'Machinic Trajectories': Appropriated Devices as Post-Digital Drawing Machines

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ABSTRACT

This article presents a series of works called *Machinic Trajectories*, consisting of domestic devices appropriated as mechanical drawing machines. These are contextualized within the post-digital discourse, which integrates messy analog conditions into the digital realm. The role of eliciting and examining glitches for investigating a technology is pointed out. Glitches are defined as short-lived, unpremeditated aesthetic results of a failure; they are mostly known as digital phenomena, but I argue that the concept is equally applicable to the output of mechanical machines. Three drawing machines will be presented: *The Opener*, *The Mixer* and *The Ventilator*. In analyzing their drawings, emergent patterns consisting of unpremeditated visual artifacts will be identified and connected to irregularities of the specific technologies. Several other artists who work with mechanical and robotic drawing machines are introduced, to situate the presented works and reflections in a larger context of practice and to investigate how glitch concepts are applicable to such mechanical systems.

KEYWORDS

Analog; Computer graphics; Digital; Drawing Machines; Generative; Glitch; Media Arts; Post-digital; Robotics.

1 | INTRODUCTION: MECHANICAL DEVICES AS POST-DIGITAL DRAWING MACHINES

This article presents a series of my original mechanical drawing machines and situates them in a post-digital discourse – even though these appropriated domestic devices have no electronic or computational components. I define post-digital art works as ones that would not be conceivable without a digital discourse, but they do not necessarily have to be digital themselves.

The critical researcher Florian Cramer (2014) looks at the realm of the 'post-digital' not as opposed to but as an extension of the digital mainstream with its seeming immateriality. Cramer states that

> *'Post-digital' … describes the messy condition of art and media after digital technology revolutions. 'Post-digital' … merges 'old' and 'new' [media], often applying network cultural experimentation to analog technologies which it re-investigates and re-uses. (Cramer, 2014)*

The German new media scholar Verena Kuni pursued similar ideas of non-distinction when she invited participants to a workshop titled 'Analogital,' looking for hybrids rather than opposites: 'Analogital describes objects finding their way from digital culture

back to material concreteness' ('Objekte, die ihren Weg aus der digitalen Kultur zurück in die materielle Gegenständlichkeit finden') (Kuni, 2013). Like some glitch theorists that are discussed below, she emphasizes the materiality of digital objects.

For the purpose of this article, I will define 'digital' as something that consists of discrete intervals or 'distinct units or states,' following a definition of Cramer. 'Analog,' on the other hand refers to something that operates on a non-discrete spectrum, yielding a continuity between cause and effect. Cramer elaborates that analog 'refers to messy currents, streams and other material where distinctions can not, or only be artificially applied.' He concludes, 'Media are thus, technologically seen, always analog' (Cramer, 2014). Therefore any digital media practice will always entail the 'messy' and the 'material' analog aspects – this also will become evident in next section.

The architect, scholar, and artist Pablo Garcia confirms this continuity between old and new technology and observes a historical continuum from Renaissance mechanical drawing aids to modern computation, finding 'a real kinship between them.' In an interview with the Fast Company's Co.Design blog, he holds that the basic technology of historical drawing machines 'is a physical and mechanical manifestation of simple mathematical principles like geometry or perspective' and frames them as 'ancestors of contemporary computation' (Kushins, 2012), highlighting the similarities between old and new media.

Cramer more precisely specifies that post-digital media objects often 'resemble older media practices, but apply processual, interaction-oriented ways of making', or '"new media" practices applied to "old media."' He emphasizes do-it-yourself aspects and prioritizes 'processual practice' over the 'packaged product': aspects of process and appropriation of technology become important here. He summarizes that post-digital artists use their media 'for their own particular material aesthetics, whether analog or digital. It is a form of practical research that understands media from their nonfunctioning' (Cramer, 2014). This investigation of non-function or malfunction of technology as an aesthetic discovery will be discussed in the following section.

2 I THE ERROR AND THE GLITCH AS PRODUCTIVE FORCES IN ART

Accidents, failures, and inaccuracies have long had an influence on art. In *The Original Accident*, Paul Virilio highlights the 'accidental potential' of any product: 'To invent the sailing ship … is to invent the shipwreck. To invent the train is to invent … derailment' (Virilio, 2007, p. 2).

The electronic musician Kim Cascone was one of the first proponents of digital culture to theorize failure. He writes

> *Indeed, 'failure' has become a prominent aesthetic in many of the arts in the late 20th century, reminding us that our control of technology is an illusion, and revealing digital tools to be only as perfect, precise, and efficient as the humans who build them (Cascone, 2000, p. 13).*

Failure, control, perfection, precision, and efficiency are thus crucial aspects for exploring and defining our relation with technology.

In recent years, many artists have playfully investigated the glitch as a phenomenon. Rosa Menkman, a leading figure in this discourse, defines the glitch as 'an unexpected occurrence, unintended result, or break or disruption in a system,' or as a 'break from (one of) the protocolized data flows within a technological system' (Menkman, 2010, p. 26). This definition may become problematic if one is purposefully eliciting glitches, as it is difficult to refer to an intentional glitch as 'unexpected'. Iman Moradi, another influential contributor to this discourse, more precisely calls the (pure) glitch 'an unpremeditated digital artifact, which may or may not have its own aesthetic merits' (Moradi, 2004, p. 10). Saying that something is evoked without premeditation is slightly different from calling it unexpected. His definition also entails the aspect of aesthetic discovery, a powerful motivator for engaging with the glitch.

Most glitch theory seems to focus on 'digital landscapes' (Moradi, Scott and Murphy, 2009, cover text). However, one could also expect embodied real-world conditions to give rise to unpremeditated artifacts. When algorithms collide with embodied conditions such as friction, vibration, or mechanical

wear, a variety of unpremeditated phenomena may arise as emergent patterns without being directly planned or programmed.

Some glitch theorists look beyond this tendency to focus on the digital. The scholar of screen studies Hugh S. Manon and the glitch artist Daniel Temkin frame the glitch as an 'intersection of analog and digital modes of (re)production' (Manon and Temkin, 2011, p. 4). Introducing a 'materiality' of the glitch, they trace glitches as resulting from a hybrid intersection between the analog and digital realms. They exemplify:

> *Despite the seeming immateriality of digital representation, it would be difficult to deny that some glitch experimentation has a materialist bent: … when broken, a JPEG looks very different from a BMP (Manon and Temkin, 2011, p. 9).*

This use of the term 'material', describes how the glitch reveals properties of a file format, or how it 'makes visible technology by its failures' and allows one to 'see the material through disruption' (Halter 2010). The term 'material glitch' is mostly used for the output of digital virtual systems (as opposed to mechanical machines), which nevertheless display the 'messy' and 'material' conditions that Cramer attributes to the analog world.

This shift of focus to the medium is elegantly described by the glitch artist and researcher Theodore Davis, who compares a digital file format to a window in which the glitch appears as a crack: 'the window transfers from a transparent or unnoticed medium to an opaque one' (Davis, 2011, p. 212). Also Menkman (2010, p. 2) affirms that the glitch 'reflects critically on a medium.' Such post-structuralist ways of seeing serve to deconstruct media and reveal their inherent properties.

The glitch reflects critically on a medium by making visible underlying protocols, such as the encoding conventions of a digital file format. Following discrete intervals, rather than continuity between cause and effect, these digital conventions present surprises: minimal code alterations may at times result in gross discontinuities; small changes and seemingly closely related code sequences may lead to drastic effects and quite different visual outputs. Such effects lie at the foundation of the surprising aesthetic discoveries that the glitch offers, with unpremeditated artifacts seemingly appearing out of the blue. Manon and Temkin observe what they call a 'glitch paradox … the individual glitchwork does not respond well to gradual refinement,' in that it is easy to make a surprising discovery, but hard to tweak that discovery just a little bit: 'to attempt to refine a glitch even slightly would be to render it unreadable' (Manon and Temkin, 2011, p. 3). As a digital effect, the glitch does not respond in a continuous way to its cause.

For the purpose of this article, let us define a glitch as an unpremeditated aesthetic result of a protocol, either analog or digital. Used to reflect critically on a medium, it makes technology visible by exposing its failures and disruptions.

In the analysis below, I argue that mechanical machines are an ideal place to look for emergent patterns of unpremeditated artifacts and I describe the visual results of failures and inaccuracies in such machines. The article will also investigate how technology becomes visible. In an attempt to complement digital glitch art with analog inquiries, it applies similar perspectives for discussing analog and digital technologies.

3 | MACHINIC TRAJECTORIES: A DESCRIPTION OF THREE DRAWING MACHINES

Building on previous reflections on glitches, this section describes three of the drawing machines from my series *Machinic Trajectories*, in which ordinary domestic devices have been appropriated to produce drawings. The devices have been minimally altered by the addition of drawing utensils, so that their mechanical motions can be traced on paper surfaces. The mechanical changes are kept to a minimum, and no electric or electronic changes are made to the devices. The examples are presented in the order of increasing velocity of movement.

3.1 THE OPENER

The Opener (Figure 1) is an electromechanical can opener with slow and powerful movements. The gear wheel of an electric motor grasps the edge of a can, gradually rotating it around its own axis, and thereby cutting its lid open with a blade. When the device is transformed into a drawing machine, a black technical

Figure 1 | The Opener. Drawing Machine.

pen (chosen for its connotations of planning and precision) is attached through a hole in the bottom of an empty can. The pen leaves marks on a strip of paper from a cash register.

The slow and forceful movement results in squiggly, flexuous curves. The pen, pressing against the paper surface only with its own weight, effects just enough friction to propagate the paper strip by a few millimeters on each rotation, so that the drawing results in a spiral rather than a repetitive circle (Figures 2 and 3). The drawing in Figure 4 was produced with more than one pen, resulting in circles of different diameters and increasing the visual density of the outcome.
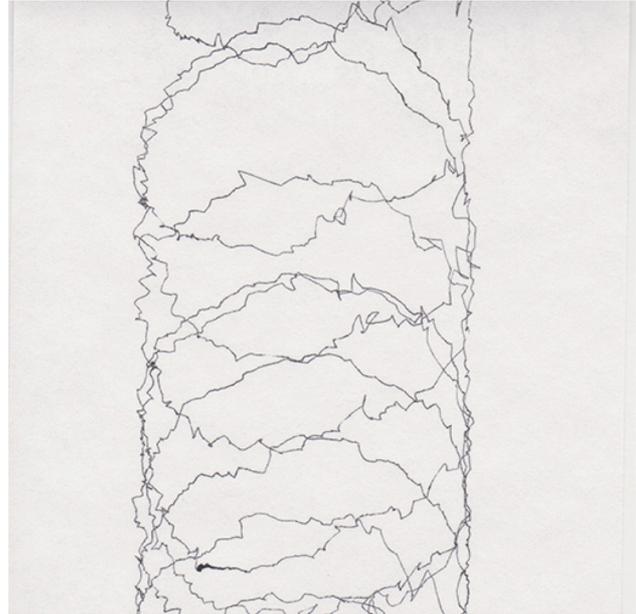
Figure 3 | Opener Drawing Nr. 2 (excerpt). A denser spiral.

The stroke gestures are reminiscent of a shivering hand. I looked for a visual expression that is neither unambiguously machinic, nor clearly human. The drawings reflect both the repetitive regularity of the can rotation, and the nervous motions of the forceful machine, mirrored by the squiggly lines. While the spiral curves can be seen as a planned or programmed outcome of the rotating repetition, the shivering scribbles emerge as unpremeditated results of the can opener's mechanical technology.

3.2 THE MIXER

The Mixer (Figure 5) is another appropriated device. A
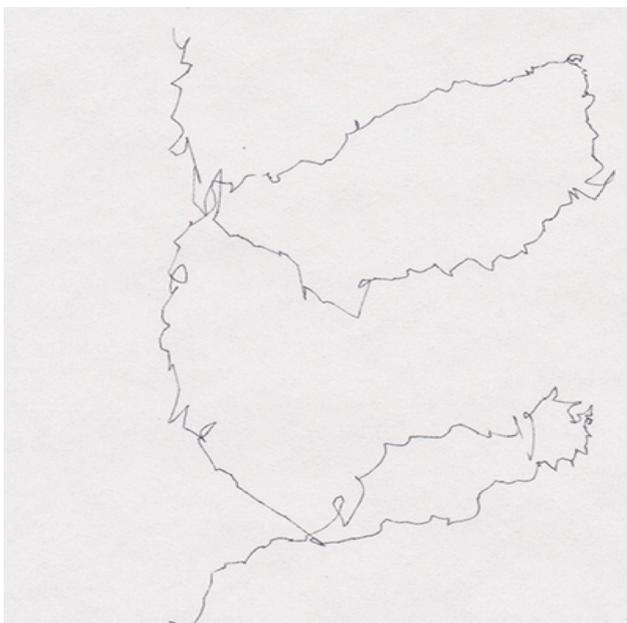
Figure 2 | Opener Drawing Nr. 1 (excerpt). An easily movable paper strip with a widely spaced spiral.
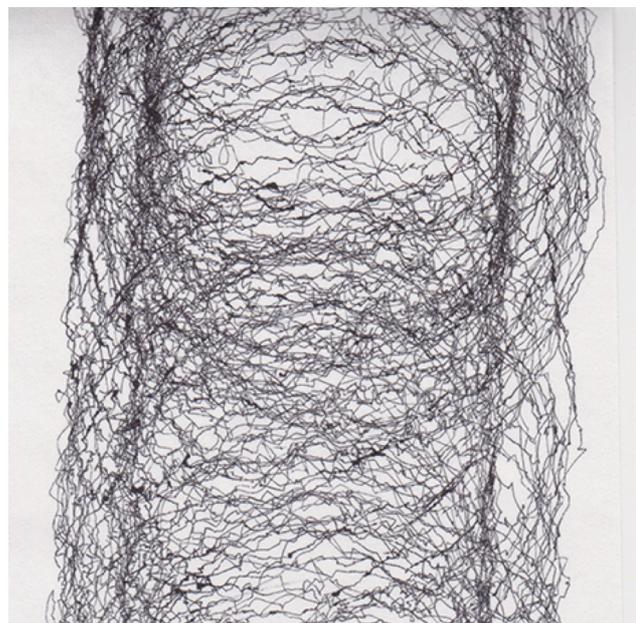
Figure 4 | Opener Drawing Nr. 3 (excerpt). Two pens are attached, resulting in dense double spirals with slightly different radii.

Figure 5 | The Mixer. Drawing machine.

Figure 7 | Mixer Drawing Nr. 9. Messiness of the analog medium.

standard kitchen appliance, it has two whisks, one of which is removed to allow flexibility in attaching a drawing utensil.

A turnable support disk would usually hold a bowl, but in this case it holds a round drawing canvas. A black pen is attached to the one remaining whisk and traces spiral curves on the paper held by the underlying, rotating support disk. This support disk is not connected to any motor and is propagated only indirectly by the friction of the pen – similar to the way the pen in *The Opener* propagates the cash register paper strip.

Searching for aesthetic discoveries, I came across the

emergent patterns visible in Figures 6 through 8. Figure 6 shows a spiral with dense parallel circles. These parallel shapes reflect the regularity and repetition of the mechanism, while the spiral emerges as an unpremeditated result of the whisk movement propagating the support disk, an undesigned feature of the device. The pattern is caused by the embodied interaction between components of this system.

Sometimes the disk temporarily slows down, resulting in higher density patterns. Unevennesses in the surfaces and fluctuating amounts of pressure from the pen produce a pattern of intermittent circles.

Figure 6 | Mixer Drawing Nr. 2. Parallel circles.
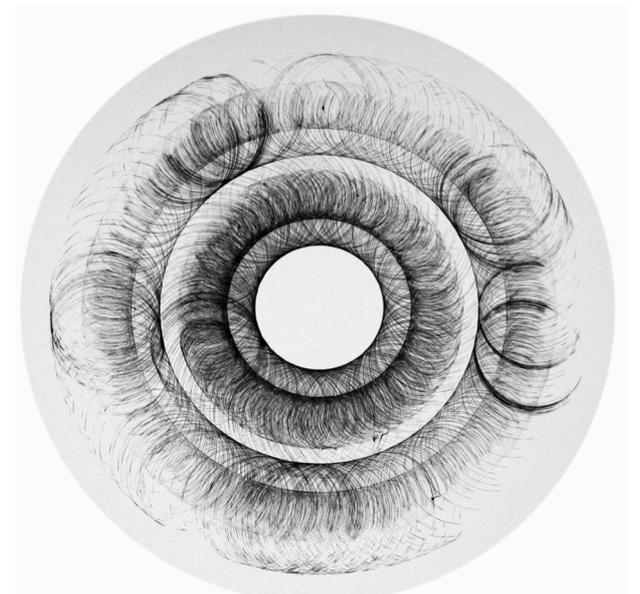
Figure 8 | Mixer Drawing Nr. 11. Intertwined circles caused by different pen positions.

Figure 9 | The Ventilator. Drawing machine.

Figure 11 | Ventilator Drawing Nr. 22.

Figure 7 illustrates another unpremeditated result: ink blobs appearing when a defective pen was rotated rapidly, literally embodying the 'messy' conditions that Cramer identified as belonging to analog media.

Figure 8 reveals specifics of the drawing setup by demonstrating how different positions and angles of attaching the pen change the picture. The drawing was made in several iterations, with the pen or the support disk positioned differently each time, causing superimposed spirals of different diameters. The pen was effecting different degrees of pressure in every iteration, resulting in a pattern of 'denser and more openly articulated circles,' as I have described in the

xCoAx conference paper on the same work (Wanner, 2014). These emergent patterns of varying densities constitute a unique characteristic of this drawing.

3.3 THE VENTILATOR

Its color and speed providing a significant contrast with *The Opener* and *The Mixer*, *The Ventilator* moves with a light and transient character. A square piece of cardboard is attached to the rotating blades of *The Ventilator*, while a pen is fixed on an external stand and only lightly touches the elastic paper surface. This results in strokes of a fast and ephemeral nature (Figures 9-12). In some instances, as it is visible in

Figure 10 | Ventilator Drawing Nr. 8.

Figure 12 | Ventilator Drawing Nr. 14.

Figure 9, the liquid paint is ejected from the center toward the outside and leaves dripping traces, evidencing the centrifugal force resulting from the high velocity.

Unlike the previous two works, which consist of slow and tedious recapitulations of an ever-repeating circle, here the strokes seem more dynamic. The drawing reveals the drive of the technology by the stroke gesture. I further emphasized this dynamic expression by using a colored brush. The velocity of the rotation becomes legible in the lines of variable thicknesses, densities, and lengths left by the flexible brush tip. The dynamic drawings appropriately reflect the fast-moving process that created them.

All the three machines are exhibited together with their drawings, giving both the machines and the drawings equal value as components of the work. In some presentations, the drawing process itself has been demonstrated as a performance in front of a live audience; on other occasions, it was made implicit in the way in which the machines and drawings were installed.

The stroke gestures and irregularities in all three machines lend the drawings their unique style, highlighting their deviations from the repetitive, mechanical regularity of functional processes. Patterns of varying densities, squiggliness or dynamics evidence the speed and accuracy of the generating process. If the mark-making pen or brush is also considered an aspect of technology, then its specifics are revealed by the ink blobs and centrifugal drippings.

These devices, designed for facilitating laborious tasks, emulate these tasks with repetitive circular motions. The drawings aesthetically trace this transformation and at the same time thematize its limits by highlighting inaccuracies in the machinic processes. Just as glitches reveal unpremeditated patterns in digital file formats, here analog technologies are made visible by their imperfections, producing documents of variability and deviation. We have seen that glitches gain their surprising aesthetic by their digital discontinuous nature. These artifacts of mechanical processes emerge in a more subtle way: due to their analog and continuous causes, they result in gradual deviations from documents of repetition.

Their aesthetic bends the underlying regularity, rather than destructively disrupting it.

A more comprehensive contextualization of these works is presented in my master's thesis (Wanner, 2013).

4 | OTHER MACHINE DRAWING PRACTICES

To provide a context for these works, and to investigate how other artists working with mechanical drawing machines consider errors, glitches and inaccuracies, this section presents a number of comparable practices.

Ted Lawson is an American artist who has received attention for *Ghost in the Machine (blood robot selfie)*, a robotic printer drawing Lawson's 'self-portrait' with his own blood. In an interview, Lawson frames the productions of this printer as 'drawings and not prints' because he allows 'certain glitches' to remain in the pictures. He sees the glitch as a distinctive feature between a purely reproductive print, on one hand, and a drawing bearing an individual note characterized by its mistakes. The appeal of such 'chance occurrences that happen outside of the programming' seems an important characteristic of this work (Azzarello, 2014).

Leonel Moura, a Portuguese robot artist, allows himself to be surprised by the works of his painting robots, autonomous, programmed vehicles that react to their environment while leaving traces on a canvas. In an online article with Henrique Pereira, he frames the paintings as originating from 'effects of randomness and … indirect communication through the environment.' (Moura and Pereira, 2003). Embodied interaction between the robots and their environment is listed as a main factor influencing emergent patterns in the paintings. Patrick Tresset, a French artist currently engaged in a robotic research project at Goldsmiths, University of London, maintains a similar emphasis on this embodied interaction with the environment. His robot Paul draws live portraits recorded by a movable video camera, using a robotic arm to sketch lines on a paper surface. Tresset and his collaborator Leymarie emphasize 'the issue of embodiment of graphical systems, in our case a robotic platform' (Tresset and Leymarie, 2013, p. 348) and invite computer graphics to 'seriously consider the embodiment' of such systems (p. 362).

Describing how Paul's drawings result from the movements of the robot arm, and as such make visible the technological process that created them, they speculate that 'this adds to the richness of the experience' for observers, and that 'due to the configuration of Paul's arm the type of errors it makes might be perceived as rather natural by a human observer' (Tresset and Leymarie, 2011, p. 114). This effect is paralleled by the line style in some of my drawing machines, which implies an aesthetic somewhere between human-made and machine-made. The errors in Paul's drawings are the result of the robotic mechanics, but they nevertheless help to create a desired 'natural' effect.

The drawings give rise to speculations on how they were made. Each line of a drawing is evidence of a process, Tresset and Leymarie state, calling it 'a direct record of the artist's hand motion' – and the irregularities in a robot-made drawing testify to the embodiment of its origins: 'Drawn lines have qualities that are a direct consequence of the characteristics of the gestures that traced them' (Tresset and Leymarie, 2013, p. 361). Furthermore, the 'recoverability of the genesis of a drawing' is crucial for its 'appeal and affective effects' on an observer (p. 360). The legibility of artistic intention may lie at the heart of such effects: its presence touches us even more if 'the action slightly fails, such as when the arm is attempting to draw a straight line but not managing to do it perfectly' (Tresset and Leymarie, 2011, p. 111). Rather than being undesired erroneous artifacts within a drawing, irregularities and failures help viewers to interpret an intention and reconstruct the motions that led to the drawing. They are crucial for how a drawing affects us, so the authors say. With relation to glitch theory, these irregularities are the place where technology becomes visible by its failures, offering us an opportunity to reflect critically on the medium.

Having talked with 'curators, critics, collectors and artists,' Tresset and Leymarie conclude that Paul's productions are 'artworks of quality.' They tacitly seem to consider the drawings (not the robot or its performance) to be the work. Similarly, Moura and Pereira (2004) define the role of human creators as 'making the artists that make the art' – the machines are not the work, only their paintings are. In *Machinic Trajectories*, I hold a different position, equally considering the machines and the drawing processes

to be part of the work, in the sense that both are worthy of being exhibited; the machines are viewed as sculptural objects and the animated evolving processes as benefitial to the viewer's aesthetic experience.

In spite of their 'emotional and aesthetic artistic effects on the observer,' Paul's robot drawings are quite 'distinct from those made by a human hand' (Tresset and Leymarie, 2013, p. 348), especially when one is 'observing at close range details of Paul's outputs' (358). The details of the drawings seem to reveal their robotic origins, but display more variety than comparable systems: 'drawings produced by Paul do not display the same serial uniformity of treatment' when compared to 'other computational systems that produce drawings from photographs' (p. 358). Even more, Paul seems to have its own handwriting, an 'autographic style' making a series of Paul drawings recognizable as 'drawn by the same author' (p. 358).

Such an autographic style could also be called a part of the media specificity of any system producing visual output. Paul's 'signature' is further described as stemming from a 'lack of precision,' due to technological choices that have caused 'disparities between the path planned and the path executed by the arm' (Tresset and Leymarie, 2013, p. 351). Again, the inaccuracies are presented as a characteristic property of the system, contributing to its uniqueness, style, and artistic success and making visible the underlying technology.

5 | CONCLUSION AND OUTLOOK

This article has presented three appropriated domestic devices that were reconfigured to function as drawing machines. The works have been contextualized with the post-digital discourse and glitch-theory, and compared to other practices with drawing machines.

Like Paul's robot-drawings, my machine drawings exhibit characteristic signatures by the stroke styles resulting from their motion qualities, which are different in every machine. While the output may not exactly be the same every time, the drawings share common qualities, such as the geometric shape of the curves, or the type of gesture present in the irregularities of the lines. Drawings from the same machine can be identified and grouped together.

I have argued that a glitch resulting from a drawing machine can be an appealing characteristic, revealing insights about the mechanical technology. It provides sufficient indeterminacy to make the difference between a print and a drawing. The physical interaction between a drawing machine and its environment may have a surprising effect on the visual output and support a natural or human-made expression. One reason for this might be the function of drawings as evidence of the drawing process: errors or inaccuracies help making this process more legible and display how the drawings deviate from intentions or programs, demonstrating how technology becomes visible by its failures. Many artists frame the machine-drawings as the actual work of art, but the machine or the process may also be included as part of the viewer's art experience. Drawings of one particular machine display a distinct autographic or media specific signature that is not human but remains different from that of other computational or non-computational systems, and reveals the mechanical technology of the particular system.

Digital virtuality is often contrasted with analog materiality. I believe it would be more productive to overcome this false dichotomy and move toward a post-digital integration of embodied messy analog aspects with computation and technology. Questions about errors evidencing the drawing process, and about the effects of embodied interaction seem equally applicable to the computational robotic works discussed in this article, as they are to my purely mechanical drawing machines.

In that sense, I join Tresset and Leymaire in appealing to the computer graphics community to consider the embodiment of graphical systems and I invite glitch artists to think of glitches beyond the confinements of digital virtuality, while also considering the full analogital spectrum (to use Kuni's term) of current technological systems.

From an artistic point of view, the question of how to make a machine drawing look more natural or human-made will benefit from further investigation. With the presented machines (notably *The Opener* with its squiggly lines), I have started exploring the boundary between human expression and machinic autographic style. This contrast and comparison holds the promise for more aesthetic discoveries.

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BIOGRAPHICAL INFORMATION

Andres Wanner is a Swiss-Canadian artist, interaction designer and educator. His interdisciplinary practice at the intersection of art and technology investigates rule-based systems – drawing machines, robots and generative computer programs. He likes to tinker, invent and to play. The exploration of inaccuracies and glitches of technology play a major role in his work. Currently a design research associate at HSLU University Lucerne, Switzerland, he has taught at art and design universities across Europe and North America for more than a decade. With an MSc in Physics, an MAA in Visual Arts and a BA in Visual Communications, his interdisciplinary academic background is complemented with many years of industry experience in interaction design. His artistic work has been exhibited in major international exhibitions such as SIGGRAPH, IDEAS, New Forms Festival, Re-new Festival, Artech, Hyperkult, interfiction, xCoAx, Expressive and he has acted as the arts chair of the Computational Aesthetics conference 2011.