ideas might have the potential to reconcile Postman's criticism with the audience's desires to project aliveness onto mechanic machines: the robot's deviations from algorithmic control could be discussed in terms of their material agency, without making any vitalist presumptions.

and organic." Postulating a breakdown of the dichotomy between alive and built, she frames our lives as highly dependent and interconnected with technology (Haraway 177-178).

In conclusion, it makes little sense for my art to interrogate the human condition, with technology as a separate and opposite pole. Instead, Moura and Pereira suggest talking about a "symbiotic relationship" between robots and humans: "what we can consider 'art' here, is the result of multiple agents, some human, some artificial" (n. pag.) – there is a hybrid human-machine continuum to be considered. My practice interrogates this hybridity. Often, the machinic component is foregrounded, with the goal of questioning the human role by concealing it. The goal lies in asking what is human, and how our lives are affected and transformed by this fusion with technology.

This investigation of the human use of technology emphasizes mechanical machines and robots, looking for paradoxical counterexamples to the digital that potentially show some of the characteristics of computers (for instance the "glitch," that is discussed in the subchapter "The Glitch – a Crack in the Window"). Building on a recent discourse about digital art, I consider my practice to be "post-digital": it is not digital in itself, yet would not make sense without the digital. The term "post-digital" has been suggested by the electronic musician Kim Cascone, who observed the use of "techniques that allow artists to work beneath the previously impenetrable veil of digital media" (12) – it is no longer crucial, whether a work has been produced with digital means or not: computers are ubiquitous, and we can refer to digital culture, whether we use it as a production tool or not. My machines (some are programmable, others not) mirror the ways in which software is used to generate images. Figure 20 and Figure 21 demonstrate how closely even my mechanically produced pictures are inspired by references from generative software art.

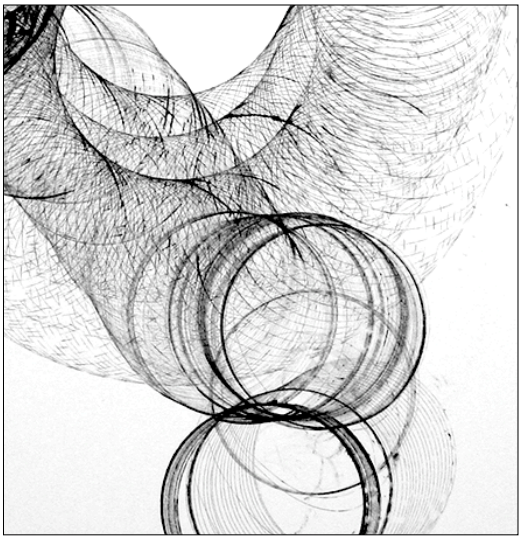

Figure 20, Andres Wanner, *Mixer Drawing Nr. 17 (detail)*, 2011. Machine drawing, gel pen on paper 30x30cm (round). Used by permission of the artist.

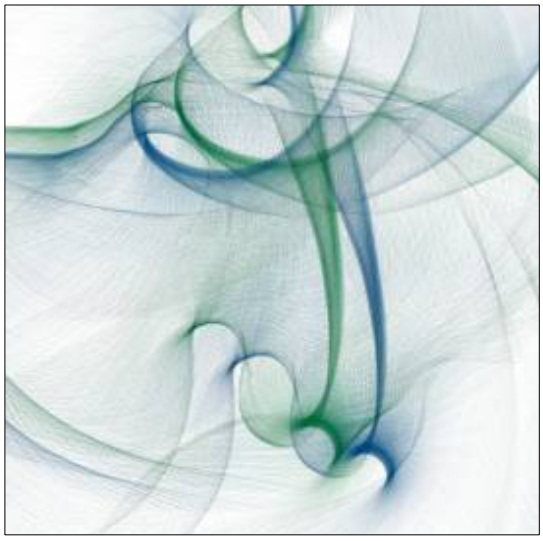

Figure 21, Jim Andrews, *dbCinema Brushings (detail),* 2009. Digital image, produced with dbCinema software. Used by permission of the artist.

Media Specificity and the Struggle between Artist and Technology

More than representing anything external to themselves, the machines in my projects give a record of their inner workings. Thematizing the way a working technology responds to my attempts at control, the machine drawings are documents of this struggle with technology. An intriguing tension occurs between the regular and the unexpected, between the predictable repetitive mechanics of machinic gear systems, and the surprising deviations from it.

Giacco Schiesser, former head of the first New Media program in Switzerland, has observed how all media have their *"*specific materiality.*"* Describing the struggle between artist-intentionality and media-specificity, he has introduced the German term "*Eigensinn*" ("own sense", "obstinacy"): "I propose to consider the *Eigensinn* […] of a media as a productive force of its own" (Schiesser n. pag.). The collision of this *Eigensinn* with the intentions of the creator "initiates and perpetuates a significant and paradoxical process" (Schiesser n. pag.). For my practice, this collision is crucial and connects to the core struggles mentioned earlier: the struggle between controlled and uncontrolled aspects of the process as a way of eliciting surprising and unexpected results, and the struggle between my aesthetic intentions and my observations of emerging phenomena.

This idea of media offering resistance to the artist who uses them has been brought up by others. One of them, Nake, specifies: "The artist as programmer looks for the resistance he has lost materially. The artist as programmer finds a resisting material. This material *a priori* is of a semiotic nature. Consequently, its resistance lies in the mental realm" ("Der Künstler als Programmierer sucht die Widerständigkeit, die ihm stofflich ja abhanden gekommen ist … Der Künstler als Programmierer findet ein widerständiges Material. Dieses ist von vornherein semiotischer Art. Seine Widerständigkeit liegt folglich im Geistigen.") (Nake n. pag.). Nake ties the digital *Eigensinn* back to the resistance that non-digital artists find in their working materials. My investigation of the resistance of physical machines is informed by Schiesser's notion of *Eigensinn*, but its focus is material.

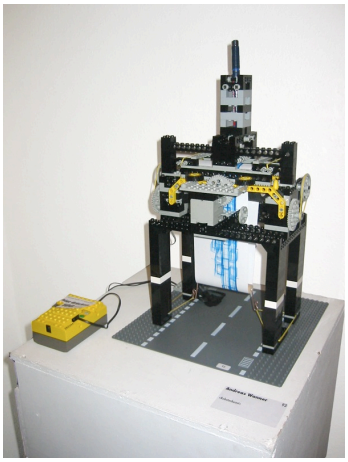

Figure 22, Andres Wanner, *The Plotter*, 2006/2011. Drawing Machine. Used by permission of the artist.

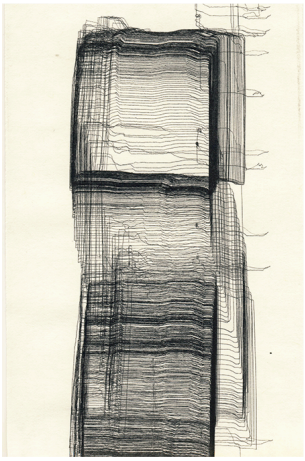

Figure 23, Andres Wanner, *Plotter Drawing (detail)*, 2011. Machine drawing, gel pen on paper, 6x50cm. Used by permission of the artist.

An example of media specific resistance is my work 'The Plotter' – a kinetic Lego-sculpture acting as a drawing machine (Figure 22). It operates on a simple algorithm composed of a minimal set of instructions (right, down, left, up). Figure 23 shows how these instructions manifest themselves as a gradually shifting inexact square-shape on the paper. The work artistically explores the deviations that are caused by the mechanical construction of the physical machine.

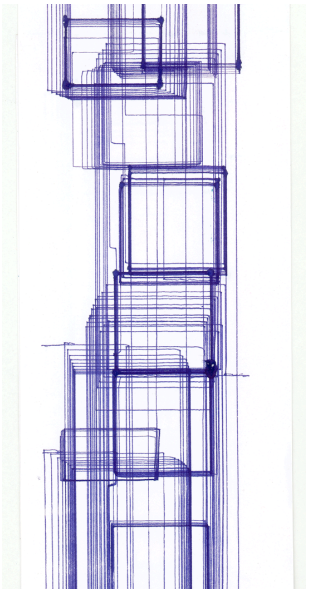

Figure 24, Andres Wanner, *Plotter Drawing No. 6 (detail),* 2006. Machine drawing, pen on paper, 6x50cm. Used by permission of the artist.

In my paper "Building 'The Plotter' – an Aesthetic Exploration with Drawing Robots," the visual parameters in *The Plotter*'s drawings are described. One of the illustrations from the paper (Figure 24) features "near-congruent forms" (the repetitive squares that are almost identical, but not exactly) and "negative-space compositions" (the white negative forms with uneven proportions) as reoccurring *Eigensinn*-attributes that give all Plotter drawings their specific aesthetics. In the paper, I make the point that these attributes, among others, are specific characteristics of this particular machine (Wanner "Building The Plotter").

My work with *Eigensinn* has an intrinsic motivation: playing with the media-specific characteristics of technology is very self-rewarding. But in addition, this investigation deals with the relations between us and the world around us, which is supported by statements from writers who have framed human relations with technology. The Canadian grandfather of media theory, Marshall McLuhan, has described our use of tools in relation to our grown bodily functions: "whenever we use a tool to exert greater control over the outside world, we change our relationship with that world" (qtd. in Carr 212). As we use tools we might change ourselves, and redefine the way we interact with the world around us. The use of tools is not neutral, every tool carries an ideological bias, as Postman has observed: 'embedded in every tool is […] a predisposition to construct

the world as one thing rather than another, to value one thing over another, to amplify one sense or skill or attitude more loudly than another' (Postman 13). Using a tool or a technology implies subscribing to the biases that underlie its function. By making art through thematizing the specifics of technology, I aim to deconstruct underlying biases, and reveal how the technology itself may shape our relation to the world. One of the ways of doing this lies in highlighting the aspect of technology that is unintended, undesired or even suppressed: the glitch.

The Glitch – a Crack in the Window

Unlike engineering, my practice embraces technical malfunctions: these malfunctions are used as generators of unexpected figures. A mechanical vibration, a friction of a gear system causing it to slightly differentiate between subsequent rotations, discontinuous motor movements, minimally uneven drawing surfaces – they are all materialization of what in a digital context is discussed as the "glitch" – "an unexpected occurrence, unintended result, or break or disruption in a system" (Menkman 26). Defining the glitch as unintended result requires a reference to an expected functionality of this system. [15,16]

The Italian theorist Vito Campanelli has linked media specificity to the "creative potential of the error," by stating that "every computer, every software, every input device has its own personality that cannot not influence the creative process" (Campanelli 222). He embraces the capacity for making errors as an aspect of a technical system that is intrinsically linked to its "personality" – its *Eigensinn*.

Others have framed the error not so much as an unintentional aspect of a system, but rather as an inherent and integral part of it. The philosopher Paul Virilio, in "The Accident of Art" for instance understands malfunctions not as signs of improper

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[15] The distinction between factual and intended outcome is a topic of interest in cybernetics, particularly in the works of Norbert Wiener. Systems such as a thermostat are kept in equilibrium by a "feedback"-mechanism that regulates between the intended and factual state of the system: If a temperature is too cold, the thermostat will provide feedback to activate the heating, and thus get the factual closer to the intended temperature (Wiener 96-97).

[16] Conceptual artist Marcel Duchamp has defined the "art coefficient" of a work as the difference between the intention and its realization: "the personal 'art coefficient' is like an arithmetical relation between the unexpressed but intended and the unintentionally expressed" (Duchamp "Creative Act" 77). The art coefficient describes the degree of intentionality in a work of art. Duchamp seems to understand it as a measure of the competency of the artist.

production, but as indicators of the "accidental potential" in any product. The invention of the locomotive contains the invention of derailment; the invention of the plane contains the invention of the plane crash (Lotringer and Virilio 2). Examining the glitch thus means looking at aspects of technology that are usually suppressed as undesired – and thus aesthetically unconsidered.

The digital artist and researcher Theodore Davis, in his Master's thesis on the glitch, compares a digital file format to a window, which "through its transparency […] allows one to view the outside surroundings and is rarely noticed until it becomes excessively dirty or a crack occurs. At this point, the window transfers from a transparent or unnoticed medium to an opaque one" (Davis 212). He praises the occurrence of a glitch for "revealing inherent qualities within the file format itself" – the study of the glitch allows us a view of the underlying mechanisms of technology (Davis 212).

Figure 25, Andres Wanner, *Opener*, 2011. Drawing machine.
Used by permission of the artist.

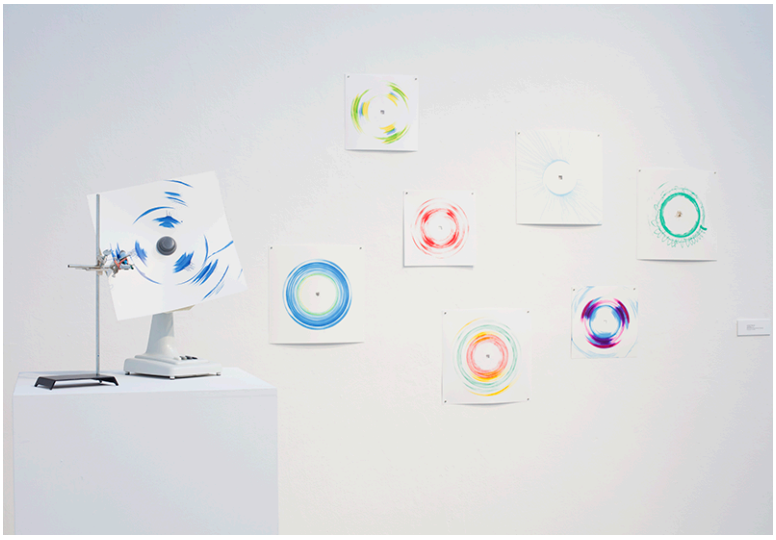

Figure 26, Andres Wanner, *Ventilator*, 2011. Drawing machine, Installation with Ventilator Drawings 1-8. Used by permission of the artist.

My series *Machinic Trajectories* (consisting of the *Mixer*, Figure 8; the *Opener*, Figure 25; the *Ventilator*, Figure 26 and the *Juicer*, Figure 27) allows investigating such underlying mechanisms. I repurpose domestic[17] devices as drawing machines by minimally altering the devices with an attached pen or pencil, and thus producing a drawing that accounts for their mechanical workings. I aim at subverting the utilitarian and factual nature of these devices and question instrumental technological objectives of precision, reliability and human control over machines. Instead, my work highlights an aesthetic dimension of technology and looks at machines in their role as cultural artefacts.

Glitches are also described as unstable, "short-lived disturbances" (Moradi cover text). This ephemeral nature may be a result of the electronic environment in which they arise. The influential German theorist Siegfried Zielinski, based in Karlsruhe's *Zentrum für Kunst und Medien* (Centre for Art and Media), has noted that media worlds relying on electricity are synonymous with artificial, processed and rhythmic time. He compared media artists to "nomads," whose works are "ephemeral and unstable," and sometimes more related to music, performance and theatre than to the visual arts (Zielinski 272).

[17] Many have read this contention with the domestic realm as a feminist statement. I think of this as a valid reading of the work, though it has not been my intention to talk about gender or feminism. The domestic is a familiar area of experience to me. Questioning the gendered use of such devices is part of my overarching question about their instrumental aspect.

Working with instabilities and short-lived disturbances of glitches is a challenge related to some of the central dichotomies at stake in this thesis. Evoking a glitch and keeping it alive means controlling the uncontrollable, stabilizing the unstable, grasping the ephemeral. Whatever work is done with glitches, a fine balance has to be acknowledged between exercising too much control, with the risk of losing the intended experience; or not enough, in which case the glitch may not even appear, or on the other hand, it may take over the entire process and bring it to a halt by permanently crashing it.[18] During a live performance at New Forms 2012 in Vancouver (see Figure 19) with the *Juicer* – one of the *Machinic Trajectories* pieces – I had warned my audience that ink was going to spread uncontrollably over a radius of 6 feet. The effect in the end was minimal: the radius estimated based on previous tests was correct, however the amount of ink was barely noticeable. A few iterations of the process were needed to provide the marks visible in Figure 27.

Figure 27, Andres Wanner, *Juicer*, 2011. Drawing Machine.
Used by permission of the artist.

[18] In the chapter "Stages of Discovery", I have described this fine balance between eliciting the unexpected and designing a predictable process for an audience.

Cascone has argued that digital tools are "only as perfect, precise, and efficient as the humans who build them"[19] and thus "failure reminds us that control of technology is an illusion, and tools are only as good as humans" (Cascone 13). This reminder of the humans who built the technology is also used by the German curator and critic Justin Hoffmann to make a point in an exhibition catalogue about machine art: "Since human beings stand behind the software, the author initiates a dialog with the software developers" (34). He frames the struggle with the machinic *Eigensinn* as a dialog between developers and users of a technology. By dealing with malfunctions artistically I thus aim at emphasizing this human aspect of technology, and at lifting technology out of the purely instrumental realm that Heidegger has described so eloquently: "So long as we represent technology as an instrument, we remain transfixed in the will to master it. When, however, we ask how the instrumental comes to presence as a kind of causality, then we experience this coming to presence as the destining of a revealing" (Heidegger "Technology" 338).[20] The causality he mentions here is understood as the way technology brings things into existence. Etymologically tracing "technology" back to the Greek term *techne*, which also meant generating beauty out of truth, he argues that art may play a decisive role in our confrontation with technology, and in our perception of the real as unconcealed truth. Subscribing to Heidegger's reasoning, I want to contrast the *instrumental* ("Technology is a means to an end") with another, *anthropological* perspective of technology ("Technology is a human activity") as part of our lives.[21] Heidegger summarizes: "The manufacture and utilization of equipment, tools, and machines, the manufactured and used things themselves, and the needs and ends that they serve, all belong to what technology is" (Heidegger "Technology" 312). His perspective

[19] This observation is a variant of the often quoted "Computers can only do what we tell them to do", paraphrasing a note of the computer pioneer Lady Ada Lovelace: "The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform. It can follow analysis; but it has no power of anticipating any analytical relations or truths" (qtd. in Toole n. pag.). This demonstrates how even in early computer history, computers were framed in relation to the humans operating them.

[20] Heidegger's original writing uses very idiosyncratic German and is hard to translate accurately. I put value in quoting his original here: "Sobald wir die Technik als Instrument vorstellen, bleiben wir im Willen hängen, sie zu meistern. Fragen wir indessen, wie das Instrumentale als eine Art des Kausalen west, dann erfahren wir dieses Wesende als das Geschick eines Entbergens." (Heidegger "Technik" 33)

[21] Emphasizing the human dimension of technology need not be the same as anthropomorphizing it. In contrary: the goal lies in negotiating the relationship between humans and technology, without conflating the two.

on technology encompasses all aspects that are involved with it, not only its instrumental goals. My practice prioritizes this utilization of technology, its history, and its inadequacies that seemingly contradict its instrumental function. The work thus provides a broader picture than the instrumental one that technology is often reduced to.

In that sense, my work deconstructs our use of technology and is in line with generative art that resonates with "post-structural thinking" (Galanter n. pag.). As we have seen, Heidegger frames technology as "the instrumental [that destines] a revealing [of the concealed truth]" (Heidegger "Technology" 338). Art with technology has the potential to reveal, for example to visualize the way an appropriated kitchen device acts upon the food it is built to process. In other words, to follow art historian and critic Grant H. Kester's analysis of post-structural thinking: "the role of the appropriated image [is to] reveal the contingency of the signifying process itself" (55). Post-structural art thematizes the way a picture comes to existence.

With this post-structuralist motivation of glitch art in mind, the next subchapter will examine an aspect that was earlier identified as critical but non-trivial for all generative art: the degree of interference by the generative artist during the execution of the work.

Hands-Off – Strategies of Appropriation

The chapter "Stages of Discovery" mentioned the moment between plan and execution, and the point I make of keeping my hands off the drawing board once the process is in motion. Keeping my hands off is crucial to me: it allows me to observe the full extent of an idea that develops in an undisturbed way. Similarly, Sol LeWitt states: "If the artist changes his mind midway through the execution of the piece he compromises the result and repeats past results" (LeWitt and Museum of Modern Art 168). This argument however needs closer examination, as it is not only a way of breaking out of the established, but also is at risk of giving away opportunities to refine the process as it unfolds. Additionally, it brings up the question concerning the authorship of the work produced without the hands of the artist. This question is equally legitimate for work that appropriates pre-existing elements or processes, such as my scientific data visualization series "Imagine the Beam," in which I used data produced completely outside of my influence, and before I even started the work. I do not interfere with the generative

process, but only harvest found data after the fact, similar to the way conceptual artists have re-contextualized banal found objects for art (Wanner and Beer “Found Data” 198).

Imagine The Beam

During a two month Art/Science residency at TRIUMF, Canada's National Laboratory for Particle and Nuclear Physics, I created the work “Imagine the Beam” – a series of digital data visualizations – interpretations of the proton beam from the cyclotron. The beam is not visible to the human eye – its data is interpreted through visualization software to imagine a rarely seen organic view on this technology. Intrigued by the contrast between the highly specialized facility and the down-to-earth routine of its daily operation, I aimed to give form to an entity that is abstract, hypothetical and invisible. With this project, I extended my practice through a link between science and technology. Re-examining my origins as a Physicist, I related them to my current art practice.

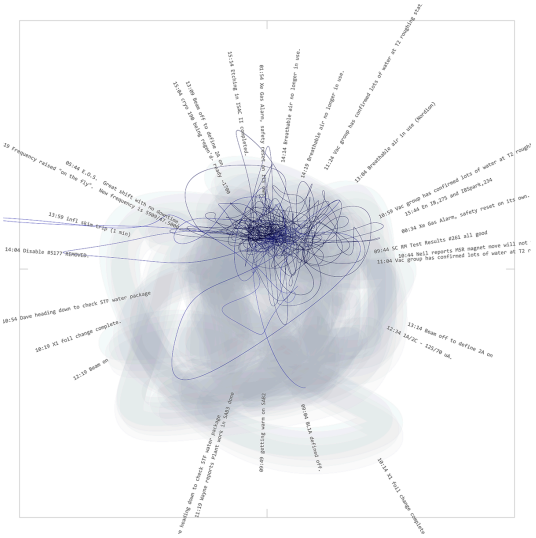

Figure 28, Andres Wanner, *Beam Sketchbook*, 2012. Bamboo-Print, Position-Data from Proton-Beamline 2A, Monitor BPM7, 61x61cm. Used by permission of the artist.

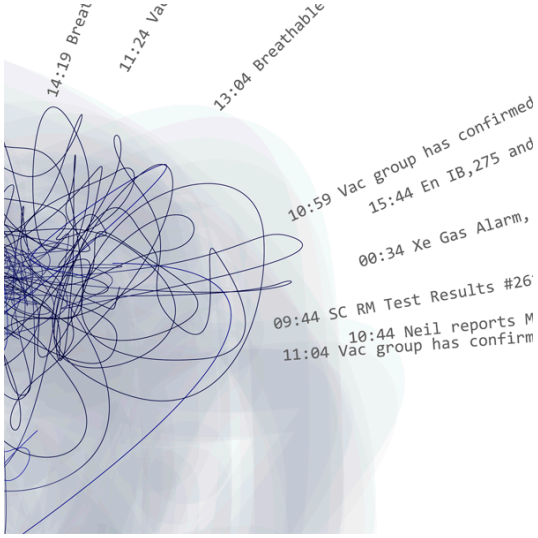

Figure 29, Andres Wanner, *Beam Sketchbook (detail)*, 2012. Bamboo-Print, Position-Data from Proton-Beamline 2A, Monitor BPM7, 61x61cm. Used by permission of the artist.

If a pencil were attached to the beam, what would it draw? In Figure 28, “Beam Sketchbook”, erratic beam motions are traced over time, as if recorded with a pencil, and they are related to textual logbook entries. The descriptive language still leaves room for speculating about the situation that produced it. The picture is reminiscent of a drawing or graph on paper.

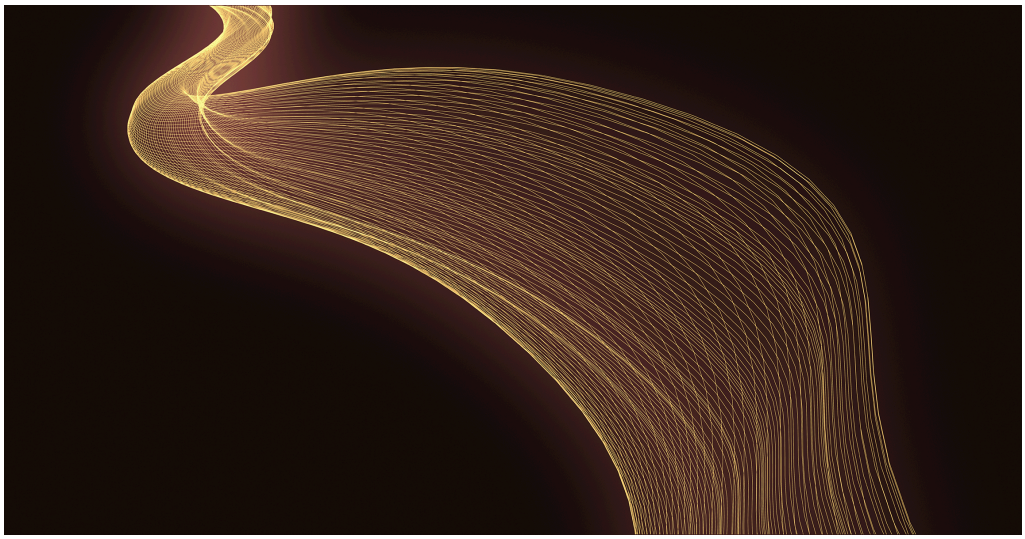

Figure 30, Andres Wanner, *Hypothetical Beam I, 2012.* Aluminum-Print, Position-, Profile- and Envelope Data from Proton-Beamline 2A, 40 x 77cm. Used by permission of the artist.

The Hypothetical Beam series (Figure 30) interprets height-, width-, profile- and position-data at five points along the beam line. The fluctuations are emphasized to visualize particularities of an entity that does not reveal itself to human eyes. The title references the Canadian science philosopher Ian Hacking (a born Vancouverite), who reflects about the reality of an electron – a subatomic particle: "By the time […] we can use the electron to manipulate other parts of nature […], the electron has ceased to be something hypothetical" (qtd. in Ihde "*Instrumental Realism*" 262). The electron according to him is not a hypothetical construct, but something we can consider real, once we make use of it. This transition from a scientific discovery to a real thing will be further discussed in the subchapter "The Experiment," in which parallels between my scientific and artistic methodologies are demonstrated.

The Authorship of Hands-Off Art

I am not the first one to make art in which the hand of the artist is not directly present. From Duchamp's "readymades" to appropriation art, from collage and assemblage to Sol LeWitt's conceptual art, works have been created in which the craft of the artist plays a minor role. The appropriation artist Marcel Duchamp himself defended his urinal

Fountain by arguing: “whether Mr. Mutt with his own hands made the fountain or not has no importance. He CHOSE it” (Duchamp “Anonymous article” 5).[22]

The writer John Roberts, in a recent book, examines the role of skill and the hand of the artist after Duchamp’s readymades. He observes that "skill reemerges as the craft of reproducibility” and "the hand is released from expressive mimeticism to find new forms of dexterity and facility through the manipulation and transformation of the sign values of extant symbolic materials" (98). The skill of the artist is preserved, the role of the hand may consist in manipulating symbolic entities, not necessarily physical objects. He goes on arguing that machines cannot be artists – they “mediate and transform artistic subjectivity. It is artists - and their hands - however, who bring use-values to machines and their programmes” (104). According to him, authorship clearly lies with the human operators of machines.

Discussing implications for authorship when manipulating symbols, the French post-structuralist philosopher Michel Foucault has argued that an author is “whoever can be understood to have produced a particular text as we interpret it,” but not necessarily who penned the text (qtd. in Nehamas 686). Giving meaning and grounds for interpretation to a work is key for taking credit for it. Sherri Irvin, a scholar for aesthetics and the philosophy of art, emphasizes intentionality, responsibility and credit as crucial terms for authorship in appropriation art. She specifies that artists release their work into a context, in which “particular interpretative conventions and knowledge are operative” (136). They bear “responsibility for all aspects of their objectives and, hence, of their products.” She concludes, “far from undermining the concept of authorship in art, then, the appropriation artists in fact reaffirm and strengthen it” (123). Like Foucault, Irvin considers the physical production of a work as subordinate to intentionality and meaning.

Even the German philosopher Walter Benjamin has appealed to authors to take ownership of their working media as a means of production (Benjamin n. pag.). Generative artists indeed shape their means of production – the processes perhaps more

[22] Similarly, the German artist Michalis Pichler uttered often quoted motivations for appropriating and building upon other works: “The world is full of texts, more or less interesting; I do not wish to add any more” (Pichler n. pag.). Like Duchamp, he rejects the idea of cultural practice as producing artefacts, and highlights the merits of selecting.

than the productions themselves. Hands-off art does not diminish credit, responsibility nor intentionality of the work.

The found element I work with is technology as an underlying constituent of my process. My pieces are less conceptual and more formal than Duchamp's and LeWitt's work; their execution is part of the work and not a "perfunctory affair" (LeWitt and Museum of Modern Art 166). The resulting picture lies between something that *could have* been drawn by a human artist, and a document of a technological process as it unfolds. My subjectivity and intentionality is present in the elaboration of the work: hiding myself behind the machine does not happen for reasons of modesty, nor of "avoiding subjectivity" (LeWitt and Museum of Modern Art 166). I do this instead to highlight the role of the machine in the production of the work. By paralleling the machine's generative process with a human gesture, the goal is to emphasize human subjectivity – to "reaffirm and strengthen" my authorship instead of "undermining" it, to use Irvin's words on authorship again.

Deviating from my own rule: hands back on

In this subchapter, I discuss the implications of the principles discussed above when applied to my practice. During the making of the work I did not always adhere to the hands-off idea in a strict way, but allowed myself to deviate from it at times. With full appreciation for its value in my work, it is worth asking: what can be observed in the works in which I deviated from my own rules?

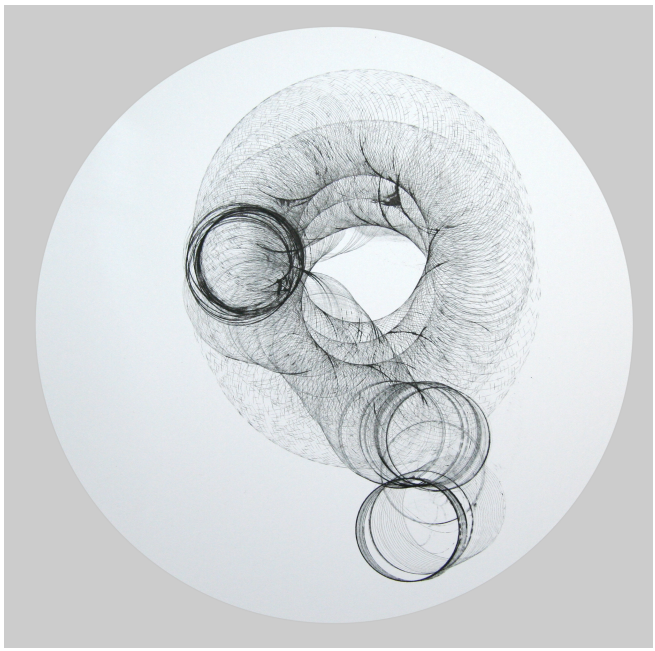

Figure 31, Andres Wanner, *Mixer drawing Nr. 17*, 2011. Machine drawing, gel pen on paper, 30x30cm (round). Used by permission of the artist.

Mixer drawing Nr. 17 (Figure 31) is an example of a drawing that was produced with the *Mixer*, introduced in an earlier chapter. The sheet of paper was only loosely attached to its support, so it started shifting as the pen drew circular traces over its surface. I allowed the paper to move, but gently pushed it back, whenever it threatened to leave its support. There was no systematic or aesthetic intention in my gestures, and yet I clearly followed the goal of keeping this process alive as long as possible. The process may be best compared to surrealist automatic drawing, where the body of the artist is lead by subconscious impulses rather than conscious deliberation. In contrast to other drawings of the same series, the mechanical regularity is complemented with a more organic compositional element, which would be impossible to achieve with machinic movements alone.

Since submitting the first version of the thesis, I have reached a looser understanding of rules and principles. I now think it is more interesting to understand my hands-off rule as a guiding line than an absolute principle, and that the investigation benefits from this variation. This does not disallow the idea to be investigated with rigour, but allows nuanced investigations and permits me to look more closely at the exchange between human and machine.

Machines and Subjectivity – a Contradiction?

The history of technology is loaded with suspicion of human subjectivity. Frederick W. Taylor, an early 20th century engineer whose "Principles of Scientific Management" were constitutional for industrial technological mass production, argues that human judgment "cannot be trusted because it is plagued by laxity, ambiguity, and unnecessary complexity" and "that subjectivity is an obstacle to clear thinking" (qtd. in Postman 51). Subjectivity is presented as contradictory to one of the core pillars of our society: industrialization. Reflecting on artistic subjectivity in a context of art and technology is not an easy enterprise – technology is not neutral, instead it has attempts to eliminate subjectivity at its roots. Making art with technology might turn out to be a paradoxical enterprise.

As we have seen, instead of understanding machines and humans as opponents with separate but individual characteristics, it might be worth examining their synergistic interplay, and interrogate modes of interaction arising from it. Heidegger has in his later work engaged with cybernetics, and presented human subjectivity in relation to the objects surrounding the human: the human is a subject, relating to the world of objects. Interacting with a machine, he becomes a human component in a subject-object feedback loop between human and machine.[23]

This human-machine feedback is also of interest to the long-term director of the German *Transmediale* media festival, Andreas Broeckmann, who understands a machine as "any kind of productive assemblages of forces, be they technical, biological, social, semiotic, or other". The "aesthetics of the machinic" according to him is not defined by "artistic intention, nor formal or controllable generative structures, but an amalgamation of material conditions, human interaction, processual restrictions, and technical instabilities play the decisive role" (Broeckmann 203). It is, according to Broeckmann, less a matter of a struggle between two separate poles, but a consequence of what arises if they collide – the mentioned "significant and paradoxical process" between Schiesser's *Eigensinn* and the intentions of the creator (Schiesser n. pag.). My machine-based

[23] "Denn im Gesichtskreis des kybernetischen Vorstellens hat der Mensch seinen Ort im weitesten Regelkreis. … ist er nämlich das Subjekt, das sich auf die Welt der Objekte bezieht, indem er sie bearbeitet. … Die Subjekt-Objekt-Beziehung ist, kybernetisch vorgestellt, die Wechselbeziehung von Informationen, die Rückkopplung im ausgezeichneten Regelkreis, die sich durch den Titel 'Mensch und Welt' umschreiben lässt." (Heidegger "Herkunft der Kunst" 17)

creative practice is not so much targeted at exploring machines themselves, but at my interplay with them.

This systemic view may come in handy for understanding human agents (myself as an author, or the viewers of my art) as part of an art system that equally includes the technological installation. Remembering Postman's warning from a "shift of responsibility away from human agents" (Postman 114), it remains important not to anthropomorphize technological parts of such systems. As humans, we have to remain committed to our responsibilities in our use of technology – for our actions as technology-users, and for our works as technology-based authors.

This is where my subjectivity as an artist becomes important. Even completely rule-based pictures bear my subjective handwriting and influences through my choices of process-duration, drawing instruments and media, selection of the mark-making process and restrictions to the drawing surface. With this in mind, every one of my pictures reflects a balance between my subjective personal choices and material technological conditions.

While technology may hold a tendency to eliminate subjectivity, in my practice it has become important to highlight my confrontation with technology as a subjective experience, with pictures and processes that are as much a result of technological properties as of my subjective choices.

The Experiment – Observing without Interfering

In this subchapter, I will compare my generative art practice with a scientific experiment. This analogy is inspired by my history as a graduate of Experimental Physics. While it would be possible to frame my generative rules as hypotheses and my pictures as their experimental confirmations or rejections, it is not my goal to take the analogy in this direction. Instead I will focus on my practice as an artist and relate it to my earlier personal experience in the lab. I will discuss implications of the subjective decision to end an experiment, frame my machine drawings as scientific graphs, and extend the parallel to the cybernetic key concept of the black box.[24]

[24] The term „black box" for a recording device in aviation may be more widely known, it is unrelated to the same term used in cybernetics that will be used here.

I find that the parallels deserve attention not only for reasons of making my personal motivations and working methods conscious, but also as a way to demonstrate an inspirational overlap between art and science. My science education may have informed my methodology as an artist: While working on my physics degree, I often let experiments run over night, and harvested the results of the measurements the next morning. I initiated a process that ran independently of my presence, and later observed the reality that had manifested during my sleep. Strikingly similar, the conceptual artist Douglas Huebler has described the charms of producing his generative work *42nd Parallel* and witnessing the results of it unfolding without his presence: "I like the idea that even as I eat, sleep, or play, the work is moving towards its completion" (qtd. in Lippard 62). The fact that my work is progressing independently of my body lends it a generality pointing beyond myself as a person. Harold Cohen, the creator of the generative painting robot "Aaron" takes this idea even further, and speculates how some of his original artworks may be created even after his death (qtd. in Boden and Edmonds 38).

In the following paragraphs, I will foreground the scientific procedure of the experiment as a strategy for making art. Donald Schön is an art and design researcher who reflected on the notion of the experiment from the perspective of practitioners. He is known for his critical framework around "reflective practice", a practical epistemology that seems invaluable for the discourse of research in the arts. According to Schön, practitioners, namely physicians, designers, architects, lawyers and engineers engage in a similar process to scientists when they tests hypotheses through an experiment. A designer "shapes the situation … the situation 'talks back', and he responds to the situation's back-talk" (78-79). A hypothesis "is initiated by the perception of something troubling or promising" and is terminated "by the discovery of new features which give the situation new meaning" (151). The practitioner may at any moment decide to end the experiment, when he finds the newly discovered features are relevant enough to generate new meaning. Ending an experiment is a subjective choice – just as ending one of my drawing processes ultimately is a subjective choice that I make.

As the end of a scientific experiment is hard to define since it relies on criteria outside of science,[25] deciding on the duration of my drawing processes has been critical, as there are no convincing conceptual criteria to help me decide when to stop. Ultimately, the processes are designed with the resulting pictures and the form of presentation in mind, and their duration is determined accordingly. With consideration for varying motor speeds, stabilities, battery power, paper surfaces and ink reservoirs in different works, I cause the process to be interrupted while its composition still retains a degree of unevenness, and before it seems overly complete. The *Harmonograph study* in Figure 32, for example, has been stopped at a moment when the drawing already was well defined, but while the composition was still open, and thus remained interesting to me. I am looking for pictures with an apparent symmetry, which on a second look is broken, pictures with a disturbed and compromised regularity and completeness.

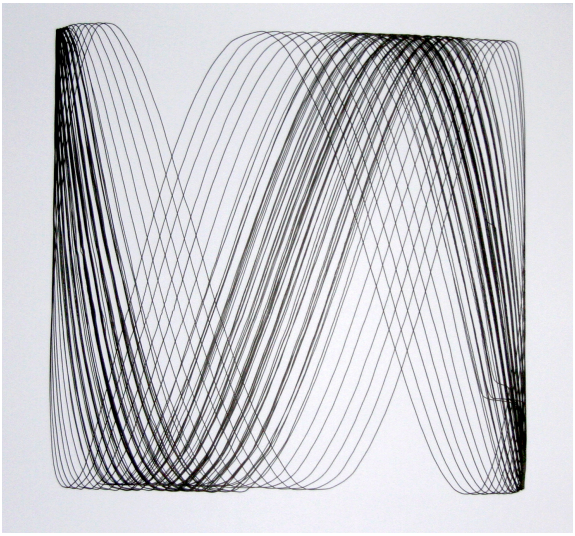

Figure 32, Andres Wanner, *Harmonograph study*, 2012. Machine drawing, gel pen on paper, 45x45cm. Used by permission of the artist.

The kitchen devices of *Machinic Trajectories* rarely take longer than two minutes to reach a stage that feels exhaustive, thus they are usually shown as short demonstrations

[25] Science historicist and physicist Peter Galison's "*How Experiments End"* suggests "that there is no obvious or unambiguous end to an experiment" (Galison qtd. in Ihde "Instrumental Realism" 124): at some point in the experiment, a scientist has to decide that enough data has been collected to make a scientific claim. According to Galison, there is nothing inherent in the data that unambiguously supports this decision – as there can never be ultimate certainty that scientific truth has been reached.

that are announced and run as a whole in front of an audience. The *Harmonograph*, in contrast, is run for two hours before accomplishing a drawing. This allows for a quiet and continuous development within a gallery context. Spectators can watch and speculate about the result, but the process is slow and will usually not hijack their attention, allowing them to move away and come back later. With *The Robot Quartet*, a robotic drawing installation comprised of four synchronized robots, the lifetime of the batteries allows durations between 45 minutes and 4 hours, depending on how the dynamics of their movements are orchestrated during that time. This duration is not only suitable to produce a picture with the intended variety and compositional heterogeneity, but it will also allow the drawing to slowly emerge over time, going through different stages of density and complexity, and allowing viewers to follow the process over the duration of an art event.

After these considerations of how both the duration of a scientific experiment, as well as the duration of my drawing processes depend on subjective choices, I will investigate parallels between my machine drawings and scientific graphs. The title "Instruments & the Imagination" by science historians Thomas Hankins and Robert Silverman traces the origins of scientific quantitative diagrams and measurements. They understand the scientific graph as an "indispensable means of reasoning and communicating in modern science" (147), providing an illustrating example of a medical graph as an "indexical" sign of the illness: "The physician does not draw the graph. An instrument draws it. Nor does the physician know in detail how the instrument operates. And yet he knows what the sign drawn by the electrocardiograph is telling him" (143). Graphs are indexical; they are in a cause and effect relationship with the reality they reference. And yet, rightfully, the authors question: "Does a recording instrument write its own signs, or does it write only what the operator tells it to write?" (144). They speculate that the recording instrument might have a sense of its own, an *Eigensinn*, causing it to influence the graph with its own inherent properties.[26] My machines are based on the contrary assumption: their "graphs" are not referencing an illness or any other aspect of an independent reality.

[26] Based on such inherent properties of instruments, Don Ihde has framed technology as the embodiment of science. Technology impacts the way we create our works of art, and it shapes the way we ask scientific questions and obtain answers. It enables science to see the invisible, "the new seeing is by means of instrumentation" (Ihde "Instrumental Realism" 42); according to Ihde, instruments provide signs of something that lies hidden from our senses.

Instead their indexical signs refer to the instruments themselves – they arise as effects of material traces, caused by the inner workings of the respective devices.

Hankins and Silverman continue by claiming that "the purpose of the instrument is to signify nature unambiguously and 'black-box' all man-made structure*"* (144) – the influence of "man" has to be hidden, so that the instrument can give a truthful record of nature. A black box is a technical system that a layperson can use without being concerned with the details of its construction. Its functionality lies hidden in a metaphoric opaque (black) container. The concept of the black box is also discussed in French social constructivist Bruno Latour's "Science in Action," in which he defines: *"*When many elements are made to act as one, this is what I will now call a black box." (131).[27] With my technology-based practice, I feel it is essential to interrogate this fundamental concept of science and technology. By building up this black-box methodology as I move from inventor, to engineer, to scientist, I appropriate the way technologists work, while bending instrumental goals of technology towards the production of artworks. By using the black box methodology, my work thematizes technology not only through the machines and technical processes, but also through its way of making. Like an engineer, I build an assembly of parts that act as one, without my intervention, without my hands. Keeping my hands off and giving room to the process allows me to foreground the machinic part of my dialogue with technology.

Latour applies the black box concept to scientific inquiry and argues that Science produces "something that I will call provisionally a new object" (87) – a scientific concept that acts as one, that does not need the interference of a scientist. This scientific object begins its fragile existence in the laboratory, a "technological production facility" (133), where it is first discovered and later brought to a point so it can be reproduced in other labs. I compare this to the inventor stage of my process, in which I discover a phenomenon that I stabilize, so I can later present it to an audience.

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[27] Latour supports this definition by a counter-example from early industrialization, where machines were highly interconnected with their operators: a machine worker's failure of attention resulted in a "gross disruption" of the result (130). The parts of this pre-black-box industrial machine do not *act as one* – and the worker instead has to be concerned with the details of its functionality. Latour lists the Kodak camera as a consumer technology example, in which the mechanism is hidden from the person who uses it. As a consequence, the camera can be used by a non-specialist, and is suitable for a mass-market: "a large number of elements is made to act as one, and Eastman benefits from the whole assembly" (131).

The laboratory as the origin of scientific objects has a corresponding concept in the artist studio. The French conceptual artist Daniel Buren wrote on the "The Function of the Studio" as the "stationary place […] where the work originates [and] portable objects are produced" (51). We can understand these portable objects in parallel to the scientific objects produced in the laboratory. And similar to a scientific object, once removed from its place of origin, Buren describes the work of art as fragile and at risk of being "lost", in a place that may impose different readings than the ones prevalent in the environment where it was produced (Buren 54). In both cases, the newly produced object of knowledge has to be strengthened, so it can survive outside its place of production.

The scientific object, in order to withstand criticism in scientific discourse, will need to be capable of surviving in the absence of the scientist who called it into existence, in order to be considered a valid contribution to scientific discourse and possibly to society. Many years after I actually carried out the experiments for my science degree, this clarifies for me why letting the experiment run during my sleep was important for the validity of my data and results. And it also backs up my desire to develop artistic generative processes that are able to unfold without my interference.

Both technology and science benefit from systems able to function without direct human interference. In my art practice, I generate an *assembly* that *acts as one* and allows viewers to perceive a process that maintains the unstable equilibrium I describe in the glitch subchapter. Black-boxing my interference allows me to highlight the balance of forces at the origin of the work: my silently manifest mantra "*I do not draw the graph. An instrument draws it"* highlights technological authorial contributions, and promises a look at technology in a non-utilitarian way. But in contrast to a scientist or technologist, I can allow myself more liberties: I configure a system that "acts as one", then use it as a black box, being able to freely transition from outside back to the inside of the black box as needed. To modify my pictures, I can either regenerate them using the same rules, or modify the rules themselves. The artistic motivation of this methodology lies in initiating something, and letting myself be surprised by its result. The scientific motivation, on the other side, consists in being able to talk about the world not only from a remote perspective, but by alternating between participant and observer.

I find the notion of the experiment is highly applicable to art and also life, and think of it as a tantalizing concept: the enticing risk of trying something of unknown outcome, and facing a surprising result. My fascination with it may be grounded in my quest to be surprised, that I had mentioned earlier: the active pursuit of something that is triggered and very deliberately initiated, then released into the world, answered by something that comes back from the world, unforeseen, but that reveals something about our relation to the world around us.

4. Conclusion: “Hands Off” in Art, Science and Technology

I have attempted, in this Master’s Thesis, to outline the role of the experiment for my practice. I have described my urge for being *surprised* by an unpredicted outcome of a process that I carefully and precisely design, which however yields results that could not be foreseen. With my generative art systems, entailing the process, the picture, and myself as an author and presenter, I investigate the interaction between an assemblage of forces in a continuum of human and machine. The practice embraces media specificities and technical malfunctions as a way of interrogating the instrumental nature of technology, and countering it with an anthropological dimension. My artistic subjectivity, even in a paradoxical relation with the technological processes, is prevalent in the work through decisions about duration, composition and choices about how to deconstruct technological mechanisms and reveal underlying paradigms.

One of these is the black-box methodology that was introduced above – an important concept of both Science and Technology that conceals much technological functionality from the people who use it. By building my systems in a way to make them capable of running without interference, I interrogate this techno-scientific paradigm, and question its use for art with hands-off. I demonstrate that there have been other attempts in art to produce works in which the artists’ hand does not interfere in a physical way, and relate this back to criteria in a current discourse on authorship, such as intentionality, responsibility and credit. My practice is inspired by scientific methodologies and thematizes these by appropriating some aspects of them. The practice examines our condition and subjectivity at a point in time, in which technology is a non-separable part of our lives.

This research bears future potential in a variety of directions. “Art and Science” has become a widely embraced fusion and is commonly accepted as unchartered yet viable territory, and a source of new inspirations for the art world. In a recent survey, scientists appreciated the benefits of an exploratory approach, “not knowing beforehand what [to look] for” (Strohecker, n.pag.). One scientist reported that collaborating with an artist allowed him to question himself and his own biases: “Why do I believe what I do, and how safe are my assumptions that support my beliefs?” (Strohecker, n.pag.)

Such collaborations may be influential for future ways of knowing. I would like to position this work at a place where it can trigger discussions between artists and scientists, as I feel I have only scratched the surface of truly interdisciplinary endeavours between Art and Science, and feel much need for further discussion. We may start engaging with such collaborations, before we know what we are looking for.

To refer back to my initial driving force, I look forward to the upcoming *surprises* that such endeavours will offer.

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