California Institute of the Arts

smArt:

An Analytical Framework for Artistic Applications of Autonomous and Semi-Autonomous Systems

by

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Abstract

The primary goal of this thesis is to disambiguate what making something "smart" actually means by establishing the genre of smArt and the smArt Framework whereby artists, audiences and critics can understand and explore the impact of the application of autonomous and semi-autonomous systems on 1). creative processes 2). art works and 3). aesthetic evaluation. Degree of autonomy is defined by the ability of a system to self-regulate or change its own processes as a response to its own output. The minima of the spectrum of autonomy is the simplest biological or electromechanical feedback loops upon which all more complex systems are built. Toward the maxima of the spectrum of autonomy (at least from our perspective as humans) is animal biology, with human agency at the top. Leveraging this autonomy in a system for creative ends means embedding the system with some degree of creative autonomy and therefore control over the artistic output. In the case of machine learning and neural networks, the system is simulating human learning and behavior and therefore simulating human creativity. By framing creative autonomy as agency within a given system or cultural field, the application of an autonomous or semi-autonomous system causes the larger artistic process to become indeterministic. Furthermore, the interaction between artist and system in the process of making is communication; an information exchange which involves fidelity loss through environmental noise and error. By understanding our own creative agency as a combination of habitus and doxa and the simulated agency of a "smart" system as program and database, we can explore the complex interaction between (real) human artist and (simulated) "smart" system. First, we can compare the relative level of agency, by establishing the elements of the form and who or what has control of them. Second, we can evaluate the behavior of the system by analyzing the quality and degree of the agency involved. This involves exploring the interaction between the habitus of the artist, the behavior of the system and *how* that is manifested in the viewer's experience. Finally, we can evaluate the application of the simulated agency by the artist and whether it improves or detracts from the work both as it exists at the time of viewing and how it and its perception or position within the cultural field will evolve over time.

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Chapter 1

Introduction

The goal of this thesis is to propose the smArt genre and present readers with a framework to expand on its aesthetic analysis. The smArt genre refers to art that includes autonomous and semi-autonomous or "smart" systems, concepts and technology. This category of art employs a range of systems extending from the most simple self-governing feedback control systems to the cutting edge of artificial intelligence (AI) and machine learning (ML) used to simulate human behavior. To that end, this paper will first discuss the current state of AI/ML technology, with a focus on media technology. This will include privacy, bias and the larger cultural impact of previous and existing applications of "Big Data." Then, we move to a description and discussion of "smart devices." This will cover the lifecycle of these devices and their current and past implementations and their commercial and artistic applications. The discussion will further address how the technologies and their applications reflect our cultural values and social priorities and what impact that has and will continue to have on our culture and economy. In addition to contextualizing smArt as a genre in the larger field of New Media, I will present the smArt Framework as a method of aesthetically evaluating this type of art. Within the Framework, I will employ the tetrad and other concepts as outlined in Marshal McLuhan's *Laws of Media* to establish the nature of these systems and then, utilizing the theory of predispositions as defined by economist Aaron Katzenlinboingen in his *Indeterminism and its Applications*, will define and analyze the relations and connections between the nodes of the system. Further, I will be employing the ideas and language of Boudreau, specifically those of the cultural field and entanglement, in order to describe the complex and dynamic nature of the relationship I propose that smArt works have to the larger cultural discourse. I conclude with a proposal for David Attenbotto as an example of such a work. In the context of art and art-making, it is the purpose of this thesis to demonstrate that the artistic application of AI/ML will allow for

the creation of works that expand on the range of complex interactions between artist, object and audience and therefore the quality and scope of their engagement. This includes the physical materials and hardware (or lack thereof), the underlying software and datasets and the intent or meaning as determined by the artist. What makes this different from interactive new media systems is that the learning element has two major impacts: one, AI/ML systems can learn in real-time and thus execute more complex and dynamic tasks that include classification and decision making; two, the application of AI/ML systems referentially implicates and interacts with the collection and application of the models and their respective training datasets and the cultural fields in which they constituent.

With that, we turn to a summary of the current state of data collection in America. Pictured in Figure 1-1, is a screenshot from data collection phase of my creative process for my piece "To Tip the Scales of Justice," presented fully in section 3.1.2. The database for the piece, consists of a collection of different perspectives on the topic of justice and is representative of the methods and applications of Big Data.

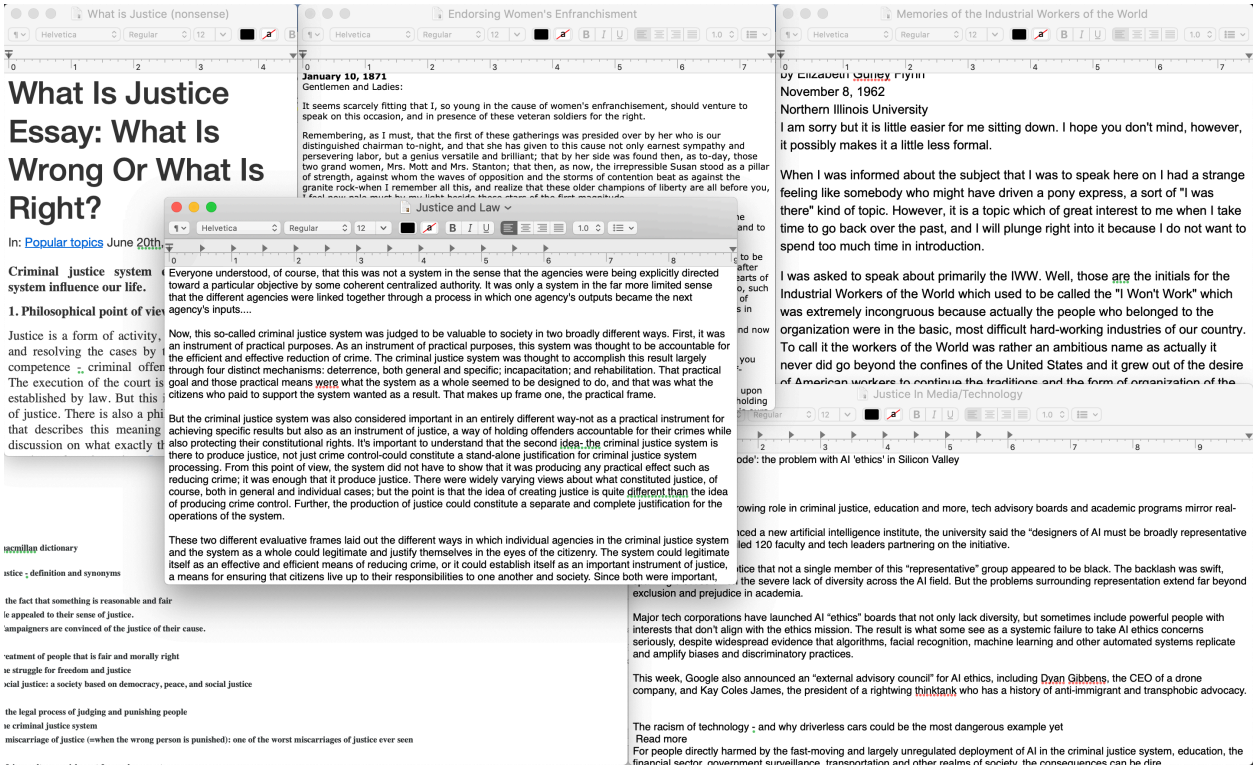

Figure 1-1 Screen Captures of Source Data Collection on the Topic of Justice

1.1 Data Collection

With the advent of Artificial Intelligence and Machine Learning, it is now possible to further leverage computer systems involved in the art making process as autonomous or semi-autonomous actors that can perform complex analysis, decision making, interpretation and generation of media. Data collection and analysis is central to creative and commercial applications of AI/ML technology as highlighted in Figure 1-1 taken during the data collection process for the creation of my piece "To Tip the Scales of Justice" which will be discussed fully in Chapter 3.1.2. In order to properly understand the artistic applications of AI/ML, we must first explore the current state of non-artistic applications of this technology which form the basis for tools being leveraged in art-making. We begin with a brief history and an overview of "Big Data."

Before we continue, I would offer my personal opinion that "Big Data" has become effectively a kinder term for the mass surveillance of people by the companies that supply them with products. In a Forbes.com article titled "How Much Data Is Collected Every Minute Of The Day" Nicole Martin reports, "Overall Americans use [(upload/download)] 4,416,720 GB of internet data including 188,000,000 emails, 18,100,00 texts and 4,497,420 Google searches every single minute." What is important to remember is that in addition to being able to collect and use specific data points that users share over these networks, companies can also track sets of these data points in order to develop marketing products based on predictive models trained on the user data. For example, they are being used in the current economy, to better predict what products one might want based on past purchases and therefore what ad one should be shown. Martin goes on to comment that,

> With these growing numbers, it is no surprise that data is on everyone's mind and data breaches are so crucial these days. These statistics tell a story of how people are interacting, engaging, and are key to marketing initiatives for many companies. The IDC predicts that by 2025, the total amount of digital data created worldwide will rise to 163 zettabytes,[1] ballooned by the growing number of devices and sensors.[2]

[1] Zettabyte = 1,000,000,000,000,000,000,000 bytes
[2] (*How Much Data Is Collected Every Minute Of The Day*)

Because this data collection is done in the name of research, efficiency and optimization of products and services, we use, and are familiar with and not by some secret government agency (that we know of), we seem to be quite willing to pretend that this behavioral surveillance is not the means that underpin the ends of post millennium life. Mass surveillance by Facebook, iPhones, Netflix, Uber etc. would be in another context anathema to the "values that we hold dear" as Americans. Values like freedom from undue search and seizure, for example. Data after all, is in most cases individual property, and yet we all as a society seem largely indifferent to its mass collection and use for other's substantial profit. Notoriously complicated and filled with legalese, each of us that participates in the current media technology ecosystem has agreed to terms and conditions that in general allow varying degrees of this continuous mass data collection.

It is worth pointing out that for a car as an example product, we can see that such an agreement would allow the maker to collect important usage data of the vehicle, which taken in aggregate could provide important insights in the future design process thus improving the end product for the consumer. In addition, the car owner has to physically bring the car to a dealership or mechanic for the data collection to take place and thus there is a real (as in physical) limitation put on the frequency and thus quantity of data collection. Therefore, the consumer has ample incentive to participate in this voluntary and occasional exchange of behavioral data for a modest return on future quality of products. The current tech economy on the other hand has discovered the commercial value of operationalizing this data to develop behavioral models to do things like improve advertising and optimize "effectiveness." Importantly, the primary mode of interaction with this technology is the through smart devices such as phones, which are commonly kept on the person most of the day. Thus, the car logic does apply in a sense to implementations of AI/ML technology, but we must reconsider what and how much data we give up and what the real value is of the products and services we get in return.

In addition to the problematic nature of "Big Data" as it relates to surveillance and civil liberties, there is also a central fallacy in its application that contends that because human behavior could in theory be simulated with a large enough dataset, this simulation can then be substituted for an individual human and one would get the "same" results. This question of "sameness" between an individual human and an AI/ML system is central to the discussion of what makes the experience of engaging with AI/ML systems unique. What is the same between them is what allows for AI/ML systems to be substitutable for a human agent in the right circumstances? So, the question becomes

two sided: How valuable is the data we're now being asked to give up? How valuable or harmful are the products and services we' re getting in return?

1.1.1 Privacy

It is worth noting that this is not the first time in history that our cultural understanding of privacy is fundamentally challenged by emerging technology. The introduction first of the telegraph and then later of the telephone were each met with their share of panic and lamentation. It is my view then for this reason that to take a cynical approach towards the future of privacy is simply an exercise in futility; standing tall against the tides of history. It is inevitable that our standards will change to reflect the technology of the times, but the work still remains for us to define and exert a new understanding of privacy in each new era of technology.

According to Cornell Law School's Legal Information Institute, the legal right to privacy was first recognized by the supreme court in 1965 in the case *Griswold v. Connecticut*, in such a way that defined the right of married couples to privacy with regard to the use of contraceptives. What is important, and highlighted in the article is that "the Supreme Court found a right to privacy, derived from the penumbras of other explicitly stated constitutional protections. The court used the personal protections expressly stated in the First, Third, Fourth, Fifth and Ninth Amendments to find that there is an implied right to privacy in the Constitution."[3] To clarify for those like myself who are not lawyers, in this context according to the Merriam-Webster dictionary, penumbra is a "a body of rights held to be guaranteed by implication."[4] Further, Justice Harlan found in his concurrence that there was "'a right to privacy derived from the Fourteenth Amendment…a statute making it a criminal offense for married couples to use contraceptives is an intolerable and unjustifiable invasion of privacy in the conduct of the most intimate concerns of an individual's personal life.'"[5] For reference, section one of the Fourteenth Amendment lays out that:

> All persons born or naturalized in the United States, and subject to the jurisdiction thereof, are citizens of the United States and of the state wherein they reside. No state shall make or enforce any

[3] ("Privacy")
[4] (*Penumbra | Definition of Penumbra by Merriam-Webster*)
[5] ("Privacy")

> law which shall abridge the privileges or immunities of citizens of the United States; nor shall any state deprive any person of life, liberty, or property, without due process of law; nor deny to any person within its jurisdiction the equal protection of the laws.[6]

The reason this is important is that is the Fourteenth Amendment and not penumbras has been the basis for subsequent privacy jurisprudence in cases like Eisenstadt v. Baird (1971), Roe v. Wade (1972) and Lawrence v. Texas (2003).[7] As this is not a legal paper, what is important is that Justice Harlan's statement outlines some of the core values we have established and elaborated upon in the United States with regards to privacy. First, the reference to our Constitution, which among other things specifically prohibits laws that "deprive" us "life liberty, or property" without due process of law. What is at the core of this statement is the public interest. That without these protections and considerations for our way of life, people are not free. Second, that he specifically characterizes it as an "invasion" of privacy that is both "intolerable" and "unjustifiable." This provides us with somewhat of a cultural heuristic for the kinds of actions that cross the line from what is for the public interest to what is against the public interest with respect to privacy. Third, that this is of utmost importance with regards to "the most intimate concerns" of one's "personal life." This suggests an expectation of a qualitative understanding of privacy, or rather that our conduct and affairs range in the level of need for privacy, and that this is at its maximum with regards to matters deemed sensitive either culturally or subjectively. What is also key here is that it is up to the individual and the culture to balance the relative needs of the culture at large and the individual. I would argue, therefore that it is well established that privacy is a core value here in the United States, up there with baseball, freedom and buffalo chicken wings.

So, what then does it mean to have privacy in this era of surveillance and data collection? Is privacy now defined solely by the specific party from which information is withheld (the government, the opposition, those outside your social circle?) We seem to simply accept the practices by the product and service providers in exchange for access to this cornucopia of information, tools and all the subsequent social, cultural and most importantly economic domains they create. Work that is focused on the ethical evaluation of this system of participation in digital mass media and AI/ML technology, and how we might best navigate through it has, at its core, one question: is this technology a cornucopia or is it a Pandora's box? Some approaches such as federated learning systems have been proposed; however, rather than discussing policy solutions, it

[6] (*Constitute*)
[7] ("Privacy")

is my goal to propose and evaluate smArt as a category of art that leverages these collections of behavioral data to create AI/ML systems as art. This is of specific importance because I believe that it is the role of art to present to viewers new perspectives that can both challenge and affirm, allowing each of us to develop or improve our understanding though our unique relationship to the work. I propose that this represents to artists and consumers of media a new type of media object/experience that as a product of "Big Data" can give us a means of contextualizing and exploring the scope and implications of surveillance through artistic methods. If this were the only application, it would be somewhat of a silver lining; however, it is the goal of this paper to demonstrate that there are several characteristic features of AI/ML systems that place them in a unique position to, when used in art, provide a new perspective to viewers on:

- humans' behavior as autonomous agents within social, political, cultural and economic systems
- the resulting complex dynamics of human systems
- how human systems are and will be affected by interactions with emerging technology.

We will return to discussions of privacy throughout the first chapter, but in terms of smart devices and AI/ML technology, it is important to highlight privacy as one of the core values being challenged in this discussion.

1.1.2 Bias

One thing that becomes immediately apparent in any thoughtful examination of AI/ML technologies is that bias within the datasets, models and applications can, often problematically, manifest itself in the output and results. The behavior being sampled may already be biased, which would subsequently be reflected as such in the behavior of the system. Or, consider that the simple act of data selection for use in analysis of human behavior along with its use in subsequent inference-based modeling creates a definable/deterministic set of perspectives that constrain and influence the resulting output. This influence is quantifiable but complex and therefore I use bias as a generalized term that encompasses the totality of these individual influences and their complex interactions.

It is my understanding that bias exists to varying degrees in all systems, and what makes AI/ML systems fascinating to me is that this bias is not just quantifiable, under the right conditions can be programmed to become apparent in the behavior of the system, or more often in its misbehavior in such a way that creates a unique experience for the viewer. The experience is unique in that it is complicated by the subjective cultural implications of the output of the system, such that the viewer must all at once, contend with the specific output and the larger social and cultural issues that relate to it. Put another way, the traditional mode of creating a foreground and a background and thus directing focus becomes one where the two are simultaneous and in some sense flattened, thus revealing the background or context for critical examination. I would contend that when the model is skewed or pushed to extremes, the experience is one of a user/viewer engaging with a representation of not just one specific bias, but of the nature of bias itself. From a commercial perspective, this bias is something that leads to incorrect behavior of the systems (malfunctions), and thus exists insofar as it should be identified and mitigated. From a larger cultural perspective, and as an artist, I wonder how to access this characteristic of representing not just the intent of the maker, but also the underlying influence of the interaction (often unexpected) between them, the program (desired behavior) and the underlying dataset (sampled from "real" people).

In an article titled "What Do We Do About The Biases in AI" written for the Harvard Business Review, James Manyika, Jake Silberg and Brittany Presten explore the current state of bias in commercial/corporate applications of AI, giving an introduction to its complex and persistent nature as well as calling attention to the urgent need for continued effort in what they call "mitigating" bias in these systems. The article begins with a frank assessment of the current state of affairs:

> Over the past few years, society has started to wrestle with just how much these human biases can make their way into artificial intelligence systems — with harmful results. At a time when many companies are looking to deploy AI systems across their operations, being acutely aware of those risks and working to reduce them is an urgent priority… AI systems learn to make decisions based on training data, which can include biased human decisions or reflect historical or social inequities, even if sensitive variables such as gender, race, or sexual orientation are removed… Another source of bias is flawed data sampling, in which groups are over- or underrepresented in the training data.[8]

This represents a simplified but very accurate portrayal of what has become a major concern for individuals and companies seeking to monetize this technology. This is due to the specific nature of

[8] (*What Do We Do About the Biases in AI?*)

the application of this technology, in that it is meant, passively or actively, to interact with humans and react to some kind of sensory input in order to generate output. In other words, unlike previous eras of machines, the commercial appeal of these systems is that they are meant to be "autonomous" or "semi-autonomous." This refers to the fact that these machines are being tasked with complex decision making as the basis or as a part of their program, thus not requiring a user or operator to be fully in control. Economically it would be easy to see how dreams of self-driving cars and fully automatic and customizable factories would drive all this research and development, but it can only be sold to people if the technology can be trusted to make those decisions to a withering degree of accuracy (for risk of losing the faith of the customers). A sensible person would not want for example, to participate in the Uber self-driving car beta-testing program. I note with irony that for a species that has a long history of fickleness, excess and lionizing impulsive decision making not to mention cruelty, we forget sometimes in the analysis and criticism of these AI/ML systems that the status quo, *we*, are our alternative. It is understandable based on the economic incentives in the field of commercial applications of AI, these corporations would not be willing to release products to the public unless they are confident that products will not physically harm us and this is something to be encouraged and applauded. By the same financial incentive however, companies have been willing to do things that are unpopular and perhaps unethical while remaining legal. It is my belief that increasing access to understanding of the technology and its applications is the only way for consumers to ensure that companies will take responsibility for the potential negative cultural and social impacts of the misuse of their media technology in the same way they would physical harm caused by a product. In addition, we must pass the necessary safeguards into law that will protect free speech while addressing things like abuse, and foreign propaganda.

Liability and the larger economic stakes by themselves have proven insufficient with regards to addressing the larger bias in the cultural and economic system, as evidenced for example by the persistence of racism and other intolerance. It is the goal of the economic community to try to eliminate bias in these systems primarily to ensure that they operate in a way that is most reliable and commercially viable. The HBR article states, "Business and organizational leaders need to ensure that the AI systems they use improve on human-decision making, and they have a responsibility to encourage progress on research and standards that will reduce bias in AI."[9] Now this is all very noble and sensible, but there are some major concerns. We risk prioritizing reducing or eliminating

[9] (*What Do We Do About the Biases in AI?*)

bias in AI/ML systems, while ignoring the somewhat obvious roots of that bias in our real social, economic and political systems. Surely what is output by these systems is a reflection on our values and social priorities, as they are constituted of real human behavioral data points and therefore what we choose to do. By focusing on the elimination of bias (read purity) in AI/ML systems we may actually suppress the potential to operationalize the mirror like quality of AI/ML systems in the pursuit of representing the harmful realities of existing social and cultural bias. If it is necessary for safety and viability etc, then companies can and should do the necessary work of eliminating bias in their models and data collection methods; however, we are missing the opportunity, perhaps intentionally, to leverage this "problematic" behavior of systems as a way of representing and thus engaging with and influencing our real/actual culture and society.

What has already been uncovered, confirmed or otherwise brought to bear in the public discourse? Such issues include the continued pervasiveness of racism in our society as shown through the inability of facial recognition to function with darker skin tones. In an article titled "Machine Bias" for ProPublica in 2016, Julia Angwin, Jeff Larson, Surya Mattu and Lauren Kirchner outline how Northpointe, a for profit software company, has created a risk assessment software that is now widely used thorough the country in courtrooms and criminal proceedings as well as throughout the criminal justice system. "Northpointe's core product is a set of scores derived from 137 questions that are either answered by defendants or pulled from criminal records" that results in a rating on likelihood of future violent crime and risk for general recidivism (Angwin et. al. 2016). Here are the findings of their independent analysis:

> We obtained the risk scores of more than 7,000 people arrested in Broward County, Florida in 2013 and 2014 and checked to see how many were charged with new crimes over the next two years, the same benchmark used by the creators of the algorithm. The score proved remarkably unreliable in forecasting violent crime: only 20 percent of the people predicted to commit violent crimes actually went on to do so. When a full range of crimes were taken into account—including misdemeanors such as driving with an expired license—the algorithm was somewhat more accurate than a coin flip. Of those deemed likely to re-offend, 61 percent were arrested for any subsequent crimes within two years…In forecasting who would re-offend, the algorithm made mistakes with black and white defendants at roughly the same rate but in very different ways. The formula was particularly likely to falsely flag black defendants as future criminals, wrongly labeling them this way at almost twice the rate as white defendants. White defendants were mislabeled as low risk more often than black defendants.[10]

[10] (Angwin et al.)

Northpointe disputes these findings, but we know that there is an answer. This answer lies in the algorithm that Northpointe implemented in its software, but we may never know this answer as these algorithms are protected trade secrets and may or may not be fully understood by the companies that offer them as products and services. Now it seems clear from the ProPublica analysis that whether the algorithm is confirming bias or imparting bias, that this bias is embedded in the algorithm, either by the former, the dataset, or by the latter, the choices made in the data collection, model structure or implementation. While it is possible to account for these errors that result from bias in systems theoretically, practically doing so would require examining the dataset and the algorithm as well as the general methodology, which in the vast majority of cases we either struggle with due to the sheer magnitude of data or simply are not given the opportunity to do. These algorithmic risk assessments are being utilized in a way that has a real impact on outcomes in the justice system, in some counties even used to make decisions about probation as well as sentencing. Public applications such as in the criminal justice system should require that any and all mechanisms of the justice system be made available to the public and be subject to legitimate scrutiny in order to ensure that they are being applied appropriately and fairly and are taking these cultural and social biases into account.

There are and will be many biases and tendencies reflected back to us by the analysis of behavioral data we collect. We might not like the picture it paints of the state of our society, but perhaps this is the point. By viewing this as a dynamic microcosm of systemic bias from an artistic perspective one can quickly see the potential in operationalizing such system for the purpose of creating art that conveys this experience of the "true" behavior of our human system.

1.1.3 Feedback Loops and Filter Bubbles

The concept of feedback and feedback systems occurs across professional fields of study including biology, psychology, marketing, electrical and mechanical engineering, computing and information theory. Feedback in such biological phenomena as homeostasis is defined by The Encyclopedia Britannica in the biological context as "a response within a system that influences the continued activity or productivity of that system. In essence, it is the control of a biological reaction by the end

products of that reaction." In his 2016 New York Times bestseller, *Other Minds: The Octopus, The Sea, and The Deep Origins of Consciousness,* Peter Godfrey-Smith discusses the role that sensory feedback systems play on our understanding of the world around us as a way of introducing his ideas about how octopuses and other animals with highly complex yet differently structured brains might subjectively experience the world. Often conflated, sentience and consciousness to Godfrey-Smith are on a continuum of subjective experience. What distinguishes consciousness is not only the degree of sensitivity to the outside world and our subsequent physical response, but also the degree to which one can influence or impact the physical world which then leads to a sensory response or consequence. Though this may seem a bit obvious, Godfrey-Smith notes, "though the idea that our actions affect what we perceive seems routine and familiar, philosophers through many centuries did not treat it as especially important… [they] looked at the link between what comes in through the senses and the thoughts or beliefs that result. Little was usually said about the link to action, and even less about the way action affects what you sense next… It is a big thing, apparently not easily achieved, to accept that there is *traffic*, a to-and-fro."[11] Thus through the feedback of our nervous system involving the sense-to-motor path (physical reactions to senses) and a motor-to-sense path (our physical actions that result in sensations) we are able to coordinate our appendages and "consciously" interact with the environment.

To reiterate, the idea is that subjectivity exists on a continuum that ranges from the perspective of systems governed by the most simple chemical feedback loops like plants and bacteria all the way to the complex and nebulous thing that we understand as consciousness, and what varies across the spectrum is the degree to which these systems or entities are able to sense and influence the world around them. With more and varied sensing abilities, sight, sound, smell, taste and touch *combined* with our physical ability to travel and manipulate objects in our environment into tools with opposable thumbs. Humans, it would seem, exist at one end of this spectrum, but I would agree that subjective experience in itself is not unique to humankind, but is rather a question of quality and degree. Godfrey-Smith makes the quite convincing argument that the science shows us that cephalopods have complex sensory abilities and the ability to maneuver themselves and manipulate objects for use as tools, despite the fact that they are from a very different evolutionary path. The essence of Godfrey-Smith's argument is that subjective experience of these beings must be

[11] (*Other Minds: The Octopus, the Sea, and the Deep Origins of Consciousness, Godfrey-Smith, Peter - Amazon.Com*)

something analogous to human consciousness as they have a similar degree of complexity, however they quality of that consciousness would clearly be profoundly different for all of the environmental and thus biological reasons. Given an electromechanical system of sufficient complexity and interconnectedness of sensory capability and an ability to maneuver and manipulate the environment, it could be argued that they also have some kind of consciousness, analogous to the octopus; similar in degree to human consciousness, but profoundly different in quality as a result of its "biology." Thus, for the purposes of analyzing self-governing systems in creative processes and applications, we might consider that relative to their degree of autonomy, complexity and sensory/output capability, all of these systems, mechanical or biological, exist along a spectrum of subjectivity. Though they are not the same by any means, for all "smart" systems, the greater their degree of complexity and "traffic" between sensing and action, the more subjectivity they express. This also sets up a frame of reference from which human and electro-mechanical systems can both be analyzed in the same terms. This will aid in the exploration of the complex interactions between artist and system and their consequences in the collaborative artistic context.

The feedBox discussed further in section 3.1.1. is an electronic instrument built to explore the interaction between a simple self-governing feedback system and a human player, and it demonstrates the profound effect this interaction has on the creative process. The instrument consists of a wooden craft box, contact microphones, a tactile transducer and a Teensy microcontroller running a Karplus-Strong string synthesis algorithm. The signal from the contact microphones excites the digital string which is output physically as vibration and sound by the transducer which in turn is picked up by the mics creating a feedback loop. While the user has some control over parameters of the system, the sound made by the instrument is largely indeterministic. This demonstrates in an interactive way, the separation introduced by the feedback-control loop between the user's input and the specific output, making the resulting sounds dynamic and unpredictable. Even with such a simple self-governing system, the relationship between artist and instrument is fundamentally shifted from a craftsman-tool paradigm to a collaborative one.

In each field, feedback occurs within and between specific sets of systems in that field, but it always has the same characteristic: the output of the system influences/is connected back to the input of the system influencing its future output. In their book *Feedback Control of Computing Systems*, Joseph Hellerstein, Yixin Diao, Sujay Parekh and Dawn Tilbury write on operationalizing feedback to control computer systems: "An appeal of feedback control is that administrators can achieve the desired output in a direct way by specifying the reference input instead of indirectly by manipulating

the control input (an approach that is time consuming and requires considerable skill)"[12]. The reality is that this type of circular information flow underpins the reality of the natural world and thus the human experience, as well as the technologies that humans have developed, particularly with respect to media and communications. In their book, Hellerstein et al. describe two important characteristics of feedback systems; stability and accuracy:

> A system is said to be *stable* if for any bounded input, the output is also bounded. Stability is typically the first property considered in designing control systems since unstable systems cannot be used for mission-critical work. The control system is *accurate* if the measured output converges (or becomes sufficiently close) to the reference input. Accurate systems are essential to ensuring that control objectives are met.[13]

It would seem that if stability and accuracy are valuable in implementing a feedback system it is possible if not likely for them to be at times both unstable and inaccurate. In the context of AI/ML applications, where there is a further step of the model (inference and decision making) inserted into the loop between users input and the output, one can imagine that any non-convergence or error in either the feedback system or the underlying model-dataset might cause the system to behave in unexpected or undesirable ways in selecting or generating its output.

One particularly notable example of AI/ML driven feedback system that most people in the world interact with is the Facebook news feed. It is worth noting that Facebook was designed as a platform for networking; connecting individuals into groups by social, cultural and other types of commonalities and giving them a forum for communication and interaction. The platform has become so embedded in culture that we often forget the dramatic evolution that it and other similar platforms such as Twitter have undergone since their introduction. Facebook, as it relates to news, began as a platform for discussion between non-expert, non-firsthand witnesses, just regular people, about news and the goings on in the world, often by posting links to newspaper articles or cable news videos. The news industry's response of entering the Facebook ecosystem marked the evolution of the news feed into a secondary news source, where professional journalism is posted through the platform in the form of links to articles behind paywalls, creating new challenges such as "fake news" (click-bait and propaganda). This has now progressed all the way to a primary news source where people can post publicly to the world or share video and audio through Facebook Live about things that are happening in real or near-real time. What is uncharacteristic and novel about

[12] (Hellerstein et al.)
[13] (Hellerstein et al.)

the evolution of this and similar technology is that the platform does not lose any of its previous characteristics or traits in the adoption of new traits, simply enveloping them into its larger functionality. What this means is that users are presented with first, second and third hand information about a topic in endless and rapid succession and in no logical order, which in itself seems to be one of the less sensible methods of consuming information. In his paper "From Editors to Algorithms: A Values-Based Approach to Understanding Story Selection in the Facebook News Feed" published in the journal, *Digital Journalism*, Michael A. Devito examines through inference and extrapolation the "values" of the news feed story selection process which he points out is held as a trade secret by Facebook and therefore not explicitly known by the user base or the public at large. He writes of the problems with the newsfeed selection process, "if Facebook is going to prioritize posts from close friends in the News Feed, engineers must decide on the criteria that defines a "close friendship" versus an acquaintance. Engineers must turn this nuanced human construct with many different interpretations into a single, operational definition, and in doing so embed their values as to what a "close friend" is into the algorithm itself"[14] This is referring to the bias that in this and many other ways is embedded into the platform itself. He goes on to say,

> …engineers must decide at this point who defines "relevance" in a relational sense. On the one hand, engineers can decide to make popularity the key value, prioritizing the majority's opinion and, potentially causing majority dominance over what should be localized topics (Gillespie 2014). On the other hand, individual preference can be made the key value, basing decisions on the user's own past actions (read as preference), and potentially opening up the possibility of feedback loops and filter bubbles.[15]

I think it is important to expand on this idea of filter bubbles put forth by Eli Pariser, the head of viral content website Upworthy, referenced here by Devito. In his 2011 New York Times bestselling book, *The Filter Bubble: What the Internet is Hiding From You*, Pariser warns of the dangers of the mass adoption of this kind of news feed as a primary means of getting news and other socially and politically relevant information. Pariser describes in an interview about the book by Jasper Jackson for *The Guardian*, how systems that employ this kind of algorithmic curation of posts are filtering information in a way that creates echo chambers where "you think you are getting a representative

[14] (DeVito)
[15] (DeVito)

view of the world and you are really, really not, and you don't know it… Some of these problems that our fellow citizens are having kind of disappear from view without our really even realizing."[16] In other terms, what Pariser is referring to is the effect of personalization of products and services on identity which taken collectively, constitutes our culture. This effect is particularly subtle in that our devices and applications are curating and framing what information is in front of us and thereby our choices. Pariser writes in a chapter titled "The You Loop" in *The Filter Bubble*, "The filter bubble doesn't just reflect your identity. It also illustrates what choices you have. Students who go to Ivy League colleges see targeted advertisements for jobs that students at state schools are never even aware of… By illustrating some possibilities and blocking out others, the filter bubble has a hand in your decisions. And in turn it shapes who you become"[17] When taken at scale, all users of this technology are impacted by the technology, but not all in identical ways. What *is* common among users about how technology has impacted their lives would be the measurable effect of filter bubbles.

One other important note here is how this filter bubble phenomenon interacts with the underlying data, in a way that relates to the previous discussion about bias. In addition to the basic challenge of inferring patterns from noisy sample data, there is a specific interaction known as "overfitting" that occurs when patterns are inferred from a dataset that are not "true, " or rather that they would not be reflected by the data were one to have better or more complete information. Pariser describes the challenge of overcoming overfitting in his book as,

> …*not* finding patterns in the data that aren't actually really there. The pattern that describes '1, 2, 3' could be 'add one to the previous number' or 'list positive prime numbers from smallest to biggest.' You don't know until you get more data. And if you leap to conclusions you're overfitting…[T]he overfitting problem gets to one of the central, irreducible problems of the filter bubble: Overfitting and stereotyping are synonyms…stereotypes and the negative consequences that flow from them aren't fair to specific people even if they're generally accurate.[18]

This example may seem innocuous, but the effects of overfitting can be disproportionately detrimental to certain groups of users, especially ones who are already marginalized in current society. This is especially true as AI/ML inference techniques are now widely used commercially for

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[16] (Jackson)
[17] (*The Filter Bubble: What The Internet Is Hiding From You by Eli Pariser (1-Mar-2012) Paperback: Amazon.Com: Books*)
[18] (*The Filter Bubble: What The Internet Is Hiding From You by Eli Pariser (1-Mar-2012) Paperback: Amazon.Com: Books*)

marketing and social networking, and even to varying degrees in areas such as law enforcement and insurance. Pariser concludes,

> …the world often follows predictable rules and falls into predictable patterns: Tides rise and fall, eclipses approach and pass; even the weather is more and more predictable. But when this way of thinking is applied to human behavior, it can be dangerous, for the simple reason that our best moments are often the most unpredictable ones. An entirely predictable life isn't worth living. But algorithmic induction can lead to a kind of information determinism, in which our past clickstreams entirely decide our future. If we don't erase our web histories, in other words, we may be doomed to repeat them[19]

Here we arrive at the central problem of this technology in its current interaction with culture and society: the cumulative stifling of innovation and free thought and choice by the logic of using past behavior to predict future behavior. While this may all be legal, we should be asking not only if the processes themselves are unfair or unethical, but also if we are satisfied with the resulting effects of this technology and its application.

Leading up to the election in 2016, it was my experience that everyone who was using the internet as a primary means of political participation genuinely thought most people in the country agreed with them about their specific hatred of either or both candidates, and it would seem they voted or didn't vote accordingly. There are of course many other reasons why one candidate was successful over the other, but what is important to this paper is that it serves as an example of how systems that are based on our behavioral data are being implemented in such a way that there are unpredictable and feedback loops leading to bad outcomes (distrust, confusion and the general degradation of our political discourse). Facebook as discussed uses an algorithm that incentivizes engagement and prioritize posts from "close friends". This resulted for each of us in a news feed that biased certain kinds of posts, for example ones that were sensational or scandalous, or ones that confirmed our previously held opinions eventually resulting in a filter bubble or echo chamber where we believe incorrectly that what we see in their feed is representative of the larger cultural discourse.

Take for example this hypothetical: a man who for the first time uses a social networking site. He logs on and after filling out his information and adding some friends his newsfeed begins showing him things his friends are engaging with. After scrolling down for a while, he finds an article that says broccoli can help with aching joints. He has aching joints, and so he clicks on the

[19] (*The Filter Bubble: What The Internet Is Hiding From You by Eli Pariser (1-Mar-2012) Paperback: Amazon.Com: Books*)

article, copies some recipes and heads out to the store to buy some ingredients. He makes some food, posts a picture and some comments and goes to bed. As people begin to engage with his posts, he sees more recipes for broccoli dishes and so he makes them and takes photos and posts them online. At some point along the way, the man asks himself if he's spending too much time doing broccoli related things. He then thinks to himself of all of the friends he's connected with online through his posts and comments and decides to really double down on the broccoli thing. After months of growing engagement, he decides to quit his job and starts a YouTube page dedicated to broccoli. One could see from this hypothetical of prolonged application of this "smart" technology, the expression of the bias in the system, in this case the confirmation bias towards broccoli and the resulting filter bubble. That which each user thought was a "real" representation of the thoughts and commentary of their now expanded social circles, was actually a very specific and limited subset of that field, limited by biases inherent in society as well as in such a simplistic engagement-based system. The user-informed selection of the newsfeed is the feedback element.

This is obviously a silly example and is hyperbolic in order to illustrate the point. In the context of politics, which in America has devolved into a drunken wandering from scandal to scandal combined with a dearth of individuals with previously held opinions, it is easy to see how bad actors are able to have an outsized influence and things simply get out of hand. More specifically, these biases that are characteristic to the system and its application were amplified to the point that it created filter bubbles where a few specific types of posts would circulate around these social groups like tumbleweeds on the set of an abandoned western. Thus, we see the perils of feedback loops in the application of behavioral data.

This is importantly not limited to the software applications of this technology. Equally bad outcomes await us if we as consumers don't begin to engage with the design and application of hardware and software with respect to its sustainability and cultural impact. This technology will change the world as we know it. I believe it is only though informed discourse and its application in creation of art that we can bring to bear what morality or ethics might apply in the creation and application of these "Big Data" driven systems.

1.2 Smart Devices

In order to properly situate the discussion of smart devices as they relate to the genre of smArt, it is necessary to define the field of smart devices as a manifestation of what it means for something to be "smart." This will begin with a categorical definition and include the current state of its applications as well as the cultural understanding of "smart" in the context of smart devices such as the Apple iPhone 4's pictured in Figure 1-2 used in my installation "To Tip the Scales of Justice," which was a manifestation of the impacts of complex communication and media systems through smart devices on meaning and cultural values. It is also worth mentioning that automated computer systems and thus the concept of a smart device have been around for over half a century.

Figure 1-2 Apple iPhone 4's sensing position in "To Tip the Scales of Justice" @ CalArts WaveCave 2019

1.2.1 Categorical Definition of Smart Devices

In an attempt to define smart devices, I will offer an eidetic reduction of smart devices, focusing on three elements as the essential features of a smart device: Network, Sensors/Indicators and Programmability. In the textbook *Connectivity Frameworks for Smart Devices: The Internet of Things from a*

Distributed Computing Perspective edited by Zaigham Mahmood, a smart device is defined as "an electronic device, generally connected to other electronic devices through high-speed bandwidth networks with the help of wireless technologies such as Bluetooth, near-field communication (NFC), Wi-Fi, and 4G, capable of communication with other devices. These smart devices can be smartphones, androids, tablets, iPads, computers, laptops, televisions, consoles, and IP cameras."[20] This has now grown to include refrigerators, coffee makers and other kitchen appliances as well as cars, watches, in what has become known collectively as the Internet of Things (IoT). The passage continues discussing the development of smart devices,

> …with the help of advanced technological tools and techniques and more powerful smart devices with high speed, extra capabilities, and more intelligence abilities, its connotation changed. Advances in technologies like very large-scale integration (VLSI) chips and microcontrollers are also creating smarter devices with low power consumption; this means that large networks of sensors can be created, with the ability to obtain information, process it and act accordingly.[21]

This propagation of networked sensors in products that we buy, is what allows for the mass collection of behavioral data that is subsequently used in the training of AI/ML systems. Just as important as the network and the underlying programmability of the system to the functionality and overall nature of these systems, is the sensor and output technology that is used to gather immediate data as input to the system and propagate media to the user as sound, images and haptic feedback. The last century of development in media and consumer electronics technology including microphones, screens, batteries, cameras, temperature and pressure sensors, hall effect and infrared sensors etc. has allowed for these systems to take on and generate a multimodal range of inputs and outputs similar to what we perceive with our human senses.

The data recorded by these sensors is also collected, analyzed and used to generate future iterations of the product, manufactures must be vigilant of the inevitable feedback loops inherent to such a system that might skew the output/product in such a way that it becomes undesirable. One approach to reconfiguring our data systems to avoid this type of feedback is to federate the data collection and analysis, so that manufacturers no longer have unfettered and continuous access to behavioral and other types of data generated by users. The term federated here implies that each person with a smart device would utilize that device as an agent; a password protected central hub for controlling the flow of and storing of each individual's data, as opposed to a shared cloud server

[20] (Mahmood)
[21] (Mahmood)

owned by the product manufacturer or some third party, in some unknown location. In their paper "Smart Devices for Next Generation Mobile Services," researchers Chie Noda and Thomas Walter outline some of the problems that exist at the cutting edge of smart devices. They propose a solution in the form of new framework for utilizing smart devices in a federated network:

> Next generation smart cards, so-called smart devices, are regarded as personal devices providing a secured execution and storage environment for the application of tasks and sensitive privacy information, respectively. Hardware evolution of smart devices enables them to provide capacity to host personal agents, implemented as mobile agents. Mobile agents perform essential tasks such as service negotiation in order to enable automated dynamic service delivery.[22]

This would give users more control over which data is collected and used in future analysis. Though not directly the subject of this thesis, it is worth noting the similarities in the egalitarian and democratic motivations behind this movement toward federated data control structures based on smart devices, and the desire to leverage such structures and devices to highlight issues and promote societal changes.

Finally, and perhaps most importantly, the fundamental programmability of these systems as devices enables the system to leverage the sensors and network to generate content and determine behaviors. For more discussion on Program as it relates to digital systems and New Media, see section 2.4.2. While there are many programmed systems that are not considered "smart," the ability of a human agent, another program, or some feedback element within the system to determine behavior of the system through code is completely essential to the practical realization of a smart device.

1.2.2 Branding and Media Coverage of Smart Devices

Another essential perspective on the meaning of smart devices is the one presented to us, consumers, by companies that develop and sell products that are smart devices or employ features that include them in the smart device category. They exert influence on our impression and understanding of these through traditional advertising, funding academic research and often through

[22] (Noda and Walter)

the devices themselves by way of social media and the internet. In an article for Bloomberg Technology by Mark Gurman and Gerrit de Vynck titled, "Apple, Google and Amazon Want One Language for Smart Devices," the writers discuss the news that these tech giants are collaborating with the Zigbee Alliance to standardize communications between smart devices and thus be made compatible across manufacturers. This presents fairly obvious privacy and security concerns: "Bringing more devices together in a home raises the prospect of personal data being shared with a higher number of companies, some of which may have more lax security or privacy standards."[23] If history is any guide, these companies will act in whatever way they predict will garner their shareholders the largest profits. A spokesman for Apple is quoted in the article saying, "the project is built around 'a shared belief that smart home devices should be secure, reliable, and seamless to use.'"[24] This is a fairly accurate summary of the points of emphasis put on all smart devices by these manufacturers. Realistically, adoption of such a standard for smart devices would expand each company's access to user data through the network of shared sensors and devices providing several benefits to the company: first, data is in itself a commodity that can be sold as is or analyzed and used in the creation of predictive models providing additional revenue; second, data is a potential asset in a supplementary capacity to improve a company's existing products and guide choices in the selection of future ones; third, adoption of an "industry standard" further entrenches smart technology in our language, culture and daily life which is good for long term security of all of these companies.

The reason this discussion seems of particular importance to me is that we are talking about media representations of the mediums themselves. Of course, the representation of products by companies is inherently and intentionally biased; however, these representations do play a significant role in shaping our cultural understanding of the devices themselves as well as the ways in which these devices are interconnected.

[23] ("Apple, Google, Amazon Want One Language for Smart Devices")
[24] ("Apple, Google, Amazon Want One Language for Smart Devices")

1.2.3 Cultural Understanding of Smart Devices

Traditionally Wikipedia is viewed as an unreliable source; however, given that it is dynamically updated and maintained by its users I think it has specific merit in this conversation about the understanding of smart devices. As a user-maintained and open-source encyclopedia it constitutes a common source of information for significant percentage of the internet using population and thus for the purposes of this thesis will be taken as representative of the contemporary "public" understanding of the concept of "smart devices." Importantly, because it is populated by a wide range of users, it is analogous to what "people know" about a given subject. Truth for Wikipedia is determined by the mutually agreeable overlapping of the experiences and acquired knowledge of a majority of contributors. Because Wikipedia is the result of the dynamic interactions between subjective agents who comment, edit and otherwise participate, each with their subjective position (knowledge + status) and predispositions (motivations + bias). In fact, it is the argument of economist and philosopher Aaron Katsenlinboigen that all human cultural systems can be understood in terms of these interactions, whether it be economic systems, government systems, games like chess, or even aesthetic systems. By combining this with Bourdieu's concept of fields and agent as will be discussed in section 2.3.5, we can consider Bourdieu's concept of habitus as analogous to Katsenlinboigen's concept of Predispositioning discussed in section 2.5.1. In these terms Wikipedia as a system where the output, a given article, is governed by the complex interactions over time of individual user's knowledge, motivations and actions that contribute to the content therein. As the user base is fairly representative of the population, and the system is set up to reward (preserve) content that is mutually agreed on and or corroborated, the content is representative of what the userbase or culture agrees to be true or "knows" about a given subject.

It just so happens that this particular Wikipedia entry has a similar definition to the academic one presented earlier: "A smart device is an electronic device, generally connected to other devices or networks via different wireless protocols such as Bluetooth, Zigbee, NFC, Wi-Fi, LiFi, 3G, etc., that can operate to some extent interactively and autonomously."[25] By juxtaposing this definition with the academic definitions, we can see the commonalities between the technical description of a smart device and the broader cultural understanding and implications of smart devices. Specifically, the fact that interactivity and autonomy are presumed in smart devices in both frames of reference.

[25] ("Smart Device")

Wikipedia is one useful way of understanding how we culturally define making something "smart," as it provides a perspective on common knowledge, but the concept of smart as in smart technology has permeated most other cultural fields. One of the many examples of how "smart" is being applied outside the context of technology is in the field of government and environmental policy, the concept of "smart regulation." Neil Gunningham and Darren Sinclair first proposed the concept in a book titled *Smart Regulation* in 1998, and in several subsequent publications:

> The term refers to a form of regulatory pluralism that embraces flexible, imaginative and innovative forms of social control…. For example, it encompasses self-regulation and co-regulation, using commercial interests and non-governmental organizations (NGOs) (such as peak bodies) as regulatory surrogates, together with improving the effectiveness and efficiency of more conventional forms of direct government regulation. The underlying rationale is that, in the majority of circumstances, the use of multiple rather than single policy instruments and a broader range of regulatory actors, will produce better regulation. As such, it envisages the implementation of complementary combinations of instruments and participants tailored to meet the imperatives of specific environmental issues. [26]

What is important here to point out is what it is Sinclair and Gunningham propose that makes this method of regulation a "smart" one. First, flexibility, imagination and innovation, all buzzwords of cutting-edge technology and AI/ML systems. Second, self-regulation and co-regulation combined with optimized direct regulation; essentially degrees of autonomy. Third and finally, the use of complex multi-layered instruments to achieve tailored outcomes that are context dependent. What is key here is that each of these points is representative of a part of what we culturally understand to be the features or qualities that make a process or a tool "smart." Importantly, each of has a subjective understanding of what "smart" actually means. It is my hope that by examining both the aggregate cultural understanding as presented by Wikipedia and the specific example of how the technological concepts have permeated other cultural fields through interaction we can see how the technological features of smart devices have, become abstracted into the cultural reality wherein objects, tools and processes can be "smart" through the mass adoption of products along with the publicity and marketing of the companies that sell them.

[26] (Gunningham and Sinclair)

1.3 The Lifecycle of Smart Devices

"At electric speed all forms are pushed to the limits of their potential"[27]

--Marshall McLuhan

In order to fully ground the conversation about the artistic applications of AI/ML technology through smart devices, it is important to understand the current life cycle of existing smart devices. By understanding the phases of the process, from design and manufacturing, advertising and sales, to purchase, user interaction and feedback via active channels and passive data collection to the end of the device's useful life when it is discarded, we can explore the life cycle of a smart device.

In his article "Exploit the Product Life Cycle" published in the Harvard Business Review in 1965, Theodore Levitt describes methods of commercially leveraging one's understanding of the "product life cycle." According to Levitt successful products have a life cycle of four consecutive stages: development, growth, maturity and decline. The development stage is "when a new product is first brought to market, before there is a proved demand for it, and often before it has been fully proved out technically in all respects."[28] Growth, which follows development, occurs when "demand begins to accelerate and the size of the total market expands rapidly. It might also be called the 'Takeoff Stage.'"[29] This is followed by the third and fourth stage which are, maturity and decline. The former occurs when "demand levels off and grows, for the most part, only at the replacement of new family-formation rate" and the latter when "[t]he product begins to lose consumer appeal and sales drift downward, such as when buggy whips lost out with the advent of automobiles and when silk lost out to nylon."[30] Here I believe we have a usable framework for understanding the life cycle of smart devices. First there is product development, then there is promotion and manufacturing, followed by a maturing phase and then the decline. This applies to individual versions of products like the iPhone 5 vs the iPhone 6, as much as it does to categories of products such as the iPod series, which over the course of several generations fulfilled a similar pattern of design, rise, maturity and decline as a type of product. In addition to providing a solid background of the processes that underlie current smart technology, I feel it is important to raise two related concerns in the hopes of bolstering their place in the general discourse about this technology. First, manufacturers either in

[27] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)
[28] (Levitt)
[29] (Levitt)
[30] (Levitt)

singular like Apple, or collectively with respect to the group of companies participating in a given product, have control of the entire product lifecycle with the exception of government regulations and our individual choice as consumers to purchase it (or not). Second, there is not sufficient incentive for manufacturers and companies to address any non-economic impacts (social, cultural, environmental) that may come as a result of the mass production or use of their products, before that impact is sufficient in size and type that it causes harm.

1.3.1 Implementations of Smart Devices

Here we will explore some typical implementations of smart devices in order to establish a baseline for the kinds of products and services that are currently made possible with this technology, then we will examine some existing artistic applications of AI/ML technology. What is important about the ecosystem of digital media technology is that it requires hardware, software and their interactions and so these works can exist in one or all of these areas of the larger field. For example, a company like Twitter only offers an application as a product to users which is a social media platform that allows people a forum for expression as well as a mechanism to connect and communicate with others globally over specific ideas in the form of hashtags. This user data then in turn becomes a marketing service to advertisers. Facebook on the other hand has expanded beyond this type of software into hardware with their Portal device.

As mentioned previously, the entire field of IoT (internet of things), has developed into real products like fridges, coffee makers and other kitchen appliances as well as other "smart home" technologies. This has now come to include the car as well as the home, with cars becoming increasingly interconnected. Smart devices have become common commercial and industrial tools, scanning barcodes swiping credit cards and allowing for faster information flow within a company. One need only turn on any cable news channel and see the number of iPads or Surfaces in front of the reporters and commentators to get a sense of how deeply embedded smart devices are in our current culture. I wrote part of this thesis on an iPad. It is estimated that there are currently seven

billion devices that can connect to the internet, and the truth is that the vast, vast majority of what exists around us are commercial applications of the technology. For this reason, this paper will examine two applications of AI/ML technology through smart devices. First, Clear View, a commercial facial-recognition application will be presented to provide a real world example of how this technology is challenging and it seems changing fundamental values of society and culture. Then we will examine, AICAN, a creative adversarial network that generates contemporary visual art, as an example of how this technology is interacting with the field of art and art making.

Ahmed Elgammal, director of the Art and Artificial Intelligence Lab at Rutgers University, presented AICAN in 2017, what is described as a creative adversarial network that creates visual art. In the introduction to their paper, "CAN: Creative Adversarial Networks Generating 'Art' by Learning About Styles and Deviating from Style Norms" published at the International Conference on Computational Creativity in 2017, they describe the goal of the AICAN system: "a computational creative system for art generation without involving a human artist in the creative process, but nevertheless involving human creative products in the learning process."[31] Essentially, this describes a digital art making process where rather than relying on the artist's interaction with the system in the process of making, the only input to the system is selection of source data from which the system learns. In order to do this, the creators of AICAN use a generative adversarial network, in which a generator and discriminator work in opposition to propagate an output that if it falls within the bounds of classifications from data in the training set, rewards the system. AICAN however is an alternative to the generative adversarial network or GAN, where rather than working to achieve an output that is within the classifications from the dataset, the system rewards novelty, or doing something not easily classified by the dataset. The output, the art it generates, is abstract but certainly compelling, despite the fact that the paper concludes, "it does not have any semantic understanding of art behind the concept of styles. It does not know anything about subject matter, or explicit models of elements or principle of art. The learning here is based only on exposure to art and concepts of styles."[32] What is perhaps most important to this paper is the fact that regardless of whether or not one likes or dislikes the specific output, the introduction of AI/ML into the production process is its own source of fascination, and in a sense artistic provocation. In other words, these works have a wider focus that in addition to artist and work, now includes the dataset

[31] (Elgammal et al.)
[32] (Elgammal et al.)

and the model. What this means practically is that we can explore how this work relates to the works that were used in training and the choices therein, as well as the algorithmic model as it relates to the nature of creative processes and human decision making. This is just one of many examples of how this technology is expanding into the field of art, and it is the goal of this thesis to explore a framework for structuring analysis of these works and their complex referential meaning.

We now turn to Clearview, a company that offers a facial recognition product to law enforcement and other private security firms, which is at the center of much recent discussion about privacy and policy with respect to AI/ML technology. Clearview AI, a tiny company founded by Australian programmer Hoan Ton-That, recently came into the public spotlight because of a New York Times article raising concerns about their product, titled, "The Secretive Company That Might End Privacy as We Know It." According to Kashmir Hill from the Times, Clearview AI is "a groundbreaking facial recognition app. You take a picture of a person, upload it and get to see public photos of that person, along with links to where those photos appeared."[33] What is unique about the product that Clearview AI is offering is that "[t]he system – whose backbone is a database of more than three billion images that Clearview claims to have scraped from Facebook, YouTube, Venmo and millions of other websites – goes far beyond anything every constructed by the United States government or Silicon Valley giants."[34] This application delivered through smart devices like iPhones and Android phones is currently being used by law enforcement to help with investigations, despite serious concerns about accuracy, privacy and potential abuse of facial recognition systems in general. Amazon has a similar technology they call "Rekognition," which the ACLU found in running their own tests that "the software incorrectly matched 28 members of Congress, identifying them as other people who have been arrested for a crime"[35] In response to recent reporting, major digital media platforms such as Google, YouTube, Venmo and LinkedIn from which Clearview gets its data, issued cease-and-desist letters.[36] There are serious issues that have not adequately been addressed about how and when this kind of technology is used, and Clearview is currently being used by federal state and local law enforcement agencies across the United States.

[33] (Hill)
[34] (Hill)
[35] ("Amazon's Face Recognition Falsely Matched 28 Members of Congress With Mugshots")
[36] (February 5 et al.)

1.3.2 Access: Technology as a Heuristic of Cultural Priorities

Beyond the implications of technology and or its impact, one important question that we should be asking ourselves is what the emergence and existence of these technologies says about our cultural values and priorities? In my research for this thesis I was reminded of a chapter from *Thus Spoke Zarathustra* by Fredrick Nietzsche, titled "On the Thousand and One Goals" in which he describes the complex interaction between symbols technology and culture and how our priorities are reflected in our cultural values:

> Praiseworthy is whatever seems difficult to a people; whatever seems indispensable and difficult is called good; and whatever liberates even out of the deepest need, the rarest, the most difficult—that they call holy. Whatever makes them rule and triumph and shine, to the awe and envy of their neighbors, that is to them the high, the first, the measure, the meaning of all things…Verily, men gave themselves all their good and evil. Verily, they did not take it, they did not find it, nor did it come to them as a voice from heaven. Only man placed values in things to preserve himself—he alone created a meaning for things, a human meaning. Therefore, he calls himself "man," which means: the esteemer. To esteem is to create: hear this, you creators! Esteem is itself is of all esteemed thing the most estimable treasure. Through esteeming alone is there value: and without esteeming, the nut of existence would be hollow…A thousand goals have there been so far, for there have been a thousand peoples. Only the yoke for the thousand necks is still lacking: the one goal is lacking. Humanity still has no goal.[37]

Researchers, engineers, developers and creators of technology are motivated in no small part by issues that are determined urgent by the larger culture. Their choices and the choices of companies and organizations reflect not just their specific priorities, but taken in aggregate, reflect on our priorities as Americans and as human beings. The simple fact that so much of our commerce and our culture has become digital, while according to Pew Research, by 2019 10% of Americans don't use the internet and 27% of Americans don't have home broadband.[38] This is nearly a quarter of Americans who can't fully participate in what is becoming a more and more significant part of our culture and economy. Consider that all scientists agree that we are facing a crisis when it comes to the Earth's climate, and yet we condone by our participation in the field of smart devices, environmentally harmful production processes that are reported to violate basic concepts of human rights. It is not my goal here to make a value judgment about the what is reflected by the state of digital media technology about our cultural priorities, but rather to draw attention to the fact that

[37] (*The Portable Nietzsche (Portable Library): Nietzsche, Friedrich, Kaufmann, Walter: 9780140150629: Amazon.Com: Books*)
[38] (NW et al.)

there is now a dynamic and complex interaction taking place between the ends, the output and resulting impact, and the means, the technology, by which we achieve them. This is to say that the technology itself, through collecting and analyzing a user's data, has direct means of manipulating presentation of future media to and thus influencing the user as determined by the interests of the manufacturer of the device and the applications or services. Assuming we allow this manipulation to take root as our new "values," at best, we get the problematic reduction of "cultural values" interpreted by a largely homogenous group of engineers and MBA's. At worst, we get a manipulation of these systems to the undue profit or benefit of the company or other nefarious actors.

Growing up in New York City, we would all fairly frequently stop on some avenue or street corner, pull out some cash and purchase some street food from a vendor, usually a hot dog, or halal food. Anyone who has eaten food from a street vendor, especially in New York, knows they are running a slightly higher risk of getting food poisoning than if they were to order the same food at a restaurant or make it at home. Despite the obvious risks and indeed because of the convenience, price and whatever it is they put in the yoghurt sauce, New York has a thriving street vendor industry. If one were to eat street food fairly often and then get sick as a result, their response will probably be to simply not go back to that vendor. Importantly, they are probably not going to complain to the vendor, let alone file a report with any regulating agency.

Now imagine that person gets a promotion and starts frequenting a licensed restaurant, only to discover that often when they eat there, they get food poisoning. That person is likely going to do two things: complain to the restaurant online or in person and report the place to the appropriate regulating agency. On top of that, this unlucky individual might spend the next few weeks cooking for themselves at home for fear of getting sick again. How does this relate to our conversation about cultural priorities in technology? Well in a sense we as users of smart devices are like patrons sitting in a restaurant. We chose to be there, but we have no control of the environment or the experience with the exception of those choices offered to us. Users are presented with menus from which they can choose different options (in this analogy food items), but they do not directly interact with any of the preparation that goes on in the kitchen, nor can they even see the process. Korean BBQ would be the exception that proves the rule. In the vast majority of cases the patron simply waits for the output to be presented to them for consumption. When the output is not to the patron's liking or not what was asked for, they report it to waitstaff and then back to the kitchen and often a new correct version is produced but this is at the discretion of the management.

It is in this sense that much of smart device technology is effectively a black box, where the process itself by which inputs become outputs is hidden from the user, much like in a restaurant kitchen. If we complete the analogy, our universe with respect to smart devices is one where for most people, without prohibitive education and training, the only place to get food is from restaurants. Further, that in this universe there is no strong and effective agency that has the power or responsibility of enforcing food safety regulations, so we must mostly take restaurants at their word that the kitchens are clean, food is fresh, and people are washing their hands. Another important point here is that smart devices are not-nor are they analogous to- kitchen appliances. They are the whole kitchen and waitstaff. Smart devices are embedded with autonomy; a platform for applications that give us access to information, sensors and other digital analytical and creative tools. Let's not forget that they are also a data product that users provide back to the manufacturers.

It might seem a stretch to compare the information and tools to which smart devices give us access and food, which is biologically necessary and a real pressing need in the world. I would argue that while having food is essential to human life, or survival, having access to information and tools is essential to human progress, or happiness. In the information age, those tools have taken on a digital form. It is clear through a basic juxtaposition of the users' interaction with the field media technology and with that of food and food services we can see a definite lack in the former in terms of democratized access to the skills, tools and underlying ingredients. Consider our unlucky person above who after his ordeal with the restaurants chose to go home and cook, and imagine he has no experience cooking. By watching videos, driving to a grocery store where they buy ingredients and a pan, and using some basic algebra to get the right proportions, they successfully make themselves food. Now consider these basic questions that arise when we apply the analogy in the context of smart devices given that this person has decided to leave the restaurant, i.e. Apple, Google, Facebook etc.:

> *Where do they go to get the recipe to make their own device?*
>
> The vast majority of this information is protected by companies as a part of their patents, or as trade secrets. They would need to use open source models and technologies or develop their own from scratch.

> *Where would they go to get ingredients?*
>
> RadioShack is no more. Through the internet, it is possible to get most electronics and software development tools, but certainly not with the physical immediacy of our grocery store infrastructure. Furthermore, at a grocery store, there is someone who you can ask for help finding a specific ingredient.

Where would they learn the necessary skills to understand and execute the recipe?

While it may be possible for people to teach themselves either through books, videos etc. the vast majority of Americans, myself included, have neither the aptitude or the persistence to teach themselves something of this breadth and complexity. After all, designing and producing a smart device requires software, hardware, fabrication etc. that each have their own mathematics, tools, methods and best practices.

Where would they find a kitchen to execute the recipe?

One could enroll in an apprenticeship or university program and get a degree in software/electrical engineering or some other degree in order to get access to the fabrication and manufacturing tools, or simply hire the necessary professionals.

The answer to all of these questions points to the fact that there are significant barriers to understanding and implementing information and media technology; academic, material and legal. Ironically it is through the platforms of digital media and smart devices that one might easily and quickly learn to cook. Due however to the complex and multi-disciplinary nature of the field of digital media and smart devices specifically the prerequisite knowledge tools and materials, it is much more challenging for the average person to engage with when compared to the other fields with which this technology interacts, like cooking. Companies that pioneer open source education in these areas like Arduino, the Processing Foundation and SparkFun serve as a reminder that lack of access has never been one of our cultural values, yet it is what is being reflected in these commercial systems in which we participate and have come to accept. In my piece "To Tip the Scales of Justice," each gilded head pictured in Figure 1-1 is representative of a specific cultural perspective or interpretation of the subject: Justice. The heads collectively are also representative of our position as consumers within the power structure of digital media technology and culture. It is my hope that artistic applications of "smart" technology will provoke thought and discourse about how barriers to access are erected to benefit companies and shareholders, to the detriment of the users and the potential for human development.

Figure 1-3 "To Tip The Scales of Justice" @ CalArts WaveCave 2019. Syrofoam Heads Represent Users Place Within Digital Media Systems

1.3.3 Sustainability

In order to contextualize the discussion of smart devices, it is important to explore not just the specific systems of production but also the collective impact of these devices at scale. Or, in the spirit of the fourth prong of McLuhan's Tetrad: "When pushed to the limits of its potential (another complimentary action), the new form will tend to reverse what had been its original characteristics. What is the reversal potential of the new form?"[39] One example of this is that cars as a technology give us the freedom to travel; however, when taken at scale, there are so many cars that the traffic on the roads prevents us from effectively traveling, reversing this characteristic of true freedom to one

[39] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)

of being stuck in the "flow" of traffic. In McLuhan's own words, "[t]he reversal aspect of the tetrad is succinctly exemplified in a maxim from information theory: data overload equals pattern recognition."[40] This resulting pattern, according to McLuhan, is a reversal or subversion of the initial output. Consider this in relation to the idea of sustainability, which is traditionally used to refer to the environmental impact of a product or a production process. Being sustainable, in the modern economy, means that at scale, the process of making has little to no negative impact on our environment and thus is a viable method for the long term. In this same way as individual technologies, McLuhan's idea of reversal can be applied to manufacturing and digital media processes; functions and characteristics can become reversed whenever there is the mass production and adoption of technology. I believe that sustainability is an important goal not only with respect to the production processes but also the culture of smart devices, in that we must cultivate cultural tools and methods that minimize harm and maximize access to the digital world. Especially considering current surveillance applications overseas and the future potential applications of AI/ML here in the United States, I believe we are in need of far more publicly available and understandable information in order to educate the population and have a productive discourse about what a sustainable future with "Big Data" might actually look like.

In his book *Secondhand: Travels in the New Global Garage Sale*, Adam Minter describes through his firsthand experiences traveling around the world, the state of the global market for reusing items and materials. One major industry that he discusses is the cloth rag industry, rags that are made from discarded clothing. What is important is that this clothing, initially made from very absorbent cotton, is now blended or made entirely of polyester which is not as absorbent. In the era of fast fashion, cheap trendy clothing that is available from national and international clothing brands like H&M and Zara, much more polyester is being used in the manufacturing process because it lowers the cost of the clothing. This has caused rag manufacturers who are unable to use the non-absorbent high-polyester discarded clothing to change their process to one that uses farmed cotton to make the rags. Consequently, these rags are much more expensive for factories, bars, restaurants and car mechanics that need to wipe things. Thus, Minter concludes, "it's a quirk of the global economy that the most direct beneficiaries of the rise of fast fashion might be paper towel manufacturers."[41] Encouraging paper towel use is obviously an environmentally problematic development, not to

[40] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)
[41] (*Amazon.Com: Secondhand: Travels in the New Global Garage Sale (9781635570106): Minter, Adam: Books*)

mention the fact that "the environmental impact of that new rag is steep compared to that of a reclaimed one (growing cotton is highly intensive)."[42] Given the context of looming climate disaster, it would seem that this constitutes a predictable failure of our economic system to incentivize anything besides the short and medium-term profits of the company. It is worth mentioning that in the long term according to science, if we do nothing and the climate changes enough, there will be no profits because we will all be dead. These same economic forces act across all types of manufacturing and thus relate directly to the waste and reuse cycle of electronic devices. As the customization and miniaturization of electronics continues to increase, we will face similar diminishing returns on the reuse of these devices. It seems to me that in many cases their use in art-making is possibly one of the only applications of discarded smart devices and electronics more generally.

One good example of this kind of application of discarded technology is Cildo Meireles's 2001 sculptural installation, "Babel," currently on exhibition at the Tate Modern in London, UK. According to Tanya Barson at the Tate, "Babel" is described as "a circular tower made from hundreds of second-hand radios that the artist has stacked in layers. The radios are tuned to a multitude of different stations and are adjusted to the minimum volume at which they are audible." [43] The title, "Babel," connects the resulting incoherence from the myriad sound sources to the concept of the Tower of Babel from "the biblical story of a tower tall enough to reach the heavens, which, offending God, caused him to make the builders speak in different tongues. Their inability to communicate with one another caused them to become divided and scatter across the earth and moreover, became the source of all mankind's conflicts"[44] In a very literal sense, following with McLuhan's assertion that the medium of discarded technology is the message, but also, the message is related both to the specific radio technology and to the impact of communication technology when applied at scale. Here I would argue that Meireles, in addition to presenting a commentary on the cumulative effects of technology on comprehension, is extending the useful life of the technology itself and therefore the constituent materials beyond the bounds of functionality and economic value, by reclaiming discarded technology and using it as a medium of artistic expression.

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[42] (*Amazon.Com: Secondhand: Travels in the New Global Garage Sale (9781635570106): Minter, Adam: Books*)
[43] (Tate)
[44] (Tate)

At the iConference proceedings in 2015, researchers from CUNY-Brooklyn, the University of Puerto Rico-Mayaguez, Vanderbilt and UNC-Chapel Hill presented a study titled "iGo Green: A Life Cycle Assessment of Apple's iPhone." This study determined that "Apple's design of the iPhone used a strategy of planned obsolescence, resulting in a shorter life cycle, increased mining of rare earth minerals(REMs), higher rates of product turnover, and higher shipping costs and fuel."[45] Further, they conclude that "[s]urveyd iPhone users were largely unaware of Apple's iPhone recycling program."[46] Essentially, they contend that Apple is actively and intentionally shortening the lifespan of their products below the useful life of the materials in order to increase sales and thereby profits. This planned obsolescence occurs as a result of active design choices, where for example, products are specially built with customized fasteners and are warrantied such that they cannot be repaired by the user or are designed with parts that are either not replaceable or can cause damage at the end of their useful life (batteries). In addition to these active efforts, the now common practice of forwards compatibility, where old devices are updated to include newly introduced software features, also causes obsolescence.[47] With each generation of hardware, the operating system and specific applications are optimized for the capabilities and features of that newest model or series of products. The software is then optimized periodically based on usage data and user feedback and updated with priority given to the newest model. In addition to incentivizing the purchase of the new model with new features and apps, the integration of new features and apps into previous models eventually puts enough strain on the power and memory resources of older versions of the device that it effectively diminishes their usefulness.

This is the crux of what is known as "planned obsolescence" and represents what I believe to be one of many symptoms of a culture that has become subordinate to the commercial interests of media technology. In addition, the technology itself creates a buy-in for what has become a significant and ever-increasing part of social and cultural participation. While the digital world is not real, a lack of access to it can have very real ramifications on a person's ability to educate themselves and contribute culturally and socially, not to mention compete economically. This is a system whose primary user base is the youngest part of the population, and yet it is that same part of the population whose economic reality is the least in their control. This is all to say that unlike a university, a company or some other "merit" based system, there is still a fixed monetary barrier to

[45] (Rodriguez et al.)
[46] (Rodriguez et al.)
[47] (Rodriguez et al.)

entry to all media technology in the form of hardware and software platforms. This is as true of EDM and Hip-Hop production and DJ'ing as it is of social media, in that often those with access to better production tools or who can afford to pay for promotions enjoy a large share of the visibility and cultural cache. We should consider what kind of culture we will have in the future if we allow a pure profit motive to be the only real driver of evolution of the system. Technology inevitably has an impact on our culture and our society, but it is up to us, especially creators, to reassert cultural and social priorities back onto our technological processes, especially in terms of reorienting development and manufacturing processes towards the goals of sustainability and access.

1.4 Cultural Impact and the Obfuscation of Value

In order to complete the discussion about smart devices, we need to examine how the intentions and motivations of those who create and commercialize these products and services manifest phenomenologically in the products and culture more generally. As previously discussed, the motivations are fairly straightforward: companies seek profit. To that end, they seek to minimize costs in terms of both material and labor. In other applications, such as research in healthcare or other sciences, these motivations may be more complex; however in the case of smart devices and the application ecosystem this profit motive is abstracted one step further by the logic that the simple act of engaging with a device or service is reducible to potential profit. This is through the prerequisite and future purchasing of the device, the connection (from the ISP) as well as future advertising and sale of complimentary services and products. Further, operationalizing this logic, feedback systems have been designed into the platforms and devices to track and record "usage" data, completing the shift in motivation from one of pure profit to one of engagement as a harbinger of profit. By tracking the changes and patterns in this data over time, the entire apparatus of predictive computer modeling and based on "Big Data" came into existence and is disrupting traditional approaches to marketing, sports, politics, manufacturing and culture more generally. To

recap, what we have in the field of smart devices is a shift of motivations from one where profit is valued most highly to one where profit by proxy is measured in real-time in the form of clicks, likes and general engagement. This has not eschewed traditional forms of economic analysis on the part of the developers and manufacturers, but it has allowed the field of smart devices to become entangled with all these other cultural fields in a way that I would argue has undermined our collective understanding of what "value" actually means. This new transition into the Information Age, where data itself is accessible and has been ascribed monetary value, is complicating our understanding of our role in establishing the value of the people and things around us.

As an individual consumer in a massive capitalist system, it is hard to imagine one's relationship to the establishment of the price of say a Snickers Bar. Conceptually people may understand that through the laws of supply and demand and the cost of manufacturing etc. a price is established, but realistically my choice whether to buy a Snickers Bar or not is not specifically going to affect any measurable change in the system that is apparent to me as a consumer. In aggregate, consumers choices determine market value, however the magnitude of the impact of any one choice is thus entirely indeterministic to us as consumers. In the field of smart devices, the reality is that through active feedback channels and through the persistent collection of usage data, the individual user's choice does actually have a measurable specific impact on the system. If we could get Facebook to reveal their secret algorithms, we could actually see how much the engineers decided to value liking or disliking a given post. This conflation of the idea of value as the price of something and value as the popularity of something is occurring and is a very real question that faces us as a society in terms of our future and the future of media technology.

1.4.1 Economic Value

It is not my goal here to examine the entirety of how the market value of companies and price of products and services is established, but rather to give a brief summary of this process in order to shed light on how the underlying logic has evolved in the age of information and Big Data. According to the Cambridge dictionary, economic value is "the value of an asset calculated

according to its ability to produce income in the future"[48] What is important here is that value is derived from predictions of future events and the degree of certainty in those events. Thus, an asset that is highly predictable is generally more valuable economically than one that is highly unpredictable. By determining the intersection between how much of that asset is available and how many people are willing to buy it at a given time and will want it in the future, a price is determined.

Price and value are importantly not equivalent: the entire business of trading financial instruments like stocks, options and bonds relies on the premise that savvy or better-informed traders can exploit differences between price and value, buying low and selling high, once the value is realized. Similarly, great loss and even economic crisis can occur when the price grows much greater than the value and this is then realized by a crash in the market. I will define price as a snapshot of value through an economic lens at a given moment in time from the perspective of the seller. I will define economic value as what is fixed economically about the company or product and will be determined persistently by interactions between the company, the product and the consumers as well as the culture generally.

Now how does this relate to smart devices? Well what is fundamentally different as a result of the technology itself is that consumers become users. What this means is that smart devices create a connection directly from the individual user-device back to the datasets being used as a basis for making inferences and propagating the system. It is a process of companies collecting data about user's behavior both within the applications on the device and through sensors in the real world and using this behavior in aggregate as the basis for models to make determinations about what content to show the user. The effective result of this system is that this feedback becomes the primary mechanism for future decision-making because it gives us "real" data about users. One problem, in addition to those discussed previously, is that by doing this we are missing the forest for the trees. These engagement-based models are in large part not systems that can qualitatively understand the difference between an impulsive reaction to something and a thoughtful response. In economic terms, the surveillance style system of Big Data is mostly clicks and likes which is ordinal data (positive or negative), and is rarely cardinal data (direction and degree). Therefore, it is not the kind of qualitative data that would reflect a holistic consideration of users' experience, context or intention. This yet another problem with relying so heavily on passive persistent data collection as a basis for predictive models.

[48] (*ECONOMIC VALUE | Definition in the Cambridge English Dictionary*)

So, it is important to ask, from who or what does the field of smart devices derive its economic value? The answer to that question is, in addition to the specific media features, that it gives us the ability to connect with other users in a way that was previously unimaginable. All of the products and services that leverage "Big Data" derive their value ultimately from the data that is created by and collected from users then subsequently from models or algorithms based on that data. By engaging with these devices and platforms, we are both consumer and product at the same time. The value is in large part derived from our willingness to participate in surveillance and then reap the benefits of the models that are based upon it.

One important note here I would like to make is that the degree that this is a problem is determined by the application of the system as much as it is by the system itself. There are applications like auto correct, where over time the system learns your preferences and writing habits, and this is in large part harmless and useful. It is when these systems are tasked with more complex and consequential problems that one can foresee complex and unpredictable problems arising. What we as a society probably should have anticipated but did not was that user behavior in aggregate is also what we commonly would refer to as culture. As the companies recorded and analyzed our existing culture, a new culture of Big Data, Silicon Valley and smart devices developed based on optimizing and capitalizing on this analysis made possible by the products and services. This culture is based on the logic that value is determined by how much a product or service is being used, its popularity. Digital media technology has since become entangled with all parts of our economic lives including currency itself and has become an indispensable mechanism through which a significant percentage of the worlds communication and commerce takes place. As was discussed previously, what began in tech startups in Silicon Valley has led to a global shift in how people approach economic, social, cultural and political relationships and interactions.

1.4.2 Cultural Value

"The work of art is an object which exists as such only by virtue of the (collective) belief which knows and acknowledges it as a work of art."[49]

– Pierre Bourdieu

In a similar sense to economic value, cultural value can be defined simplistically as the benefit culturally that one might derive from something. How that value is derived and to what degree is a much more complex proposition. In order to explore cultural value, I will be employing the work of Pierre Bourdieu, a French writer and philosopher who rose to public prominence in the 1990's for his work in sociology. Specifically, his ideas of cultural and social capital as an extension of the traditional concept of capital, as well as the interactions between what he calls the field and the agent. Bourdieu considers the question of cultural value as chiefly one of legitimacy. Artists, publishers, collectors and academics all accrue cultural and social capital in the form of degrees and awards and critical acclaim, and thereby establish their legitimacy in the field. Further that in the field of art, often subversion of the established norms, such as in the Avant Garde, is considered its own form of cultural capital. We must begin with an understanding of the concept of cultural fields as presented by Bourdieu and further discussed in section 2.3.5. They are constituted of agents or individuals who have a relative position and what he calls position-takings:

> The task is that of constructing the space of positions and the space of position-takings in which they are expressed… a form of *analysis situs* which establishes that each position…is subjectively defined by the system of distinctive properties by which it can be situated relative to the other positions; that every position, even the dominant one, depends for its very existence, and for the determinations it imposes on its occupants, on the other positions constituting the field; and that the structure of the field, i.e. of the space of positions is nothing other than the structure of the distribution of the capital of specific properties which governs success in the field and the winning of the external or specific profits… which are at stake in the field.[50]

So the field is a summation of all the subjective positions and their interactions and in some sense is therefore objective. Bourdieu elaborates on the ideas of position and position taking in the cultural

[49] (*Amazon.Com: The Field of Cultural Production (0884417770233): Bourdieu, Pierre, Johnson, Randal: Books*)
[50] (*Amazon.Com: The Field of Cultural Production (0884417770233): Bourdieu, Pierre, Johnson, Randal: Books*)

context by describing habitus and doxa. Bourdieu describes the doxa as "the unproblematic, taken for-granted worlds of the dominant groups."[51] One might think of it simply as the pre-existing knowledge or understanding that an agent or field has entering into an interaction. Bourdieu defines habitus, "as systems of dispositions, [which] are effectively realized only in relation to a determinate structure of positions socially marked by the social properties of their occupants, through which they manifest themselves."[52] In other words, habitus is the summation of all the complex individual and interconnected motivations, impulses and desires of a given agent. What is perhaps most important about Bourdieu's concepts of the field and agent is that the agents and their dispositions constitute the field at the same time that its structure and properties shape the behavior of the agents:

> All relations among agents and institutions of diffusion or consecration are mediated by the field's structure. To the extent that the ever-ambiguous marks of recognition owe their specific form to the objective relations (perceived and interpreted as they are in accordance with the unconscious schemes of the habitus) they contribute to form the *subjective* representation which agents have of the *social* representation of their position within the hierarchy of consecrations. And This semi-conscious representation itself constitutes one of the mediations through which, by reference to the social representation of possible, probable or impossible position-takings, the system of relatively unconscious strategies of the occupants of a given class of positions is define.[53]

Now that we've defined the field and the agents within it, how then do we derive cultural value? Based on this field-agent, theory, we derive cultural value from the interactions with other agents, and the degree to which those interactions affirm our habitus and reinforce or subvert the larger existing structures in the field. Generally speaking, we receive affirmation and thus cultural status or value through the attention we receive from others, especially when those interactions reinforce cultural and social norms. According to Bourdieu, this can be in the form of honors, academic degrees, letters of recommendation, reviews by critics, social media following, or in the "style" or quality of the products and services that we use. Bourdieu's assessment is that all of these things confer cultural value and thus constitute cultural capital.

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[51] (*Amazon.Com: The Field of Cultural Production (0884417770233): Bourdieu, Pierre, Johnson, Randal: Books*)
[52] (*Amazon.Com: The Field of Cultural Production (0884417770233): Bourdieu, Pierre, Johnson, Randal: Books*)
[53] (*Amazon.Com: The Field of Cultural Production (0884417770233): Bourdieu, Pierre, Johnson, Randal: Books*)

As technology has made it possible to monetize the recording of past human behavior, the fields of economics, technology and culture become entangled in new and potentially problematic ways. It is through this understanding of how we establish cultural value in terms of legitimacy, that we can compare it to the engagement and popularity driven systems that currently constitute the field of smart devices. Does the fact that something is popular, or that most people use something mean that it has legitimacy and in turn cultural value? Yes, probably. Does that mean that popularity or ubiquity is reducible to legitimacy? Not really, I would argue that popularity is just one of many ways that our culture determines legitimacy. In fact, it is a frequent feature of whole artistic fields to value above all else efforts to undermine existing methods of current conceptions and methods of determining of legitimacy. What is most important to this discussion is that in the field of smart devices, the commercially driven reduction of cultural value through data collection and inference begs the question, what is lost? This is essentially a flattening of understanding of cultural capital so it can be conferred through the given medium. Because companies can profitably trade on cultural value as determined by likes and clicks, there is no reason to temper their confidence in their relationship to cultural value. This confidence, borne out of the economic potential of the technology, in turn confers legitimacy to the product which then establishes cultural value. Companies can also tailor the medium to increase usage, therefore legitimacy which is subsequently capitalized.

1.4.3 Conflicts of Interest

Through through examination of the current state of these systems it is clear that there is an inherent conflict of interest between the products as platforms for expression and communication thus establishing cultural value and the economic value companies derive thereby. The complex and unpredictable motivations and actions of individuals and companies may become the dominant force in the progression and propagation of our culture. Our way of seeing the world will become dependent on the quality and accuracy of information that we receive from corporations who have a

strong financial incentive to lie and manipulate, all with little to no risk. One can understand that all businesses have a financial incentive to prevent regulation by the government but given the dramatic impact that potential misuse of this technology can have in eroding the public trust, it would seem that this field is most in need of it. This is specifically because they can continuously curate multimedia content and experiences through their products, at the same time receiving multimodal feedback in the form of behavioral data points from those same products. The speed of this interaction combined with the mass adoption of these devices, makes their collective impact on culture and society more and more substantial. It has been shown that the profit motivated systems lead to unexpected outcomes caused by emergent feedback loops and filter bubbles that have a lasting negative impact on the entire society, causing confusion division and mistrust. In other words, allowing a company to substitute its profit motivated logic for your own as the sole arbiter of what kinds information you consume is an extremely problematic approach to consuming information and taken generally is aligned with or related to in any way a consideration of the public interest. In his book, *Beyond the Valley: How Innovators around the World Are Overcoming Inequality and Creating the Technologies of Tomorrow*, Ramesh Srinivasan outlines what he sees as a new cultural approach to information technology, but he begins by describing the current state of the technology industry: "What we have in the digital world are privately owned public spaces. They are branded as public, civic and virtuous but in reality, are dominated by the single logic— extending profitability and economic value."[54] In fact, I would argue that it is indeed thoroughly undemocratic; we should be empowering individuals to form their opinions based on as unmotivated a set of facts as possible. While it may not be possible to remove all bias from a system, it is certainly necessary to make the effort, especially while we are passively accepting this very identifiable and impactful profit motive underlying the current systems. To this effect Srinivasan writes,

> shareholder trade is what ultimately matters for commercial valuation, because those creating the technologies that reach the hands of billions are members of private corporations. Meanwhile we, the users, the ones whose data and attention run through the pipes to fuel this entire endeavor, are reduced to just that: a passive resource to be burned through, with no meaningful voice, value, or vision of our own to contribute as equal citizens.[55]

[54] (*Beyond the Valley: How Innovators around the World Are Overcoming Inequality and Creating the Technologies of Tomorrow (The MIT Press): Srinivasan, Ramesh, Rushkoff, Douglas: 9780262043137: Amazon.Com: Books*)
[55] (*Beyond the Valley: How Innovators around the World Are Overcoming Inequality and Creating the Technologies of Tomorrow (The MIT Press): Srinivasan, Ramesh, Rushkoff, Douglas: 9780262043137: Amazon.Com: Books*)

It seems there is no limiting factor on the feedback in the system between the devices implemented at scale and the culture that consumes and propagates them. Any company who is expected to self-regulate or self-police in order to protect the public good can be accused of a profound conflict of interest, in that their selfish profit motives will always outweigh the public interest. Simply put, we cannot and should not accept this as the status quo or expect any legitimate effort or protection; it is simply naïve and unrealistic to take companies at their word given this conflict of interest.

1.4.4 Hyper-Reality

"In the West, electronic technology displaces visual space and retrieves acoustic space in a new form, as the ground now includes the detritus of the alphabetic civilization"[56]

- Marshall McLuhan

Now that we've established what a smart device is and discussed its complex nature and relationship with culture, we can now address how we might come to understand and describe its cultural impact. There are of course many different theories as to the long-term impact of this technology, but without a doubt we can establish a few basic ways in which smart devices have already impacted our lives and our culture:

1. The ubiquity of these devices and use of these services
2. The speed and quantity of communications and commerce
3. Increasing access to knowledge, tools as well as political and artistic expression
4. The rise of social media with its distinct sub-cultures and its immense economic and cultural value

[56] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)

Now these are just some of the observable effects of mass-adoption of this technology, and rather than make an exhaustive list, I will point to the general concept of hyperreality as presented by French writer and philosopher Jean Baudrillard in *Simulacra and Simulation,* to encapsulate the cumulative effects of existing applications of digital media systems:

> We are witnessing the end of perspectival and panoptic space… The medium itself is no longer identifiable as such, and the confusion of the medium and the message (McLuhan) is the first great formula of this new era. There is no longer a medium in the literal sense: it is now intangible, diffused, and diffracted in the real, and one can no longer even say the medium is altered by it. Such a blending, such a viral, endemic, chronic, alarming presence of the medium, without the possibility of isolating the effects—spectralized…One must think instead of the media as if they were, in outer orbit, a kind of genetic code that directs the mutation of the real in to the hyperreal, just as the other micromolecular code controls the passage from a representative sphere of meaning to the genetic one of the programmed signal.[57]

This transduction from our complex choices and motivations, what he calls the representative sphere of meaning, into data points that can be processed by algorithms, this normalization, is the process of simulation by which we transition from the real into the hyperreal. What does seem clear is that there are lasting effects of what he describes as the confusion between the medium and the message. He writes that this confusion is

> …a corollary of that between the sender and the receiver, thus sealing the disappearance of all dual polar structures that formed the discursive organization of language, of all determined articulation of meaning…That discourse "circulates" is to be taken literally that is, it no longer goes from one point to another, but it traverses a cycle that without distinction includes the positions of transmitter and receiver, now unlocatable as such. Thus there is no instance of power, no instance of transmission—power is something that circulates and whose source can no longer be located, a cycle in which the positions of the dominator and the dominated are exchanged in an endless reversion that is also the end of power in its classical definition.[58]

To Baudrillard, there is one inescapable outcome of this "vast saturation of a system by its own forces, now neutralized, unusable, unintelligible, nonexplosive" which is "the possibility of *an explosion towards the center*, of an *implosion* where all these energies would be abolished in a catastrophic

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[57] (*Amazon.Com: Simulacra and Simulation (The Body, In Theory: Histories of Cultural Materialism) (9780472065219): Jean Baudrillard, Sheila Faria Glaser: Books*)

[58] (*Amazon.Com: Simulacra and Simulation (The Body, In Theory: Histories of Cultural Materialism) (9780472065219): Jean Baudrillard, Sheila Faria Glaser: Books*)

process"[59] and perhaps he's right. Who really knows what the long term impact of will be of far too many hours spent in front of screens working on projects like Bassthoven as pictured in Figure 1-4?

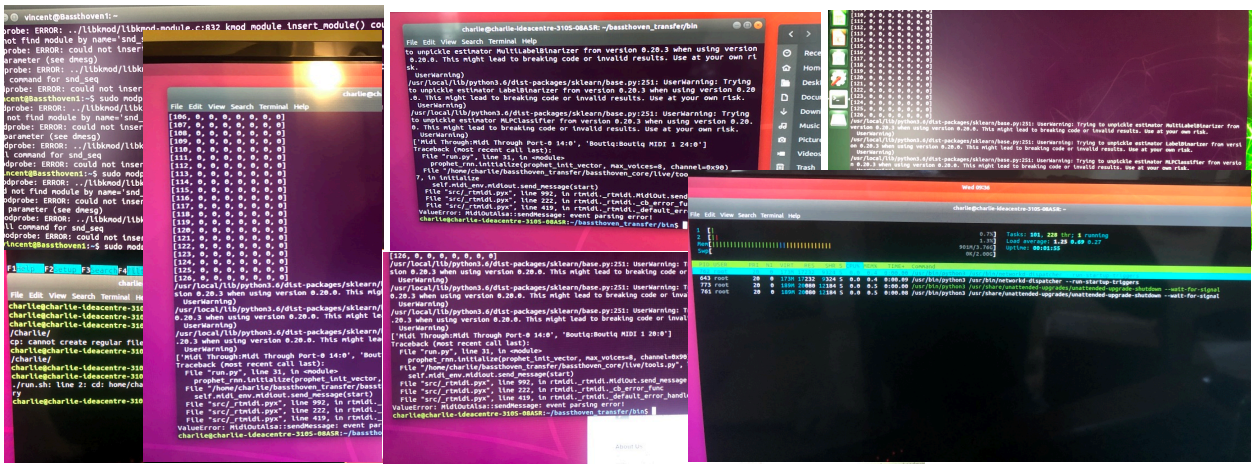

Figure 1-4 Installing Bassthoven on a Cheap Desktop, A Study of Life on Screens

Now it is important to remember that this was published in 1983, and even then, the effects of mass media consumption were visible, at least to Baudrillard. One might argue that smart devices and the application ecosystem that currently exists represents a further evolution towards a complete circularization of information, and thus a lack of distinct positions. for example, our relationship to the companies that produce smart devices, is one where we are simultaneously customers as users and products as sources of data. Baudrillard continues,

> The circularization of power, of knowledge, of discourse puts an end to any localization of instances and poles. In the psychoanalytic interpretation itself, the 'power' of the interpreter does not come from any outside instance but from the interpreted himself. This changes everything, because one can always ask of the traditional holders of power where they get their power from. Who made you duke? The king. Who made you king? God. Only God no longer answers. But to the question: who made you a psychoanalyst? The analyst can well reply: You...[60]

It seems that Baudrillard's point is that this process of circularizing the way we consecrate meaning undermines the very premise of meaning, in that we have no reference point from which to draw observations, only the continuous circular flow of information and meaning, from which nothing

[59] (*Amazon.Com: Simulacra and Simulation (The Body, In Theory: Histories of Cultural Materialism) (9780472065219): Jean Baudrillard, Sheila Faria Glaser: Books*)
[60] (*Amazon.Com: Simulacra and Simulation (The Body, In Theory: Histories of Cultural Materialism) (9780472065219): Jean Baudrillard, Sheila Faria Glaser: Books*)

can be effectively observed. All that is left is what is not rendered moot by circular discourse and is itself a source of power:

> This simulacrum of the inversion or the involution of poles, this clever subterfuge, which is the secret of the whole discourse of manipulation and thus, today, in every domain, the secret of any new power in the erasure of the scene of power, in the assumption of all words from which has resulted this fantastic silent majority characteristic of our time.[61]

I believe in this sense that it is this shift into hyper-reality and its manifestations that is the net result of the mass adoption of smart devices, where what remains as "culturally valuable" is reflective mostly of specific values or business incentives related to the production and development of a medium without any tangible benefit to the public and therefore cultural value becomes effectively meaningless. What then can be done about it? I think the first step towards dealing with our new hyperreality is making sure that people are aware of it, that most of what we engage with, everything digital is simulation rather than "real." Just as importantly, the digital universe is *not* "imaginary," and through smart devices and other networked technology has a tangible and increasing impact on our culture and our values. Ultimately it us up to us to determine the nature and degree of that impact as we are the users, the consumers for whose benefit these devices are made "smart" in the first place. It is my hope through the categorization of the genre of smArt to promote the exploration of these issues by focusing on self-governance and degrees of autonomy and how that complicates art making and aesthetic analysis. By framing art works in the context of the relation between the behavior of the system, the data on which the system is predicated and the eventual use-case, I hope to provide a foundation for dialogue surrounding the current and future impact of autonomous and semi-autonomous systems and devices.

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[61] (*Amazon.Com: Simulacra and Simulation (The Body, In Theory: Histories of Cultural Materialism) (9780472065219): Jean Baudrillard, Sheila Faria Glaser: Books*)

Chapter 2

smArt + the smArt Framework

At the outset, I will reiterate that the genre of smArt refers to the category of art that leverages "smart" systems which express agency in the artistic process relative to their degree of autonomy and influence the works themselves in complex and indeterministic ways. The smArt Framework is an application of philosophical, sociological and aesthetic concepts and ideas that is designed for critical examination of those interactions between the artist and system to facilitate a more productive aesthetic and cultural evaluation and experience of smArt works. This Chapter is devoted to defining the genre of smArt by outlining the various underlying concepts that are used in the three phases of the smArt Framework.

To date, my work has fallen in to one of three categories: devices and instruments that are designed around increasing access to electronic music making; interactive installation pieces and sound making objects that feature dynamic systems that employ information loops; and finally, with Ben Brodie as the duo "Van Broh," narrative operatic works and technology that engages directly with the effects of emerging technology on culture and society. As media technology has developed, all sides have converged at the nexus of AI/ML technology and the hardware and software we use to interact with and create the sensory data points that drive these models. This technology is changing the way we make art as much as it is changing our culture and I feel there is a critical lack of common understanding among the general public given the complexity and diverse nature of the field to properly engage with the full potential of the technology. In other words, if people don't understand the nature of the model and the way the data is collected, or that that is even relevant, how can we expect them to understand its role in creating the work. If however, we provide them with a means by which to relate the underlying function of the systems that are being employed to the complex range of references that constitute "Big Data" and the desired output or application of the system, we open a new super-

perspective onto a range of behaviors in the past and can begin a productive and necessary dialogue, which implicitly is about our practical understanding and implications of this technology. It is my hope that this framework will benefit artists and audiences in their possible range of expression and understanding as well as generally demystifying the field.

It is the purpose of this paper to outline a framework for artistic/aesthetic analysis of works that leverage or operationalize in some way being "smart," as it relates to smart devices. This is a category that as explained in detail above generally refers to the use of autonomous or semi-autonomous systems within such a device. This includes hardware and software involved in the physical or digital artifact that allows it to interface with the outside world through sensors, lights, speakers and the digital world through the internet as pure information. This also includes the AI/ML systems that make up the backbone of such a system's intelligence. There are many methods and works that will not be covered here and many yet to be discovered and created; however, it is my goal that this framework be general enough to inclusive in its usefulness and or applicability. As can be seen in Figure 2-1, compared to fixed media and new media, artistic applications of AI/ML systems enter into the continuum of autonomy wherein the artist cedes control of specific choices to the AI/ML system. Anytime there is an introduction of an AI/ML system in this way, I argue this constitutes a demi-agent in the making process, thus fundamentally changing the nature of the artistic process and resulting work. In a sense, the demi-agent is like an actor who has specific lines to deliver and staging set by the director, but the freedom to deviate from the exact plan within certain bounds motivated by their own sense of what is artistically appropriate.

This technology gives artists a new range of tools and abilities to engage with as it does software engineers and hedge-fund managers. Unlike in other fields, where the underlying processes are a trade secret, process itself is a significant part of an artistic work and thus the meaning that is embedded in the work that might be conveyed to an audience. It is my hope that implementing this framework will provide a means for understanding the cultural implications of AI/ML processes and methods and how they relate to the artistic "meaning" of a work. Traditionally in aesthetic analysis, the function of a work is not considered as a part of its artistic meaning. A painting for example is not more or less artistic if it hangs in a home or in a museum. Because AI/ML systems are trained with and designed to emulate human behaviors, there is referential meaning in the way that they behave, thus their function can be leveraged artistically, and should be included in an analysis. In summary, contextualizing works within the

genre of smArt through the application of the smArt Framework can supplement existing methods of artistic analysis to include the cultural and artistic implications of "smart" technology used in artistic works.

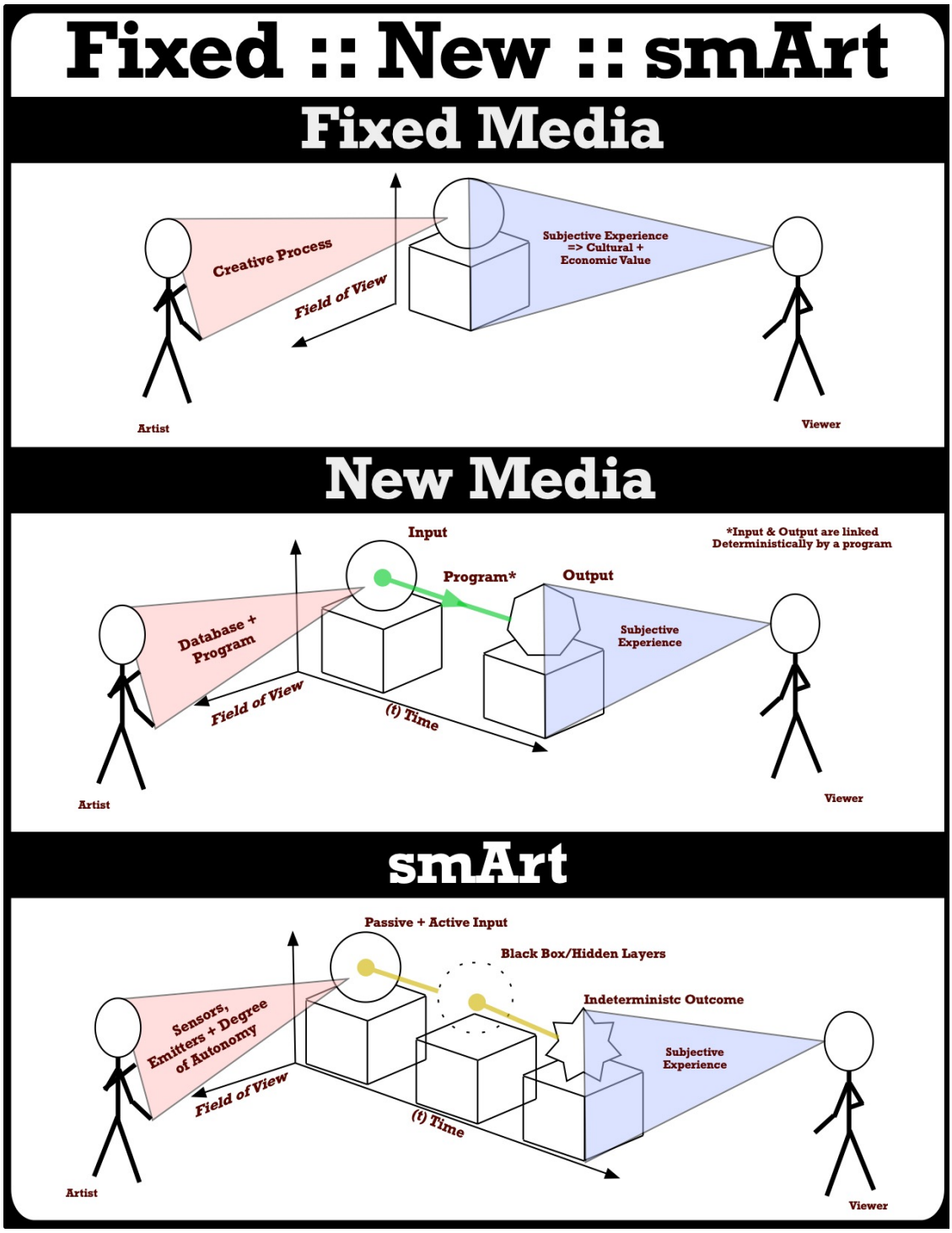

Figure 2-1 Juxtaposition of Fixed Media, New Media & smArt

2.1 How smArt?

As discussed in Chapter 1, in the context of smart devices, "smart" is partly a technical classification and partly a cultural abstraction. Technically, this includes some degree of autonomy, or self-regulation in the behavior of the product as well as the ability to access databases via a network as well as sensors and emitters to interact with the user and the environment. Culturally "smart" refers to leveraging some degree self-regulation or autonomy to improve or optimize the experience of a device or service, bounded by the range of products and services that currently exist in the space. I feel it is important therefore, to consider how one might establish or perhaps measure how "smart" a device actually is.

It is one thing to establish the outer bounds of autonomy, the most basic self-governing feedback systems all the way to complex human consciousness and "free will." In order to actually measure the degree of autonomy, I offer Katsenlinboigen's analysis of the programmatic nature of the human condition. He classifies the overlapping levels of behavior as orders of programming, the complex interaction of which results in our actions:

> First, programs differ in their sources of origination. There are biological programs that are innate, and there are cognitive programs that are acquired by the individual throughout his life. Both types of programs may have different levels, more or less powerful. *Behavioral program* which, according to Herbert Simon, governs the behavior of the system directly will be denoted as a zero-level program. A first-level program is a program that changes the zero-level program, the second-level program is a program which changes the first level program, etc. The mere ability of a first-level program to alter a zero-level program is sufficient to speak of the zero-level program as an indeterministic one…if the hierarchy has at least two levels and if it allows for change-inducing feedback between different levels, the whole picture changes dramatically…. Moreover, assume that zero-level programs may be run either in imagination or in real life. Playing out the possible consequences of one's actions in the mind's eye could be beneficial because the results of this exercise may induce changes in the second-level program that will alter the first-level program… Thus, will and will power may be viewed as the ability of man to carry off his zero-level cognitive program and to change a cognitive program of a given level through changing a higher-level cognitive program. They also involve the ability of man to suppress the desires that produce a conflict between his emotions and his cognitive judgements.[62]

In the context of establishing a heuristic for autonomy that applies across biological and electro-mechanical systems, Katsenlinboigen is defining free will or self-governance as the degree to which something has fluidity and optimization between levels of programming. In a sense it

[62] (Katsenelinboigen)

boils down to the degree to which the combination and interaction of sub-systems can cause the larger system, or vice versa, to change or behave in ways that reverse or go beyond the summation of the sub-systems. Thus, we arrive at a working definition: the degree of autonomy or freedom is measurable as the resulting coherent deviation from expected behavior of a complex system. While degree of autonomy is not *everything* that constitutes the "smart" designation, it is important in considering the relationship between the agency or freedom of a "smart" system to that of the artist with whom it will collaborate in making a smArt work.

2.2 The smArt Framework

At the outset, it should be said that this framework is in development. I have found it useful, but it is far from perfect or complete. I have arrived at this three-phase analysis inspired by the work of Feminist AI's Cultural AI Design Tool[63] which I will discuss further in section 4.1. As a consequence of the need to articulate and relate, my own and other's artistic work, which operationalizes semi or fully autonomous systems. As this work exists as a combination of artistic and technological fields, the function or behavior of the system in question becomes an integral part in how the work is realized for the audience or viewer and therefore is a part of the meaning of the work. Even in the simplest of systems, the degree of autonomy of the system itself distances the artist from the creative output in a way that takes on the character of the system based on its structure, behavior and static and dynamic inputs. As I have begun to employ learning algorithms and behavioral models to creative ends, it has become essential to move beyond a strictly artistic perspective in order to capture the complex nature of the relationship between inputs, the systems and their outputs, and how the character of these learning systems takes on qualities of the developers themselves.

The specific manufacturer of a paintbrush has a small role in dictating the style or meaning of a specific painting it was used in. The manufacturer of instruments has a much more

[63] (*Feminist Search*)

significant role both acoustically and culturally in determining the referential meaning of the works they are used to create. By manually or programmatically creating datasets, designing learning algorithms to extract meaning from that data and then implementing the resulting inferences in predictive or selective programs, programmers and developers imbue every part of the process with their own cultural and social values and understanding. These characteristics are what ultimately determine the quality and nature of the output of the system to the viewer, and therefore exist between the artist and the behavior of the system as determined by its program and dataset, or more generally the system's behavior. When that dataset is taken from real behavior of people, or the program is used in ways that affect or reflect culture or human behavior, it then constitutes an important part of the referential meaning of the work.

By combining concepts as can be seen in Figure 2-3and methods of critical examination across a range of different fields and perspectives, I believe that the smArt framework creates more access points to the many layers of meaning within works that operationalize semi or fully autonomous systems. This has been to my benefit both as an artist who wants to be able to find language to summarize my work and as a consumer of media who wants to be able to understand the complex and dynamic interactions between the technology used to create, promote and distribute media and the very culture and society from which that media is derived. In addition, the very exploration of AI/ML systems and the concept of a fully autonomous creative system actively and persistently challenges our understanding of humanity and consciousness as exceptional, and presents us with a medium through which to explore both the micro forces that govern specific acts of creativity as well as the macro forces that transform the yield of those creative acts in the form of a specific work into subjects of cultural value and fascination. This is intended to be a living framework in that each person hopefully is using this as a foundation to build upon the range of ideas and perspectives that are covered by the analysis. By drawing on the wide range of concepts and language from the various artists, writers and philosophers introduced in Chapter 1, I will now proceed with organizing these concepts into the three phases of the smArt framework; form, function and application respectively.

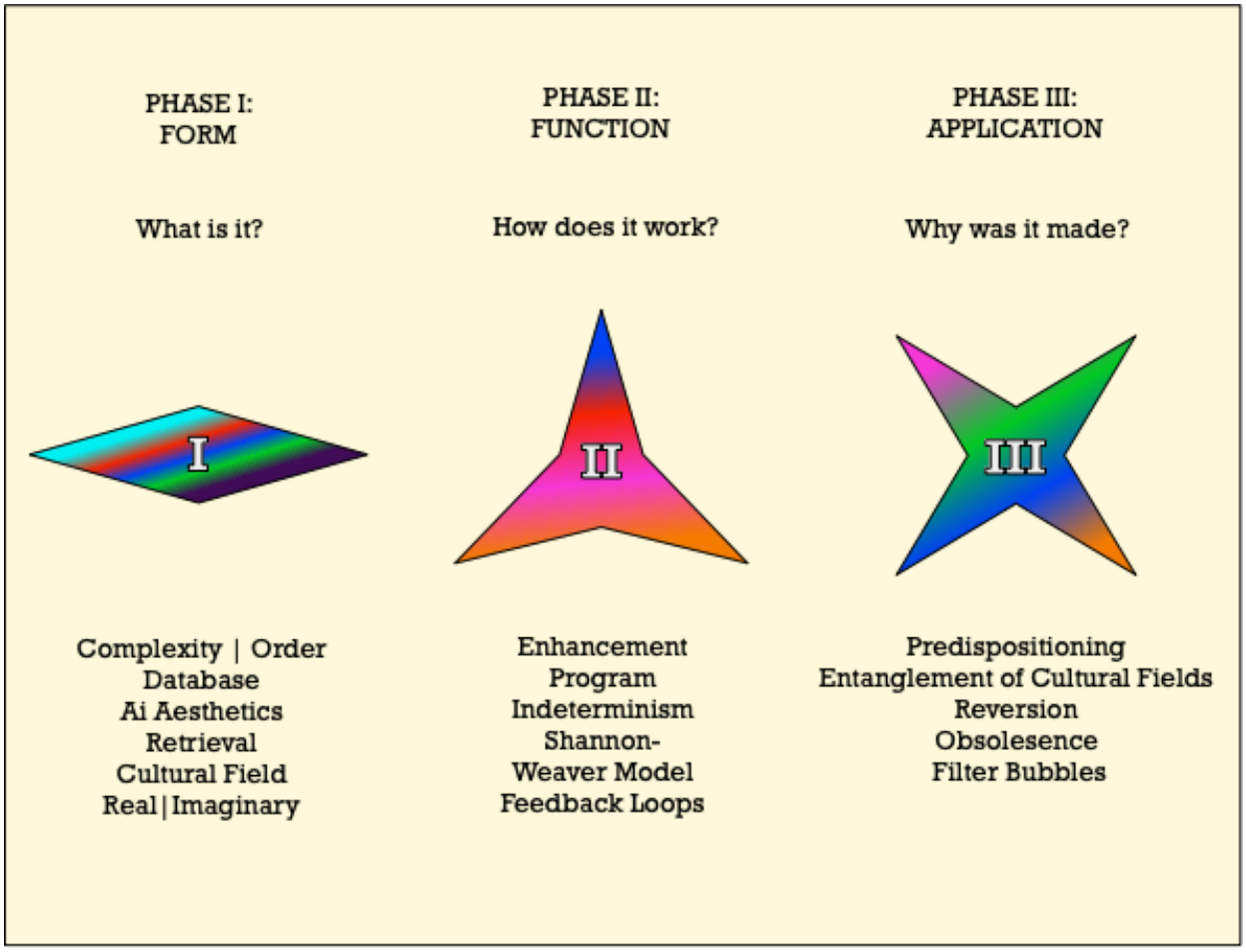

Figure 2-2 Phases and Key Concepts of the Smart Framework

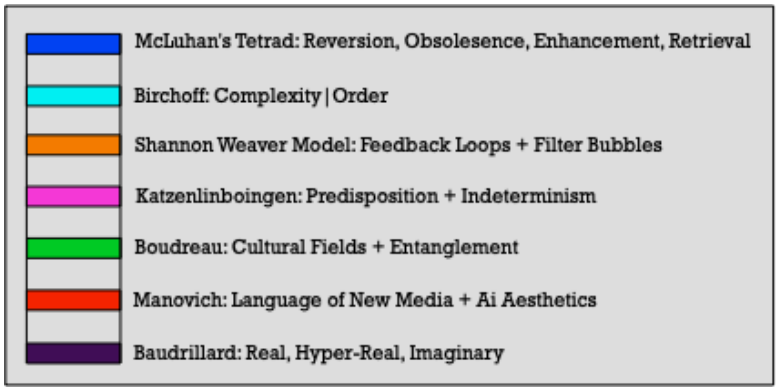

Figure 2-3 smArt Framework Color Concept Key

Phase I

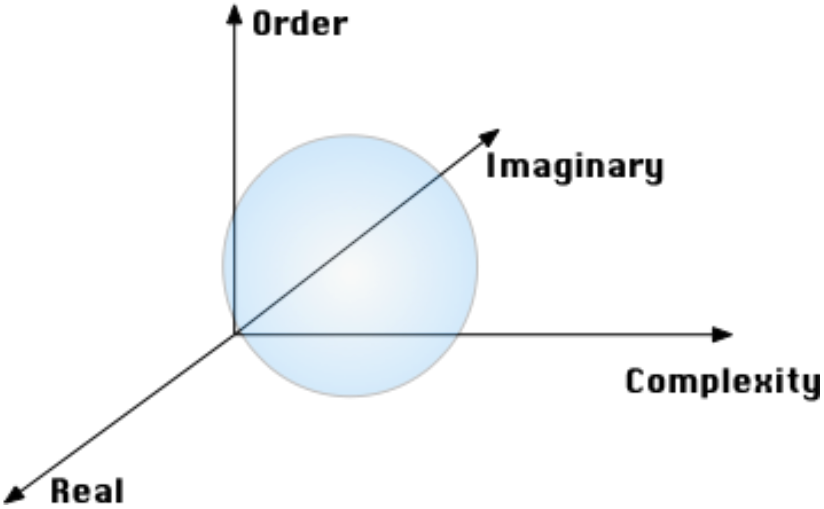

Figure 2-4 Conceptual Map of smArt Framework Phase I: Form

2.3 Form

Topics: Complexity-Order, Database, Ai Aesthetics, Retrieval, Cultural Fields, Real-Imaginary

The first phase of the smArt Framework deals with the work as a combination of characteristics and materiel that constitute the work. This includes underlying data, medium, aesthetics, references and cultural meaning, and the relationship between ordered and unordered components within the work. By combining a phenomenological analysis, how it feels to experience the work, traditional aesthetic analysis, the relationship between complexity and order of forms within the work and the sociological analysis, by which we place the technology and underlying source data within its larger cultural context, we arrive at a holistic synthesis of the form of the work. In order to accomplish this, I offer some existing concepts through which one might realize these methods of analysis:

2.3.1 Complexity-Order

In his 1933, *The Aesthetic Measure*, American mathematician George David Birkhoff published a formulaic method for establishing the aesthetic value of a given work. In order to accomplish this, he creates one larger formula into which many different formulas that refer to specific mediums or cultural forms can be inserted. Ostensibly, when applied to a given work, this allows us to come up with a number that represents the value of the work. Now in reality, this kind of numerical valuation is not particularly useful unless everyone agrees to put faith in the formulas as in the stock market, which I assure you they have not. Ultimately in economics, something is worth what someone is willing to pay for it, and in this sense applies to media and cultural artifacts. The process of aesthetic evaluation of media and art is and must be partly subjective; part of what makes the connection each viewer forms with a work valuable is exactly this subjectivity and individual experience. Different elements of a piece resonate differently with each person, yet the piece is representational of the artist and of itself (physically). I would argue that there is a complex interaction between the art and the viewer that involves the synthesis of shared and individual experience. The individual experience is determined by the resonance or connection between the unique aspects of a person's perspective and the work, that which is subjective. The shared experience is what is recorded about the work, what exists materially and factually about the artist and the work and generally what can be considered for these purposes to be objective. For this reason, though it is not ultimately useful for artists or fans to trumpet a numerical valuation of a work of art that isn't in currency or views, it is important to establish the nature of Birkhoff's aesthetic valuation as a way of establishing the complex nature of the viewing experience, and examining the shared or "objective" elements of a work. Essentially, this boils down to the relationship in a given artifact between what Birkhoff calls the ordered and the complex which taken together can be used to establish a numerical value:

> The typical aesthetic experience may be regarded as compounded of three successive phases: (1) a preliminary effort of attention, which is necessary for the act of perception, and which increases in proportion to what we shall call the *complexity* (C) of the object; (2) the feeling of value or *aesthetic measure* (M) which rewards this effort; and finally (3) a realization that the object is characterized by a certain harmony, symmetry or *order* (O), more or less concealed, which seems necessary to the aesthetic effect.[64]

[64] (Birkhoff)

Birkhoff goes on to define the relationship formally as M=O/C, where the value is equal to the proportion of ordered elements like symmetry and contrast to complex elements of a work like the number of sides of a polygon or the number of notes in a melody. Birkhoff proceeds to rigorously apply this formulaic approach to different aesthetic objects and forms, and this is where I think the measurement begins to have diminishing returns. For the purposes of this paper, I would expand Birkhoff's theory such that for a given aesthetic object, the viewer establishes its aesthetic value through some process that involves this ratio of complexity to order but is taken as the product of both the objective/measurable/shared-experience in one dimension and the subjective/personal/intangible in another. This gives us a basis upon which the range of theoretical, phenomenological and sociological perspectives that we use to understand works of art can be unified. Furthermore, the electro-mechanical and digital systems that we use to create, and curate smArt are as highly ordered as they are complex.

2.3.2 Database

In his book "The Language of New Media," Lev Manovich describes the database as one of the essential elements of new media. It would likely be clear to the observer of a collection of smArt works that as a genre, smArt is an extension or evolution of new media in that it relies on computer based technologies and employs language, forms and concepts of new media developed throughout the last century. Because of this connection to the larger field of new media, I have chosen Manovich's definition of the database, rather than a more generic academic one, in order to highlight its relationship to the content it is used to create:

> From the point of view of the user's experience, a large proportion of [new media objects] are databases in a more basic sense. They appear as collections of items on which the user can perform various operations—view, navigate, search. The user's experience of such computerized collections is, therefore, quite distinct from reading a narrative or watching a film or navigating an architectural site. Similarly, a literary or cinematic narrative, an architectural plan, and a database each present a different model of what a world is like… a database, as a cultural form of its own.[65]

[65] (*Amazon.Com: The Language of New Media (Leonardo Books) (0000262632551): Manovich, Lev: Books*)

Especially in the context of predictive modelling, the database is foundational to the process and it represents what is "known" to the algorithm. In a sense, the database represents a set of universal truths or irrefutable known facts without which a model could not be inferred let alone implemented in a larger system. Because of this essential and influential status, critical examination of databases, how they are created/collected and how they are used is essential to understanding their application in works of art.

2.3.3 Ai-Aesthetics

Ai-Aesthetics, a short book by Lev Manovich, lays out this concept of the same name in which he describes the different ways in which Ai systems are currently interacting with media and media consumption. Generally, aesthetics is more concerned with valuation, but in this instance, it refers to the application of the Ai system—to aesthetic ends: "We moved from the automation of a single mind to a kind of 'super-cognition.'… the scale of digital culture demands intelligence that is qualitatively similar to a human, but operates on a quantitatively different scale."[66] Manovich outlines four specific types of what he calls "cultural AI" systems, which gives us a foundation for many of the essential categories in the field: selection, targeting, assistance and fully autonomous creation. Selection refers to AI systems that help us locate or filter media in tasks like search and recommendation. Targeting refers to AI systems that market or advertise media. Manovich considers AI systems that assist in creation of media as participating in creation. Finally, there is fully autonomous creation in which the system is designed to generate media without direct interaction. Each of these categories represent a current application of AI in media. As a genre, smArt is an effort to find a name for works that leverage these systems not just in ways that relate to media, but specifically as, or in the direct creation of, works of art. Given that this includes just the latter two of Manovich's categories, it is important to understand the larger context of where smArt fits into the field of cultural-AI. Manovich poses

[66] (*Amazon.Com: AI Aesthetics EBook: Manovich, Lev: Kindle Store*)

an essential question "Does such automation lead to a *decrease in aesthetic diversity over time?* Is this inevitable, or are there other forces that may counteract this, increasing diversity?"[67]

2.3.4 Retrieval

The concept of retrieval as outlined in *Laws of Media: The New Science* by Marshall and Eric McLuhan is framed in the form of a question: "What recurrence or retrieval of earlier actions and services is brought into play simultaneously by the new form? What older, previously obsolesced ground is brought back and inheres in the new form?"[68] In general this retrieval can be seen in the references, biases and influences both conscious and unconscious that exist between the artifact, the creator and the culture at large. One example of retrieval given is that the introduction of the car "ended the age of the horse and buggy, but these returned with new significance and experience as the movie 'Western.'"[69] To McLuhan, retrieval is related to obsolescence and enhancement in that as technologies and ideas age from something which at first obsolesces other technology into things which are themselves considered obsolete, they become established as archetypes which are what is retrieved in future ideas and technology. The archetype is defined as

> …retrieved awareness or consciousness. It is consequently a retrieved cliché—an old cliché retrieved by a new cliché. Since a cliché is a unit extension of man, an archetype is a quoted extension, medium, technology or environment, an old ground seen as figure through a new ground. The cliché, in other words is incompatible with other clichés, but the archetype is extremely cohesive; the residues of other archetypes adhere to it. When we consciously set out to retrieve one archetype, we unconsciously retrieve others; and this retrieval recurs in infinite regress.[70]

This is a loop whereby a technology begins as innovative and then becomes obsolete, to eventually become the inspiration or basis for future technology. The perpetual cycle of life, death and rebirth of ideas unfolds on every level, from the individual all the way up to

[67] (*Amazon.Com: AI Aesthetics EBook: Manovich, Lev: Kindle Store*)
[68] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)
[69] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)
[70] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)

"humanity," and is largely delimited by culture and location. In the context of smArt and autonomous systems, by exploring retrieval rather than simply reference we connect not only with the specific referential content presented by the artifact, but also the retrieval existing within the intention and perspectives of the artists. Importantly, this includes potential bias within the specific datasets and algorithms. In short, the application of an AI system, involving data collection and inference, is a retrieval of that data both in a literal sense as well as in a cultural sense: the artifact is symbolic of the underlying data. By exploring a work through the lens of retrieval, we can critically explore the aesthetic and/or ethical choices of the artist in curating/selecting data and the topic of Big Data more generally, in addition to the specific references in the style or content of the artifact.

2.3.5 Cultural Fields

Bourdieu outlines the cultural field as a descriptor for the dynamic and subjective nature of a given artistic culture or subculture in his book *The Field of Cultural Production:* "the *space of literary or artistic position-takings,* i.e. the structured set of the manifestations of the social agents involved in the field- literary or artistic works… is inseparable from the *space of literary or artistic positions* defined by possession of a determinate quantity of specific capital (recognition) and, at the same time, by occupation of a determinate position in the structure of the distribution of this specific capital."[71] It should be noted that capital here does not refer to currency or monetary value, but rather what Bourdieu describes as cultural capital which exists in many forms and includes everything from critical acclaim to academic degrees to awards and general popularity. Each cultural field exhibits its own set of "laws" that govern the value of different kinds of cultural capital, for example within the field of popular music, popularity measured in followers and views is much more valuable than academic degrees. In a field like Classical Opera for example, things like awards and critical acclaim would have much higher value within that field than say the number of Instagram followers. Within a given field, Bourdieu writes that each artistic

[71] (*Amazon.Com: The Field of Cultural Production (0884417770233): Bourdieu, Pierre, Johnson, Randal: Books*)

contribution exists not just in relation to the other works in the field, but in part because of those relations. Taking the literary field as an example, Bourdieu outlines the characteristics of a cultural field:

> the task is that of constructing the space of positions and the space of the position-takings [prises de position] in which they are expressed. The science of the literary field is a form of *analysis situs* which establishes that each position—e.g. the one which corresponds to a genre such as the novel, or within this, to a sub-category such as the 'society novel' [roman mondain] or the 'popular' novel—is subjectively defined by the system of positions; that every positon, even the dominant one depends for its very existence, and for the determinations it imposes on its occupants on the other positions constituting the field; and that the structure of the field i.e. of the space of positions, is nothing other than the structure of the distribution of the capital of specific properties which governs success in the field and the winning of the external or specific profits (such as literary prestige) which are at stake in the field.[72]

Bourdieu sees the cultural field as the dynamic relationship between all the different agents within the field and the forces they exert on each other. Furthermore,

> the network of objective relations between positions subtends and orients the strategies which the occupants of the different positions implement in their struggles to defend or improve their positions (i.e. their position-takings), strategies which depend for their force and form on the position each agent occupies in the power relations [rapports de force]. Every position-taking is defined in relation to the *space of possible* which is objectively realized as a *problematic* in the form of the actual or potential position-takings corresponding to the different positions; and it receives its distinctive *value* from its negative relationship with the coexistent position takings to which it is objectively related and which determine it by delimiting it. It follows from this, for example, that a position-taking changes, even when the position remains identical, whenever there is change in the universe of options that are simultaneously offered for producers and consumers to choose from. The meaning of a work (artistic, literary, philosophical, etc.) changes automatically with each change in the field within which it is situated for the spectator or reader.[73]

As time progresses, each of these agents formulates a winning strategy, what Bourdieu calls habitus, based on their current knowledge, abilities and circumstances, what Bourdieu calls doxa. Based on this habitus, each agent takes action in ways that they see fit to gain cultural capital. Following with the field analogy, each action by an agent creates a reaction or change in all the other agents if for no other reason than by a change in their relative position and thus the field as a whole. While this is most certainly applicable to all artistic genres, the concept of cultural fields is a particularly useful way to establish and illustrate the complex context and cultural

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[72] (*Amazon.Com: The Field of Cultural Production (0884417770233): Bourdieu, Pierre, Johnson, Randal: Books*)

[73] (*Amazon.Com: The Field of Cultural Production (0884417770233): Bourdieu, Pierre, Johnson, Randal: Books*)

grounding for works that leverage autonomy. Partly, this is because of the dynamic and indeterministic nature of autonomy itself as a paradigm. Such a system used in an artistic process, leaves the realm of creative tool, and enters the realm of creator or a collaborator. In a sense, the system itself has its own habitus (behavior) and doxa (database) and can be viewed similarly as a yet another agent within the field, or as the work itself as a field defined by the interaction between artist and system. Furthermore, establishing the work as existing across cultural fields, provides the context necessary to explore potential implications of the work in Phase III, section 2.5.

2.3.6 Real-Imaginary

For full discussion on Baudrillard's concept of hyperreality as presented in *Simulation and Simulacra* and how it relates to the real and the imaginary, see chapter 1.1.4. For the purposes of this paper, it is important to understand the relative position of the simulated, the digital, to what is physically real and what is abstract, or imaginary given that it is neither yet somewhere in-between. There is economic and thus cultural incentive in equating reality and the digital world, but importantly it is a simulation and therefore is not the same. The value of making a device "smart" is not a direct tangible value, but it does impact the real world by introducing some degree of automation into the user experience. This changes the nature of our experience to one that is partially simulated and according to Baudrillard is therefore hyperreal, which in itself complicates our ability to establish what is real and what is not in the experience and thereby derive meaning. This paper proposes smArt as a genre straddling the real, the simulated and the imaginary. Generally, the works exist physically, they leverage digital systems and simulation and are referential, rely on abstractions and on the imagination of the artist. By organizing the discussion of works through the smArt Framework in a way that delineates the abstract concepts, the simulated behaviors and the reality of the form and user experience we are better able to access meaning in the work and evaluate it, as well as understand the possible implications.

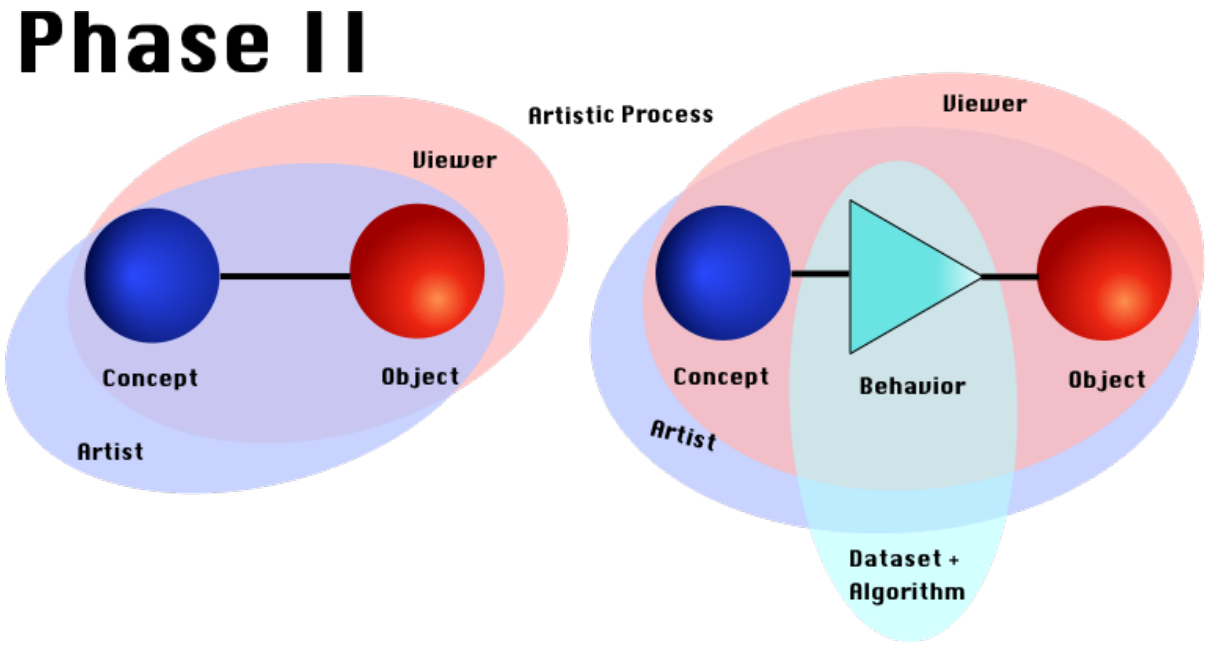

Figure 2-5 Conceptual Map of smArt Framework Phase II: Function

2.4 Function

Topics: Enhancement, Program, Indeterminism, Shannon Weaver Model, Neural Network

The second phase of the smArt Framework shifts the focus to the underlying mechanisms or programs that are what transform the inputs to the system into the output or behavior. This begins with a functional description of the processes involved. The programs and methods themselves, when used in making art, become embedded in the work as a part of the artistic process and for that reason alone merit exploration and examination. Furthermore, this includes the degree of autonomy of the system and the degree of predictability, and how that autonomy is achieved. Once again, this is especially important because the nature of interactions with these creative systems is fundamentally different from immediate creation, in that the system is inserted as an actor between the artist as director and the specific output. This is important I believe both in understanding the meaning of a work but also in evaluating it critically, in that there is great opportunity for additional layers of expression. In addition, creativity as expressed by or involving autonomous systems challenges our understanding of art, art making and culture more generally, even metaphysical questions about the nature of the human condition. In order to realize meaning in these experiences, it is essential for the artist and audience to be able to share a common understanding of the basic functioning and thus strengths and weaknesses of

these systems. I will now offer some concepts as a foundation for a common understanding of the function of smArt systems:

2.4.1 Enhancement

McLuhan's concept of enhancement as introduced in *Laws of Media*, considers all technology to be an extension of our human senses and bodies. To define the law of enhancement, he poses this question: "What does the artefact enhance or intensify or make possible or accelerate? This can be asked concerning a wastebasket, a painting, a steamroller, or a zipper, as well as about a proposition in Euclid or a law of physics."[74] Every tool that is created, is created in order to extend or increase an ability that exists within us innately. The first tools and weapons can be seen as enhancements of our arms hands and teeth, that which we use to kill, crush and cut open. Fire enhanced our eyes in the dark and our skin during cold weather. Horses and wagons enhanced our arms, backs, legs and feet by allowing us to travel greater distances with our possessions. Enhancement is the basic function of technology and is the primary purpose for its development and application. For this reason, I believe it necessary to include an exploration of function in any practical analysis or critical evaluation of art that leverages technology. It is worth noting that traditionally, function is not something that is associated with art. Art's function, as it were, is related to the magnitude and nature of the subjective response of the audience. Art is functional if it provokes a response in the viewer. I would argue however, that because smArt is a genre in which digital media technology is a central theme, the function of the artifact has a critical role in determining its aesthetic value, whether that be in the form of a set of modeled behaviors or a single feedback loop. Essentially, the subjective and artistic choices that go into the development of an autonomous or semi-autonomous creative system are reflected by how it works, and therefore we must include function in any useful aesthetic evaluation.

[74] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)

2.4.2 Algorithm

In his discussion of the Database as an essential form of new media, Manovich discusses the fundamental relationship between the database and the algorithm. He writes that the nature of a computer's understanding of the world is a world "reduced to two kinds of software objects that are complimentary to each-other—data structures and algorithms. Any process or task is reduced to an algorithm, a final sequence of simple operations that a computer can execute to accomplish a given task."[75] An algorithm is a set of rules that govern the behavior of a program, the means by which it transforms a given input into a given output. In this sense, an algorithm is a deterministic method in which the author has complete control of its the nature and characteristics. These algorithms are characterized by the range of inputs and outputs as well as their structure. Depending on the desired results or behavior, different data structures like networks, data-trees, tables and lists are employed each with their own strengths, weaknesses and inherent biases. Though in commercial applications algorithms are typically closely guarded trade secrets, algorithms that are leveraged in artistic applications should be the subject of the same rigorous scrutiny as the rest of the formal elements of the work. This includes the aesthetic implications of the algorithms used as well as cultural references and social implications. How a given work functions can change or determine the meaning of the work to a specific viewer or the culture at large and thus its value; therefore, it must be included in any substantive aesthetic evaluation of smArt.

2.4.3 Indeterminism

Indeterminism as defined by Aaron Katsenlinboigen, refers to "*inecluctability* or *unavoidability* of an event, or more precisely, to the degree of its inevitability."[76] Where uncertainty pertains to error introduced by limitations on measurement and sampling, indeterminism pertains to our inability

[75] (*Amazon.Com: The Language of New Media (Leonardo Books) (0000262632551): Manovich, Lev: Books*)
[76] (Katsenelinboigen)

to predict outcomes. Importantly, indeterminism does not qualify the nature of the unpredictability, simply the degree to which we are able to understand, control and thus predict outcomes. Because it is measured as the deviation of real outcomes from predicted outcomes, degree of indeterminism is a heuristic that can be applied to stochastic digital systems that rely on pseudo-randomness as productively as it can be applied to performances involving real human actors. It simply indicates the scope of possible outcomes:

> the degree of indeterminacy is the degree of our ability to change the path of a system as its constituent parts themselves change. If our ability to change the parts is finite, the occurrence of a particular event may be ultimately unavoidable. This is determinism, the case of the inevitable event. Indeterminacy, on the other hand is characterized by avoidability or alterability of an outcome of an entire category of events rather than a single outcome. For instance, a category of some possible outcomes may be unavoidable, while some particular event belonging to that category is avoidable.[77]

It may in fact prove useful to more qualitatively measure indeterminism of a system to further understand the differences between types of unpredictability such as stochastic, artificial-human and real-human, and how that affects the artistic process, the work itself and the way we experience and evaluate work as an audience and as a culture.

2.4.4 Shannon Weaver Model

In 1949, Claude Shannon and Warren Weaver published their *Mathematical Theory of Communications* and *Recent Contributions to the Mathematical Theory of Communications* in one volume, which outlines what is generally accepted as the foundational model for the application of mathematics to information transmission and communication known as the Shannon-Weaver Model. Their basic model of communication consists of five parts: source, transmitter, channel receiver and destination. At the outset of a communication there is "[a]n *information source* which produces a message or sequence of messages to be communicated to the receiving terminal."[78] This could be a sequence of letters, or some number of temporal functions of some fixed

[77] (Katsenelinboigen)
[78] (Shannon and Weaver)

dimensionality such as radio, one function in one dimension or television, three three-dimensional functions as "components of a vector field defined in the region."[79] Once the information source is established, the communication moves to the transmitter, "which operates on the message in some way to produce a signal suitable for transmission over the channel."[80] Each transmitter is specifically designed to translate a specific type of information source such as speech, text or the visual field of a camera for a specific type of channel such as PCM or analog tape. What distinguishes the transmitter is the simple or even "complex operations applied to the message to obtain the signal."[81] Once obtained from the transmitter, "The *channel* is merely the medium used to transmit the signal from transmitter to receiver."[82] What is crucial here is that in practice, the channel is wires, electromagnetic waves or a beam of light which, as Shannon indicates in the model, are all subject to environmental noise which can impact the fidelity of the signal in the channel, causing it to degrade. Even digital channels are subject to their own fidelity limitations due to physical limitations of the hardware. On the receiving end of the communication things are largely the exact reverse as on the transmitting end: "the *receiver* ordinarily performs the inverse operation of that done by the transmitter, reconstructing the message from the signal" and then it follows that "the *destination* is the person (or thing) for whom the message is intended."[83] As can be seen in Shannon's parenthetical, what makes this model foundational in the field of communication theory and information science, is that it applies both to all kinds of communications and messages, whether they be analog or digital, between people or between machines or even between a person and a machine.

What is commonly understood, and central to the field of modern media technology, is that communication involves noise and or error induced by physical limitations of the system and the environment. The problem then becomes one of determining the point at which the message is no longer understandable due to the presence of noise. In the context of aesthetic evaluation and the genre of smArt, the problem is more complex. One would hope that when directly communicating through spoken language or symbols, we try to optimize language through cultural practice and education to prioritize effective and thoughtful transmission of

[79] (Shannon and Weaver)
[80] (Shannon and Weaver)
[81] (Shannon and Weaver)
[82] (Shannon and Weaver)
[83] (Shannon and Weaver)

information. There are even many organizations dedicated to the preservation and maintenance of national languages. In Germany, for example, the Gesellschaft für deutesche Sprache (Association for the German Language), is a federally sponsored agency that is tasked with "promoting awareness and interest in the German language – for its function, its peculiarities and its idiosyncrasies- for everyone who speaks and learns German."[84] Meaning or message in the context of art however, cannot be established by a government or non-profit organization. This is because it involves the choice by the viewer to "see it as art," which implies both the referential context of the fields of art the work inhabits, as well as the subjective evaluation on a number of levels, (formal, phenomenological etc.) by the viewer.

Take for example, the English language: first we have a grocery list which is a series of numbers, words and phrases left justified on a page with only one or a few words and numbers per line. Second, we have a poem which is similarly words and phrases, perhaps a few more per line but perhaps not, left justified etc. Realistically, both could be viewed as art, the list as representative of an individual's life and culinary culture, and the poem in the traditional context of poetry. A significant part of what makes us assume the latter is artistic and former is not, is our own cultural experience and knowledge by which the latter follows culturally accepted and recognizable forms of poetic practice. If both the poem and the grocery list were presented in a gallery then perhaps viewers would evaluate the list aesthetically and culturally, but this is generally an involved process and so it would be comically burdensome to literally view *everything* as art. Without context in terms of presentation we generally rely on this kind of identifiable formal or cultural association to classify things as art and then evaluate them accordingly. The Shannon Weaver Model represents a foundational perspective that has framed academic understanding throughout the formulation of information technology and digital media systems. Furthermore, it reminds us that in all transmission-based communications, even between machines, there is noise and error and that our task is not only to remove this error, but to accept that these systems have degrees of indeterminism that become more or less relevant based on the complexity of the message. When we try to use transmission technology to facilitate human simulation through autonomous systems, the complexity of the messages and tasks involved increase exponentially, as do the consequences of miscommunication.

[84] (*Introducing the German Language Society | GfdS*)

2.4.5 Neural Network

Understanding the basic function and application of neural networks will allow us to aesthetically evaluate them by outlining the structures and methods that drive the autonomy in AI/ML systems. Further, this will allow us to explore the effect of these systems on artistic process. The term neural network refers to the mathematical process of modelling a system based on a given set of correlated input-output data in a way that is intended to simulate the processes inside the human brain. I am not a mathematician, and this is not a mathematics paper so I will not dive formally into the explanation of the theory or notation of machine learning. I would note that there are several free online video-lecture courses from renowned institutions like MIT and Stanford on machine learning and the related mathematics and would urge anyone reading this paper to explore those resources for further information on the subject.

To give enough context for this process as it relates to art, it is crucial we explore the relationship between data, inference and the resulting model within a neural network to establish it aesthetically as a means to the kind of simulated agency that is what gets used creatively in the making of smArt. In his essay titled "Machine Learning" published in *Artificial Intelligence: Handbook of Perception and Cognition* ed. by Margaret Boden, Stuart Russell summarizes how the neural network functions:

> Viewed as a performance element, a neural network is a nonlinear function with a large set of parameters called *weights*…. Given a training set of examples, the output of the neural network on those examples can be compared with the correct values to give the *training error*. The total training error can be written as a function of the weights and then differentiated with respect to the weights to find the *error gradient*. By making changes in the weights to reduce the error, one obtains a *gradient descent* algorithm. The well-known *back propagation* algorithm (Bryson & Ho, 1969) shows that the error gradient can be calculated using a local propagation method. Like decision-tree algorithms, neural network algorithms are subject to overfitting. Unlike decision trees, the gradient descent process can get stuck in local minima on the error surface. This means that the standard back-propagation algorithms is not guaranteed to find a good fit to the training examples even if one exists.[85]

Through this mathematical process, neural networks are able to infer a model based on the training data in such a way that the network is able to effectively simulate the behavior of an agent from the environment from which the data is sampled. The specific behavior, or rather, what the network "learns to do" is defined by the weights within the algorithm of different elements or features in the data, as well as the structure of the network and number of layers.

[85] (*Artificial Intelligence (Handbook Of Perception And Cognition): 9780121619640: Medicine & Health Science Books @ Amazon.Com*)

What is also important is that what a network learns is constrained and to some degree defined by the quality and quantity of the data in the training set.

In the process of "training," the network is moving through a series of states in an effort to minimize error between its correlation between inputs and outputs and that of the training data, thereby optimizing utility. Russel defines utility to a network as "the reward for being in the state plus the expected total reward from the next state onward, given an optimal action."[86] By comparing the change in amount of error between state zero and the training data, and state one and the training data the network is able to decide if the changes made from state zero to state one have positively or negatively impacted its utility, thus the network establishes whether it should continue with the same kinds of changes or revert to state zero and try something else. The neural network is able to learn what changes to its model will make its correlations between input and output more or less akin to that in the training data. By being rewarded for eliminating difference, the error, the network takes on the behavior of what is represented by the training data.

There are many different popularized subtypes of neural networks, including the convolutional, generative-adversarial and long-short term memory networks, also known by their acronyms CNN, GANN, LSTM, just to name a few. They and other machine learning methods are the foundation of such technology as computer-vision, style-transfer, speech analysis and synthesis and many more. The implementation of machine learning through methods such as neural networks is responsible for creating and evolving the algorithmic models at the core of the technology's autonomous behavior. By inferring a complex algorithm from huge datasets, these networks can approximate the relationship of a range of inputs to a range of outputs thus simulating the behavior represented by the dataset.

What is crucial about the artistic applications of neural networks is that they complicate the artistic process. First, networks do this by introducing an agent between the artist and the artistic output. One might think, "these are programs; therefore, artists are in control of their behaviors. Why bother considering them as agents in the artistic process?" The reason is based partly on how these systems function and partly how they are applied, both of which result in some degree of indeterminism (outcomes the artist cannot predict therefore cannot determine).

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[86] (*Artificial Intelligence (Handbook Of Perception And Cognition): 9780121619640: Medicine & Health Science Books @ Amazon.Com*)

With respect to networks as independent agents Russel writes, "the agent's own actions are responsible for its experiences. The agent therefore has two conflicting goals: maximizing its reward over the short-term horizon and learning more about its environment so that it can gain greater rewards in the long term."[87] In terms of application, these are used in products and devices that are automate all or some element of a task that would otherwise require a human whether that be information retrieval, classification, prediction or generation of content. This is to say they are used to simulate some degree of human agency, and therefore it has agency, but of the same quality or to the same degree as human agency. This simulated agency is what is inferred by the model from the training data. It is also what an artist applies by using "smart" technology to create or perform. It follows therefore that the nature of this simulated agency has a direct impact on the resulting work. Speaking more broadly, neural networks used in artworks can illuminate the inner workings of the human mind by embodying and representing for critical examination the levels of cultural perspective, personal experience and subjectivity that go into simulating human behavior and creativity.

[87] (*Artificial Intelligence (Handbook Of Perception And Cognition): 9780121619640: Medicine & Health Science Books @ Amazon.Com*)

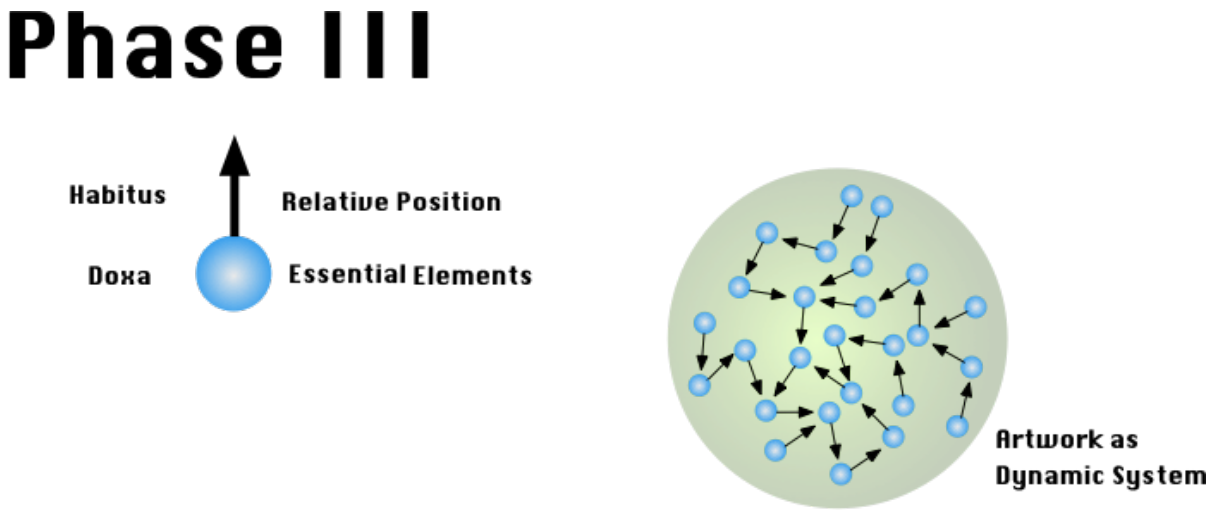


Figure 2-6 Conceptual Map of smArt Framework Phase III: Application

2.5 Application

Topics: Predispositioning, Reversion, Obsolescence, Filter Bubbles

Figure 2-6 shows a conceptual map of the third and final phase of the smArt framework. Central to phase III is establishing the intended and or actual application of the system. This involves the presentation of the work, the intentions of the artist, and the relationship of the work to the viewer and larger community. First, the task is to connect the work itself to the intended meaning of the work via the nature/behavior of the processes or systems involved. Then, we turn to the actual or hypothetical results or output of the system as it unfolds dynamically. This has two important components cultural and technological that involve consequences to the system itself, how it evolves over time and how that is or might be perceived, as well as the way in which the system may or will cause changes in the fields with which it interacts. Based on the establishing phases I & II, phase III is designed to consider the work within the actual context in which it will exist and connect it to the underlying meaning as intended by the artist. It is also an opportunity to explore the cultural impact of the specific work as well as the constituent technology more generally. I will now offer some specific concepts that are intended to help in realizing this third phase of the analysis:

2.5.1 Predispositioning

Central to his theory of Indeterminism, which Aaron Katsenlinboigen outlines in his *The Concept of Indeterminism and its Applications*, is the concept of Predispositioning. Katsenlinboigen outlines the four phases in the continuum of **determinism-indeterminism**, which represent different levels of predictability in a system: mess, chaos, predispositioning and programming. Mess and Chaos are similar in that they tend towards indeterminism, however, "[m]ess should not be confused with the next phase, chaos, as this term is understood today. Arguably, chaos is the first phase of indeterminism that displays sufficient order to talk of the general problem of system development. The chaos phase is characterized by some ordering of accumulated statistical data and the emergence of the basic rules of interactions of inputs and outputs."[88] Essentially, chaos is the cumulative inferences of observed mess; the point at which rules and ordering can be observed. Importantly, this is framed as an ordering of data and a set of basic rules, though they may be formative or incomplete. He also notes that generally with chaotic systems, we are only able to extrapolate or determine the extreme states or boundary conditions of the system, not any specific behavior. Jumping to the other end of the determinism-indeterminism spectrum, programming refers to "when linkages between states are established through reactive procedures, either by table functions or analytically, it is often assumed that each state is represented only by essentials. For instance, the production function in economics ties together inputs and outputs in physical terms."[89] This category is just what it sounds like: algorithms or rules that deterministically link inputs and outputs based on formulaic abstractions of the world. With programmatic systems, we are able to leverage the fixed nature of the systems to select and optimize a specific output. Finally, we arrive at predispositioning which is what occurs between chaos and programming in the spectrum of determinism-indeterminism. Characteristically, predispositioning results in solutions that are "expressed explicitly or implicitly in terms of probabilities, if we conceptualize probability broadly enough as a chance of an event occurring.…The exposition of predispositioning will consist of two parts. The first part will deal with the ways a system is represented by means of essentials and their valuations; in the second

[88] (Katsenelinboigen)
[89] (Katsenelinboigen)

part will be enriched by relations and their values."[90] Chapter two of *The Concept of Indeterminism and its Applications* is devoted to a rigorous application of predispositioning to a well-known indeterministic system, chess, which I think makes for a quite useful example of how this might then apply to creative or aesthetic systems. Once again, indeterministic systems unfold dynamically over time and often consist of multiple agents or components that through their interaction determine the outcome. In chess, the king has the highest value, descending from queen down to pawn based on the maneuverability of the piece. The first phase of predispositioning involves establishing the essentials, the pieces, and their values. The second phase establishes another value based on the relative position of the different pieces, i.e. the state of the board on any given turn.[91] In the context of art and aesthetic valuation, predispositioning is an evaluation of a system wherein we establish the relative position and interaction between essential components. I feel this is essential to defining smArt as a genre as well as the application of the smArt Framework because the introduction of an autonomous or semi-autonomous system into an artist process pushes any possible output or work out of the realm of the direct or programmatic, and into the realm of predispositions. By viewing the artistic process as the complex-dynamic interaction of artist and semi or fully autonomous system we are better able to understand, evaluate and give context for the specific output and future implications.

2.5.2 Reversion

Reversion is defined by McLuhan in *Laws of Media* as "a maxim from information theory: data overload equals pattern recognition. Any word or process or form, pushed to the limits of its potential, reverses its characteristics and becomes a complimentary form."[92] One of the examples he gives of this is how currency began as physical metal coins but when pushed to its

[90] (Katsenelinboigen)
[91] (Katsenelinboigen)
[92] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)

technological limits, has become the absence of physical currency in the form of credit cards and digital banking. McLuhan goes on to describe what he sees as the larger trend brought on by electric (digital) media as a reversion from visual space to acoustic space. Essentially, he describes visual space as preoccupied with idea or concept as the mode of thinking, or rather where only one thing is in focus, called the figure, and everything around it that forms the context, called the ground, is not.[93] According to McLuhan, in acoustic space, to which media technology is reverting, we perceive things simultaneously in the foreground and the background. Taking the perspective that digital space is analogous to acoustic space can be an extremely useful way to access meaning through language as it is often difficult to eloquently or poetically describe dynamic digital systems. Furthermore, the concept of reversion reminds us of the question that we must always ask of applications of AI technology: is this really a good idea? It is essential at this time where there is now widespread use of the technology, that we as creators, consumers and members of society examine the consequences of the applications we propose. Not only is this issue of consequences a tremendous artistic opportunity for cultural exploration and examination, but also to highlight the fact that this phenomenon of 'unintended consequences' is not unexpected, it is a *law* of media.

2.5.3 Obsolescence

The law of obsolescence, as described in McLuhan's *Laws of Media*, refers to the fact that all new technology and ideas displace existing, older ideas in the process of their adoption and propagation. In America today, with the ever-increasing pace of technology, things becoming obsolete is a fairly commonplace occurrence, with some companies going so far as to plan it in advance in order to sell more products and services. As a law of media, obsolescence is part of the natural cycle of ideas, by which established or accepted ideas or methods are pushed aside by

[93] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)

newer more useful or effective ones. McLuhan notes that this is a necessary and productive part of the cycle of new ideas:

> Obsolecence is not the end of anything; it's the beginning of aesthetics, the cradle of taste, of art, of eloquence and of slang. That is, the cultural midden-heap of cast-off clichés and obsolescent forms is the matrix of all innovation. Petrach's *Ruins of Rome* was the fount of a new humanist culture. Gutenberg's technology revived the entire ancient world, while obsolescing the scriptoria and scholasticism of the Middle Ages. The needs of poet, musician and artist for ever-new means of probing and exploring experience send them back again and again to the rag-and-bone shop of abandoned cliché.[94]

All technology succumbs to obsolescence. In the case of media technology which is not life or death as in agriculture or healthcare, it seems that the lower risks and barriers to entry make this turnover happen at an even more rapid pace. Furthermore, obsolescence is driven by the subscription paywall and ad-based business model that currently dominates the media technology sector, which can only function with both immense scale in terms of daily users, and the perpetual improvement and creation of new products and services due to the many alternatives driving fierce market competition.

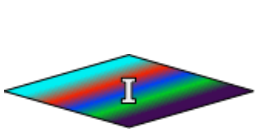
2.5.4 Filter Bubbles

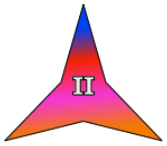
For a full discussion on filter bubbles as presented by Eli Pariser in his book *The Filter Bubble: What the Internet is Hiding From You*, see chapter 1.1.3. In the context of smArt and the smArt Framework, filter bubbles are a sociological phenomenon of smart devices as well as a potential creative form in themselves. With respect to the former, it is important for creators and consumers to understand the current state of applications of "smart" technology in order to establish context for works in the smArt genre. With respect to the latter, there may be potential in framing systems that create these bubbles for us to illustrate the potential harm of misapplication of the technology as well as the nature of human interaction through digital media.

[94] (*Laws of Media: The New Science: 9780802077158: Communication Books @ Amazon.Com*)

2.6 Additional Figures

In conclusion of the concepts covered within each phase of the smArt Framework, I will offer a set of figures to place the genre of smArt within the context of the different perspectives described above and better define the individual phases. First, Figure 2-7 is a series of what I call "relational analogies" that when taken in aggregate describe the range of meaning that the smArt Framework is intended to cover. In addition, this type of juxtaposition is useful in understanding both the ways in which the elements of the system interact but also the ways we use language to characterize the different phases in specific contexts and under various circumstances.





Form	Function	Application
Dataset	Behavior	Use
Sensory Input	Method	Purpose
Material	Means	Ends
Memory	Program	Device
Raw Data	Process	Product
Source Data	Logic	Solution
Understanding	Inference	Conclusion
Subject	Perspective	Object
Inspiration	Practice	Intention

examples:

Form is to Function as Memory is to Program
Function is to Application as Method is to Purpose

Figure 2-7 smArt Framework Relational Analogies

Second, I offer Figure 2-8 which illustrates the smArt genre's position within the spectrum of Determinism-Indeterminism. In addition to placing smArt within the context of the language discussed above, it is also worth emphasizing how the introduction of autonomy shifts the control of the artistic output away from the human artist in a very specific, semi-controlled subset of Indeterminism. In a way, this is analogous to how we might evaluate the way training and method of individual human actors lead to artistic choices within a play. Each performance relies on the same people, script, blocking etc. yet each performance is unique because each actor makes artistic choices in response to the other actors and even the audience over the course of the performance. Thus, the task of predicting the range of possible performances is one of considering both the fixed materials of the piece the script etc, as well as the dynamic agents, their range of knowledge and their motivations: Predispositioning. In the context of "smart" systems, it is neither a direct function, nor is it stochastic or pseudo-random, but rather the environment and conditions set by the user defines the behavior of the system and thereby delimits a range of possible outputs without determining the specific results. In order then to evaluate a specific smArt work, understanding the function or behavior of the system becomes essential to understanding or analyzing the artifact and artistic process.

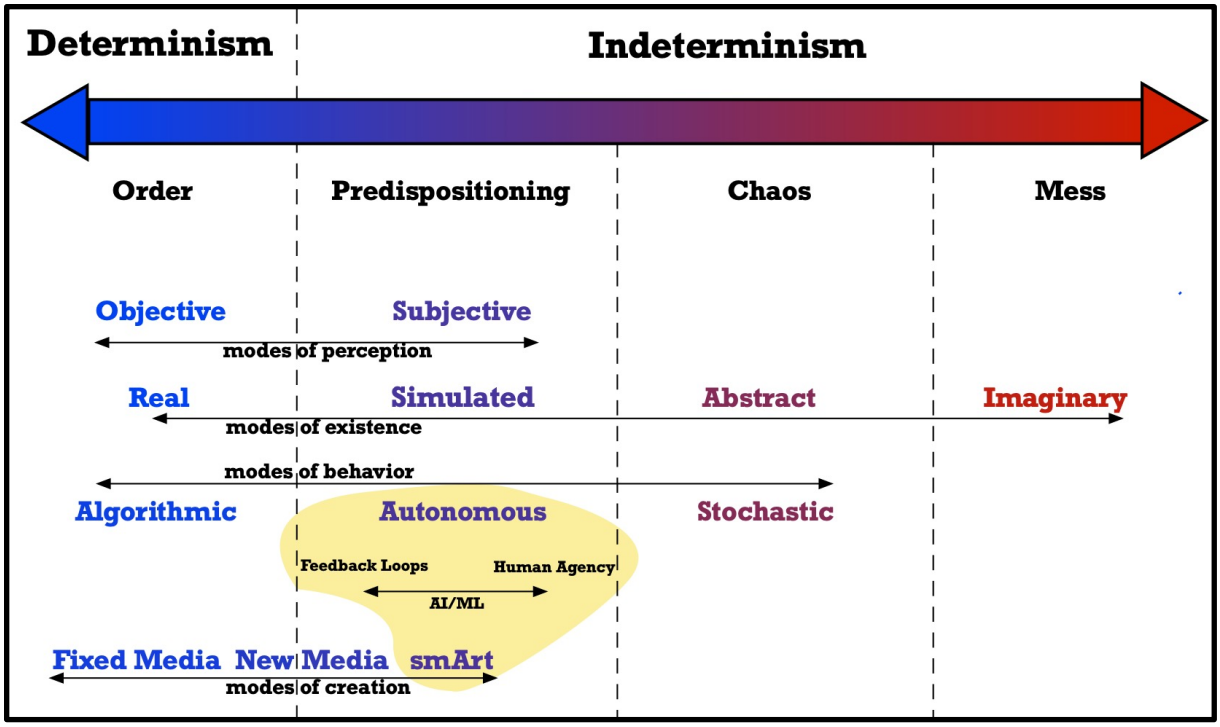


Figure 2-8 smArt on the Determinism-Indeterminism Spectrum

Chapter 3

Applying the smArt Framework

The goal of the smArt Framework is to evaluate art that leverages fully or semi-autonomous systems. In order to do this, the Framework synthesizes a range of ideas from fields that relate to the artistic application of "smart" systems, optimizing critical examination and hopefully lowering the rather significant barriers to accessing the meaning presented in such work. The reality of this type of art is that on top of the capital costs for running servers that train the underlying models, it currently requires a high degree of specialization and training to be able to implement these systems to creative ends. There is tremendous and rapid development in the space, as more and more tools are created to bridge the levels between the low-level programming of the models and the higher-level behaviors that we might want to leverage creatively, such as object recognition or gesture tracking. While there is certainly movement in this field towards greater access and understanding it is not nearly at the rate of research and commercial application; therefore, I will end this chapter with two important questions that have motivated much of my work and the development of this framework. First, how will the underlying forces that drive the current movement in the field of media technology impact or even determine the character or values of the field in the future? Second, as the culture of art relies more and more on mass exposure and interaction with audiences and the specific choices within the artistic process become shared with simulated agents and therefore less easily understood or accessible, will this divergence result in a loss of meaning in-translation, or even a loss of value, that might delegitimize the work or erode the trust between the artist and the audience?

3.1 From Real to Imaginary and Back Again

The concept of smArt has developed as a result of work and study that I have been pursuing exploring the effects of interconnected physical, digital and analog media systems we use on the underlying messages and meaning that is being transmitted. It has been a fascination of mine, the often mysterious and indeterministic effects of dynamic and complex systems, that reach a certain scale and level of energy or information. With the inherent programmatic nature of digital media, the interplay between the chaotic nature of continuous real analog information and the order and precision of discrete digital information systems emerges through the user's shared control of the output with the programmer or artist through the proxy of the behavior of the program. Further, these systems draw their information and parts from the real world, and encode it in hardware, software and datasets, and then are used by people to great consequence in the real world.

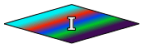
These physical-analog-digital systems exhibit the kind of originality and unpredictability that make them ideal for artistic exploration and new abstract creative applications. In addition, "smart devices" are commonly used either in the making of the work, the presentation or both due to the availability and compact sensing and processing capabilities these devices offer. Put simply, while we are interfacing with these systems directly, we as users are often either not in direct control of every aspect of the output or are unaware of the actual scope and degree of our control of the output. Through the creation and presentation of these systems I have discovered tremendous artistic and referential meaning in the programmatic behavior within dynamic new media pieces I have created, read about or been lucky enough to see in person. It is through the confluence of these two fascinations, the intersection of the digital, the analog and the physical, and the cumulative effects of technological systems on culture, society and human understanding that the smArt framework developed. I found it essential in elaborating on the nature and purpose of my work to attempt this framework as a way of structuring critical examination especially in the context of AI/ML systems in order to access the meaning between the subjective experience and the objective nature of the work. The system itself is created by the artist or by a developer and selected by the artist and thus when presented as a part of a work its process becomes connected to the work. When that process is significantly autonomous, as it is in AI/ML systems, and involves mass data collection and behavioral modeling, there is cultural meaning in the structure and behavior of these systems that can be

operationalized as a super-perspective to further complicate the work. Therefore, I will present a brief evolution of my work in the smArt genre that has driven the development of the smArt framework.

3.1.1 The feedBox

I will begin with an electroacoustic instrument that is the simplest of the indeterministic digital-analog systems I will present in this paper in order to establish the lower bounds of the category of autonomous systems as well as how the smArt framework developed. The discussion will proceed answering the three reduced questions that are central to the framework: What is it? How does it work? Why is it? First, we will answer the question of what constitutes the work which includes inputs, datasets and physical materials. Second, we will explore the behavior of the system, the algorithms/programs in use and how they are connect to the interface. Third we will explore the purpose/application of the work and some general conclusions about the piece. As we will see, the answers to these questions overlap in ways that are unique to each work, but each phase will have a specific focus to its conceptual approach.

Figure 3-1 The feedBox



Phase I: Form

The feedBox is a drone/noise instrument housed in a wooden craft box that uses two contact mics, a teensy 3.6 with a teensy audio shield and an amplifier connected to a tactile transducer to generate sound. The interface consists of five potentiometers and four buttons and the instrument is played by exciting the contact mics either by striking or scratching the box or by introducing the box to a noisy environment. The noise making element consists of a feedback loop wherein the signal from the contact mics excites a Karplus-Strong string synthesis model and is output through the speaker inside the box such that it causes resonance within the box. The two contact mics are placed on different sides of the box on the outside and the user can control the blend between them.

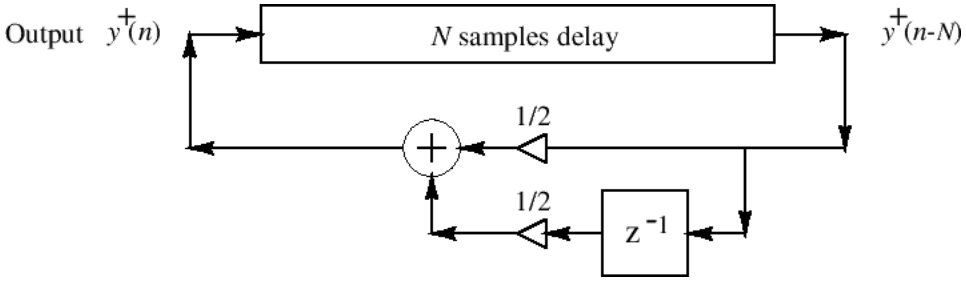


Figure 3-2 Diagram of Karplus Strong Algorithm from CCRMA @ Stanford

Phase II: Function

The feedBox creates complex sustained tones and textures by using the knobs and buttons to control these parameters: input gain from the contact mics; pitch of the string synthesis; low pass filter cutoff; contact mic blend; the resonance level of the system. The Karplus-Strong model, as seen in Figure 3-2, consists of a delay line and a filter which is mixed back in with the input signal, creating a feedback loop.[95] By taking the output of the delay line, and tuning the time of the delay (440hz = 440 cycles/second = .00227 seconds/cycle = 2.27ms) you can hear string like pitches excited by the audio input. By changing the gain or filtering the

[95] (*The Karplus-Strong Algorithm*)

signal before it is fed back into the delay line, we can control the resonance/damping and the timbre of the synthesis respectively. Once the signal is reproduced as sound by the speaker within the box, the acoustic properties of the box in its environment (what its resting on or if its being held) determine how it will resonate and thus be picked up by the contact mics.

Phase III: Application

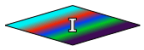
There are two modes to this work, first as an instrument and second as an installation piece or experiential performance art. The former and perhaps most obvious application of the feedBox is as an abstract musical instrument or noise maker for recording or performance. The latter consists of a "new" user being presented with the feedBox in a public space to discover the range of sounds and behaviors and have a tactile exploration of the feedback between the digital model, the analog speakers and mics and the physical box and environment. What I think is most interesting about the user interaction is that even on such a minimal system, not knowing the relationship between the interface and the model's behavior can make it extremely difficult for users to create sustained tones. With a simple explanation, and more importantly the attention drawn to the relevant acoustical properties, it becomes fairly self evident to users how to fully explore the system.

Conclusion

I think there is absolutely merit to allowing for unsupervised discovery in art, however even in traditional fine arts, there is often a baseline of understanding required in order to access the information contained within the language of a given medium. Through the feedBox, we can play with a complex interactive feedback system and through the active efforts of the user, we can use them to achieve specific sustained results. With respect to the larger genre of smArt, the feedBox exists at the simplest example in the range of autonomy. The user's input, the environment around the user, placement of the device and the single internal feedback loop governs the resulting indeterministic output.

3.1.2 "To Tip The Scales of Justice"

Presented in the CalArts WaveCave in October 2019, my piece titled "To Tip The Scales of Justice," is a mobile kinetic sound sculpture controlling a hand-made cassette tape loop quadraphonic system gave users the ability to control the spatialization and the specific category of the subject of the piece, the meaning of the word justice.



Phase I: Form

The sculpture consisted of 8 gilded Styrofoam heads in which users place marbles, hanging from a mobile structure of 2x4 beams with reclaimed iPhone 4's at each of the seven pivot points. The tape loop consists of two cassette players, a magnet, and a hand made loop of tape (~30sec) which takes audio in on one side from the control software and outputs audio on the other to the four speakers. The control software consists of a network in touch designer and a teensy 3.6 that controls the speed of the loop and the relative levels of the four speakers with digital potentiometers. The content that is selected is of audio recordings that pertain to specific categories or ways of thinking about justice: definitions of justice, legal justice, environmental justice, social justice, internet discourse on justice, historical moments relating to justice, academic discourse on justice and justice as it relates to technology. These recordings consist of both real humans speaking and Amazon's Polly text to speech algorithm. Thus, we complete the loop between the physical orientation of the structure, the digital sensor and control network and the analog tape loop and speaker system and taken together, determine specific experience.

Phase II: Function

The system is such that the active interaction of users is in complete control of all the aspects of the piece, but there is no direct connection or indication of how the controls effect the elements of the form. The behavior of the system is such that the head with the most weight (most interaction) determines the perspective of Justice in the audio message that is recorded into the tape loop. This ties the level of interaction directly to the content of the message in a way that is unknown to the viewer, to illustrate the way that our AI/ML based social media systems function, and impact/control the messages and content we are exposed to. As users place coins into eight baskets, the system checks the angular rotation of the 7 iPhone's using Hexler's TouchOsc application and determines which basket is the lowest in the Z dimension in three dimensional space and transmits the index number and XYZ coordinates to a control

network in TouchDesigner as an OSC message. This network selects a recording from the categories indicated above by index number and outputs the audio to the record head of the tape loop as well as the XYZ data as MIDI to a teensy 3.6 which is controlling a series of 6 digital potentiometers. The Z dimension controls the two digital potentiometers that regulate the speed of the motors driving the tape loop. The X and Y dimensions are converted to a polar angle, which is sent to each of the four quad speakers spaced at 90 degree angles around the sculpture such that the spatialization reflects the rotation of the basket. The categories of "meaning" included social justice, environmental justice, legal definitions, academic discourse, dictionary definitions and nonsensical definitions from internet searches.

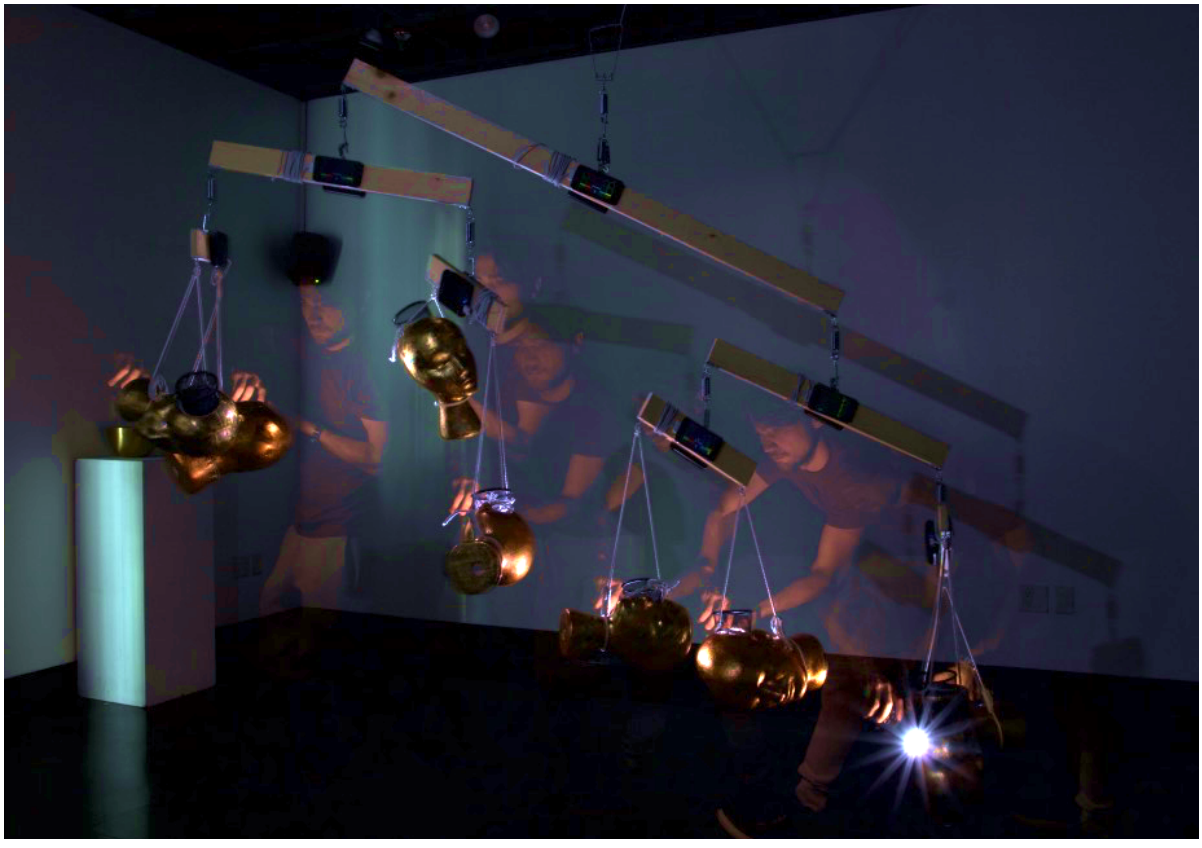


Figure 3-3 "To Tip the Scales of Justice" presented @ CalArts WaveCave 2019

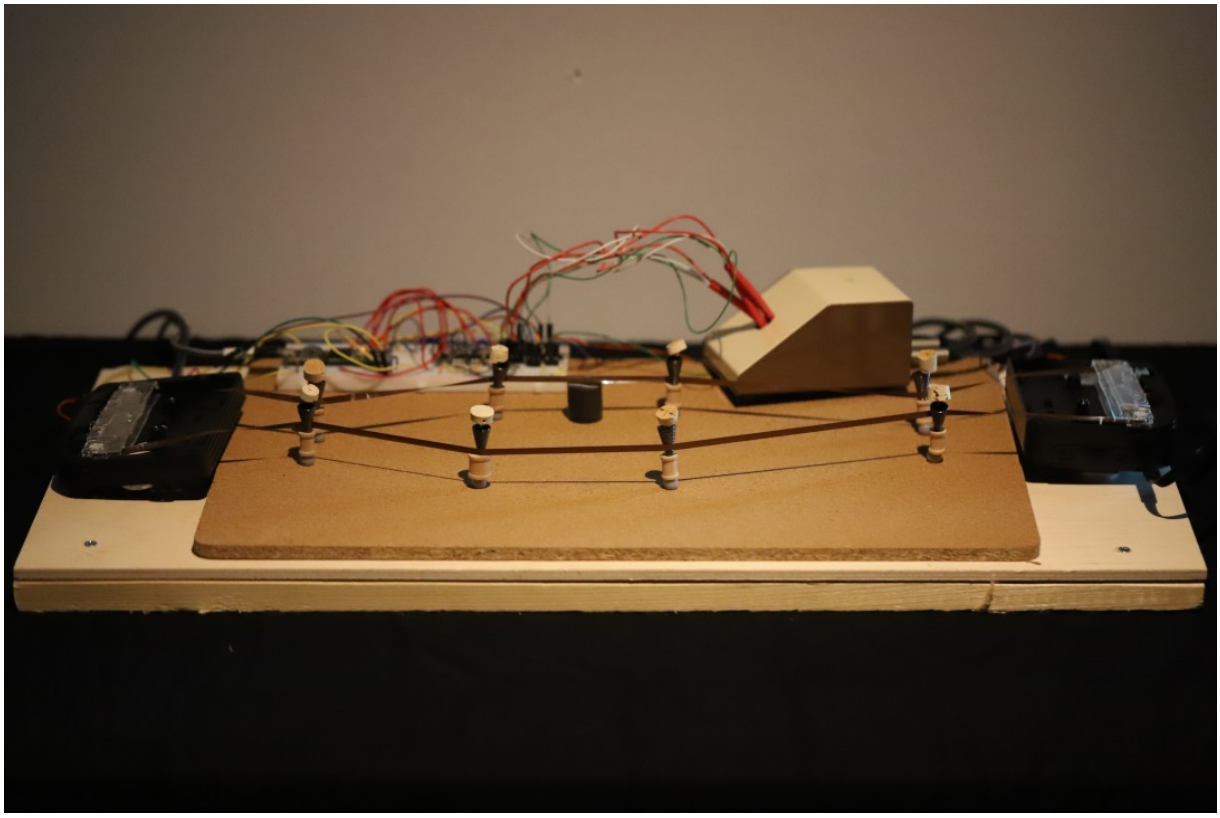


Figure 3-4 Teensy Controlled Dual Cassette Tape Loop and Quadraphonic Mixer

Phase III: Application

The result of this was a deliberate distancing of the user from control of the experience of "meaning" in the piece in a way where they can cause changes to the system but only in a way that is indeterministic. Again, to make tangible the transduction of information from the real through the analog into the digital and back again making subtle changes with each transformation. As a way to summarize the application or intent of the work I have included with Figure 3-5 Kinetic Sculpture @ Equilibrium, the text that was presented alongside the installation:

Figure 3-5 Kinetic Sculpture @ Equilibrium

What is justice? To each individual, some things seem just, some unjust. Each of us forms an opinion based on our cultural background, education, socio-economic status etc., as well as on our individual impression of the world based on our own personal experiences and the experiences of those close to us. As a society, it is of utmost importance that we are able to have meaningful discourse on this subject given that it is in the name of justice that we restrict people's freedoms and still, to this day, execute them.

The concept of justice is something we as Americans collectively tout as a pillar of our national ethos, despite the fact that most of our discourse manifests as gross generalization of legal and political disputes over specific cases. I ask myself why that is the case, and further, why it seems more and more of the conversations that relate to "fairness" come in the form of grievance, some legitimate and some completely absurd. As we further commit ourselves collectively and individually to the implementation of social media and its related technologies, there occurs an abstraction of our social/political discourse as a function of its expression through the system. This installation is an attempt to explore the impact these media systems can have on our understanding of the complexity and nuance of the underlying content.

The primary mechanism of "understanding" that media systems adhere to is one based on engagement. In the digital/information age, this has been further reduced to a binary choice: Either you like something, or you don't. Even if I asked, and you replied, "I can't decide," there exists a large data set collected about your behavior from which an inference will be made about whether or not you're the "kind of person" who likes it or dislikes it. That choice will be reflected in future content that is curated for you. Even though these systems take a wide range of types of input data, the

information is often still reduced to an acceptable range of outcomes based on the same commercial criteria. I would argue that embedding these engagement-driven media systems in our lives has resulted in the further entrenchment of our existing perspectives creating and perpetuating the illusion that shared opinions constitute objective reality. Often the beliefs that are reinforced originate from within these self-selecting systems and are circulated and re-circulated through them, masquerading as social interactions.

This kinetic sound sculpture emphasizes the consumer's participation in formulating and selecting the media through which they access and evaluate information. As they select a head and place multiple coins inside, they change the orientation of the sculpture and the resulting sonic output. Each head represents a different category or interpretation of the term "justice." The heads are distributed in a pattern of binary multiplication, 1248, with 4th generation iPods and batteries at each junction point. The consumer force (capitalism) is represented by the force of gravity acting through the system (media technology) on the heads (you and me), ultimately determining their spatial orientation (perspective). Speed and pitch manipulation and fidelity loss introduced by the tape loop are representative of both the literal information-loss introduced by media technology (that can lead to incorrect judgments), as well as the larger metaphorical information-loss introduced by the use of these integrated, self-perpetuating and commercially motivated media systems. The sonic material consists of real recordings of speeches, lectures and conversations juxtaposed with artificially generated speech based on written text using a variety of commercially available Text-to-Speech algorithms.

Figure 3-6 Gilded Heads

Conclusion

It was my hope that by creating this piece, the viewers would be empowered to interact with the system in original and unexpected ways. In part this is to explore the unpredictable nature of such complex systems from the perspective of the user. This arises from the complex behaviors embedded in digital media and communications systems that are often beyond our understanding and are certainly outside our control. In this sense we are all, through our active daily interactions, contributing to these higher order determinations about the nature of the system and what kinds of messages and content we receive, symbolized by Figure 3-6 Gilded Heads. One particularly interesting result of the installation was that I frequently found the tape loop to be stuck or broken upon entering the room. What I discovered through feedback was that people had been interacting directly with the tape loop itself as well as the kinetic sculpture. While this was not what I had originally imagined, it leads me to conclude that after experiencing the unpredictable results of control in the physical system, some viewers impulse was to find ways to interact that directly impacted the output of the system. In this sense, while the piece does not actively employ AI/ML in its structure, it as a piece is a facsimile of the quality and type of the interactions we have through AI/ML enabled media technology and smart devices.

3.1.3 Bassthoven & Brohzart

Finally, we turn to a pair of algorithms that I worked on with my artistic partner Ben Brodie that can serve as musical accompaniment, as a semi-autonomous performance tool or when used together as a fully autonomous composition system. We named the two algorithms Brohzart and Bassthoven after famous composers from the western cannon, in a way that would be aligned with our Van Broh moniker and brand. In terms of this analysis, Bassthoven was a project that was largely completed by the time Brohzart was in its first iteration and was largely developed by Ben Brodie. My development of Brohzart alongside Bassthoven grew out of the need for both algorithms, but in this paper I will not explore the specific architecture of the Basstoven network, as this was not primary my area of work beyond its application.

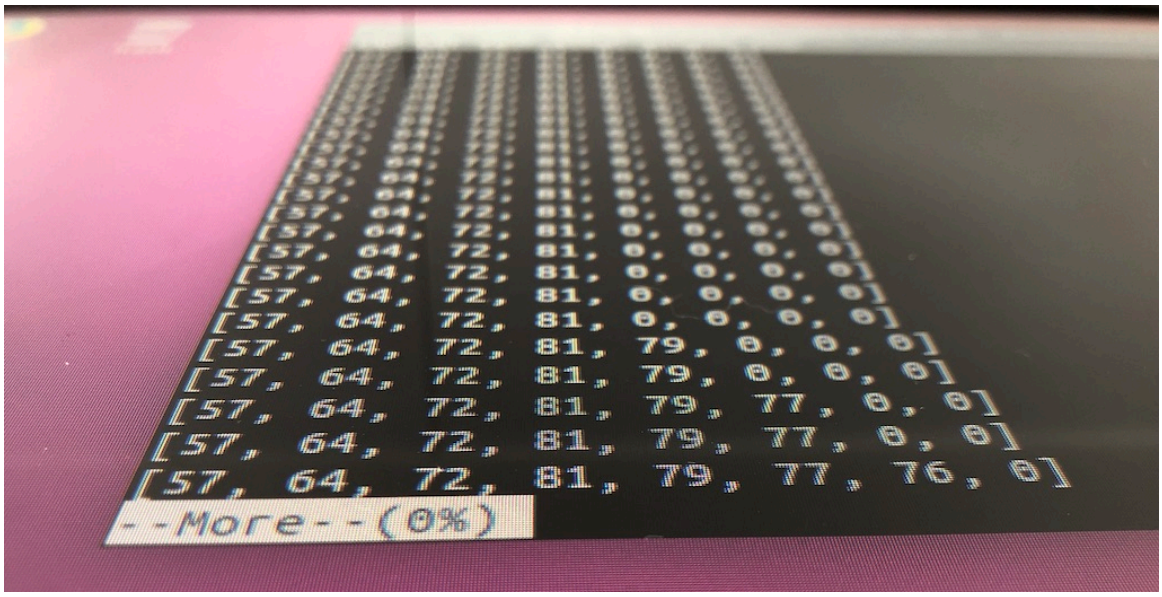


Figure 3-7 Midi Note Array Output of Bassthoven

Phase I: Form

Brohzart is a custom library written in the ChucK programming language that generates stochastic modal musical sequences as midi notes, as well as midi drum patterns. Brohzart has several modes to determine what controls the current chord parameter: a semi random mode where the chord progression is randomized by pressing a designated button, a listening mode where it gleans chords from incoming midi data and a fully random mode where it picks a random chord progression after a designated number of measures. Bassthoven is a customized recursive neural network written in the Python programming language, using the scikit library that as can be seen in Figure 3-7 generates midi notes. Bassthoven's network is trained on Western classical music, music Ben and I wrote, and about four hours-worth of the stochastic output of Brohzart.

Phase II: Function

As can be seen in Figure 3-8 Brohzart has parameters that determine the behavior of the system such as sequence length, tempo etc. are all called by initializing functions and then a p.play() function is called that drives the system and outputs a midi clock to the system/network. Each voice's harmonic and rhythmic behavior is determined by a p.playNote() function and a series of arguments as well as global parameters. These parameters include midi channel and the

sequence index number and can be used to pair voices together as chords. The essential sequencing of the system is based on a regular time division set by the tempo() and a two dimensional array of integers that is the length of the "phrase" in the X domain and the number of voices in the Y domain. Each cell of the array is populated with a random value 0-16 and at each time division is compared to the threshold value set by the first argument of each voice. If the threshold is met, the note is played.

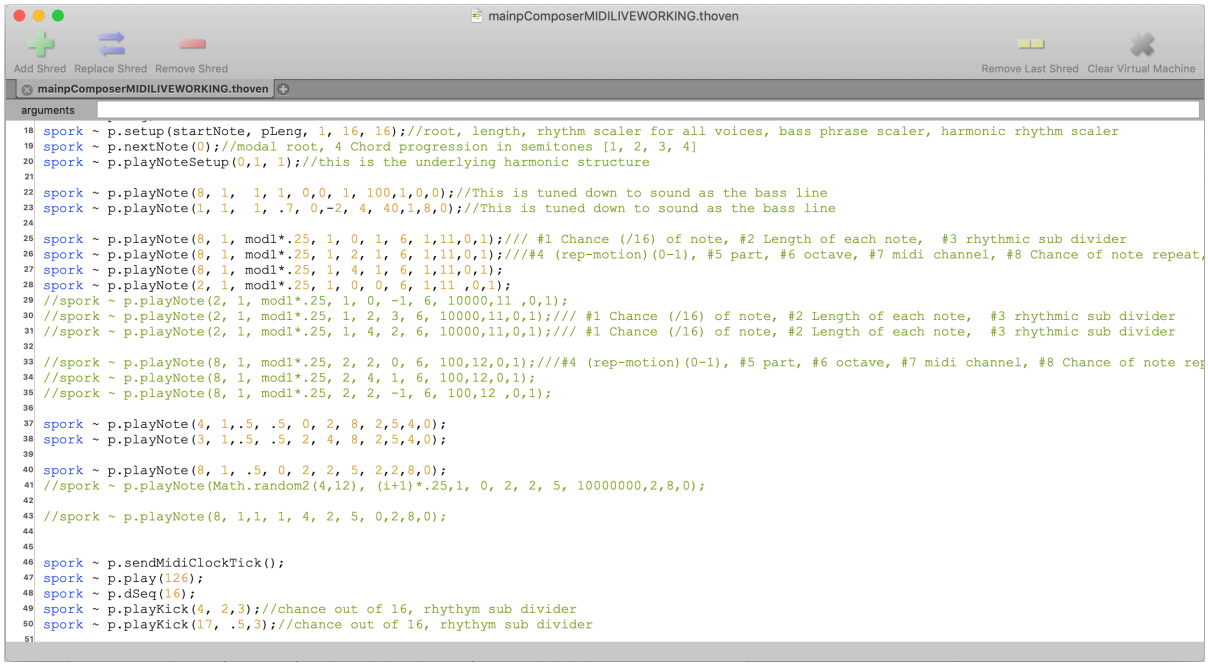


Figure 3-8 Brohzart written in ChucK

The harmonic movement is determined by a "musical" decision tree, governed by a series of arguments that take floating point values that determine the likelihood of a range of possible melodic motions: step, leap, note from a chord and repeat. The drum sequencer's voices function in the same way, but without any harmonic movement. In selecting the chords for the voices to follow, Brohzart can read from an array in memory and/or populate a new array with random values 1-7 corresponding to the roman numeral analysis chord numbers I-vii. There are two banks of four chords that can be used to store progressions and buttons to randomize them and switch between. In addition, there are buttons to randomize the trigger threshold and rhythmic subdivision of the chord voices and the bass line used as a part of stochastic performance mode. Brohzart also has a listening function in which the harmony is

determined by incoming midi data from a selected channel which is parsed into chords (MIDI notes 60, 64, 67, 70 = C Maj7). By sending the Midi output from Bassthoven into the input of Brohzart, we create a fully autonomous composition system for any instruments that accept Midi data. As the Basstoven network is trained on data from Brohzart in stochastic mode and then is used as an input to Brohzart in listening mode to generate the final MIDI output, it is important to note that there is a feedback loop within content used by the system that will emphasize the stochastic "musical" behaviors that are coded into Brohzart's decision tree.

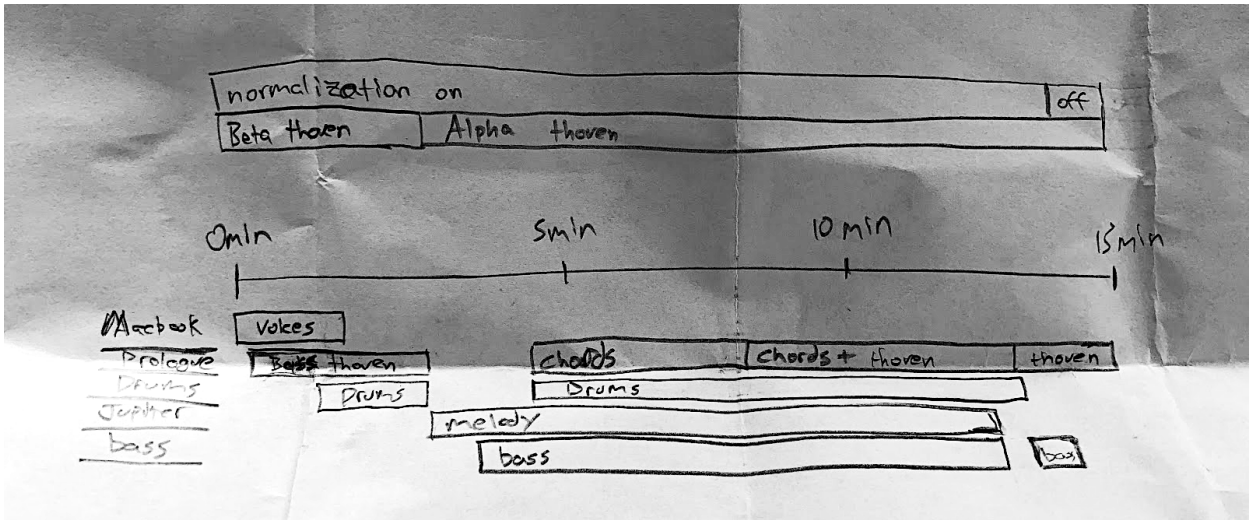


Figure 3-9 Score for "Bassthoven feat. Brohzart" Performed @ CalArts Expo 2019

Phase III: Application

As stated previously, this duo of programs can be used in a variety of ways. Originally, Brohzart was designed simply to generate non-objectionable midi note sequences for testing patches in vst and outboard synthesizers. The first performance of these algorithms at CalArts Expo 2019 of the score in Figure 3-9 titled "Bassthoven feat. Brohzart" highlighted the fully autonomous composition system with Bassthoven controlling Brohzart and in addition this accompanied by Ben and I as the human performers. In other words, we gave complete control of the composition to the Bassthoven-Brohzart system and only controlled production parameters including synthesis, drum sequencing, mixing and effects.

Figure 3-10 Bassthoven @ SupplyFrame DesignLab 2019

The next iteration of the project seen in Figure 3-10 was an installation piece that ran continuously for a week at SupplyFrame DesignLab in Pasadena, CA. This consisted of just the raw Bassthoven algorithm outputting midi notes to a Roland Boutique JU-08 with headphones for listening in order to highlight the machine learning aspect of the project. What was clear from this installation was that while the Bassthoven network clearly had an understanding of common harmonic motion, the specific timing and selection of notes was not in any particular or recognizable style, but rather abstract. In this way, I feel Brohzart represents to Bassthoven the specific cultural traits and constraints that allow us to recognize the resulting output as a style or genre of music. In a sense Bassthoven is accessing something behind music, reduced in a way that it is stripped of referential meaning. Perhaps with additional layers in the network, or additional networks, there would be a way to access both the specific style as well as the underlying musicality.

Last December, Brohzart made its solo debut in a piece performed by the CalArts Machine Orchestra, in which seven players spread around the main gallery were networked via MIDI each performing a different instrument being orchestrated by the algorithm. This performance consisted of Brohzart generating random chord progressions initiated by a button press. The piece was orchestrated by controlling which instruments received MIDI data at a given time using Ableton to route the MIDI to the network. One interesting aspect of this application of Brohzart was adjusting to and/or incorporating the time delays introduced digitally by the local network traffic and acoustically by the physical placement of the audience surrounded by each of the performers' hemispheric speaker arrays.

Conclusion

Bassthoven on its own has the sensory experience of music without being any kind of music, which in a way makes it hyper-musical or of music. Despite the fact they are following the same harmonic line, it requires the application of a Brohzart, with more specific and intentional constraints to meet the basic referential expectations that are required for the listener to categorize it in any particular way. Brohzart in itself gives the user a wide range of control over the predictability of the output but still has a stochastic unguided sound. It is worth noting that Brohzart's function could also be done by a neural network, instead of the stochastic Brohzart system, but would require the additional task of quantitative characterization of styles across a sufficient range of musical understanding to be useful and would not lend itself to interaction or human control.

Chapter 4

Inspiration

In addition to the many writers, mathematicians, artists and philosophers whose ideas I have enlisted in the creation and application of the smArt Framework, I want to highlight some specific sources of inspiration who have really helped me to situate my work within existing discourse both culturally and historically. Furthermore, both sources have reaffirmed my belief that as technology becomes more dominant in the field of art, we must continuously re-evaluate the complex effects on the artistic message and the aesthetic value of a work wherein artists employ semi-autonomous systems or fully autonomous simulations.

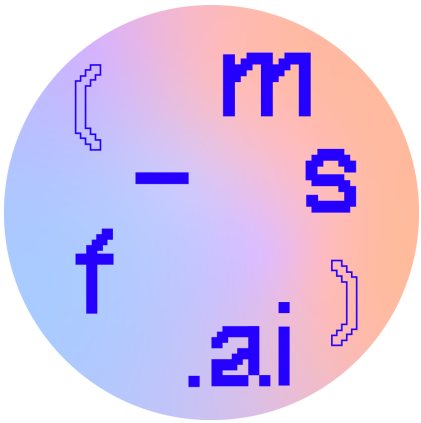


Figure 4-1 Feminist AI Logo

4.1 CAIDT – Feminist AI

The Cultural Ai Design Tool is a generative and exploratory teaching/ design tool in which users establish the relevant context and content of their current or future projects and then frame them through different cultural and social lenses in order to illuminate and explore the potential

social and cultural impacts of the actualization of the project.[96] The CAIDT was developed by Christine Meinders and inspired by and used with the Feminist AI community, and credits Dr. Rebecca Fiebrink and many others for its development. The tool is divided into three parts: Discover, Blueprint, Audit. In the Discover phase, users are prompted to describe their project, themselves and their cultural context and their intended users. The Blueprint phase is at the heart of the design tool and is its own three phase sub-process. First, the user outlines the inputs to the system and source data, the rules or behavior of those programs and models and the material/digital form it will take. This is done by answering three questions: Who created/sourced the data? Who created the rules? What is the form? Then the user selects lenses either from the pre-existing list of community sourced lenses that are included with CAIDT or their own. These lenses represent perspectives and concepts through which one might explore the different aspects of an AI project, such as feminism or privacy. Finally, the user applies those lenses to the input, rules and form to answering the three questions above, updating their answer with new discoveries and insights. The third phase of the CAIDT is the Audit phase where the user is prompted to answer four prompts about the project now that it has gone through the discovery/blueprint phases: What is your project? Where does it live? What could go wrong (socially and culturally) Do you think this is a good idea?. This third phase is a critically important step in understanding the impact that this kind of technology has on culture and particularly communities that are underrepresented in the technology industry.

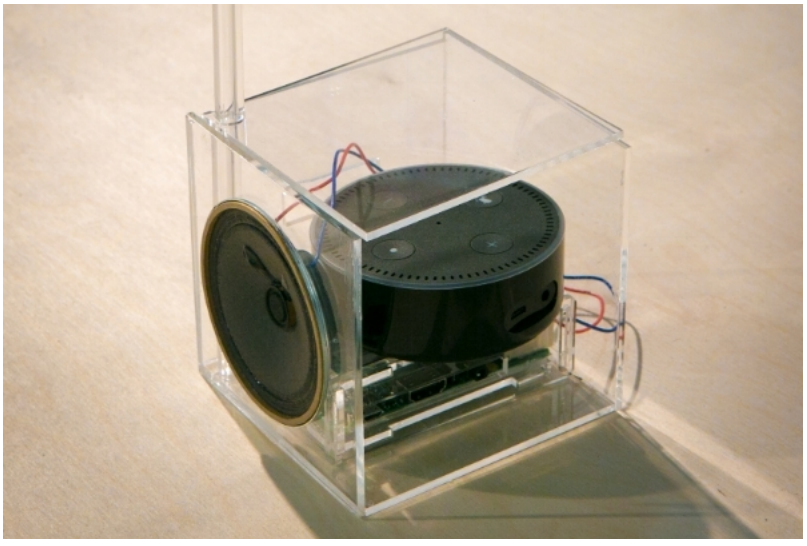


Figure 4-2 "Thoughtful Voice Design" presented in 2016 by Feminist AI.

[96] (*Feminist Search*)

What is perhaps most important about Feminist AI and CAIDT to my work is that it draws attention to the interactions between the different phases of a fully realized work or product; how, for example, the way the data on crime rates in a given area interacts by way of a predictive model with the way the technology is used by local government agencies, and what behaviors or biases are emergent. I have always believed that it is the place of artists in a society to engage in the work of showing culture to itself, and with the rapid development in the field of creative applications for AI/ML systems I believe that there is yet another layer of reflection and super-perspective which can be accessed through this technology. It will all be increasingly meaningless, however, unless we as creators and consumers are able to understand the complex nature of the resulting work. This problem of categorization, summarization and understanding this kind of media has motivated defining the smArt genre and developing the smArt Framework.

The smArt Framework is inspired by and shares many of the goals and approaches of CAIDT, but is more geared towards aesthetic analysis, as a way to simply and effectively represent the artistic intention/meaning of a piece with language, rather than as an generative/design tool. I would argue that the Framework is in a way an implementation or product of the design tool, in that it exists with fixed lenses that I have selected for this specific purpose. There is also a slight difference in priorities between CAIDT and the smArt Framework. Where the former is a cultural design tool wherein the implications are paramount, the perspective from which the smArt Framework approaches Ai/Ml systems includes aesthetic valuation, and therefore degree of autonomy or self-governance takes high priority and has a significant impact on meaning as it relates to artistic process.

My work has benefited tremendously from using the CAIDT particularly in the development of the Brohzart/Bassthoven system. What was perhaps the most interesting in the application of the tool is that the system both in terms of the deterministic rules of Brohzart, as well as the underlying dataset in Bassthoven, is constrained in its focus on western classical music. This is of course because we were aiming to get a specific stylistic result, chosen in part due to familiarity Ben and I both have with Western notation systems and music theory "rules." These constraints ultimately are what we recognize as differences in style or genre and so for the purposes of composing "music" as it is commonly understood, Western Classical music offers a rigorous degree of "objectivity" compared to many other popular genres, in that there is a score and a culture that celebrates fidelity and accuracy. As this was our first foray into creative

applications of AI, limiting our training and our expectations mainly to the genre of classical made it easier (less subjective) to understand the "quality" of the results from the Bassthoven network. Furthermore, given that the application was for use with analog synthesizers, we decided to pick a genre that did not rely as much on referential sounds or samples as many popular genres do, but rather on harmony and structure.

In summary, I feel that there is a critical point of need in our current cultural climate, that we work towards a shared understanding among consumers and creators of AI technology, the unexpected and sometimes harmful consequences of the development and application. It is my hope that through tools like CAIDT that we can start to establish practices in the field of AI, practices that are ethical and sustainable and that benefit culture and society rather than exploit it.

4.2 Naim Jun Paik

Generally considered to be the founder of video feedback as an artistic medium, Naim Jun Paik pictured in **Error! Reference source not found.** was a technologist and artist who is best known for his work with the FLUXUS collective, Charlotte Moorman and his installation work. Paik pioneered a unique vision for the role of technology in culture, and I have found great inspiration in Paik's work and writing. Specifically, his willingness as an artist to exist outside the bounds of a single medium or cultural field and allow his exploration of technology to expand his understanding of contemporary cultural forms. In a letter dated March 30, 1967 to Ralph Burgard, Paik discusses the potential of media technology for broadening existing cultural fields:

> It is a very rare opportunity that an artist is allowed to use various expensive equipment at Bell Labs under the guidance of prominent scientists such as Messrs. M.V. Mathews, P. Denes, M. Noll. I have been studying computer programming for the last year for this prestigious chance, and I and confident of positive results both in short range and long-range projects.… My work will have a great meaning to music also, because it will expand the conventional electronic to 3-D electronic Opera, thus giving new possibilities for composition and distribution.[97]

[97] (*We Are in Open Circuits: Writings by Nam June Paik (Writing Art): Paik, Nam June, Hanhardt, John G., Zinman, Gregory, Decker-Phillips, Edith: 9780262039802: Amazon.Com: Books*)

This resonates deeply with my own journey and approach as technologist and artist. One immediate example is *Lazer Eyes*, our first release as Van Broh, which premiered at National Sawdust in Brooklyn in 2019. *Lazer Eyes* is almost exactly what Paik describes: a two act, multimedia adaptation of modern dance music technology to the operatic format.

Figure 4-3 Naim June Paik courtesy of Smithsonian American Art Museum

Paik's work is well established in the field of contemporary art and new media and I have found great inspiration in his visionary use of technology and his willingness to challenge what I think is a reductive and fearful artistic representation of a future in which technology and nature are at by necessity odds. One great example of this is Paik's "TV Garden," Figure 4-4, an installation piece in which cathode ray TVs are nestled in a beautiful life size garden scene giving the viewer a sense of calm and harmoniousness rather than the standard dichotomy between nature and technology. Furthermore, Paik seemed to understand that the future of the media technology and content it can generate lies in interactivity and simulation of experiences, and like McLuhan, saw parallels in the globalization of media and creative systems.

Originally printed in an article titled "Expanded Education For the Paperless Society" for *Radical Software*, Paik describes the transcendent experience of interactivity in artwork wherein, like a drug, the viewer is creator, audience and critic all at once:

> in the drug experience, all three parties are united into one. A kid who smokes a joint or so is at the same time creator, audience, and critic. There is no room for comparison and grading, such as "first class drug taker" or "second rated pot smoker" etc… This ontological analysis demonstrates to us once again that drug is a short cut effort to recover the sense of participation…and basic cause lies in our passive state of mind, such as TV watching, etc. Can we transplant this strange 'ontology' of drug experience to 'safer' and more 'authentic' art medium, without transplanting the inherent danger of drug overdose??? Participation TV (the one-ness of creator, audience, and critic) is surely one probable way for this goal.. and it is not a small virtue.. not at all.[98]

[98] (*We Are in Open Circuits: Writings by Nam June Paik (Writing Art): Paik, Nam June, Hanhardt, John G., Zinman, Gregory, Decker-Phillips, Edith: 9780262039802: Amazon.Com: Books*)

Paik was crafting works and performances that synthesize the experience of artist, audience and critics by having audience interaction with the piece be critical to its form, presentation and criticism. One example of this is "One Candle (Candle Projection)" originally presented in 1989, in which Paik presents a single candle, with a camera focused on it and a projection of the flame split into its red, green and blue channels slightly displaced from each other. As the audience enters the room, the change in air movement causes the flame to flicker and dance creating the video piece seen on the wall in real time.

Figure 4-4 "TV Garden" by Naim June Paik 2019 @ Tate Modern London, UK

What I realized, seeing his work is that user interaction is not always an active process. Passive interaction can at times be more aesthetically effective and more importantly is often overlooked in the context of autonomous systems. If you consider the perspective that an artist or programmer is finding subjects, random people or specific sources, to sample data from to create a dataset, that is a passive interaction with the system by the sample-ees, which as previously discussed impacts the quality and range of behaviors of the system which in turn impacts the resulting artwork. Paik's use of air as a medium of passive interaction has an active

aesthetic role in the piece, and by extension, we can see that the passive interaction that is the creation and implementation of a dataset is similarly, a determining aesthetic factor.

After seeing his work in person at the Tate Modern in London this past January, I found myself asking what Paik's perspective was on aesthetic evaluation as an performer/artist as well as someone who worked with interactive and indeterministic systems and technology. In his essay, "To The 'Symphony For 20 Rooms,'" Naim June Paik writes about a conversation he had with composer Karlheinz Stockhousen in which Stockhausen challenges Paik's understanding of what makes something aesthetically valuable or beautiful:

> he began to explain that we must get rid of fixed musical form because it is like sex. It has no freedom. It is as old as the theory of tragedy of Aristotle, of Faust, etc. Then Stockhausen explained the possibility of a free and calm love… Next spring, on my way to take a cure at Titisee, while looking out of the window of the moving train, I realized for the first time the old Zen-Cage thesis: 'It is beautiful, not because it changes beautifully but – simply – because it changes.' If nature is more beautiful than art is, it is not so because of its intensity or complexity but because of its variability, abundant abundancy, endless quantity.[99]

Clearly to Paik, the aesthetic value of nature over art lies in the unpredictable and infinitely variable nature of the physical world. Through his connection to John Cage, Paik was exposed to applications of the theory of indeterminism in music. In essay titled "About the Exposition of the music" written in 1963, Paik writes,

> In most indeterminate music, the composer gives the possibility for the indeterminacy or the freedom to the interpreter, but not to the audience. The audience has only one freedom; that is, to hear or not to hear the music going on-a quite old freedom which they had, or were compelled to have, by listening to boring classical music such as Brahm's Symphonies or "Tristain et Melisande". The end result of 'indetermined' music becomes (at least for the audience) usually nothing but a 'normal strip of time-good or bad or mediocre, or very good-strip' of time- a time flow of only direction, as in traditional music, or in our life, destined later or sooner to the certain death with one way-time.[100]

It seems Paik's interpretation of what would constitute a truly indeterministic piece is one in which each audience member is fully able to determine their experience for themselves.

Paik sees his role as an artist not as the direct generator of content, but rather as a purveyor of aesthetic and cultural experiences. Whether this is as a result of technology leading creativity and culture or vice versa, this transformation of the role of the artist is something that

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[99] (*We Are in Open Circuits: Writings by Nam June Paik (Writing Art): Paik, Nam June, Hanhardt, John G., Zinman, Gregory, Decker-Phillips, Edith: 9780262039802: Amazon.Com: Books*)
[100] (*We Are in Open Circuits: Writings by Nam June Paik (Writing Art): Paik, Nam June, Hanhardt, John G., Zinman, Gregory, Decker-Phillips, Edith: 9780262039802: Amazon.Com: Books*)

resonates tremendously with my practice and work with autonomous and semi-autonomous systems. Considering the art-historical context in which he lived and worked, taking all of the agency from the artist and vesting it in the audience was both an innovative aesthetic choice as well as a culturally and politically motivated one. To Paik, human freedom is the ability to express agency, and freedom is good. Furthermore he writes about responding to other contemporary experimental artists and working out how to achieve a truly free creative experience:

> As the next step toward more indeterminacy, I wanted to let the audience (or congregation in this case) act and play by itself. So I have resigned the performance of music. I expose the music, I made various kinds of musical instruments, object sonores, to expose them in a room so that the congregation may play them as they please. I am no longer a cook (composer), but only a feinkosthandler (delicatessen proprietor). This self-degradation gives me also some other unexpected joys, as every self degradation usually does. For instance: they give me possibilities of combining many senses; touching, blowing, caressing seeding, treading, walking, running, hearing, striking etc. … They make music more calm than any former calm music, and they make the room more mobile than any former mobile room; therefore they can exploit a new category between music and architecture… the wise play the wise music, and the stupid play the stupid music; this curious fraternité is perhaps a necessary evil of democracy; even the wisest has no right to compel the idiot to happiness; the freedom is the good, but the compelled good is no longer the freedom, and no-freedom is no more the good. (Berdjaiev) music for the people by the people of the people.[101]

What strikes me as it relates to the context of smArt and the smArt Framework is how that valuation of freedom-goodness changes, when freedom or agency is limited or removed from the experience. I think it is well established that over the last half-century that television, the internet and now social media have exponentially democratized the means of content production and distribution. This has given millions of people the freedom and means to create and distribute all kinds of media artistic, historical etc. The question is, does the "wisdom" or intelligence that we impart into smart devices in order to offer these complex and creative tools deprive us of the freedom of using them in "stupid" or even just unintended ways?

When faced with Paik's perspective on the value of freedom and agency in the artistic process, I ask myself what happens when we start to simulate behaviors within those processes or the process entirely. This leads me to a series of questions: will media continue to serve as a democratizing agent if all or much of the agency lies within the system and it's embedded or networked intelligence, regardless of how well it may simulate human behavior? If creative

[101] (*We Are in Open Circuits: Writings by Nam June Paik (Writing Art): Paik, Nam June, Hanhardt, John G., Zinman, Gregory, Decker-Phillips, Edith: 9780262039802: Amazon.Com: Books*)

agency is embedded in the tools, the range of possible experiences or outcomes will be limited to the knowledge and behavior embedded in the tool. If we optimize our tools to automate higher level tasks, that involves teaching them to recognize the context in which they are needed, by for instance saying, "Hey Siri," or "Alexa." As a byproduct of feedback and optimization, the system "knows" what it can do. In the case of AI/ML, we are interfacing with the systems through higher order communication systems like language and gesture, which involve noise and error and require knowledge base and dynamic sensory analysis (cognition). The user can only offer an input to the network or system and it can only do its best to interpret the input based on the probabilities inferred from the training data and offer an output. While this output may be indeterministic, in the sense that one cannot predict the exact result ahead of time, a neural network trained to compose music like Bassthoven will never suddenly and unexpectedly write symbols or shapes with the MIDI notes. I can however very easily creatively re-interpret the use of a paintbrush from a painting implement to a drum-stick, just by whacking stuff with it. The point is that by embedding the higher order "understanding" into a device or system, we delimit the possible applications of the user, because the device knows what it's functions are and how well it is doing them it will now only function within the context of this "purpose."

Much of the freedom that Paik celebrates and that is cherished in art and aesthetic experiences comes from the freedom of the artist and viewer to subvert or reimagine the purpose of tools, concepts or artistic forms outside and often directly in spite of the intentions of the tool or form's creator. Once again because of the exponentially increasing ubiquity of this technology and indeterminacy introduced by these higher order AI/ML systems, we run the risk that such a vast majority of content will fall within the bounds set up by the technology that it becomes homogenized. I believe the cure to this as with all technology is to equip the users, the content creators and viewers, with the knowledge and tools necessary for them to engage on a personal and subjective level with the creative processes and technology involved.

Chapter 5

Conclusion

5.1 Summary

The primary goal of this thesis is to disambiguate what making something "smart" actually means by establishing the genre of smArt and the smArt Framework whereby artists, audiences and critics can understand and explore the impact of the application of autonomous and semi-autonomous systems on creative processes and complete works and their aesthetic evaluation. Degree of autonomy is defined by the ability of a system to self-regulate or change its own processes as a response to its own output. The minima of the spectrum of autonomy is the simplest biological or electromechanical feedback loops upon which all more complex systems are built. Toward the maxima of the spectrum of autonomy (at least from our perspective as humans) is animal biology, with human agency at the top. Leveraging this autonomy in a system for creative ends means embedding the system with some degree of creative autonomy and therefore control over the artistic output. In the case of machine learning and neural networks, the program is simulating human learning and behavior and therefore simulating human creativity. By framing creative autonomy as agency within a given system or cultural field, the application of an autonomous or semi-autonomous system causes the larger artistic process to become indeterministic. Furthermore, the interaction between artist and system in the process of making is communication; an information exchange which involves fidelity loss through environmental noise and error. By understanding our own creative agency as a combination of habitus and doxa and the simulated agency of a "smart" system as program and database, we can explore the complex interaction between (real) human artist and (simulated) "smart" system.

First, we can compare the relative level of agency, by establishing the elements of the form and who or what has control of them. Second, we can evaluate the behavior of the system by analyzing the nature and of the agency involved. This involves exploring the interaction between the habitus of the artist, the behavior of the system and *how* that is manifested in the viewer's experience. Finally, we can evaluate the application of the simulated agency by the artist and whether it improves or detracts from the work both as it exists at the time of viewing and how it and its perception or position within the cultural field will evolve over time.

5.2 Primary Contributions

In my solo and collaborative work exploring the genre of smArt, I have been seeking to conjure unique and fascinating experiences for users or viewers by confronting them with the realistic and sometimes unexpected results of collaboration with self-regulating systems, both as a subject and as an artistic practice. Put simply, I have always been fascinated by the feeling that these devices and tools have "a life of their own," and have tried to explore critically what the nature of that "life" or indeterminacy is. The feedBox, in the most direct way, puts an instrument in the hands of the user with no instruction, cultural reference to other instruments in the form of familiar mechanisms of control and by interacting with the object physically, the viewer can create for themselves a Paik-esque object sonores experience. "To Tip the Scales of Justice," is a kinetic sound sculpture that utilizes smartphones to give the sculpture the ability to sense its position and movement and alter the perspective on the concept of justice of the spoken audio depending on its orientation. The sound is played through a quadraphonic cassette tape loop at a speed and spatial position determined also by the orientation of the sculpture. Finally, Brohzart and Bassthoven are a pair of algorithms developed with Ben Brodie to work both as a collaborative music making tool and as an autonomous composition system.

5.3 Final Thoughts

There is much discussion of the ethics pertaining to the implementation of Artificial Intelligence (AI) and Machine Learning (ML) systems, however participation in, let alone practical understanding of, these discussions suffers from the extremely high barrier of entry presented by the complexity of the systems themselves. In other words, the average consumer who interacts with AI/ML technology has very little understanding of how it works or how it's implemented at scale. By the same logic, the average artist or art consumer has very little understanding of how such technology works and thus how it might or might not be used to its fullest as an artistic medium. This is not for lack of trying. The vast majority of interactions we currently have with AI/ML systems are passive, in that we do not participate in choosing how to implement these algorithms, they run perpetually or are called automatically on our phones and other devices in the form of "features" like faceID or Alexa. Any company that does or might invest in AI/ML research and/or application through a "product" has a vested interest in protecting their intellectual property as well as the "barrier of entry" created by the complexity of the systems involved and the knowledge and experience required to implement their platforms. They have even created a segment within consumer electronics, "smart devices," to help culturally distinguish this sphere of interactive, networked, AI/ML driven technology from standard PC based digital computing.

In the current world of consumer electronics, the concept of a "smart" device denotes the implementation of some form of autonomy or self-governance either embedded onto the device or via internet access. Initially, the category of "smart" devices was an aspirational branding term that denoted increased interactivity and connectivity, beginning with the introduction of the iPod and popularized by the mass adoption of the iPhone and the subsequent "smart" Phone model, including Google, Samsung, Motorola and all other major phone manufacturers. {Date + Source}. The "smart phone" model can be identified by design and function: these include the large touchscreen, camera, phone and wifi connectivity, data transfer networking and storage capability (photos, text, email, social media) and some audio player features, a speaker and headphone connection. "Smart" devices, specifically phones, have revolutionized our culture, as well as the nature of interactions between culture and technology, for example the global rise of mass participation in "social media" in the 21'st century. Unsurprisingly, the implementation of these devices in our daily life has had dramatic effects on

how each of us functions in the world and participates in culture. In many ways this has been a tremendous positive force; it has increased access to information, it has given a platform for expression to people who would otherwise be without one, and it has connected us together globally in a way that was previously unimaginable. There are however many cultural, social and economic problems that have arisen as a result of the introduction of smart devices which I generally refer to as "bad outcomes." These include bias, decreasing attention span, privacy concerns and a general obfuscation of the "truth" and "reality" as a result of sheer information overload as well as the work of anonymized bad actors. Obviously the advent of the internet was a necessary precondition for the effects of "smart" devices to propagate, however the distinction is important between the interface itself (smart device) and the means and conditions by which it accesses and handles user data and creates and contributes to databases, given that the onset of these cultural and economic changes occurred most dramatically as these devices and data collection more generally became widespread, almost a half century after the advent of the World Wide Web. This phenomenon is colloquially referred to as the rise of "Big Data." This paper explores the effects and effectiveness of artistic applications of smart devices and systems in these terms: the underlying technology, our cultural understanding based on media representations and the practice of leveraging these devices and their related technology to create art. I have come to believe that the resulting work of such processes is distinct in its nature and perspective from other artistic methods due to the dynamic and self-propagating structure of the systems (creative practice), and therefore adds a dimension, layer of meaning or type of information that becomes part of the dialogue with the viewer/audience. Because this represents a unique and continuous mode of interaction between the artist, the viewer and the artifact itself, it seems useful to define the concept of smArt and a smArt framework, which refers to a category of art which employs autonomous or semi-autonomous systems and a subsequent framework for incorporating the material and functional elements introduced by AI/ML within an aesthetic analysis.

It is my understanding that art exists as a result of an individual imbuing an object or physical action with a predisposition (force or significance that relates it to the creator). To use some "extreme" cases, Deschamps's fountain qualifies as art in my understanding *because* of the significance implied by the gallery presentation (regardless of the work itself). Similarly, Cage's 4.33 places a tremendous significance on the naturally occurring sounds in a performance space, despite the fact that the substance of the piece presents "silence" as a vehicle through which we

can experience the self-awareness that is evidently what Cage found significant. Thus art, in my view, can be defined as anything in which aesthetic meaning or value is bestowed by a creator and conveyed to a viewer or audience. In most cases this relationship comes into being in some physical form or action and is further defined by exposure of this artifact to an observer as a consequence of them defining their own relationship to the artist-work continuum. Each of us, based on our own unique characteristics, spectrum of perspectives and predispositions within the field of culture, will have a slightly different positional relationship to the artist-work and therefore a different interpretation and understanding. Art is therefore highly subjective in that the positional relationships of the observers, as defined above, will almost never be identical and therefore are highly indeterministic. It would seem that the point of "art" as a classification is to distinguish a category that employs subjectivity as its primary mode of consumption and subsequent understanding. Something is "art" if it leverages subjectivity to evoke a response in the observer. It would follow then that something is "science" if it leverages objectivity (uniformity of experience) in order to evoke a response, however I do not intend to present these ideas as mutually exclusive or in any way at odds, in fact quite the opposite.

This paper explores the practice and implications of using AI/ML to "artistic" ends as described above. Due to the way in which the training data is collected, analyzed, and subsequently implemented, current AI/ML systems exhibit behavior that exists beyond the bounds of a singular experience-based relationship between the artist and the medium. Art that is created using AI/ML systems would therefore reflect not only the artist's predisposition, their unique relationship to the work, but the convolution of that subjectivity across all the individuals' subjectivity whose behavior is collected and normalized into data-points used in training the model as well as that of the designers of the model's architecture and the underlying technology (software, hardware etc.). I would argue that what this constitutes is art that represents the synthesis of a collective predisposition of a group of individuals as defined by the artist's choice or selection. In other words, the artist, in addition to invoking their own personal subjectivity in the making process, is invoking/representing a super-subjectivity as experienced by the audience/viewer through the output of AI/ML systems.

In my estimation, art is defined by subjectivity (perspective), and what makes each of our 'subjectivities' unique is the fact that our singular experiences cannot be directly shared between individuals except through communication: the use of an externalizing medium or symbols. In the way that art is representative of the individual artist, it is my hypothesis that smArt

represents the embodiment and presentation (synthesis/simulation) of a group of individuals, more specifically the complex interactions (entanglement) of their myriad predispositions. This represents an artistic method of exploring and evoking the predisposition of groups, from which a new and kind of circular and dynamic relationship, previously impossible to create, is made between the smArt object and the individual viewer. To give an example, AI/ML implementations in a field like human resources or policing have been culturally problematic to date because they exhibit/express biases that already exist within the subjects of sampled data or in the application of the system. This act of designing and implementing such a system, if done as an artistic work or gesture, is actually quite valuable and powerful in what it can then "mean" to the individual viewer. It becomes possible to embody and conjure in a repeatable way through interaction with a simulation, a dynamic representation of a super-perspective on human behavior which can be evaluated by critical means that currently define aesthetics, culture and technology. This requires the incorporation of the programmatic function, the underlying sample data and the method and scope of application into the traditional aesthetic analysis of the work. This is different from collaborative art in that collaborative art is either a representation of individual's fixed perspectives translated into media and juxtaposed for artistic effect. For example, the actors on a stage each embody their character and evolve dynamically over the course of the plot. The actors learn direction and text but their collective interpretation, actions and interactions, are what constitute the thing we call a play. AI/ML systems have by their nature complex and dynamic interactions between data (samples) and architecture (program), and therefore the "juxtaposition" of individual perspectives happens before and during the learning process as well as referentially at the output (presentation) stage.

One major conclusion I have drawn from this effort to define this category is highlighting the importance of the difference between the simulated indeterminism presented by AI/ML systems that have what I call super-perspective and the chaotic reality of the task itself wherein individuals try to quantify the perspective of groups. The very term "smart" used to describe devices and systems, implies knowledge, understanding and learning. Importantly, knowledge implies some fixed understanding of what is possible or is "true" about the universe, what is known and by negation what is unknown. Similarly, understanding implies an ability to filter information to recognize and reproduce patterns to communicate; learning implies the dynamic application of quantitative and qualitative analysis to modify and expand knowledge and understanding.

Many people, especially those with a financial interest in controlling the cultural identity of "smart" devices, have proposed a simple justification for the use of these technologies which is based on the idea that if we can get a large enough and diverse enough sample size we can use AI/ML to simulate human behavior, and then substitute it for humans. This premise however relies on the idea that given this ideal dataset, the algorithms can be perfected to extract some understanding of "objective truth" and by harnessing that can perform complex and dynamic tasks from an "objective" perspective. This notion on its face is quickly refuted by the prevalence of bias and error in these systems. I would additionally argue that any understanding or agency that is gleaned from such a dataset, regardless of how ideal, is not from a singular-objective perspective but rather a definable collectivized perspective of the parties who happen to be involved with the particular model and implementation. Both cases involve generalization and therefore indeterminacy, but the former (objective) ignores the known cultural feedback interactions introduced by AI/ML technology and all the participants which complicate and constrain the perspective from which a given model makes an inference or computes an output. Put more simply, because we can categorize the sample dataset, the application and the desired behavior, we can operationalize this layer of control/programming as artists in the creative process in order to present a new perspective on humanity.

5.4 Future Work

The main consequence of this work developing the smArt Framework has been the concept for "David Attenbotto" - an experiment in trying to capture the essence of smArt. Still in development, David is an AI/ML system that utilizes open source models OpenCV, GPT-2 and Tachotron, a camera and a projector to create a perpetual human-nature documentary. Objects that appear in his field of view are recognized, elaborated on in encyclopedia style and then synthesized as audio in the voice of BBC documentarian and the voice of "Planet Earth," David Attenborough. This audio is overlaid onto the footage used in the initial object recognition and

projected for viewing. The goal of this specific work is to present for the viewer the "natural' world of humans as one of objects and our relationship to them; homogeneity through mass production. Branding of products, consumption of those products, waste and occasionally recycling of those products once they are deemed "used," all of these processes that pervade our modern lives that relate us to specific objects and the meaning we as a culture have invested in them. If planet earth is a project centered on a fascination and reverence for the complex processes and products of the natural world, it is my goal to present though "David Attenbotto" the same fascination and reverence directed at us with a similar aloof and inquisitive perspective. The larger goal of this work is to explore the new levels of referential and meta meaning that is invoked by smArt works. It is my hope to highlight the dynamic interaction between the sensory input and the super-understanding of objects and the language we use to describe them. It is in this way that smArt works can represent or expose the nature of understanding itself. By peeling back the layers of complex reality and giving us a window into the inner workings of what is common among human minds, smArt can allow for an exploration of new perspectives, perhaps on what if anything makes each of us as human beings truly unique or exceptional.

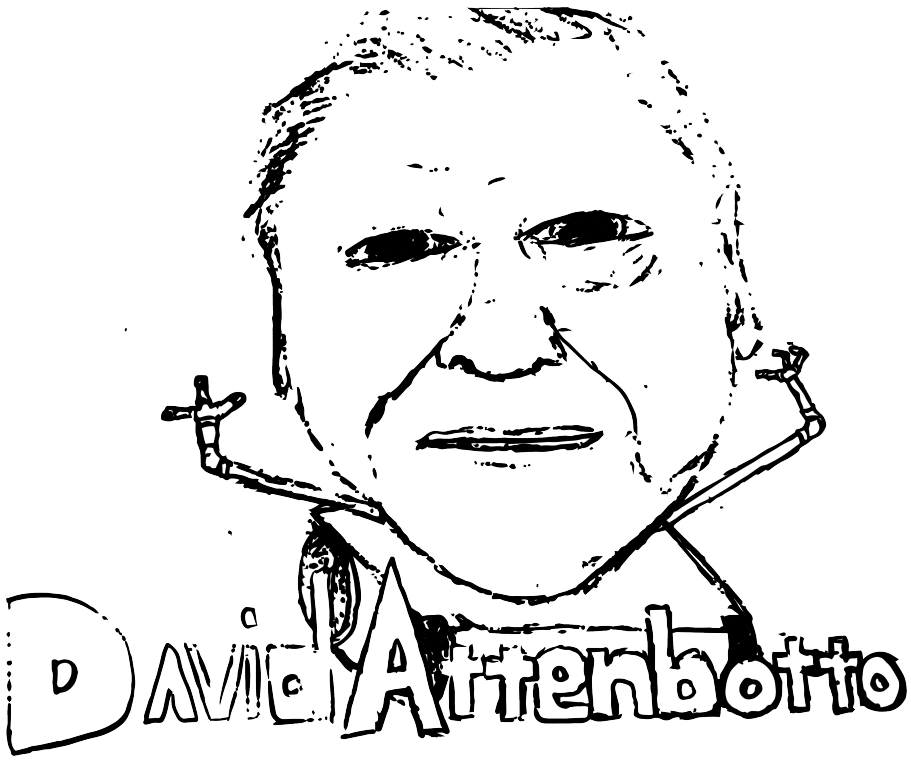

Figure 5-1 "David Attenbotto" Concept Art

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