

© Copyright 2017

Joel Ong

Aeolian Traces

Joel Ong

A dissertation

submitted in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy

University of Washington

2017

Reading Committee:

Juan Pampin - chair

Richard Karpen

Rebecca Cummins

Program Authorized to Offer Degree:

Center for Digital Arts and Experimental Media

University of Washington

ABSTRACT

Aeolian Traces

Joel Ong

Chair of the Supervisory Committee:
Associate Professor, Director of DXARTS
Dr. Juan C. Pampin
Center for Digital Arts and Experimental Media

Aeolian Traces is a multimedia artwork installed first at the University of Washington's Jacob Lawrence Gallery in 2016 and subsequently at the Seattle Art Museum in 2017. The project collects human migration data to generate gusts of wind around the gallery space and trigger sounds in a database of recordings in these countries' native languages. A work of data sonification and visualization, this project is an extension of two previous artworks, *The Aeolus Notification System* and *Those who Observe the Wind..*, where wind data is harvested as a metaphor for geographical and cultural nomadism.

This dissertation describes the thematic and technical development of *Aeolian Traces* and aforementioned works, describing the artistic, literary and theoretical research conducted at the University of Washington's Center for Digital Art and Experimental Media (DXARTS). It further places these works in context within a growing field of information design and data-based

artworks, especially in the areas of environmental and ecological data. By discussing strategies that encourage a merging of two very fraternal but institutionally separate disciplines - Design and Art, the works presented offer ways information and affect may coexist as commensal entities.

Chapter one provides a brief, practical introduction to *Aeolian Traces*. Chapter two expands on the interdisciplinary backdrop of contemporary hybrid or informational ecologies and art that informs the artwork. Chapters three through five detail the artistic and theoretical research, studio experimentations, and gallery documentation of each individual installation. Finally, the dissertation concludes with reflections on the body of work as a whole, and future projects of these ideas into further artworks.

TABLE OF CONTENTS

Abstract.....	iii
List of Figures.....	iii
Acknowledgements	vi
Dedication.....	vii
Chapter 1. Introduction.....	8
Chapter 2. Research Trajectories.....	12
2.1 Introduction/Personal Background.....	12
2.2 <i>Terra Naturalis</i> <i>Terra Notitia</i>	14
2.3 A Cosmic Witness	18
2.4 Informational Ecologies	23
2.5 Towards the Creation of a Digital Wind	27
2.5.1 Tracing, Measuring Air	27
2.5.2 Aeolian Metaphors and the Romantic Impulse	29
2.5.3 Soundwalking	36
2.5.4 Abstracting the Atmosphere : visual abstractions	45
2.5.5 Abstracting the Atmosphere II : Digital Abstractions	51
2.6 Strategies for Creative Data Aesthetics.....	56
2.6.1 The Immeasurable and the Measurable	56
2.6.2 Exploratory Environments.....	58
2.6.3 Abstractions of Nature.....	63
2.6.4 Parameter Mapping.....	68
2.6.5 Immersive Sites of Presentation	72
Chapter 3. <i>Aeolus Notification System</i>	75
3.1 Introduction	75
3.2 Cultural Nomadism	76
3.3 Organization	79
3.4 Dispersed, mobile media	82
3.5 Conclusion.....	83
Chapter 4. <i>Those Who Observe the Wind</i>	85
4.1 Introduction	85
4.2 Motivations.....	86
4.3 Organization	90
4.4 Observing The Wind	93
4.5 Workshop	95

Chapter 5. Aeolian Traces	98
5.1 <i>Background</i>	98
5.2 Data Art/Visualization.....	103
5.2.1 Precursors: #home	103
5.2.2 Precursors: Sombrer: An Intertidal City #lost and #found	108
5.2.3 Data Visualization in Aeolian Traces	111
5.2.4 Composing in Time	116
5.3 Fans /Physical Setup.....	123
5.4 Sound.....	126
5.5 Installation Setup.....	128
5.6 Feedback / Reflection.....	135
5.7 Improvements.....	137
Bibliography.....	140
Appendix A: <i>42 Degrees Southwest</i> Material	148
Appendix B: <i>Those who observe the wind</i> Material.....	150
Appendix c: <i>The Cybernetic Monochord</i> Material	153
Appendix D: <i>Aeolian Traces</i> Material	157
Appendix E: <i>The Northwest Detention Center</i>	160
Appendix F: <i>Sombrer: An intertidal City #lost and #found</i> Material	165
Appendix G: <i>Aperture II</i> Analysis	167

LIST OF FIGURES

Figure 1.1. <i>Aeolian Traces</i> Exhibition view (Seattle Art Museum).....	9
Figure 1.2. <i>Aeolian Traces</i> Data Visualization	10
Figure 1.3. <i>Aeolian Traces</i> Exhibition view (Jacob Lawrence Gallery)	10
Figure 1.4. <i>Aeolian Traces</i> Ambisonic (Periphonic) testing	11
Figure 2.1. The World Earth Catalog Fall 1968	18
Figure 2.2. <i>Earth Wind Map</i> 's Interactive Wind Map	21
Figure 2.3. The Composition of dry, atmospheric air	27
Figure 2.4. The Aeolian Harp in Athanasius Kircher's <i>Phonurgia Nova</i>	31
Figure 2.5. Athanasius Kircher's Aeolian-human ensemble.....	33
Figure 2.6. The <i>Panacousticon</i>	35
Figure 2.7. Blueprints of an Aeolian harp to be positioned at a Georgian Sash window ...	35
Figure 2.8: Drawing of the installation A Piano Listening to Itself, 2009	39
Figure 2.9. Gordon Monahan. A Piano Listening to Itself: Chopin Chord, 2009	39
Figure 2.10. Monahan's <i>Piano on Frozen Lake Nipissing</i>	40
Figure 2.11. Max Eastley's Aeolian Harp 2014	41
Figure 2.12. Doug Hollis' <i>Soundgarden</i>	43
Figure 2.13. Charles Sower's <i>Windswept</i> (2011)	44
Figure 2.14. JMW Turner's <i>Rain, Steam, Speed:</i>	45
Figure 2.15. Caspar David Friedrich, <i>The Monk and the Sea</i>	46
Figure 2.16. Mark Rothko's <i>Untitled (purple, white and red)</i>	47
Figure 2.17.: Piet Mondrian's <i>Red Tree</i> (1910)	48
Figure 2.18. Piet Mondrian's <i>Grey Tree</i> (1912).....	48
Figure 2.19. Piet Mondrian's <i>Flowering Apple Tree</i> (1912).....	49
Figure 2.20. Piet Mondrian's <i>Composition No. VII</i> (1913).....	49
Figure 2.21. Jackson Pollock's <i>Number 14 Grey</i>	50
Figure 2.22. Weather station	52
Figure 2.23. An Arduino-compatible Digital Anemometer	53
Figure 2.24. Wunderground Screenshot of Weather station at SeaTac.....	53
Figure 2.25. Scott Snibbe's <i>Blow Up</i> , 2005	54
Figure 2.26. Rafael Lozano-Hemmer's <i>Vicious Circular Breathing</i> . 2013	55
Figure 2.27. Roy Ascott's <i>Aspects of Gaia</i>	59
Figure 2.28. Jeffrey Shaw's <i>Legible City</i>	60
Figure 2.29. <i>Electric Walks</i> by Christina Kubisch	62
Figure 2.30. Polak Van Bekkum's <i>Wall Drawing Wind</i>	63
Figure 2.31. Installation View	64
Figure 2.32. Scott Hessel's <i>Celestial Mechanics</i>	65
Figure 2.33. Sabrina Raaf's <i>Translator II: Grower</i>	66
Figure 2.34. Spencer Finch's <i>2 hours, 2 minutes, 2 seconds(Wind at Walden Pond, March 12,2007)</i> 2007	67
Figure 2.35. Tao Sambolec's <i>Virtual Hole- Wind1:1</i> 2011	69
Figure 2.36. Tao Sambolec's <i>Virtual Mirror</i> Schematic.....	70
Figure 2.37. Tao Sambolec's <i>Virtual Mirror</i>	70

Figure 2.38. Studio Roosegaarde’s <i>Flow 5.0</i>	71
Figure 2.39. Olafur Eliasson’s <i>Beauty</i>	73
Figure 2.40. Olafur Eliasson’s <i>Vær i vejret, 2016</i>	74
Figure 3.1. The <i>Aeolus Notification System</i> SMS Query	75
Figure 3.2. <i>42 degrees South West (if by any means we get there)</i>	77
Figure 3.3. <i>The Aeolus Notification System</i>	79
Figure 3.4. The <i>Aeolus Notification System</i> form.....	79
Figure 3.5. The <i>Aeolus Notification system</i> data visualization.....	80
Figure 3.6. The <i>Aeolus Notification system</i> ’s bag of “winds”	81
Figure 3.7. The <i>Aeolus Notification System</i> SMS notification.....	82
Figure 4.1. <i>Those who Observe the Wind</i>	85
Figure 4.2 Harvesting the wind as data at Ballard, Seattle.....	86
Figure 4.3. <i>Cybernetic Monochord</i> as an aeolian string instrument.....	88
Figure 4.4 Box interior.	89
Figure 4.5 : <i>Those who Observe the Wind</i> ... installation	90
Figure 4.6 The Jack Straw New Media Center modelled	91
Figure 4.7 <i>Those who Observe the Wind</i>	92
Figure 4.8 Screenshot of control interface	92
Figure 4.9 DC motor triggered monochord workshop	96
Figure 4.10 . 3D model of the workshop device showing components	96
Figure 4.11 Post-workshop performance/improvisation with the monochords	97
Figure 5.1 <i>Aeolian Traces</i> 3D model	98
Figure 5.2 : Sample visualization of <i>Invisible Cities</i>	104
Figure 5.3 Collection of abstract visualizations of each city.....	104
Figure 5.4 3D printed cities in <i>#home</i>	105
Figure 5.5 Survey Form and Twitter scraping.....	106
Figure 5.6. 3D printing	106
Figure 5.7 Actual visualization of Tweets, and eventual 3d form	107
Figure 5.8 <i>Sombrer: An Intertidal City #lost and #found</i>	108
Figure 5.9 Tide charts in <i>Sombrer</i>	110
Figure 5.10 Final Tide Chart	110
Figure 5.11 Data visualization of countries most inward (red) and outward (blue migration)	111
Figure 5.12 <i>Series I</i> : Data visualization of migration	112
Figure 5.13 <i>Series I</i> : Data visualization experiments.....	112
Figure 5.14. Dynamic Visualization Experiments	113
Figure 5.15. Final visualization screen shots.....	114
Figure 5.16. Final visualizations screen shots	114
Figure 5.17. Color added to visualization to create accents	115
Figure 5.18. Data visualization of a segment of <i>Aperture II</i>	117
Figure 5.19. Flow Chart of initial experimentation	119
Figure 5.20. <i>Aeolian Traces</i> : Accent seen forming from Canada	119
Figure 5.21. <i>Aeolian Traces</i>	120
Figure 5.22. Revised parameter mapping.....	121
Figure 5.23. Screen shot with scrolling score:	122

Figure 5.24. <i>Aeolian Traces</i> Installation setup	123
Figure 5.25. Calculating radial distance.	124
Figure 5.26. Data visualization of the fans' activity and relative speeds. Speaker '0' is North.	125
Figure 5.27. <i>Research Process at DXARTS' Ballard Warehouse</i>	128
Figure 5.28. Jacob Lawrence Gallery	129
Figure 5.29. 3D model for ambisonic setup	130
Figure 5.30. Installation and Testing	130
Figure 5.31. Mock up of the installation at the Seattle Art Museum	131
Figure 5.32. Installation details on Floor Plan	132
Figure 5.33. Installation at Seattle Art Museum.....	132
Figure 5.34. Installation at Seattle Art Museum.....	133
Figure 5.35. Installation at Seattle Art Museum.....	133
Figure 5.36. Installation at Seattle Art Museum.....	134
Figure 5.37. Proposed modifications to original system.	138
Figure 6.38. <i>42 degrees SouthWest (if by any means we get there)</i> 3D mockup	148
Figure 6.39. Prototype Presentation	148
Figure 6.40. prototype presentation showing information LCD screen and spool.....	149
Figure 6.41. Flow Chart for the Aeolus Notification System.....	149
Figure 7.42: Setting up the ceiling wire mesh at Jack Straw New Media Center	151
Figure 7.43: Electronics to trigger aeolian boxes.....	152
Figure 8.44: Initial Monochord Prototype.....	153
Figure 8.45: Improvisational performance with guitars and monochord.....	154
Figure 8.46: Machine improvisation with electric guitar	154
Figure 8.47: Presentation of the final monochord sculpture at the Deep Listening Conference 2015 (seen here with Pauline Oliveros).....	155
Figure 8.48. Prototype development of Control Interface at DXARTS.	155
Figure 8.49: Tetraktys-inspired visualization for the Cybernetic Monochord project	156
Figure 9.50: Interview with a Casa Latina member	157
Figure 8.51 World Relief training manual for NWDC visitation and befriending	160
Figure 8.52. CITI certificate of completion.....	161
Figure 8.53: Sample consent form for interview request	162
Figure 8.54. <i>Windward</i>	163
Figure 8.55: <i>Between us a Breeze</i>	164
Figure 9.56: Data Visualization	165
Figure 10.57. Supercollider plots	167
Figure 10.58. Supercollider plots	169
Figure 10.59. Supercollider plots	170
Figure 10.60. Supercollider plots	171
Figure 10.61 <i>Score Visualization</i>	171
Figure 10.62. Supercollider Screen shot.....	172

ACKNOWLEDGEMENTS

I would first like to thank my supervisor Juan Pampin for his invaluable guidance and patience over the years. I would also like to express my heartfelt gratitude to my other supervisors whose mentorship have been pivotal to my development – Richard Karpen, James Coupe, Rebecca Cummins and Phillip Thurtle. Having had the opportunity to be mentored by you, and in some cases to present and teach alongside has been one of the most cherished memories I have of my doctoral experience.

To my colleagues at DXARTS, I am so grateful to have your friendship and collegiality as the backdrop to my studies. To my friends and DXARTS family Inmi Lee, Hana Lee, Robert Twomey, Marcin Paczkowski, Tivon Rice, Jimmy Johnson etc. – may we continue to collaborate and develop new ideas together.

Special mention goes also to my mentor and great friend Edward Shanken, whose supervision, guidance and friendship taught me so much. I look forward to more fireside discussions with your beautiful family. You have truly shown me how to merge art and life.

Last but not least, to the wonderful people who have made one or more of these installations a success thank you all– Joan, Levi and all at Jack Straw, Billie Grace, Scott Larimore and many others.

DEDICATION

For Lynette, Iain & Isla

*“What it taught me before, i keep. It’s air
Ceaseless wind, water and sand”*

-- Neruda

Chapter 1. INTRODUCTION

Aeolian Traces is an immersive installation that utilizes a hybridization of data harvesting, physical installation, algorithmic composition and spatial sound. Presented through a combination of a multi-channel sound diffusion system and an 8-channel ventilator (DC motor fan) setup, the piece creates wind currents in a gallery space triggered by human migration data. A screen displays the project's informational content, visualizing migration data as suspensions of nodes in three dimensional space, and displays connections between each node as they come into close proximity with each other.

To establish an ephemeral sense of movement around and about the visitor, the ventilators are synced with sounds of wind, where visitors to the space are able to simultaneously feel and listen to them. On the screen, each node represents a percentage of the migrant population from a particular country, geo-located and set in motion towards their documented destinations. Sound, image and wind are profoundly connected- the directionality of migration mapped to the movement of all three elements within the Ambisonic sphere. Spoken narratives in native languages are also introduced in the piece as whispers that reveal themselves as they passage from one location to another.

Aeolian Traces was first presented as part of the Windward||Windword exhibition at the Jacob Lawrence Gallery after a period of artistic and technical research at DXARTS at the University of Washington. It was also presented at the Alice Lab for Computational Worldmaking at York

University in Toronto, and was most recently presented at the Seattle Art Museum in conjunction with the REMIX festival (pictured below).



Figure 1.1. *Aeolian Traces* Exhibition view (Seattle Art Museum)



Figure 1.2. *Aeolian Traces* Data Visualization



Figure 1.3. *Aeolian Traces* Exhibition view (Jacob Lawrence Gallery)



Figure 1.4. *Aeolian Traces* Ambisonic (Periphonic) testing

Chapter 2. RESEARCH TRAJECTORIES

2.1 INTRODUCTION/PERSONAL BACKGROUND

While exhaled air usually vanishes without a trace, the breath encased in these orbs is granted a momentary afterlife. While the bubbles move through space, the creator is truly outside himself - with them and in them¹.

-Peter Sloterdijk

In Peter Sloterdijk's description of the soap bubble in flight, the bubble, carried up and out into the open is attentively followed by its creator-observer. He watches as it is steered and tossed about, until it emphatically bursts and both its contents and the his focus are thrown into expanded space. Breath that was previously circulated within the body of the creator now inhabits a larger atmospheric space. In Tim Ingold's words, the body becomes *enwinded*² in the process of merging the scales of personal and global. The creator experiences a "soul expansion", these mobile orbs becoming spectacles that leave him at his penultimate end in open, boundless space.

Both wind (in the environment) and breath share a common neglect. These quotidian and often overlooked aspects of everyday life offer profound metaphors for life and death, self and society, ecological interconnectivity etc. It is the subject of this dissertation to explore the way the metaphors of the wind have evolved through metaphysical and religious invocations, to telematic, data-rich information ecologies, in order to contextualize the artistic projects described here within today's hybrid digital/organic environment. It discusses key developments in the growing intersections of technology and nature to appreciate the way digital tools form

¹ Sloterdijk, 2011. p18

² Ingold, 2007.

informational ecologies that augment our senses beyond human scales of perception. Crucially, it also discusses trends in the opposite direction - ways natural phenomena or *elemental* media can be introduced back into our digital topographies as metaphor, narrative and raw material. It is this perspective that inspires and informs the three key projects in this dissertation, and will be explored through theoretical and artistic works in literature, inter-media, visual, immersive and time-based installation.

In a way, the intensive studio experience at DXARTS has been a sort of bubble in itself, in which internal perturbations reorganize and connect new knowledges with existing ones. It has been in this space that by far the largest paradigmatic shifts in my understanding and appreciation of ecological/environmental relationships have happened - ironically through the initiation, cultivation and sustenance of an *in silico* computational arts practice. In attempting to coalesce my past academic experiences and recent studio work, the body of work i present is diverse, individually unique; and finds its voice through a revival of neo-Romantic, Transcendentalist literacy that has been transplanted to a digital literacy that aims to address, organize and creatively manipulate the expanse of information today.

In seeing these body of work through the metaphor of the soap bubble, i cast under the proverbial microscope the elemental quantities of bits, digits, packets of data that form numbers, words, information and stories in the hope that they expand, through interactive platforms and multi-media installations, into spaces where human-scaled socialites, aesthetic and ethical concerns may be articulated.

2.2 *TERRA NATURALIS | TERRA NOTITIA*

Since the dawn of time, man has always looked to the skies in wonder. The expanse of space was an immeasurable void for the natural philosophers; the cosmos an indivisible, infinite symbol of God as well as the spatial container He existed in³. The imagination of vastness and infinity forms the philosophical tradition of the sublime, the basis of modern aesthetic theory in the visual and plastic arts⁴. In Kantian aesthetics, the sublime is associated with a feeling of terror at the vast “synthesis of world and self, facts and ideas, images and feelings.”⁵ Indeed the imagining of the extra-cosmic expanse reveals a paradoxical truth: that we are at once insignificantly small and an integral part of this universe.

Today a different ‘cosmos’ exists as the infinite virtual spaces of digital technology. Emerging from a mixture of material and immaterial infrastructures, the digital Universe is a large informational habitat that sustains the mobility and agency of advanced human civilisation. Encyclopedic and inscriptive, archival and present, interactive and participatory, this universe comprises of immense number of digital signals generated through the activity of millions of users, running through cables stretched, strung, suspended and submerged across our physical landscapes.

³ Grant, 1983. p78

⁴ Davis, 2005. P7.

⁵ *ibid.*

Much of course, has been written on the contributions of pioneers in the History of Science as Copernicus, Kepler, Galileo and Huygens⁶ and their pivotal roles in the development of optics and astronomical instruments. Similarly, key engineers, mathematicians, cyberneticians and hippies in the countercultural 60s collectively lay foundations for the ideological and material infrastructure of the Internet, collectively envisioning a future where information was collaboratively developed, rendered malleable, communicative, and democratized for public consumption⁷.

For the forefathers of astronomy, each new technical development or invention brought the mysteries of the heavens closer to them, some might argue in Heisenberg fashion that their observations had brought the celestial entities into being, increasing the recognition of the immense universe in relation to their physical bodies. Similarly, the tools of the digital age provide a sense of scale of how much information there is out there. The “cosmological vertigo”⁸ documented in those early days has its parallel in the vertiginous experience (and realization) of the immensity of the Internet’s data piles that arise from the activity of a global body of users.

Janet Murray provides a way to characterize digital media today through four key elements- participatory, spatial, procedural and encyclopedic. It is the last of these that I will focus on.

Murray describes this nascent encyclopedic medium as “the largest. . . human beings have ever

⁶ Refers to pioneering astronomers Nicolaus Copernicus, Johannes Kepler, Galileo Galilei, and Christiaan Huygens. For more information see Grant, 1983 or Gribbin, 2002.

⁷ Protagonists such as JCR Licklider, Tim Berners-Lee and Joseph Weisenbaum join the likes of Norbert Wiener and Claude Shannon in imagining a digital future of feedback systems and collaborative technologies. See Murray 2003, Negroponte 1995.

⁸ Thomas Hardy writes about a cosmological vertigo that he felt in his first experience looking through a telescope in *Two on a Tower* (1882), attributed to the experience of a vastness that his body in its tiny magnitude was unable to cope with. See Hankins and Silverman, 1995, p 118

invented”, laying prophetic charges that the computer would eventually be able to represent all of human knowledge⁹. Attempting to imagine a single medium so vast, or an observer so small, has precedences in both literary imagination and in the imagining of new technological paradigms. For instance, in the wake of the nanotechnological revolution, Richard Feynman predicted that the entire Encyclopedia Britannica would fit on the head of pin¹⁰. Writers like William Blake and William Faulkner have written about viewing the “universe in a grain of sand”¹¹, or getting the “whole impossible history of the human heart into one sentence”¹².

The metaphor of digital space as an encyclopedic, immense library of information is most useful for our discussion of information aesthetics. In Jorge Luis Borges’s *Library of Babel*, a library is imagined that holds every book possible:

The Library is total and that its shelves register. . . everything: the minutely detailed history of the future. . . the faithful catalogues of the Library, thousands and thousands of false catalogues . . . the translation of every book in all languages, the interpolations of every book in all books¹³.

The vastness of Borges’ library is a metaphor for the encyclopedic, omniscient and *modern* storehouse of data. The rise of the Internet and of modern storage devices in the Information Revolution has allowed a generous increase in the amount of data created (and then stored). Today, more digital data is generated each year than all the writing done in history¹⁴. Access to online sources has also widened the pool of data resources from which analysts are able to solicit anything from sales figures, voter sentiment, investment data, weather patterns, football scores

⁹ Murray, 2003. p6.

¹⁰ Feynman, 1960. Online at <http://resolver.caltech.edu/CaltechES:23.5.0>. Accessed October 2015

¹¹ Blake, 1863. Online at <https://www.poetryfoundation.org/poems/43650/auguries-of-innocence>. Accessed October 2015.

¹² Weinstein, 2012. p236

¹³ Borges, 1962. P85.

¹⁴ Peters, 2015.

etc. for analysis. In Borges' library, an existentialism is depicted in the way "some shelf in some hexagon contains precious books and that these books were inaccessible"¹⁵. Similarly, we are unable to read every simple bit of information in the data universe. To search and index it, therefore, is also to reduce and discard:

The art of searching. . . consists largely in elimination. Knowledge is not the gathering but the throwing away of information¹⁶.

The urge to measure the expanse of digital information today, through reductive quantification and abstraction is core to this dissertation and the aesthetic foundations of the pieces depicted.

¹⁵ *ibid.*

¹⁶ *Ibid.* p318

2.3 A COSMIC WITNESS

When Sputnik went around the planet, the planet became an art form.
-Marshal McLuhan

The publication of NASA's *Blue Marble* inaugurated a perspectival shift towards a planetary view of the earth. Instead of pointing the lenses outward into the vast expanse of the Universe, now they were turned inward, simultaneously casting the viewer within the photograph, enabling and empowering the self-reflexive perspective of humanity as part of an ecological or topographical whole.

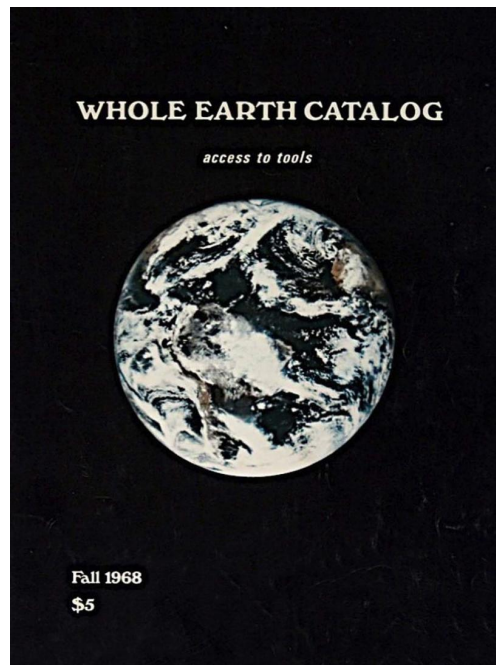


Figure 2.1. The World Earth Catalog Fall 1968

Published in on the cover of Stewart Brand's *Whole Earth Catalog* in 1968, it became politically charged in the wake of the counterculture revolution of the era. Amidst emerging worldviews of the earth as synergistic and self-regulating such as the Gaia hypothesis (James Lovelock) and Spaceship Earth (Buckminster Fuller), and along with seminal texts by Rachel Carson and Edward Abbey¹⁷, a focus on the total or networked effects of human activity across the globe entered popular culture and reinforced the environmentalist viewpoint.

NASA's imagery was not the first recorded instance of the planetary view, antecedents like recordings from the Russian Sputnik launch preceded *Apollo 8*, being released into orbit in 1958. Its perception of the planet - a series of "inexplicable beeps through a radio transponder"¹⁸ aimed at multiple scientific objectives, including measuring the density of the upper layers of the atmosphere, and the propagation of radio signals in the ionosphere¹⁹. The satellite broadcast beeped at 20 and 40 MHz worldwide, survived for 3 weeks in orbit before the chemical batteries failed. The inactive Sputnik remained in orbit for another 3 months and then fell into the earth's atmosphere and burnt up.

In this act of technological mastery over the physical laws of gravity, Sputnik had extended the human ear into the celestial ether; and in a poetic allusion to human birth, this first "real time" recording of a solar wind had birthed the planet in sound. And since the data set recorded by the satellite did not belong to the sound domain²⁰, a systematic process of *audification*²¹ was

¹⁷ Environmentalist literature include Rachel Carson's *Silent Spring* and Edward Abbey's *Monkey Wrench Gang*

¹⁸ Gabrys, Jennifer. 2016. Program Earth

¹⁹ NASA Space Science Coordinated Archive. Online at <https://nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=1957-001B>. Accessed 8 June 2017.

²⁰ Data from the Sputnik 1,2 and 3 are available in D.G. King-Hele's "Analysis of the Orbits of the Russian Satellites". In Proceedings of the Royal Society of London. Series A, Mathematical and Physical Sciences

necessary. This assemblage of radiophonic and telemetric components in Sputnik - its telecommunicative medium - was to inspire generations of sound and images through sampling, transmitting and creatively manipulating orbital phenomena - presenting a computational or programmatic view of the earth through remote monitoring from space.

According to the United Nations Office for Outer Space Affairs²², there are now over four thousand satellites in orbit today engaged in the processes of observation, monitoring, navigation and communication. Complementing the aerial surveillance are networked, distributed, digital sensors at ground level, these technologies transform the planet into a ‘digital earth’. Sensing technologies, as they become ubiquitous in society, are now indispensable in the development of scientific understanding of environmental change²³. As well as the potential for increased knowledge about our environments, the data that these technologies offer are often available on open data sources, promoting a myriad of creative engagements with data as raw material.

Today, sonifications and visualizations abound in the depiction of our planet. Maps, graph, pie charts, plots etc adorn the visual universe with technical imageries, abstracted forms of data and caricatured drawings of the earth and its ecosystemic functions. Interactive maps such as the ones found on Earth.nullschool.net’s websites allow you to pull a digital globe in any direction

Vol. 253, No. 1275 (Dec. 29, 1959), pp. 529-538. Online: https://www.jstor.org/stable/100703?seq=4#page_scan_tab_contents. Accessed 9 June 2017.

²¹ Audification differs from sonification in that it is a direct translation of a data waveform into sound. Sonification is most recognized as an art form and type of auditory display technique used to convey information or perceptualize data through audio signals. It involves a further step of parameter mapping from audification that can be a result of both creative or utilitarian motivation. Both processes however typically seek to present information in the form of sound and noise. See Thomas Hermann, Andy Hunt, John G. Neuhoff (Eds.)2011.

²² Online Index of Objects Launched into Outer Space. United Nations Office for Outer Space Affairs. Online at <http://www.unoosa.org/oosa/osoindex/search-ng.jsp>. Accessed May 29th.

²³ Gabrys, p3. Gabrys expands on the types of information sensors typically collect - including social and smartphone data for “managing cities and facilitating logistics”.

and view a simulation of the real-time surface wind speeds and directions at any location. NASA's GEOSS-5 numerical weather model also periodically releases data on specific parameters such as carbon monoxide sensing that are routinely put on informative albeit low-resolution maps²⁴.

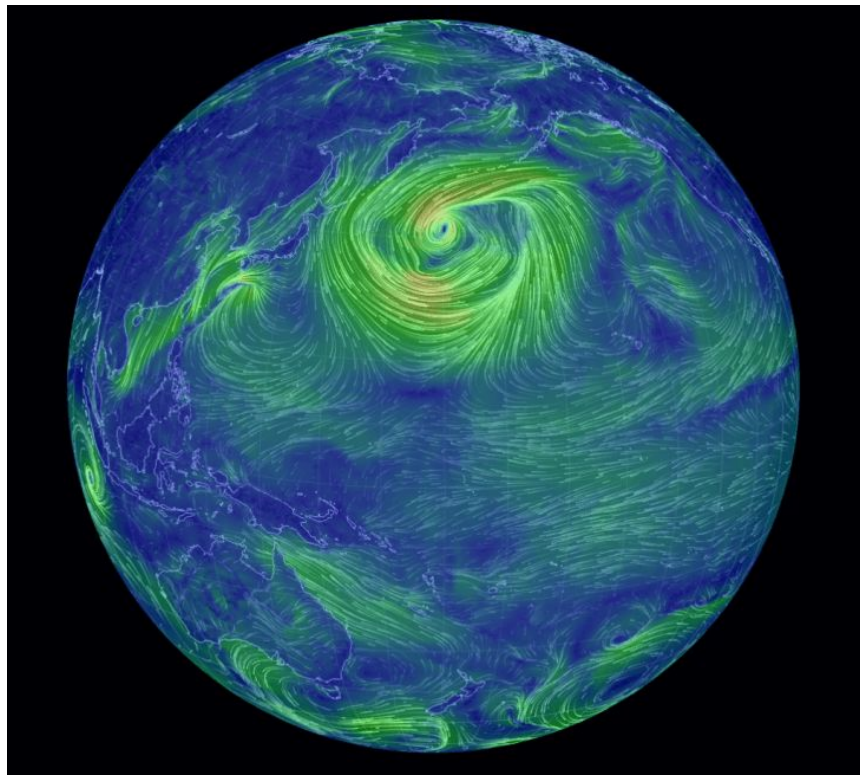


Figure 2.2. *Earth Wind Map's* Interactive Wind Map²⁵

While most information design focuses mainly on the visual aspects, sonification can also be an example of a sensual or experiential art-making process. In fact, there are many works of music and sonic arts today that derive their raw material from open data sources such as satellite or systemic data from the Internet of Things. The rapid rise at which this practice is developing is

²⁴“Global Modelling and Assimilation Office”. Online at: <https://gmao.gsfc.nasa.gov/forecasts/>. Accessed 12 June 2017.

²⁵“EarthWindMap” Online at <https://earth.nullschool.net/#current/chem/surface/level/anim=off/overlay=cosc/orthographic>. Accessed June 12 2017

due both to the proliferation of entry-level consumer DAWs (Digital Audio Workstations) and software tools for sound design and the increasing amount of data that is made publicly available. Sonification pioneers like Mark Ballora bridge institutional disciplines of music, software programming and engineering aim to create sonifications that are both musically compelling and scientifically informative²⁶.

A notable example of such sonifications in the classical music tradition is Charles Dodge's *The Earth's Magnetic Fields*, composed at Bell Labs in 1968 and predating more recognizable work in speech synthesis. Dodge's piece makes use of data derived from recordings done by geophysicists at the Goddard Institute for Space Studies of fluctuations in the Earth's ionosphere (caused by solar winds) over the course of the year 1961. A total of 2920 readings were acquired that were measured according to the Kp Index, a scale that had 28 values or degrees of magnitude. Dodge mapped these values both to a 28-semitone scale, and more arbitrarily to a 4-octave scale. Other data was used consistently to vary tempo, dynamics and timbre²⁷.

²⁶ "Professor Mark Ballora Translates Numbers to Music" in Onward States. Online: <http://onwardstate.com/2015/04/02/professor-mark-ballora-translates-numbers-to-music/> . Accessed June 18 2017

²⁷ Taruskin, 2010. p497

2.4 INFORMATIONAL ECOLOGIES

In the introduction to the online journal ‘Critical Ecologies’, editor Joseph Tabbi explains how two types of ecology had gradually emerged in the project : “biological, organic ecologies - we usually just call ‘the environment’ - and. . . abstract, inorganic, informational and digital systems and networks”²⁸ . Indeed modern environments refer not only to the biological as they do refer to the embeddedness of digital information within our everyday lives. As Nardi and O’Day describe:

(An) information ecology is a system of people, practices, values, and technologies in a particular local environment. In information ecologies, the spotlight is not on technology, but on human activities that are served by technology²⁹

The material technologies in today’s complex informational systems are often so ubiquitous they become invisible, they form so much a part of our everyday life that they “disappear into the background”³⁰, so much so that the philosophical adage of a fish being unaware of the water it exists in is more true today than ever before. The technological milieu that we live in can be said to be infrastructural³¹, and adding to the proverbial metaphor:

Fish probably know a lot about water’s temperature, clarity, currents, weather, prey and so on, but the point was that they did not recognize it as water. It was just background, the stuff that slides into infrastructural obliviousness.³²

Sensing technologies are the new portals through which we experience our environment, and to the extent that these technological augmentations are indistinguishable from our own senses, it becomes our new *nature* - the way we recognize, navigate, organize and *survive* aforementioned

²⁸ Tabbi and Cary, 1996.

²⁹ Nardi, Bonnie and Vicki O’Day, 1999.

³⁰ Weiser, 1991.

³¹ Infrastructural media is a neologism by media theorist John Peters. It is focused on “the basic, the boring, the mundane, and all the mischievous work done behind the scenes”. From Peters,2015. p33

³² Ibid, p 55

ecosystems of analog/digital devices. Marshall McLuhan proposes that Sputnik's launch had paved the way for a new environmental system of belief:

For the first time the natural world was completely enclosed in a man-made container. Nature became enclosed in a man-made environment - and 'nature' was dead, 'ecology' was born³³.

This man-made container of human technology is both an extension of man and a metaphor for a reductionist view of nature inaugurated through a uniquely digital process of sampling the environment. Therefore the roles of the modern ecologist is not only that of field-worker, but also theoretical modeler³⁴, adding the practice of bioinformatics and computational modelling of environmental data to this ecosystem. Consequently, a spatial and phenomenological dichotomy between a personal experience of the environment and technologically-mediated one is one of many arterial complications common to both ecological science and media ecology:

Envisioning media as an environment leads different theorists to radically divergent conclusions: to an emphasis on the generality, systematicity, and autonomous logic of technological change, on one side, and to an emphasis on the local implantations, changeability, and social logic of technologies, on the other; ecology, therefore, functions in media theory as a metaphor for technology as an all-encompassing system or, in contrast, as an image that counteracts this kind of system³⁵.

Indeed today's hybrid environment exists simultaneously *in vivo*, *in vitro* and *in silico*. In the environmental sciences, the study of ecology (coined by German zoologist Ernst Haeckel in 1869) lies in a total engagement with the "economy of nature"³⁶. In general terms, this refers to a multidimensional approach of merging biological, computational, social, cultural, geographical

³³ McLuhan. 1974.

³⁴ In my academic history as an Ecologist, my work saw this very transition from embodied field research to lab based computational analysis.

³⁵ Heise, 2002.

³⁶ Coined in 1869 by German zoologist Ernst Haeckel the term "ecology" would mean "the body of knowledge concerning the economy of nature - the investigation of the total relations of the animal both to its inorganic and to its organic environment; including about all, its friendly and inimical relations with those animals and plants with which it comes directly or indirectly into contact". In Scheiner and Willig, 2011. P 5

etc. information that leads to a perspective of a *particular angle of nature*³⁷. McLuhan's ecology most aptly follows the definition of scientific ecology as a "science of synthesis"³⁸ that encourages an amalgamation of technological instrumentation and a dexterity across different observational approaches to achieve a desired perspective.

We can observe such hybrid informational ecologies through responsive architecture. A part of the movement towards ubiquitous computing and an integral part in the planning of intelligent buildings and future *smart cities*³⁹, the development of responsive architecture aims to fuse urban materialities and programmatic or computational infrastructure⁴⁰. Traditional architecture that revolves around monochromatic antagonism, invasion and wanton plunder of the environment is a relationship epitomized in Jane Gaskell's *This Summer Lands*:

Like all these long low squat houses, it had been built not *for* but *against*. They were built against the forest, against the sea, against the elements, against the world. They had roof-beams and doors and hatred - as though in this part of the world an architect always included hatred among his tools, and said to his apprentice: 'Mind you've brought along enough hatred today'⁴¹.

Instead, responsive architecture focuses on the way embedded systems may imbue buildings with a technological sentience, where interactivity emerges from the recognition of the building as sensitive and fragile in its engagement with the environment:

Fragility provides a strategy for allowing an architectural structure to embrace multiple openings in the fact of its own demise. Because of fragility, the openings are inherently part of the system and they can be accessed and manipulated. Empathy arises, but also

³⁷ Keller and Golley, 2000.

³⁸ *ibid*

³⁹ Gabrys, 2016. p197

⁴⁰ This is ideological because the reality of ubiquitous urban planning "would require a considerable outlay of materials and resources in order for cities to operate in these modalities". *Ibid*. p198

⁴¹ Jane Gaskell, "Some Summer Lands", quoted in China Melville's "This Census Taker".

participation because not only is this architecture a body, but it is a body we can manipulate⁴².

Encouraging a form of fragility, opposed to rigidity is a way to embrace contingencies and unpredictability in the environment. This philosophy is antithetical to a scientific mode of observation, where perturbations and lack of control over all parameters can cause discrepancies in the experiment results. However, it is more true to the way sensing systems function within these technological ecosystems - anyone who has set up interactive systems to observe the environment, or more viscerally, tried to pin an RFID tag on a wild animal to observe its mobility, would know how fragile this connection can be.

Our hybrid environment today is perceived both *in vivo* and *in silico*, our ecosystems and habitats - constituents of McLuhan's post-Sputnik ecology - boast digital tools that augment our senses beyond human scales of perception and create immersive worlds that tantalize our bodily senses. In moving from *terra naturalis* (the natural earth) to *terra notitia* (informational or programmatic earth), we are encouraged to expand our 'bubble' of consciousness into the ether, and to directly experience the way natural phenomena or *elemental* media can revitalise our digital topographies as metaphor, narrative and raw material.

⁴² Beesley and Khan. 2009.

2.5 TOWARDS THE CREATION OF A DIGITAL WIND

2.5.1 *Tracing, Measuring Air*

There is a dead space between mouth and lung.
It's the volume of inhaled air that does not take part in gas exchange.
-Madhur Anand⁴³

In 1776, the discovery of oxygen by Joseph Priestly would shatter the illusion that air was a basic, indivisible element. In his seminal work *Experiments on Different Kinds of Air* (1774), Priestly would demonstrate the differences between respiration (human breathing of oxygen and release of carbon dioxide) and transpiration (plants absorbing carbon dioxide through photosynthesis and returning oxygen to the atmosphere), and processes of combustion that required a constant flow of oxygen in the experimental setup. His observations unravelled the atmosphere as a composition of multiple gases, usurping prior perspectives of the 4 indivisible elements: Earth, Water, Air, Fire⁴⁴.

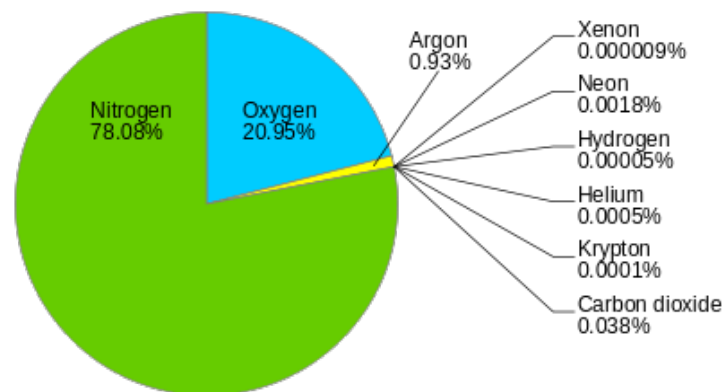


Figure 2.3. The Composition of dry, atmospheric air⁴⁵

⁴³ Anand, 2015.

⁴⁴ Holmes, 2008.

⁴⁵ "Air separation". Wikipedia. Online:https://en.wikipedia.org/wiki/Air_separation. Access 8 June 2017.

Today we know the atmosphere to consist of an array of gases in predictable proportion and balance, but for Priestly, air had *materialized* through quantification and measuring. The elemental media of air would be seen as not just atmosphere for breath, but also as a repository and database of divisible entities.

Where nature was the original repository of “natural history” held in genetic lineages over evolutionary time, the hierarchical stratification of biological material now is used as organizing principles for designing digital infrastructure. The elements of the *atmosphere*, *cloud* and *wind* also are used as structural metaphors to describe modern data storage and navigation. Charles Babbage was particularly conscious of way the air could be seen as an infinite database. In the *Ninth Bridgewater Treatise* of 1837 he describes how “the air we breathe is the never-failing historian of the sentiments we have uttered”⁴⁶, where the atmosphere becomes stored vestiges of human conversation, utterances and *all* sound:

The pulsations of the air, once set in motion by the human voice, cease not to exist with the sounds to which they give rise⁴⁷.

And in adapting this to Nature in Romantic prose:

No motion impressed by natural causes, or by human agency, is ever obliterated. The ripple on the ocean’s surface caused by a gentle breeze, or the still water which marks the more immediate track of a ponderous vessel gliding. . . are equally indelible. The momentary waves raised . . . leave behind them an endless progeny, which . . . will pursue their ceaseless course till ocean be itself annihilated⁴⁸.

⁴⁶ Babbage, 1837

⁴⁷ *ibid.*

⁴⁸ *ibid.*

In Thoreau's *Walden*, we see a similar experience of listening to sounds that acquire a sort of immortality in the way they never seem to die but are taken up and 'echoed' by different agents in the woods. Here he describes the experience of listening to the bells from Walden:

There came to me in this case a melody which the air had strained, and which had conversed with every leaf and needle of the wood, that portion of the sound which the elements had taken up and modulated and echoed from vale to vale. The echo is, to some extent, an original sound, and therein is the magic and charm of it. It is not merely a repetition of what was worth repeating in the bell, but partly the voice of the wood; the same trivial words and notes sung by a wood-nymph⁴⁹.

Here traces of sounds are heard in every part of the forest, animal vocalizations, or echoes through open spaces, are seen as what they are - sympathetic resonances in a vibratory continuum that ferry sonic messages through space.

2.5.2 *Aeolian Metaphors and the Romantic Impulse*

In the same way sound establishes networks of resonance, breath sets the air around us into motion and establishes resonances between humans. In Hebrew, Greek and Latin the words for wind - *ruach*, *pnuema* and *spiritus* respectively have interchangeable meanings between breath, wind and spirit. And for the Romantic poets, observing and writing about the wind was a way to personify it within these metaphors of Nature, breath and spirit.

In the intertwining of self and nature, immanence and transcendence, Romanticism proposed that *aesthetics* and not rationalism (brought about by the Renaissance and the Enlightenment)

⁴⁹ Thoreau, 1989. p196

was to shape and permeate everyday life, seeking to elevate aesthetics (art and beauty broadly defined) as the “foundation of knowledge and the pursuit of truth”:

The Romantic imperative demands all nature and science should become art, art should become nature and science, poetry and philosophy should be united, and life and society made poetic⁵⁰

The Romantic urge to *poeticize* life can be seen in the way Nature is depicted in their poetry - as a source of comfort and inspiration, and as a way to appreciate a universal beauty from the attention to the smallest of details:

The most important of these for science was their attention to the particular among the universal, the single flower that spoke for all of organic nature, the church bell that resonated to the harmony of the heavens. They avoided abstractions . . . and analysis, which mean that for them, the universal had to be perceived almost intuitively in the particular object. . . they refused to stand apart from nature and insisted that the objects perceived could not be separated from the subjects perceiving them⁵¹.

Adding to the keen, poetic observation of the environment by the Romantics and its subsequent representation as an extension of the human emotion, instruments that reveal certain wonders of nature, or showcase surprising complexities and unpredictabilities of nature were particularly referenced and used. The Aeolian harp, for instance, was a recurrent theme in the inspiration and imagination of Romantic writers like Shelley, Coleridge, Wordsworth and Melville.

Invented by Jesuit priest Athanasius Kircher, the Aeolian harp was one in a series of instruments that Kircher had proposed in his *Musurgia universalis* (1650) (along with the Magic Lantern) and again, in *Phonurgia nova* (1673)⁵².

⁵⁰ Friedrich Schlegel, 1797. Cited in Gorodeisky, Keren, "19th Century Romantic Aesthetics", The Stanford Encyclopedia of Philosophy (Fall 2016 Edition), Edward N. Zalta (ed.), Online at <https://plato.stanford.edu/archives/fall2016/entries/aesthetics-19th-romantic>. Accessed June 2017.

⁵¹ Hankins, 1995. p87

⁵² Hankins, Thomas and Silverman, Robert. 1995

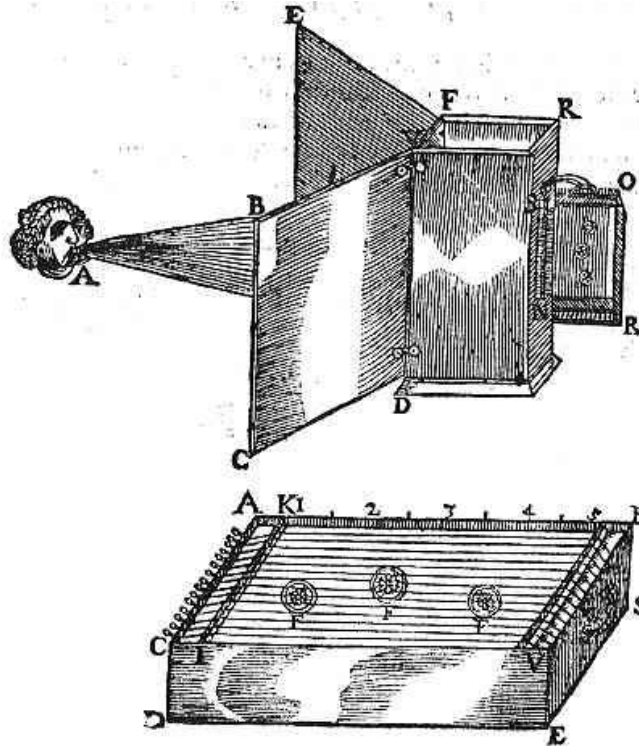


Figure 2.4. The Aeolian Harp in Athanasius Kircher's *Phonurgia Nova*⁵³

Thomas Hankins provides a physical description and activity of the Aeolian harp:

The aeolian harp is a stringed instrument played by the wind. The most common form is a rectangular closed box about three feet long, six inches wide and three inches deep. Three to twelve strings, tuned in unison, are stretched the length of the box between two bridges, and one or more sounding holes is cut in the top of the box above the string. The harp sits on a windowsill with the sash drawn down just above the strings. When there is a draft through the window, the harp will sound one or more notes, the pitch depending on the strength of the wind. The music has an eerie quality and is difficult to locate. Very slight changes in the draft will bring on different notes, at first harmonious and indolent, but as the wind strengthens, marked dissonances occur until in a strong wind the music becomes more like a scream. Nothing could better match the sentiment of the romantic soul⁵⁴.

⁵³ Kircher, Athanasius. 1673 *Phonurgia Nova*. University of Washington.

⁵⁴ Hankins and Silverman. 1995

This personification of the wind is seen predominantly in Romantic literature where the Aeolian harp⁵⁵ was not only a physical instrument that was celebrated, but a symbol of the transcendent breath of Nature⁵⁶. Attributing a *voice* to the elements is a vestigial trace of the Romantic fascination with Nature and a desire to communicate with her. The Aeolian harp is distinguished from other wind-driven instruments in that it does not require human agency the way bullroarers, wind wands, or more common orchestral woodwinds and brass wind instruments; instead it “was superior to other instruments because its music was unpredictable and because it was played, not by man, but by the breath of Nature herself”⁵⁷.

As its name suggests, the Aeolian harp references Greek Mythology in the character of Aeolus, King of the floating islands of Aeolia and divine keeper of winds in Homer’s *Odyssey*⁵⁸.

Athanasius Kircher continues his fabrication of the Aeolian harp with the creation of a unique aeolian-human orchestra, in which musical performers could take the stage alongside these harps in quadrangles that were partially exposed to the wind. Athanasius Kircher was a pious Jesuit priest, and one might venture to suggest that by playing along to, and improvising with these wind-driven harps, Kircher sought to communicate with God through music. In this way, the observer of the winds was transformed from mere witness to interpreter and conversationalist.

⁵⁵ Musical applications of the aeolian harp are documented within the Western classical tradition, though variations of the harp can be found in Asian influences such as the Cambodian singing kite (khleng ek). More installation based version of the harps are available as sound sculptures from such artists such as Max Eastley and will be discussed shortly.

⁵⁶ Hankins and Silverman. 1995

⁵⁷ Ibid. p88.

⁵⁸ Homer. 2007.



Figure 2.5. Athanasius Kircher's Aeolian-human ensemble⁵⁹

Extending into the 18th Century through parallel movements such as American Transcendentalism, variations in the Aeolian harp's metaphors continued to appear in poetry and literature across geographical camps in Germany, England and the US. Through Emerson's transcendentalist imaginations, the instrument would be elevated to religious proportions as a mouthpiece for the voice of Nature and Beauty:

It seems as if the day was not wholly profane, in which we have given heed to some natural object. The fall of snowflakes in a still air, preserving to each crystal its perfect form; the blowing of sleet over a wide sheet of water, and over plains; the waving rye-fields; the mimic waving of acres of houstonia, whose innumerable florets whiten and ripple before the eye; the reflections of trees and flowers in glassy lakes; the musical

⁵⁹ Kircher.1673.

steaming odorous south wind, which converts all trees to windharps. . . these are the music and picture of the most ancient religion⁶⁰.

In Shelley's poetry, the Aeolian harp becomes a symbol of the human psyche's sensitivity to emotional flux, both externally and internally:

Man is an instrument over which a series of external and internal impressions are driven, like the alternations of an every-changing wind over an aeolian lyre, which move it by their motion to ever-changing melody. But there is a principle within the human being, and perhaps within all sentient beings, which acts otherwise than in the lyre, and produces not melody alone, but harmony, by an internal adjustment of the sounds or motions thus excited to the impressions which excite them⁶¹.

Designed to be architectural (it was intended to be attached to a window or a wall), the metaphor of the Aeolian harp as situated between interior and exterior space could be extended to the built environment. In fact, Kircher's interests in the Aeolian harp were aligned with his explorations of urban acoustic space. In *Phonurgia Nova*, Kircher's blueprints for a *Panacousticon* proposed the transmission (and amplification) of sounds through tunnels built into the infrastructure of buildings. Thus all sounds from the open spaces in the architecture would end up in focused listening portals such as the mouth of automatons, or small sonic 'peepholes', allowing the listener to access *all sounds* occurring simultaneously through multiple spaces. As a way to depict the currents of an external space, the Aeolian harp was also as much musical as it was architectural where it was typically installed at the window of a house, allowing inside-outside dichotomies to dissolve through sound.

⁶⁰ Emerson, Ralph Waldo. *Nature* (1844) p37

⁶¹ Shelley 2004.

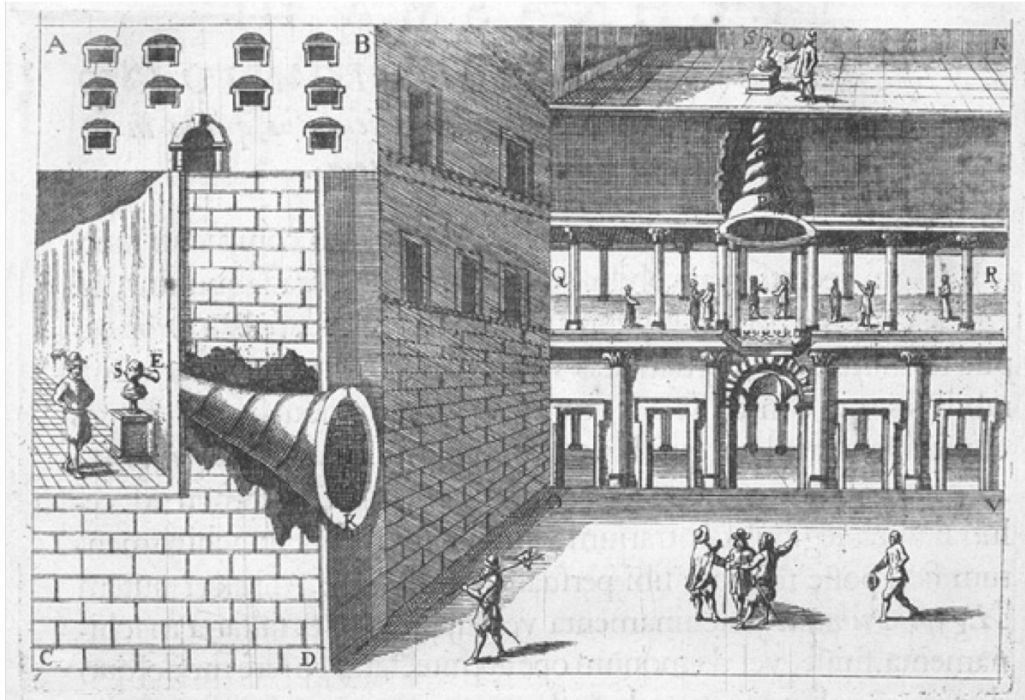


Figure 2.6. The *Panacousticon*⁶²

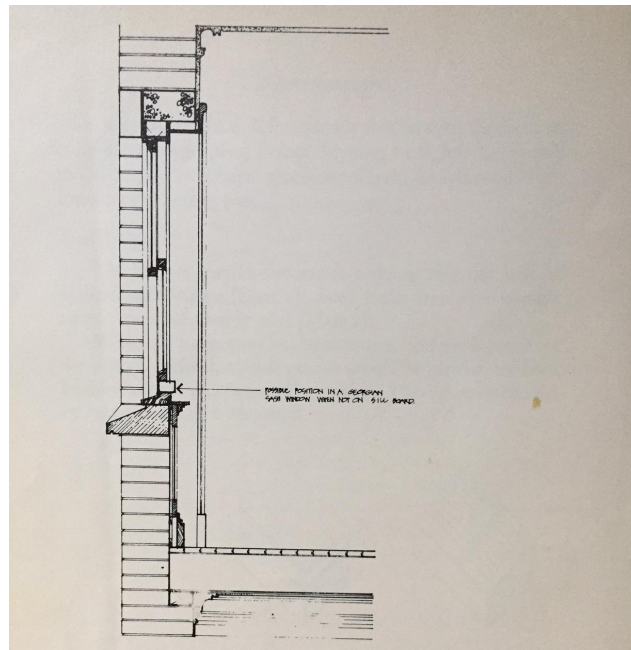


Figure 2.7. Blueprints of an Aeolian harp to be positioned at a Georgian Sash window⁶³

⁶² Kircher. 1673

⁶³ Mansfield, 1968. Plate 5, p26.

Barbara Kendra discusses how a building “was envisioned as a mediator between the inhabitant’s soul and the *anima mundi* ; the soul of the world”⁶⁴ In this way, the circulation of wind was an important consideration in Renaissance pneumatic architecture. The Aeolian harp with its unique ability to amplify and vocalize ambient wind becomes a symbol of the established harmony in the triangular relationship of human body, architecture and the cosmos⁶⁵.

2.5.3 *Soundwalking*

In line with the Romantic impulse to nature, the Transcendentalists sought to rise above worldly and “animalistic impulses” and move from the rational to the spiritual realm⁶⁶ and encouraged a relationship to the earth that was not based on a philosophy of colonisation, but one of sensitivity - listening and being attentive to nature. And listening outward was to come hand in hand with an inward focus. In the words of Emerson: “the difference between the observer and the spectacle - between man and nature. . . whilst the world is a spectacle, something in himself is stable.” To accentuate the position of the observer as witness, the Transcendentalists encouraged a listening/observation platform from which this could take place.

Writing about Thoreau’s experience at Walden, R. Murray Schafer describes how he experiences “in the sounds and sights of nature an inexhaustible entertainment”⁶⁷. In line with the transcendentalist school of thought, Schafer and the Acoustic Ecology movement sought to

⁶⁴ Kendra. 2006. p1.

⁶⁵ Ibid.

⁶⁶ Emerson, 2009 p21

⁶⁷ Schaffer, 1977. p5

create a revolution in auditory experience of the environment by “tuning” the ear to the earth’s audible wilderness. Merging a rationalist urge to catalog and diagnose a particular soundscape, with an imaginative, transcendent mode of listening to nature, Schafer developed a lexicon of terms⁶⁸ for describing and discussing sounds in the environment that would include both literary prose and narrative anecdotes, but also musical and mathematical bases for sound.

For Thoreau, the wind represents a sort of wilderness in the way it is untamed, not controlled by man or society. His clarion call to experience nature directly through walking or *sauntering* parallels Schafer’s practice of the soundwalk in its focus on the embodied and holistic perception of auditory stimulus in the environment. Thoreau’s walking functions for him as a politically subversive act. By asserting his freedom in the ‘wild’, he is able to imagine a ‘wilderness’ without civil and societal burden. In the opening lines to his chapter on *Walking*, Thoreau writes:

I wish to speak a word for Nature, for absolute freedom and wildness, as contrasted with a freedom and culture merely civil, - to regard man as an inhabitant, or a part and parcel of Nature, rather than a member of society⁶⁹.

Aeolian instruments today aim to elucidate untapped wildness in Nature by creating a spectacle of ephemeral wind and musical civility. In Schafer’s descriptions, the wind creates an aural illusion, because “without objects in its path, the wind betrays no apparent movement”⁷⁰. The Aeolian harp thus creates a site-specific spectacle in its vocalization of wind *in situ*⁷¹.

⁶⁸ The terms soundscape, soundmark, and keynote sounds are all terms proposed to describe the sonic character or identity of any given space. Schafer also advocated good listening habits and wrote about noise pollution, contrasting high fidelity and low fidelity soundscapes. See Schafer, 1977.

⁶⁹ Thoreau, 1980. P 93

⁷⁰ Schafer, 1977. p22

⁷¹ While its reference to transcendentalist imaginations of Nature are strong, political metaphors of the Aeolian are not well developed and are worth a measure of further research.

Today, Aeolian instruments bear multiple shapes and forms and vocalize the winds in myriad ways. In Gordon Monahan's 1984 *Long Aeolian Piano*, exhibited in New Brunswick in 1984, long piano wires are strung through the piano's soundboard and anchored to peg boards at the other end. Oriented perpendicular to the prevailing wind, aeolian tones are thus excited in the strings.

The sounds that emerge in Monahan's artwork are described in his project description:

Because of the long length of the strings, the predominant tones are those between the 20th to 100th harmonic partial (usually in the 400 Hz. to 2000 Hz. range) of the string's fundamental frequency. Some strings vibrate multiphonicly, that is, two or more frequencies are simultaneously excited on a single string. Mysterious low frequency tones (100 Hz. and lower) have also been excited in the strings in the seeming absence of wind. In some cases, in a quiet soundscape, the aeolian tones can be heard up to 700 meters away, without any electronic amplification⁷².

Monahan follows this seminal work with several iterations of Aeolian pianos, notably at Castle Square in Warsaw, and on Lake Nipissing in North Bay, Ontario:

⁷² Gordon Monahan's artist website. http://www.gordonmonahan.com/pages/long_aeolian_page.html. Accessed June 1 2017

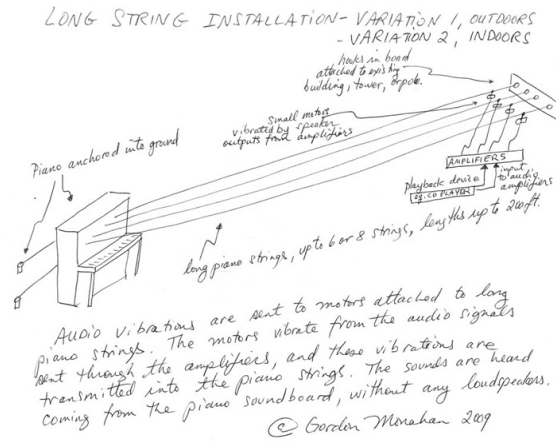


Figure 2.8: Drawing of the installation A Piano Listening to Itself, 2009



Figure 2.9. Gordon Monahan. A Piano Listening to Itself: Chopin Chord, 2009



Figure 2.10. Monaham's *Piano on Frozen Lake Nipissing*

British sound sculptor Max Eastley's aeolian installations provide a sensitivity to nature and are distinctly harmonious and feel like extensions that arose from the environment organically rather than imposed on it. His artist statement describes his work as "sculptures (that) exist on the border between the natural environment and human intervention and use the driving forces of electricity, wind, water and ice"⁷³. Eastley's aeolian sculptures are interesting because of the way they take the traditional form of stringed harps which are then amplified and subsequent piped (dislocated) into separate listening spaces.

⁷³ Ibid.



Figure 2.11. Max Eastley's Aeolian Harp 2014⁷⁴

Nascent experimental traditions of amplifying (and in some cases, electromagnetically activating) long strings approaches the resonant harmonics of the Aeolian harp. Works such as Alvin Lucier's *Music on a Long Thin Wire*, Ellen Fullman's performances with her *Long String Instrument*, join recordings of the wind through wires, fences and strings by Alan Lamb, Jon Rose and Chris Watson in demonstrating the artistic value of the Aeolian harp. Simulations of the tonality of the aeolian harp can also be seen in work with electromagnetically activated pianos in CCRMA's Electromagnetically-activated Piano (EMMP) invented by Per Boland, Steven Becker and Edgar Berdahl⁷⁵.

⁷⁴ "Max Eastley: Installation for Springhornhof Gallery and Landscape art Center". Online at <http://www.maxeastley.co.uk/2014/07/02/installation-springhornhof-gallery/>. Accessed June 1 2017

⁷⁵ This was the inspiration for my work with the cybernetic monochord where an electromagnet activated a single string instrument to multiple overtones and resonances. This is described later on in the dissertation.

Representations of the “warble”⁷⁶ of the Aeolian harps can also be found in classical music, most notably in Frederick Chopin’s Etude Op.25 no.1 (1836), where rapid arpeggios and harmonic modulations mimic the activated harp’s complex harmonic content. Especially in the last 4 bars of the piece, the player transitions both hands to the treble in sweeping passage in the higher register of 16th notes. Variations on the accents in performance provide a distinctly ‘aeolian’ ebb and flow. Henry Cowell’s *Aeolian Harp* (1923) as well introduced gestural sweep of the hand across the strings of the piano to simulate the passage of wind over the harp⁷⁷. The vibrations of the Aeolian harp have also been a symbol for the transmission of sensation as vibrations in the nervous system⁷⁸.

Of course, other forms of Aeolian instruments exist. For instance, *Soundgarden* by Doug Hollis at the NOAA campus in Seattle is a collection of Helmholtz resonators, metal tubes of different lengths that sound as wind at the site blows across their mouths. Other installations that exploit the wind through rhythmic tappings, spinning, striking or swinging parts abound in the visual/sound sculptural arts. For instance, the permanent installation *Windswept* by Charles at the Randall Museum features freely rotating directional arrows that are mounted on a grid. Each arrow serves as a “discrete data point that provides a sample of the wind at its point of contact with the museum building”⁷⁹.

⁷⁶ The Aeolian harp is described to replicate the ‘warble’ in the air in Coleridge’s poem *The Eolian Harp*: “Where the breeze warbles /and the mute still air / Is Music slumbering on her instrument”. Online at https://en.wikipedia.org/wiki/The_Eolian_Harp. Accessed June 1 2017.

⁷⁷ Such extended techniques for the piano are typical of the composer, and are described in greater detail in his scores. This score was viewed online at <https://musescore.com/nicolas/scores/33185> . Accessed June 1 2017.

⁷⁸ Trower, 2009.

⁷⁹ “Sculpture: Art Commission Installations” on “Randall Museum’s Website at <https://www.randallmuseum.org/project/sculpture/>. Accessed 16 June 2017.



Figure 2.12. Doug Hollis' *Soundgarden*⁸⁰

⁸⁰ "A Sound Garden". Wikipedia. Online at https://en.wikipedia.org/wiki/A_Sound_Garden. Accessed June 1 2017.



Figure 2.13. Charles Sower's *Windswept* (2011)⁸¹

⁸¹ "Windswept". <http://charlessowers.com/windswept>. Accessed June 16 2017.

2.5.4 *Abstracting the Atmosphere : visual abstractions*

In Romantic painting, the emphasis on ‘landscape’ as a depiction of the human psyche was a primary aesthetic form. Such atmospheric paintings can be seen in the works of painters like JMW Turner, Caspar David Friedrich and Eugene Delacroix. Employing color as a “psychico-expressive medium”, background landscapes were imbued with emotions and ‘moods’⁸².

Turner’s work *Rain, Steam and Speed - The Great Western Railroad (1844)* for instance not only captured the visual atmosphere of the landscape, but also a broad emotional response to Industrialization in its hazy depiction of the surrounding air.



Figure 2.14. JMW Turner’s *Rain, Steam, Speed*:⁸³

⁸² Itten, 1970. p10

⁸³ “Turner: Rain, Steam Speed” Online [https://upload.wikimedia.org/wikipedia/commons/9/96/Turner - Rain%2C_Steam_and_Speed - National Gallery file.jpg](https://upload.wikimedia.org/wikipedia/commons/9/96/Turner_-_Rain%2C_Steam_and_Speed_-_National_Gallery_file.jpg). Accessed May 31st 2017.

Likewise, Friedrich's *Monk by the Sea* was an exploration into dense background textures that create a subjective perception of mood. The expanse of atmosphere contrasted with the lone protagonist in the foreground creates a sense of infinite and overbearing space. In Friedrich's image, classical techniques of delivering anecdotal spectacles of mythic significance are supplanted by the invocation of an immense void.



Figure 2.15. Caspar David Friedrich, *The Monk and the Sea*

The emphasis on subjective emotional experiences that arise through the perception of color *fields* represents an abstraction of the anecdotalist culture of classical painting. Friedrich's work would be an inspiration to Impressionists like Claude Monet and Camille Pissaro, as well as later

Abstract Expressionists like Mark Rothko. Rothko's color field paintings such as *Untitled (Purple, White and Red)* of 1953 invite us to take the position of Friedrich's monk in contemplating the atmospheric expanse and the intersubjective emotions that arise from it. Rothko describes the way an objective abstraction and subjective emotionality unite to give rise to a mythic reality⁸⁴:

When this unity provided a generalization large enough to give a comprehensive expression of the artist's notion of reality - that is, when the objective mechanics of the picture produced a sense of infinity that referred the mechanics to ultimate mechanical order, and when the mood sentiment reached the proportion of universality, of symbolism rather than sentimental illustration - then we had a generalization whose equivalence at least approached the domains of mythical reality⁸⁵.



Figure 2.16. Mark Rothko's *Untitled (purple, white and red)*

⁸⁴ Rosenblum, 1975.

⁸⁵ Rothko, 2004. p35

Abstractions of characteristics in the depiction of natural elements can also be seen in Mondrian's progressive abstraction of the tree into what its elemental compositional forms. Painted over the span of 6 years, the paintings show a gradual decomposition of the tree from realist to abstract, composed lines.

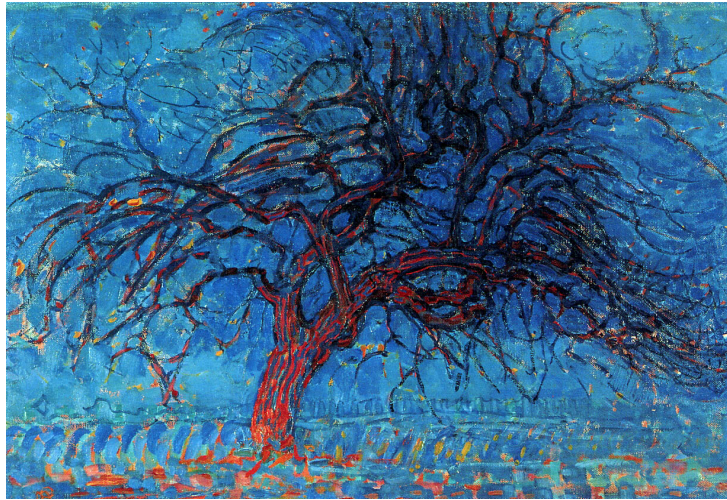


Figure 2.17.: Piet Mondrian's *Red Tree* (1910)⁸⁶



Figure 2.18. Piet Mondrian's *Grey Tree* (1912)⁸⁷

⁸⁶ "The Red Tree, 1908 by Piet Mondrian" online at <http://www.piet-mondrian.org/the-red-tree.jsp>. Accessed June 2017

⁸⁷ "The Gray Tree, 1912 by Piet Mondrian" online at <http://www.piet-mondrian.org/the-gray-tree.jsp/> Accessed June 2017

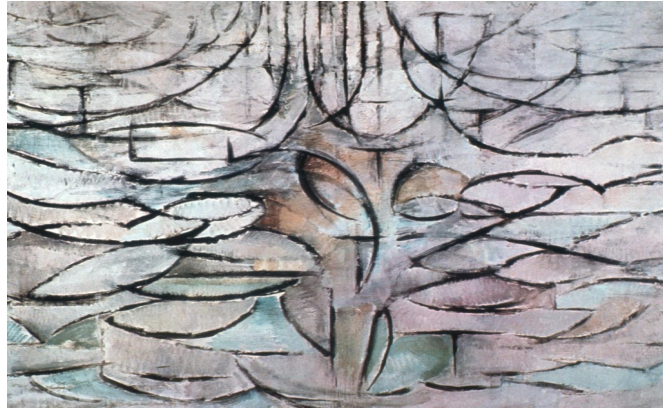


Figure 2.19. Piet Mondrian's *Flowering Apple Tree* (1912)⁸⁸

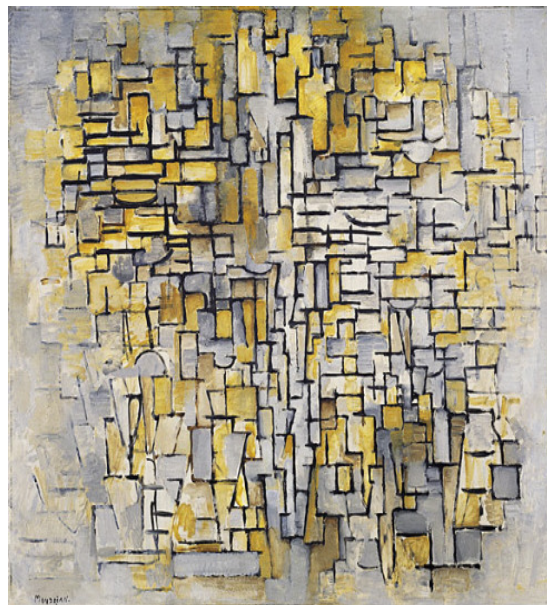


Figure 2.20. Piet Mondrian's *Composition No. VII* (1913)⁸⁹

⁸⁸ “The Flowering Apple Tree, 1912 by Piet Mondrian”. Online at <http://www.piet-mondrian.org/the-flowering-apple-tree.jsp>. Accessed June 2017

⁸⁹ “Piet Mondrian Tableau No. 2/Composition No. VII” Guggenheim Collection Online. Online at <https://www.guggenheim.org/artwork/3007>. Accessed March 2017.

In similar fashion, Jackson Pollock's Drip Paintings can be seen as abstractions of the human psyche, the ultimate expression of the painter's emotional self. Pollock's sensation of movements depicted on the canvas represent traces in his unfolding psychology.

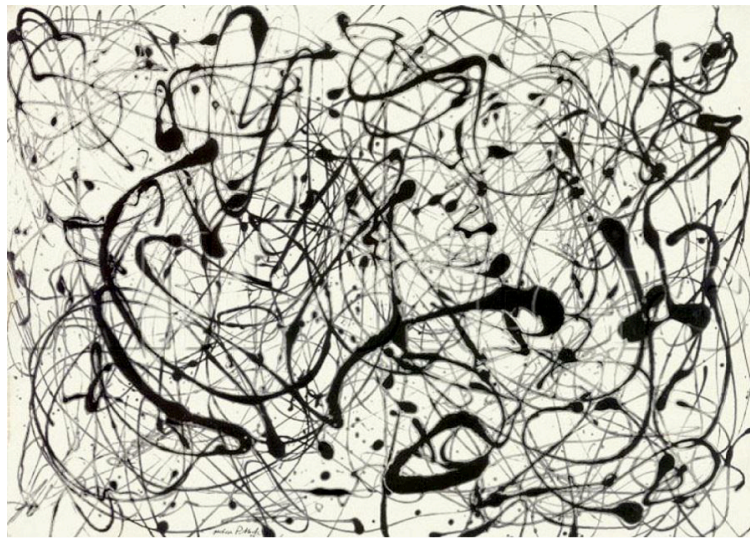


Figure 2.21. Jackson Pollock's *Number 14 Grey*⁹⁰

The abstraction of both natural and psychological elements presents an opportunity to combine both of these into a single effect. Sensations of motion also provide the viewer with a sense of an unfolding of time and space, and imbue the piece with an inherent emotionality and narrative. These forms of visual language approach the intensity of Shelley's poetics where he describes Man as "an instrument over which a series of external and internal impressions are driven, like the alternations of an every-changing wind over an aeolian lyre"⁹¹.

⁹⁰ "Number 14 grey- Jackson Pollock" Online at <http://www.jackson-pollock.org/images/paintings/number-14-gray.jpg>. Accessed June 2016.

⁹¹ Shelley 2004. Accessed June 2014.

2.5.5 *Abstracting the Atmosphere II : Digital Abstractions*

When the Romantic poets wrote about the Aeolian harps, they heard in it a transcendent sonority of the external environment. The harp's mysterious resonance was at once pleasing to the ear and communicative of a distanced planetary circulation of air. Today, the wind and the elements hold more than literary significance. The weather for instance, has become more of a visual graphic than a physical sensation since our primary experience of it is from smartphone weather updates or from weather reports on television.

Symptomatic of the rise to a *terra notitia* or an *informational* earth, digital sampling has abstracted the weather into spliced chunks of information. The array of atmospheric and climate observation systems includes weather radars and satellites, surface observation sites at airports around the world equipped with full range of sensors, and drifting or moored weather buoys offshore, that contribute to providing critical weather information.



Figure 2.22. Weather station⁹²

The generation of climate information as well, is a quantitative exercise that involves both observations and forecasting. Through the combined efforts of the assemblages of sensing equipment, observational data is assimilated into computational models for numerical weather prediction⁹³. Relatively inexpensive climate monitoring tools, coupled with consumer-level micro-computers like the Arduino and Raspberry Pi in recent years allow environmental monitoring to become a citizen science activity. Websites like Wunderground.com allow users to stream live weather updates from their weather stations, creating a digital map of weather data across the world. Currently wunderground.com has an expansive network of over 250,000 registered weather stations.

⁹² “Station ELXC1 – Caspian Weather Station, Elkhorn Slough Reserve, CA”.
Online:http://www.ndbc.noaa.gov/station_page.php?station=elxc1 . Access 9June 2017

⁹³ Mass, 2008



Figure 2.23. An Arduino-compatible Digital Anemometer⁹⁴

 A screenshot of the Wunderground website for SeaTac, WA. The page displays various weather metrics:

- Current temperature: 11 °C
- Feels Like: 11 °C
- Wind: 13 mph from SSW
- Conditions: Overcast
- Forecast: Today is forecast to be NEARLY THE SAME temperature as yesterday.
- Today: High 18, Low 10 °C, 20% Chance of Precip.
- Yesterday: High 17, Low 10 °C, Precip. 0.1 mm.
- Pressure: 1012 hPa
- Visibility: 16.1 kilometers
- Clouds: Few 762 m, Mostly Cloudy 2133 m, Mostly Cloudy 3048 m, Overcast 5181 m
- Dew Point: 9 °C
- Humidity: 89%
- Rainfall: 0.0 mm
- Snow Depth: Not available.
- Sun & Moon: 5:12 am, 9:05 pm, Full, 99% visible.

 A map on the right shows the location of SeaTac, WA, with labels for nearby areas like Burien, Renton, and Des Moines.

Figure 2.24. Wunderground Screenshot of Weather station at SeaTac⁹⁵

⁹⁴ “Anemometer Wind Speed Sensor w/Analog Output”. <https://www.adafruit.com/product/1733>. Accessed 9 June 2017

⁹⁵ “SeaTac, WA”. Wunderground weather station. Online at <https://www.wunderground.com/us/wa/seatac>. Accessed 9 June 2017.

The wind's connection to breath is also exploited in artistic installations, ranging from direct transductions across scale, to deep sentimental interpretation. Scott Snibbe's *Blow Up* invites visitors to sit at a table and blow into a breath console made up of 12 small impellers. This input is then mapped to the activity of 12 large electric fans. This wall of fans thus blows magnified breathing patterns over the entire bodies of the passers-by.

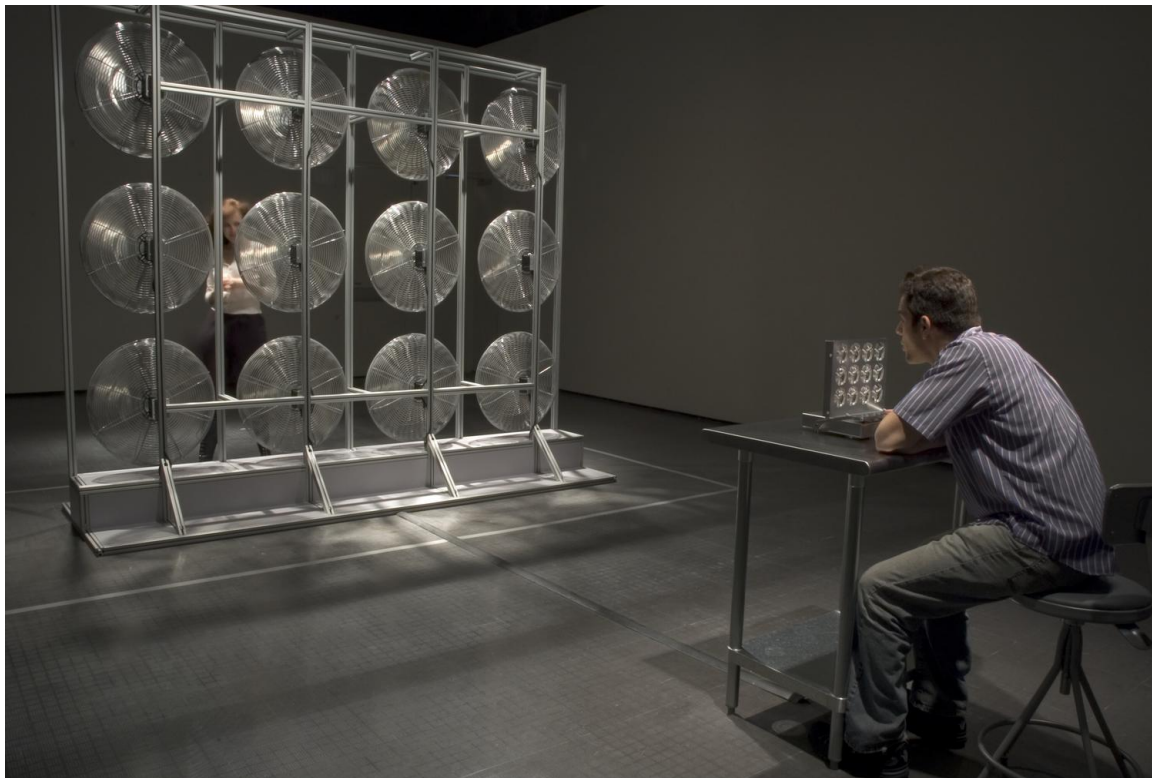


Figure 2.25. Scott Snibbe's *Blow Up*, 2005⁹⁶

In Rafael Lozano-Hemmer's *Vicious Circular Breathing*, visitors are invited to sit in a glass prism that has a controlled atmosphere. It is connected to a repository of breaths that circulates

⁹⁶“Blow Up (2005)”. Scott Snibbe. Online at <https://www.snibbe.com/projects/interactive/blowup>. Accessed 9 June 2017.

constantly in this prism. In this way, the visitors who agree to enter the prism breathe in the recycled air collected from previous visitors and circulates it in a controlled environment.



Figure 2.26. Rafael Lozano-Hemmer's *Vicious Circular Breathing*. 2013⁹⁷

⁹⁷“Vicious Circular Breathing.” Rafael Lozano-Hemmer. Online at http://www.lozano-hemmer.com/showimage.php?img=Mexico_2015&proj=285&type=artwork&id=16. Accessed June 17 2017

2.6 STRATEGIES FOR CREATIVE DATA AESTHETICS

2.6.1 *The Immeasurable and the Measurable*

A God that can be measured has to be man-made. Revelation has no dimension. If it did, it would be dead in space and time.

-Robert Smithson

Art has always been invested in the aesthetization of information. From early cave drawings, paintings through the ages, graphic notations, animation and film, information flows through the artist into his canvas. Information design is not a nascent development, but is an age old interplay of impression, abstraction and inscription grounded in an artistic tradition of quantitative mapping and parameter mapping. Albeit, the nascent practice of data representation has placed much emphasis on the constraints of their mediums of propagation whether screens, maps or paper, and the requirements to fulfil a demand for information - designing information today opposes the artistic lineage of *visual language* in developing infographics that seek more to reduce that to tantalize the senses:

If Romantic artists thought certain phenomena and effects as un-representable, data visualization artists aim at precisely the opposite: to map such phenomena into a representation whose scale is comparable to the scales of human perception and cognition. . . The macro and the micro, the infinite and the endless are mapped into manageable visual objects that fit within a single browser frame⁹⁸

Smithson's opening quote relates to information design in being unable to reveal anymore than its measured components. Indeed all artistic activity oscillates between immeasurable and measurable quotients. In the words of architect Louis Kahn:

⁹⁸ Manovich, 2002.

A great building must, in my opinion, begin with the unmeasurable, must go through the measurable in the process of design, but must again in the end by unmeasurable. The design, the making of things, is a measurable act. . . What is unmeasurable is the psychic spirit. The psyche is expressed by feeling, and also by thought, and i believe it will always remain unmeasurable. . . To accomplish a building you must start in the unmeasurable and go through the measurable. It is the only way you can build, the only way you can bring the building into being - it is through the measurable. You must follow the laws, but in the end, when the building becomes part of living, it must evoke unmeasurable qualities. The design phase involving quantities of brick, methods of construction and engineering is over, and the spirit of the building's existence takes over⁹⁹.

In this way, data aesthetic practices that revolve around the transduction of data from one form to another are able to move from the impetus of an immeasurable origin, through the measured resources of computational practices (sonification or visualization programming) to the immeasurable outputs of immersive or transcendent experiences.

Kahn's approach to architecture parallels data visualization pioneer Edward Tufte's approach. In his introduction to the seminal *Visual Explanations* (1997), Tufte describes how assessments both intuitive or approximate and exact may coexist in the representation of quantities. While much of Tufte's instruction follows a scientific urge towards *accurate*, quantitative analysis, he also describes how "inexpensive computing and ingenious techniques for image processing have provided endless new opportunities for mischief¹⁰⁰". In transforming qualities such as the scale and mapping of the visualization, Tufte proposes occasions for a more creative and unpredictable expressions of the datasets beyond the constraints of the informative.

⁹⁹ Kahn, Luis. "The Value and Aim in Sketching". Quoted in Stockli, Tobi. *The Measurable and the Unmeasurable or from Form to Design to Existence*. Online at <http://papers.cumincad.org/data/works/att/1b31.content.03079.pdf>. Accessed June 2017.

¹⁰⁰ Tufte, 1997 p25.

Cognizant of the way data aesthetics can depict more interesting, uninhibited experiences, I propose some strategies to re-introduce the sublime into data-based projects based on lessons and examples derived from this dissertation's artistic research trajectories. Each of the projects further described in subsequent chapters make use of some or all of these strategies in an attempt make the immeasurable *measurable* in a way that is *immeasurable*.

2.6.2 *Exploratory Environments*

The Romantic tradition (through science and literature) propelled by the impetus to explore and journey to new lands creates the potential of generating narrative trajectories through data. In Roy Ascott's *Aspects of Gaia* (1989), one would see the way scale factors into the experience of an artwork. Visitors mount a cart that is self-propelled through a staging of *Inner Earth* where LED screens display collected texts and narratives about the environment. The textual elements form an informatic representation of the planet, and are collected from networkers all around the world. The visitor's immediate sensory experience of an unfolding journey through a subterranean wilderness mirrors the way the textual elements expand the psychogeography of the present moment.



Figure 2.27. Roy Ascott's *Aspects of Gaia*.

In Jeffrey Shaw's *Legible City*, the city is recomposed as a database of text that the visitor is invited to take a joyride through:

In *The Legible City* the visitor is able to ride a stationary bicycle through a simulated representation of a city that is constituted by computer-generated three-dimensional letters that form words and sentences along the sides of the streets. Using the ground plans of actual cities - Manhattan, Amsterdam and Karlsruhe - the existing architecture of these cities is completely replaced by textual formations written and compiled by Dirk Groeneveld. Travelling through these cities of words is consequently a journey of reading; choosing the path one takes is a choice of texts as well as their spontaneous juxtapositions and conjunctions of meaning¹⁰¹.

¹⁰¹ "Jeffrey Shaw. Description of Installation the Legible City". Online at http://www.jeffrey-shaw.net/html_main/frameset-biography.php. Accessed June 2nd 2017



Figure 2.28. Jeffrey Shaw's *Legible City*

Shaw's installation constructs the city as a database of narratives, allowing the user to read the city as a text, and in so doing, move through the database. The city, a compendium of information, is experience as a book with a nonlinear trajectory that the user can define through reading and connecting spurious narratives. It is important to note Shaw's distinct use of narrative as a way to order the database. This contrast between the narrative form and the elemental constituents of the database that are "collections of individual items, where every item has the same significance as any other"¹⁰² is taken up in Lev Manovich's "Database as Symbolic Order":

As a cultural form, database represents the world as a list of items and it refuses to order this list, narrative implies a cause-and-effect trajectory of seemingly unordered items (events)¹⁰³

¹⁰² Manovich, 2016

¹⁰³ Ibid.

A narrative-centric focus to the database allows the reader and her *reading* renders a transcendent quality to the database's otherwise sentiment-agnostic array of elements. In the words of John Peters, "the reader activates the book as the ship activates the sea"¹⁰⁴. Shaw's *Legible City* can be seen as a strategy not only for the coherent experience of an otherwise discontinuous or anecdotal database, but also as a critical activation of medium through the user's navigation of it.

In creating personal trajectories through space, one might also extend the Thoreau's practice of walking (and the Acoustic Ecology soundwalking practice) with soundwalks through data environments or *datascap*es. In today's techno-geography, the ether is an actual reservoir of electromagnetic and acoustic radiations awaiting aural discovery. As Douglas Kahn describes:

Audiophonic technologies (telegraphy telephony, phonography, radiophony) raised expectations that phenomena should be audible, increased the sphere of what had yet to be heard, and based all sound, music included, more firmly in a materialistic rhetoric of acoustical vibrations¹⁰⁵.

Artists like Christina Kubisch, Yolande Harris, and Shintaro Miyazaki probe the resonant spaces of the immaterial to create installations and soundwalks highlighting the electromagnetic spectrums, GPS connectivities and wireless perturbations that we experience mostly unconsciously on a daily basis. Such projects develop an experience of data as a narrative trajectory, exploratory journey and soundwalk through virtual space.

¹⁰⁴ Peters, 2015.

¹⁰⁵ Kahn, 2004 p108



Figure 2.29. *Electric Walks* by Christina Kubisch¹⁰⁶.

Other works that involve exploratory symbols or narrative landscapes can be seen in the projects discussed later in the dissertation: *Aeolian Traces* (which symbolically ties human migration data to global wind movements), *The Aeolus Notification Project* (which imagines desired destinations for visitors to the gallery space and displays them on a collective map), *#home* (which creates 3D printed forms from visitors' memories of home and Twitter metadata) and *Those who Observe the Wind...* (which allows visitors to take a soundwalk through wind data represented as sound through mechatronic instruments)

¹⁰⁶ "Christina Kubisch". Online :http://www.galeriemazzoli.com/porfolio/gmm_kubisch_portfolio_en.pdf. Accessed June 2 2017.

2.6.3 *Abstractions of Nature*

Natural rhythms like wind and tides are good examples of paradoxical entities, because they are both measurable and immeasurable at the same time - simultaneously quantifiable and ephemeral, observable and fleeting. To approach these from an artistic context is to acknowledge the observation process itself as a form of composition, and to see data organization and mapping as a form of storytelling.

In Polak Van Bakkum's *Wall Drawing Wind* for instance, an abstract series of lines is presented over a blurry background. The visitor realizes later that this is a visualization of the routes of a balloon left to the elements. The squiggly lines that resemble scratchings or random inscriptions now are attributed to an agency of the wind.



Figure 2.30. Polak Van Bakkum's *Wall Drawing Wind*

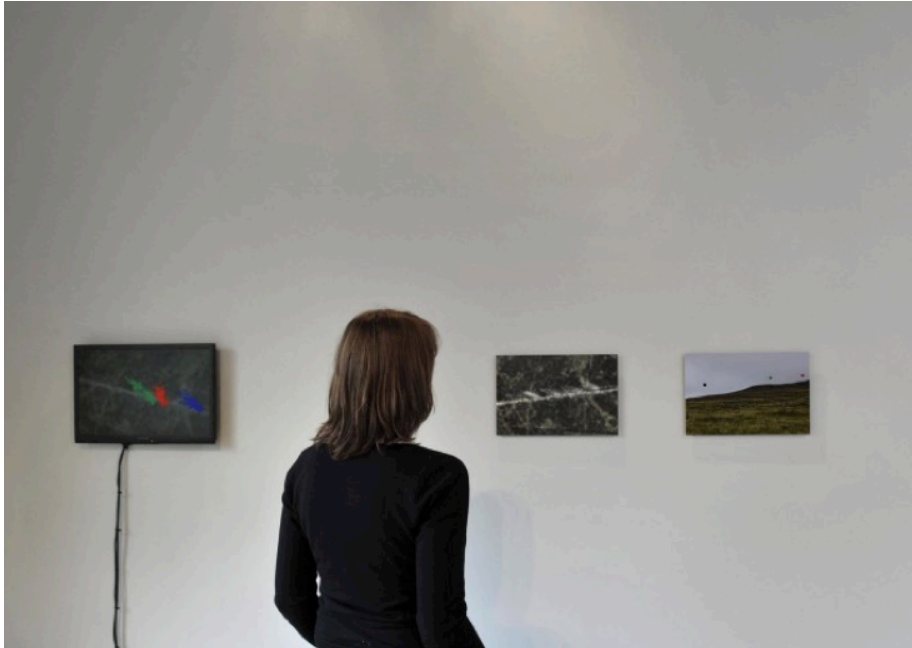


Figure 2.31. Installation View

Similarly, Scot Hessel's *Celestial Mechanics* presents a visualization of all the air traffic flying in the air above in real time. Hessel's reference to celestial bodies attributes an ethereal presence to these aerial flight paths, and localizes the networks of traffic and hardware that influence our daily technologies. Hessel specified a planetarium as the ideal propagation medium, approaching the scale of the objects he is representing:

Scale is part of information, yet we continue to reduce and enlarge everything in our increasingly well-documented world to 720x540 pixels. Our glowing screens cannot present any of the phenomenology of the data...that awe that scale inspires. Planetariums give us a way to visualize a complex system without losing the emotion of the data. Scale creates wonder, and we should not separate our feelings from the statistics...they help us understand them¹⁰⁷.

¹⁰⁷ "Scott Hessel. *Celestial Mechanics*". Online at <http://www.dshessels.com/artworks/celestialmechanics/about.htm>. Accessed June 2 2017.

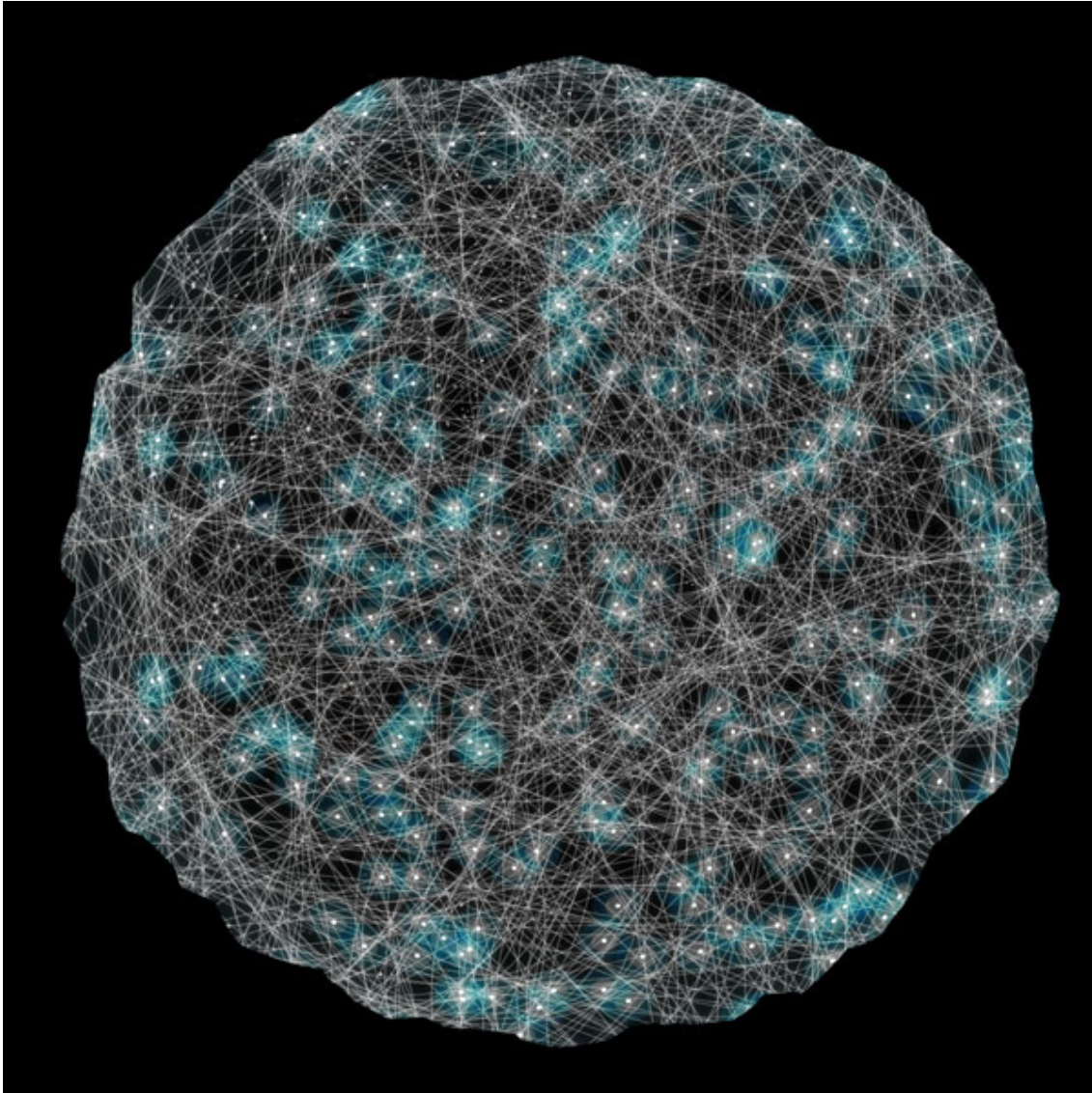


Figure 2.32. Scott Hessel's *Celestial Mechanics*

Another example is Sabrina Raaf's *Translator II : Grower*, which consists of a machine that maps the amount of CO₂ in the room to the heights of green lines that it draws along the walls. This information ecology renders the invisible qualities of the gas visible, but by association, also is able to inform on the number of human bodies that have entered and respired within the gallery space over time.



Figure 2.33. Sabrina Raaf's *Translator II: Grower*¹⁰⁸

In Spencer Finch's *2hours, 2minutes, 2 seconds (Wind at Walden Pond, March 12, 2007)* an array of industrial fans recreates the wind conditions at Walden. Framed in this way, the work is a sensory tribute to the dichotomous activity of Thoreau in his assiduous collection of data from the environment, and his call to a direct and uninhibited Nature aesthetics.

¹⁰⁸ "Grower, 2004-6" Online at <http://raaf.org/projects.php?pcat=2&proj=4>. Accessed Jan 2017.



Figure 2.34. Spencer Finch's *2 hours, 2 minutes, 2 seconds(Wind at Walden Pond, March 12,2007) 2007*¹⁰⁹

¹⁰⁹ "Spencer Finch Archive". Online at http://www.postmastersart.com/archive/finch07/finch07_222_1.html. Accessed June 1 2017.

2.6.4 *Parameter Mapping*

If need be, mere absurdity can be a source of freedom
-Gaston Bachelard¹¹⁰

In Gaston Bachelard's *Poetics of Space*, a prisoner draws a landscape of a tunnel with a miniature train on the wall of his cell, subsequently "makes himself very tiny, entered into my picture and climbed into the little train, which started moving, then disappeared into the darkness of the tunnel" in front of his incredulous jailers. Through an absurdist imagination, the boundaries of architectural space can be overcome. Similarly, absurd or irregular parameter mapping techniques for data ensures freedom and fluidity between hardware and software paradigms where unconventional mapping can take place across forms, media and transmission methods. Tying in to Tufte's ideas of *disinformation* design¹¹¹, this also ensures that the final product never ceases to surprise.

In Tao Sambolec's series entitled *Virtual Holes and Virtual Mirrors*, he contests the very constraints of architecture to be a protective barrier between the inside and the outside by allowing weather conditions to be represented or mirrored inside. In *Virtual Hole - Wind 1:1*, a wind sensor on the top of the building sends wind data into the installation space, where an array of industrial fans synthesizes gusts of wind.

¹¹⁰ Bachelard, 1994 p150

¹¹¹ Edward Tufte discusses disinformation design as a process of create illusions of accuracy - "situations of disguise and attention control to regulate the optical information available to the spectator". Tufte, 1997. p64.

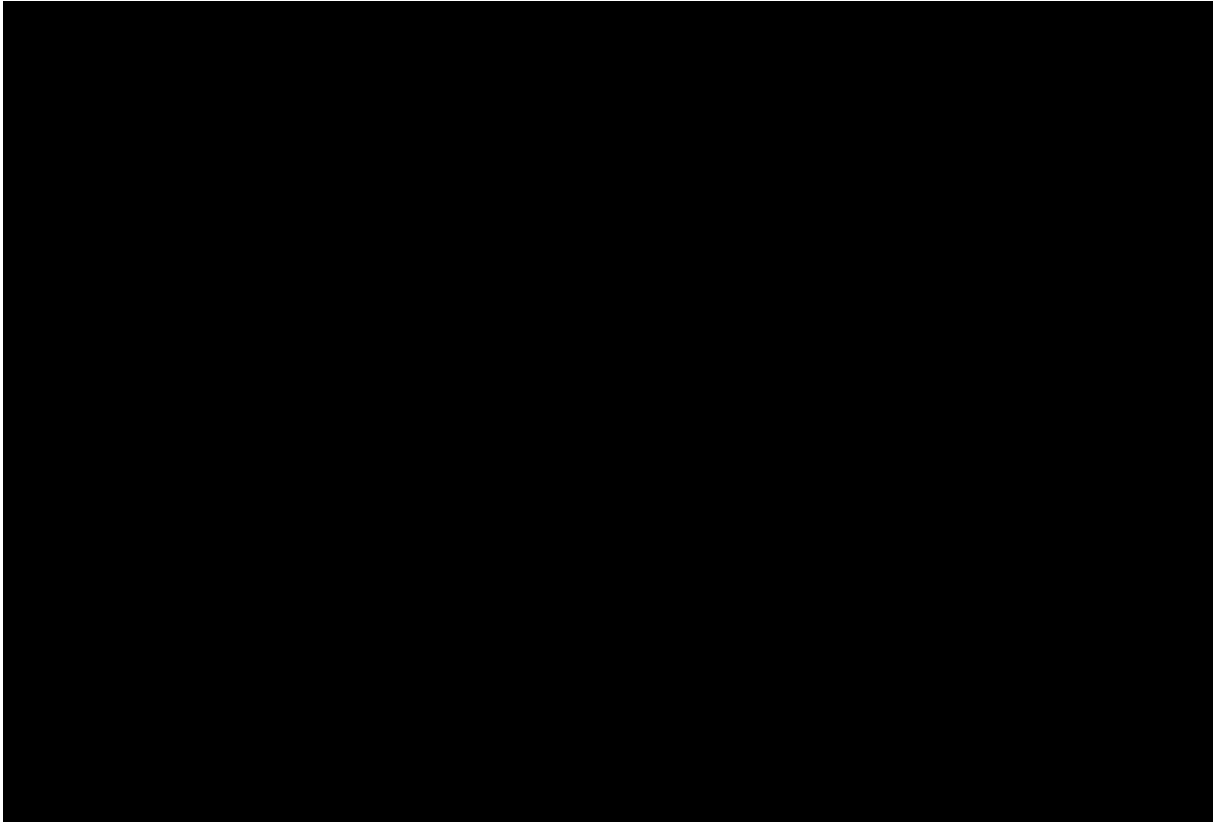


Figure 2.35. Tao Sambolec's *Virtual Hole- Wind1:1* 2011 ¹¹²

A particular example of an absurdist incarnation of data representation can be seen in Sambolec's *Virtual Mirror - Rain*. In this installation, water droplets in the gallery flow against gravity from ground to sky, triggered by the data output of a sensor sensing the intensity of rain outside.

¹¹² "Tao Sambolec. *Virtual Hole- Wind 1:1*". Online at <http://www.taogvs.org/VirtualHoleWind11Main.html> . Accessed June2 2017

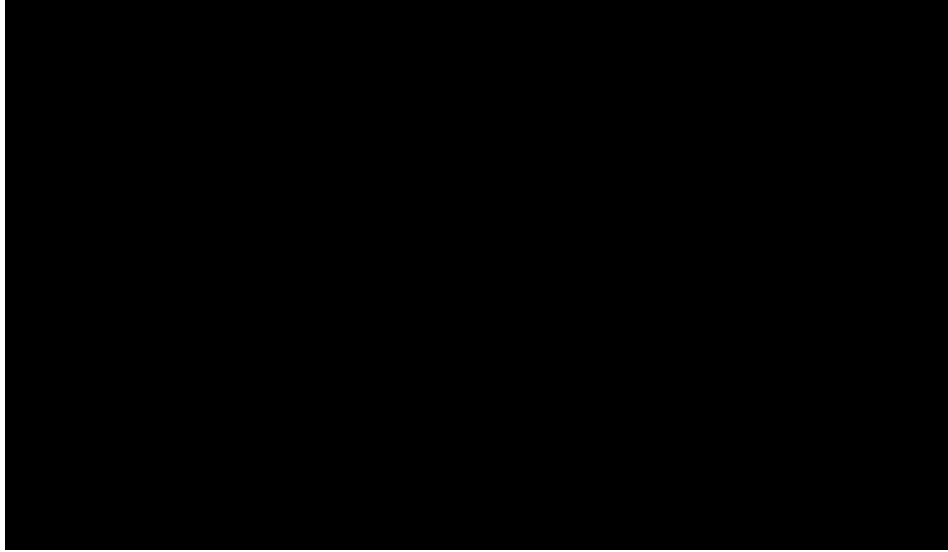


Figure 2.36. Tao Sambolec's *Virtual Mirror* Schematic¹¹³

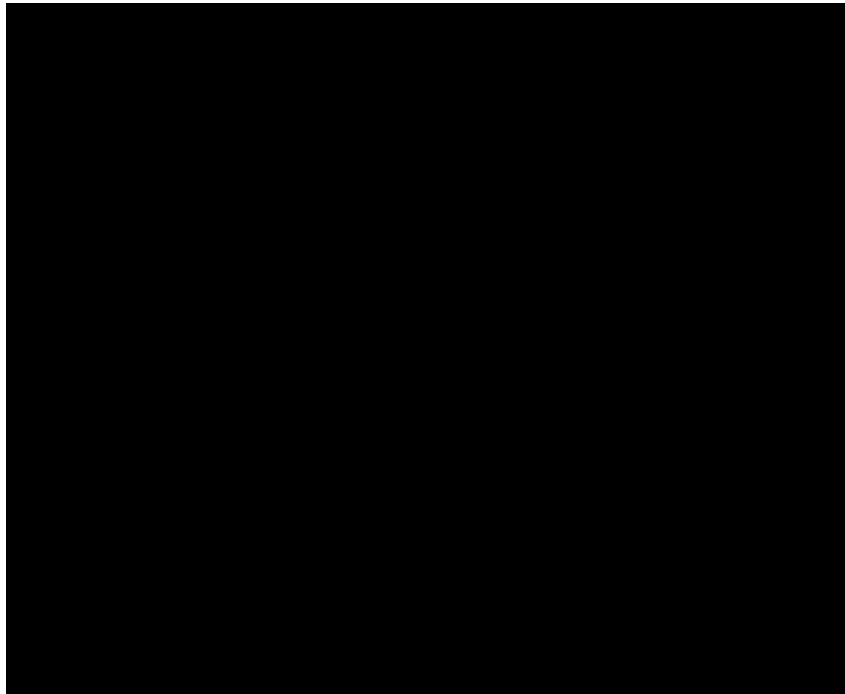


Figure 2.37. Tao Sambolec's *Virtual Mirror*¹¹⁴

¹¹³ "Tao Sambolec. *Virtual Mirror*". Online at :<http://www.taogvs.org/VirtualMirroRainPict1.html>. Accessed June2 2017

¹¹⁴ *ibid.*

Going beyond a simple dislocation of the wind from external to internal environments, Sambolec's *City Velocities - Body Speeds* maps synthesized wind in a gallery space to velocities of trams in Amsterdam in real time. Wind here is used as a symbol and experience of speed, where "resisting to offer an interpretation, it rather embodies the phenomena - creating the experience and thus confronting the visitor with its existence"¹¹⁵.

In more direct fashion, the work of Studio Roosegaarde entitled *Flow* comprises hundreds of ventilators and sensors organized in a modular, interactive sculpture. Each module senses movement in front of it, triggering the ventilator locally. What ensues is an illusive landscape of synthetic wind.

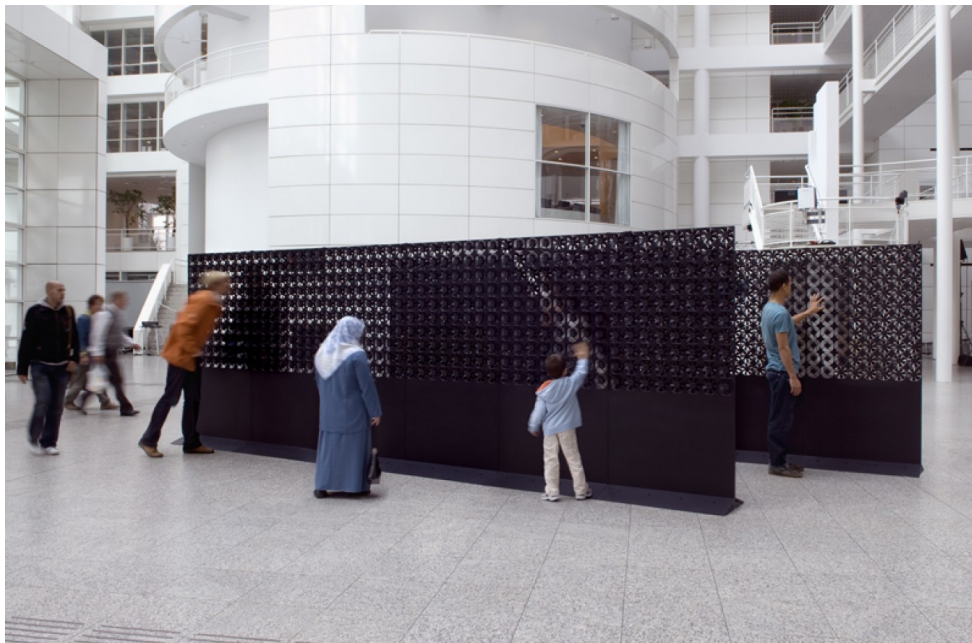


Figure 2.38. Studio Roosegaarde's *Flow 5.0*¹¹⁶

¹¹⁵ "City Velocities - Body Speeds(2012)". Tao Sambolec. Online at <http://www.taogvs.org/CVBSMain.html>. Accessed June 12 2017.

¹¹⁶ "Flow Studio Roosegaarde." Online at <https://www.studioroosegaarde.net/project/flow/info/>. Accessed Juen9 2017.

Other expressions of fluidity across hardware and software platforms can be seen in the projects discussed later in the dissertation: *Aeolian Traces* (which maps human migration data as wind gusts), *Sombrer* (which maps the frequency of Twitter feeds onto tide charts) and *#home* (which maps Twitter data onto point clouds for 3D printing)

2.6.5 *Immersive Sites of Presentation*

Immersive installations constructed off spatial-temporal dislocations are offered by artist Olafur Eliasson, whose works involve close relationships between the perception and scales of natural phenomena. In his work *The Weather Project*, Eliasson converts the Tate Modern's Turbine Gallery into a sensual representation of sun and sky.

Eliasson's work approaches the scale and experience of an sunny outdoor day, complete with monochromatic lighting and mists that simulate cloud formations. His installation creates what Moderna Museet curator Matilda Olof-Ors refers to as a shattering of the *natural* illusion¹¹⁷, exposing the work as a composed form as much as the idea of reality it creates, a process that is tangential to the hyperreality of postmodern literature.

Olof-Ors describes this further with respect to the Olafur Eliasson's work *Beauty*, an early work from 1993 in which the artist creates a rainbow in a darkened room by shining a light through a cloud of mist made up of droplets of water. The mechanism is exposed, the physics that governs

¹¹⁷ Olof-Ors, 2015.

the refraction of light if not already recognizable, could be grasped at a fundamental level.

Technology and affect are correlated but not horizontal. By entitling the piece *Beauty*, Eliasson assumes a gestalt transcendent value that his configuration of tools will bring to the piece.

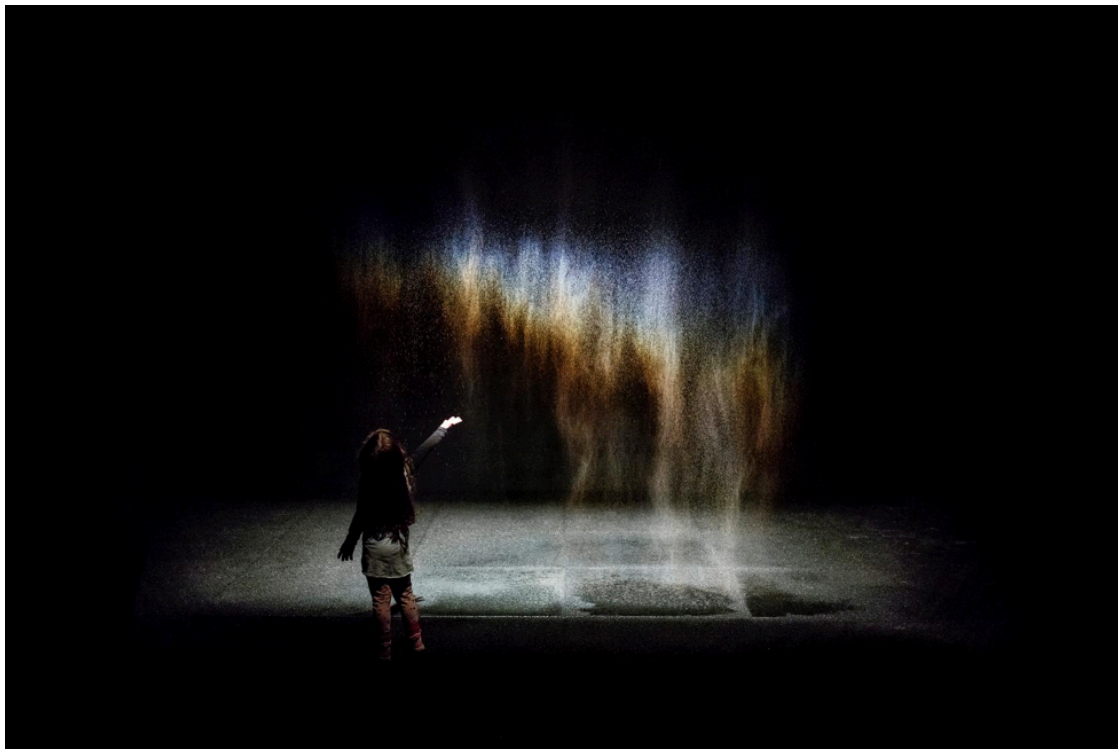


Figure 2.39. Olafur Eliasson's *Beauty*

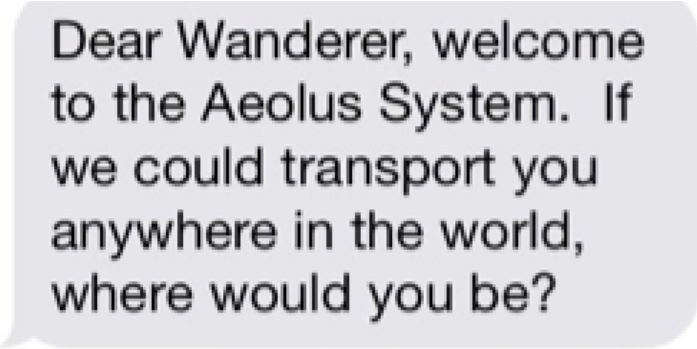
In later works, the representation of natural phenomena in the artist's work would become more pervasive - for instance, in his piece *Vær i vejret* presented in 2016 at the Ordrupgaard Kunstopark in Denmark, Eliasson uses real time wind data from a weather station located at the gallery's roof to trigger the spurting of mist from a bronze ring in the museum's gardens. Eliasson reimagines the park, a space of aesthetic wilderness, as a canvas for the accentuation of a transient entity. The wind data component here is used as a trigger to introduce a quotidian form

to the play out of the piece over time. In natural space, the installation is decidedly *aeolian*, in the way it hints at quotidian natural processes as a spectacle.



Figure 2.40. Olafur Eliasson's *Vær i vejret*, 2016

Chapter 3. *AEOLUS NOTIFICATION SYSTEM*



Dear Wanderer, welcome to the Aeolus System. If we could transport you anywhere in the world, where would you be?

Figure 3.1. The *Aeolus Notification System* SMS Query

3.1 INTRODUCTION

Created as part of the Pioneer Square Art Walk in 2014, the *Aeolus Notification System* was the first in a series of installations that uses the wind as an aesthetic and narrative source for the creation of immersive, computational environments.

All three projects described in following offer aggregative strategies for dealing with the digital materiality of wind. *Those who Observe the Wind...* creates an aesthetic representation of wind through real time data harvesting (and hence dislocating phenomena from its natural environment), *Aeolian Traces* creates wind currents within a gallery space from human migration data to imagine displacements as part of a global environmental system. The *Aeolus Notification System*, the first project in this series uses wind data as a metaphorical spur to connect distant geographies through mobile media.

3.2 CULTURAL NOMADISM

Why on earth do we ever leave this place no matter how fair the place may be, and then the next place, and the one after that, all our lives long, and I suspect beyond our lives here, because the voyage feels as though it reaches beyond the stars? Of course we never really know. To live is to leave, that is all¹¹⁸.

-Frederick Buechner

A pilgrim... a migrant.... a wanderer.... a nomad... all descriptions of a process of constant removal. As Frederick Buechner's emphatic conclusion reveals, "to live is to leave, that is all", such is the inevitability of our modern, globalized societies where we are but travellers acting on a universal desire to progress or return to one space or the next.

The motivation for the *Aeolus Notification System* began in the project *42 degrees SouthWest (if by any means we get there¹¹⁹)*, prototyped in the Summer 2013, where a mishap in the family prompted a deep desire to return to my place of birth. The piece represented this desire with a small cart that was fitted with a GPS unit directed towards home, albeit tethered to the gallery wall by an unfolding spool of string - a symbol of inevitability, of being unable to realize this journey in its entirety. In experiencing the piece, visitors were able to imagine the distance between the gallery and the cart's destination despite the fact that the piece's inherent tragedy lay in the way it was setup to fail.

¹¹⁸ Buechner, 1985, pp 119-123

¹¹⁹ For more information, please refer to Appendix A.

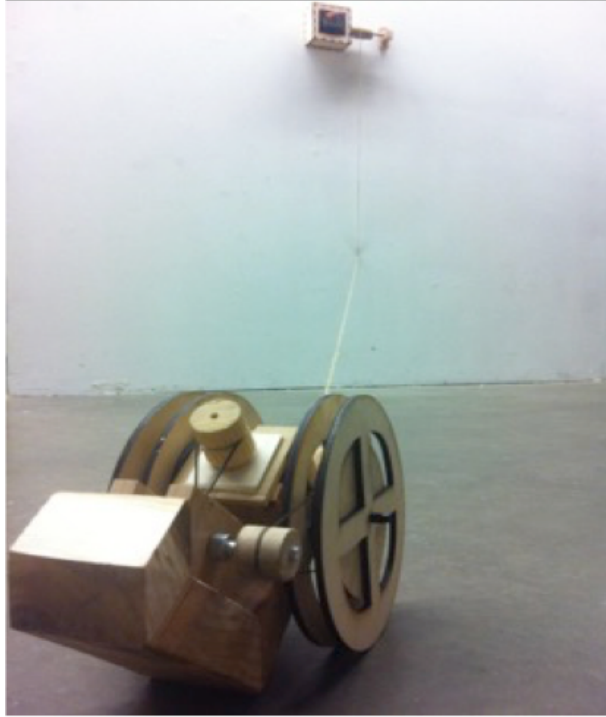


Figure 3.2. *42 degrees South West (if by any means we get there)*

While the Sisyphian tragedy need not apply to everyone, journeys are universal and the shared identities of the pilgrim or migrant were especially obvious in conversations with coursemates and fellow international students at the University of Washington. This inevitability of a journey undertaken not only metaphorically, but also geographically in the sense of a perpetual desire for physical migration can be seen as symptomatic of 21st Century globalisation. Flusser describes Cultural nomadism as a “collapse of settledness”¹²⁰ as being a condition that holds not to the possessions and values of settledness at any particular location - not even the assumption of a “heimat” or homeland that one can say she belongs to. Being “free from geographic attachment”, he defines the quintessential role of the migrant in our society today:

Although the migrant, this human representative of a beckoning future without heimat, carries in his unconscious bits and pieces of the mysteries of all the heimats through

¹²⁰ Flusser, 2003. p4

which he has wandered, he is not anchored in any of them. . . The loss of the original, dimly sensed mystery of the heimat has opened him up to a different sort of mystery: the mystery of living together with others. . . How can I overcome the prejudices of the bits and pieces of mysteries that reside within me, and how can i break through the prejudices that are anchored in the mysteries of other, so that together with them we may create something beautiful out of something that is ugly?¹²¹

Flusser's proposal of a sort of conviviality in a community is paradoxically created in the absence of a traditional social/nationalistic unit - instead writing in favour of transient and liberal sociality, something he personally experienced in his geographical dislocation from his land of birth to his adopted home in the way he realizes he is free to "choose his neighbours". He continues, perhaps most crucially, in his chapter on "Nomads" where the collapse of settledness and digital societies converge:

The settled person, the farmer, and the citizen can be localized in space; they have defining addresses. That disintegrates as soon as we compute. Within the network everyone is an omnipresent potential¹²².

Flusser's description of an wanderer through digital space can be seen in the *Aeolus Notification Project*, where all visitors to the installation are imagined as voyagers on the same sea, awaiting a digital wind that symbolically lifts and pushes the visitor in the direction of her destination. Within today's digital environment the metaphor of wind coursing through these systems also references the fluidity by which information *migrates* from address to address. Finally, the narrative of the *Aeolus Notification System* also references Odysseus's journey and his encounter with the Keeper of winds, Aeolus in Homer's *Odyssey*¹²³.

¹²¹ Ibid. pp14-1

¹²² Flusser, 2003. p51

¹²³ Homer, 1967.

3.3 ORGANIZATION

The *Aeolus Notification System* was presented at the Design Commission office-gallery space in Pioneer Square in Fall 2014.



Figure 3.3. *The Aeolus Notification System*

Aeolus Notification System: Enter Details Here

Name:

Destination Address:

Latitude:

Longitude:

Calculate Bearings: degrees

To Receive Notifications, Enter

Mobile:

Service Provider:

Figure 3.4. *The Aeolus Notification System* form

At the computer terminal, visitors signed up to be part of the system, providing their mobile phone numbers and the geographical location of a place they would like to be at. This entry was then converted to geocoordinates to be visualized on a user generated map projected on an adjacent wall. Beyond the gallery an SMS notification system ran for a month, comparing the bearings of each user's destination with the current wind direction. When a match was found, an SMS would be sent to the target user with the message: "Dear (user), the wind is currently blowing in the direction of (destination) at (compass direction) (direction) at (speed) . Respond by observing a moment in the direction depicted by your compass" .

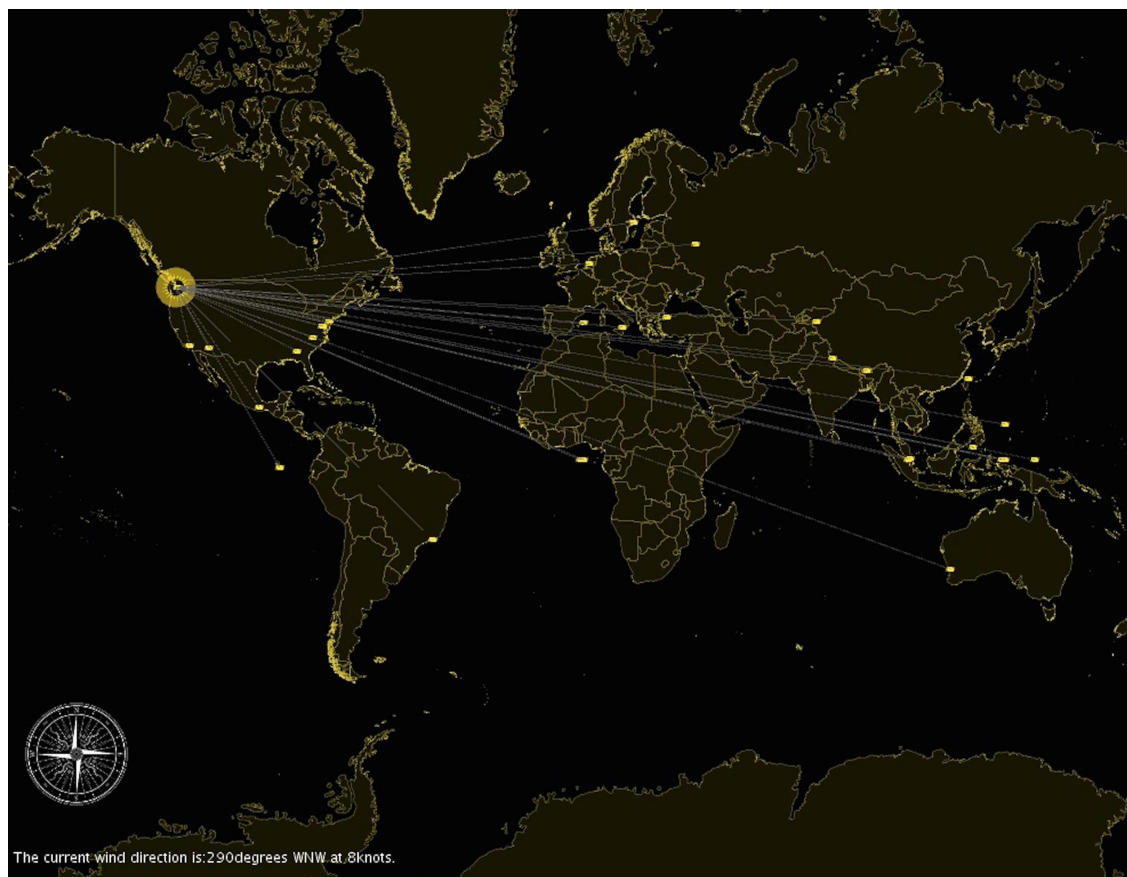


Figure 3.5. The *Aeolus Notification system* data visualization

With its lines drawn outwards from a central location representing the imaginary passages of each visitor, the *Aeolus Notification System* data visualization served as a cartographic map of longing or desire. It also bore formal similarity to the string and cart in *42degrees Southwest* showing an aesthetic consistency in both pieces.

In Odysseus' journey, the bag of wind bestowed upon him by Aeolus, keeper of the winds, would ensure the conditions necessary for him to sail home. Likewise, visitors to the installation are presented with a symbolic bag of wind and a compass inside to help them on their metaphorical journey. Each bag bears a print of Athanasius Kircher's 1673 drawing of a celestial being breathing into an Aeolian harp.



Figure 3.6. The *Aeolus Notification system's* bag of “winds”

3.4 DISPERSED, MOBILE MEDIA

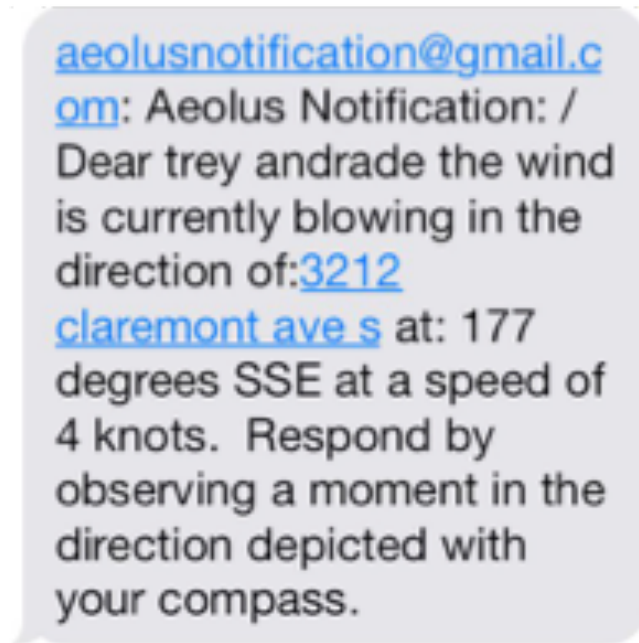


Figure 3.7. The *Aeolus Notification System* SMS notification

A key part of the installation is the use of mobile technologies as a way to extend the gallery experience beyond the space and time of a visitor's first encounter with the piece. In the computation of wind direction, the origin is taken to be the gallery space¹²⁴, creating a form of memory loop of the installation experience every time the wind blows in the direction of the user's destination. The dispersal of mobile phones away from the gallery space (and possibly around the globe) creates a dispersed audience that ties into the project's symbolic image of geographical expanse. Mobile media is used here as a way to ensure the participant gains real-time information since mobile phones are carried on the self most if not all of the time, as well as to take advantage of the intimacy that these devices have in constructing personal spaces for viewing and reading texts.

¹²⁴ At the project's first presentation, it was defined as Design Commission Seattle's GPS coordinates at 47.601563, -122.334467.

3.5 CONCLUSION

After initial presentations of the piece, the following shortcomings were discussed:

1. The initial experience at the gallery space was not pivotal enough to warrant a ‘memory’ of the project, thus diluting some of the effect when an SMS was indeed received long after the visitor had left the space. In further projects such as *Aeolian Traces*, this gallery experience was enhanced through spatial sound and physical installation.
2. An interactive performance type situation was prototyped shortly after that conducted a correspondence over SMS. user input was then aggregated in real-time and added to a combinatorial literature algorithm. Responses from the user would then appear on a public screen creatively compiled amongst previous responses. While this had its share of difficulties, the essential process of aggregated and fusing fragmented narratives from visitors to develop a mental picture of a “collaboratory destination” became the impetus for the work *#home*.
3. The use of such *location-aware* media without utilizing some of the phone’s inherent localising technologies was also one of the project’s shortcomings. In further development, the Aeolus Notification System will feature a smartphone app that polls and reports real time wind data closest to the location of the user. It will also display a visualization of the map of all the users’ destinations on each phone’s screen, and allow user-generated, location-specific text and spoken narratives to be uploaded to the system

and accessed by other users whether on their own devices, or in a shared space like a gallery.

Chapter 4. *THOSE WHO OBSERVE THE WIND...*



Figure 4.1. *Those who Observe the Wind...*

4.1 INTRODUCTION

After the creation of the *Aeolus Notification Project* in 2015, the following project *Those who Observe the Wind..* focused on exploring sonification strategies of the wind through real time observation of wind data. Created as part of the Sound Art Residency at the Jack Straw New Media Center in 2015, the project was generously supported by a grant from the Singapore International Foundation's Initiative for the Arts, the Jack Straw New Media Center and the University of Washington's Center for Digital Arts and Experimental Media.

Those who Observe the Wind... explored a particular sonic interpretation of the wind through aeolian or wind-activated instruments. It attempted to choreograph an impression of the wind by computationally mapping its behavior to a tuned scale of 16 string instruments. The installation transformed the gallery into a darkened chamber in which these suspended string instruments played along to immersive sounds of digitally synthesized wind. The Aeolian boxes were activated by wind data that was collected from a weather station outside the gallery.

4.2 MOTIVATIONS



Figure 4.2 Harvesting the wind as data at Ballard, Seattle

The project began initially as a way to expand the sounding portions of the *Aeolus Notification System* into a more sensory-rich installation. At that time, studio based experiments in resonating strings were being done through a parallel research trajectory entitled the *Cybernetic Monochord*, which aimed to recreate the sounds of an aeolian harp on a single-stringed instrument *in vitro* using a combination of a mechanical tuning system and an electromagnet resonating system¹²⁵.

The monochord was one of the earliest pedagogical tools for linking numerical ratios and musical harmony, led by sixth century B.C. mathematician Pythagoras, for whom the logical harmony of abstraction and reality could be framed in such philosophical questioning as “What is the status of mathematical entities, such as numbers in the realm of things?”¹²⁶. With this instrument, Pythagoras laid claim for ratios as the basis upon which we know, learn and empirically define relationships within the environment. He taught and demonstrated that all empirically measured ratios could be experienced as musical:

Through numbers and their proportions, anything that could be measured spatially became a principle of harmony, that is, something metaphysical.¹²⁷

In this way, the monochord was a symbol of an ancient yet timeless juxtaposition of myth and rationality. Like the Aeolian harp, its musicality has been theorized as an instrument that sonifies larger cosmological or religious relationships most prominently in Robert Fludd’s depiction of the earth’s *tuning system*¹²⁸. *Those who Observe the Wind...* extends this reach into

¹²⁵ Inspiration and guidelines for the use of electromagnetic excitation of the string was the Electromagnetically-activated Piano developed at CCRMA, Stanford by composers Per Bloland, Steven Backer and Edgar Berdahl. For more information please see Appendix C.

¹²⁶ Whitehead, 1967. Pp19-38.

¹²⁷ Zielinski. 2006. Pp101-158.

¹²⁸ Schafer, 1977..

the quotidian environmental systems, proposing that our desire to observe, communicate and understand is a result of a closer realization of how interconnected and entangled we are with them.

Those who Observe the Wind... was developed in response to the saturation of computational data in our experience of nature - empirical data about the weather is now favored over a direct bodily experience of the climate. It aimed to observe these environmental systems through the *in vitro*, digital processes of collection and analysis of data.

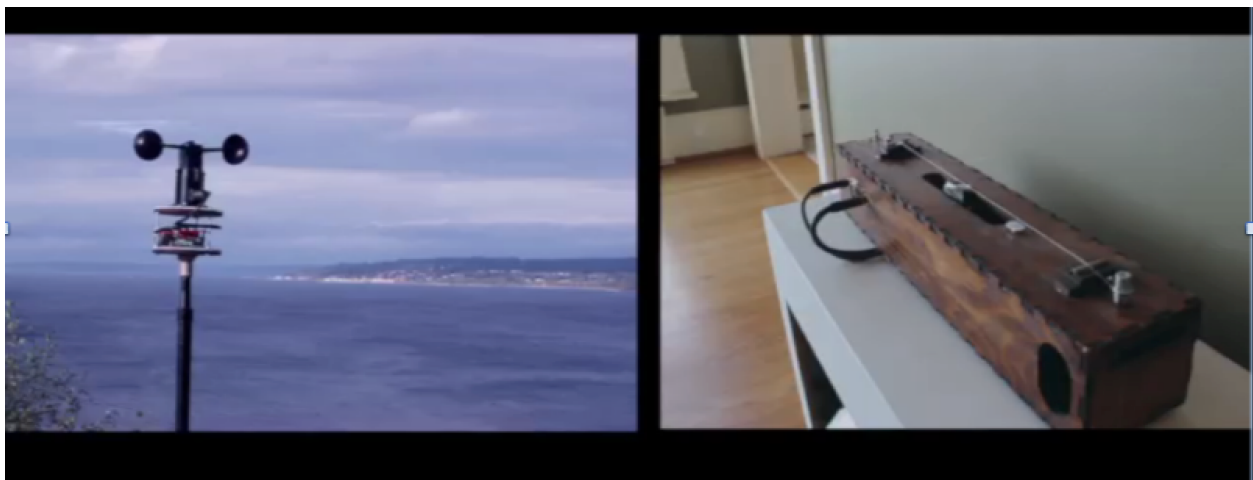


Figure 4.3. *Cybernetic Monochord* as an aeolian string instrument¹²⁹.

In previous experiments, the *Cybernetic Monochord* had been used as a telematic aeolian string instrument, receiving wind data in real time from a weather anemometer located some distance away. The intensity of the collected wind data would then control the intensity of the monochord's resonance. The boxes in *Those who Observe the Wind. . .* feature a similar

¹²⁹ In this iteration, wind is sensed by the anemometer and sent in real time to the monochord. A short video documentation for this can be found at <https://vimeo.com/124079779>

aesthetic - where the monochord is embedded within the box in a PVC pipe resonator. The interior of each box consists of a monochord strung across a PVC pipe resonator and DC motor that plucks the string when triggered.

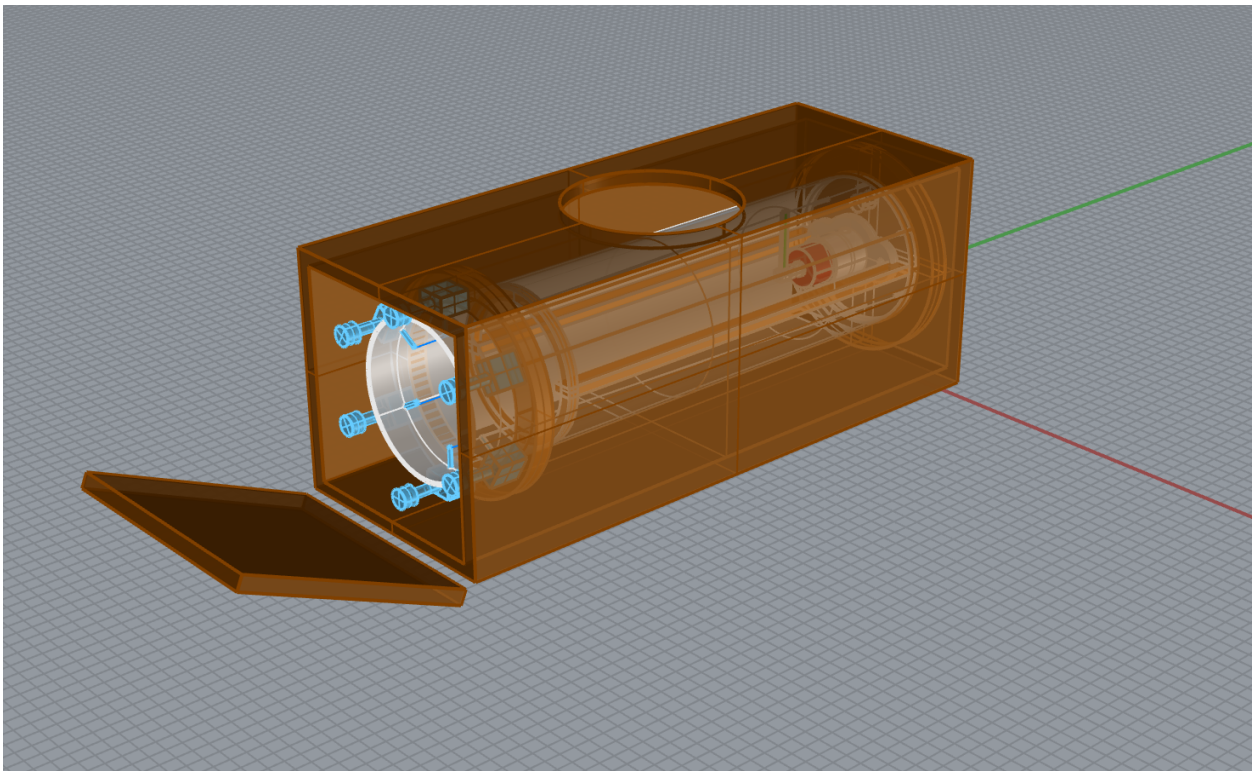


Figure 4.4 Box interior.

4.3 ORGANIZATION



Figure 4.5 : *Those who Observe the Wind...* installation¹³⁰

¹³⁰ For more information about the setup please see Appendix C.



Figure 4.6 The Jack Straw New Media Center modelled

The gallery was filled with 16 suspended boxes that were connected to a central control panel that interfaced Python, Supercollider and Arduino IDEs to connect a live web scraping algorithm to the triggering of string resonators in the boxes. The boxes were arranged from head-height up to the ceiling of the gallery, positioned in such a way that the installation could not be seen in its entirety from the door to retain a measure of mystery. At the base of the array (not shown in the 3D model and hidden from view in the actual installation space) was a stereo set of speakers that played digitally synthesized wind at preset intervals.

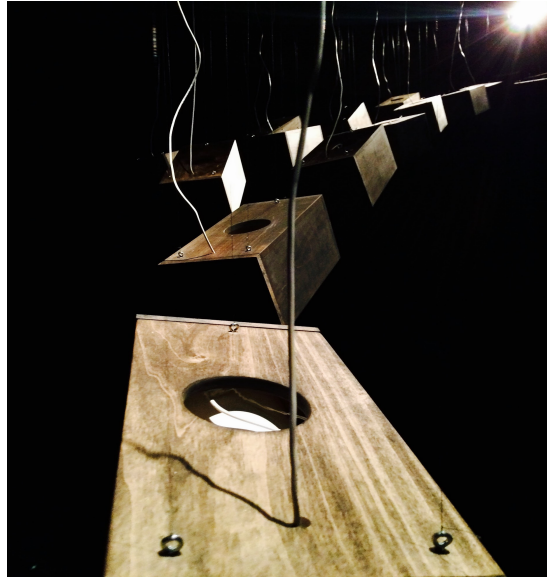


Figure 4.7 *Those who Observe the Wind...*

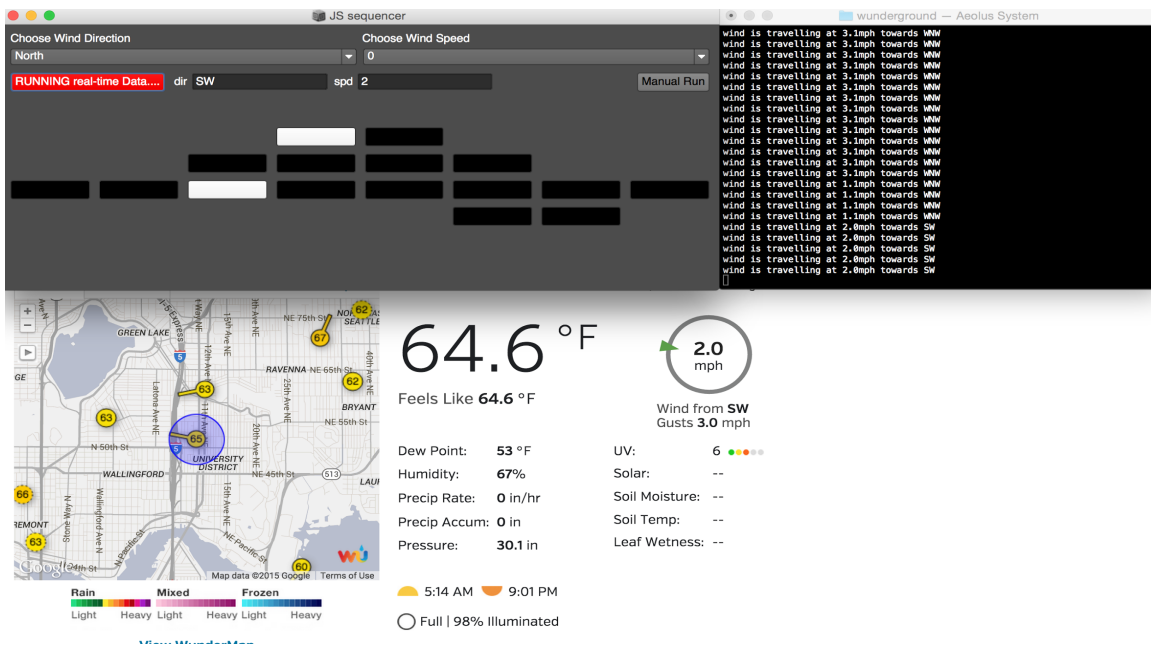


Figure 4.8 Screenshot of control interface¹³¹

¹³¹This figure shows real time scraping on Terminal application through Python, view of the actual website data is harvested from (wunderground) and the supercollider control terminal that shows which boxes are activated on the onset of changes in the wind data.

The project was controlled by a GUI created in the Supercollider environment that triggered a Python patch to scrape weather data from a wunderground.com weather station located near to the gallery. Two dimensions: wind direction and speed (mph) were collected and mapped. If the wind direction was not flowing along the installation's central axis (NE ascending and SW descending), random boxes were triggered in quick succession, the number of which was directly correlated to the speed of the wind. If the wind outside were to travel in these directions, all the boxes would ring in quick succession. The system was refreshed at a rate of once a second, with random fluctuations (between 0.1 and 0.5) introduced to break the regularity of the scraping process.

4.4 OBSERVING THE WIND

Observing the wind, the titular process in this installation, occurred in real time. Its spatial organization encouraged a form of wandering around the sounding objects, and could be seen as a soundwalk through a digital, virtual space. The sound created by these boxes was a magnified surrogate of the real environment, since it had resulted from a reduction of the gestalt sensation of the environment into two dimensions - speed and directionality. Creating such surrogate environments emphasizes the qualities of technical intervention not unlike the way conventional soundwalking/phonography processes amplify the window through which recording tools constraint and choreograph perception.

In such works as Hildergaard Westerkamp's *Kit's Beach Soundwalk*¹³², she narrates the technical manipulations done to the recording as it is being made, describing perceptual changes in distance, noisiness and corresponding modulations in the volume and position:

The city is roaring around these tiny sounds. But it's not masking them.
[Louder waves and crow] (Wave) [1:42]
I could shock you or fool you by saying that the soundscape is this loud. (INCREASE LEVELS) But it is more like this. (LOWER LEVELS AGAIN)
The view is beautiful — in fact, it is spectacular. So the sound level seems more like this. (LOWER LEVELS FURTHER)
It doesn't seem that loud. But I'm trying to listen to those tiny sounds in more detail now. Suddenly the background sound of the city seems louder again. (INCREASE LEVELS)
It interferes with my listening. It occupies all acoustic space and I can't hear the barnacles in all their tininess. It seems too much effort to filter the city out¹³³.

Westerkamp goes further by substituting the actual field recording with studio-manipulated sound, describing these new sounds as “the tiny, the intimate voices of nature, of bodies, of dreams, of the imagination”. With this addition, real space ceases to exist in the recordings, in its place a surrogate environment that hints at the real, but now a distorted, imagined and literary other. The symbolism within these sounds, the relationships to their original sources now directly reinforce the technical filters through which our perceptions of reality exist, rewriting a Thoreau-esque trajectory of walking through *digital* instead of *literary* metaphors. In this way, sonification processes highlight the tools used to manipulate data as they bring into human experience data sets that are invisible/inaudible. They also (in the case of this installation) replace gestalt sensations of environment factors and create new occasions for a heightened experience of them. Not least of all, these processes reveal the artist's individual compositional and creative biases.

¹³² A transcript of Westerkamp audio recording is found here: <https://soundart01.files.wordpress.com/2013/03/kits-beach-hildegard-westerkamp-transcript.pdf> and was accessed on May 22nd 2017.

¹³³ Ibid.

Creative data sonifications also enhance the theatricality of real life, as seen in the way non-diegetic, creatively organized sound can be juxtaposed with image in cinema to create interesting resonances in the perception of the entire film:

In itself, accurately recorded sound adds nothing to the image system of cinema, for it still has no aesthetic content. As soon as the sounds of the visible world are removed from it, or that world is filled, for the sake of the image, with extraneous sounds that don't exist literally, or if the real sounds are distorted so that they no longer correspond with the image – then the film acquires a resonance¹³⁴.

By creating a distorted mirror of direct natural impulses, *Those who Observe the Wind...* exists as a digital and sculptural metaphor of movement and dynamism. In the project's run at the Jack Straw New Media Center, its form has been likened to a shoal of salmon swimming upstream and a flight of birds migrating towards a point in the sky - all of which speak to the project's immeasurable relationship to the natural elements.

4.5 WORKSHOP

In conjunction with the project, a workshop was also organized at the Jack Straw New Media Center which witnessed students, some visually impaired, from neighbouring high schools producing and activating their own string monochords. Based on the initial prototype for the monochord resonators, the students assembled prefabricated laser cut boxes and 3D printed components. A short introduction to the Arduino was also given, as each box was fitted with an optical sensor that was driving the strumming. At the end of the workshop, a small

¹³⁴ Tarchosky. 2016. p162

“performance-installation” was made with the instruments and recorded, the subsequent audio files were added to the speakers in the gallery.

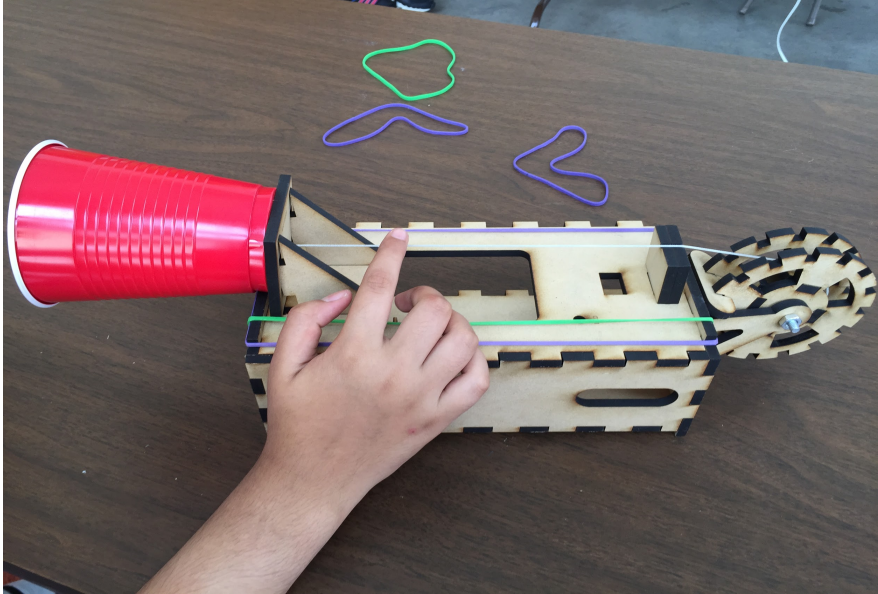


Figure 4.9 DC motor triggered monochord workshop

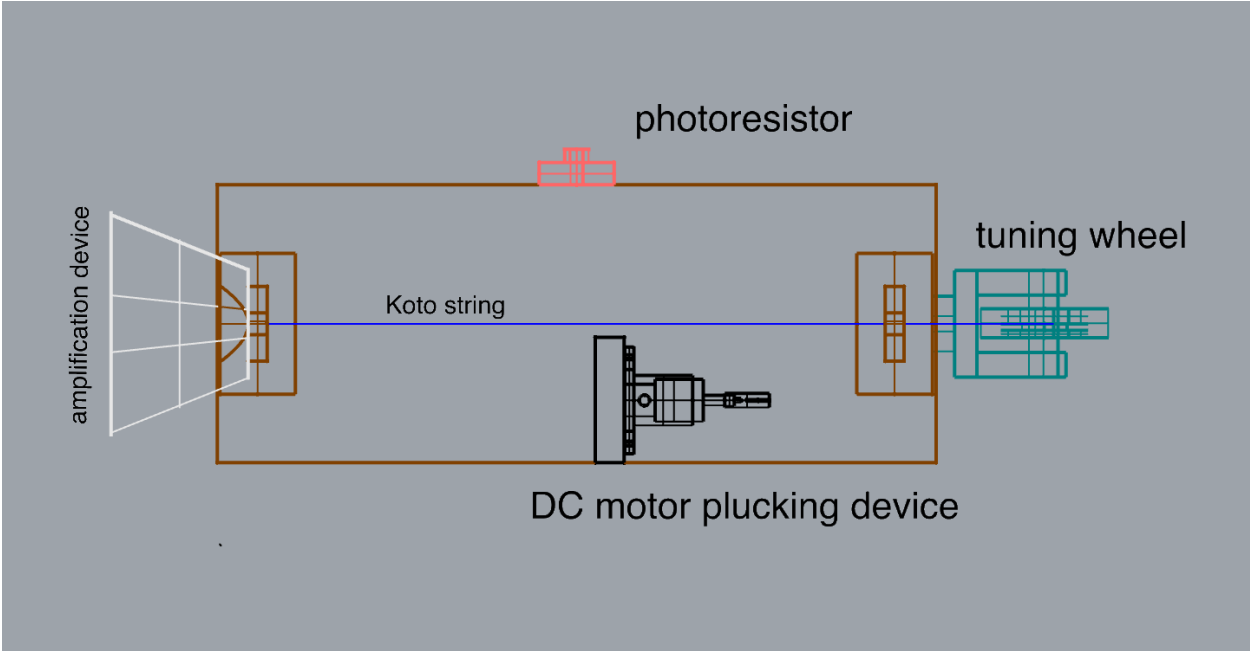


Figure 4.10 . 3D model of the workshop device showing components



Figure 4.11 Post-workshop performance/improvisation with the monochords

Chapter 5. AEOLIAN TRACES

5.1 BACKGROUND



Figure 5.1 *Aeolian Traces* 3D model

Air does not show itself. As such, it escapes appearing as a being. It allows itself to be forgotten . . . except in cases where human activity has fabricated the air to begin with.

-Luce Irigaray¹³⁵

Aeolian Traces is the third project that explores ways of mapping the natural environment in order to create artistic narratives/experiences through computational means. While the *Aeolus Notification Project* and *Those who Observe the Wind..* feature the primary translation of wind data into other forms, *Aeolian Traces* uses data to generate synthetic wind that forms the sensory focus of the installation.

Aeolian Traces involves the imagination of global human migration as particles freely floating in space. Its gestalt experience fuses wind, sound and image proposes a symbolic connection between the movements of peoples around the globe and the flow of aeolian, natural currents in order to envision, perhaps even to propose a world where transnational movement is seen as a naturalized rather than politicized activity.

Through its setup of ambisonic sound, whispers and narratives break up and join back together in a polyglottic amalgam, hinting at shifting demographics created through globalization. In the visualization, its inspiration is that of connective thread that proposes the migrant as a universal, interwoven identity. The project's emphasis on collected, *real* data through UN's migrant stock figures allows us to *enter* these abstractions, knowing that we were contributors to the data in our seasonal travels, and allowing our memories and stories become part of our intersubjective experience of the piece.

¹³⁵ Irigaray, 1999.p14

Aeolian Traces began initially in response to ongoing political discourse around topics of human migration and mobility, the treatment of undocumented migrants and an emerging form of nationalism and border-centrism despite the rising numbers of refugees and asylum-seekers that enter our shores. Especially since 2015, around the time of this project's first conception, the start of the European Migration Crisis led to rising xenophobia in the United State and has made migration and human movement an inevitable topic of discussion.

It is within this environment of community, social action and humanitarian need that the project was initially fueled. Washington's refugee resettlement programme is 7th in the States¹³⁶, and many initiatives around town support the reintegration of refugees and migrants (documented or otherwise) within the workforce and society. At the time of writing in 2017, there exists a bifurcation amongst communities between those that possess a strong nationalistic urge and those that support a countering, global view on citizenship and transnational migration, evidenced in the results of the 2016 US election, and exacerbated by the recent declaration by Governor Jay Inslee of Washington's status as a "sanctuary state"¹³⁷.

Initial attempts to understand the way border restrictions were affecting the lives of individuals and families around the area involved conducting interviews with members of Casa Latina¹³⁸, a not for profit organization in the International District working to provide migrant (documented and/or otherwise) workers from South America with economic and educational opportunities, to

¹³⁶“What King County's refugee populations look like | Interactive Map”. Seattle Times Online: <http://www.seattletimes.com/seattle-news/what-king-countys-refugee-populations-look-like-interactive-map/>. Accessed 10 May 2017

¹³⁷“How Washington State became the epicenter of resistance to Trump's agenda”. Washington Post Online: <https://www.washingtonpost.com/news/the-fix/wp/2017/02/05/how-washington-state-became-the-epicenter-of-resistance-to-trumps-agenda/>. Accessed 10 May 2017

¹³⁸“Casa Latina”: <http://casa-latina.org/>. Accessed 10 May 2017

understand more about their lives moving and living across the border. In a bid to understand the plight of undocumented migrants, interviews were also conducted with members of the NWDC (Northwest Detention Center) Resistance movement¹³⁹, as well as undergoing training with World Relief Seattle to become a volunteer visitor to the inmates at the Northwest Detention Center¹⁴⁰. While these activities did not translate directly into material within the final installation (due to a lack of critical mass in the resulting database), they were the subject of a series of installations outside the Tacoma Detention Center and at the Jacob Lawrence Gallery in Summer 2016¹⁴¹. They were also very helpful in gaining first-hand experience with the ethical restrictions to research with human subjects for further iterations of the project.

Aeolian Traces develops a visual and sonic experience that contributes to an emotive experience of human migration in the installation space. The project works directly with data from the UN Migration Stock 2015¹⁴² that presents estimates of international migrant by age, sex and origin for all countries and areas of the world. According to the documentation available with the database, the estimates are based on official population census statistics from each country on the foreign-born or the foreign population present in the country for the year in question. To classify the ‘international migrant’, the dataset referred to the “foreign-born population”. Where country of birth was not available, the dataset defaulted to the individual’s country of citizenship. Also, the dataset accounted for the number of refugees by referencing the Office of the United Nations High Commissioner for Refugees (UNHCR) and the United Nations Relief and Works

¹³⁹ For more information about the interviews, see Appendix D

¹⁴⁰ For more information about the Northwest Detention Center volunteer visitation process, see Appendix E.

¹⁴¹ For more information about the installations at the Jacob Lawrence Gallery, please see Appendix D.

¹⁴² “United Nations International Migrant Stock 2015” Online at <http://www.un.org/en/development/desa/population/migration/data/estimates2/estimates15.shtml>. Accessed 14 Nov 2016

Agency for Palestine Refugees in the Near East (UNWRA). The project also made use of figures from the Visa Restriction Index (VRI) of 2015¹⁴³ compiled by Henly and Partners. This dataset was instrumental in determining the extent of mobility an average citizen would have entering another country of her destination.

While visualizations of this dataset are not uncommon (one simply has to plug in the search phrase “Human migration 2015 Visualization” into Google’s Image Search), the emphasis on a static visual display prevents the dataset from functioning as anything other than an information panel. Expanding the dataset to provide more sensory information beyond an initial visualization/information design, it also involved curating a sound component, a composition of physical wind and organizing the piece in time.

¹⁴³“Visa Restriction Index 2015. Henley and Partners. Online at <https://www.henleyglobal.com/files/download/HP/hvri/HP%20Visa%20Restrictions%20Index%20151001.pdf>. Accessed 10 Nov 2016

5.2 DATA ART/VISUALIZATION

5.2.1 *Precursors: #home*

It's not down on any map, true places never are.

-Herman Melville

Aeolian Traces builds on previous aesthetic explorations into the use of Processing¹⁴⁴ to map geo-located entities. In particular, it focuses on the way geolocation can reveal impressions of a global phenomenon and even imply connections across vast geographical areas. A primary milestone in the research trajectory of this piece was the project *#home*, presented as part of the 2nd Black Box International Art, Film and Technology Festival in 2015 in Seattle.¹⁴⁵ In this project, data was sourced from Twitter in the form of geo-located tweets corresponding to a chosen set of keywords supplied by the visitors describing their memories of their homes.

#home was inspired by Calvino's *Invisible Cities*, where each city transits from one to the next through fluid descriptions and caricatures, providing a hint that all of them are not but different facades of a single place. During the research process for this piece, focus was on the narratives in the story - in an effort to visualize and materialize these cities on a map purely based on their text, Twitter was scraped to collect geolocated tweets corresponding to keywords from each of the city's descriptions.

¹⁴⁴ "Processing" Program Website Online at <https://processing.org/>

¹⁴⁵ Black Box 2.0 was curated by Anne Couillaud (Independent Curator) and Julia Fryett (Founder, Aktionsart) and ran from May 6 – June 7, 2015.



Figure 5.2 : Sample visualization of *Invisible Cities*

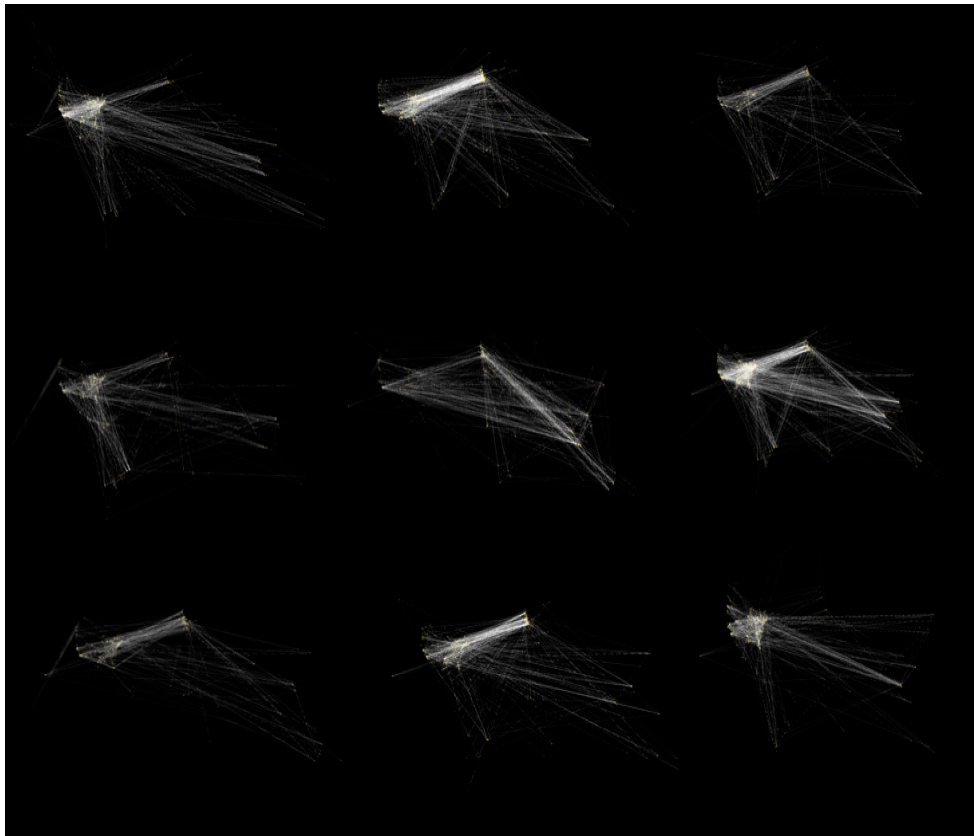


Figure 5.3 Collection of abstract visualizations of each city

Similarly, at the installation *#home*, visitors were invited to share a short sentence and 5 keywords about their homes via an Ipad at the installation venue. Each individual's descriptions and keywords were then used to filter a live Twitter stream, catching tweets around the world where the chosen word/phrase was talked about. The locations of these tweets were visualized on a map, and as they aggregated over time, a city was 'grown' for each participant and subsequently 3D printed into physical form. The physical form was then placed in a jar and returned to the visitors.



Figure 5.4 3D printed cities in *#home*

especially through Twitter, was an exercise in controlling an open system since there was no possible way to predict how many data points each set would have. Trends on the social network that corresponded to the keywords also exaggerated data findings and blew certain geographically hot-spots out of proportion. A moderate amount of scaling and ‘cleaning up’ of points in the eventual point cloud was required.

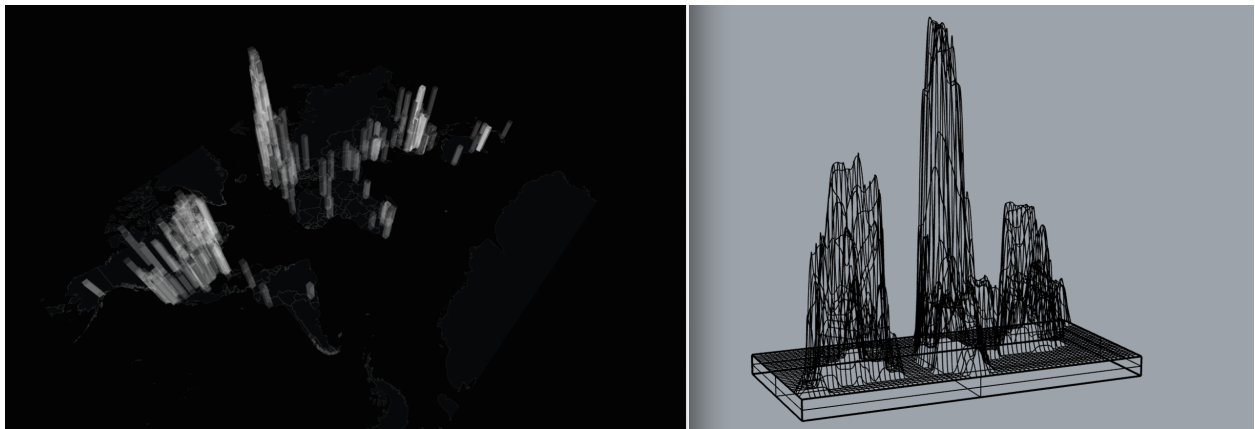


Figure 5.7 Actual visualization of Tweets, and eventual 3d form¹⁴⁶.

¹⁴⁶ Note the clean up of data points on either side of the city

5.2.2 *Precursors: Sombrer: An Intertidal City #lost and #found*

*“this drowned world lies beneath a skin,
of moving water, as within ;
The glassy surface of their frown
The ladies’ grieving passions drown
And can be seen to ebb and flow
In Crimson as the currents go”*

Christabel LaMotte, The Drowned City in Possession by A.S.Byatt

No city is more inclined . . . to enjoy lift and flee care.
And to make the leap from life to death less abrupt,
the inhabitants have constructed an identical copy of
their city, underground

Invisible Cities, Italo Calvino

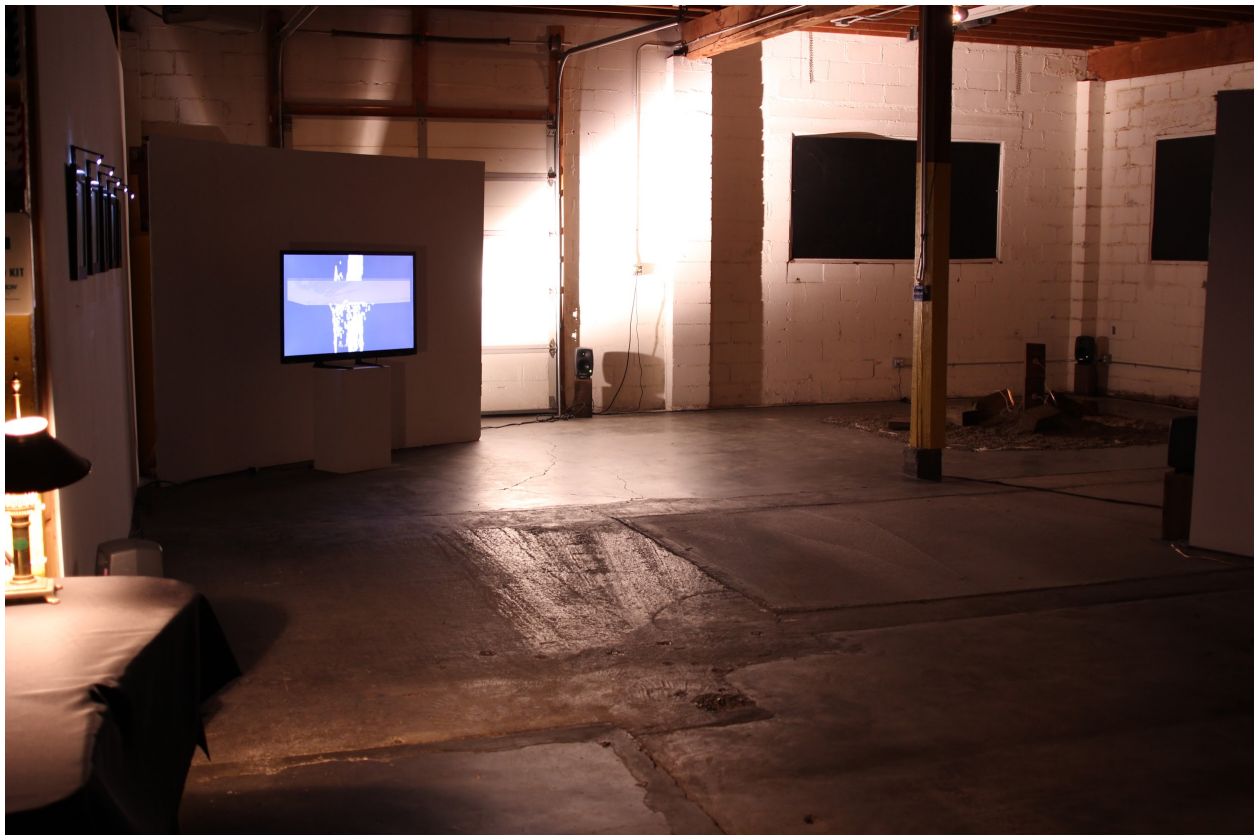


Figure 5.8 *Sombrer: An Intertidal City #lost and #found*

The second milestone presentation in the project's research phase was created in response to the General Examination at DXARTS entitled *Sombrer: An Intertidal City #lost and #found*¹⁴⁷. *Sombrer*, (“sunk”) was an audio visual installation that collected filtered Twitter feeds to create both the architectural of an imaginary sunken city, as well as the tidal charts that governed the durational portion of the project. It was inspired by the Breton myth of the city of Ys, which was constructed at the shoreline (thought to be at the Baie de Doarnenez on the Western front of France). In some versions, Ys is only visible at low tide, at high tides, it is fully submerged, or lost. Like Ys, *Sombrer* also resides at the intertidal and is dependant on the ebb and flow of the oceans that surround it.

To create this city, Twitter feeds were filtered for keywords ‘lost’ and ‘found’ over a 5 day period. The instances of each were visualized - ‘lost’ tweets aggregate to form buildings ‘under’ the surface, ‘found’ tweets aggregated a towering city awash. A synthetic ebb and flow was then calculated from the data, creating a digital tide that was visualized in tide tables daily, as well as used to modulate the progression of the 6-channel soundscape in the gallery. In the gallery, 2 parametric speakers mounted on pan-tilt motor heads also provided a punctuation of sounds at random locations, accentuating the feeling of immersion.

¹⁴⁷ For more information about the project, please see Appendix F.

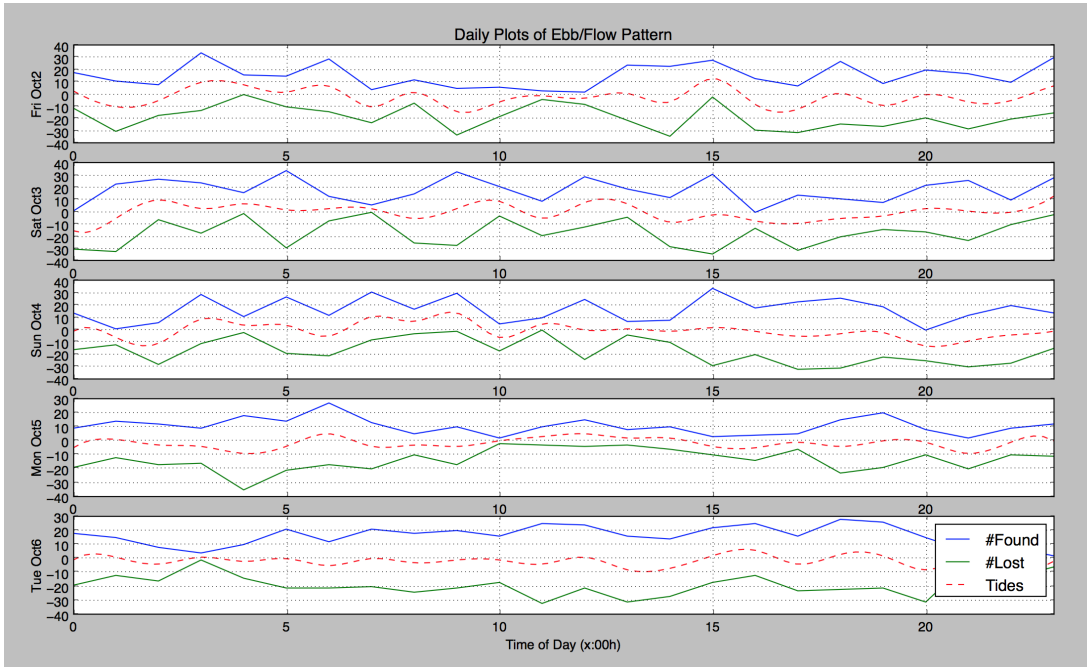


Figure 5.9 Tide charts in *Sombrer*

FIG 1.

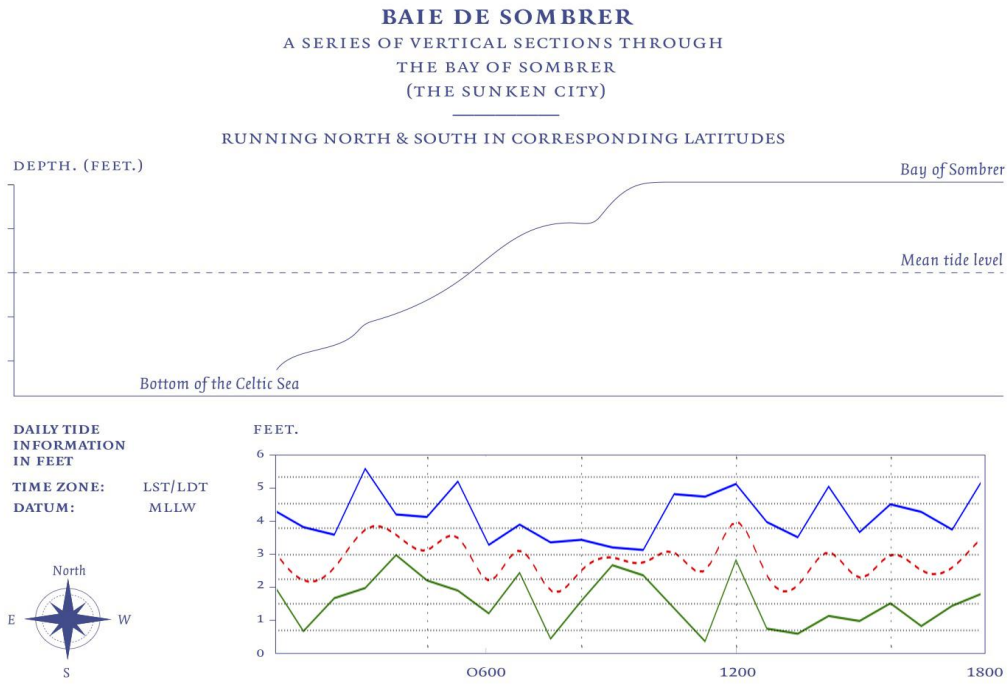


Figure 5.10 Final Tide Chart

5.2.3 Data Visualization in Aeolian Traces

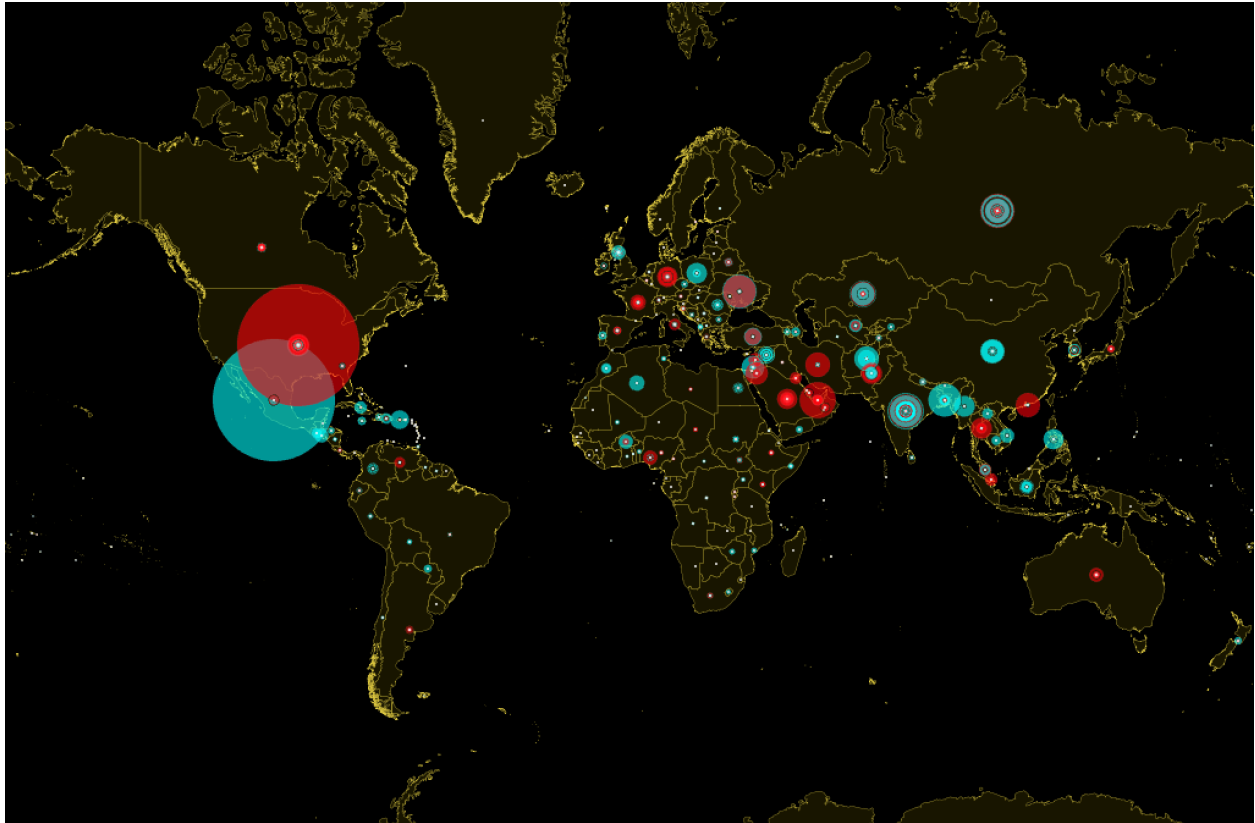


Figure 5.11 Data visualization of countries most inward (red) and outward (blue migration)

Aeolian Traces looked to continue the thread of connectivity and digital visualizations with its data from the UN Migrant Stock and the Visa Restriction Index (VRI). Progressive experimentation with the display moved from static 2D “flat” surface infographics to more 3-dimensional imaging and finally to dynamically rotating 3D surfaces. In the first series, the points were connected via bezier curves drawn in 3-D.

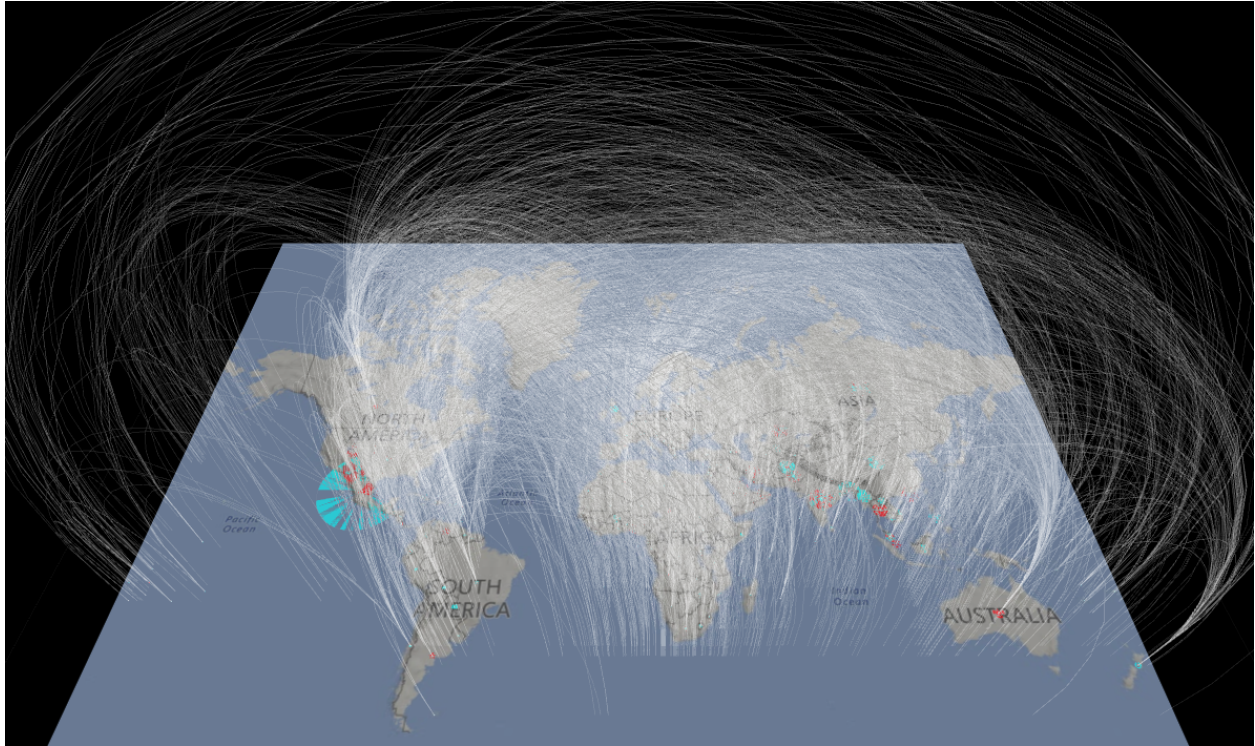


Figure 5.12 *Series I*: Data visualization of migration

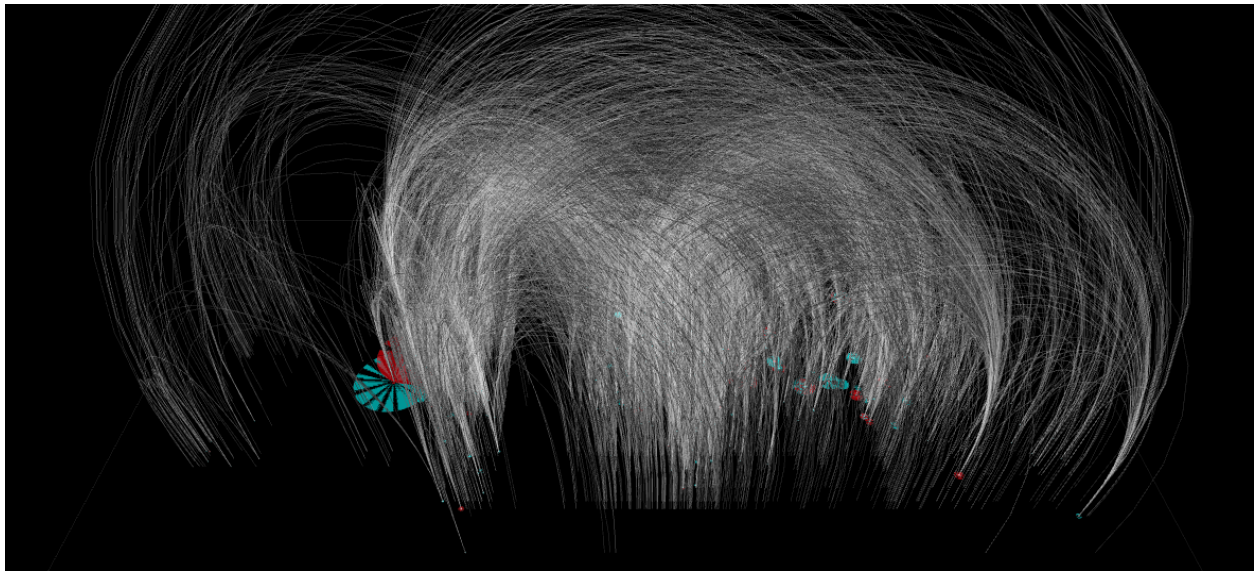


Figure 5.13 *Series I*: Data visualization experiments

In the next series, human populations were represented as floating particles, relating the size of these particles to migration statistics. These particles were also animated inspired by balloons in flight. Their representation to human beings connected to their origin has conceptual lineages through the works listed in this dissertation, but also to the opening sequences of Federico Fellini's *8½*¹⁴⁸ where the main protagonist is shown as a balloon “flown” .



Figure 5.14. Dynamic Visualization Experiments

The final series of visualizations focused on the creation of abstract geometrical shapes by connecting the particles floating in mid-air. Organized in time, these experiments explored different options of stretching and connected lines representing each data point's movement from origin to destination. . Connective threads connect and spread over areas of the globe. In this graph, density is better visualized.

[1] ¹⁴⁸8½. Director Federico Fellini. 1963.

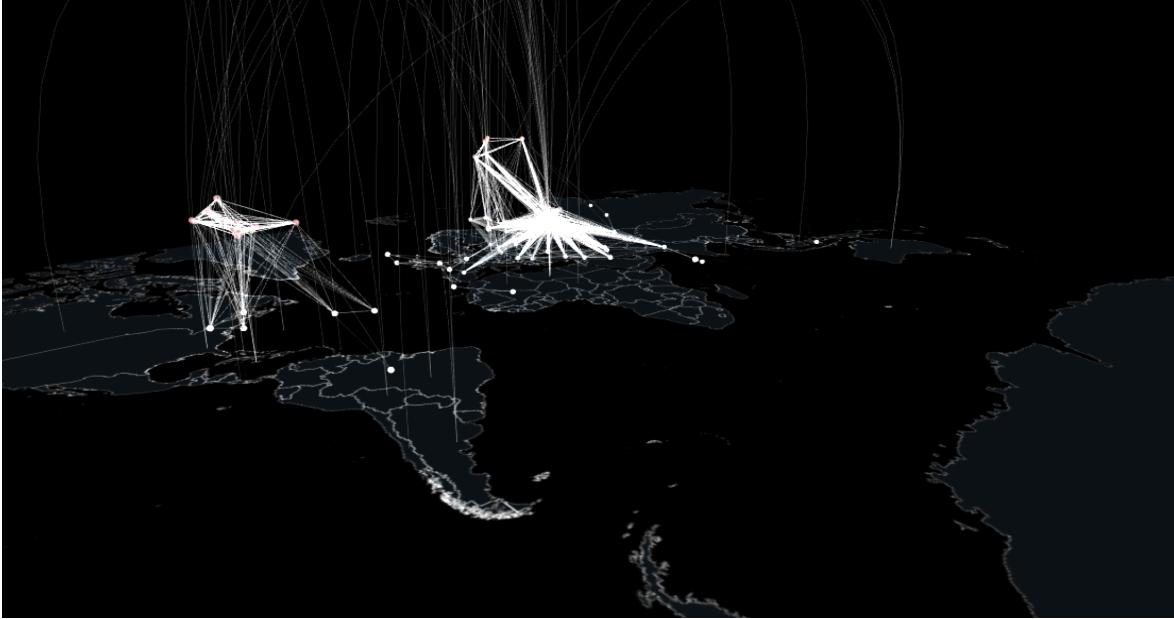


Figure 5.15. Final visualization screen shots



Figure 5.16. Final visualizations screen shots



Figure 5.17. Color added to visualization to create accents

5.2.4 *Composing in Time*

You will find hardly any improvising on camera anywhere in my films. It's very structured, but it's all worked out from elaborate improvisations over a long period, as you know.

-- Mike Leigh

To begin the composition process, the project was inspired by a conversation with composer Richard Karpen about improvisation and the 'triggering' of events particularly in his piece *Aperture II* that was performed by the Jack Quartet at Floyd & Delores Jones Playhouse in 2013. In the 2016 release's liner notes, James Pritchett writes about the "intuition of process" in the piece constructed off "a sense of scale" and "crests of activity"¹⁴⁹. In our email correspondence¹⁵⁰, Karpen described this intuitive process further in the rejection of a scored piece and a collaborative mode of composition:

Aperture II does not have a score. This is one of a series of works that I have done over the last 10 years by having the musicians memorize how to play the piece while I'm "composing" it with them. . . the main reason to do this is to be able to have the performers focus on their bodies and their memories and for them to play in ways that notation impedes. . . When it works, it's kind of magic. The musicians are often surprised that they can play this music from memory even across 30-40 minutes and have it be the same piece every time.

Aperture II's narrative arc features a gradual shift in the evolution of the textures accented by sudden pitched strokes by the players. These accents form what evolutionary biologist Niles Eldridge describes as 'punctuated equilibriums' - steady states of development (stasis) that

¹⁴⁹Pritchett, James. "Richard Karpen: Processes Universal and Human" Online at <http://rosewhitemusic.com/piano/writings/richard-karpen-processes-universal-and-human/>. Accessed 20 July 2015

¹⁵⁰Karpen, Richard. "Re: Those Who Observe the Wind post- conversation." Message to Joel Ong, 14 July 2015. E-mail.

feature mild and relatively benign changes. Any significant changes in evolutionary states are caused not by this gradual shifting but by rare and rapid, often large scale, and global (geologic) events. Modelling the spectral and amplitude data of the piece, a visualization of these punctuations was created that could imbue the passage of *Aeolian Traces* with a sense of geologic time¹⁵¹.

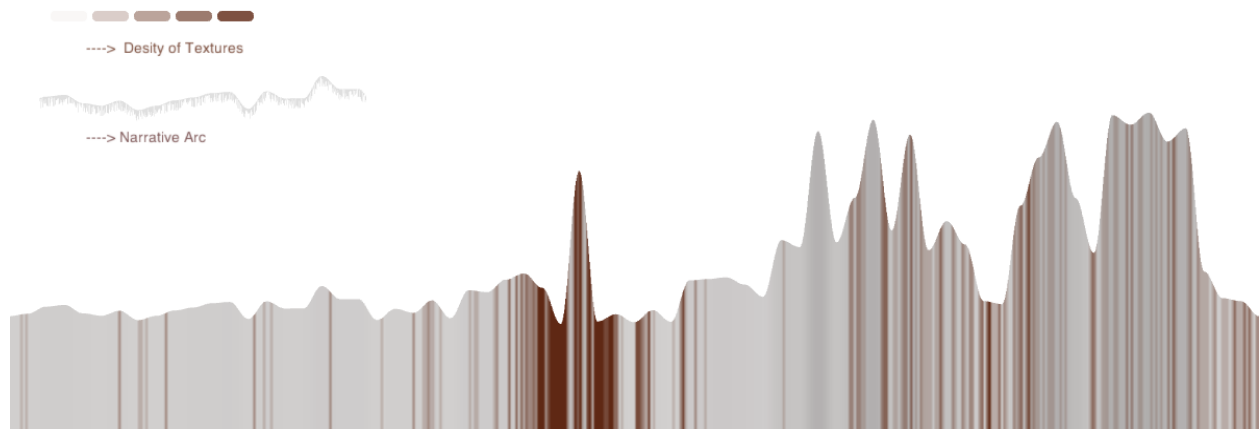


Figure 5.18. Data visualization of a segment of *Aperture II*

5.2.4.1 Retrofitting structure of “Aperture II” to “Aeolian Traces”

The retrofitting on temporal events onto the structure of *Aeolian Traces* is not without irony, since the main tenet of improvisation is the inspired moment - the ephemerality of the performance, how it exists in the moment. However, structure is not absent from even such a performance, and by analysing pieces such as *Aperture II*, there is a relationship of time and density of events that emerges as a result of the musician’s individual maturity that can be

¹⁵¹ For the detailed data analysis required to create the score, please refer to Appendix G.

adopted. Sequences such as these have been studied in the machine learning of improvisational techniques to trigger events, musical phrases and in some cases, even the articulations and performative aspects of robotic musicians/instruments¹⁵².

As a methodology for art, all creative processes begin with an improvisation of materials. Thus the notion of improvisation could be seen not as an extemporaneous stream of consciousness, but as a learned behavioural response to material and environmental cues that are observable and repeatable. Even with forms of data e.g. numbers, coordinates, symbols and shapes, to create an ‘improvisation’ of data materials therefore results from a structured manipulation of these environmental cues and the extent to which natural drifts/deviations of expected behaviours are allowed. The structuring of events also allows an *initial* ordering and mapping of parts across mediums. Subsequently, revealed intricacies through fine tuning can be added to the system.

Mapping values to Aeolian Traces was initially straightforward. Two states were created - A background noise that would follow the narrative arc created from the amplitude envelope, and a ‘punctuated’ state that was triggered only when the density of accents (how pure the sounding tone is) was at maximum. The punctuated state was also mapped to the amplitude envelope, providing a further level of complexity. The diagram below shows the initial mapping setup:

¹⁵² Gill Weinberg’s Shimon for instance is a jazz improvisational robot that not only follows the musical styles of Thelonious Monk and Miles Davis but also mimics their performative gestures (head movements) . See Hoffman and Weinberg 2011.

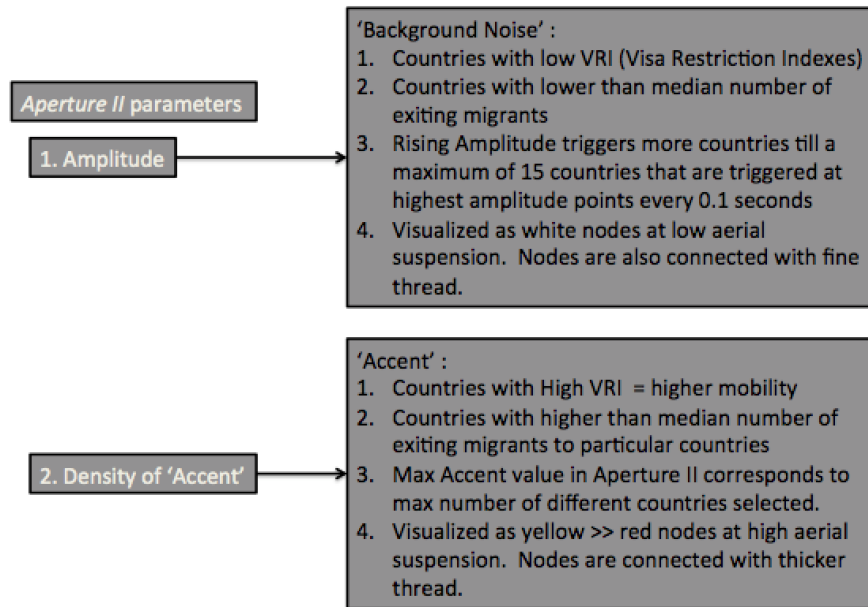


Figure 5.19. Flow Chart of initial experimentation

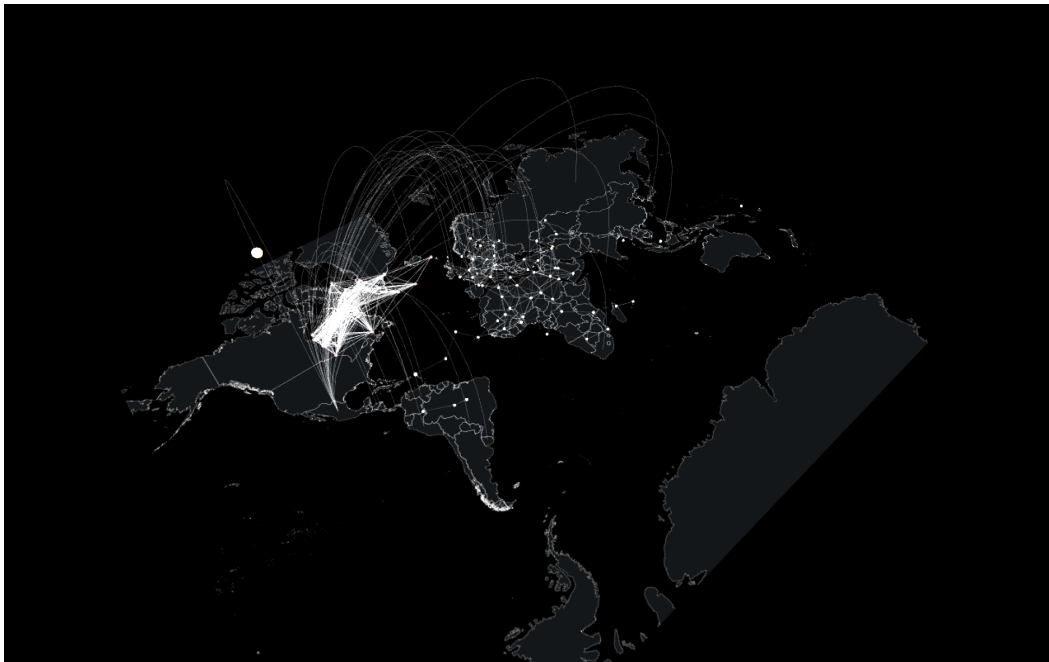


Figure 5.20. *Aeolian Traces*: Accent seen forming from Canada

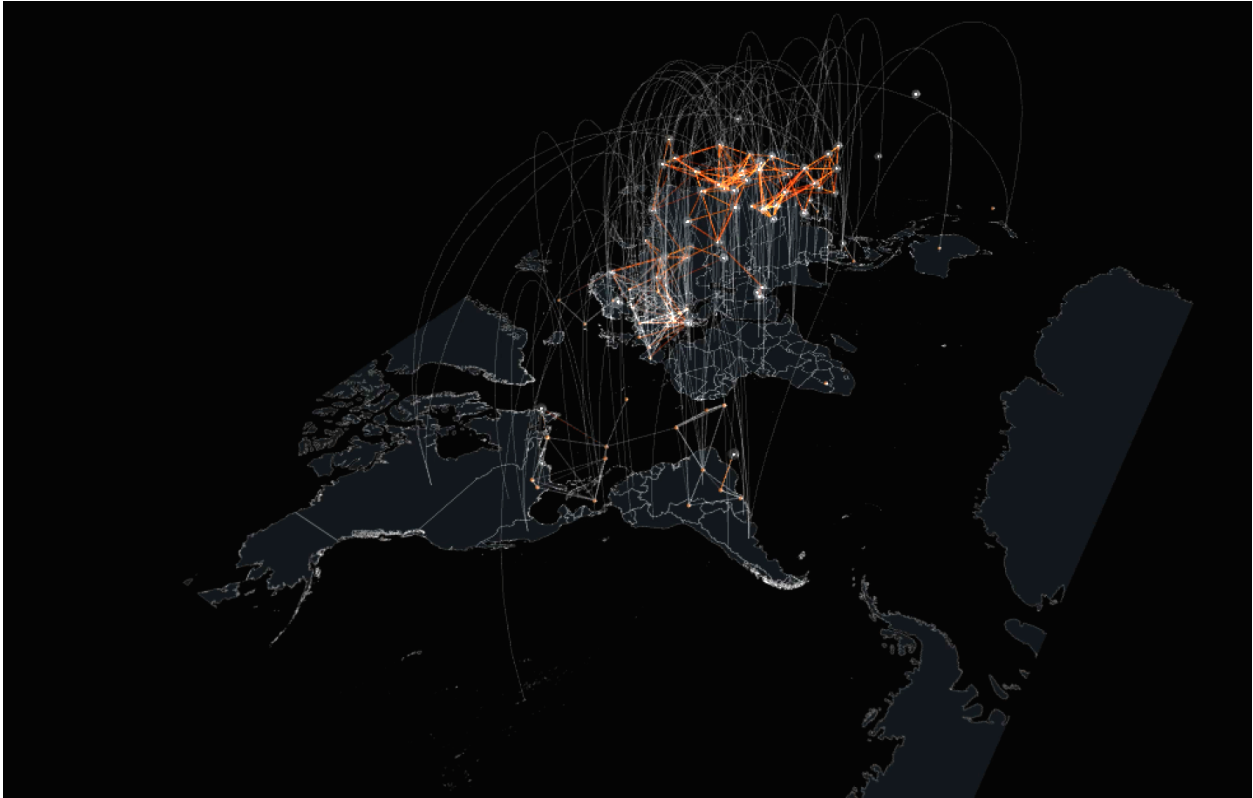


Figure 5.21. *Aeolian Traces*

5.2.4.2 Intricacies / Post structural Modifications

Countries with low Visa Restriction Indexes (low mobility) also tended to be the ones torn by war and conflict e.g. Afghanistan, Syria; and consequently were most likely to contribute to the rising tide of refugees and asylum seekers in 2015-16. Countries with high VRI meant high mobility for their citizens, but often also correlated to the most popular destination for migrants e.g. Germany. The project aimed to ‘suspend’ in red nodes the countries with the most potential for political strife.

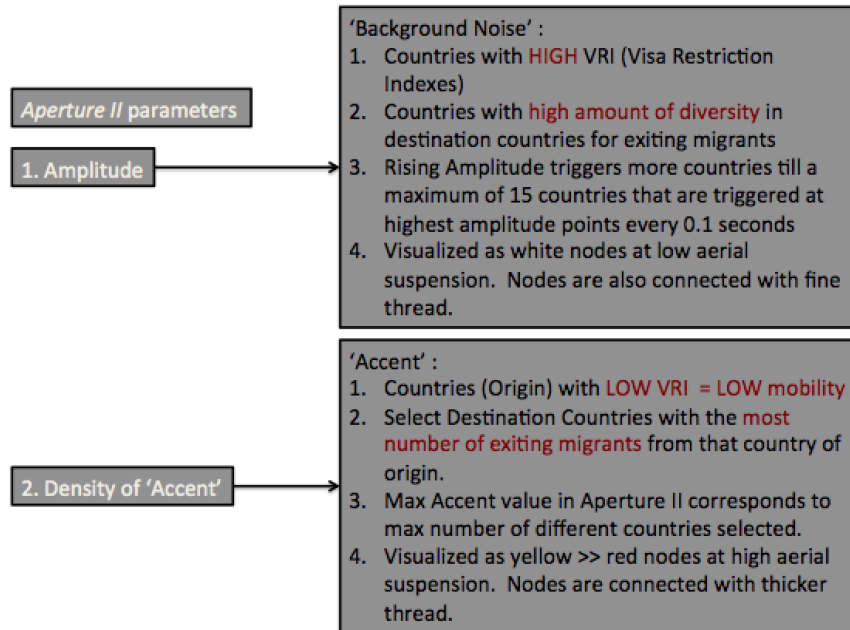


Figure 5.22. Revised parameter mapping

For each, a dictionary is populated that has countries that fit the description as keys and as values, the country's gps coordinates, UN country code, destination country and coordinate, number of migrants and VRI index. The list for "background noise" is as follows: Portugal, Bulgaria, Argentina, Brazil, Poland, Spain, New Zealand, Republic of Korea, Romania, France, Italy, United States of America, Peru, United Kingdom of Great Britain and Northern Ireland, Canada, Netherlands, Germany, Mexico, Ireland, Malaysia, Greece. The list for "punctuations" is as follows: State of Palestine, Bangladesh, Algeria, Haiti, Sri Lanka, Iraq, Pakistan, Nepal, Somalia, Sudan, Afghanistan, Lao People's Democratic Republic, Myanmar, Viet Nam, India, Mexico, Egypt, Uzbekistan, China, Syrian Arab Republic.

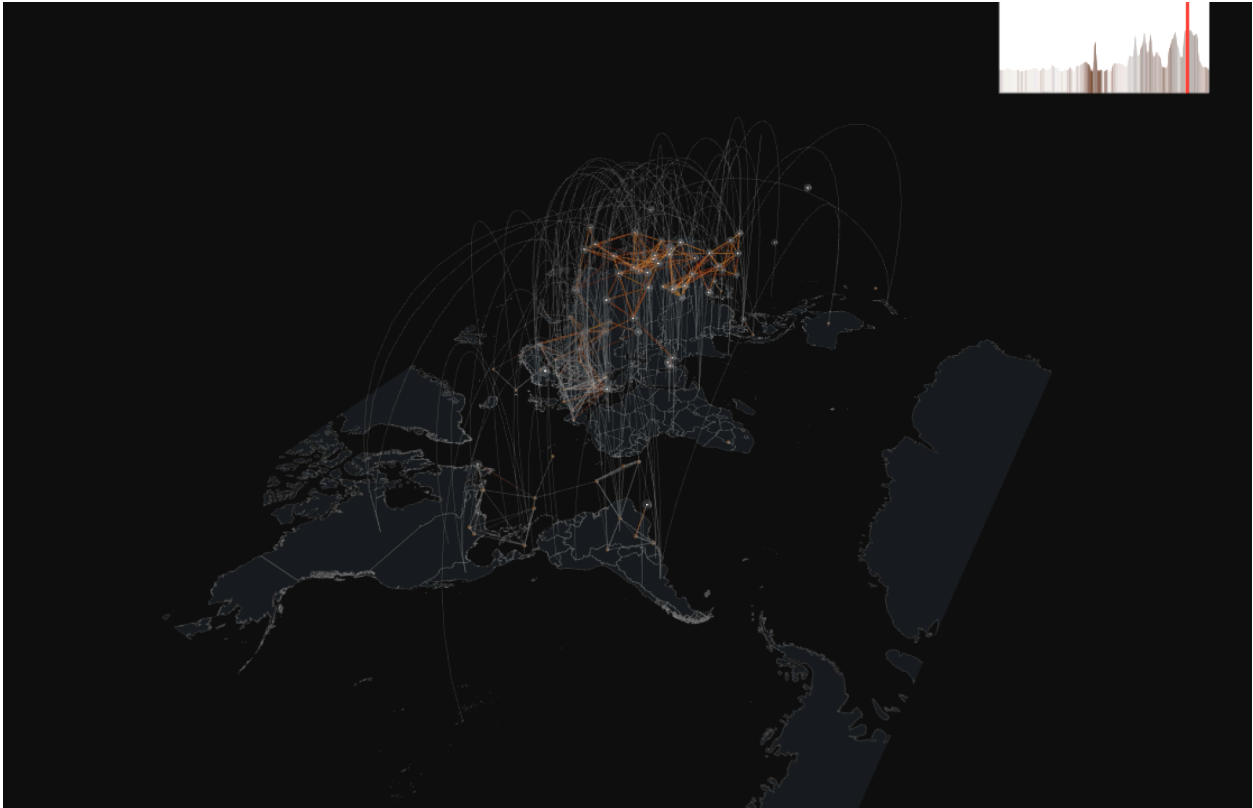


Figure 5.23. Screen shot with scrolling score:

5.3 FANS /PHYSICAL SETUP

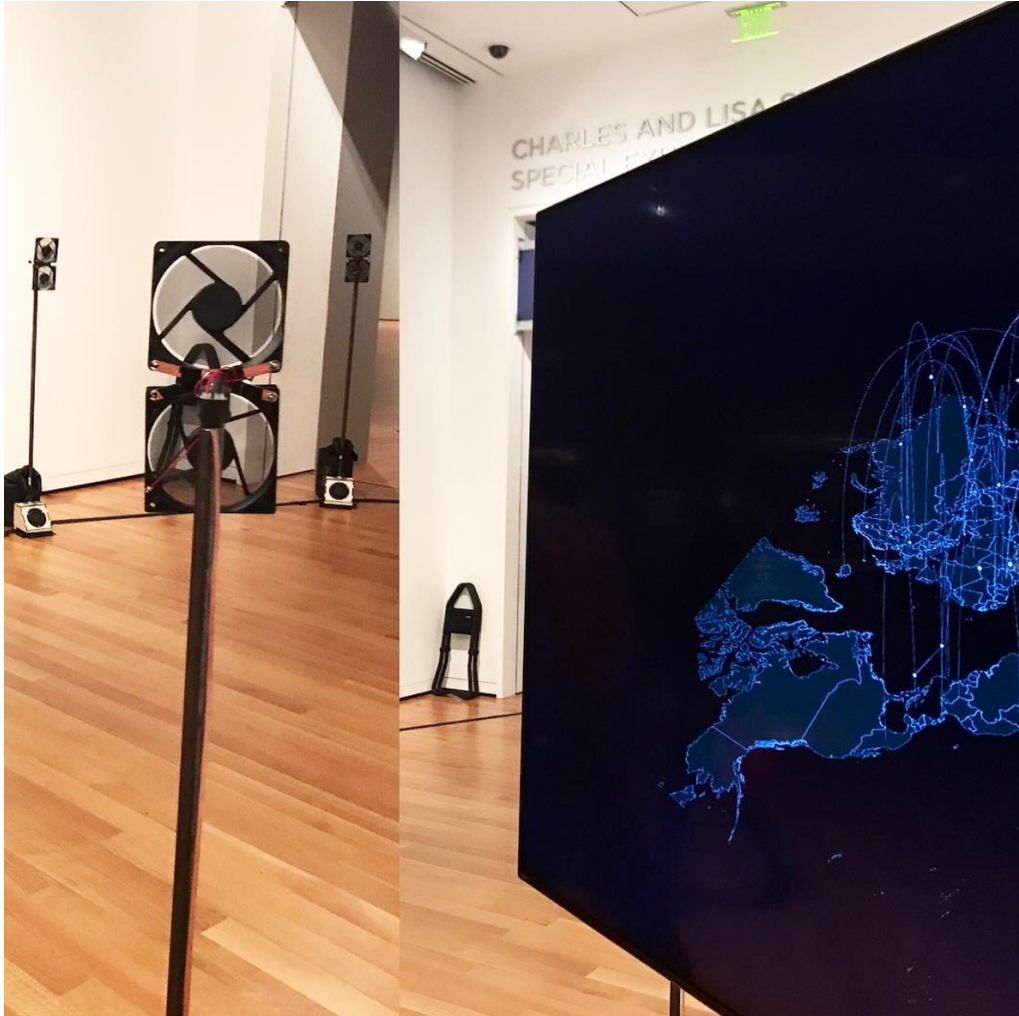


Figure 5.24. *Aeolian Traces* Installation setup

The fans were part of an 8-channel system that was triggered by the incoming data. They were triggered primarily with directional data corresponding to instances of sonified breezes. Since each of the breezes was a direct mapping of an instance of human movement across the globe, they have a GPS vector for both origin and destination countries. By assuming latitude to be the x-axis, and longitude to be y-axis, the movement was calculated by first drawing a circle with 8

nodes equally spaced along the curve in Rhino¹⁵³. These 8 nodes were given vectors in an array :
[[1.0,0.5],[0.854,0.854],[0.5,1.0],[0.146,0.854],[0.0,0.5],[0.146,0.146],[0.5,0.0],[0.854,0.146]].

By calculating the radial distance of each of these points from the GPS coordinates (scaled) of the origin country, a cascade of values between 4000 (max speed of fan) and 800 (minimum speed of fan) could be determined where the closest fan would run at a speed of 4000.

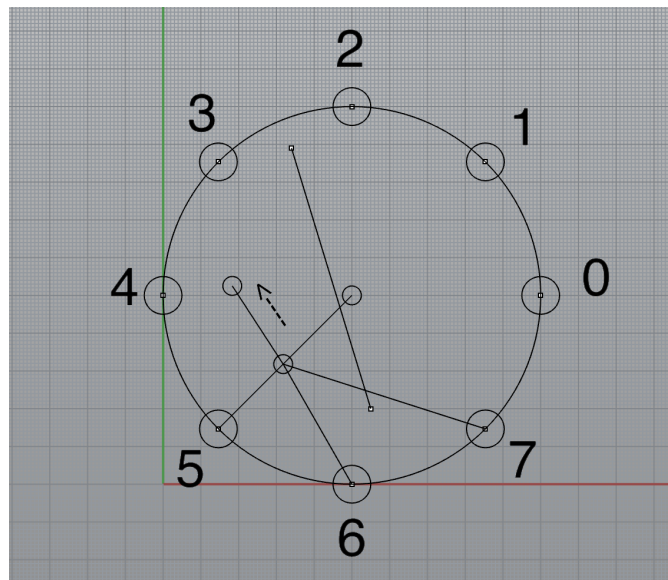
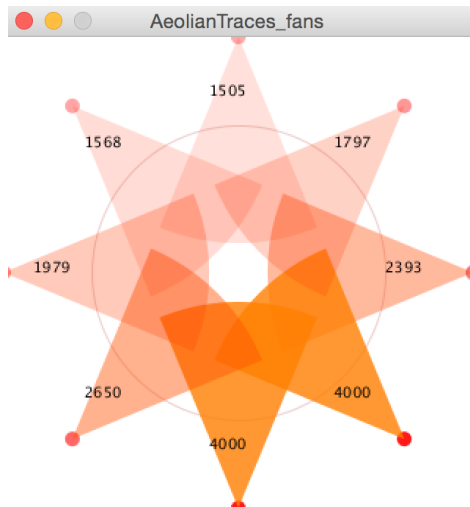


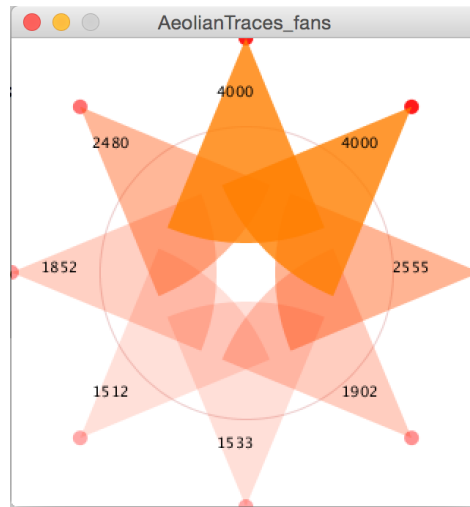
Figure 5.25. Calculating radial distance¹⁵⁴.

¹⁵³ Rhinoceros 3D. Online software website: <https://www.rhino3d.com/>.

¹⁵⁴ Each small circle represents the position of a given origin country. By measuring the radial distance to each fan we can determine the intensity of the fan's motor



India (GPS: 20.593684, 78.96288)



Mexico (GPS: 23.634501,-102.552784)

Figure 5.26. Data visualization of the fans' activity and relative speeds. Speaker '0' is North¹⁵⁵.

¹⁵⁵ A video of this in action can be found at <https://vimeo.com/215793062>

5.4 SOUND

The sounds in *Aeolian Traces* emphasized the layering of multiple textures. Audio narratives were taken from online sources in multiple languages corresponding to the project's database of origin and destination countries. Initial composition methods were focused on the synthesis of a believable 'wind' that could be moved around in space simply. Following an ongoing dialogue with my advisor, Prof Juan Pampin and discussions of his work *A Line*, the diegetic transformations of whispers to voices and breath to wind became the main focus of the composition process. To create whispers, an FFT filter was used to accentuate certain frequency bands of the incoming audio tracks, A pre-recorded whisper track was also added. At the base of the soundscape is a texture that resembles a Helmholtz resonator, imagining what the wind might sound like blowing through resonant tubes.

In setting up the Ambisonic system, the audio shifting was done by mapping the geographical coordinates of each selected country to the First Order Ambisonic polar array. In this way, the movements of people from one country to the next could directly create a gust of wind in the corresponding direction. Each installation has featured a different audio setup based on what was practically feasible at the gallery space and will be described in greater detail in the following subchapter.

Sound and image were choreographed together to promote haptic/sonic feedback for the visual elements. In testing the project's setup in a controlled environment, a delay was added to the sound to compensate for the time it took the physical wind to arrive at the idea listening position. This was calculated by mapping the polar coordinates of selected countries to the physical

distance between the fans and the center of the listening sphere. The visuals also featured fading that corresponded to the sounds fading away, aiming at an experience of quiet and fragile traces of sound and movement.

5.5 INSTALLATION SETUP

The initial setup at the Jacob Lawrence Gallery comprised of a sound/wind segment limited to 6 channels of 2D ambisonic audio. Testing for the piece was done at the DXARTS Ballard warehouse, as well as the DXARTS Ambisonics studios at Raitt Hall at the University of Washington. At the Jacob Lawrence Gallery, the project was installed in relative isolation, contained within a small room by itself.

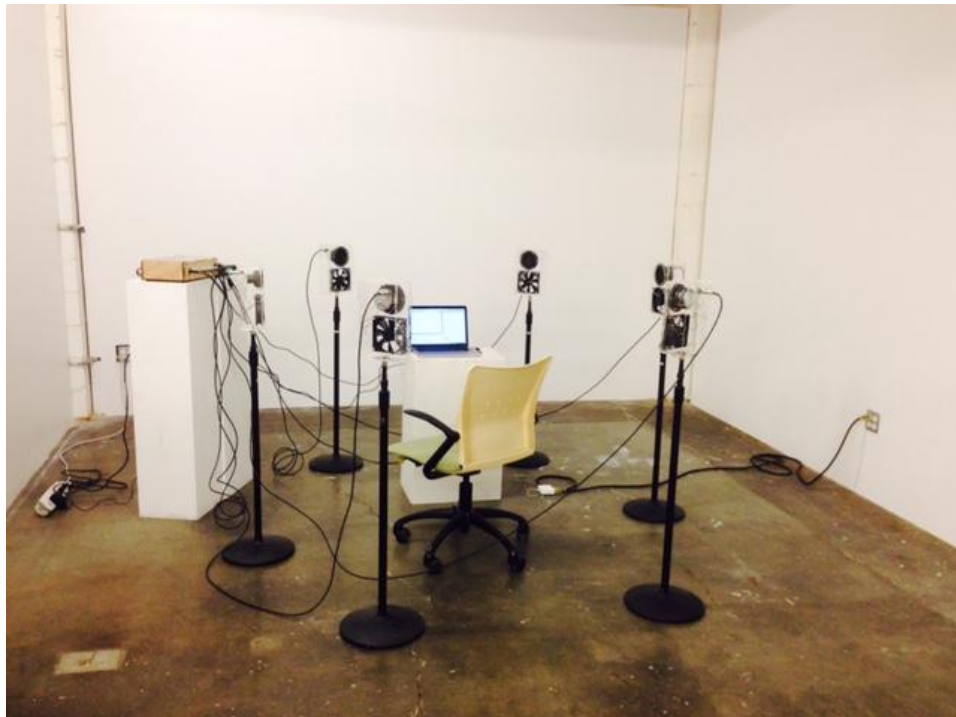


Figure 5.27. *Research Process at DXARTS' Ballard Warehouse*



Figure 5.28. Jacob Lawrence Gallery

Subsequently in Fall 2016, the project was set up at the Alice Lab for Computational Worldmaking at York University in Toronto for testing. The speaker configuration selected was that of a 16-channel periphonic setup with each speaker angled at 35 degree for a 10 foot diameter sphere. Each base speaker was housed in a laser cut box connected by piping adaptors to the fans which were mounted in pairs. Lightweight and easily replaceable materials were chosen that encouraged the portability of the installation. Modularity was also a big part of the hardware to maximize efficiency with the 3D printer and laser cutter.

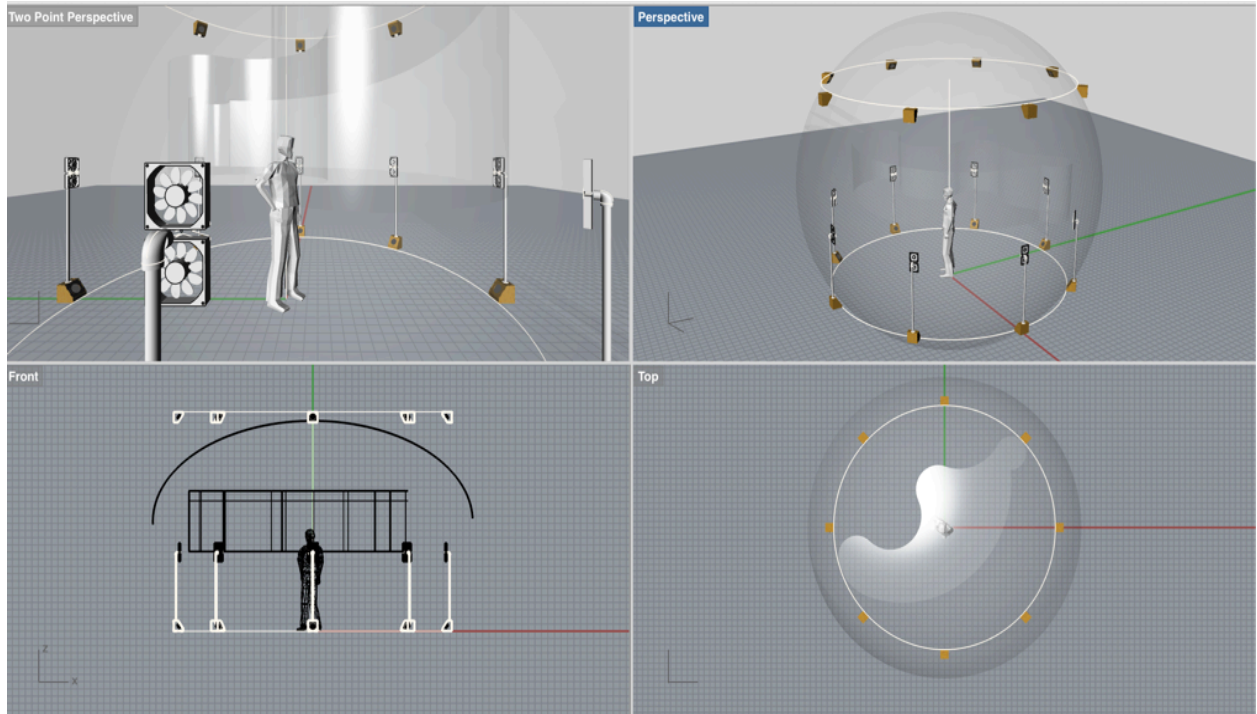


Figure 5.29. 3D model for ambisonic setup



Figure 5.30. Installation and Testing

In its most recent showing in April 2017, the project was moved to the Seattle Art Museum as part of their REMIX Festival. Due to practical constraints, only the lower level of the sphere was installed, resulting in a 8 channel 2D ambisonic layout. The position of the speakers on the floor also meant that the fans were free to be the main visual feature of the installation, an improvement from the initial install at the Jacob Lawrence Gallery.



Figure 5.31. Mock up of the installation at the Seattle Art Museum

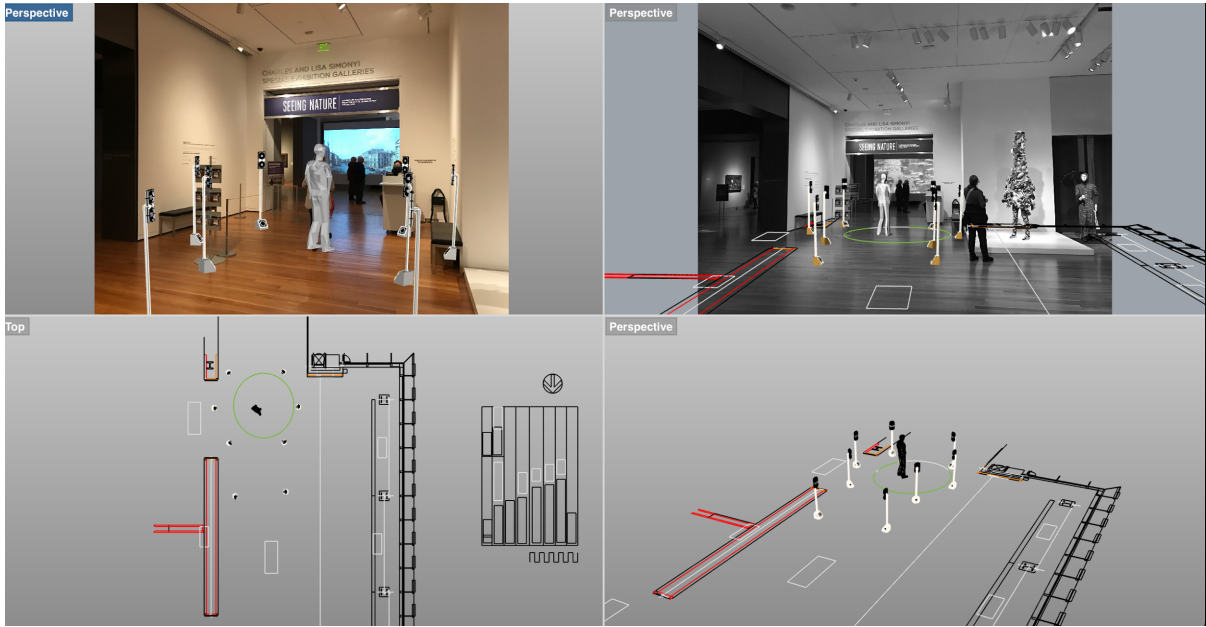


Figure 5.32. Installation details on Floor Plan



Figure 5.33. Installation at Seattle Art Museum



Figure 5.34. Installation at Seattle Art Museum



Figure 5.35. Installation at Seattle Art Museum



Figure 5.36. Installation at Seattle Art Museum

5.6 FEEDBACK / REFLECTION

The previous data-centric artworks described scales of the engagement that exist between the human level and that of the global. In *#home*, personal descriptions and memories are used to generate connections amongst Twitter users around the world; in *Sombrer: An Intertidal City* *#lost and #found*, the city is imagined at a transition state, oscillating between submerged and awash at a rate determined by, again, global updates in the Twitterverse. Similarly, *Aeolian Traces* sought a global scale for its visualization, to hope to run an algorithm and allow the system to create patterns between the sequences of human movement. Scale is a challenging idea because the larger the scale of something is, the less detail it contains. By creating both affective and informative graphics, the project was able to merge these two scales.

Site was also a very important consideration. At the Jacob Lawrence Gallery, the site used was acoustically isolated, and allowed the creation of a small personal space that one could feel the movement of the wind around him and listen to the spatial movements of sounds. At the Seattle Art Museum, the site was less than ideal - an open area at the mouth of a gallery where visitors could file past in large numbers. The amount of wind experienced at the 'epicenter' of the installation was also not only created by the installation but also by the mass movement of people in and out of the gallery. In that sense, the project was able to achieve an almost invisible, quotidian feel - something one might not notice immediately. The piece's positioning at the mouth of the exhibition *Seeing Nature: Landscape Masterworks From The Paul G. Allen Family Collection* also allowed it to come into conversation with the largely visual and

impressionistic portrayals of nature within, thereby creating resonances with these experiences of mediated landscapes.

5.7 IMPROVEMENTS

Certain improvements to the installation format might allow the ideas embedded within to become more accentuated:

1. Interactive elements could be designed for the work. Karpen's music was created for string players and not instruments, this distinction established through a complex mode of listening/feedback of the players to each other guided by the memories of their previous rehearsals. In the same way in *Aeolian Traces*, data could be choreographed for *people* and not for data's sake. This could be effected through a machine-listening process that was dependent on non-human actants, and essentially create an unfolding narrative that was non-linear, dynamic and constantly different every time it was run. For this to happen it would require a mix of real-time events and non-real time events - real-time events to simulate site-specific 'listening' to what is going on with all other actants and reacting accordingly. One possibly would be for the system to 'listen' to real time wind data as setup in *Those who Observe the Wind ...* allowing realtime wind directional data to trigger visuals corresponding to the countries in its path. Another possible element of the project would be to invite visitors to add to the database by sharing their personal journeys across the world. While this was not explicitly part of either of the project presentations, an interactive component was prototyped in Python that could receive data from visitors in a poll (*similar to the Aeolus Notification System* and *#home*) and then could create an even more diverse visualization strategy.

- The connection of sound to image was not always apparent due to the physical distance between the auditory setup and the visualization screen. This meant that at the sweet spot for the Ambisonic setup, the viewer would be unable to see a corresponding development in the image. While this could be rectified easily with a different setup (with the screen rear projected closer to the audio setup, or even on the floor), in discussions with my advisor Prof Juan Pampin, this problem actually opened up the possibilities of separating these two experiential elements. The image, as an informative backdrop to the project that people could observe prior to entering the ambisonic space. This would allow the visitors to experience the conceptual and emotional premise before experiencing an immersive soundscape.

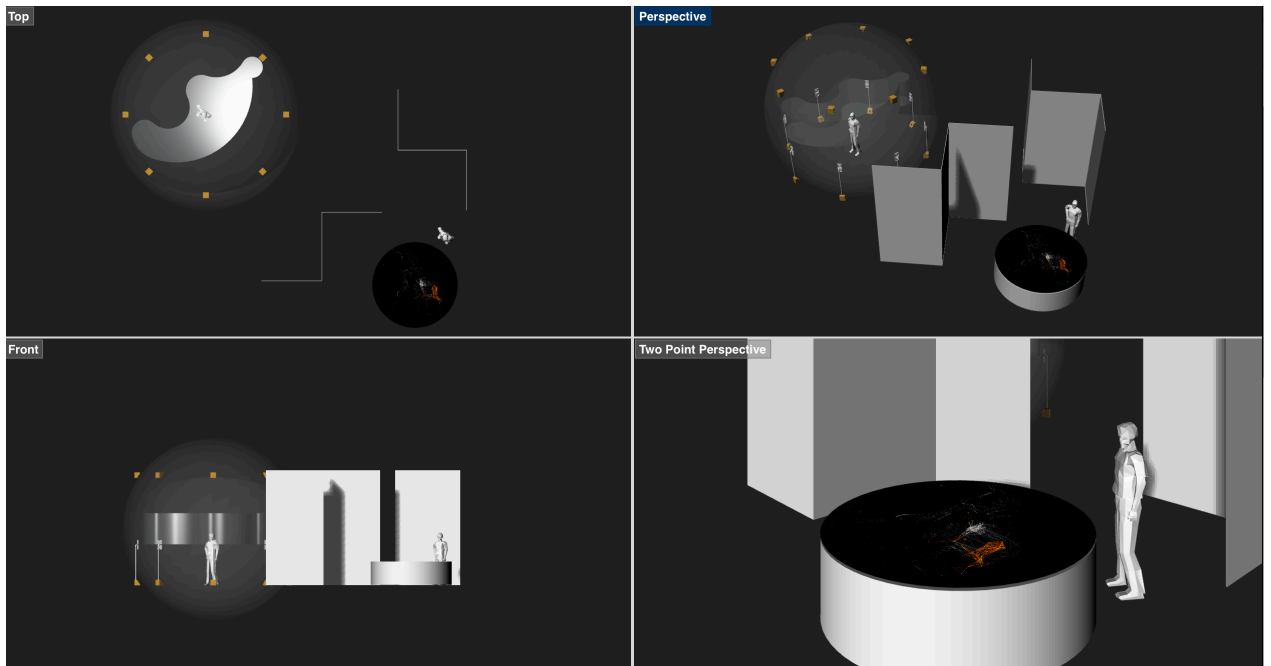


Figure 5.37. Proposed modifications to original system.

3. The notion of natural space and in vitro environments could be better contrasted by immersing the installation in a black box type environment. In its time at the Alice Lab for Computational World Making, much discussion was had with its founder and direction Graham Wakefield about the possibility of adapting this to a virtual or mixed reality installation. Within the constraints of the virtual headset, the piece could be envisioned as a walk on the surface of the globe observing as thousands of data points lift off around and fly around.

4. The notion of mediated/constructed nature could also be critiqued by immersing the installation within natural space where the surrounding landscape could imbue the project with a further sense of human migration and movement. Sites such as indigenous grounds, border territories, areas of politicized activity etc. would all be interesting subjects for further exploration.

BIBLIOGRAPHY

- [1] *8½*. Dir. Federico Fellini. 1963.
- [2] “A Sound Garden”. Wikipedia. Online at https://en.wikipedia.org/wiki/A_Sound_Garden. Accessed June 1 2017.
- [3] “Air separation”. Wikipedia. Online at https://en.wikipedia.org/wiki/Air_separation. Access 8 June 2017.
- [4] Anand, Madhur. *A New Index for Predicting Catastrophe*. McClelland & Stewart, 2015.
- [5] “Anemometer Wind Speed Sensor w/Analog Output”. <https://www.adafruit.com/product/1733>. Accessed 9 June 2017
- [6] Babbage, Charles. “On the permanent Impression of our Words and Actions on the Globe we inhabit”, in Ninth Bridgewater Thesis. 1837. http://victorianweb.org/science/science_texts/bridgewater/b9.htm Accessed 27 May 2017.
- [7] Bachelard, Gaston. *The Poetics of Space*. Beacon Press, 1994.
- [8] Barfield, Owen. “The Harp and the Camera.” In *The Rediscovery of Meaning, and Other Essays*. Wesleyan University Press, 1977. pp65-79.
- [9] Buechner, Frederick. *The Magnificent Defeat* Harper San Francisco. 1985
- [10] Beesley, Philip and Omar Khan. ‘Responsive Architecture/Performing Instruments’, in *Situated Technologies Pamphlets 4*. Eds. Omar Khan, Treber Scholz and Mark Shepard. The Architectural League of New York, 2009.
- [11] Beesley, Philip, Sachiko Hirose, and Jim Ruxton. “Toward Responsive Architectures.” in *Responsive Architectures: Subtle Technologies*. Eds. Philip Beesley, Sachiko Hirose, Jim Ruxton, M. Trankle and C. Turner. Toronto: Riverside Architectural Press, 2006. pp3-11.
- [12] Bennett, Jane. *Thoreau’s Nature: Ethics Politics and the Wild*. Rowman and Littlefield Publishers, 2000.
- [13] Blake, William. “Auguries of Innocence”.1863. Online at <https://www.poetryfoundation.org/poems/43650/auguries-of-innocence>. Accessed October 2015.
- [14] “Blow Up (2005)”. Scott Snibbe. Online at <https://www.snibbe.com/projects/interactive/blowup>. Accessed 9 June 2017.
- [15] Borges, Jorge Luis. “The Library of Babel” in *Ficciones*. Grove Press, 1962. Pp 79-89.

- [16] Brown, Steven C. *Native Visions: Evolution in Northwest Coast Art from the Eighteenth through the Twentieth Century*. 1998. Seattle Art Museum. Douglas and McIntyre Ltd, Canada
- [17] Carlyle, Angus, ed. *Autumn Leaves: Sound and the Environment in Artistic Practice*. Double Entendre. France, 2007.
- [18] “Casa Latina”: <http://casa-latina.org/> . Accessed 10 May 2017
- [19] “Christina Kubisch”. Online
: http://www.galeriemazzoli.com/porfolio/gmm_kubisch_portfolio_en.pdf. Accessed June 2 2017.
- [20] Davis, Keith E.. “Admiration and Awe: David Stephenson and the Photographic Sublime” in *Visions of Heaven: The Dome in European Architecture*. Princeton Architectural Press. 2005
- [21] De Souza e Silva, Adriana. "Mobile Narratives: Reading and Writing Urban Space with Location-Based Technologies," in *Comparative Textual Media: Transforming the Humanities in the Postmodern Era*, eds. N. Katherine Hayles and Jessica Pressman. Minneapolis: University of Minnesota Press, 2013. pp. 33-52.
- [22] Debord, Guy. *Society of the Spectacle*. Black and Red. 2016
- [23] “Max Eastley: Installation for Springhornhof Gallery and Landscape Art Center”. Online at <http://www.maxeastley.co.uk/2014/07/02/installation-springhornhof-gallery/>. Accessed June 1 2017
- [24] “EarthWindMap” Online at
<https://earth.nullschool.net/#current/chem/surface/level/anim=off/overlay=cosc/orthographic>
. Accessed June 12 2017
- [25] Emerson, Ralph Waldo. *Nature and Other Essays*. Dover Publications Inc. 2009
- [26] Eldredge, Niles. *Time Frames: The Rethinking of Darwinian Evolution and the Theory of Punctuated Equilibria*. Simon and Schuster. 1985.
- [27] Feynman, Richard. “There’s Plenty of Room at the Bottom” *Engineering and Science*, Volume 23:5, Feb 1960. Online at <http://resolver.caltech.edu/CaltechES:23.5.0>. Accessed October 2015
- [28] Flake, Gary William. *The Computational Beauty of Nature*. MIT Press. 1998.
- [29] “Flow: Studio Roosegaarde”. Online at
<https://www.studio Roosegaarde.net/project/flow/info/>. Accessed Juen9 2017.
- [30] Flusser, Vilém. *The Freedom of the Migrant: Objections to Nationalism*. Translated by Kenneth Kronenberg. Ed, Anke K. Finger. University of Illinois Press. 2003.

- [31] Gabrys, Jennifer. *Program Earth: Environmental Sensing Technology and the Making of a Computational Planet*. University of Minnesota Press, 2016.
- [32] Giddings, Seth and Lister, Martin, eds. *The New Media and Techocultures Reader*. Routledge, 2011.
- [33] Grant, Edward. "Earth, Heavens and Beyond" in *Physical Science in the Middle Ages*. Cambridge University Press. 1983
- [34] "Global Modelling and Assimilation Office". Online at: <https://gmao.gsfc.nasa.gov/forecasts/>. Accessed 12 June 2017.
- [35] "Gordan Monohan's artist website." http://www.gordonmonohan.com/pages/long_aeolian_page.html. Accessed June 1 2017
- [36] "Grower, 2004-6" Online at <http://raaf.org/projects.php?pcat=2&proj=4>. Accessed Jan 2017.
- [37] Gribbin, John. *The Scientists*. Random House, 2002.
- [38] Hankins, Thomas L. and Silverman, Robert J. "The Aeolian Harp and the Quest for Nature." in *Instruments and the Imagination*. Princeton University Press. 1995.
- [39] Heise, U. K. "Unnatural Ecologies: The Metaphor of the Environment in Media Theory." *Configurations*, vol. 10 no. 1, 2002, pp. 149-168. *Project MUSE*, doi:10.1353/con.2003.0006
- [40] Hermann, Thomas, Hunt, Andy and Nehoff, John G., eds. *The Sonification Handbook*. Logos Publishing. 2011. Online: <http://sonification.de/handbook/>
- [41] Hoffman, G., Weinberg G., "Interactive Improvisation with a Robotic Marimba Player," *Journal Autonomous Robots*, Vol. 31. Springer Press. 2011.
- [42] Holmes, Richard. *The Age of Wonder*. Pantheon Books, New York. 2008
- [43] Homer. *The Odyssey of Homer*. Translated by Richmond Lattimore. Harper & Row, 2007.
- [44] "How Washington State became the epicenter of resistance to Trump's agenda". Washington Post Online: <https://www.washingtonpost.com/news/the-fix/wp/2017/02/05/how-washington-state-became-the-epicenter-of-resistance-to-trumps-agenda/>. Accessed 10 May 2017
- [45] Jacobson, Robert, ed. *Information Design*. MIT Press. 2000.
- [46] Karpen, Richard. "Re: Those Who Observe the Wind post- conversation." Message to Joel Ong, 14 July 2015. E-mail.
- [47] Ingold, Tim. "Against Soundscape". In *Autumn Leaves*. Angus Carlyle (ed) Double Entendre Publishing. 2007. pp

- [48] Irigaray, Luce. *The Forgetting of Air in Martin Heidegger* (trans) Mary Beth Mader. 1999.
- [49] Itten, Johannes. *The Elements of Color*. John Wiley and Sons. 1970.
- [50] “Jeffrey Shaw. Description of Installation the Legible City”. Online at http://www.jeffrey-shaw.net/html_main/frameset-biography.php. Accessed June 2nd 2017
- [51] Kahn, Luis. “The Value and Aim in Sketching”. Quoted in Stockli, Tobi. *The Measurable and the Unmeasurable or from Form to Design to Existence*. Online at <http://papers.cumincad.org/data/works/att/1b31.content.03079.pdf>. Accessed June 2 2017.
- [52] Kendra, Barbara. “Aeolian Winds and the Spirit of Renaissance Architecture”. In *Aeolian Winds and the Spirit in Renaissance Architecture: Academia Eolia Revisited*. Routledge. 2006.
- [53] Keller, David R. and Golley, Frank B, eds. *The Philosophy of Ecology: From Science to Synthesis*. University of Georgia Press. 2000.
- [54] King-Hele, D.G. “Analysis of the Orbits of the Russian Satellites”. In *Proceedings of the Royal Society of London. Series A, Mathematical and Physical Sciences* Vol. 253, No. 1275 (Dec. 29, 1959), pp. 529-538. Online: https://www.jstor.org/stable/100703?seq=4#page_scan_tab_contents. Accessed 9 June 2017.
- [55] Kircher, Athanasius. 1673 *Phonurgia Nova*. University of Washington Press.
- [56] Lobell, John. *Between Silence and Light: Spirit in the Architecture of Louis I. Kahn*. Shambhala Publications, 2008.
- [57] Manovich, Lev. “Database as Symbolic Form.” *Convergence* Vol 5, Issue 2, 2016. pp. 80 – 99
- [58] Manovich, Lev. “Data Visualization as New Abstraction and Anti-Sublime,” *SMAC!*, 2002. San Francisco.
- [59] Mansfield, Jonathan. *Aeolian Harp Series: Volume 1 The Design and Construction of an Aeolian Harp*. Bois de Boulogne. 1970.
- [60] Mass, Cliff. *The Weather of the Pacific Northwest*. University of Washington Press. 2008
- [61] McAllister, Robin. “Borges’ Poetics of Visible Unrealities”. *Journal of Literature and Art Studies* Vol 4. No. 5, 2014. Pp 338-344.
- [62] McLuhan, Marshall. “At the moment of Sputnik the planet became a global theater in which there are no spectators but only actors” *Journal of Communication*, 24, 1974. pp 48–58. doi:10.1111/j.1460-2466.1974.tb00354.
- [63] Merchant, Carolyn. *Radical Ecology: The Search for a Livable World*. Routledge, 2005.

- [64] Miéville, China. *The Census-taker*. Del Ray. 2016.
- [65] Murray, Janet. "Inventing the Medium". In *The New Media Reader*. Eds Noah Wardrip-Fruin and Nick Montfort. 2003.
- [66] Nardi, Bonnie and O'Day, Vicki "Information Ecologies". In *Information Ecology: Using Technology with Heart*. Cambridge: MIT Press,1999.
- [67] "NASA Space Science Coordinated Archive". Online at <https://nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=1957-001B>. Accessed 8 June 2017.
- [68] Negroponte, Nicholas. *Being Digital*. Vintage Books, 1995
- [69] "Number 14 grey- Jackson Pollock" Online at <http://www.jackson-pollock.org/images/paintings/number-14-gray.jpg>. Accessed June 2016.
- [70] Olof-Ors, Matilda. "Introduction". In *Olafur Eliasson Reality Machines*. Moderna Museet and Koenig Books. 2015.
- [71] Online Index of Objects Launched into Outer Space. United Nations Office for Outer Space Affairs. Online at <http://www.unoosa.org/oosa/osoindex/search-ng.jspx>. Accessed May 29th.
- [72] Peters, John Durham. *The Marvellous Clouds: Towards a Philosophy of Elemental Media*. The University of Chicago Press, 2015.
- [73] "Piet Mondrian Tableau No. 2/Composition No. VII" Guggenheim Collection Online. Online at <https://www.guggenheim.org/artwork/3007>. Accessed March 2017.
- [74] Prichett, James. "Richard Karpen: Processes Universal and Human" Online at <http://rosewhitemusic.com/piano/writings/richard-karpen-processes-universal-and-human/>. Accessed 20 July 2015
- [75] "Processing" Program Website Online at <https://processing.org/>
- [76] Professor Mark Ballora Translates Numbers to Music" in Onward States. Online: <http://onwardstate.com/2015/04/02/professor-mark-ballora-translates-numbers-to-music/> . Accessed June 18 2017
- [77] "Rhinceros 3D". Online software website: <https://www.rhino3d.com/>.
- [78] Rosenblum, Robert. *Modern Painting and the Northern Romantic Tradition: Friedrich to Rothko*. New York: Harper & Row, 1975.
- [79] Rothko, Christopher, ed. *The Artist's Reality*. By Mark Rothko. Yale University Press. 2004.
- [80] Schafer, R. Murray. *The Tuning of The World*. McClelland and Stewart Limited. 1977

- [81] Scheiner, Samuel M. and Willig, Michael R, eds. *The Theory of Ecology*. University of Chicago Press, 2011.
- [82] Schlegel, Friedrich . 1797. Cited in Gorodeisky, Keren, "19th Century Romantic Aesthetics", The Stanford Encyclopedia of Philosophy (Fall 2016 Edition), Edward N. Zalta (ed.), Online at <https://plato.stanford.edu/archives/fall2016/entries/aesthetics-19th-romantic>.
- [83] "Scott Hessels. Celestial Mechanics". Online at <http://www.dshessels.com/artworks/celestialmechanics/about.htm>. Accessed June 2 2017.
- [84] "Sculpture: Art Commission Installations" on "Randall Museum's Website at <https://www.randallmuseum.org/project/sculpture/>. Accessed 16 June 2017.
- [85] "SeaTac, WA". Wunderground weather station. Online at <https://www.wunderground.com/us/wa/seatac>. Accessed 9 June 2017.
- [86] Shelley, Percy Bysshe. 2004 "A Defence of Poetry and Other Essays" in *Project Gutenberg EBooks*. Online at <https://www.gutenberg.org/files/5428/5428-h/5428-h.htm>.
- [87] Sloterdijk, Peter. *Bubbles*. MIT Press. 2011
- [88] Smithson, Robert. *Robert Smithson: The Collected Writings*. Ed, Jack Flam. University of California Press. 1996.
- [89] "Spencer Finch Archive". Online at http://www.postmastersart.com/archive/finch07/finch07_222_1.html. Accessed June 1 2017.
- [90] "Station ELXC1 – Caspian Weather Station, Elkhorn Slough Reserve, CA". Online: http://www.ndbc.noaa.gov/station_page.php?station=elxc1 . Access 9June 2017
- [91] Stephenson, David. *Visions of Heaven: The Dome in European Architecture*. Princeton Architectural Press. 2005.
- [92] Tabbi, Joseph and Wolfe, Cary (eds). *Critical Ecologies*. Online at <http://www.electronicbookreview.com/thread/criticalecologies>. 1996.
- [93] "Tao Sambolec. Virtual Hole- Wind 1:1". Online at <http://www.taogvs.org/VirtualHoleWind11Main.html> . Accessed June2 2017
- [94] "Tao Sambolec. Virtual Mirror". Online at <http://www.taogvs.org/VirtualMirroRainPict1.html>. Accessed June2 2017
- [95] "Tao Sambolec. City Velocities - Body Speeds(2012)". Online at <http://www.taogvs.org/CVBSMain.html>. Accessed June 12 2017.
- [96] Tarkovsky, Andrey. *Sculpting in Time*. Translated by Kitty Hunter-Blair. University of Texas Press. 2016.

- [97] Taruskin, Richard. *Music in the Late Twentieth Century: The Oxford History of Western Music*. Oxford University Press. 2010
- [98] "The Eolian Harp". Wikipedia. Online at https://en.wikipedia.org/wiki/The_Eolian_Harp. Accessed June 1 2017
- [99] "The Flowering Apple Tree, 1912 by Piet Mondrian". Online at <http://www.piet-mondrian.org/the-flowering-apple-tree.jsp>. Accessed June 2017
- [100] "The Red Tree, 1908 by Piet Mondrian" online at <http://www.piet-mondrian.org/the-red-tree.jsp>. Accessed June 2017
- [101] "The Gray Tree, 1912 by Piet Mondrian" online at <http://www.piet-mondrian.org/the-gray-tree.jsp/> Accessed June 2017
- [102] Thoreau, Henry David. "Walden" in *Walden and Other Writings by Henry David Thoreau*. Ed, Joseph Wood Krutch. Bantam Books. 1989. pp105-353.
- [103] Thoreau, Henry David. "Walking" in *The Natural History Essays*. Gibbs Smith. 1980. pp93-137
- [104] Tilney, Nicholas L. *Transplant: From Myth to Reality*. Yale University Press. 2003.
- [105] Trower, Shelley. "Nerves, Vibration and the Aeolian Harp." *Romanticism and Victorianism on the Net* 54, 2009. DOI:10.7202/038761ar
- [106] Tufte, Edward. *Visual Explanations*. Graphics Press, 1997.
- [107] "Turner: Rain, Steam Speed" Online
https://upload.wikimedia.org/wikipedia/commons/9/96/Turner_-_Rain%2C_Steam_and_Speed_-_National_Gallery_file.jpg. Accessed May 31st 2017.
- [108] "United Nations International Migrant Stock 2015" Online at
<http://www.un.org/en/development/desa/population/migration/data/estimates2/estimates15.shtml>. Accessed 14 Nov 2016
- [109] "Visa Restriction Index 2015. Henley and Partners. Online at
<https://www.henleyglobal.com/files/download/HP/hvri/HP%20Visa%20Restrictions%20Index%20151001.pdf>. Accessed 10 Nov 2016
- [110] "Vicious Circular Breathing." Rafael Lozano-Hemmer. Online at http://www.lozano-hemmer.com/showimage.php?img=Mexico_2015&proj=285&type=artwork&id=16. Accessed June 17 2017
- [111] Wardrip-Fruin, Noah and Montfort, Nick (eds). *The New Media Reader*. MIT Press. 2003.
- [112] Weinstein, Phillip. *Becoming Faulkner: The Art and Life of William Faulkner*. Oxford University Press. 2012.

- [113] Weiser, Mark. "The computer for the 21st century." *Scientific American*, Vol. 265, No. 3, September 1991, pp. 66-75.
- [114] Westerkamp, Hildergard. "Kit's Beach Soundscape Transcript". In McCartney, Andra Shirley Jean. Doctoral Dissertation. <https://soundart01.files.wordpress.com/2013/03/kits-beach-hildegard-westerkamp-transcript.pdf>
- [115] What King County's refugee populations look like | Interactive Map". Seattle Times Online: <http://www.seattletimes.com/seattle-news/what-king-countys-refugee-populations-look-like-interactive-map/>. Accessed 10 May 2017
- [116] Whitehead, Alfred North. *Science and The Modern World*. The Free Press.1967.
- [117] Whitman, Walt. *Leaves of Grass*. Wisehouse Classics. 2016.
- [118] "Windswept". <http://charlessowers.com/windswept>. Accessed June 16 2017.
- [119] Zielinski, Siegfried. 2006. "Light and Shadow – Consonance and Dissonance". In *Deep Time of the Media*. MIT Press. USA.

APPENDIX A: 42 DEGREES SOUTHWEST MATERIAL

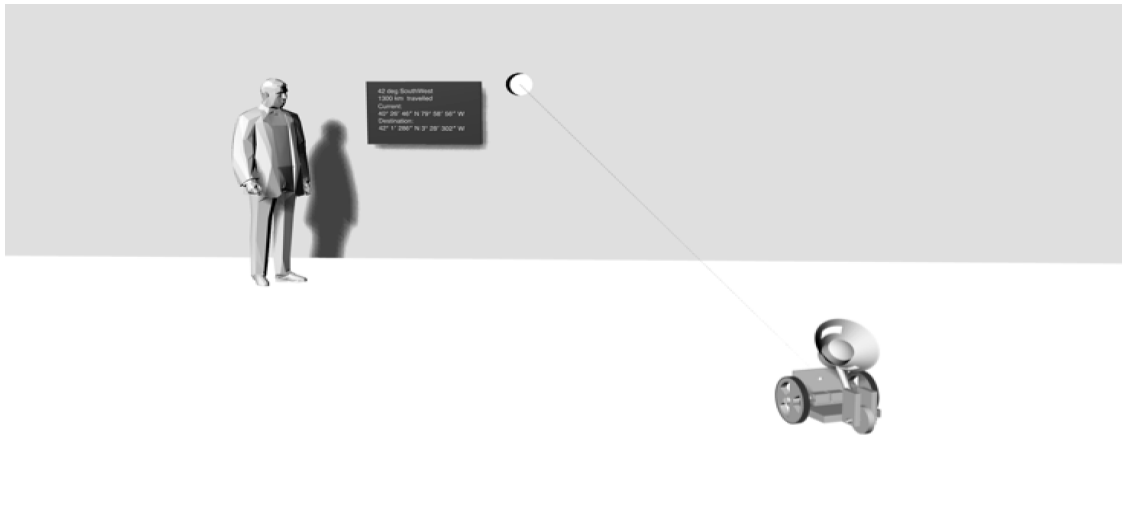


Figure 6.38. *42 degrees SouthWest (if by any means we get there)* 3D mockup



Figure 6.39. Prototype Presentation

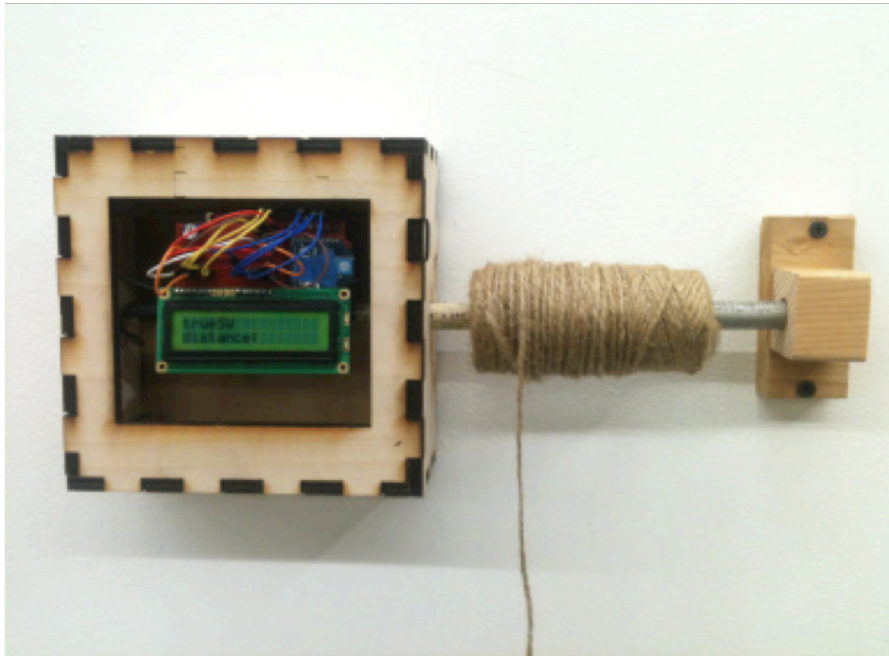


Figure 6.40. prototype presentation showing information LCD screen and spool

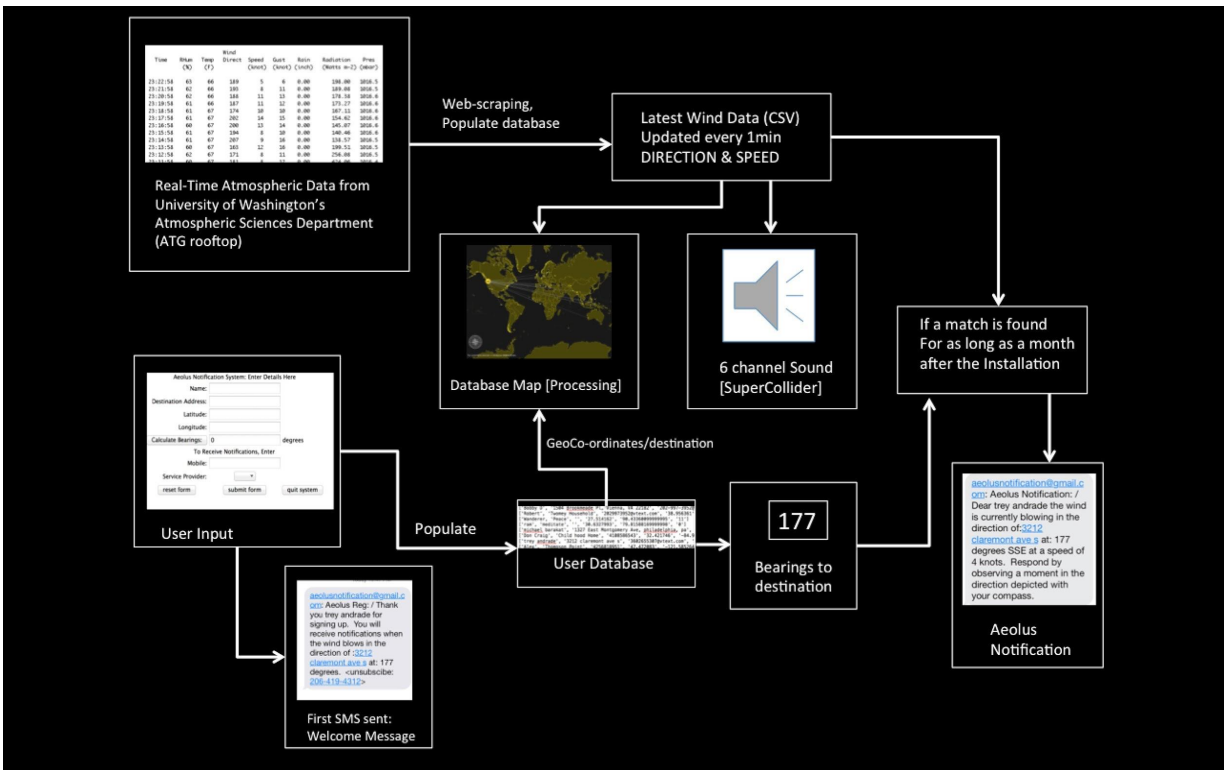


Figure 6.41. Flow Chart for the Aeolus Notification System

APPENDIX B: *THOSE WHO OBSERVE THE WIND MATERIAL*

Setup at Jack Straw involved the installation of a steel wire mesh in the ceiling in order to hang the boxes. The boxes were suspended with fishing wire after modelling and calculating the necessary lengths and angles.



Figure 7.42: Setting up the ceiling wire mesh at Jack Straw New Media Center

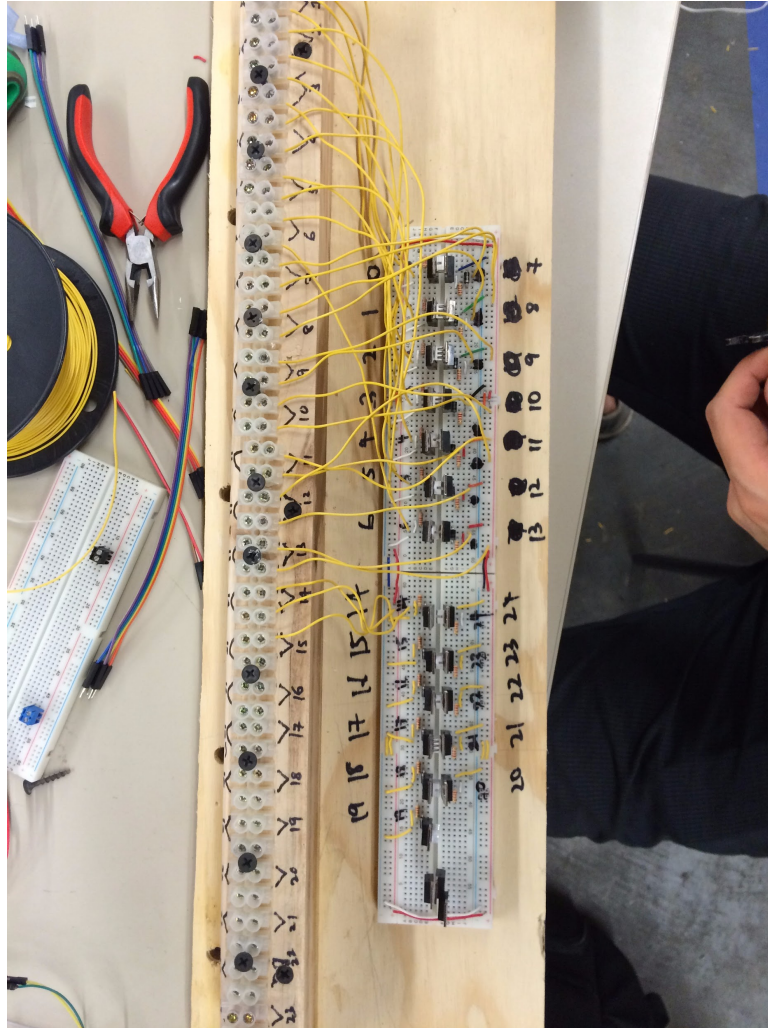


Figure 7.43: Electronics to trigger aeolian boxes

APPENDIX C: THE *CYBERNETIC MONOCHORD* MATERIAL

The Cybernetic Monochord project aimed to multiple phases of development saw experiments in improvisational performances centered around resonating/bowed stringed instruments, machine improvisation with electric guitar, interactive installation with proximity sensors, as an aeolian instrument of digital wind (data), and finally a ‘table-top’ version that involved a control panel designed in Supercollider that users could use to locate resonant nodes on the string. This was exhibited at the Deep Listening Conference in 2015.

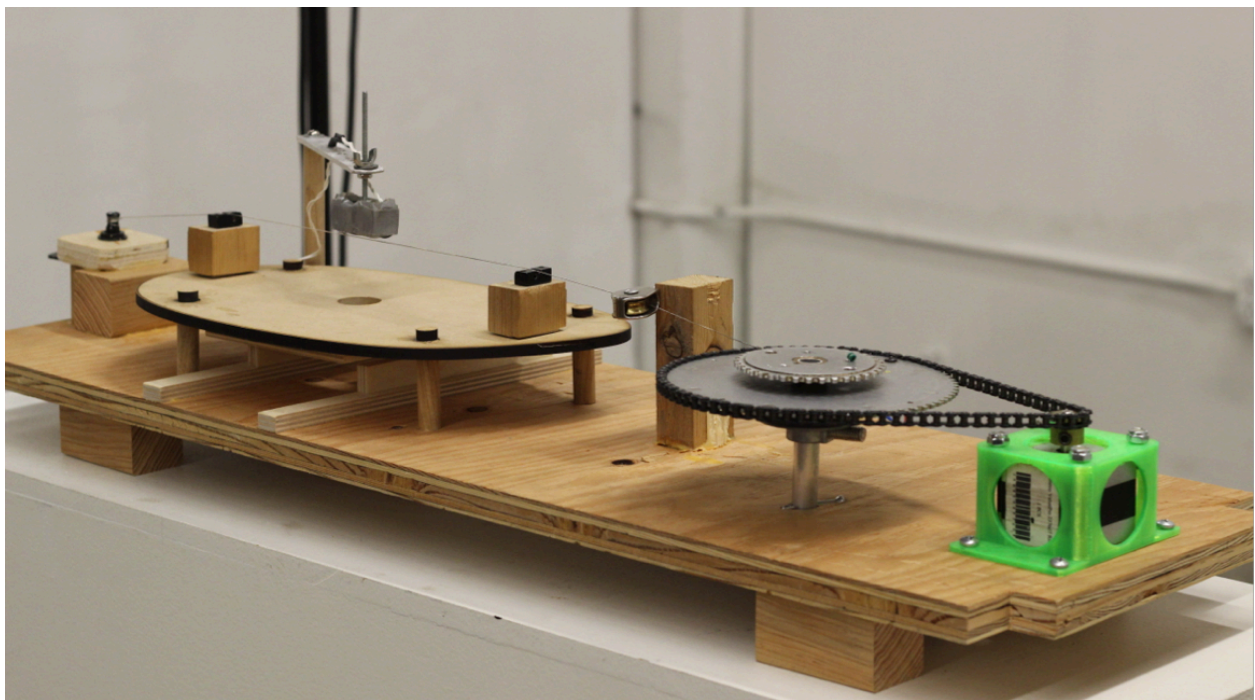


Figure 8.44: Initial Monochord Prototype



Figure 8.45: Improvisational performance with guitars and monochord

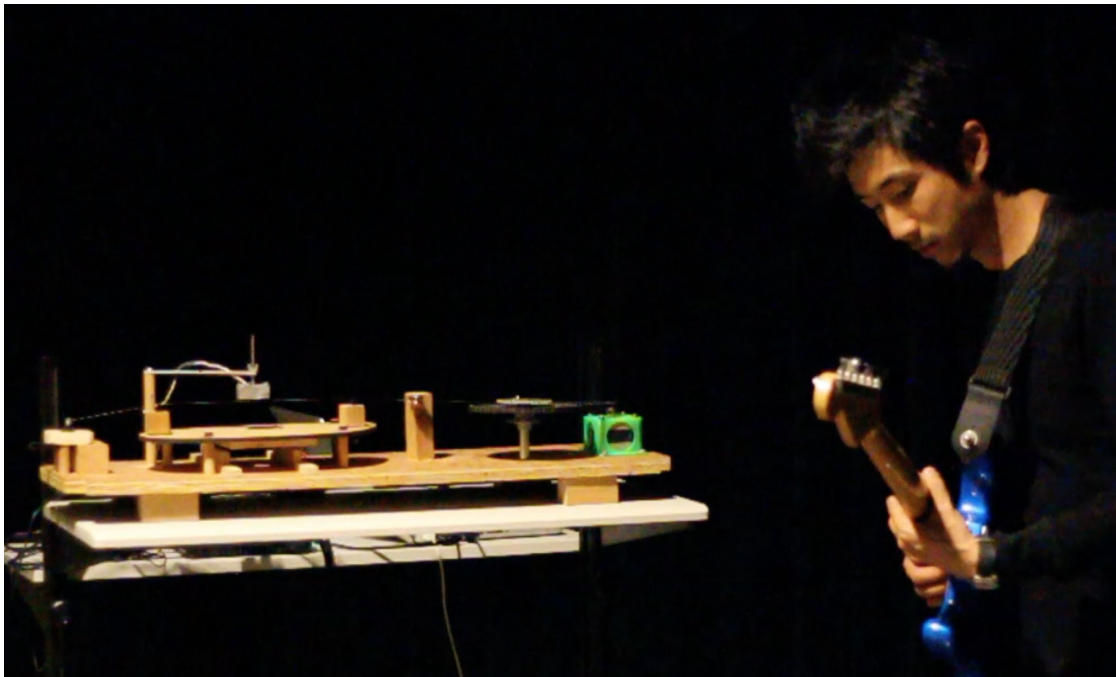


Figure 8.46: Machine improvisation with electric guitar



Figure 8.47: Presentation of the final monochord sculpture at the Deep Listening Conference 2015 (seen here with Pauline Oliveros).

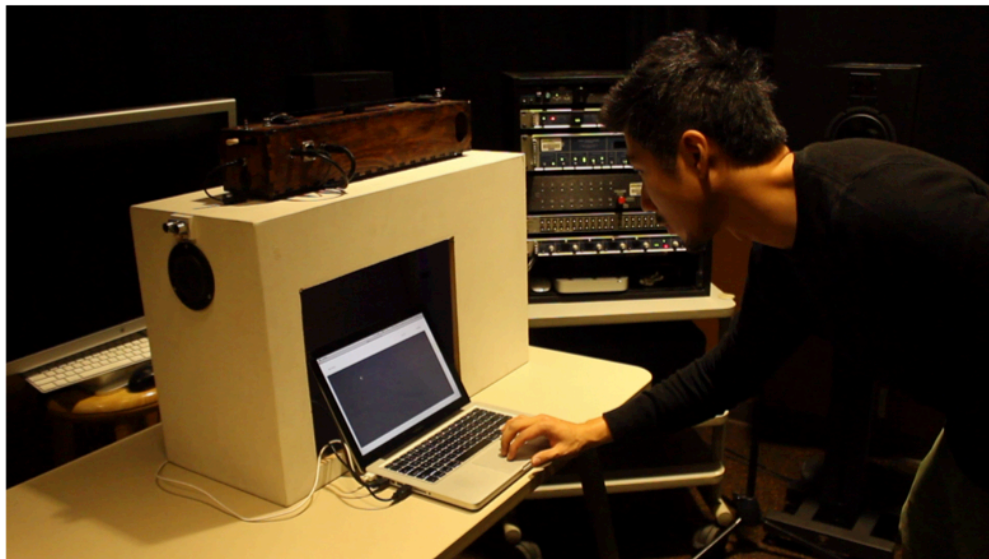


Figure 8.48. Prototype development of Control Interface at DXARTS.

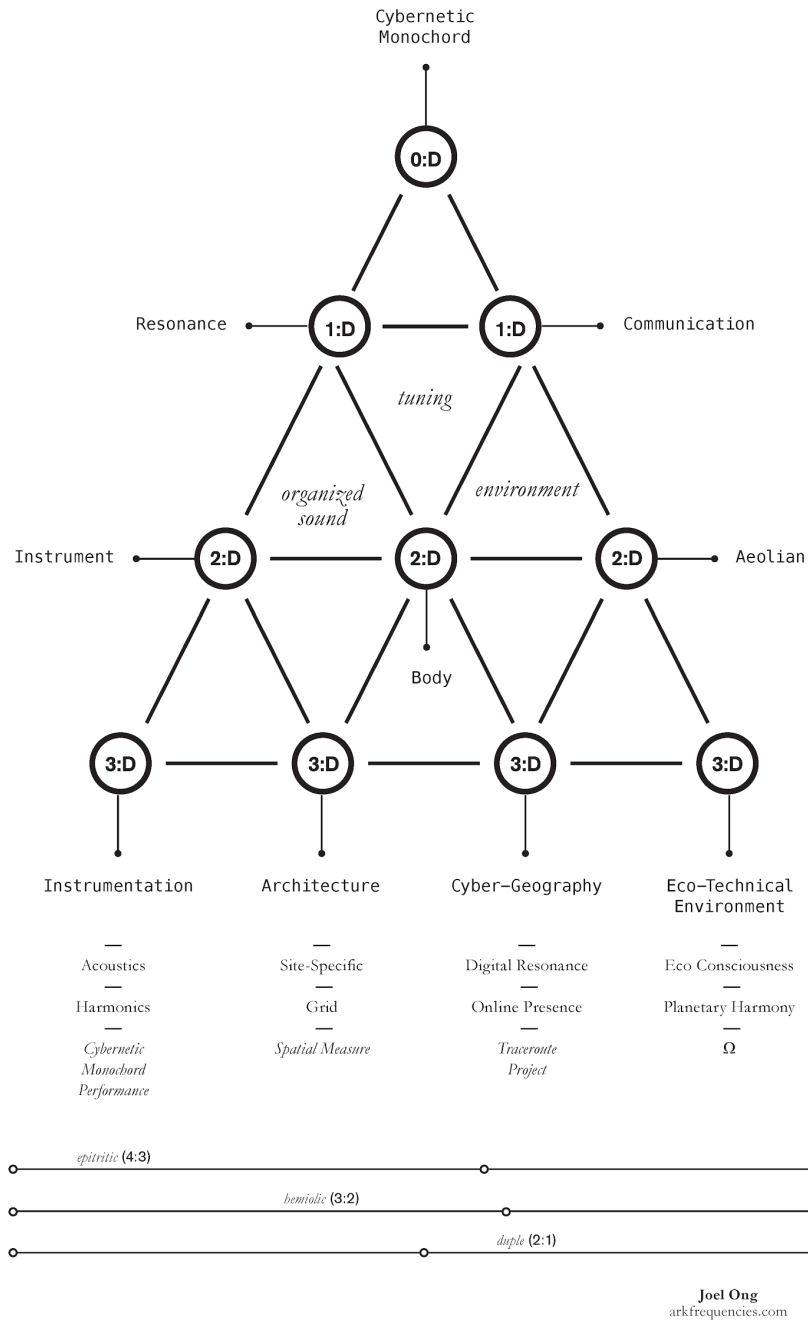


Figure 8.49: Tetraktys-inspired visualization for the Cybernetic Monochord project

APPENDIX D: *AEOLIAN TRACES* MATERIAL



Figure 9.50: Interview with a Casa Latina member

The interviews were inspired by the work of UW Information School Associate Professor Ricardo Gomez, whose work *Fotohistorias: Participatory Photography and Migration* featured volunteers from Casa Latina in Seattle, El Comedor, in Nogales, Mexico, as well as community organizations in Cali and Bahía Málaga, Colombia. In the *Fotohistorias* project, Gomez gave each migrant a disposable camera for them to curate their own journeys across the border. My emphasis was in discussing these journeys with volunteers, and in particular consider hypothetical options of places they would rather be if not where they were currently located. A transcript of the interview follows:

What is your name, age and occupation?

My name is xxx and I'm 48. I'm a painter. Im originally from Oaxaca Mexico and I'm from outside Oaxaca from a region called Zapotec. That's the place where I was born, and then my family they moved to Oaxaca city. And very much I was raised in Oaxaca city so I went to school – middle school and high school - at the Oaxaca city.

Are there many people in Seattle from your hometown?

We have a large community from the Oaxaca so I don't have the number but they are in different areas in Washington state and also in Seattle. . . they are from the place we call Yakima and people from Oaxaca specifically from a region that we call the Mixtec area and also the Zapotec area. . .

What kind of activities do you do to help to bring your communities together?

So we have a group where we call Grupo Cultural Oaxaqueño, and what we are doing is try to share what we have in Oaxaca in the different regions. So we present every year a big celebration what we do in Oaxaca called Guelaguetza. . . this is the time where different kinds of culture come into the city and dance and share the food, music and language. . . That gives us the opportunity to be together and like a community we try to share with other people in Seattle.

Do you feel like you belong in America?

Some people they told me you know we have these in the state or here in Seattle, we have a group that we call Chicanos- they are Mexican-Americans. And then I feel this is my home, but my real spirit of my home, is in the Oaxaca state you know . . . But this is my second home. So it is very important for me too because I have my family here, and my community. . .

If you could be anywhere in the world, where would you be?

What I say, my heart is in Oaxaca so I think it's good to me if I can go back to my state in Oaxaca and then I start to be with my family, my community and then I can try to do something more you know to try to paint more and be in that culture and continue that celebration . . .

When I was a little boy somewhere between 8 and 12, I have a lot of memories so Im trying to represent them in my paintings . . . Being children in those times meant we had a really hard time because we didn't have enough money so one of my several memories is how you can create different kind of toys to play with yourself or with the neighbour. . . So I remember we played different kind of games so we went into the rail and also we played in the street different kind of games. So there was so great to see all the children in my neighbourhood getting together and play all the time in the street.

APPENDIX E: THE NORTHWEST DETENTION CENTER

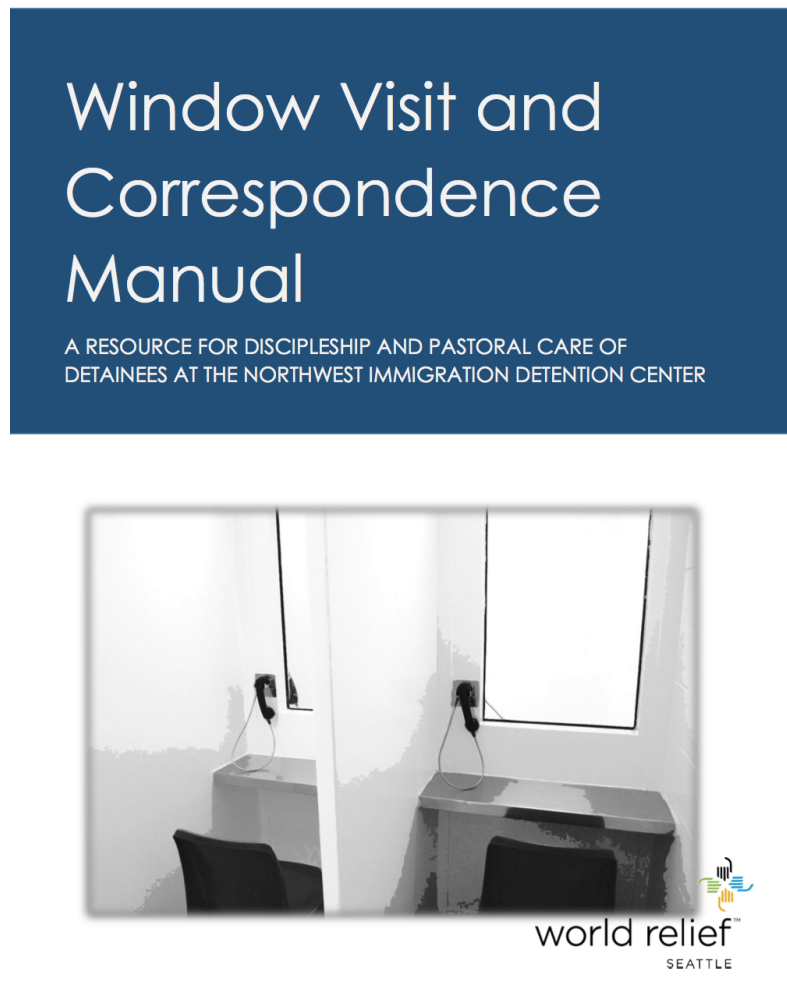


Figure 8.51 World Relief training manual for NWDC visitation and befriending

To gain access into the NWDC, i registered as a volunteer with World Relief Seattle and underwent a training course. In order to conduct interviews within the Detention Center, i also completed a Collaborative Institutional Training Initiative (CITI) Human Subject Learnings for Human Research through the University of Washington's Human Research Ethics division to ensure the process was within ethical guidelines. I had also previously initiated contact with an immigration lawyer and discussed plans to gain further access to the inmates.

**COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)
COURSEWORK REQUIREMENTS REPORT***

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: JOELONG (ID: 5549465)
- Email: joelong@uw.edu
- Institution Affiliation: University of Washington (ID: 430)
- Institution Unit: DXARTS
- Phone: 2064194312

- Curriculum Group: Human Research
- Course Learner Group: Human Subjects Learners
- Stage: Stage 1 - Basic Course

- Report ID: 19506408
- Completion Date: 05/11/2016
- Expiration Date: N/A
- Minimum Passing: 80
- Reported Score*: 91

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
History and Ethical Principles - SBE (ID: 490)	05/11/16	4/5 (80%)
Defining Research with Human Subjects - SBE (ID: 491)	05/11/16	5/5 (100%)
Basic Institutional Review Board (IRB) Regulations and Review Process (ID: 2)	05/11/16	5/5 (100%)
Informed Consent - SBE (ID: 504)	05/11/16	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	05/11/16	3/5 (60%)
Records-Based Research (ID: 5)	05/11/16	3/3 (100%)
Populations in Research: Requiring Additional Considerations and/or Protections (ID: 16680)	05/11/16	5/5 (100%)
University of Washington (ID: 574)	05/11/16	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

CITI Program
 Email: citi.support@miami.edu
 Phone: 305-243-7970
 Web: <http://www.citiprogram.org>

Figure 8.52. CITI certificate of completion

D:ARTS

Center for Digital Arts and Experimental Media
University of Washington

Project Title: *WindWard* || *WindWord*

Introduction and Purpose

My name is JOEL ONG I am a(n) *PhD CANDIDATE* at the CENTER FOR DIGITAL ARTS AND EXPERIMENTAL MEDIA at the UNIVERSITY OF WASHINGTON. I would like to invite you to take part in my aesthetic research study, which concerns the artistic representation of spoken memories and emotions. The project is an artistic project where the information gathered will be used to generate scripts for an actor to perform.

Procedures

If you agree to participate in my research, the interview will involve questions about YOUR HOME TOWN AND OTHER NARRATIVES RELATED TO YOUR COUNTRY OF BIRTH, FAMILY AND JOURNEYS.

It should last about **10- 15 MINS**. With your permission, I will take notes during the interview. The note-taking is to accurately record the information you provide, and if you feel uncomfortable at any time during the interview, you can stop the interview at any time. I expect to conduct only one interview.

Risks/Discomforts

Some of the research questions may make you uncomfortable or upset. You are free to decline to answer any questions you don't wish to, or to stop the interview at any time.

Confidentiality

Your study data will be handled as confidentially as possible. During the final presentation of the project, individual names and other personally identifiable information will not be used.

When the research is completed, I may save the notes for use in future research done by myself or others. I will retain these records for up to 12 months after the study is over. The same measures described above will be taken to protect confidentiality of this study data.

Participation in research is completely voluntary. You are free to decline to take part in the project. You can decline to answer any questions and are free to stop taking part in the project at any time. Whether or not you choose to participate in the research and whether or not you choose to answer a question or continue participating in the project, there will be no penalty to you or loss of benefits to which you are otherwise entitled.

Questions

If you have any questions about this research, please feel free to contact me. I can be reached at **206-419-4312** or joelong@uw.edu.

Figure 8.53: Sample consent form for interview request



Figure 8.54. *Windward*

Windward is an ongoing project that looks at the way the experience of our natural environment is mediated through computational technologies. In particular this series is interested in the way directionality of the elements trace imaginary pathways from which we have come, establishing an emotionally affective connection to our past, present and future.

In this iteration, a site specific installation is set up outside the NorthWest Detention Center (NWDC) in Tacoma where over 1500 undocumented migrants are held and are faced with the threat of deportation – each of the arrows in the sand represent the directions of 102 countries from which they have come from. By orienting ourselves in the right direction, memories, thoughts and hopeful futures can be metaphorically projected



Figure 8.55: *Between us a Breeze*

Between Us a Breeze aims to create an experience of shared space between 2 conversationalists. In this piece the physical space between 2 booths is extended, and breath taken as a form of collaborative activity stretching currents across the face of a reflecting pool. It directly references visitation booths in such facilities as the NWDC – the context is amplified through field recordings that are played through iconic telephone headsets. These recordings are of

marches organized by the NWDC Resistance Movement and individuals who advocate for the welfare of inmates.

APPENDIX F: *SOMBRER: AN INTERTIDAL CITY #LOST AND #FOUND MATERIAL*

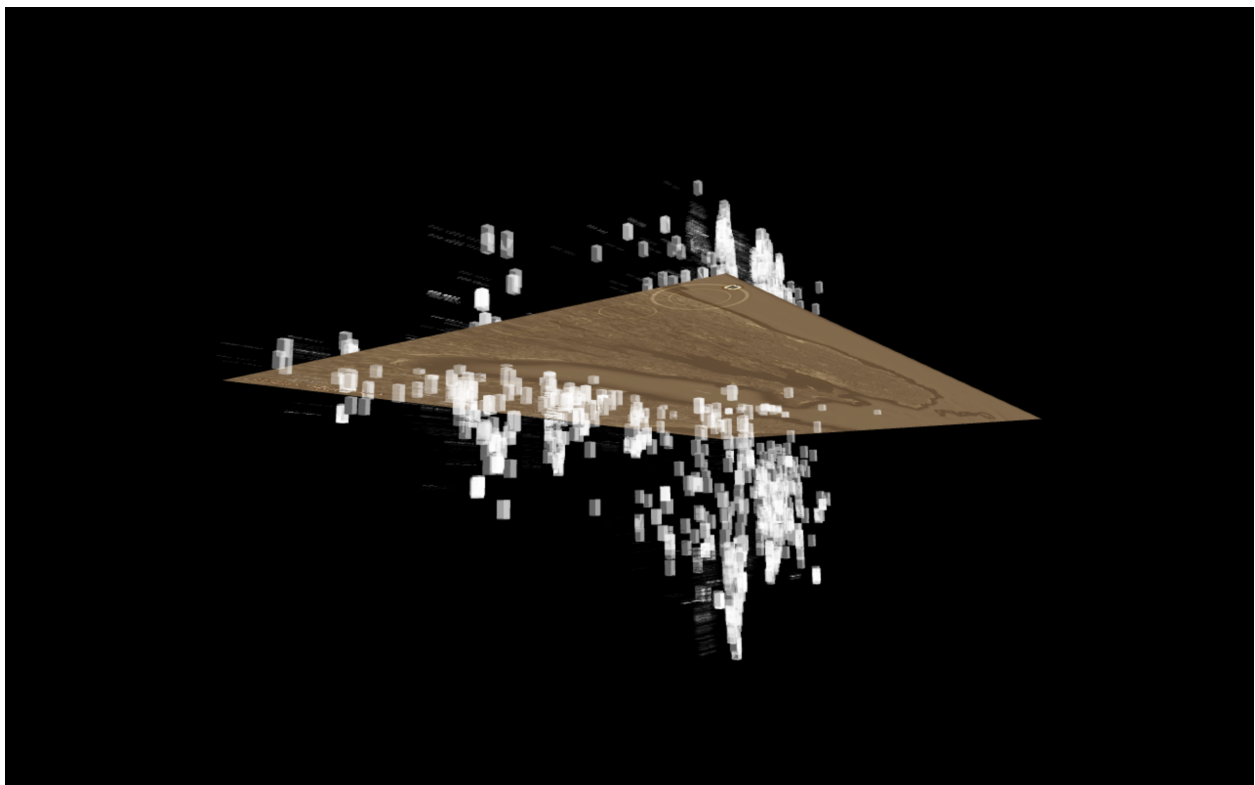


Figure 9.56: Data Visualization

*“Deep in the silence of drowned Is,
Beneath the wavering precipice
The church-spire in the thickened green
Points to the trembling surface sheen
From which descends a glossy cone
A mirror-spire that mocks its own.
Between these two the mackerel sails*

*As did the swallow in the vales
Of summer air, and he too sees
His mirrored self amongst the trees
That hang to meet themselves, for here
All things are doubled, and the clear
thick element is doubled too
Finite and limited the view
As though the world of roofs and rocks
Were stored inside a glassy box.
And damned and drowned transparent things
Hold silent commerce. . . .*

*This drowned world lies beneath a skin
... ”*

from “The Drowned City” by Christabel LaMotte, in Possessions by A.S.Byatt.

Text used in the video presentation, viewable at permalink:

<http://www.arkfrequencies.com/sombrer-an-imaginary-city-lost-and-found2015/>

APPENDIX G: APERTURE II ANALYSIS

For greater focus, i selected a sample of the piece from 4'55" to 14'55", including most of the improvisational moments leading into the first big swell.

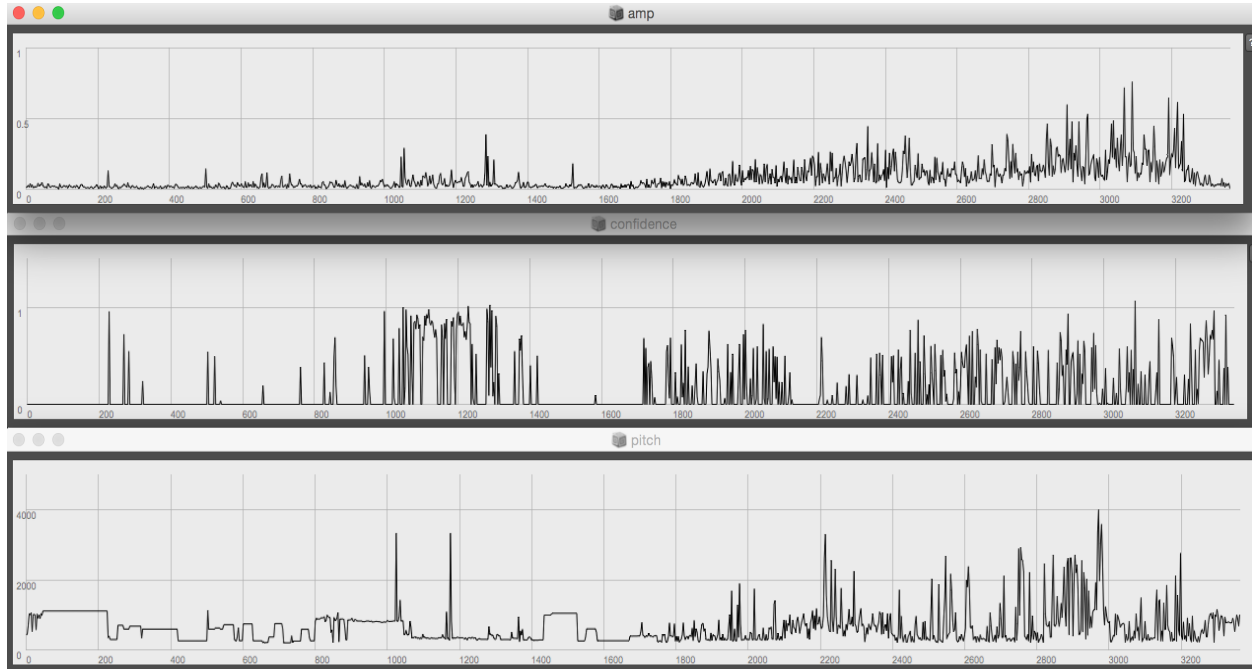


Figure 10.57. Supercollider plots

Running a mix of pitch tracking, amplitude tracking and confidence testing (from Pitch.kr) in Supercollider, i was able to retrieve approximate 3000 data points over 10mins sampled at 5Hz. In analysing the data, i looked primarily at the ‘Confidence’ plot, set in this case to provide a floating point between 0 and 1 - 1 being the most confidence the machine listening algorithm has in locating a pitch in the tracked subsample. It therefore provides “a kind of measure of *purity* of the pitched signal”¹⁵⁶.

¹⁵⁶ Supercollider notes for Pitch.kr. Online source: <http://danielnouri.org/docs/SuperColliderHelp/UGens/Analysis/Pitch.html>

At the peaks are where the musicians had chosen to 'break texture' and add abrupt, pitched articulations with the bowing of their instruments. The amplitude plot at the same subsample number confirms a rise in the overall volume, and the pitch plot then identifies the pitch of the articulation.

Here is what the data reveals in detail:

1. At confidence peaks close to 1, musicians have bowed abruptly. Since the loud bowing (as opposed to slow and textural) is the essence of the 'call - response' portion of the improvisation, this reveals the overall timing of the piece.
2. At these confidence peaks, it is possible to note what pitches are being played up to a certain amplitude. The more closely jagged these are, it reflects articulations that have been initiated by different musicians simultaneously.
3. However, once the overall texture surpasses the amplitude threshold of the pitch-tracking mechanism, it reveals the volume of the base texture to have risen to a level where they can be heard as a mass of articulations.
4. The amplitude curves reveal the overall trajectory of the sampled piece.

Based on the data amassed from Aperture II, the following data 'scores' were generated.

(2 data scores - 1 based on amplitude and 1 based on where and how close the confidence ratings are)

1. Amplitude Curve (to construct Narrative Arc)

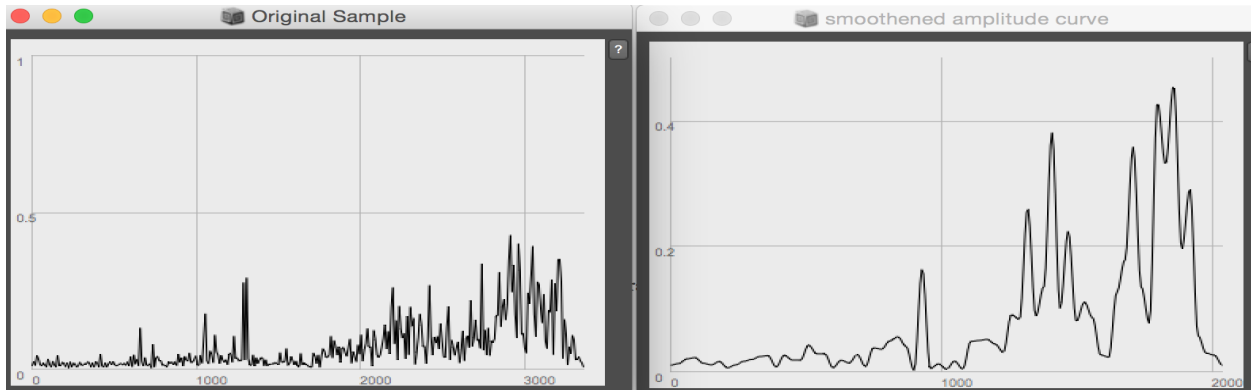


Figure 10.58. Supercollider plots

- Interpolated curve to 'smoothen' out values for overall amplitude
- Final curve with more gradual, 'compressed' peaks, using simple compression

```
algorithm : ~ampGathered.collect({|i| var thresh = 0.2; var ratio=0.1;
```

```
if(i>thresh){var diff = (i-thresh)*ratio; i = thresh +
```

```
diff}{i}).interpolate(30,type:'sine').plot
```

Figure 112: Supercollider screen Grab

- Get number of events from pitch confidence levels, scaled to 2040 data points, providing about 34 mins worth of control points with 1:1 matching of point to second and 17 mins with 2:1 with 2 data points reflected/s, bringing total possible simultaneous instruments to 10.

- a. Values from 0-5 reveal how many ‘pitches’ were sensed with a confidence level above a selected threshold in a window of 5 subsamples

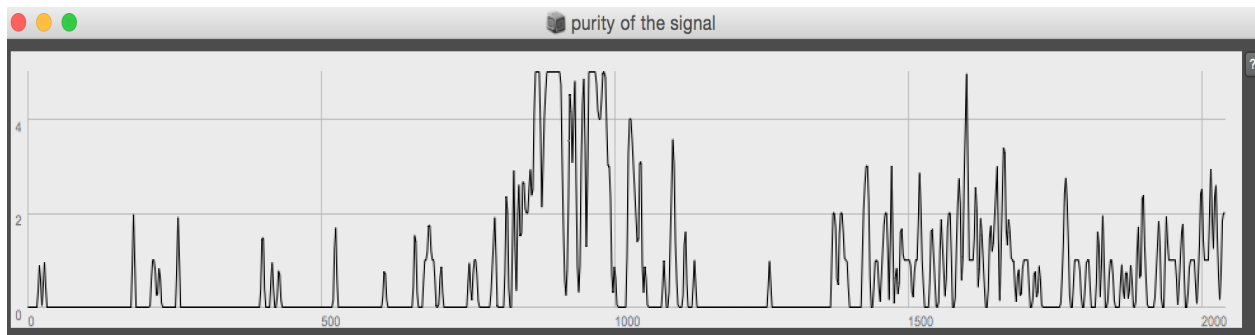


Figure 10.59. Supercollider plots

3. With both data on the purity of the signal and the amplitude envelope of the piece we can line both graphs up to get a ‘score’ that is reflects the improvisational structure of Aperture II.

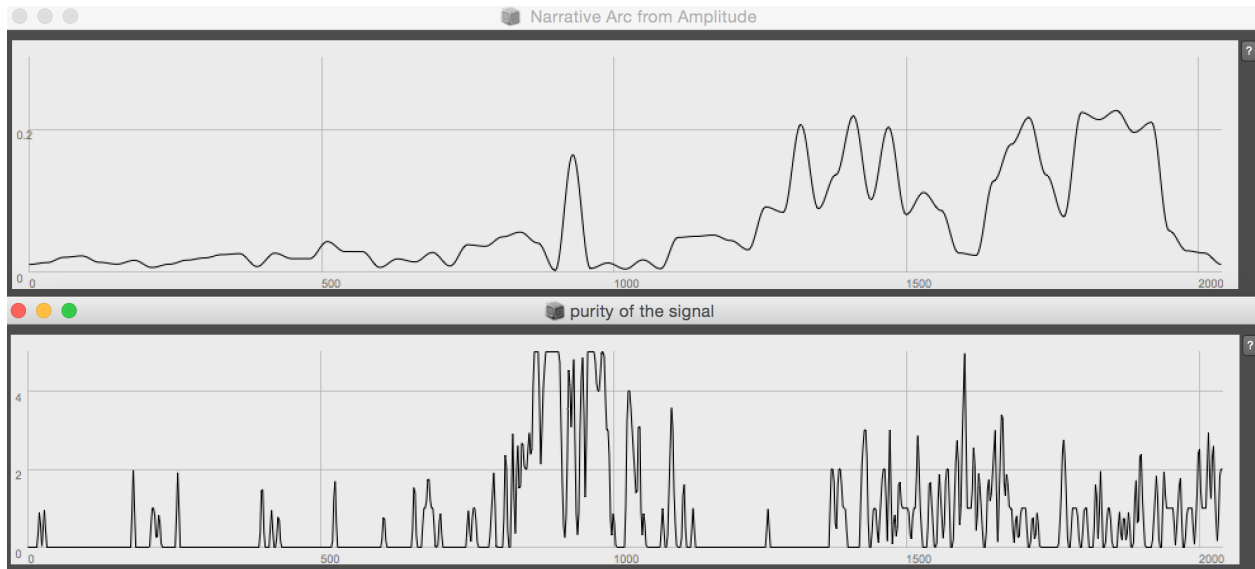


Figure 10.60. Supercollider plots

Combining all these together into a straightforward data visualization we have:

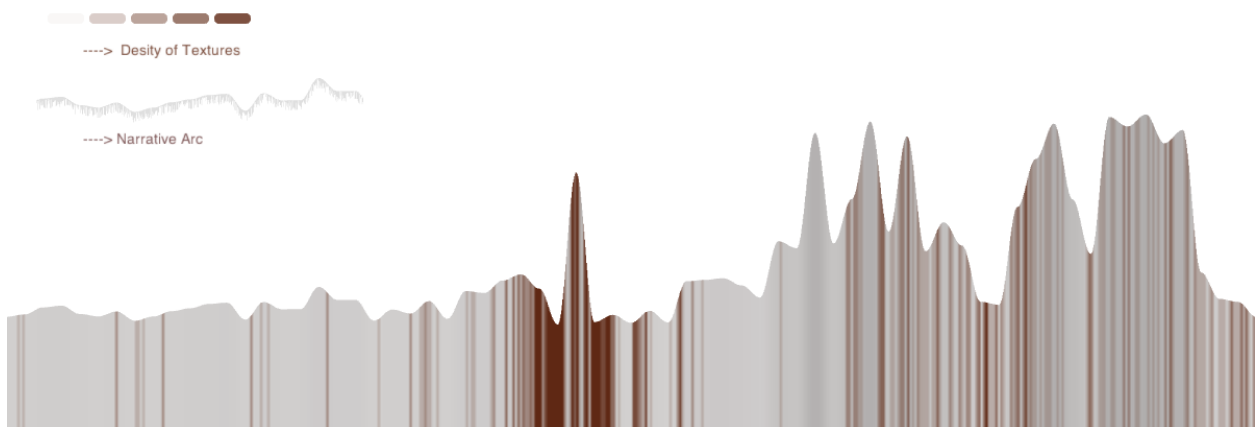
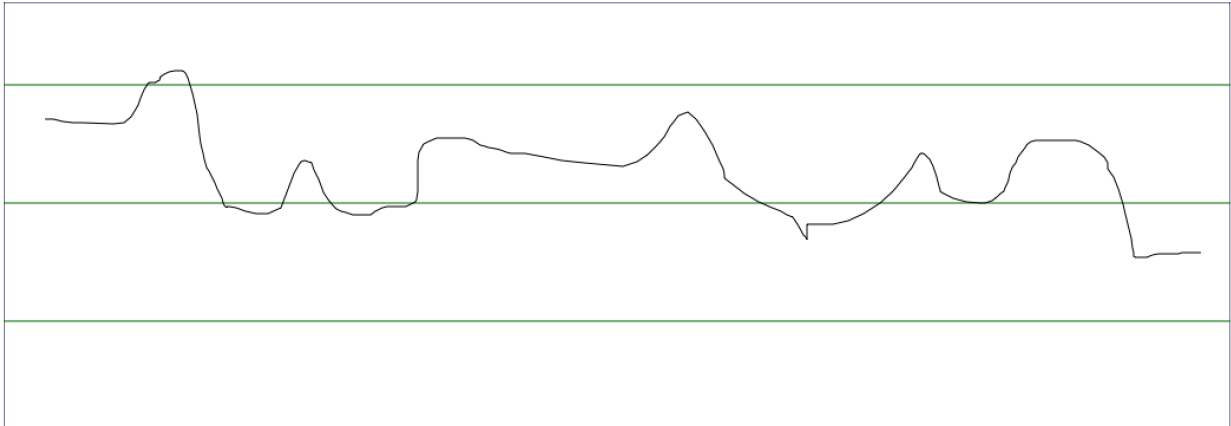


Figure 10.61 *Score Visualization*

A separate model was created in SuperCollider to test out values according to a drawn values.

SC returns an array of values that can be used as control envelopes for dynamic values.



Get Array Sonify Reset Points choose sounds ▾

Figure 10.62. Supercollider Screen shot

VITA

Joel Ong is a media artist whose work typically involves the creation and composition of space through sound, video and interactive elements. His installations and research projects have been shown and presented at various venues around the world. Following his studies in Biology and Ecology at the National University of Singapore, his graduate studies at SymbioticA, the Center of Excellence in Biological Arts at the University of Western Australia resulted in a project that merged nanotechnology, tissue culture and sound. He has continued his explorations in the Interdisciplinary Arts through collaborations with scientists in environmental studies, oceanography and microfluidics at the University of Washington often at the meeting point of computational, open source hardware/software. Joel is also a visiting artist at the UCLA ArtSci Center. Joel is currently Assistant Professor in Computational Arts at York University in Toronto, Canada. His works can be found at www.arkfrequencies.com.