UNIVERSITY OF CALIFORNIA, SANTA BARBARA

Translating Between Art and Technology Through Interactive Visualizations

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in

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By

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ABSTRACT

Translating Between Art and Technology Through Interactive Visualizations

By

Xindi Kang

In the practice of media arts, which resides at the intersection of art, engineering and science, seamless communication between disciplines is crucial to creating work that can make an impact in all three areas. The need for a language that enables effective communication between artists, scientists and engineers becomes more prominent as experts from each field strive to push boundaries in their research. In this master's project, I propose several approaches utilizing abstract representations afforded by interactive visualizations to translate between discipline specific languages, creating works that are understood and valued by researchers in fields ranging from arts and humanities to engineering and data science. I will introduce two case studies in support of each of the proposed approaches, demonstrating their translating effect in both interactive art and data visualization.

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Chapter 1

Introduction

Humans discover the world in many ways. In most cases, people acquire information through sight, hearing, touch and various sensory modalities, then process them in the brain in order to form a cohesive cognition of a subject matter. Naturally, in a complex human society, people often discover through communication that their cognitions of a certain matter may differ based on each individual's distribution of their sensory capabilities, and hence our understanding of the world is more complete through this communication between different cognitions. For example, some people may distinguish oranges and lemons through sight, while others do so through taste. In the same sense, the complementarity of various cognitive and sensory capabilities within and among different individuals in a larger cultural and societal context form the force that drives the acquisition of knowledge.

While the benefits of communication between different senses and cognitions may seem obvious, the integration and conversation between disciplines have not always been an easy task. Especially between subjects utilizing different cognitive abilities, achieving effective communication and gaining mutual understanding have always been an ongoing dilemma, and the tension between the disciplines of art, science, and technology is a typical example.

1.1 Background

In the 21st century, the field of art and technology has been widely regarded as a melting pot for artistic expression and scientific inquiries. However, these disciplines are often treated as separate ends of the spectrum, with "science as the logical 'left brain' expression of human endeavor and of art as the lateral 'right lobe' activity" [1]. Therefore, the advancement in the communication between the two has required strenuous effort from both sides. As British novelist and scientist Charles Percy Snow (C.P. Snow) stated in his 1959 lecture "The Two Cultures", communication between humanists and scientists have been greatly obstructed by the gulf created by the lack of mutual understanding. As many artists and scientists involved in the field of media arts would resonate with, C.P Snow lamented in his lecture: "A good many times I have been present at gatherings of people who, by the standards of the traditional culture, are thought highly educated and who have with considerable gusto been expressing their incredulity at the illiteracy of scientists. Once or twice, I have been provoked and have asked the company how many of them could describe the Second Law of Thermodynamics. The response was cold: it was also negative. Yet I was asking something which is about the scientific equivalent of: 'Have you read a work of Shakespeare's?'". As his action of publicly revealing this long-standing conflict generated heated debate [2], the world began to shift their focus onto the value and significance of interdisciplinary research and education. Thanks to this shift of focus artists and scientists are able to collaborate and form the field that is known as media arts today.

1.2 Motivation

Albert Einstein once said: "After a certain high level of technical skill is achieved science and art tend to coalesce in aesthetics, plasticity, and form. The greatest scientists are always artists as well". I cannot agree more with this his point of view. Deep in my mind, the idea of art and science have never been two separate subjects. However, looking at the real world and interacting with people from different fields, I found that the presumed dichotomy between art and science is still much more prevalent than the idea of their unification. As an art student growing up in an engineering family, I have always wondered why I was taught only to choose one between the two, as if choosing to learn one of two different languages. What can I do to help build a bridge over this gulf dividing these two fields that are meant to complement each other?

Likewise, these questions have been my motivation throughout my graduate study at MAT, as I face these questions in every class I take, and every project I do. When I encounter people from outside the media arts community, I find myself constantly having to explain why is pursuing hybridity in art and technology significant? This question is often a challenge to answer, as I am so used to this concept but often forget how it came about.

While answering the first question, another question automatically comes up. How to translate between artistic expression and technological expertise? Coming from a fine art background in undergrad and entering a field heavily intertwined with technology, I find myself constantly having to jump between two languages, the language of art, and the language of technology. I believe only by answering these two

questions, I can find my place in such a diverse community, and develop a language that can help me understand and communicate to artists, engineers and scientists equally.

This paper will attempt to answer the two research questions. I will approach the first question by explaining the history of the relationship between art and technology, how they became two separate fields and how they are gradually come together as time progressed, and answer the second question, by introducing my approach to translating between art and technology. After that I will demonstrate how I incorporated these approaches into my practice through two projects I have done in my master's study, with one representing my creative practice in interactive installations, and the other representing my methods in designing data visualization.

Chapter 2

History

In 1959, British scientist and novelist C. P. Snow, in his influential Lecture "The Two Cultures" brought out the dilemma that he faced as a scientist and an artist by saying:

> "Two polar groups: at one pole we have the literary intellectuals, at the other scientists. Between the two a gulf of mutual incomprehension. [3]"

We can see from this quote that at this time, the separation between art and science has become a very imminent problem. His entire lecture, if fact, focused on the prejudice that hinders communication when artists and scientists collide, as if two people are speaking two different languages.

Although Snow's lecture happened in 1959, the prejudice standing between art and science can be traced all the way back to the 1830s, when the word 'scientist' had been coined in counterpoint to 'artist' [4], in order to form a sense of distinction between two professions. But like an ancient Chinese idiom says: "Those long united shall be divided, those long divided shall unite; such is the way of the universe." So after nearly two centuries, with the tremendous advancement in technology, the world

is finally beginning to see the value in uniting artists and scientists, as it is an imperative way forward in human development.

2.1 The 4th Industrial Revolution

To begin understanding the motivation for hybridizing art and technology, we first need to understand the process that led to fundamental societal changes throughout history. While the 1830's was when science and art began to part ways, it is also the dawn of the first industrial revolution, where humanity had just begun to taste the power of the machine. It is around this time, the word "machine" started to take root in people's lives, and really shifted people's attention towards the power of science and technology. But as time progressed, the word "machine" and has been re-defined each time technology goes through revolutionary progress.

During the first industrial revolution, which happened in the late 18th century, the steam engine was invented, jumpstarting the speed of physical traveling of population and goods; Then in the second industrial revolution around mid-19th century, the advent of electricity began to infuse into machines like the circulating blood in veins. A century later, in the third industrial revolution, which is around the same time when C.P Snow gave the "Two Cultures" lecture, information technology and the computer redefined the machine as an intelligence that speeds up calculations, extending the speed of the human brain's logical operations. Towards the end of the century, just like Alan Turing predicted in 1950, machines are no longer defined as moving, but also "thinking". Finally, in the 21st century, many experts argue that we are currently going through the 4th industrial revolution, where cyber physical systems such as auto-driving technology, and AI such as personal assistants like Siri and Alexa,

are machines that are becoming more intangible, invisible, and multimodal, they are "redefining and blurring the boundary between the digital and physical worlds [5]". Our current technology is enabling the machine to see, hear, and feel. We are hoping to see them connect emotionally and create expressively, just like a human would. This requires the creators of the machine to be able to translate from the physical to the virtual, and from one modality to another. And this ability is exactly what abstract artists have been perfecting in their practice for the past century.

2.2 From Language Translation to Modality Translation

Historically, the discipline of translation studies has long been intertwined with many other important areas of study such as religious studies, philosophy, cultural studies, medicine and so on. The first emergence of language translation began as early as 1st century BC when Roman scholar Cicero translated Greek Philosophy into Latin, as well as during the Han Dynasty in China (1st century CE), when Buddhism started spreading in the country and Buddhist scriptures were translated from Indian languages to Chinese. Translation studies became an official academic discipline that is set apart from linguistic and literary studies in the US by the 1960's in the US [6].

Just as the development of language translation was driven by the desire to spread ideas and knowledge (e.g., philosophical ideas, religious teachings), the translations between modalities are driven by the same force. In order to express ideas to an audience as wide as possible, people naturally seek beyond verbal and written language to achieve better results – creating various fields enabled by multimodality (e.g., theater, film, games and so on). In fact, multimodality as a phenomenon has

received increasingly theoretical characterizations throughout the history of creative expression, and has been studied at least since the 4th century BC, when classical rhetoricians alluded to it with their emphasis on voice, gesture, and expressions in public speaking [7] [8]. In the 21st century, with the advancement in technology creating a myriad of expression channels, multimodality has been accepted as the norm for many decades.

2.2.1 Audio - Visual Translations

When thinking of the modes of multimodal expressions throughout history, theater, film, dance and many forms of art comes to mind. But one of the most fundamental forms of translation between modalities can actually be found in a seemingly mono-modal way of creative expression – painting, particularly in abstractionist paintings in the early 20th century, when artists such as Umberto Boccioni and Wassily Kandinsky seek artistic expression through abstractly incorporating motion and music in their work.

As one of the pioneers of the Futurist Movement, knowing that perfect representation was already available through photography and cinema, Boccioni expressed his unique perspective on dynamism through his paintings and sculptures. One of my favorite examples is this piece shown here titled: Horse, Rider and Buildings (Figure 1). Upon closer look, we can see a rider racing though the city, as we can still see representational components of a horse, and rider and the 3D geometries in the background representing buildings. But we can also see that this work is not bound by the rules of realist representation, and visually defined an abstract concept of speed, as commonly depicted in Futurists works which celebrates the speed of industrial

developments. In this painting, “rather than trying to imitate or mimic motion, (Boccioni) intuitively conveyed the truth of motion through abstract means [9]”.

Figure 1. Cavallo + Cavaliere + Case (Horse, Rider and Houses), Boccioni 1914

Another Futurist and Expressionist painter, Wassily Kandinsky also demonstrated a trans-modal approach to his work. In 1896, Kandinsky at age 30, abandoned his successful career in law and economics, began to experiment with art through oil painting. Perhaps it was his interdisciplinary background that gave him a unique perspective that allowed him to push the boundaries of abstract visual composition.

Even further removed from realist representation than Boccioni, his work can be described as a visual symphony, as they often reflected synesthetic senses, meaning

the blending between senses of sound, color and so on. For Kandinsky, music and color were inextricably tied to one another. So clear was this relationship, that Kandinsky associated each note with an exact hue [10](Figure 2). He once said, "the sound of colors is so definite that it would be hard to find anyone who would express bright yellow with bass notes or a dark lake with treble."

Figure 2. Composition VI, Kandinsky 1913

In Kandinsky's later compositions, such as these experimentations with more geometric and three-dimensional components (Figure 3), he not only reflected aspects of music but also movement, a subject that Boccioni had focused on. In a sense, he has shown his effort in incorporating multimodal expression into his work. In his book *Concerning the Spiritual in Art* in 1911, he described this effort as the "desire for rhythm in painting, for mathematical, abstract construction, for repeated notes of

color, for setting color in motion [11]". This concept is a highly prevalent method and a guiding force for 21st century media artists that are taking art creation to a higher level with modern technology.

Figure 3. Jaune Rouge Bleu, Kandinsky 1925

The same theory is also applicable to the composition and notation in contemporary classical music, represented by John Cage, Iannis Xenakis and Gyrogy Ligeti. The figure below (Figure 4) is a graphical score for Ligeti's electronic piece Artikulaition, created by designer Rainer Wehinger (Figure 4). In this graphical score, although frequency is plotted with approximation on the Y-axis, the colors and abstract shapes plotted against time increments in seconds resembles the accuracy provided by traditional notation. Since the sounds in the piece are different from traditional classical music, modalities such as colors and shapes became the key to

representing the work. The overall stylistic choice shows high similarity to the synesthetic expressions in some of Kandinsky's work.

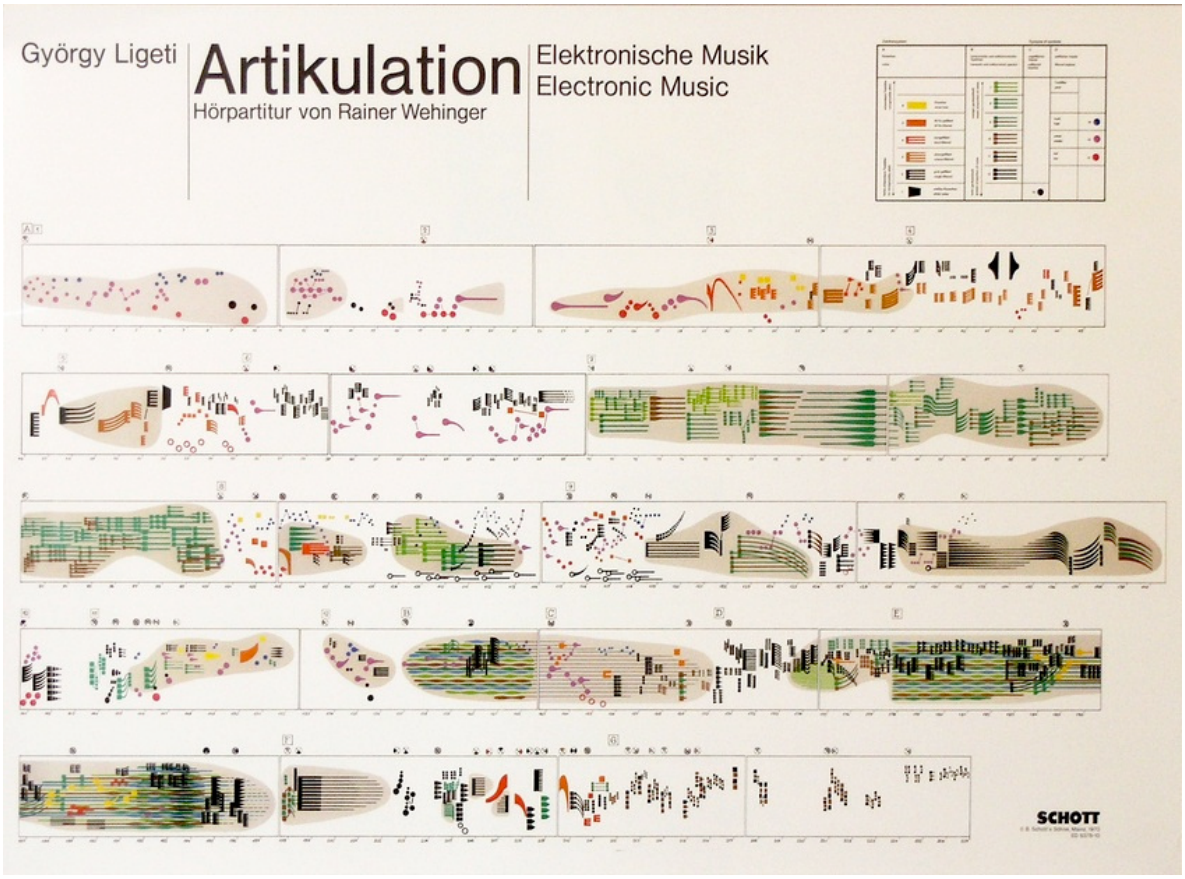


Figure 4. A graphical score for Ligeti's Artikulaition by Rainer Wehinger

While the score shows the translating effect of visual language. The musical piece itself, created 12 years before the score came out, demonstrates a trans-modality approach as well, as Ligeti was inspired by "the age-old question of the relationship between music and speech". He explained that "the piece is called 'Artikulation' because in this sense an artificial language is articulated", and the sounds represent "question and answer, high and low voices, polyglot speaking and interruptions, impulsive outbreaks and humor, charring and whispering". Like many visual artists,

Ligeti is using a non-verbal form of language to reveal an abstract concept and expressing his sense of wonder to what technology provide for his music.

2.2.2 Data – Visual Translation

As translations between sound and visual can offer ways to express abstract concepts, translations between data and visual helps us acquire hidden insights. Data scientist utilizes visualizations to achieve their analytical goals, and artists can generate data narratives and data-based art through data visualization. Since data visualization requires both design skills, statistical skills and computing skills in order to visualize data effectively, it is both an Art and a Science [12].

An early example of data to visual translation is a visualization created by Charles Joseph Minard in 1869 (Figure 5), depicting the horrific loss of life that Napoleon's army suffered in 1812 and 1813, during its invasion of Russia and subsequent retreat. The tremendous numbers of casualties suffered by both armies are shown by the thinning of the lines, as 1 millimeter of thickness is equal to 10,000 men. The graphic is notable for "its representation in two dimensions of six types of data: the size of the troops; distance; temperature; the latitude and longitude; direction of travel; and location relative to specific dates [13]".

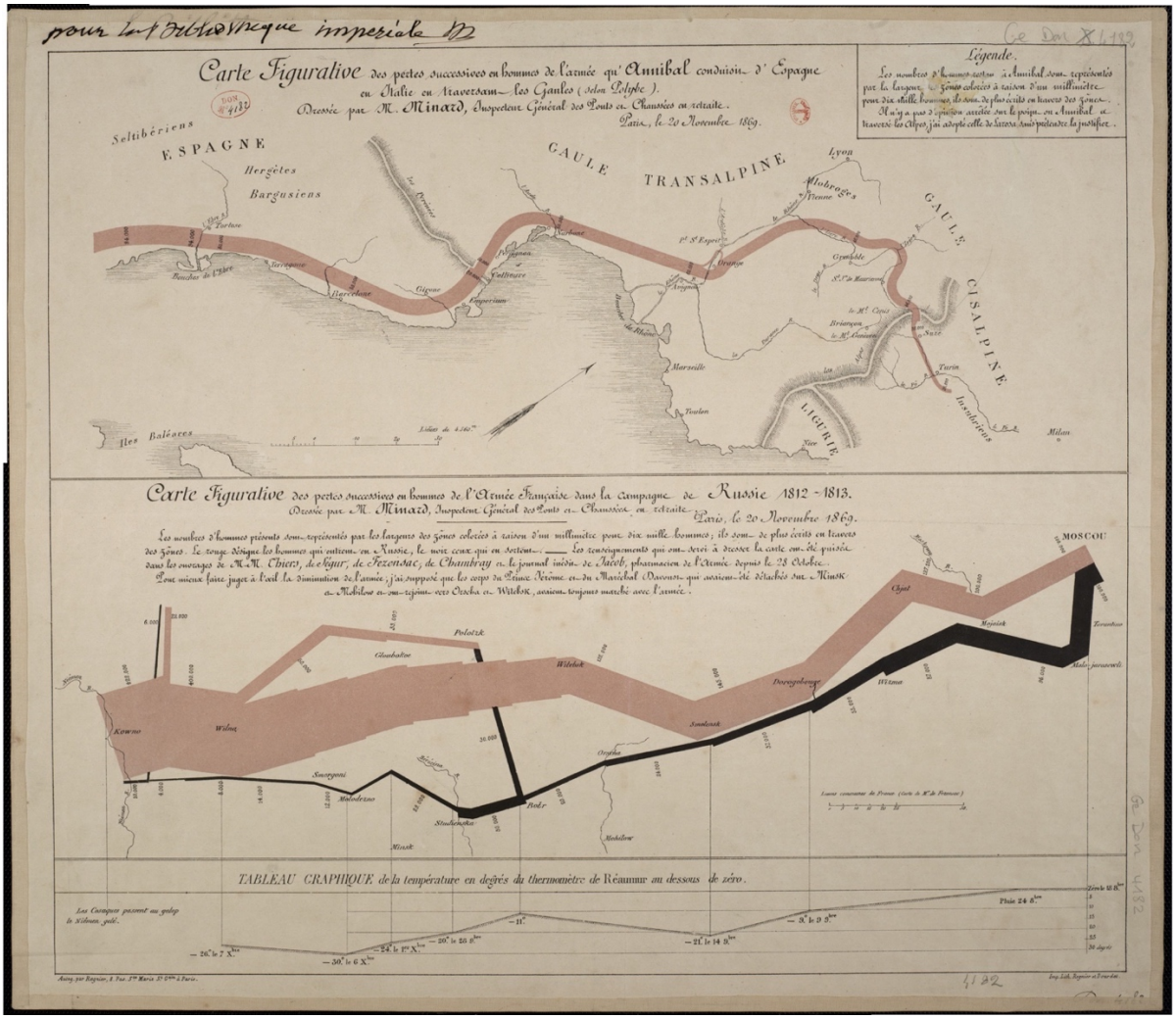


Figure 5. Charles Joseph Minard's 1869 diagram of Napoleonic France's invasion of Russia

Minard's Visualization was highly praised by Edward Tufte, a pioneer of modern data visualization, who believes it is "possibly the best data visualization there is", and approves Minard's great efficiency in using the visual language to communicate to his audience. The efficiency is termed by Tufte as "data-ink ratio", to argue against using excessive decoration in visual displays of quantitative information.

Chapter 3

Theory

In attempt to answer the question of "how to translate between art and technology?", this chapter introduces a few established theories in translation studies as well as multimodal studies, as well as my own interpretation of these theories. I will also introduce my set of approaches particular to the subjects of investigation in my master's study, such as audio-visual installations, interactive installations, and interactive data-visualizations. There are of course many other modalities and channels of relevance and my interest, which I will talk about in Chapter 5, future direction.

3.1 Translation in Verbal and Non-verbal Communication

The expression and communication of ideas and emotion are achieved in many ways. One of the most common ways of expression is through verbal and written language, where ideas can be effectively delivered through established linguistic and cultural norms. One flaw of this form of delivery is that it can easily be interrupted if language and cultural barriers come into play. Theories in translation studies aim to tackle these problems, and they can often shed light on the process of art creation as many artists utilize senses other than verbal expression to communicate ideas that are otherwise indescribable through words.

One theory that transformed the field of translation studies is the Interpretive Theory of Translation (ITT), introduced by a French translation scholar Danica Seleskovitch in the 1970s [14]. With ITT, Seleskovitch challenged the previous standard of translation being a linguistic activity of transcoding one language to another with word-for-word equivalence. Instead, she described translation as a triangular process of "from one language to sense and from sense to the other language". This process is illustrated by the figure below (Figure 6).

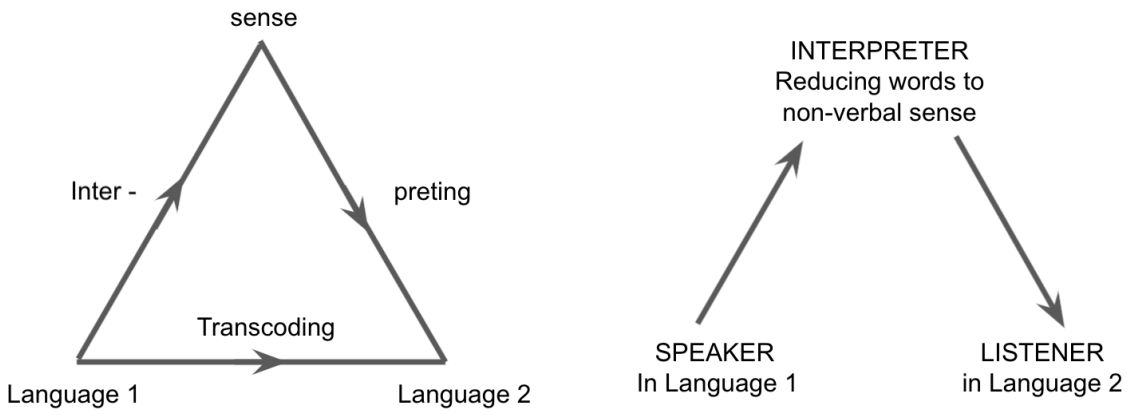


Figure 6. 2 Seleskovitch's triangular model (two versions)

In Selekovitch's interpretive model [15] [16], emphasis is placed on the "non-verbal" sense that the interpreter/translator should utilize as an intermediation while translating from one language to another. Equally, this theory applies to other activities involving non-verbal expressions such as art creation. This non-verbal sense is essentially translated by the artist through audio visual composition, interactivity, and various other modalities of expression. In creative arts, with the intention of communicating to the audience, the artist acts as an "interpreter" who speaks the language of their particular medium, and interprets an artistic idea through non-verbal

language to the listener/viewer. The figure below summarizes some of the major criteria considered by a communicator when choosing between verbal and non-verbal communication (Figure 7).

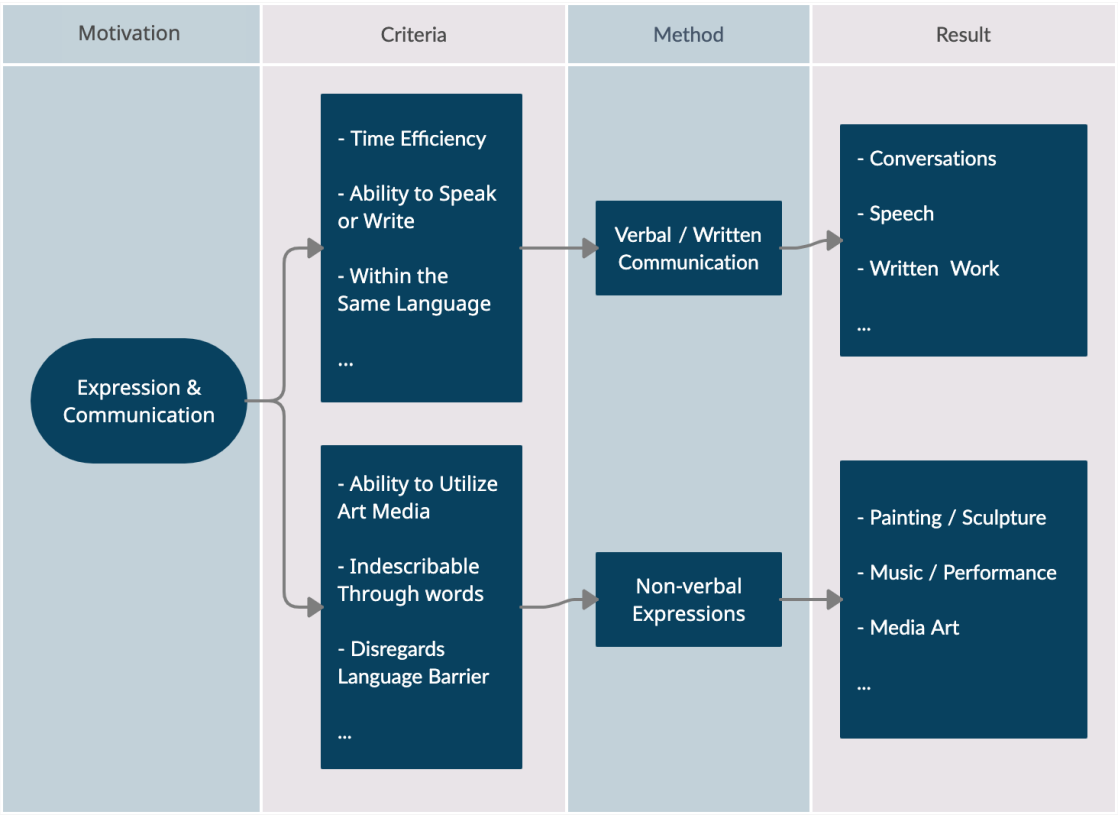


Figure 7. Flow diagram of single/multi-channel expression

With Expression and communication as the motivation, an artist/interpreter may choose to utilize a verbal or non-verbal medium to communicate their ideas. Verbal/written communication/translation provides a direct and quick pathway for communicators who require time efficiency, while they must possess the ability to speak or write in the language that their audience uses, otherwise they will require an extra step of translation when trying to reach to the audience outside of their language.

When the communicator desires a method that disregards language barriers, or find verbal/written language insufficient to fulfil their expression needs, they have the option to use a non-verbal form of communication (especially artistic expressions, which are forms that are outside of the definition of typical non-verbal language in communication studies, such as facial expression, body language, and so on), keeping in mind that they will also need to possess the ability of using artistic means.

3.2 Increasing the Bandwidth of Expression

Artistic forms of non-verbal communication utilize many different modalities to achieve communication and expression. In today's artistic practices, with easy access to the internet, audio visual technology and computing, multimodality is considered a norm. In the 1960s, when film, photography, and audio recording technology opened up the bandwidth of artistic expression, theorists interested in multimodality began formulating guidelines and philosophies for creatives to use non-verbal communication across all disciplines. For example, in the field of creative writing, expressionists encourage writers to find their voice outside of language by placing it in a visual, oral, spatial, or temporal medium [17]; In translation studies, there is a specialized branch of translation know as multimodal translation (or audio visual translation) which deals with the transfer of multimodal and multimedia texts into another language and/or culture [18]. Simultaneously, the field of creative art naturally adopted multimodality as a medium to form the field we now know as media art, a name which implies the use of technology in the creative process. The figure below (Figure 8) illustrates the relationship between certain art practices (using

traditional or technological medium) and their bandwidth of expression, as well as their relationship to interactivity.

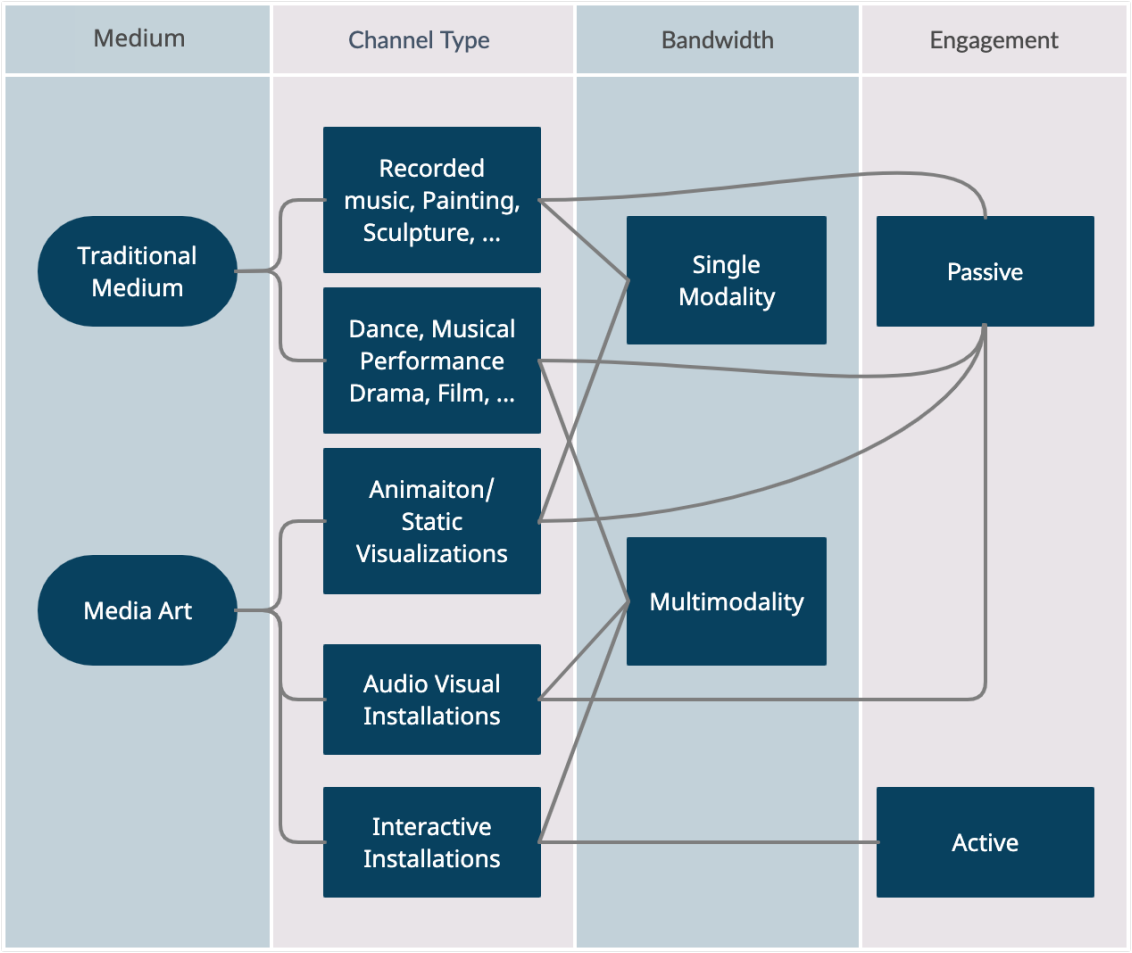


Figure 8. Relationship between two types of art medium and their expression bandwidth

3.3 Approaches in Media Art Practice

Based on the established theories in translation and multimodal studies, here is a summary of the approaches I've learned as guiding principles in my practice of creating interactive media artworks and data visualizations.

1. **Communicate through a natural non-verbal language**:

   Whether the language is visual, audio or multimodal communication, the design of the work should be done in the same way a painter would use colors, shapes and spatial relationship to communicate abstract ideas while maintaining technical precision.

2. **Forming feedback loops in different sensory modalities to achieve organic interaction**:

   so that the work becomes an extension to the user or audience's current sensory experience, enabled by their interaction with technology.

3. **Mutual facilitation between human and machine through embodiment**:

   meaning a visible or tangible form of interaction that can create a relationship where not only the machine facilitates human, but the human can gain insight by learn from the machine's response.

4. **Simplicity with consideration in data-ink ratio**:

   like Tufte emphasized, the number of visual elements should be carefully considered in order to limit confusion to the audience.

5. **Meaning driving the design of medium and form**:

similar to data-ink ratio, you may refer to this as a form-meaning ratio, where the mono/multimodal form should be driven by meaning, or as Kandinsky suggested: "with the fundamental driving the superficial".

6. **Design with content driving the use of technology**:

This is perhaps the easiest to say and the hardest to do, as new technology is coming out on a daily basis, it's hard to not follow the temptation of chasing the newest trend without thinking about why. But ultimately, I believe the content that the technology creates is what gives a work meaning, not the technology itself.

3.4 The Role of Hybridity

Through looking at works from the past and the present that hybridize art and technology, I categorize works of others and of my own into these two groups, with one being technology and research Dominant, and the other one being Art and creative expression Dominant (Figure 9). Work created with different intentions have different balance in hybridity. For example, Kandinsky's work is a creative expression Dominant form of hybrid, while Minard's data graphics would fall into the Technology dominant form of hybrid. My two case studies are the same way, where Oscilla was created with the intention of artistic expression, and GeoD with scientific research as the goal. However, both works cannot be complete without borrowing the translating powers from each other.

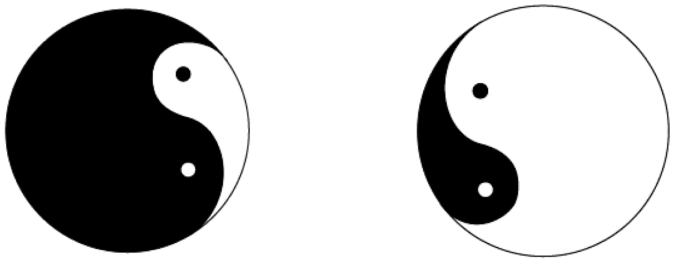


Figure 9. Illustration of science and technology dominant (left), and artistic expression dominant (right) form of hybridity in media art works

As art and technology continue to merge in the future, and the boundary between the role of artists and technologists becomes increasingly blurred, my goal is to strive to create works that can be harmoniously balanced in both art and technology (Figure 10).

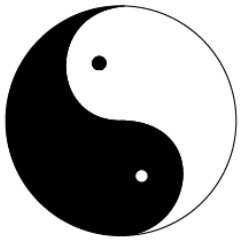


Figure 10. Illustration of an ideal balance between art and technology

Finally, I want to end this chapter with an inspirational quote from Kandinsky, where he points out his view on translating between different modalities of expression:

> "This borrowing of method by one art from another, can only be truly successful when the application of the borrowed methods is not superficial but fundamental.

> "One art must learn first how another uses its methods, so that the methods may afterwards be applied to the borrower's art from the beginning, and suitably. The artist must not forget that in him lies the power of true application of every method, but that that power must be developed."

Kandinsky's words deeply inspire me, because they really cleared up the confusion I've had as I run into bottle necks in tackling with technology, such as mathematical problems, coding errors, and hardware design. The struggle is real, but I believe my process of "borrowing" from technology is gradually going from superficial to fundamental. His words encourage me to believe that I do have the power of true application of every method, even if the process may be slow and strenuous.

Chapter 4

Practice

This chapter introduces two projects from my body of work from my master's study to demonstrate how I incorporated the approaches I mentioned in the previous chapter. The first project is Oscilla, an Interactive Installation visualizing ring modulated human voice, and the second one is GeoD, a location mapping visualization for topic model data. While the two projects differ in both creative intention, system design and their forms of hybridity (with Oscilla as an artistic installation created for exhibitions, and GeoD created as a data exploration tool for social science research), both projects were created under the principles mentioned in the previous chapter.

4.1 Oscilla - An Interactive Art Installation Visualizing Voice

Oscilla is a result of collaboration with my colleague Rodney Duplessis, a talented composer and programmer who explores intersections of science and music. Oscilla would not exist without his amazing knowledge in programming and audio engineering. The figure below (Figure 11) demonstrates a father and his daughter interacting with Oscilla at the Museum of Sensory and Movement Experiences in Santa Barbara.

Figure 11. A pair of father and daughter interacting with Oscilla at the Museum of Sensory and Movement Experiences in Santa Barbara

The creation of Oscilla began in the winter quarter of 2019, at the VectorHack workshop led by Derek Holzer, a media artist and guest lecturer from Helsinki. Thanks to this opportunity, I was able to work with my talented colleagues on this versatile vector synthesis library that Derek created. In the workshop, we were familiarized with the basic visual representations of harmonics, as shown here (Figure 12), called Lissajous figures discovered in 1857 by Jules Lissajous. They plot the relationship of two periodic movements (X and Y) in terms of the harmonic relationship of their

frequencies. As aperiodic and inharmonic movements will not form stable figures, to remain stable, they must have a whole number relationship.

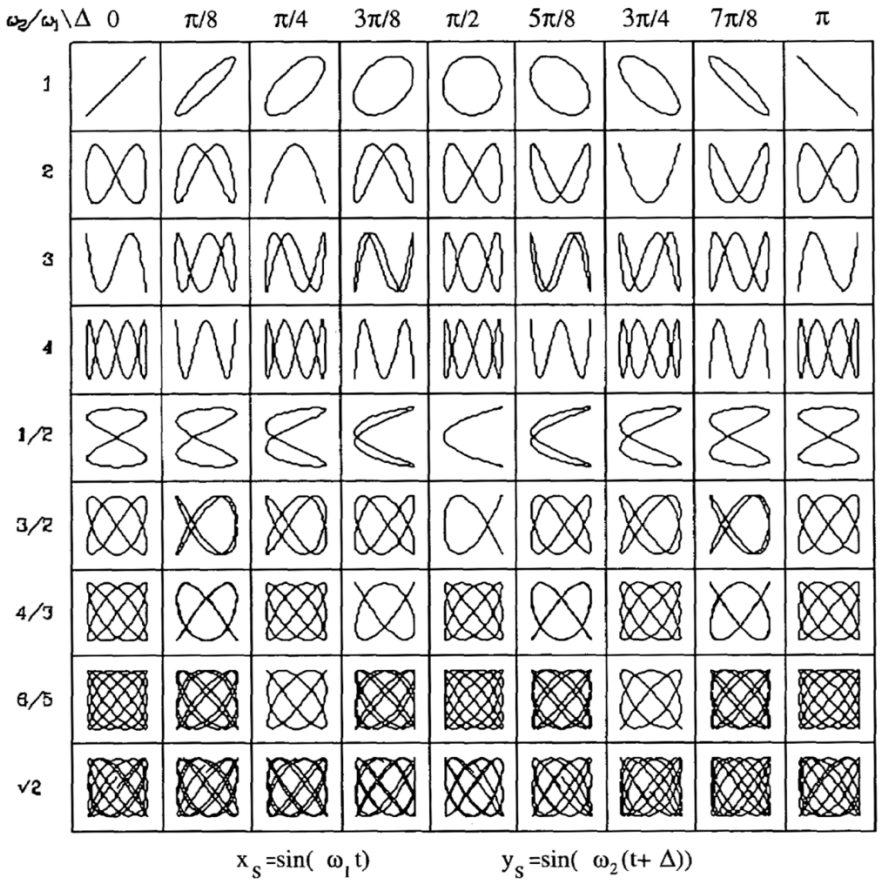


Figure 12. Lissajous figures visualized with different frequency relationships

The number of lobes indicates the harmonic interval between the movements, and changes in phase relationship cause the illusion of rotation in 3D space. This largely intrigued me as I have never used such a medium so closely connected with both audio and visual representations of sound. These forms not only represent mathematical models, but the audio-visual correspondence is actually scientifically accurate translations between visual and audio information.

4.1.1 Design Concept

While I was inspired by the medium of vector synthesis, when it came to making my own work, I wanted to add a component of organic complexity to this very sleek and polished form of art. And as I mentioned previously, forming feedback loops in different sensory modalities would achieve an organic interaction. After some experimenting, I decided to use a microphone input to make it interactive. This figure below (Figure 13) shows the sketch I created for the initial design. It's more like a storyboard scenario than a system design.

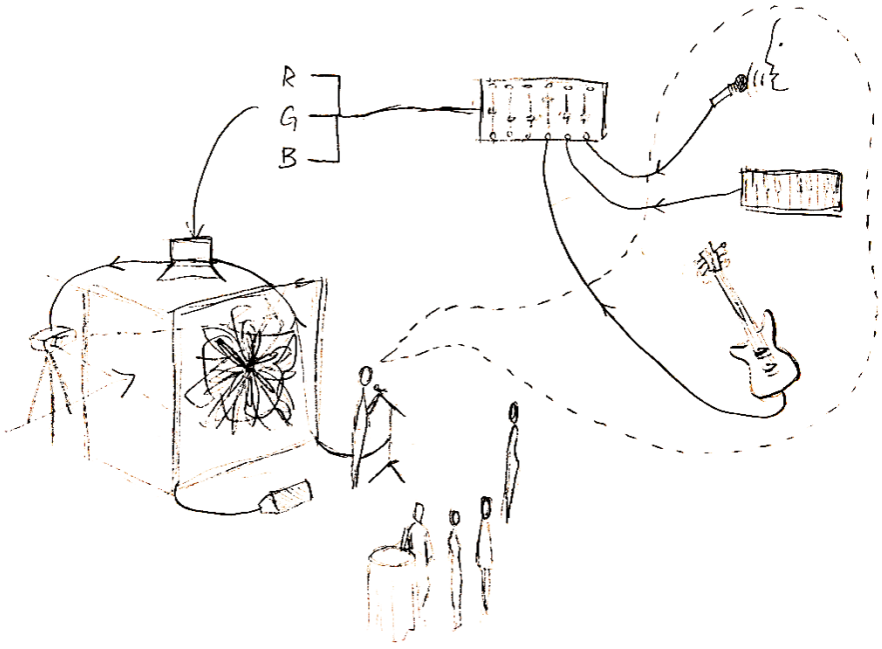


Figure 13. Initial design for Oscilla's exhibition scenario

With the microphone as the interface between the human and the machine, the user actively participates in the audio/visual feedback loop. Simultaneously, the passive audiences' reaction also acts as an extra feedback loop that encourages the

user to further explore the system. In the real exhibition environment, we found that the latter encouraged not only the active user's participation, but also incentivized collaboration.

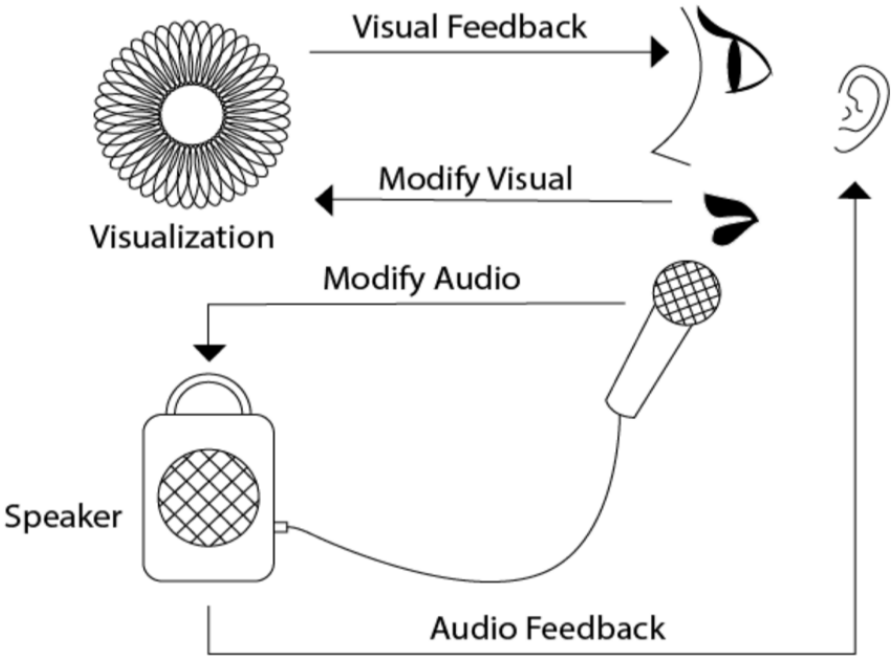


Figure 14. Oscilla System Design

The Diagram above (Figure 14) is a cleaner version of the system design, where the two feedback loops, the visual one and the audio one are illustrated here. The visual is synthesized using Alloscope, a software developed using AlloLib by the AlloSphere Research Group here at the Media Arts and Technology program. The Alloscope is an X-Y or "octopus" configuration oscilloscope application for visualizing stereo audio files. The software aims to mimic analog vector displays such as an oscilloscope, but on a pixel-based display like a computer screen [19]. The ring

modulation filter is developed using PureData, a visual programming language developed by Miller Puckette.

The design of the two feedback loops were not only aimed to encourage the user's vocalization, but also to let the user explore a machine identity. In other words, as the user becomes familiar with the feedback system, they unconsciously identify with the visual form and the audio feedback. Since the audio retains part of each individual's voice features, the user achieves a sense of embodiment in the experience. This process brings the user closer to a state of mutual facilitation between the machine and the human.

4.1.2 Implementation of Audio-visual Information

Ring modulation is the key behind the visual and audio feedback that Oscilla Generates. Ring modulation is a term used in both electrical engineering and in the audio domain, as the name derives from the fact that the analog circuit of diodes originally used to implement this technique takes the shape of a ring: a diode ring [20]. As the nature of ring modulation resembles the theory behind the Lissajous figure, with a change in mapping, a ring-modulated signal can actually generate Lissajous figures.

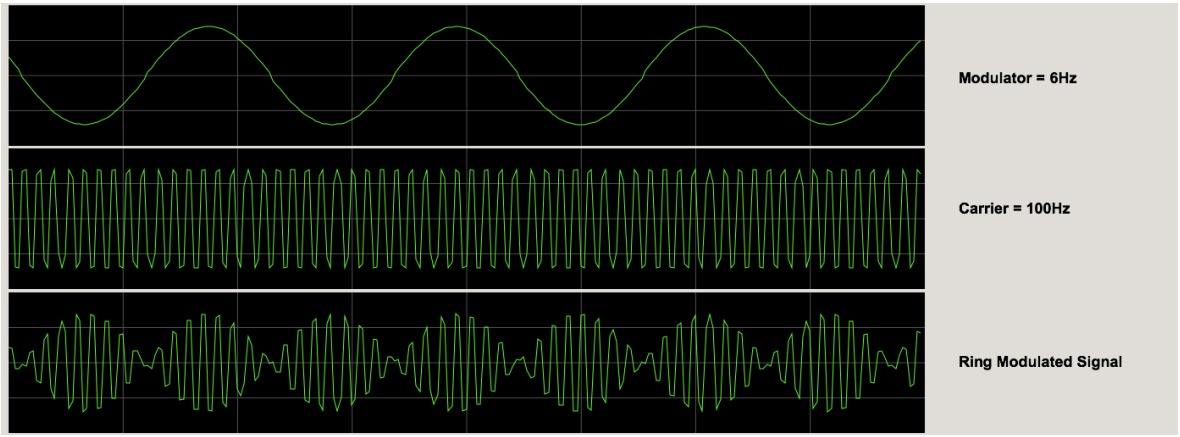


Figure 15. Multiplication of carrier frequency and modulating frequency forming a ring modulated signal

As illustrated in the diagram above, the modulator is a sine wave with a frequency of 6 Hz, and the Carrier is a sine wave at 100 Hz, the resulting signal is a multiplication of the two sine waves that contains features from both the carrier frequency and the modulator frequency. Sonically, the resulting tone sounds like a tremolo if the modulator frequency is low enough, and if we ring modulate a human voice with a modulator frequency in the audio domain, the result would turn into a machine-like voice. Visually, if we plot the y position of the modulator frequency, against the y position of the carrier frequency, with a whole number frequency relationship, we result in a Lissajous figure.

4.1.3 Reception

Oscilla was created with the purpose of showing the audience the beauty of their own voice and to potentially help them experience the joy of interacting with waveform that is both visually and sonically controlled by themselves. The audience may see the result appearing on the screen as their own visual art creation and the

sound output as their own musical performance. After the initial debut at Santa Barbara Center for Arts, Science and Technology (SBCAST) (Figure 16), Oscilla has been exhibited at the MAT End of Year Show (Figure 17) and the Museum of Sensory and Movement Experience directed by MAT alumnus Marco Pinter (Figure 18).

Figure 16. Oscilla Exhibiting at the Vector Hack Exhibition at SBCAST

Figure 17. Oscilla Exhibiting at the MAT End of Year Show 2019

Figure 18. Oscilla Exhibiting at The Museum of Sensory and Movement Experiences

4.2 GeoD – A Geographical Data Exploration Interface for Digital Humanities

GeoD is a data visualization tool for geographical trends in topic models. I started working on designing the visualizations in GeoD in Spring 2019 in collaboration with my colleague Sihwa Park, who is a very experienced interaction designer, media artist, and researcher in data-driven audiovisual art. I really appreciated the time we worked together as I learned much from him about interaction design and coding in JavaScript.

GeoD was initially developed for the the WhatEvery1Says project (WE1S), a three-year long research project directed by Professor Alan Liu. The project uses digital humanities methods to study media discourse about the humanities at large data scales. To put it in simpler words, WE1S is trying to understand "what everyone says" about the humanities. The data being analyzed included journalistic articles in the U.S. available in digital form beginning 1981, as well as social media content, news articles and other forms of publication. Before joining WE1S, I had very little knowledge on the field of Digital Humanities. Thanks to this opportunity, I was able to gain valuable experience and insights through working with many researchers coming from a variety of backgrounds.

4.2.1 Research Objective

As mentioned previously, the research project studies media discourse about the humanities at large data scales. To be exact, the data scale consists of 1 million journal articles, 1.38 million random sampled news articles and 6 million social media posts mentioning the word "humanities". Figure 19 illustrates the source data and its output. It would be nearly impossible for researchers to read through every single document to determine the discourse of a topic. Therefore, a machine learning method called "topic modeling" is used. Topic models generated by this machine learning method help identify major themes in the articles, and form clusters of keywords representing the abstract "topics" in the modeled corpus, with weight information to signify their relative importance. Widely used in the sciences, social sciences, and recently in digital humanities, topic modeling is one of the ways computers can now assist humans in understanding large collections of texts and other materials [21].

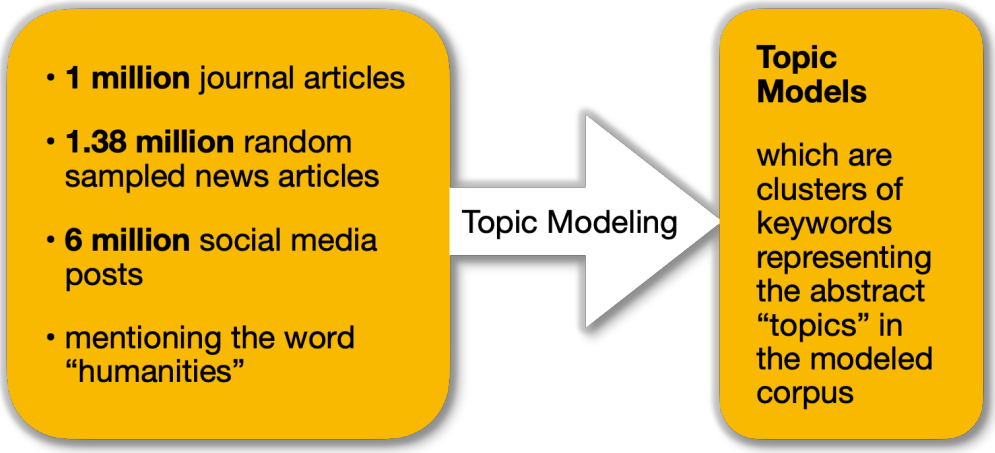


Figure 19. WE1S research group's data source for topic modeling

4.2.2 Design and Development

The idea of designing a geographical data visualization for topic models first came up when I obtained a set of annotated text data from one of the principle investigators of WE1S, Dr. Dan Baciu, who's interest lies in urban planning and architecture. Using a geographical map to visualize the data gives an interesting perspective to the location distributions in text data. The added visual dimension of geographical maps can provide researchers a sense of real-world embodiment and allow them to see topic data in a tangible context. Since this sense of geographical embodiment is also crucial in urban planning and analysis of cultural trends, GeoD has not only been used in the WE1S project, but also produced research results in cultural diversification analysis (featured in Dr. Baciu's paper "Cultural life: Theory and Empirical testing").

After some data processing and visual experimentation, I developed the first prototype with the Google Maps JavaScript API (Figure 20) and showed it to the research group. As the group found that the interface may provide valuable insights, Dr. Baciu, Sihwa, and I started improving this design.

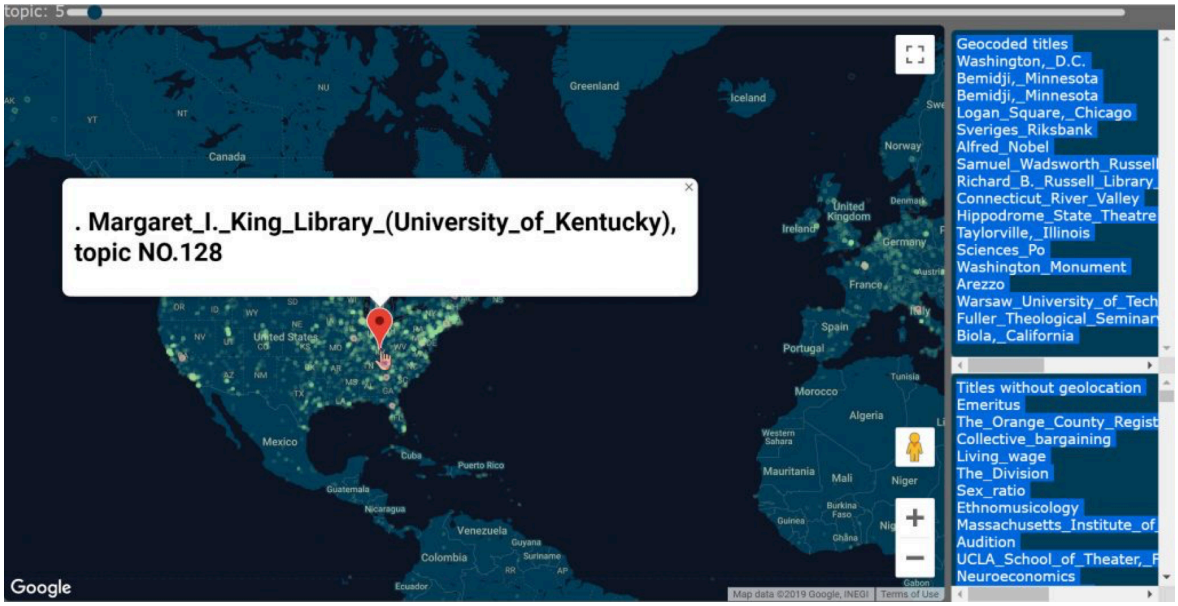


Figure 20. First Prototype of GeoD

Figure 21 is the final design of GeoD's main viewport. It is designed to give researchers an overview of the geographical distribution of place names mentioned in a topic. The geographical data points listed in the "Geocoded Titles" section on the right side of the main viewport are also translated as dots that light up on a dark themed map, resembling city lights at night. Each topic generates a unique line pattern on the map area, informing different hotspots and discourse from different publishers. The green haze is a heat map that shows the general geographical distribution of the entire corpus, so that outliers and special trends can be detected when a particular topic lights up at a certain area.

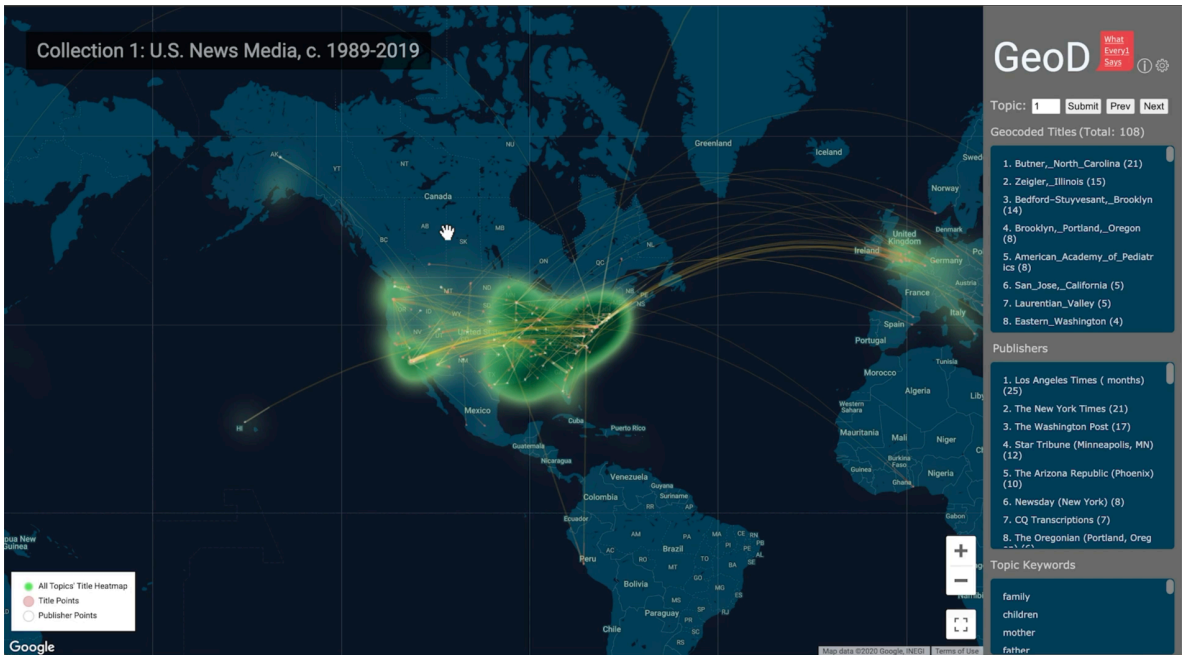


Figure 21. GeoD final version main viewport

4.2.3 Data Processing

As GeoD mainly visualizes geographical information, a few steps in data processing are needed before generating the final data format for GeoD to visualize. I mainly worked on the "wikification" and "geo-coding" process of the data, which is shown on the right half of Figure 22. The data source would first go through "wikification", a process that disambiguates the input text data by linking entities to Wikipedia. For instance, the word "apple" can mean a fruit or the company. The "wikificaiton" process identifies the specific meanings based on context and annotates the wikified titles with their individual "wiki-id", which becomes useful in the Geo-coding process. Utilizing the wiki-id handles in the xml outputs of the wikifier, we wrote a python script to extract the geo-locations (as in latitude and longitude) of the titles from Wikipedia, and store them in a geo-json file for later to combine with topic

keys generated from topic modeling. Simultaneously, other members of the group focus generate the topic key data with MALLET, a machine learning toolkit for natural language processing. After both topic keys data and geo-coded titles are ready to go, they are then combined into one final Json data sheet for us to visualize.

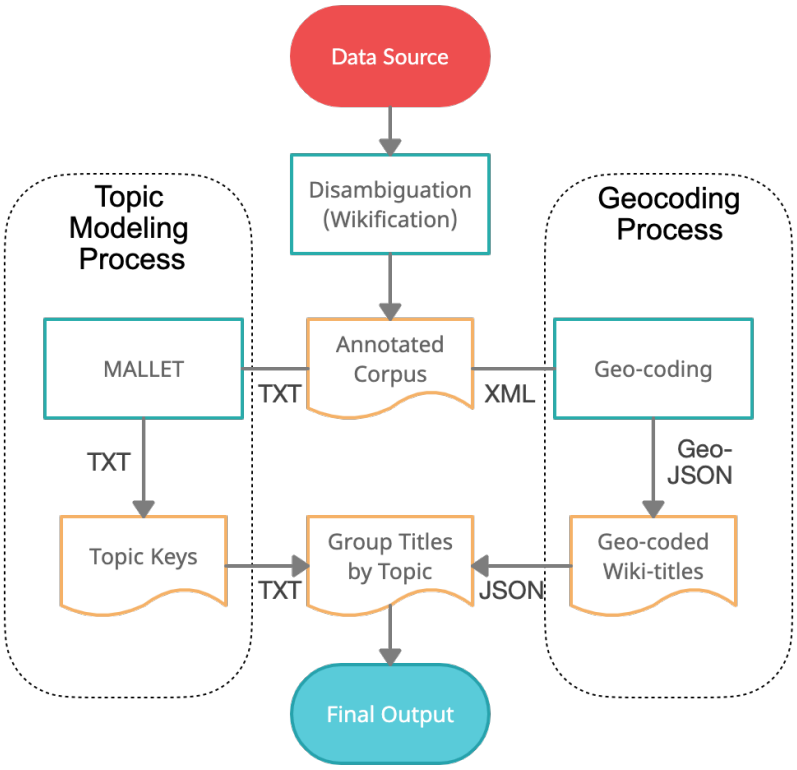


Figure 22. GeoD's data processing pipeline

Although GeoD was created for practical research purposes, the visual elements generated from it can also be viewed as data driven art. The groupings of curved lines form abstract visuals that have both meaning in a digital humanities context as well as when viewed as a generative artwork (Figure 23).

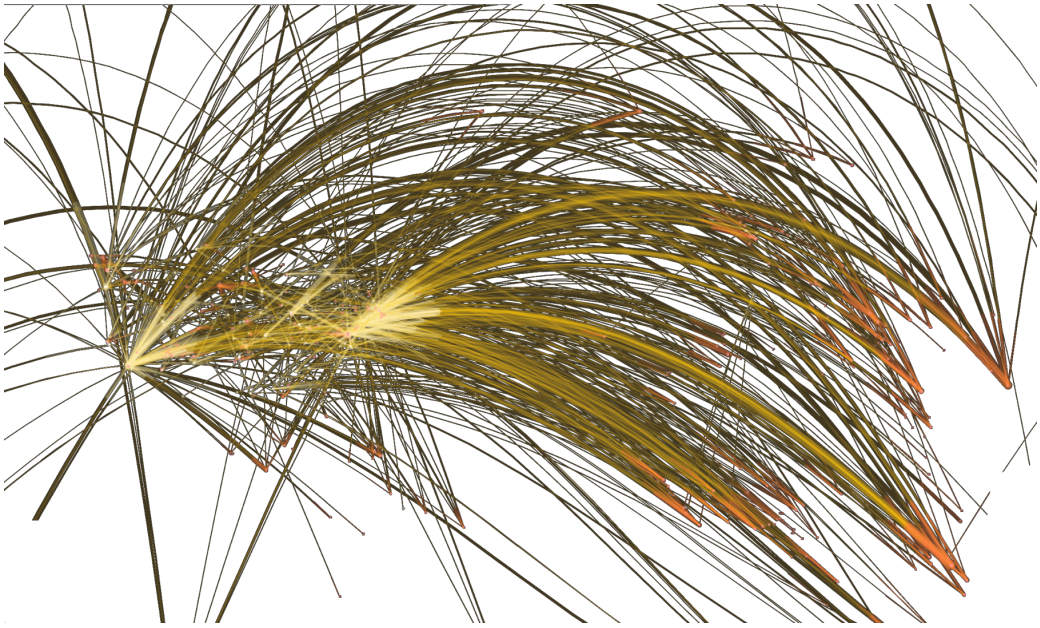


Figure 23a. Generative artwork extracted from GeoD's visual output

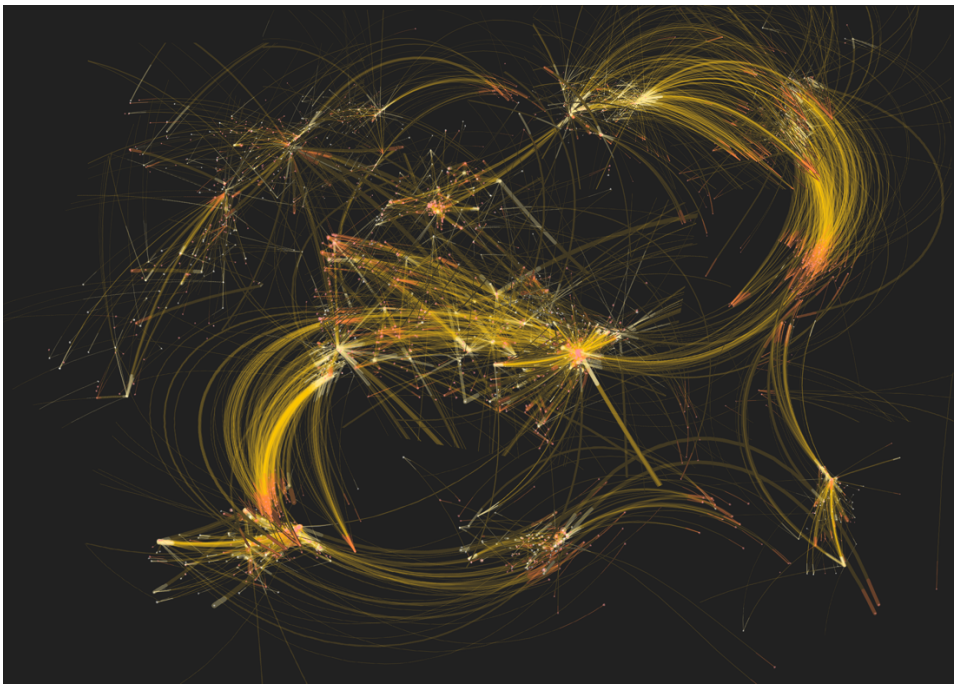


Figure 22b. Generative artwork extracted from GeoD's visual output

Chapter 5

Future Direction

In my future research and artistic practice, I would like to not only incorporate the technical skills I've gained into my work, but also explore the insight and understanding I have developed towards the field of media arts on a more fundamental level. Just like Kandinsky proposed in his book, "when the application of the borrowed methods is not superficial but fundamental, the methods may afterwards be applied to the borrower's art from the beginning". And in order to apply the method of media art into my practice "from the beginning", I would like to go back to the medium I worked with when I first started my creative journey – oil painting.

5.1 Translations - An Oil Painting Series

In undergraduate years, I started my artistic practice as a landscape painter. While painting outdoors, I discovered the joy of depicting the gorgeous Californian landscapes and being at one with nature. Studying from Professor Hank Pitcher, an accomplished landscape painter in Santa Barbara, I've gained invaluable compositional and technical skills in landscape painting. However, after trying many different techniques, I never truly felt that I developed a style of my own, and I did not get to a level where my compositions truly represent my perspective. In my painting process,

being unable to extract abstract shapes from realistic objects was one of my biggest struggles, as I have always taken pride in being able to paint intricate details in my still-life studies.

Sunrise, Jan 2020, oil on canvas

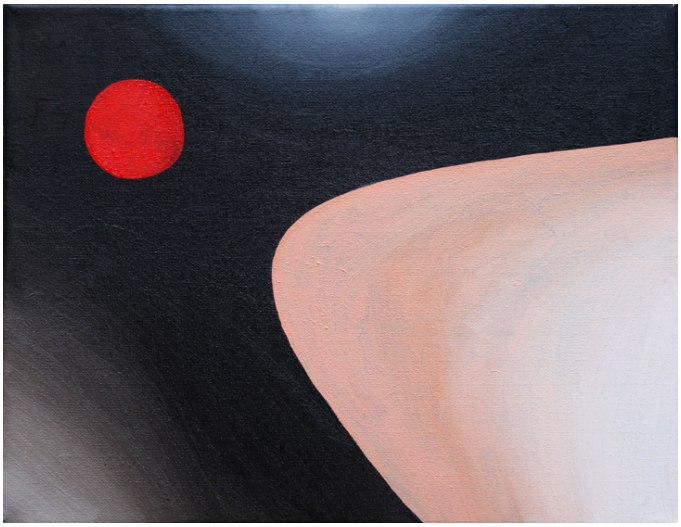
The painting shown here is one of the last paintings I did in my undergraduate work. The initial sketch was made at 5 am in the morning, when the twilight stripped away many details. The lack of lighting forced me to focus on the abstract lines and the color gradients of the landscape. Due to the abstractness of the composition, I did not develop the artistic sense to appreciate it until a few years later in my graduate study in media arts. Last year, I began to revisit some of my old paintings, and I chose to repaint this one. It had been quite a while since I last picked up the brush, as I made mastering the language of technology my priority for the past few years. Surprisingly, going back to my roots in painting helped me to gain significant clarity in my creative practice. After shifting my focus to extensively incorporate technology

in my creative practice, the medium of oil painting, and the expressive power of abstract composition started to clear my disorientation in trying to navigate the world of technology.

Through the brush strokes I found happiness in the simplicity of the medium. More importantly, I found a new level of comprehension in abstract visual representation, which is something I never understood as a realist landscape painter in my undergraduate years, when it was difficult to understand the process of coming up with original abstract compositions. Since this new found compositional practice, I began to create a series of oil paintings named "Translations" exploring the expressiveness of pure abstraction (paintings No.1 to 4 in the series are shown in this chapter). Unlike some of my previous attempts from my undergraduate years, I found the process not only much easier, but also much more meaningful to me. Throughout the painting process, I found that the ideas I were trying to convey could not be better represented in realist means. In this new way of expression, I was able to convey ideas through simple shapes and colors, less distracted by details from realist references. Specific subjects of interest

Translation No.2, Aug 2020, oil on Canvas

become simple shapes and color sets; lines and gradients no longer mean boundaries, but transitions, movements, tension and release.



Translation No.3, Jul 2020, oil on canvas

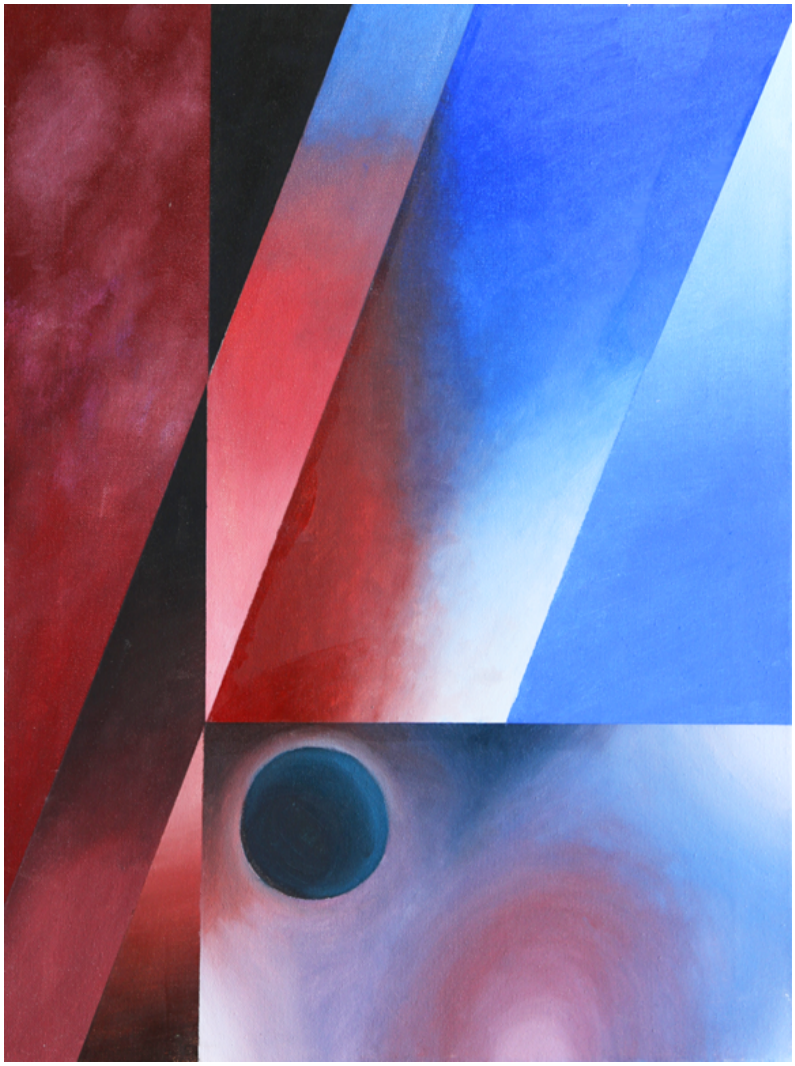
My revisit to oil painting provided a brand-new perspective on my practice as a media artist. My practice is not to speak only the language of technology, but to translate the language of technology into art, and art into technology. Therefore, in the future I plan to incorporate my roots in traditional medium into my media art practice. As a trained artist speaking both the language of art and the language of technology, I want to contribute to an interactive multimedia canvas that allows the physical and the virtual, the visible and the invisible to connect and translate.

5.2 Medium of Interest in Future Work

In my master's study, I've not only worked in two-dimensional design space, but also engaged in 3-dimentional design in both data visualization and interactive installations. Due to the limit of the length of this document, I did not include documentations of Aurora, a 3D interactive data visualization (created for a data query for book check-out data from the Seattle Public Library, provided by Prof. George Legrady's data-visualization class), as well as a three-dimensional version of Oscilla in virtual reality (made in Unity in Prof. Misha Sra's future user interface

class). In the future, I would like to explore the power of audio-visual/data-visual translations in three-dimensions with the power of virtual reality technology. I am excited and determined to keep exploring possibilities with multimodal design of experiences that can inspire people to discover and understand their expressive powers, as it is my greatest pleasure to provide positive impact to visitors and users of my work and help them discover their potential.

Translation No.4, Dec 2020, oil on canvas



Translation No.1, May 2020, oil on canvas

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Appendix A: List of Figures