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Logical Conclusion

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Logical Conclusion

by

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Abstract

My work is focused on finding a way to talk about algorithms in society through art. I aim to create experiences that examine the status quo of our relationship with technology by throwing it into stark relief. My work looks to help visitors move from passive engagement with algorithmic systems, to active questioning of and engagement with them.

This paper details the development of *Logical Conclusion*, a collection of logic puzzles based on algorithms that impact our society — from Trust Scores that the Chinese government is issuing to its citizens, to the Facebook news feed algorithm. The puzzles are presented on blackboards with magnetic tiles that visitors can manipulate to solve the puzzles, and accompanied by illustrations that underscore the absurdity of the puzzles. The blackboards are paired with a workbook of additional puzzles, which visitors can take away to complete. I invite visitors to step into the school for algorithms, where young computer programs come to complete their early logic training. Visitors can apply their logical faculties to the puzzles. Are the premises upon which the logical statements are based valid? Does the combination of premises lead to truly logical conclusions?

Preface

This thesis is original, unpublished work by the author, K. Blair.

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Epigraph

"You couldn't have it if you *did* want it," the Queen said. "The rule is, jam to-morrow and jam yesterday – but never jam to-day."

"It must come sometimes to 'jam to-day'," Alice objected.

"No, it can't," said the Queen. "It's jam every other day: to-day isn't any other day, you know."

"I don't understand you," said Alice. "It's dreadfully confusing!"

— Lewis Carroll, *Through the Looking-Glass and What Alice Found There*. 1871.

Chapter 1: Introduction

My work in the Master of Fine Art (MFA) program has been focused on finding a way to talk about algorithms in society through art. I came to the program initially interested in the idea that, as technology advances, the world people live in becomes more responsive, automatically responding to needs they haven't articulated. As I started to investigate that idea, I realized that algorithms – "methods for solving problems which are suited for computer implementation" (Sedgewick, 1983, p. 3) – are the tools that make the world more seem responsive, and that corporations and governments use algorithms to make decisions about people which can have great impacts on their lives. For example, in the United States, algorithms are used to suggest sentences for convicted criminals (Holt, Johnson, Roger, & Ret, 2013), and in Washington, DC, they choose which teachers should be fired or get a raise (Turque, 2012). The details about how algorithms work are often confidential, and their use can be defended by people who employ them as fair because they use math to come to their results (O'Neil, 2016a, p. 3). In fact, the algorithms were developed by humans based on their judgement about what factors are relevant to the problem at hand. Even algorithms based on machine learning are only as good as the information humans train them on.

In my work, I focus on investigating algorithms that are used to make predictions about people, and which are then used to make decisions about those people which impact their lives. These algorithms take information supplied to them, and process it, within the framework of how they were programmed. Then, they provide an output, which can be passed to human decision makers to finalize what will happen to the actual subject being evaluated. Some of those outcomes, like the order of posts on your Facebook news feed, might seem trivial. Others, like those mentioned above, have an obvious impact on their subjects.

Frank Pasquale, Law Professor at the University of Maryland makes the point in *The Black Box Society*:

> Neither New York [quantitative analysts] nor California engineers can deliver a sound economy or a secure society. Those are the tasks of a citizenry, which can perform its job only as well as it understands the stakes. (Pasquale, 2015, p. 218)

In my work, my goal is to create a site for visitors to better understand those stakes, by exploring some of the ways that algorithms make their determinations. I attempt to develop a creative way of opening critique of these systems, so that society can use them consciously as tools and make them more just, or decide not to use them when they are based on invalid assumptions and misuses of data.

The overarching question driving my research has been:

> *How can we understand and critique through art the way that algorithms impact our society?*

With regards to my wish to open critique of these systems through art, Stephen Wilson and Jill Scott have both discussed the potential role of the arts in building public awareness of ethical issues in the sciences and posing alternative futures, setting up cross-pollination opportunities where people can encounter issues of ethics in technology in a context in which they can engage with them (Scott, 2006; Wilson, 1991, 2006). I hope that my work can allow for this type of reflection.

In this paper, I will detail the way that my work throughout my MFA program has

endeavoured to engage with these ideas. Each semester, I experimented with different tactics, and learned from each one. This process has culminated in *Logical Conclusion*, my work for my thesis exhibition.

First, I will provide context for my artistic research. I will cover the current use of algorithms in society and some of the information about their use that has influenced my thinking on this issue, and how I contribute to that discourse.

For each experiment, I will detail how I intended to engage with the use of algorithms in society, the visual methods I used, what I learned from the experiment, and how I took that information forward into my subsequent work. I will also provide context for the artistic discourse I contribute to with regards to each individual piece.

I will move on to a detailed discussion of how these ideas are realized in *Logical Conclusion*, including my methodology for this particular body of work, a discussion of how the elements of the exhibition function, and a reflection on the success of this body of work.

Finally, I will conclude with a discussion of ways I can extend this research in the future, with a focus on my intended research for the Computational Media Design PhD program at the University of Calgary.

Chapter 2: Social Context — Algorithms in Society

To provide background for my work, I will discuss why I want to investigate the role of algorithms in society, and why I wish to address this issue by making art. My research-creation practice investigates computer systems that use algorithms to make decisions that affect society. I seek to raise awareness of the way that such systems encode social values, and thereby improve our society's capacity to question the impact of algorithms on our lives.

I will contribute to the social discourse about society's use of technology by asking how people are impacted by algorithmically encoded biases. The question of *how* technological systems favour particular social values assumes that algorithms *do* favour them. A significant body of literature indicates that the use of algorithms does enact value systems.

In computer science, algorithms are the sets of rules, usually unknown to the user of the technology, by which information is processed. In other words, the results of algorithms that the user sees are "processed" reality, not "unprocessed" reality. The increasing prevalence of algorithmic processing of large amounts of data to solve problems and make decisions quickly is an issue that Cathy O'Neil addresses in her article for *Discover* magazine, "Weapons of Math Destruction":

> The math-powered applications driving the data economy were based on choices made by fallible human beings. Some of these choices were no doubt made with the best intentions. Nevertheless, many of these models and algorithms encoded human prejudice, misunderstanding and bias into the software systems that increasingly managed our lives. Like gods, these mathematical models were opaque, their workings invisible to all but the

> highest priests in their domain: mathematicians and computer scientists. (O'Neil, 2016b, p. 51)

Another example of how the use of algorithms impacts people's daily lives is the Facebook news feed algorithm, which determines which of their friend's posts users see. Because the algorithm is proprietary, users cannot scrutinize the details of how it works. Zeynep Tufecki describes the implications of the Facebook news feed algorithm:

> [A study published in *Science*] found that the algorithm suppresses the diversity of the content you see in your feed by occasionally hiding items that you may disagree with and letting through the ones you are likely to agree with. The effect wasn't all or nothing: for self-identified liberals, one in 13 diverse news stories were removed, for example. Overall, this confirms what many of us had suspected: that the Facebook algorithm is biased towards producing agreement, not dissent. (Tufekci, 2015, p. 11)

In 2014, a White House report about big data identified both opportunities (such as a system that identifies babies in neonatal intensive care who may be at higher risk for infection) and discriminatory implementations (such as web searches with black-identified names being shown more ads with the word "arrest" than white-identified names) (Podesta, Pritzker, Moniz, John Holdren, & Jeffrey Zients, 2014, p. 6–7; Sweeney, 2013).

A chilling example of how governments can use algorithms to control their citizens is that of a program which is currently being implemented by the Chinese government. Its "Social Credit System" will rate its citizens for their "overall trustworthiness" and could use data such as one's shopping habits and friends' online activity, as well as factors like whether one has been

caught riding transit without a fare, to determine the social credit score (Botsman, 2017). The Chinese government has recently started using its current iteration of this score to block people from travelling (Fullerton, 2018).

In fact, there are inherent limitations of algorithmic data processing. Jon Kleinberg, Sendil Mullainathan and Manish Raghavan argue that it is impossible to simultaneously satisfy different ways of conceptualizing "fairness" mathematically in a prediction algorithm, except in cases too restrictive to be useful (whether the algorithmically-assigned probability score is accurate regardless of other characteristics of the individual, and ensuring that individuals from different groups who exhibit similar results in reality get similar scores), (2017, p. 4–5). Thus, there is a tension between how "fair" an algorithm is, and how accurate its predictions are.

Cathy O'Neil makes the point that the potential harm of an algorithm comes not only from how it is developed (the input information used, whether its predictions are verified and the algorithm is updated, and the transparency of the process), but also from how its results are used (to punish people who fall on the wrong side of the prediction, to make or save money on them, or to help them) (O'Neil, 2016a, Conclusion). The way algorithms are developed and used contributes to whether the system they operate within is fair. What society *does* with the output of an algorithm is not a technical question, and can therefore be evaluated by anyone who is informed about the basics of what algorithms are used to determine. If an individual sees that algorithms are used unjustly, they can protest and vote (with their political capital or dollars) against that injustice, even if they are not technicians themselves.

In artistic and cultural discourse, the issues I am concerned with are often discussed through the lens of cybernetics, "the science of control and communication systems in the animal

and the machine" (Parkman, 1972, p. 5). Cybernetics is concerned with how feedback loops (biological, social, mechanical, and even governmental) operate within systems, which, it argues, can be precisely described and modelled (Parkman, 1972, p. 132; Wiener, 1961, p. 27). Cybernetics also posits that information is medium-independent, which opens the conceptual door for consciousness to be coded and put on hard drives, and bodies to be coded in DNA and reconstituted (Hayles, 2008, p. 50; Wiener, 1956, p. 103).

The use of algorithms to control various aspects of society is a logical outgrowth of cybernetics, so this line of theorizing has been important in my research. Donna Haraway's "A Cyborg Manifesto" takes up these topics. In the article, Haraway argues, "Furthermore, communications science and modern biologies are contrasted by a common move – *the translation of the world into a problem of coding.*" (emphasis in original) (Haraway, 1991, p. 302). Artist Roy Ascott articulated a vision of cybernetics in relation to art: "We are moving towards a fully cybernated society […] where processes of retroaction, instant communication, and autonomic flexibility will inform every aspect of our environment" (Ascott, 2003, p. 126). He concludes:

> The artist is faced with two possibilities; either to be carried along in the stream of events, mindlessly, half-aware […]; or he can come to terms with his world, shape it and develop it by understanding its underlying cybernetic characteristics. (Ascott, 2003, p. 127)

Algorithmic systems are one of the ways command, communication and control systems are implemented in society, and are essentially a "translation of the world into a problem of coding". I draw on Ascott's and Haraway's ideas mentioned above to create art that engages

viewers with cybernetic society, by investigating the gray areas of how people implement social values through technology, to resist being half-aware of the mechanisms used to manipulate society.

In cybernetics, I find tension between the assertion that it is possible or valuable to represent all systems or all relations between organisms programmatically, simply because there are many factors in the world that people can't account for (Dreyfus, 1979, p. 98). However, I do think there are some benefits in attempting to represent some systems programmatically. I think doing so can pave the way for useful new technology and provide insight into how systems function. Finding a balance between representing a system programmatically and avoiding oversimplifying it is part of the challenge with algorithms exemplified by the work of Kleinberg, Mullainathan, and Raghavan mentioned above. In my work, I must also walk a line beteen grappling with the complexity of the problems (and benefits) with the use of algorithms in society, with communicating in a way that is accessible to a lay audience. Choosing to oversimplify a system and bringing attention to that using humour is a strategy I have used in *Logical Conclusion* (Chapter 4) as well as *Custom Emoji* and *Persephone's Bedroom* (Chapter 3.3 and 3.4).

As someone who is very excited by the possibilities presented by technology, I am also wary of risks I have discussed in this chapter. I want society to pursue the positive possibilities, but I also want to live in society that is as fair as possible. In my opinion, a way to work towards this goal is to engage the public with the challenges that stem from the way our society uses algorithms. If citizens know about the impacts of technological systems, they are better equipped to hold companies and governments accountable for how they implement such systems, and the

biases of the algorithms companies and governments employ. As expressed by Stephen Wilson writing in *Leonardo* in 1991, "Our culture needs artists to knowledgeably analyze the implications of technological developments" (Wilson, 1991, p. 433). In "Suggested Transdisciplinary Discourses for More Art_Sci Collaborations" in *Artists-in-Labs*: *Processes of Inquiry*, Jill Scott invokes the potential role for artists to communicate about the complicated ethical questions of science in their work, to allow the public to engage with these issues (Scott, 2006, p. 29). I hope to contribute to expanding public engagement with the social impact of algorithms through my art.

An indicator that this a good time to address these issues is that there are several popular television shows that present the world as a cybernetic system. *Orphan Black* explores issues of the idea of the human body as information through the genetic clones (main characters of the show) that are claimed as "intellectual property" by the corporation that "developed" them (Fawcett & Manson, 2013). Netflix's series *Black Mirror* featured a third season episode, "Nosedive," which paints a picture of a world where each person's rating based on others' reviews of their social interactions determines everything about one's life (Wright, Brooker, Schur, & Jones, 2016). China's social credit system, mentioned above, is compared to this episode of *Black Mirror* in news coverage (Ahsan, 2018; Botsman, 2017; Nguyen, 2016; Vincent, 2017), which underscores that these connections are being discussed in cultural discourse, and that therefore it's a good time to discuss this issue through art.

My original contribution to this research area is to make work that creates a framework in which visitors may consider the stakes of how society deploys and uses technology. My work is intended to pull back the curtain on the implications of how algorithmic systems are

implemented, and provide a context in which visitors can gain a greater understanding of those implications.

Having provided social context for my work and why I feel it is an important issue to address through art, I will now move to providing detailed descriptions of the development of my artistic engagement with algorithms in society, by discussing each of the works I completed in my MFA program.

Chapter 3: Previous Experiments

In the upcoming sections of this paper, I will detail the experiments which have moved me forward in understanding how I can make art about algorithms. I will discuss each experiment, the artistic references I drew on for each work, my methodological approach, and what I learned from it.

3.1 Experiment: Connect

My first exhibition in the MFA program was entitled *Experiment: Connect*. I hoped that visitors would engage with the use of technological systems that respond to users without their conscious input. Wendy Ju and Larry Leifer explain these interfaces as "Implicit interactions—those that occur without the explicit behest or awareness of the user" and state that they "will become increasingly important as human-computer interactions extend beyond the desktop computer into new arenas" (Ju & Leifer, 2008, p. 72). I was interested in these systems because they seem poised to revolutionize what people expect from the world around them. I wanted to create a system that visitors could control consciously, hoping that they would be able to discover how the system worked and connect that to experiences in their lives with technological systems that respond automatically. I hoped that visitors would reflect on whether their expectations of how the world should "cater" to them are changing. Roy Ascott's artistic practice dealt with engaging visitors directly with a cybernetic system by having them manipulate a series of paintings on glass to change the overall visual experience. His intention was that these systems mirror the systems they are part of in their everyday lives (Ascott, 2003; Shanken, 2002), and his work was integral in informing the way I hoped visitors would interact with *Experiment: Connect.*

The installation consisted of two electroencephalogram (EEG) headsets[1] (*Figure 3-1*). Visitors could put on the headsets, and the EEG data from each headset controlled a visualization that was projected on the opposite wall (*Figure 3-2*). The visualization consisted of triangles ("boids") moving around the projection. There were two sets of boids which were colour-coded based on the headset that was the source of the data influencing that set of boids.

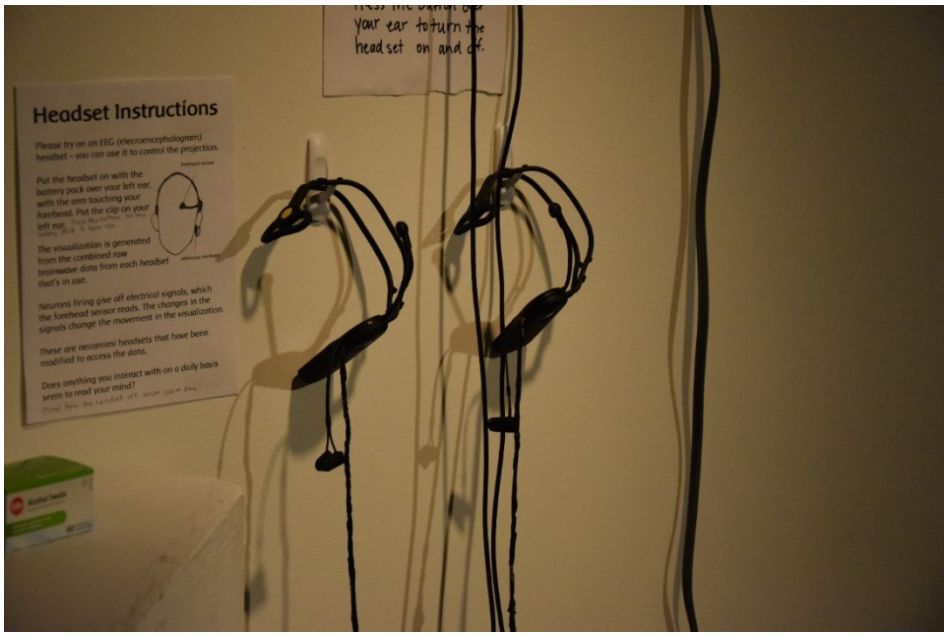

Figure 3-1. Experiment: Connect – headset view, 2016, Kathryn Blair. Interactive Installation. Gallery 621, University of Calgary, Oct 31—Nov 4 2016. Photo by Ryan Blair.

[1] I used Necomimi headsets, which are based on the Neurosky TGAM chip. I implemented the connection to the headsets based on an online tutorial (Artronix1, 2015).

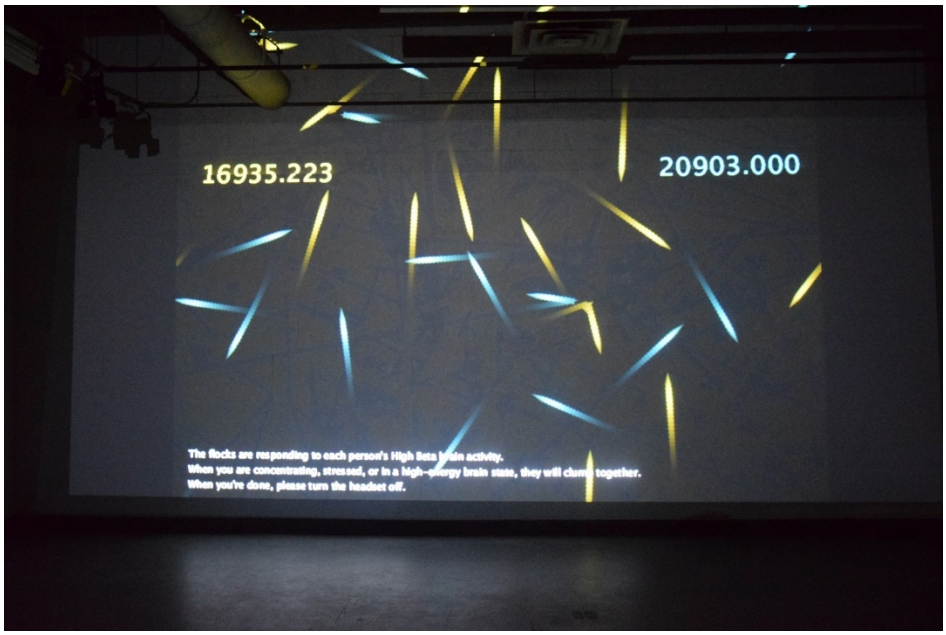

Figure 3-2. *Experiment: Connect* – visualization view, 2016, Kathryn Blair. Interactive Installation. Gallery 621, University of Calgary, Oct 31—Nov 4 2016. Photo by Ryan Blair.

The exhibition was called *Experiment: Connect* because it was experimental. Installing the work in Gallery 621 allowed me to test how visitors would interact with my work, which has been a vital element of my process throughout my MFA. I spent a lot of time in the exhibition space and made changes to the installation throughout the week that it was up. I did this to get information about how the work was functioning for people who came to see it, on both a technical and conceptual level, and I learned a lot about both aspects of the work. During the exhibition, I made changes to how data was collected from the headset, as well as how that data was translated into the visualization, based on the conversations I had with visitors.

I chose EEG headsets for the sensor because they can function as an interface that visitors can either consciously control, or that can respond without conscious input. Unfortunately, the raw EEG sensor value I obtained from the headset was changing constantly, which made the

visualization difficult to interpret. Visitors also had trouble using the headsets. They were difficult to put on correctly, and although I posted instructions on the wall beside the headsets, wearing them was a big hurdle. If visitors can't get the headsets on correctly, they certainly won't be able to control the system consciously.

The visualization was developed in Processing, an open-source programming language and environment intended for use by artists (Fry & Reas, 2001). I based the visualization on the "flocking" program by Craig Reynolds (2001). In the gallery, some visitors using the piece competed to try and get their boids to move in a specific way, while others undertook an experimental back-and-forth of suggestions of how to control the visualization. These interactions created social systems in the gallery, on which the technological system of the artwork acted.

During the process of working on the exhibition while it was installed, I found that the interactions I had with people while I was changing the code were quite compelling. We discussed what I was trying to accomplish with the piece, and they would talk about whether the visualization of the brainwave data made sense to them. I often made changes to the code while they were using the headsets. Visitor suggestions led to me refine the way the data affected the visualization, helping me make it as consciously-controllable as we were able[2].

After the exhibition, I considered how I had visitors change the program generating the visualization in collaboration with me. During that process, we talked about what the input data from the EEG headsets meant, and how the visualization was representing it. As I researched

[2]Based on suggestions by visitors at the reception on Wednesday November 2nd and Friday November 4th, 2016.

ubiquitous computing in society, I realized that a way that technological systems are becoming more responsive to individuals in ways people are unconscious of, is that algorithms are used to analyze data more effectively, with results that have wide-ranging impacts. This insight led me to shift my focus from implicit interactions, to the role of algorithms in society. Interacting with visitors gave me the idea to create an algorithmic system and then to expose its inner workings to the visitors in the gallery, by making changes to it, investigating it directly. I tested this idea in the installation *Encountering Algorithms 1.0,* which I will discuss in the next section.

3.2 Encountering Algorithms 1.0

My second exhibition was an interactive installation with which visitors were intended to experiment with. It was exhibited in Gallery 621 at the University of Calgary from January 16-20, 2017 (*Figure 3-4*). I used a webcam in the space to map visitors' motion to a location in the projection. I chose motion as input data as it was easy for visitors to consciously control. I continued using the format of an interactive installation because of the connection to cybernetic art. Carlos Castellanos discusses interactive art as works that can "provoke or enable a bodily, felt sense of this co-emergent dynamic [between ourselves and our increasingly technologized environment], and thus bring into greater consciousness what can be described as the co-evolutionary nature of our relationship with our technological environment " (2016, p. 160). I hoped to provoke those bodily sensations and sense of connection with the technological environment in this work.

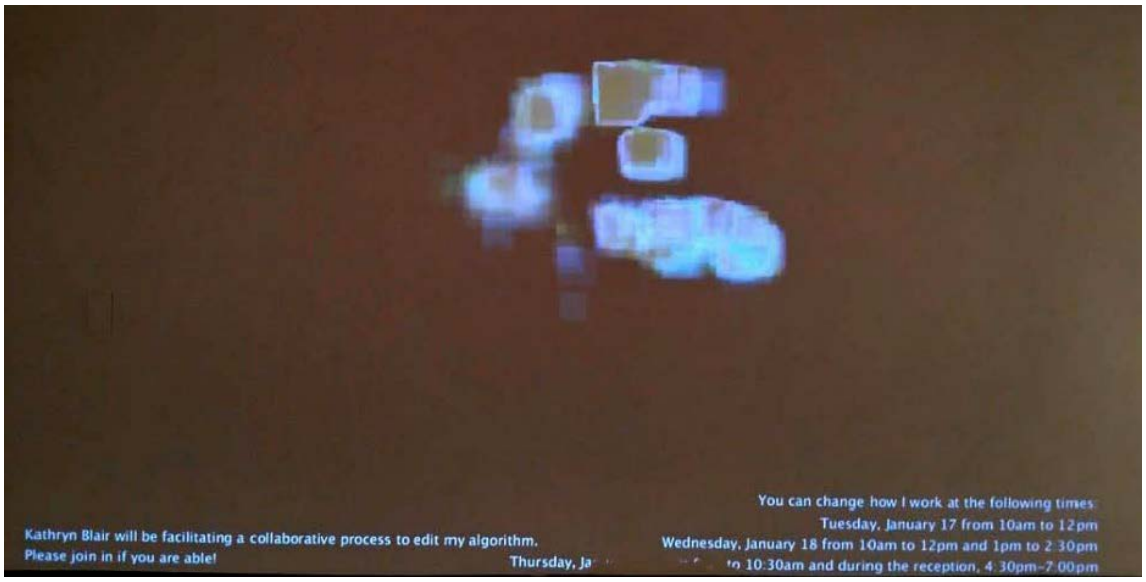

Figure 3-3. Encountering Algorithms 1.0, 2016, Kathryn Blair. Part of "The Nature of Interactions" at Gallery 621, University of Calgary, Jan 16 - 20 2016. Interactive installation.

An example of a work of art that engages viewers with algorithms directly is Jesse Colin Jackson's *Marching Cubes* (2016), in which visitors participate in building the installation by putting together 3D printed building blocks with colour-coded sides (*Figure 3-3*). In so doing, they enact the marching cubes algorithm, which is widely used in computer graphics (Newman & Yi, 2006). *Encountering Algorithms 1.0* was one of my initial attempts to allow visitors to engage directly with algorithms, and ended up being similarly abstract to *Marching Cubes* in its approach to representing how those algorithms are related to our society, because it doesn't refer to algorithms visitors would be able to identify at work in their daily lives.

Figure 3-4. *Marching Cubes*, 2017, Jesse Colin Jackson. Participatory installation.[3]

I based the visualization on the Processing example Smoke Particle System by Daniel Shiffman (2013). The location of the people in the room generated the clusters of shapes as visitors moved around. I intended that the large projection would make the experience immersive and increase the "bodily sense" of the work described by Castellanos. The interaction of visitors in the room while they engaged with the work would add to the "bodily sense," as they navigate and experiment with movement in a public space. Interactions between visitors create a social system as in *Experiment: Connect*, which will be impacted by the algorithmic workings of the art, serving as a microcosm of the social impacts of algorithms that I am investigating.

I engaged visitors directly during exhibition, asking them how the visualization could be changed to be easier to understand or more visually interesting, and I attempted to make the changes to the code when possible. We discussed what was possible, and how the resulting

[3] © Jesse Colin Jackson, 2017. Photo courtesy Jesse Colin Jackson.

visualization functioned as an aesthetic experience. This mode of visitor engagement drew on the work of Dr. Pratim Sengupta. Dr. Sengupta uses a playful, participatory framework to increase engagement with coding because “even short term playful excursions into new, emerging and previously counter-worlds can dishabituate us from the active identities and figurations of our usual worlds, leaving players and their home worlds both transformed” (Sengupta & Shanahan, 2016). I hoped that the art context, combined with the accessibility of this process for engaging with the algorithm, would cause visitors to reflect on algorithms and their role in their lives. I was also excited about using participatory visual methods, viewing the iterations to the algorithm as creative contributions by visitors. Participatory visual methods involves having participants generate creative expressions of their experience as part of the research process (Richards, 2011). In *Encountering Algorithms,* I documented what visitors suggested I change on post-it notes on the wall of the gallery, hoping that being able to trace the changes made to the work would make previous visitors’ contributions visible to subsequent viewers.

In practice, I found that it was difficult for visitors to engage with the connection between their movement and the visualization as an algorithmic system. Since I did the coding, and they didn’t have a framework for understanding it, I don’t think they thought a lot about the code I was editing. And, because the visualization was so obviously controlled by their movement, there wasn’t an obvious way in which that connection needed to be altered, and thus iterating the visualization didn’t prompt reflection about how visitors experience algorithmic systems.

After *Encountering Algorithms,* I moved toward more concrete attempts to make the connection between algorithms and society. In my work, I wanted to create an experience that would still respond to visitors with an algorithmically controlled system, but that would relate

directly to the way they experience algorithms in their everyday life. Each of the following experiments discussed in this chapter (Chapters 3.3 *Custom Emoji*, 3.4 *Persephone's Bedroom*, 3.5 *Autonomous)* and Chapters 4 and 5 (*Logical Conclusion*) detail successive attempts be more concrete in how I invoke consideration of the role of algorithms in society.

3.3 Custom Emoji

Custom Emoji (*Figure 3-5*) was a satirical emoji[4] customization kiosk, at which visitors use a webcam to take a picture of themselves. The system generated a set of emoji based on the dimensions of their face[5]. Before they could see the "complete set" of personalized emoji and download them, visitors were asked to provide a continuous stream of personal information (from postal code to income level[6]) and were presented with facsimiles of personalized advertisements. Visitors could not, in fact, download the emoji set, as the set of questions was an infinite loop. I hoped that the ridiculous progression of the process, paired with the faked ads would embody the quality of Rich Gold's "Algorithmic Symbolism": a formal aspect of computer-based art, which "uses various computer programs that seem to have a lifelike quality—a charm and humanness" (Gold, 1993, p. 10). I hoped that the trickery of the piece would read to visitors as a lifelike quality, though it may not have been charming. The visual style of the application and kiosk were simple and coloruful, to reference marketing imagery and contrast with the onerous information-gathering process. I hoped that the combination would prompt visitors to consider how their data may be used to make assumptions about them and influence their behaviour.

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[4] "Emoji" are symbols used to express emotion in text communication, such as a happy face sent in a text message (Merriam-Webster, 2018a).

[5] I used tracking.js for the facial recognition (Lundgren, Rocha, Rocha, Carvalho, & Bello, 2012).

[6] I did not save any of the entered data or use it.

Figure 3-5. Custom Emoji, 2017, Kathryn Blair. The Little Gallery, University of Calgary, April 3—7 2017. Interactive kiosk. Photo by Ryan Blair.

In this project, my approach was to use the process of data collection to transparently reflect visitors' primary value as a consumer to the creator of the system. I used humour to frame the work, in a strategy I have seen applied effectively in Byron Rich and Mary Tsang's *Open Source Estrogen* (2015). *Open Source Estrogen* (*Figure 3-6*) is presented as a comically suspicious blend of corporate and do-it-yourself (DIY) approaches. I attempted to walk this line in *Custom Emoji*, with the corporate kiosk, graphics, app, and outcome, that promise more than they can deliver. I attempted to undercut a sleek, technocratic narrative of fancy customized emoji with a DIY, hacked-together, ad-hoc impression. I intended for this quality to cast the entire system in which they might exist as a questionable enterprise. I also used DIY aesthetics to undercut the promise of technological tools in *Autonomous* (Chapter 3.5) as well.

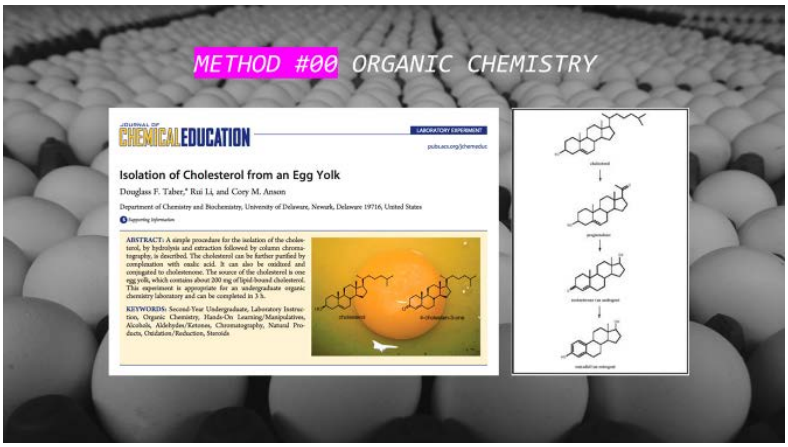

Figure 3-6. Screenshot from *Open Source Estrogen*, 2017, Byron Rich and Mary Tsang. Performative bio-art.[7]

Some works of art that inspired my approach to *Custom Emoji* include Chris Cummins' *Grow Your Own Picture*, a website where visitors can set the parameters of a genetic algorithm that "evolves" an image to resemble the Mona Lisa (2014) and Karl Sims's *Galapagos* (1997), an installation which allowed visitors to "evolve" animated creatures based on how long they stood in front of the images. In both projects, the use of genetic algorithms provides a way to set up a feedback loop with visitors that reflects the feedback loops created by algorithms in society. For *Custom Emoji*, I initially intended to evolve the emoji based on whether the visitor liked their emoji set. I ended up moving away from that mechanic but retained the inspiration in terms of the idea of a customized creative product generated by an algorithm. I take inspiration from both works with regards to this format for creating a feedback loop, playing with the transparency and readability of the feedback loop and the role of the algorithm, which is present in both Sims's and Cummins's work.

In discussions with people who saw the work, it seemed like the overall approach was

[7] © Byron Rich and Mary Tsang, 2015. Image courtesy Byron Rich and Mary Tsang.

successful, as viewers could connect customized ad display with their experience and knew the ads they see are determined by computer programs. They also appreciated the humour, but didn't like that the art was "mean", trapping them in an endless loop of questions. It made them feel used, and didn't open avenues of inquiry or consideration. My attempt to walk the line between corporate and DIY aesthetics wasn't clear enough to be effective. Using the corporate aesthetic faithfully, and letting the work undercut itself with its actual uselessness, would have given a better sense of undermined authority.

Because I thought the use of humour was successful in this work, I continued to use it in future projects, especially in *Persephone's Bedroom* (discussed in the following section) and in my work for my thesis exhibition, *Logical Conclusion* (Chapters 4 and 5). I also liked the more relatable way of framing the algorithmic systems, directly connecting them to actual uses visitors might be familiar with, so I took up that approach again in *Logical Conclusion*. Finally, *Custom Emoji* functioned as a specifically contextualized fictional space, a mall emoji kiosk, that visitors entered. I worked with these types of fictional spaces again in *Persephone's Bedroom* and *Logical Conclusion*. The autobiographical design process I used for *Autonomous,* discussed in section 3.5, also involved creating a semi-fictional space for myself, in which creating a mood control device was a desirable course of action.

3.4 Persephone's Bedroom

After the first year of my MFA program, I decided to focus on the intersection of the body with algorithmic systems, and explored this topic in *Persephone's Bedroom* (*Figure 3-7*), which was part of Mars 112 for Beakerhead 2017. Mars 112 was an installation that took over the Loft 112 literary arts space, lead by Gina Freeman with Nick Taylor, Andrew Sayer, Julia

MacGregor, Steven Duggins, Cody Kupper, Stephen Holman, Ashley and Lauren Voisin and myself. My contribution to the project was *Persephone's Bedroom*, which was the bedroom space of the main character of Mars 112, an astronaut named Persephone who has been monitoring robots for a bit too long.

Figure 3-7. Persephone's Bedroom, 2017, Kathryn Blair. Part of Mars 112, Beakerhead, September 13-17, 2017 at Loft 112, Calgary AB. Interactive Installation. Photo by Ryan Blair.

After I completed a literature review on the intersection of the body and technology in May and June 2017, I came to a research question that guided my work for *Persephone's Bedroom*:

> *Might algorithmic technologies become integrated into our lives so that they become invisible parts of our bodies? If we don't notice them, how might they empower or disempower us, and what social constructs might they inscribe on our bodies?*

The elements of the installation that I used to address these questions were a sales uniform that became fancier – to appeal to potential Mars condo buyers – based on social media activity, and an exercise bike that harassed and cajoled the astronaut, Persephone, to keep active. These projects imagined some of the ways companies might use algorithmic systems to control their employees.

An artist whose work I found to be a helpful reference when thinking about this installation was Lucy McRae. She frames her speculative pictures of possible human bodies as prototyping a future that is more visceral, feminine, and embodied (McRae, 2017). The sci-fi approach of providing a vision of a possible future is, I think, quite persuasive and open to viewers' imaginations. The context of Mars 112 was a perfect setting for a funny and creepy "prototype of the future" of my own. The sales uniform had servos[8] which pulled its hemline up, forcing a Mars condo saleswoman to use her body to sell condos, and show more as her company is more popular. In this piece, I was playing out an idea I encountered in Anne Balsamo's work. Balsamo discusses the possibility of virtual bodies to free people from their culturally-constructed bodies, but instead, current power structures are re-inscribed on virtual bodies in cyberspace (1996, p. 127). In the case of the condo sales dress, the potentially freeing possibility of enhancing clothing with technology is co-opted by corporations, who exercise control over workers' bodies for their time and labour, re-inscribing that power structure through a technology that might have been used to resist it.

[8] Servos are small motors which can be controlled accurately within their range of motion. I used sail winch servos for this project, which are used in remote control boats.

McRae's work is also a useful reference for generating the narrative framework for a piece. Having a narrative around a work assists with the dissemination of technologically-enabled work, because only a small number of people will be able to experience it firsthand and many will have to rely solely on the narrative built around it and documentation to experience it. McRae's prototypes of the future emphasize that these narratives don't always require the work of art to be technically functional; McRae's photos of imagined future bodies created with Bart Hess under the name LUCYANDBART are staged photographs, not interactive physical computing systems (McRae & Hess, 2008). Creating a narrative around a piece (or using elements that suggest a narrative), as LUCYANDBART do, allows viewers to understand the conceptual possibilities of a work, even if they can't see it functioning in front of them. As part of Mars 112, *Persephone's Bedroom* was part of a larger story that gave visitors a better context in which to approach the work from the outset. I found that element of the work to support its conceptual interpretation, and have returned to that strategy in *Logical Conclusion*, discussed in Chapters 4 and 5.

Rich Gold's "Algorithmic Symbolism," introduced in relation to Custom Emoji on page 20, was also a touchpoint for *Persephone's Bedroom* (Gold, 1993, p. 10). The exercise bike, which used a motion sensor to trigger a text-to-speech reading of a random admonition to exercise, is my most thorough attempt to implement algorithmic symbolism in my work. The bike was disconcerting to me as I was building it, because it gets increasingly personal and disturbing in its orders to exercise, and seems to address visitors from a place of its own subjectivity. The effect is uncanny, as the bike seems to become an "actor". Its appearance of having subjectivity challenges the subjectivity of the viewer. How machines can challenge human subjectivity is thoroughly discussed in the context of literature and culture in N.

Katherine Hayles' *How We Became Posthuman* (2008). An example of a work of art that functions this way is *Shy Fountain*, in which the water disappears when people come closer to inspect (or enjoy) it (Faithfull, 2008). A wearable piece that has this quality is *Extrovert Dress* by fashion student Michal Stern (2017), which has motorized eyes that move when activated by sound sensors, and are meant to engage other people so that the introverted wearer has an easier time in social situations. These works underscore the interplay of agency between humans and the agency humans ascribe to machines. The bike, with its evaluation of Persephone's exercise habits transferred onto visitors, is my exploration of that interplay, and undermines one's subjectivity in a way similar to being berated by a bully might, making the bike seem even more disturbingly human.

Reflecting on *Persephone's Bedroom*, I was happy with the use of humour, and the ridiculous context of the overall project. I enjoyed working with the other Mars 112 collaborators, and while I haven't had an opportunity to explore collaboration further in my MFA program, I would like to explore that collaborative storytelling more in the future. I carried forward the focus on the intersection of technology and the body and the idea of ridiculous undertakings to my next work, *Autonomous*, which I will discuss in detail in the next section.

3.5 Autonomous

Following *Persephone's Bedroom*, I carried forward the technology-body focus in a personal context. I began a project to create an algorithmic control system for myself, with the intention of opening the process to be viewed by the public, to make it – and other algorithms – easier to critique. I decided to start developing a system to control my mood, because emotional control is something very personal that underscores the connection between the physical

experience of our bodies with our thoughts. It's also a device I wish I could use, but using it would require me to give up conscious engagement with my body and mind to a computer system. The question of to what extent I might relinquish my emotional autonomy to a computer system is the source of the project title, *Autonomous* (*Figure 3-8*).

Figure 3-8. Autonomous, 2017, Kathryn Blair. Gallery 621, University of Calgary, December 4 – 8 2017. Data sculpture. Photo by Ryan Blair.

In computer science, the practice of making objects that are intended to critique or complicate human-computer interaction is called critical design, and this idea within computer science discourse provides a useful bridge to connect my work generally, and *Autonomous* specifically, to the discipline whose social impact I seek to investigate. In the chapter "Research Through Design in HCI" from *Ways of Knowing in HCI*, Zimmerman and Forlizzi define critical

design: “design researchers make provocative artifacts that force people to think, to notice, and to reconsider some aspect of the world,” which is what I intended to do via the process of developing a mood-control system (2014, p. 173).

Developing the system would be a long-term undertaking, and as the goal of the project is to expose the *process* of developing the algorithm, I planned to exhibit the different stages of that process as it progressed. The first step, which I exhibited in the Little Gallery at the University of Calgary from December 4 to 8, 2017, was to gather physiological and mood data, and see what conclusions I could draw about how a system might be able to sense my mood. To do this, I created a data sculpture that physicalized the data I collected to better understand it.

Personal devices intended to manage the emotions of their users are coming onto the consumer market, including Feel (2016) and Spire (2014). These systems use physiological indicators such as heart rate, skin conductivity and skin temperature to identify the emotional state of the user, and trigger interventions to improve the user’s mood (Pollreisz & Taherinejad, 2017, p. 2354).

I collected physiological data using a smart watch,[9] tracked my mood data both via a chart in my sketchbook inspired by bullet-journaling (Miller & Borges, 2016), and with the Daylio app (Daylio, 2016). After I collected the data, I visualized my physiological and mood information for each day using yarn hung on a neuron made from pallet wrap and packing tape. The neuron represented both the time over which I tracked the data (each dendrite or arm of the neuron represented a week of data), and my self. I included my notes on the conclusions I drew

[9] I purchased the “Daping fitness tracker” from Amazon.ca: https://www.amazon.ca/gp/product/B073QPGBM5/ref=oh_aui_detailpage_o06_s00?ie=UTF8&psc=1

from the data as well as audio recordings of weekly reflections on my mood, using motion sensors to trigger the sounds as people moved around the data sculpture. The final element was a set of lights in the body of the neuron, which pulsed to my average heart rate.

Data sculpture uses 3D objects to embody data (Zhao & Moere, 2008, p. 344). Nathalie Miebach's weather data physicalizations use reed and wood to make intricate sculptures of weather information, which are beautiful and make viewers curious about the information behind them (Miebach, 2008) (*Figure 3-9*). The process of making the data I collected into a physical form was a way for me to explore and understand the data more completely than by reviewing it on a computer.

Figure 3-9.Temporal Warmth: Tango Between Air, Land and Sea, 2008, Nathalie Miebach. Data sculpture. [10]

To open my development process to scrutiny, I adopted the Autobiographical Design

[10] © Nathalie Miebach, 2008. Photo courtesy Nathalie Miebach.

methodology from Human-Computer Interaction.

> "Autobiographical design occurs when people build a system, use it themselves [..] [over the long term] during which new knowledge is obtained." (Neustaedter, Harrison, & Whittaker, 2012, p. 28)

I also drew on autoethnograhy as a research practice and artistic strategy, as I documented my process as a method of cultural critique (Ellis, Adams, & Bochner, 2011, p. 1). One of the primary references for this phase of my work was Mary Kelly's *Post Partum Document* (1973), in which Kelly documents her son's early life from weaning until his acquisition of language, and in so doing, explores her experience of becoming a mother (*Figure 3-10*). I adapted this strategy to document the process of making myself a "cyborg."

Figure 3-10. Post Partum Document, 1973, Mary Kelly. Installation View, Generali Foundation. Installation[11]

[11] © Mary Kelly, 1973. Photo courtesy Mary Kelly.

I again looked to a DIY aesthetic, undercutting the idea that my wish to make a mood-control device is practical (in fact, it is "DIY" taken to a ridiculous extreme), and resonates with the process of personal data collection and analysis. I also wished to evoke the visceral quality of the body, to connect this process to separate myself from engagement with my emotions as a way of separating myself from my body through technology. Artists who have used this technique include Stelarc, whose work (for example, *Ear on Arm* (2008)) is a graphic and shocking way for him to intervene with technology into his body. Oksana Kryzhanivska's work, such as *Disturbed System* (2015), evokes the interior of the body, inviting visitors to touch and engage with them while being both off-putting and beautiful simultaneously (*Figure 3-11*). Similarly, I hoped to suggest both the attractiveness of maintaining a connection with my body and emotions, as well as their complicated nature and potential repulsiveness as things I can't always control, using the shiny whiteness of palette wrap to refer to the look of neural tissue.

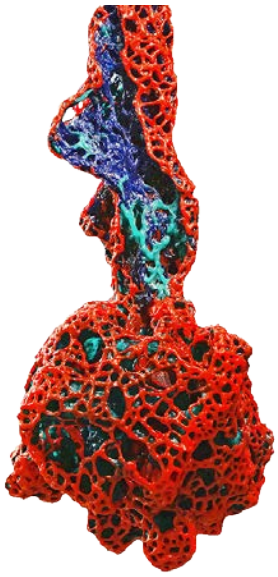

Figure 3-11. *Disturbed System.* 2015. Oksana Kryzhanivska, Jeff Boyd, and Simon Fay. Tactile

Interactive Sculpture.[12]

Because I could only exhibit the data sculpture element of the process at this stage, and because the sculptural form that wasn't easy to read as "data", the resulting work was not accessible for visitors, though they responded positively to the concept of documenting a process of creating a ridiculous algorithmic system for myself. The next stage of the process would be to start developing prototypes for my mood control system, track how they function, and exhibit prototypes. This process would be time-intensive, so I decided not to pursue it further in my MFA research. Finally, the work would benefit from use and testing with visitors to see how they might interact with or feel about my mood-control algorithm as well. This element of the piece would also take a long time to execute, including significant testing and refinement. Instead, I focused on developing an idea I stumbled upon in November 2017, which became *Logical Conclusion*, discussed in the next chapter.

[12] © Oksana Kryzhanivska, Jeff Boyd and Simon Fay, 2015. Photo courtesy Oksana Kryzhanivska.

Chapter 4: Logical Conclusion, March 2018

For my Winter 2018 exhibition, which I presented from March 12 to 16 in the Little Gallery at the University of Calgary Department of Art, I decided to approach the question of algorithms in society via a new avenue. In November 2017 I went to an artist talk by Miruna Dragan (2017b) at the Nickle Galleries for her exhibition, *Everywhere Possible Therefore True*. This exhibition featured a work that chains logical symbols together to make a content-less assertion, ∴ ∃ ≔ ≡◇ ∵ ⊕, or "… Because There Exists Another Name For Everywhere It Is Possible Therefore It Is True When Either But Not Both Are True … " (2017a). Dragan's use of logic symbols reminded me of Lewis Carroll's logic puzzles, in which a (often nonsensical) chain of premises can be combined to reach a conclusion, and it occurred to me that I could make logic puzzles in the same format as Lewis Carroll based on the algorithms that impact society and invite visitors to step through the rigid type of logic that is necessarily employed in a computer system by working through the puzzles. This idea struck me as being much more direct than my previous attempts at making art about algorithms, so I decided to pursue it.

An apt example of the type of problem the puzzles investigate was provided by artist Trevor Paglen. In a talk at MIT's Being Material Symposium, Paglen illustrated one of his concerns about the way these algorithms function through a discussion of Rene Magritte's *The Treachery of Images* (1929) (the famous painting of a pipe, labelled "*Ceci n'est pas une pipe*" or "this is not a pipe"), which an image identification algorithm had identified as a pipe. Paglen's point was that algorithms do not have the nuance or contextual awareness to understand that the image of the pipe is not the pipe, and that the data they analyze isn't the world. That fact is thrown into comical relief by Magritte's label juxtaposed with the algorithm's conclusion. Additionally, many algorithmic systems pass data on to more algorithms, meaning that human

operators don't have opportunities to apply nuance or context (Paglen, 2017). Paglen's artistic practice deals with surveillance, and the use of algorithms to increase the level of surveillance the state can support. His work – and his use of Magritte as an illustrative example – can function as a focusing device on some of the core things that can go wrong when algorithms are in control, and his direct way of making the point was something I tried to emulate in *Logical Conclusion*.

4.1 Exhibition Elements

I presented five puzzles, with magnetic pieces representing the elements of each puzzle on a blackboard (*Figure 4-1*). Visitors were invited to manipulate the pieces to solve the puzzles (*Figure 4-2*). Each puzzle was accompanied by a screen-printed illustration inspired by John Tenniel's engravings for Lewis Carroll's *Alice in Wonderland* and *Through the Looking Glass* (*Figure 4-3*). The puzzle illustrations feature animals in place of the people impacted by the algorithms, and invoke the illustrations in reading primer books. The absurdity of the illustrations underscores the arbitrariness of formal logic, in which the conclusion is deduced from premises which are taken as fact within the algorithm or logic problem. My intention is that solving the puzzles allows visitors to get "inside" the algorithm and see how it "thinks," so to speak.

Figure 4-1. Logical Conclusion, 2018, Kathryn Blair. Little Gallery, Department of Art, University of Calgary, March 12 to 16, 2018. Participatory installation. Photo by Ryan Blair.

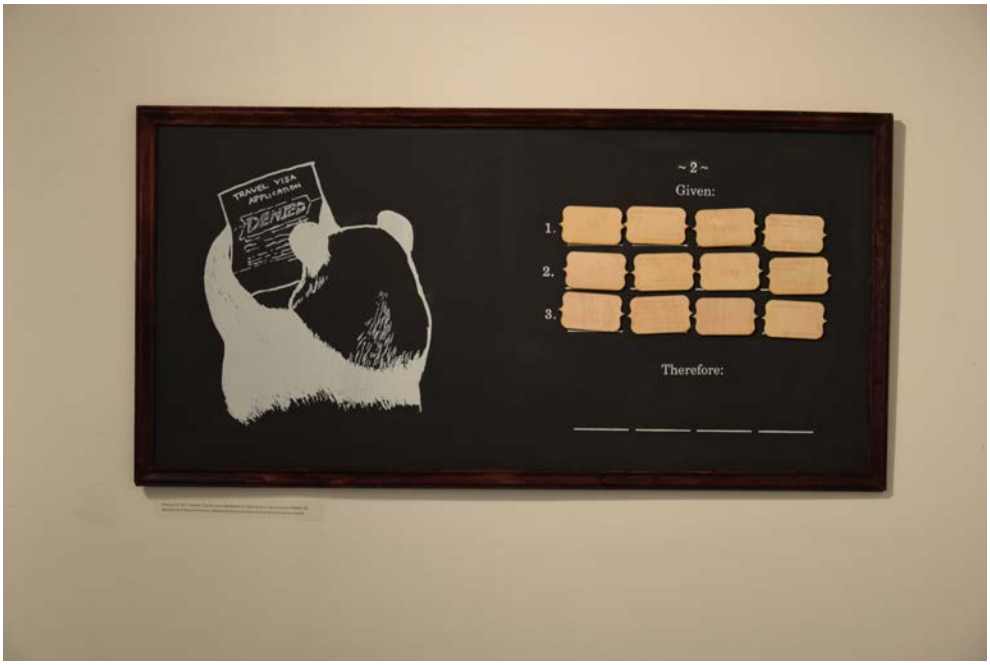

Figure 4-2. Puzzle 2 from *Logical Conclusion*, 2018, Kathryn Blair. Photo by Ryan Blair.

Figure 4-3. "Mouse telling its tale to Alice and creatures" 1865. John Tenniel. From *Alice's Adventures in Wonderland* by Lewis Carroll. Chapter 3, page 29.

I have conceptualized the installation as a school for algorithms, drawing on the narrative framing technique and use of fictional spaces discussed in sections 3.3 and 3.4. To complete the impression, I added a table and chairs (*Figure 4-1*). On the table were tablets with an interactive version of the puzzles and a zine,[13] each of which included all ten puzzles I had developed for the winter exhibition. With the intention of underscoring the school reference, I added a hanging sign. The reference to the school as a setting connects the rigidity and control of a classroom in terms of the way students are supposed to think, with the social control and rigidity of a society controlled by un-critiqued algorithms[14]. The suggestion of the Victorian period maintains the

[13] "Zines" are non-commercial booklets or magazines (Merriam-Webster, 2018b).

[14] I am indebted to Diana Sherlock, guest curator at the March 13, 2018 critique of the exhibition, for making this point very clearly.

reference to Lewis Carroll, and adds an additional level of absurdity, as the antique styling clashes with the contemporary content of the puzzles[15].

4.2 Artistic References

My artistic references for *Logical Conclusion* came from several sources. First, there was the artist talk by Miruna Dragan in which she discussed her piece that uses logic symbols, as detailed above. Lewis Carroll's logic puzzles, also discussed above, were a core reference for the form and structure of the puzzles, as well as inspiration for a way of looking at the logic of the algorithms as abstract, arbitrary and absurd. Tenniel's illustrations were a key reference for the look and whimsy I was aiming for in the illustrations.

Figure 4-4. NAOS, 2008, Carlos Castellanos, Phillipe Pasquier, Luther Thie. Interactive

[15] The Victorian styling of the exhibition also resonates with Victorian art criticism, which emphasized a moralistic view of art that should improve society, as put forward by John Ruskin (Teukolsky, 2009, p. 104). The rigidity of that view is mirrored in the rigidity of the logic in the puzzles, as well as the scholastic framework of my installation. Thus, as the rigid logic of the puzzles is made ridiculous, and space is created for visitors to critique algorithms, the didactic role of the school and of art is also undermined.

installation.[16]

Logical Conclusion extends the exploration of how visitors might engage with algorithms that I began to investigate in *Encountering Algorithms 1.0*, but seeks to question the way that the logic in the algorithms is implemented directly, calling into question the impact the algorithms have in society. A contemporary artwork that critiques the social impact of algorithms, and is also a reference for my work, is *NAOS* (*Figure 4-4*). The piece uses brainwaves, skin conductivity, and a database of user profiles to classify individuals based on their reactions to images of people of different races (Castellanos, Pasquier, & Thie, 2008) . However, while visitors in *NAOS* experience the outcome of the algorithm, they don't execute it themselves. *Logical Conclusion* puts the viewer in the place of solving the outcome of an algorithm.

The interactivity of *Logical Conclusion* was inspired by art games, in particular Brenda Romero's *Train* (2009) (*Figure 4-5*). In this game, players roll dice and load people-tokens onto trains, advancing them to concentration camps. Players must physically push the people pieces into the trains, which creates a violent motion reflective of the horror of the content of the game (Bogost, 2015). In the case of *Logical Conclusion*, the form of the puzzles is meant to imply the obedient, orderly behaviour of students working on chalkboards on problems at school.

[16] © Carlos Castellanos, Phillipe Pasquier, and Luther Thie. 2008. Photo courtesy Castellanos, Pasquier and Thie.

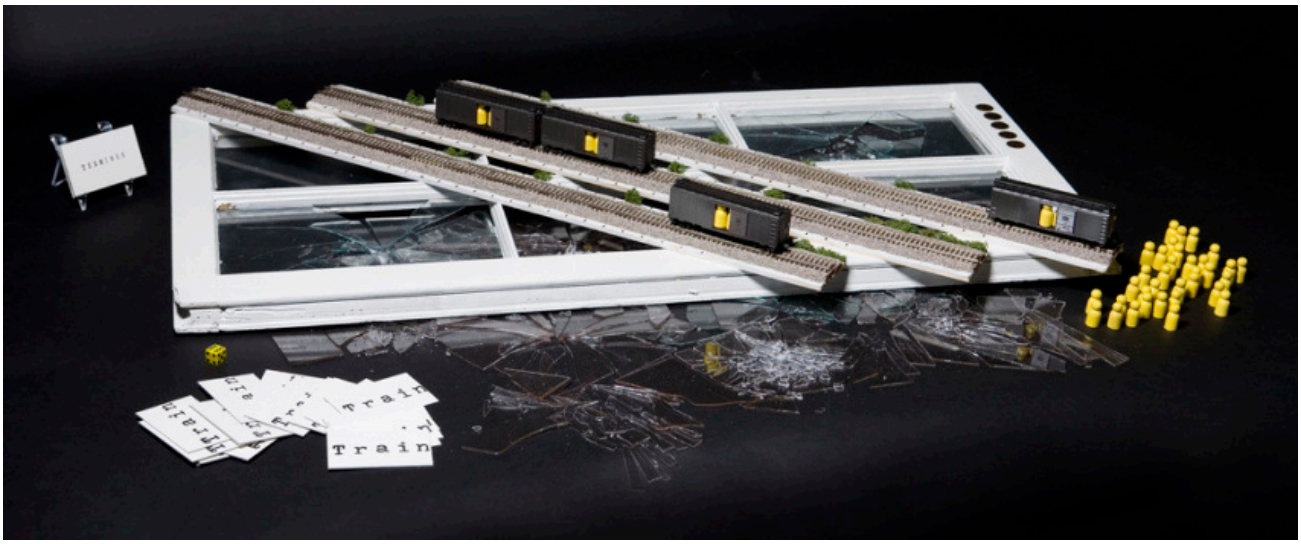

Figure 4-5. Romero, Brenda. 2009. "Train." Art game.[17]

4.3 Methodology

I will now describe the methodology I used to create *Logical Conclusion*. First, I researched Carroll's puzzles themselves, to learn their form, using Lewis Carroll's *Symbolic Logic* as my primary reference (Bartley III, 1977).

Then, I researched and identified algorithms that currently have, or are being developed to have impact on the societies in which they are implemented. Some examples include the Facebook news feed algorithm (Mosseri, 2016; Tufekci, 2015), predictive policing algorithms (Barrett, 2017), and the social credit score system that China is starting to implement in 2018 (Botsman, 2017). I then researched what type of information the algorithms were known to or appeared to use to reach their conclusions and used those metrics in the puzzles. The puzzles are not perfect translations of the algorithms – they are simplified, and the chain-based logic used in Carroll's syllogistic logic puzzles is less complicated than the logic that can be implemented in algorithms. Additionally, most of the algorithms are proprietary, so I can't access the details of

[17] © Brenda Romero 2009, photo courtesy Brenda Romero.

exactly how they work. Therefore, I had to use the available information to try to look inside these "black boxes". However, I endeavoured to make the puzzles accurately reflect some of the inputs and outputs of the algorithms they are based on. An example of one of the puzzles is:

1. Facebook only shows me posts similar to ones I have liked.
2. I only like Facebook posts I agree with.
3. You never post anything I agree with

   Therefore: I never see any of your Facebook posts

I chose to make simple forms of the puzzles, with few premises,[18] to make the puzzles more accessible. To solve the puzzles, visitors read the puzzle, consider each premise, and identify which terms[19] match between the premises and which do not. Then, visitors attempt to use the information in the premises to determine the connection between the two terms that do not have a match. Here is an example of the process for working through the Facebook puzzle:

a. Identify what we're talking about – Facebook posts, in this case.
b. Identify terms in the premises that match, indicated buy underline style:
    4. Facebook only shows me posts similar to ones I have liked.
    5. I only like Facebook posts I agree with.
    6. You never post anything I agree with
c. Identify two terms that don't have a match – the answer connects them.
    - In this case, "posts Facebook shows me" and "posts by you"

[18] Initial statements that are combined to reach the conclusion.
[19] Elements of the premises.

d. Start with one of the premises with a term that doesn't match, pair it with the premise that has the matching second term and link the two different ones to make a new premise.

    1. Facebook only shows me posts ~~similar to ones I have liked~~.
    2. ~~I only like Facebook posts~~ I agree with.

       Therefore: Facebook only shows me posts I agree with.

e. Repeat until the terms without a match are linked.

    1. Facebook only shows me posts ~~I agree with~~.
    2. You never post anything ~~I agree with~~.

       Therefore: You never post anything that Facebook shows me (or, I never see any of your Facebook posts).

Then I drew a sketch of each scene described by a puzzle, inked it, and scanned it. I used the scanned images to put together the zine, and silkscreen the images onto the blackboards.

I built the blackboards from pieces of 20-guage sheet steel, so that they would be magnetic, and coated them with blackboard paint. I added trim to evoke the Victorian timeframe, and laser-cut the text pieces for the puzzles.

4.4 Iterations

When I started developing the puzzles, I knew I would need to test the puzzles themselves, and the format I displayed them in, before finalizing the work. So, I booked two test exhibitions in the Sculpture Studio at the University of Calgary, and put together prototypes of the exhibition each time.

The first test included four puzzles. Two were printed as dry-erasable posters, one was copied onto a blackboard surface, and one was copied onto white melamine. Whiteboard markers

and chalk allowed visitors to attempt to solve the puzzles, and I set up chairs and a side table to make the space into a salon or office for "the Logician," the creator of the puzzles and a figure inspired by Lewis Carroll's Mad Hatter. This test allowed me to get feedback on how the puzzles functioned, which led me to creating the magnetic pieces that visitors could move around. Visitors were reluctant to make marks on the blackboard or whiteboards, as it seemed like marking on someone else's art. I also got feedback about how visitors understood the puzzles and approached solving them, and I tried to incorporate that as I further developed the puzzles, especially in their level of complexity to make them neither too intimidating, nor too simple.

I considered adding a performative element to this piece, in which I would be in the gallery as the Logician, encouraging visitors to complete the puzzles. In the first test exhibition, I had trouble conceptualizing what the exact context of the "Logician's Laboratory" would be, and thinking of a reason for visitors to be there, talking to the Logician. To solve this challenge, I spoke with Georgina Freeman, the leader of the Mars 112 project I worked on in the summer of 2017. She helped me refine the idea for the narrative of the work to be that of a school for algorithms, and her input was invaluable in bringing that concept together. I find the context of a school particularly apt as machine learning does include a process by which algorithms are trained on data sets (Reese, Reese, Kaluza, Kamath, & Choppella, 2017), which could be considered a real-world "school for algorithms."

The second test consisted of four new puzzles, and was my first test of the magnet format. I was happy with how visitors responded to that format change, and to the blackboards. In this test, I tried a digital version of the puzzles as a kiosk for a short period of time, and tried the first iteration of the school setting. I also considered the performative element further, and

appreciated my classmate Nicole Tritter's input on using performance as a tool in one's work, but finally decided that I couldn't find a framework in which it made sense for me to address visitors as a character.

These test exhibitions allowed me to test the basic validity of and interest in my concept, as well as the physical and formal elements of the work. They were invaluable because they allowed me to improve the work as much as possible, as quickly as possible.

4.5 Feedback and Reflection

I found the winter iteration of the work to be quite successful. Based on the feedback at the critique on March 13, 2018, it seemed that the intention to investigate the way society uses algorithms was understood by the audience, and that they considered the format of the puzzles on the blackboards with illustrations to be effective. What the puzzles were intended to say about how algorithms work, how they were supposed to function as a way into considering these issues for visitors, and the role of the illustrations in providing an access point, contextualizing the algorithms, their absurdity and the reference to children's books, all seemed to make sense to visitors I spoke with. This was a strong indicator to me that I was moving in a productive direction, as I have found it challenging to develop a successful mode to approach these topics in my work, as discussed in the previous chapter of this paper.

The feedback I received was particularly helpful as it clarified that the tablet component was not necessary. The primary contribution of the tablets was to provide a way for people to check their answers. The feedback I got also indicated that the zine wasn't the best way to present a print form of the puzzles, and workbooks were suggested as an alternative format, which I have included the final thesis exhibition with an answer key at the back.

Feedback on how to fine-tune the presentation of the puzzles was also extremely helpful. I received suggestions on how to make the pieces easier to read. I also heard, several times, that the fact that the pieces were difficult to read drew people in closer to the puzzles and contributed to the critique of algorithms as opaque. Combining these two pieces of feedback, I altered the magnetic pieces so that they are easier to read, but are not so stark that visitors won't be drawn in. Feedback on how to present the solved puzzle, how to make it clear where the pieces should be returned to reset the puzzles, and a format for the table and seating with benches which would work more successfully in the school context were all very helpful pieces of feedback that I took forward into thesis exhibition. I got feedback about the difficulty level of the puzzles, and continue to try to walk a fine line in making them both interesting to solve, and accessible.

Diana Sherlock, the guest curator participating in the critique, asked me about the connection between the school context and games, and I think there is an interesting pairing between the constructed and somewhat arbitrary nature of a world controlled by algorithms, and of the world of a game. Additionally, from the perspective of the algorithms that are ostensibly in this school, the results of the algorithms' operation in the world might be similar to people's perspective on the outcome of a game.

Chapter 5: Logical Conclusion: Thesis Exhibition

I have iterated and refined *Logical Conclusion* for my thesis exhibition for my Master of Fine Art degree, which takes place in June 2018 at Emmedia in Calgary (*Figures 5-1* to *5-4*). For this exhibition, I developed several more puzzles, to give a more varied picture of the algorithms operating in society. One solved example puzzle plus eight puzzles visitors can solve were presented on blackboards. I placed a "welcome letter" on a music stand at the entrance to the gallery (Appendix C), which serves as an introduction to the scene (in which visitors are in the place of the young algorithms), creating a threshold between the "real world" and the school for algorithms. I posted a copy of the references for the puzzles and answer key behind a frosted glass door in the gallery, so that if visitors look for the key, they can check their answers, without spoiling the answers for visitors who want to work through the puzzles.

Figure 5-1. Logical Conclusion, example puzzle and puzzle 1. Photo by Yufan Zhang.

Figure 5-2. Logical Conclusion, puzzles 2 and 3 plus character information. Photo by Yufan Zhang.

Figure 5-3. Logical Conclusion, puzzles 4, 5 and 6 plus table and benches, music stand with welcome letter. Photo by Yufan Zhang.

Figure 5-4. Logical Conclusion, puzzles 7 and 8. Photo by Yufan Zhang.

I re-printed the images on the blackboards in positive, so that the black chalkboard shows through for the dark portions of the image, and white ink indicates the light portions, to make them easier to visually interpret. I iterated the magnetic tiles to improve readability. In the March exhibition, each piece was reversible, with a positive version of the term on one half and a negative version on the other (*Figure 5-5*). For the final exhibition, I ensured that pieces did not need to be made negative to solve the puzzles so that I needed only one set of text, and increased the text size. Then, I laser cut them with the text outlined (*Figure 5-6*). To ensure visitors (and gallery staff once a day) can reset the puzzles, I added hand-written notes with the text of each tile in chalk marker behind the tiles, representing the Logician's notes on the puzzles. Visitors will be able to see others' solutions before they replace the tiles, but they won't be sure the solution was accurate. I also used chalk marker to hand write the instructions on the example

puzzle, again representing the Logician's notes to their students. I used the same hand-written format to write notes for the solved example puzzle.

Figure 5-5. Puzzle tile from March 2018 iteration of *Logical Conclusion*.

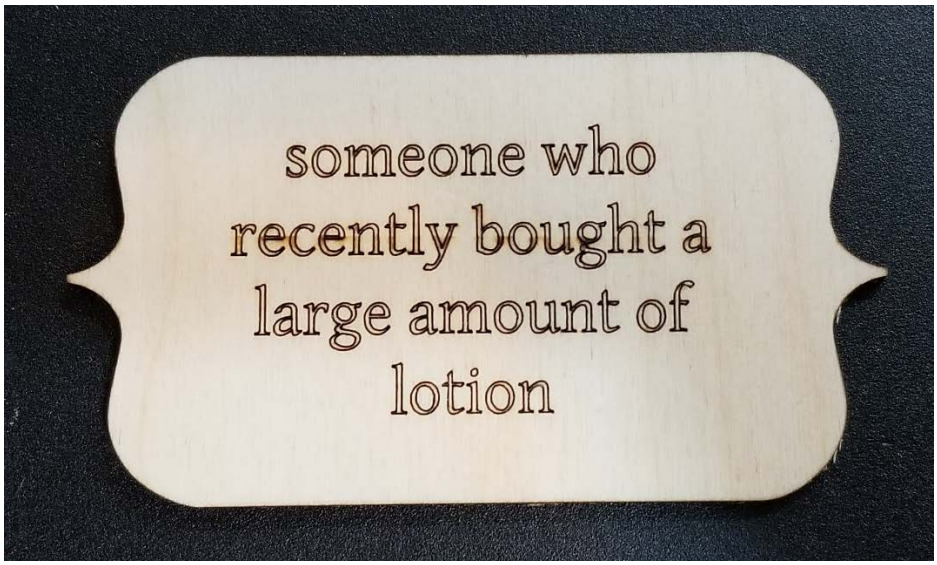

Figure 5-6. Puzzle tile from June 2018 exhibition of *Logical Conclusion*.

Because the digital versions of the puzzles on the tablets didn't contribute positively to the gallery experience in the March exhibition, I removed them.

I iterated the zine from the March exhibition into a workbook containing the entire suite of 20 puzzles, with a solved example as well as a list of references for the relevant algorithms and an answer key in the back (Appendix A). The workbook includes blank spaces to cue visitors to solve the puzzles, and a supply of pencils in the exhibition make the intention clear. The workbooks fit in with the school context, and can be taken away by visitors. They can think of the workbook either as an art book, or something to complete, allowing visitors to extend the experience outside of the gallery. The workbooks sit on the table in the centre of the gallery, with the pencils, and a sign informing visitors that they can take a workbook. Benches at the table provide school-appropriate seating.

To make the content of the puzzles more relatable, I added a grid of character profiles for each of the animals that appear in the puzzles (in either the workbook or the blackboards), of which there were nine in total (Appendix B, *Figure 5-7*). I extracted a drawing of each animal's head from the illustrations, and wrote a summary of their experiences as detailed in the puzzles, which I printed and framed. The character profiles provide narrative context for the puzzles as a whole, underscoring the impact of the algorithms in the characters' lives, and provide an additional point of entry for visitors before starting the puzzles.

Figure 5-7. Character grid from *Logical Conclusion*, June 2018. Photo by Yufan Zhang.

5.1 Future Possibilities of this body of work

I am quite excited about the potential for exploring this line of engagement with the topic of algorithms in society in the future, as visitors seemed to connect with the puzzles and the narrative conceit of the school for algorithms more effectively than any of my other works.

One way I have been considering doing so would be to further develop the online implementation of the puzzles, by purchasing online advertisements, bringing people who click through into a parallel internet of courses for algorithms in which they can encounter mathematical logic.

A second way I could further explore these ideas would be to extend their physical implementation. In a studio visitor with curator Dr. Curtis Collins on April 6, 2018, Collins suggested building a maze-like experience, where visitors could choose their path based on an algorithm's logic flow. I think an installation like that would be an interesting way to explore

citizens' complicity in the systems our society builds, and would provide opportunities for adding immersive elements and additional puzzle interactions. I have also received suggestions from my supervisory committee member, Dr. Lora Oehlberg, to create physical (possibly block-based) versions of the puzzles that would be more abstract, to make the point that in the algorithm, every element is simply a variable. After completing the puzzles, visitors could open a door and find out what they had actually concluded and how it might impact someone. Dr. Oelhberg and I also discussed versions of the puzzles that visitors can re-assemble into their own algorithmic logic puzzles. I'd need to think about how to set up that interaction, and test it with visitors to refine it, but I'm interested in how it could implicate our own behaviour and decisions as users of algorithms.

Chapter 6: Conclusion

I have found the time spent in my Master of Fine Arts degree, investigating how I can make work about the role of algorithms in society, to be very rewarding. In particular, *Logical Conclusion* has been my most successful attempt to "understand and critique through art the way that algorithms impact our society", and to ask visitors whether they need to take a more active hand in criticizing technological systems, the values they prioritize, and their results, to return to the research question I set out in the introduction.

I had several conversations with visitors about how they experienced the work, which gave me insight into how successful the exhibition was. Their feedback validated many of the changes I made from the March exhibition. They mentioned appreciating the character sheets as a way to connect with the characters in the puzzles and understand a fuller picture of their world. The feedback that I found most interesting was visitors' reflections on the experience of doing the puzzles. They mentioned finding the puzzles funny, especially paired with the illustrations, but they also commented on feeling sad or deflated (because of the content) when they finished the puzzles. This emotional arc mirrored the reflection I was hoping visitors would have on the use of algorithms in society quite well.

One element of the exhibition that I have struggled with, and which is still problematic for me, is how visitors feel about their ability to complete the puzzles. I like putting visitors in the place of having to execute the logic of the puzzles, and they mentioned feeling uncomfortable about making the conclusions that the puzzles required. One visitor mentioned struggling with solving the puzzles because she thought that the correct answer would feel "right" – that she would agree, based on her sense of right and wrong, with the logic of the puzzle, which prevented her from solving them because the puzzles were intended to feel "wrong". That

tension was what I was trying to elicit. However, completing the puzzles doesn't come easily to all visitors, and doesn't use reasoning methods we practice in our daily lives. I think the experience of fighting against the puzzles' rigid logic is a key element of making the point of the exhibition, but I don't want to give visitors the message that it's important to be able to solve logic puzzles to understand algorithms, and I don't want to make anyone feel stupid. The performative nature of completing the puzzles in the space also had positive and negative elements. It contributed to the impression of a school experience, and to making the experience of completing the puzzles more uncomfortable, which fit in with the overall goals of the exhibition. But having to perform the puzzle-solving also makes the pressure to solve the puzzles correctly more acute, and made it feel worse for visitors if they didn't think they could.

Coming out of my MFA work, I have also a few potential avenues of further investigation into these questions for future work: particularly, further work on the autobiographical design / autoethnography approach via my performative project to create a mood control device, and continuing to develop the method of engaging people with algorithms and their social impact via logic puzzles.

I remain convinced that the role of algorithms in society is an important topic for art, and that facilitating any greater public engagement with it, and creating different ways for the public to encounter these ideas, is worthwhile. As our society relies more heavily on computational systems, and as more economic productivity is contributed by computers and technology, humans need to make sure that the benefits and harms of these systems aren't distributed unevenly, leaving certain segments of society behind.

In the fall of 2018, I will be starting work on a PhD in Computational Media Design here at the University of Calgary. My proposed research topic is to move forward with the *Autonomous* project, and I am excited about continuing my contribution to the discussion of algorithms in society, developing new knowledge about the topic through art, and contributing to knowledge about examining our technological society via artistic means.

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Appendix A: Workbook

Please see attached PDF (ucalgary_2018_blair_kathryn_appendixa.pdf) or visit:

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Appendix B: Character Sheets

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Appendix C: Welcome Letter

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